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Evaluating the Impact of the 'Zooming-In' Approach on Malaria Prevention and Control in Uganda

Daudi Ochieng[1*], JB Bwanika[2]
[1]*Public Health, Texila American University, Georgetown,Guyana*
[2]*Monitoring and Evaluation, Malaria Consortium, Kampala, Uganda*

Abstract

This study assessed the effectiveness of the Zooming-In strategy, a community-based household intervention designed to strengthen malaria prevention and control in Uganda. The intervention employed structured interpersonal communication and routine follow-up visits to promote improved malaria-related behaviours. A quasi-experimental design was implemented across three regions—Hoima, Masaka, and Rwenzori—using a total sample of 1,200 households (600 intervention; 600 control). Data were obtained through household surveys and secondary analysis of District Health Information System 2 (DHIS2) records. Descriptive statistics, chi-square tests, and interrupted time series (ITS) analysis were applied to determine the intervention's effects.The Zooming-In strategy was associated with significant improvements in key malaria prevention indicators. Consistent insecticide-treated net (ITN) use was higher in the intervention group compared to the control group (81.8% vs. 76.5%; p = 0.028). Early treatment-seeking behaviour increased markedly among intervention households (81.6% vs. 64.4%; p < 0.001). Test positivity rates declined to 52% in intervention areas compared with 61% in control areas, and malaria prevalence among pregnant women was lower in the intervention group (13% vs. 21%). Overall, the findings demonstrate that the Zooming-In approach enhances household malaria prevention practices and contributes to improved malaria-related outcomes. The strategy shows potential for adaptation and replication in other malaria-endemic settings. Further research is warranted to examine long-term behavioural sustainability and to explore cost-effective avenues for broader implementation.

Keywords: *Community-based Interventions, Early Treatment-seeking, Insecticide-Treated Nets (ITNs), Malaria Prevention, Uganda, Zooming-In Approach.*

Introduction

Malaria remains a major public health challenge globally, with an estimated 263 million cases and 597,000 deaths reported in 2023, the majority of which occurred in sub-Saharan Africa. The region accounts for approximately 94% of global malaria cases and 95% of malaria-related mortality, disproportionately affecting children under five and pregnant women. Uganda alone contributes an estimated 4.8% of global malaria infections, highlighting persistent difficulties in achieving sustained malaria control despite decades of intervention efforts [1].

Although proven malaria prevention strategies—such as insecticide-treated nets (ITNs), indoor residual spraying (IRS), and intermittent preventive treatment in pregnancy (IPTp)—have reduced disease burden, their effectiveness is often diminished by gaps in adoption, adherence, and continuity. Low and inconsistent ITN use, delayed care-seeking, limited male involvement in household health

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****Corresponding Author: sunditive@gmail.com***

decisions, and socio-cultural barriers continue to undermine the overall impact of national malaria control programmes. These behavioural and structural constraints necessitate innovative, community-centred approaches capable of addressing household-level determinants of malaria prevention.

Global experience demonstrates that interventions such as ITN distribution and IRS can reduce malaria incidence by 50–60% under optimal conditions [2, 3]. However, persistent barriers remain: ITN usage is frequently lower than ownership due to discomfort or misconceptions; IRS does not consistently reach remote or underserved communities; and care-seeking delays are often driven by financial limitations, gender norms, or poor risk perception [2–4]. These limitations underscore the need for complementary strategies that strengthen behaviour change and reinforce existing prevention tools.

The *Zooming-In* approach was developed as a targeted, household-level intervention designed to address these behavioural and socio-cultural constraints. The strategy applies structured interpersonal communication and routine follow-up visits to support correct and consistent use of malaria prevention methods. A central component of the approach is the integration of gender-sensitive techniques to enhance male involvement in household health decision-making, thereby addressing known gender-related barriers to malaria prevention.

While the *Zooming-In* approach shows promise, potential challenges include its resource-intensive nature, reliance on frequent household engagement, and context-specific adaptability. In addition, the possibility of recall or social desirability bias in self-reported outcomes requires cautious interpretation of its effects. Nonetheless, preliminary evidence suggests that the approach may contribute to measurable improvements in malaria-related behaviours and outcomes, including increased ITN use, improved early treatment-seeking, reductions in test positivity rates, and lower malaria prevalence in pregnancy.

Objective

The primary objective of this study was to assess the effectiveness of the *Zooming-In* approach in improving malaria prevention behaviours and reducing malaria-related outcomes in selected regions of Uganda.

Specific Objectives

1. To determine the effect of the *Zooming-In* approach on ITN use and early treatment-seeking behaviours.
2. To assess the intervention's impact on malaria outcomes, including test positivity rates (TPR) and malaria incidence among pregnant women.
3. To examine the contribution of gender-sensitive strategies, including male involvement, to malaria prevention behaviours.

Novelty of the Work

This study provides an empirically grounded examination of a participatory, gender-responsive malaria prevention model designed to address household-level determinants of behaviour. Unlike traditional top-down approaches, the *Zooming-In* strategy emphasises continuous engagement, personalised action planning, and adaptive follow-up. By integrating socio-cultural considerations and gender dynamics into intervention design, the study contributes to the evidence base on community-tailored malaria prevention strategies. The conceptual framework guiding this approach is illustrated in *Figure 1*: *Visualizing the Framework of the Zooming-In Approach*, which outlines the sequential logic linking behavioural barriers, gender dynamics, intervention components, and expected outcomes.

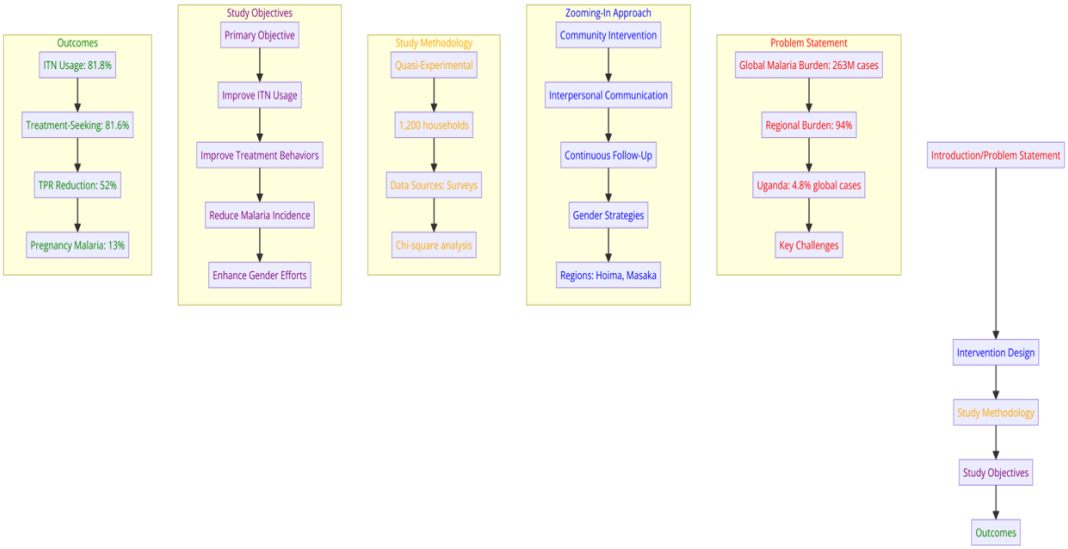


Figure 1. Visualizing the Framework of the Zooming-In Approach

Figure 1. Author-designed schematic framework of the "*Zooming-In*" approach showing the sequential link from the problem statement through intervention design, methodology, objectives, and key outcomes. The diagram illustrates how gender-sensitive, community-based strategies contribute to improved malaria prevention results.

Materials and methods

Study Setting

This study was conducted in three regions of Uganda—Hoima, Masaka, and Rwenzori—selected based on consistently high malaria transmission as reported through the District Health Information System 2 (DHIS2) [1, 3]. These regions represent diverse ecological and socio-cultural contexts that influence malaria risk and prevention behaviors.

Hoima Region is characterized by extensive seasonal wetlands that sustain year-round mosquito breeding. Its predominantly rural population relies on subsistence farming, and traditional beliefs frequently delay timely malaria treatment. Limited economic opportunities further constrain access to healthcare services.

Masaka Region experiences moderate to high malaria prevalence driven by bimodal rainfall patterns. Community structures led by traditional Baganda leaders support local mobilization; however, widespread poverty hinders access to essential malaria prevention resources.

The **Rwenzori Region**, consisting of mountainous terrain and forested valleys, maintains persistently high malaria incidence. Dense vegetation supports vector survival, while socio-cultural norms among the Bakonzo population influence health-related practices. Periodic conflict and weak infrastructure disrupt access to consistent healthcare services.

Study Design

A quasi-experimental design was employed to compare malaria prevention behaviors and outcomes between intervention and control households. This design was selected due to ethical and operational constraints that precluded randomized assignment of communities [5]. The approach enabled evaluation under real-world conditions by leveraging naturally occurring community structures. Matching of intervention and control areas and adjustment for potential confounders strengthened internal validity.

The intervention consisted of structured interpersonal communication (IPC), tailored action plans, and regular follow-up visits

delivered by Village Health Teams (VHTs) and community leaders trained for the study. Households with demonstrated weaknesses in malaria prevention behaviors were purposively selected for intervention participation. Continuous monitoring emphasized consistent ITN use, prompt treatment-seeking, and uptake of intermittent preventive treatment in pregnancy (IPTp). Control households received only routine malaria messaging provided through the health system. Data collection occurred six months after intervention initiation using standardized household survey tools administered by trained research assistants [7].

Sampling and Sample Size Determination

Systematic random sampling was applied using district community registries as the sampling frame. Households exhibiting inadequate malaria prevention practices (e.g., low ITN use or delayed care-seeking) were prioritized in the intervention group, while control households were selected from comparable but geographically distinct areas to minimize contamination.

Sample size was calculated using the standard formula for comparing two independent proportions:

$$n = \frac{Z^2_{(1-\frac{\alpha}{2})}[p_1(1-p_1) + p_2(1-p_2)]}{(p_1 - p_2)^2}$$

Where:

- nn = sample size per group
- $Z(1-\alpha/2)Z(1-\alpha/2)$ = Z-score for the desired confidence level (e.g., 1.96 for 95%)
- p1p1 = expected proportion of the primary outcome in the intervention group
- p2p2 = expected proportion in the control group
- (p1−p2)(p1−p2) = minimum detectable difference between groups

Assumptions included a baseline ITN usage rate of 70% in control households and an anticipated 85% usage rate in intervention households, based on the Uganda Malaria Indicator Survey (2014–15). A 95% confidence level and 80% power yielded a minimum sample size of 200 households per group per site, corresponding to 1,200 households across the three regions. The achieved response rate was 90%, resulting in 1,080 completed surveys.

Sample Size Distribution

Table 1: presents the distribution of the sample across study sites.

Table 1. Sample Size Distribution Across Study Sites

Study Site	Intervention Households	Control Households	Total Households
Hoima	200	200	400
Masaka	200	200	400
Rwenzori	200	200	400
Total	**600**	**600**	**1,200**

Contamination Control Measures

Several strategies were applied to minimize contamination between intervention and control households:

1. **Geographic separation:** Control households were selected from areas spatially distinct from the intervention sites.
2. **Community sensitization:** Community members were briefed on intervention boundaries to limit unintended exposure.
3. **Restricted implementation zones:** VHTs and community leaders operated exclusively within designated intervention areas.

4. **Independent data collection teams:** Separate teams were assigned to intervention and control sites to reduce bias.

Data Sources and Laboratory Methods

No laboratory analyses were conducted as part of this study. Instead, secondary DHIS2 data on malaria test positivity rates and incidence were used to complement household-level behavioral data. Selection of DHIS2 indicators aligned with global and national malaria monitoring guidelines, including the *World Malaria Report 2024* and established literature on malaria surveillance in sub-Saharan Africa [1–4].

Data Analysis

Quantitative data were analyzed using STATA and Microsoft Excel. Descriptive statistics summarized household characteristics and malaria prevention behaviors. Inferential analysis included chi-square tests to compare proportions between groups and calculation of odds ratios (ORs) to assess the likelihood of achieving specific outcomes among intervention households relative to controls.

Advanced analytical techniques included:

1. **Interrupted Time Series (ITS) analysis** to evaluate temporal changes in test positivity rates and malaria incidence.
2. **Modified Poisson regression** to estimate relative risks (RR) for binary outcomes while adjusting for potential confounders.

Key model findings indicated that intervention households were significantly more likely to use ITNs consistently (OR = 1.38; 95% CI: 1.04–1.82) and to seek treatment within 24 hours of fever onset (OR = 2.34; 95% CI: 1.76–3.12).

Results

Impact of the Zooming-In Approach on Malaria Prevention and Control

The *Zooming-In* intervention was associated with significant improvements in multiple malaria prevention and control indicators across the study regions. Notable gains were observed in insecticide-treated net (ITN) use, early treatment-seeking behaviour, malaria test positivity rates, malaria incidence among pregnant women, and male participation in household health decisions.

Household Demographic Characteristics

Table 2 presents the demographic distribution of households across the three regions. The characteristics of intervention and control groups were comparable, with similar proportions of large households (≥5 members), female-headed households, primary caregiver education levels, and socio-economic status.

Table 2. Household Demographic Distribution by Study Site

Characteristic	Hoima (%)	Masaka (%)	Rwenzori (%)	Overall (%)
Household Size ≥ 5	65	58	62	61
Female-headed Households	32	37	30	33
Primary Caregiver Completed Primary Education	45	48	43	45
Low Socio-Economic Status	54	59	52	55

Effect on Core Malaria Prevention Indicators

Six months after implementation, households in the intervention group demonstrated consistently higher performance across malaria prevention indicators compared to controls *(Figure 2)*.

Intervention households had 38% higher odds of consistent ITN use (OR = 1.38; 95% CI: 1.04–1.82) and were significantly more likely

to seek treatment within 24 hours of fever onset (OR = 2.34; 95% CI: 1.76–3.12). These results highlight the influence of structured interpersonal communication and follow-up on improving behaviour change outcomes.

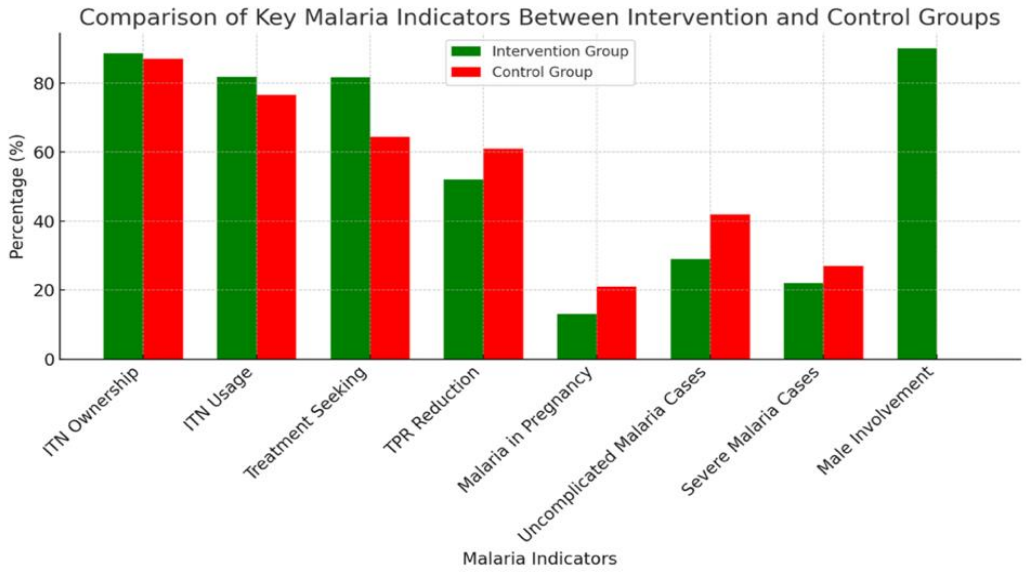


Figure 2. This Chart Visually Represents the Positive Impact of the Zooming-In Approach across Multiple Indicators, Highlighting the Differences in Outcomes between the Intervention and Control Groups

Insecticide-Treated Net (ITN) Use

ITN ownership was high in both groups (86.6% in intervention vs. 87.1% in control). However, consistent ITN use the night before the survey was significantly higher among intervention households (81.8%) compared with control households (76.5%) (p = 0.028) *(Figure 3)*.

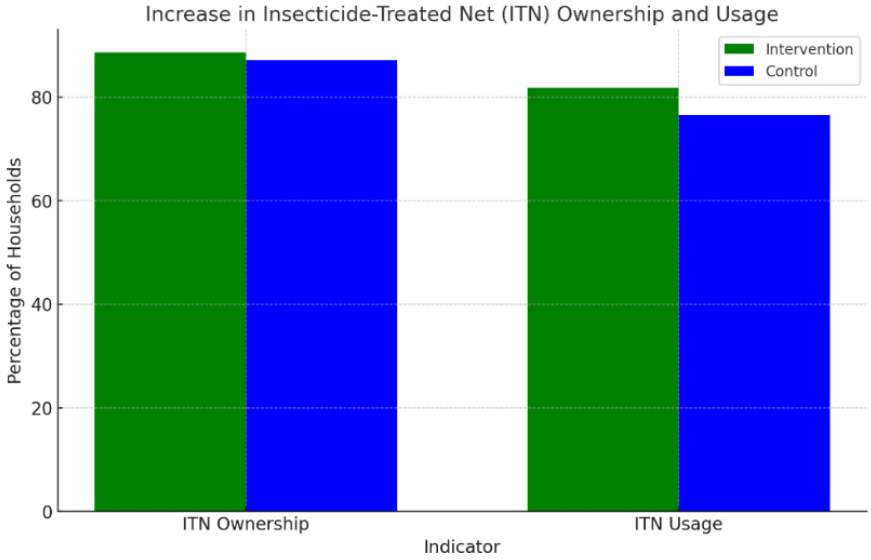


Figure 3. This Grouped Bar Chart Compares ITN Ownership and Consistent usage between the Intervention and Control Groups

Early Treatment-Seeking Behaviour

Among respondents reporting fever in the preceding two weeks, 81.6% of intervention household members sought treatment within 24 hours, compared to 64.4% in the control group (p < 0.001), as shown in *Figure 4*. This improvement reflects the effect of continuous follow-up and tailored messaging.

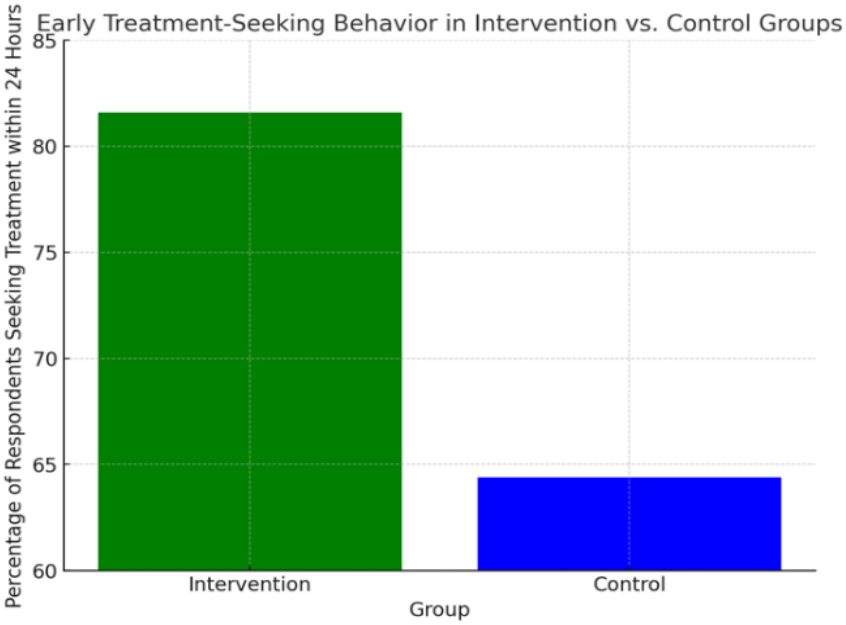


Figure 4. The Bar Chart Compares the Percentage of Respondents who sought Treatment within 24 hours in the Intervention and Control Groups

Test Positivity Rate (TPR)

A reduction in malaria test positivity was observed in intervention areas relative to controls. Six months post-intervention, the TPR was 52% in intervention sites, compared with 61% in control sites *(Figure 5)*. The 9-percentage point difference indicates a meaningful decline in community-level malaria burden.

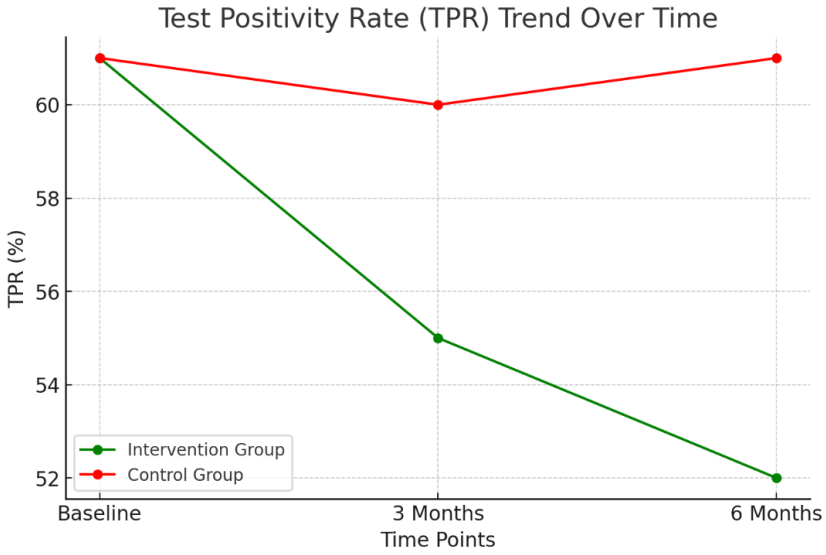


Figure 5. This Graph shows the Changes in TPR Over Time (baseline, 3 months, 6 months) for both the intervention and control groups. This graph effectively illustrates the positive impact of the Zooming-In approach in reducing TPR compared to the control group

Malaria in Pregnancy

Malaria incidence among pregnant women was substantially lower in intervention areas. Thirteen percent of pregnant women reported malaria during pregnancy in the intervention group, compared to 21% in the control group. Uptake of at least three IPTp doses was also significantly higher (78% vs. 58%) *(Figure 6)*.

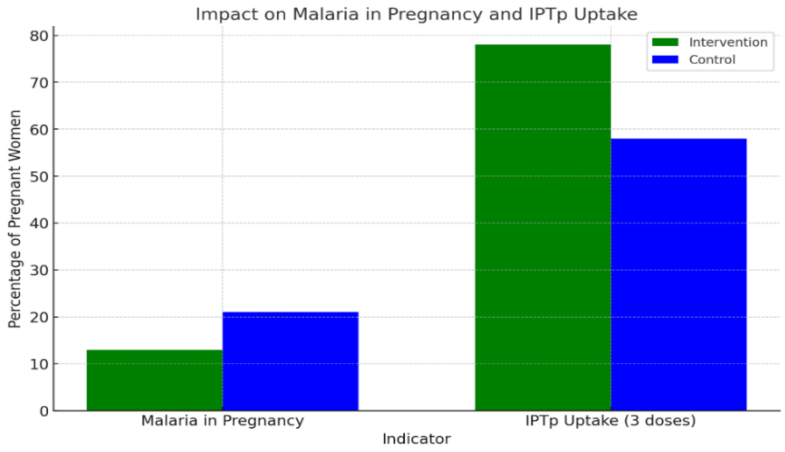


Figure 6. This Grouped Bar Chart compares the Percentage of Pregnant Women Reporting Malaria during Pregnancy and those Receiving three Doses of IPTp between the Intervention and Control Groups

Uncomplicated and Severe Malaria Cases

The proportion of uncomplicated malaria cases was lower among intervention households (29%) than controls (42%). Severe malaria was also less common in intervention areas (22%) compared to control areas (27%) *(Figure 7)*. These results indicate improvements in timely care-seeking and preventive behaviours.

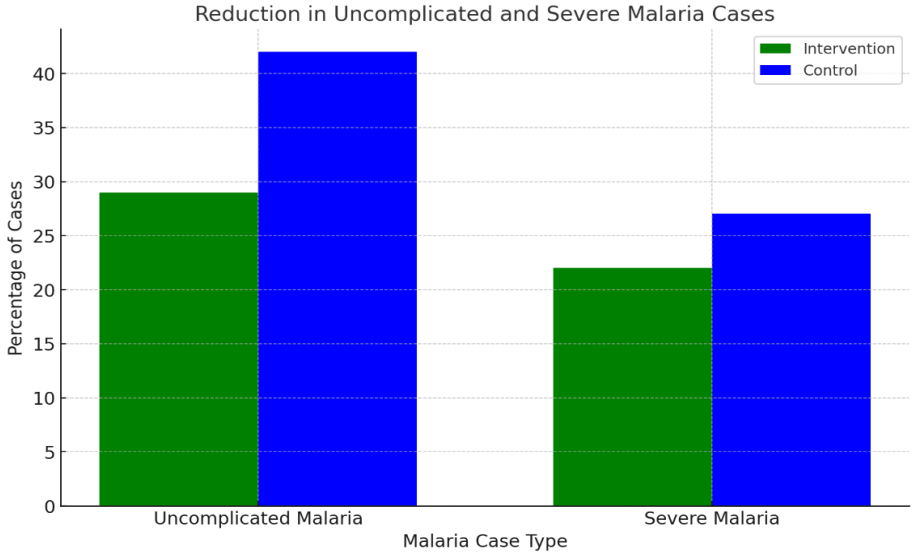


Figure 7. This Grouped Bar Chart Compares the Percentages of Uncomplicated and Severe Malaria Cases between the Intervention and Control Groups

Male Involvement in Malaria-Related Health Decisions

Male engagement in malaria prevention efforts was substantially higher in intervention households. Ninety percent of households reported male participation in malaria-related health actions—such as accompanying family members to care, purchasing medication, or supporting preventive practices—compared with 10% reporting no involvement *(Figure 8)*.

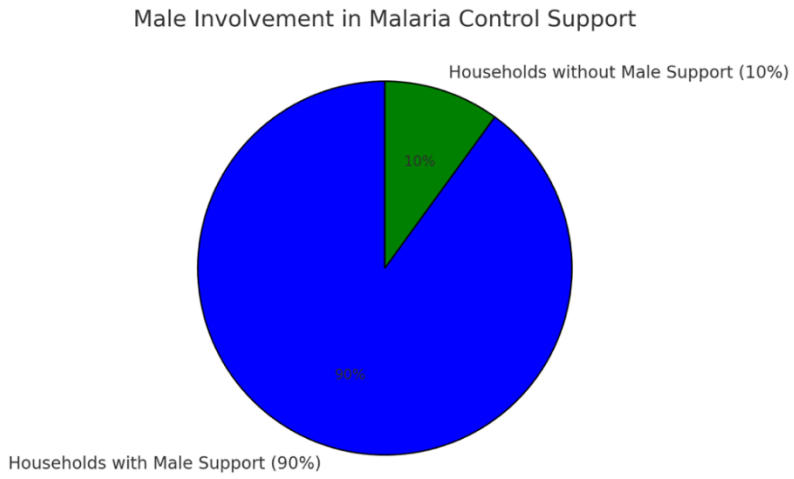


Figure 8. This Pie Chart Illustrates Male Involvement in Household Health Decisions for Malaria Control. It shows that 90% of households reported receiving male support, while 10% did not

Summary of Findings

Across all assessed indicators, the *Zooming-In* approach demonstrated measurable and favourable effects on malaria prevention behaviours and outcomes. Intervention households exhibited higher ITN use, improved prompt care-seeking, reduced malaria test positivity, lower malaria incidence among pregnant women, and strengthened male involvement in health decisions. These findings provide evidence of the potential for structured, household-level interventions to enhance malaria control in endemic settings and form the basis for further analysis in the Discussion section.

Discussion

Effectiveness of the Zooming-In Approach

The findings of this study demonstrate that the *Zooming-In* approach effectively improved key malaria prevention behaviours and outcomes in the study regions. Significant increases in ITN use, early treatment-seeking, and IPTp uptake indicate that household-level, behaviourally informed interventions can address persistent gaps in malaria prevention. These improvements are consistent with global evidence showing that tailored community and household-focused strategies can generate sustained behaviour change in malaria-endemic settings [4, 8, 12]. Additionally, reductions in test positivity rates and malaria incidence among pregnant women provide further support for the intervention's potential to influence both behavioural and epidemiological outcomes [13, 14].

Alignment With Study Objectives

The study's primary objective was to assess the impact of the Zooming-In approach on malaria prevention and control. The substantial improvements observed across intervention households—including higher ITN use and markedly improved timely care-seeking—demonstrate the model's effectiveness in addressing entrenched behavioural barriers. These outcomes help narrow gaps that conventional malaria control interventions often fail to overcome due to inadequate follow-up and limited community engagement [9, 16].

Comparison With Existing Literature

The study's findings align with research from other malaria-endemic countries demonstrating that community-based, personalized malaria prevention strategies enhance adoption of protective behaviours. Evidence from Ghana indicates a 20% increase in ITN use following community-tailored

interventions, compared with mass distribution alone [4]. Similarly, data from Kenya show that interpersonal communication delivered by trained community health workers improved early treatment-seeking behaviours and contributed to a 30% reduction in severe malaria cases [8, 18].

The gender-responsive component of the *Zooming-In* approach further reflects findings in the literature identifying male involvement as a critical determinant of malaria-related decision-making and uptake of preventive actions [10, 17, 19]. These parallels reinforce the value of integrating gender-sensitive approaches into malaria control programming.

Divergence From Other Findings and Implementation Challenges

Despite its effectiveness, several contextual considerations may limit the broader applicability of the *Zooming-In* approach. Behaviour change interventions have been shown to be less effective in settings with high socio-economic inequality or limited community cohesion, where structural barriers may outweigh individual and household-level influences [11, 15]. Moreover, the labour-intensive nature of household follow-ups presents challenges for scalability, particularly in low-resource health systems where personnel capacity is already constrained [20].

Policy and Programming Implications

The study's results have important implications for malaria prevention efforts:

1. **Integration into National Malaria Strategies:** The ***Zooming-In*** model aligns with Uganda's Malaria Reduction Strategic Plan [17] and global initiatives such as WHO's *High Burden to High Impact* framework [16] and the RBM Partnership's *Action and Investment to Defeat Malaria* strategy [18]. Embedding this model within national programming may strengthen community-level prevention outcomes.
2. **Gender-Responsive Programming:** The intervention's effectiveness in increasing male involvement highlights the need for malaria programmes to incorporate gender-transformative approaches that support shared household responsibility for health [10].
3. **Scalability and Cost Considerations:** Adoption of digital tools—such as mobile follow-up systems and automated reminders—may reduce implementation costs while preserving essential behavioural reinforcement components.

Research Gaps and Recommendations

Several areas warrant further investigation:

1. **Sustainability of Behaviour Change:** Long-term evaluations are needed to determine whether improvements in ITN use and treatment-seeking persist after active follow-up ends [12, 14].
2. **Adaptability Across Contexts:** Additional studies should assess the feasibility of implementing the Zooming-In approach in regions with varying socio-economic, cultural, or epidemiological profiles [15, 19].
3. **Cost-Effectiveness:** Comparative cost-effectiveness analyses are essential to inform policymakers on the value of scaling the model relative to traditional malaria control strategies [18, 20].
4. **Expanded Gender Analysis:** Future research should further examine the mechanisms through which male involvement influences malaria outcomes and explore opportunities to integrate such strategies across broader maternal and child health programmes.

Conclusion

This study provides robust evidence that the ***Zooming-In*** approach significantly enhances malaria prevention behaviours and reduces malaria-related morbidity in Uganda. By employing household-level interpersonal communication, tailored action plans, and repeated follow-up, the model addresses behavioural and socio-cultural gaps that traditional strategies often leave unresolved. Improvements in ITN use, timely treatment-seeking, and malaria outcomes among pregnant women illustrate the intervention's potential to strengthen malaria control in settings with high transmission.

The model's emphasis on gender-sensitive engagement and continuous household support suggests its relevance for broader adoption across malaria-endemic regions, provided adaptations are made to local contexts. Future efforts should explore the integration of digital health tools to streamline follow-up and reduce implementation costs, enhancing scalability. Long-term studies are essential to assess sustainability and understand the factors that influence successful replication in diverse settings.

Overall, the *Zooming-In* approach offers a promising community-driven methodology for advancing malaria prevention and contributes meaningful insights to ongoing efforts aimed at reducing malaria transmission and improving population health outcomes.

Conflict of Interest

The author declares no conflict of interest related to this study. All efforts were made to ensure impartiality and objectivity throughout the research, analysis, and reporting process.

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Ethical Approval

This study received ethical approval from the Uganda National Council for Science and Technology (UNCST) under reference REC REF 0503-2018. All study procedures were conducted in accordance with national guidelines for research involving human participants, with informed consent obtained from all respondents.

Data Availability

The datasets generated and analyzed during the current study are not publicly available due to ethical restrictions but are available from the corresponding author on reasonable request and with permission from the Uganda Ministry of Health.

Author Contributions

D.O. conceived and designed the study, conducted data collection and analysis, and drafted the manuscript. J.B. provided technical guidance on study design and interpretation of findings. All authors reviewed and approved the final manuscript.

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Gender Differences in Postnatal Depression in Southwestern Nigeria: A Quantitative Analysis

Adeola Oluwatobi Aminu[1*], Wakili Adelani Tijani[2], Olalekan Amos Oladejo[3], Michael Oloyede Oladeji[4], Fatimah Omobolanle Azeez[5], Doubra Aanuoluwapo Onoviron[6]
[1]*Department of Public Health, Texila American University, Georgetown, Guyana, United Kingdom*
[2]*Department of Nursing, Federal University of Technology Oye-Ekiti, Nigeria*
[3]*Department of Nursing, Liverpool John Moore's University, United Kingdom*
[4]*Department of Nursing, Ajayi Crowther University, Oyo State, Nigeria*
[5]*School of Nursing, University College Hospital Ibadan, Nigeria*
[6]*Department of Public Health, Liverpool John Moore's University, United Kingdom*

Abstract

This study examined gender disparities in postnatal depression (PND) among parents in Southwestern Nigeria, along with the associated sociodemographic factors. A descriptive cross-sectional design was employed alongside stratified random sampling to recruit 200 respondents, comprising 113 mothers and 87 fathers attending postnatal and family planning clinics. The Edinburgh Postnatal Depression Scale (EPDS) was employed to collect data, and SPSS version 25 was used for analysis, encompassing both descriptive and inferential statistical techniques. The overall prevalence of probable postnatal depression (PND) was determined to be 29.6%. Women had significantly elevated mean EPDS scores (M = 1.53, SD = 0.50) in contrast to men (M = 1.16, SD = 0.39; t (198) = –5.33, p < 0.001). A statistically significant connection (p < 0.05) was identified between depressive symptoms and educational level, occupational status, and social support. The findings illuminate the persistence of gender disparities in postnatal emotional health and underscore the necessity of integrating gender-inclusive mental health screenings into postnatal care programs in Nigeria.

Keywords*: Depression, EPDS, Gender, Mental Health, Nigeria, Post Natal.*

Introduction

Background and Global Context

Postnatal depression (PND) is a highly widespread mood condition that impacts individuals following childbirth, resulting in considerable repercussions for family dynamics and child development [1]. The World Health Organisation (WHO) estimates that roughly 10–20% of women exhibit depression symptoms post-childbirth, however prevalence rates differ significantly based on socioeconomic and cultural factors [1, 2]. In addition to maternal distress, an increasing amount of research indicates that fathers may also suffer from depressive symptoms during the postnatal period, but these symptoms frequently go unrecognised and untreated [3, 4].

Perinatal mental illnesses are widely recognised as public health issues worldwide due to their significant impact on maternal health, marital relationships, and infant development [4]. Offspring of depressive parents encounter heightened risks of emotional and behavioural challenges. compromised attachment, and developmental delays [5].

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****Corresponding Author: adeolaaminu95@gmail.com***

In low- and middle-income countries (LMICs), these results are exacerbated by poverty, gender inequality, and restricted access to mental health treatments [6].

Gender and Postnatal Depression

Gender is a significant predictor of mental health, affecting both susceptibility to risk factors and modes of emotional expression [7]. Women's susceptibility to postpartum depression (PND) is linked to hormonal fluctuations, caregiving stress, and inadequate marital support, but men's experiences are influenced by sociocultural expectations to maintain emotional stoicism and financial competence [8, 9]. Paulson and Bazemore's meta-analysis [10] revealed that paternal postpartum depression affects roughly 10% of fathers worldwide, with elevated incidence occurring when mothers are simultaneously depressed. Nonetheless, father's mental health is predominantly overlooked in both study and practice, especially in African countries where patriarchal traditions perpetuate silence regarding male emotional suffering [10].

The Nigeria Sociocultural Perspective

In Nigeria, childbearing is deeply rooted in robust societal and spiritual values that honour fertility and familial continuity [11]. Emotional distress during childbirth is frequently misconstrued as a sign of weakness, a spiritual assault, or a lack of thankfulness [11]. Women are anticipated to undertake comprehensive caregiving duties immediately upon childbirth whereas men encounter economic pressures to support their families. These conflicting expectations exacerbate stress and may lead to depression [11, 12]. Furthermore, mental health services in primary care settings are inadequately integrated, with postnatal visits mostly concentrating on physical recovery and newborn vaccinations [12]. Consequently, both mothers and fathers infrequently obtain mental health assessments or psychosocial assistance.

Research Objectives

This study aimed to:

1. Evaluate gender disparities in the prevalence and severity of postnatal depression among parents in Southwestern Nigeria.
2. Analyse the sociodemographic variables correlated with depressed symptoms.
3. Enhance the expanding body of scholarship on paternal postnatal depression within the African sociocultural framework.

Materials and Methods

Research Design and Settings

A descriptive cross-sectional design was utilised for this study. Data collection was carried out from April to June 2025 in Ibadan, Oyo State, Southwestern Nigeria. a significant urban hub, features am healthcare facilities catering to varied demographics. The study location included postnatal, family planning, and immunisation clinics within Adeoyo maternity teaching hospital chosen to reflect both low- and middle-income households who attend the facility.

Sampling Frame and Selection of Respondents

A stratified random sampling method was employed to guarantee proportional representation of both mothers and fathers.

The sampling frame consisted of clinic records of postnatal attendees, family planning and immunisation clinics. Parents of infants aged 0–6 months were categorised by gender, and respondents were chosen from each category by simple random sampling.

Inclusion criteria

Biological parents aged 18 years or older, residing in Ibadan, and visiting the designated clinics.

Exclusion criteria

Parents with pre-existing diagnosed psychiatric conditions or recent neonatal

bereavement. Research assistants evaluated attendance for eligibility and supply study information. Informed consent was acquired in writing form from all participants. The final sample had 200 respondents, evenly divided between 87 males and 113 females.

Data Collection Instruments and Procedures

The research instrument comprised two components. The initial recorded demographic attributes include age, education, marital status, employment, income, and social support. The second employed the Edinburgh Postnatal Depression Scale (EPDS), a standardised 10-item screening instrument validated across several groups [13]. Each item is evaluated on a 4-point scale (0–3), resulting in a cumulative score ranging from 0 to 30; scores of 13 or more suggest probable depression. The questionnaire was translated into Yoruba and subsequently back-translated to ensure semantic similarity. A pilot study with 20 parents at a comparable clinic produced a Cronbach's alpha of 0.84, indicating substantial dependability.

Trained research assistants, proficient in English and Yoruba, conducted interviewer-administered surveys in private rooms to ensure anonymity.

Male assistants conducted interviews with male participants to reduce awkwardness in addressing emotional matters. Supervisors conducted daily reviews of submitted surveys for thoroughness and precision.

Data Analysis

Data were input into IBM SPSS version 25 and subsequently cleaned before analysis. Descriptive statistics encapsulated demographic attributes. Inferential statistics, namely Chi-square tests and independent t-tests, analysed the relationships between sociodemographic variables and PND score. Effect sizes were interpreted via Cohen's d and Cramer's V. The threshold for statistical significance was established at $p < 0.05$. Missing data (less than 5%) were addressed via pairwise deletion.

Results

Overview of Respondents

The average age of responders was 31.8 ± 6.2 years. Most individuals (93.5%) were married, 46.5% possessed tertiary education and 57.5% were self-employed. Females represented 56.5% of the sample, while urban inhabitants accounted for two-thirds (66.5%). These demographics exemplify the diversity characteristic of urban postnatal clinics in Nigeria.

Prevalence and Gender Disparities

The total prevalence of probable postnatal depression (EPDS > 13) was 29.6 percent. Female respondents demonstrated a greater prevalence (34.5%) than their male counterparts (24.1%). The average EPDS score for females (1.53 ± 0.50) was greater than that for males (1.16 ± 0.39), $t(198) = –5.33$, $p < 0.001$.

This data suggests that although men experience mental distress post-childbirth, women are disproportionately impacted possibly due to a confluence of biological and social factors.

Association with Sociodemographic Variables

Notable correlations were identified between depressed symptoms and education ($\chi^2 = 8.23$, $p = 0.041$), employment position ($\chi^2 = 6.78$, $p = 0.034$), and social support ($\chi^2 = 9.65$, $p = 0.009$). Individuals with better education and robust familial support exhibited a reduction in depressed symptoms. Marital status and residence shown no significant correlations.

These findings underscore the mitigating influence of education and social support in alleviating postnatal mental discomfort.

Table 1. Sociodemographic Characteristics of Respondents (n=200)

Variables		**Gender**		**Total n (%)**	**p**
		Male n (%)	**Female n (%)**		
Age	18–25	13(14.9)	36(31.9)	49 (24.5)	0.002
	26–35	40(46.0)	59(52.2)	99 (49.5)	
	36–45	29(33.3)	13(11.5)	42 (21.0)	
	46–55	3(3.4)	3(2.7)	6 (3.0)	
	56+	2(2.3)	2(1.8)	4 (2.0)	
Marital Status	Single	4(4.6)	3(2.7)	7 (3.5)	0.488
	Married	82(94.3)	105(92.9)	187 (93.5)	
	Separated	1(1.1)	4(3.5)	5 (2.5)	
	Widowed	0(0)	1(0.9)	1 (0.5)	
Educational Level	No formal education	0(0)	4(3.5)	4 (2.0)	0.217
	Primary	6(6.9)	3(2.7)	9 (4.5)	
	Secondary	34(39.1)	49(43.4)	83 (41.5)	
	Tertiary	43(49.4)	50(44.2)	93 (46.5)	
	Others	4(4.6)	7(6.2)	11 (5.5)	
Employment Status	Full time	32(36.8)	19(16.8)	51 (25.5)	0.012
	Part time	7(8.0)	9(8.0)	16 (8.0)	
	Self-employed	44(50.6)	71(62.8)	115 (57.5)	
	Unemployed	3(3.4)	7(6.2)	10 (5.0)	
	Student	1(1.1)	7(6.2)	8 (4.0)	
Household Income	< 50,000	3(3.4)	37(32.7)	40 (20.0)	0.000
	50,000 – 100,000	30(34.5)	42(37.2)	72 (36.0)	
	100,000 – 200,000	25(28.7)	22(19.5)	47 (23.5)	
	200,000 – 500,000	25(28.7)	11(9.7)	36 (18.0)	
	> 500,000	4(4.6)	1(0.9)	5 (2.5)	
Residential Area	Urban	68(78.2)	65(57.5)	133(66.5)	0.007
	Semi-urban	13(14.9)	37(32.7)	50(25.0)	
	Rural	6(6.9)	11(9.7)	17(8.5)	
Ethnicity	Yoruba	77(88.5)	106(93.8)	183(91.5)	0.237
	Hausa	2(2.3)	4(3.5)	6(3.0)	
	Igbo	5(5.7)	2(1.8)	7(3.5)	
	Others	3(3.4)	1(0.9)	4(2.0)	

Source: (Field Survey, 2025)

Table 1 presents the sociodemographic characteristics of the respondents; with respect to the age of the participant, more than half 113 (56.5%) were female. The age distribution showed that the largest group of respondents were aged 26–35 years, representing about half 99 (49.5%). In terms of marital status, the majority of respondents were married 187 (93.5%). Regarding educational attainment, approximately half of the respondents had attained tertiary education 93 (46.5%). Employment status revealed that self-employment was the most common, accounting for more than half 115 (57.5%) of the respondents. Household income distribution indicated that few over one-third 72 (36.0%) earned between ₦50,000–₦100,000. With respect to residential location, the majority

resided in urban areas 133 (66.5%). Ethnic distribution showed that the Yoruba ethnic group predominated, with 183 (91.5%) respondents.

The majority of respondents in both genders were aged 26–35 years, though females had a slightly higher proportion in the 18–25 age group compared to males (31.9% vs. 14.9%, p = 0.002). Most participants were married, with no significant gender difference in marital status (p = 0.488). Educational attainment was generally high, with tertiary education being most common; however, differences by gender were not statistically significant (p = 0.217). Employment status showed a significant association with gender (p = 0.012), as males were more likely to be in full-time work, whereas females were more represented in self-employment and student categories. Household income also differed significantly by gender (p < 0.001), with males more frequently in higher income brackets (≥ 200,000) and females more concentrated in the lowest category (< 50,000). Residential area was significantly related to gender (p = 0.007), with males more often living in urban settings and females more in semi-urban areas. Ethnicity distribution showed no significant gender difference (p = 0.237), with Yoruba being the predominant ethnic group among both males and females.

Table 2. Edinburgh Postnatal Depression Scale (EPDS)

Variables		**Gender**		**Total n (%)**	**P**
		Male n (%)	**Female n (%)**		
Able to laugh and see the funny side of things	As much as always	67(77.0%)	85(75.2%)	152 (76.0%)	0.868
	Not quite so much	10(11.5%)	17(15.0%)	27 (13.5%)	
	Definitely less	7(8.0%)	7(6.2%)	14 (7.0%)	
	Not at all	3(3.4%)	4(3.5%)	7 (3.5%)	
Looked forward with enjoyment to things	As much as always	72(82.8%)	88(77.9%)	160 (80.0%)	0.510
	Less than usual	8(9.2%)	14(12.4%)	22 (11.0%)	
	Definitely less	3(3.4%)	8(7.1%)	11 (5.5%)	
	Hardly at all	4(4.6%)	3(2.7%)	7 (3.5%)	
Blamed self unnecessarily when things went wrong	Yes, most of the time	4(4.6%)	21(18.6%)	25 (12.5%)	0.000
	Sometimes	12(13.8%)	36(31.9%)	48 (24.0%)	
	Not often	26(29.9%)	39(34.5%)	65 (32.5%)	
	No, never	45(51.7%)	17(15.0%)	62 (31.0%)	
Felt anxious or worried for no good reason	No	47(54.0%)	37(32.7%)	84 (42.0%)	0.001
	Hardly ever	11(2.6%)	8(7.1%)	19 (9.5%)	
	Yes, sometimes	26(9.9%)	54(47.8%)	80 (40.0%)	
	Yes, very often	3(3.4%)	14(12.4%)	17 (8.5%)	
Felt scared or panicky for no very good reason	Yes, quite a lot	8(9.2%)	18(15.9%)	26 (13.0%)	0.001
	Yes, sometimes	12(13.8%)	35(31.0%)	47 (23.5%)	
	No, not much	17(19.5%)	26(23.0%)	43 (21.5%)	
	No, not at all	50(57.5%)	34(30.1%)	84 (42.0%)	
Things have been getting on top of me	Yes, most of the time	11(12.6%)	21(18.6%)	32 (16.0%)	0.004
	Yes, sometimes	15(17.2%)	36(31.9%)	51 (25.5%)	
	No, I have coped well	22(25.3%)	31(27.4%)	53 (26.5%)	
	No, as well as ever	39(44.8%)	25(22.1%)	64 (32.0%)	
	Yes, most of the time	16(18.4%)	21(18.6%)	37 (18.5%)	0.117
	Sometimes	8(9.2%)	21(18.6%)	29 (14.5%)	

Been so unhappy that I have had difficulty sleeping	Not often	18(20.7%)	29(25.7%)	47 (23.5%)	
	No, not at all	45(51.7%)	42(37.2%)	87 (43.5%)	
Felt sad or miserable	Yes, most of the time	2(2.3%)	18(15.9%)	20 (10.0%)	0.002
	Quite often	7(8.0%)	15(13.3%)	22 (11.0%)	
	Not often	25(28.7%)	35(31.0%)	60 (30.0%)	
	No, not at all	53(60.9%)	45(39.8%)	98 (49.0%)	
Been so unhappy that I have been crying	Yes, most of the time	6(6.9%)	20(17.7%)	26 (13.0%)	0.001
	Quite often	3(3.4%)	13(11.5%)	16 (8.0%)	
	Occasionally	6(6.9%)	16(14.2%)	22 (11.0%)	
	No, never	72(82.8%)	64(56.6%)	136 (68.0%)	
The thought of harming myself has occurred to me	Yes, quite often	2(2.3%)	15(13.3%)	17 (8.5%)	0.009
	Sometimes	7(8.0%)	16(4.2%)	23 (11.5%)	
	Hardly ever	2(2.3%)	5(4.4%)	7 (3.5%)	
	Never	76(87.4%)	77(68.1%)	153 (76.5%)	

Table 2 presents the Edinburgh Postnatal Depression scale of the respondents; majority 152(76.0%) were able to laugh and see the funny side of things as much as always. Similarly, majority160(80.0%) looked forward to things as much as always. Regarding self-blame when things went wrong, below one-quarter 25(12.5%) reported blaming themselves most of the time. Feelings of anxiety or worry without a clear reason were reported by approximately two out of five 80(40.0%), sometimes. In terms of feeling scared or panicky for no good reason, about half 84(42.0%) were not experiencing it at all. Sleep disturbances due to unhappiness were reported most of the time by less than one-quarter 37(18.5%), and not at all by about half 87(43.5%). Feelings of sadness or misery were experienced most of the time by below one-quarter20(10.0%), and not at all by about half 98(49.0%).

Episodes of crying due to unhappiness occurred most of the time in less than one-quarter 26(13.0%), while more than two-third 136(68.0%) never experienced it. Concerning thoughts of self-harm, few 17(8.5%) reported this quite often, while the majority, 153(76.5%), had never experienced such thoughts. Cross-tabulation of Edinburgh Postnatal Depression Scale (EPDS) items by gender showed several significant differences. Female respondents were significantly more likely than males to report blaming themselves unnecessarily ($p < .001$), feeling anxious or worried without reason ($p = .001$), feeling scared or panicky ($p = .001$), and feeling overwhelmed by problems ($p = .004$). Females were also more likely to report feeling sad or miserable ($p = .002$), crying more often ($p = .001$), and having thoughts of self-harm ($p = .009$).

No significant gender differences were found in the ability to laugh, enjoyment of activities, difficulty sleeping, or most other emotional symptoms, although females tended to report higher frequencies of distress in these areas.

About two-third (80.0%) were not depressed,53(26.6%) were probably depressed while 23(11.5%) were possibly depressed.

Participants' overall postnatal depression was determined based on their responses to 10 Edinburgh Postnatal Depression questions with questions 1, 2, and 4 scored 0 – 3 and 3, 5-10 scored 3 - 0; participants with total scores between (0 - 9), (10 - 12) and (13 - 30) were adjudged to have no depression, possible and probable depression respectively.

Table 3. Reproductive and Parental Health History

Variables		**Gender**		**Total n (%)**	**p**
		Male n (%)	**Female n (%)**		
Number of Children	1	32(36.8)	54(47.8)	86(43.0)	0.249
	2	31(35.6)	27(23.9)	58(29.0)	
	3	13(14.9)	20(17.7)	33(16.5)	
	4+	11(12.6)	12(10.6)	23(11.5)	
Age of Youngest Child	0–3 years	71(81.6)	82(72.6)	153(76.5)	0.180
	4–6 years	14(16.1)	21(18.6)	35(17.5)	
	7–12 years	2(2.3)	6(5.3)	8(4.0)	
	>12 years	0(0)	4(3.5)	4(2.0)	
Was the last pregnancy planned?	Yes	68(78.2)	77(68.1)	145(72.5)	0.150
	No	19(21.8)	36(31.9)	55(27.5)	
Complications during pregnancy or childbirth	Yes	19(21.8)	14(12.4)	33(16.5)	0.086
	No	68(78.2)	99(87.6)	167(83.5)	
If yes, type of complications experienced	Caesarean section	18(20.7)	10(8.8)	28(84.8)	0.100
	Baby complications	1(1.1)	1(0.9)	2(6.1)	
	Prolonged labour	0(0)	1(0.9)	1(3.0)	
	Abnormal positioning of the child	0(0)	2(1.8)	2(6.1)	
Experienced Complications postnatally	Yes	5(5.7)	6(5.3)	11(5.5)	0.100
	No	82(94.3)	107(94.7)	189(94.5)	
If yes, type of postnatal complications	Bleeding after discharge	5(5.7)	6(5.3)	11(100.0)	0.100
Primary caregiver of the child	Mother	27(31.0)	66(58.4)	93(46.5)	0.000
	Father	7(8.0)	8(7.1)	15(7.5)	
	Both equally	39(44.8)	36(31.9)	75(37.5)	
	Grandparent	10(11.5)	2(1.8)	12(6.0)	
	Others	4(4.6)	1(0.9)	5(2.5)	

Table 3 presents the reproductive and parental health history of the respondents; about half 86(43.0%) had one child. Regarding the age of the youngest child, the majority 153(76.5%) reported that their youngest child was between 0–3 years old. Most respondents, 145(72.5%), indicated that their last pregnancy was planned. Complications during pregnancy or childbirth were reported by below one-quarter 33(16.5%) of the respondents, whereas 167(83.5%) did not experience such complications. Among those who experienced complications, caesarean section was the most common, occurring in most 28(84.8%) cases. Postnatal complications were reported by a minority11(5.5%) respondents, with the remaining 189(94.5%) indicating no such issues. All those who experienced postnatal complications reported bleeding after discharge 11(100.0%). Regarding caregiving roles, about half 93(46.5%) stated that the mother was the primary caregiver.

Cross-tabulation of reproductive and parental health history by gender revealed that the number of children did not significantly differ between males and females (p = .249), with one child being the most common category for both genders. The age of the youngest child

also showed no significant gender differences (p = .180), though the majority in both groups had children aged 0–3 years. Whether the last pregnancy was planned was not significantly associated with gender (p = .150), though planned pregnancies were more common in both groups. Reports of complications during pregnancy or childbirth showed no significant gender differences (p = .086), with caesarean section being the most reported complication reported by both males and females. Postnatal complications were rare and did not differ significantly by gender (p = .100). A significant gender difference was found in the primary caregiver of the child (p < .001), with mothers being more frequently reported as primary caregivers in female respondents (58.4%) compared to males (31.0%), while fathers and grandparents were more commonly reported among male respondents.

Table 4. Sociocultural Factors Affecting Postnatal Depression

Variables	Categories	Gender		N (%)	p
		Male	Female		
In your community, do people believe men can experience postnatal depression	Yes	41(47.1)	49(43.4)	90(45.0)	0.356
	No	15(17.2)	29(25.7)	44(22.0)	
	Unsure	31(35.6)	35(31.0)	66(33.0)	
Feels there is stigma around mental health issues in your community?	Yes, a lot	23(26.4)	41(36.3)	64(32.0)	0.328
	Yes, but only for severe cases	30(34.5)	35(31.0)	65(32.5)	
	No	34(39.1)	37(32.7)	71(35.5)	
Ever sought help for emotional distress or mental health issues	Yes	15(17.2)	37(32.7)	52(26.0)	0.015
	No	72(82.8)	76(67.3)	148(74)	
Factors preventing people from seeking help for depression in community *	Stigma	x	x	28(11.6)	
	Lack of awareness	x	x	100(41.3)	
	High cost	x	x	48(19.8)	
	Lack of trust	x	x	58(24.0)	
	Other	x	x	8(3.3)	
Typically discuss emotional challenges with *	No one	x	x	18(8.7)	
	Partner	x	x	103(49.8)	
	Family	x	x	40(19.3)	
	Friends	x	x	15(7.2)	
	Religious leader	x	x	13(6.3)	
	Therapist	x	x	17(8.2)	
	Elderly people	x	x	1(0.5)	
Believe men and women experience depression differently?	Yes	72(82.8)	89(8.8)	161(80.5)	0.053
	No	1(.1)	10(8.8)	11(5.5)	
	Unsure	14(16.1)	14(12.4)	28(14.0)	

** Multiple responses allowed*

Table 4 presents sociocultural factors affecting postnatal depression; when respondents were asked whether people in their community believe men can experience postnatal depression, about half 90(45.0%) indicated yes. Regarding the presence of stigma around mental health issues in their community, about one-third 64(32.0%) believed there is a lot of stigma. When asked about help-seeking behavior, few over one-quarter 52(26.0%) had

ever sought help for emotional distress or mental health issues, while majority 148(74.0%) reported never seeking help. In terms of barriers preventing people from seeking help for depression, lack of awareness was the most reported factor 100(41.3%). Concerning who respondents typically discuss emotional challenges with partners were the most common option 103(49.8%). Finally, a large majority 161(80.5%) believed that men and women experience depression differently.

Analysis of sociocultural factors showed that beliefs about men experiencing postnatal depression and perceptions of mental health stigma did not differ significantly by gender ($p > .05$). However, females were significantly more likely than males to have sought help for emotional distress or mental health issues ($p = .015$). A higher proportion of both genders believed men and women experience depression differently, though this difference approached but did not reach statistical significance ($p = .053$).

Discussion

Interpretation of Findings

This study examined gender disparities in postnatal depression (PND) among parents in Southwestern Nigeria, focussing on prevalence, sociodemographic factors, and sociocultural impacts. PND impacts both mothers and fathers, however women predominantly suffer its consequences. Postpartum depression is influenced by social, economic, and cultural factors.

Gender-based Prevalence Variation

The prevalence of probable postnatal depression among respondents was 29.6%, indicating that nearly one in three parents had depression. This aligns with estimates from low- and middle-income countries (LMICs) such as Ethiopia (25–31%) and Kenya (28%) (17,18), however exceeds the rates observed in high-income nations (10–15%) (1,2). Women exhibited greater depression scores (34.5%) compared to men (24.1%), indicating that postnatal depression is more prevalent among women. This substantiates international research connecting hormonal fluctuations, psychosocial stress, and caregiving to female susceptibility (7,8,9). Nevertheless, the depressive symptoms in men indicate that paternal postnatal depression is an escalating public health concern, particularly in Africa (3,4,14). The findings corroborate Paulson and Bazemore's (10) assertion that paternal postpartum depression frequently coexists with maternal depression and is affected by emotional stress and societal standards of masculinity.

Sociodemographic Factors Contributing to Depression

Education, employment status, and social support exhibited a significant correlation with depression symptoms ($p < 0.05$). Tertiary education and stable employment were correlated with reduced depressive tendencies, indicating that socioeconomic empowerment and literacy serve as protective factors against emotional discomfort (6,17). Reduced education and precarious employment conditions may elevate financial stress and impair health literacy, rendering individuals susceptible to depression. Participants with considerable familial or spousal support exhibited markedly reduced depressive symptoms. Prior research has emphasised the significance of interpersonal networks and spousal involvement in postnatal mental health (9,16). Marital status and residential location were not statistically significant, indicating that social connections may have a greater impact on postnatal well-being than demographic factors.

Parental and Reproductive variables

The quantity of children, pregnancy intentions, and childbirth complications did not forecast depression. Nonetheless, 58.4% of mothers served as primary carers, in contrast to

31.0% of fathers. This imbalance exacerbates women's fatigue, stress, and emotional depletion, potentially elucidating their elevated rates of postpartum depression. Fathers facing economic difficulties but experiencing minimal caregiving stress typically withdraw emotionally rather than exhibit signs of depression [19]. The statistics substantiate the notion that gendered caregiving expectations influence emotional outcomes. Shared parenting and paternal postnatal care may mitigate these disparities and enhance familial stability [15, 20].

Social Stigma and its Influences

The research identified significant social factors affecting the perception and management of postnatal depression. Approximately 45% of respondents believed that men could have postnatal depression, whereas others were either uncertain or refuted this notion. This reflects Nigerian gender norms that stigmatise emotional distress, particularly in men, as a sign of weakness or spiritual affliction [11]. Thirty-two percent of respondents recognised mental health stigma, but only twenty-six percent had pursued assistance for emotional distress. The predominant obstacles to getting assistance were lack of awareness (41.3%) and cynicism towards mental health services (24.0%). Research indicates that cultural stigma and inadequate mental health literacy hinder Nigerians from pursuing treatment [8, 12]. Women exhibited a higher propensity to seek assistance compared to men (32.7% vs. 17.2%), illustrating the influence of gender norms on coping mechanisms. The hesitance of males to seek assistance illustrates masculinity standards that constrain emotional openness [7, 9]. Such trends underscore the necessity for culturally sensitive mental health education that challenges stigma and fosters open discourse around mental health across all genders.

Theoretical Implications

The findings are elucidated by Family Systems Theory, Social Relation Theory and Gender Role Theory. Family Systems Theory posits that emotional turmoil in one individual impacts other members. Consequently, maternal and paternal depression can influence familial harmony, communication, and neonatal development. Similarly Social Relations Theory elucidates how gendered roles and power dynamics influence mental health: women internalise shame and hopelessness whilst men display withdrawal or irritability. Comprehending these frameworks underscores that PND is not merely a maternal concern but a relational and societal issue that necessitates systemic remedies. These findings align with Oppong's investigation of paternal postnatal depression in African contexts [14] and Connell's framework on gender relations [15], both highlighting the social and relational mechanisms that influence emotional well-being. Gender Role Theory posits that societal standards dictate emotional expression. Nigerians anticipate that women would exhibit affection and emotionality, whereas men are instructed to embody strength and resilience [7, 15]. These gendered inclinations may elucidate the variations in depressive symptoms between genders.

Implications for Health Systems and Policy

The research indicates that Nigeria's maternal and child health system is deficient in thorough mental health assessments during postnatal treatment. Current initiatives prioritise physical rehabilitation and infant vaccination over mental health [12]. Routine postnatal appointments may incorporate screening tools such as the Edinburgh Postnatal Depression Scale (EPDS) for prompt identification and intervention. Integrate mental health as a fundamental aspect of postnatal care by educating healthcare professionals to recognise and address depression in both

mothers and fathers [16]. Paternity leave and couple-based counselling can alleviate maternal stress and foster emotional equilibrium. The stigma and ignorance surrounding mental illness must be confronted through educational initiatives at the community level. Healthcare professionals and religious organisations can enhance the acceptance of psychiatric treatment and encourage early help-seeking via public awareness initiatives [11, 12]. These strategies facilitate Sustainable Development Goal 3, which advocates for mental health and well-being for all.

Comparisons with Global and African Studies

The observed prevalence of 29.6% corresponds with estimates from comparable LMIC contexts, such as Ethiopia (25–31%) [17] and Kenya (28%) [18]. Nonetheless, it surpasses documented rates in industrialised nations, including 10–15% in Europe and North America [19]. Divergences may arise from economic strain, inadequate health systems, and insufficient social protection in Nigeria. The prevalence of paternal postpartum depression (PND) in this study (24.1%) aligns with findings from South Africa (21%) and Ghana (23%), indicating that African men similarly encounter emotional difficulties following childbirth [20].

Study Limitations

This work, however its merits, possesses significant drawbacks:

1. **Sample Size:** The final sample (n = 200) fell short of the projected 236 respondents due to challenges in recruiting fathers. While the power was adequate for significant comparisons, the precision for minor gender subgroups may be constrained.
2. **Measurement Bias:** The data relied on self-reported EPDS scores instead of clinical diagnoses, potentially introducing reporting bias.
3. **Cross-sectional Design:** This design prevents the establishment of causal links between variables.
4. **The study's contextual scope was confined to urban clinics in Ibadan;** rural people and other parts of Nigeria may exhibit variations in cultural attitudes and access to help.
5. **Gender Sensitivity:** Due to cultural norms, certain males may have underreported emotional symptoms because of the stigma linked to susceptibility.

Future research should consider utilising longitudinal designs, greater sample sizes, and mixed-method techniques to investigate temporal patterns and contextual subtleties in postnatal mental health.

Conclusion

This study concludes that Southwestern Nigeria faces a gender-sensitive, multifactorial issue of postnatal depression. Women experience heightened depression symptoms due to biological, caregiving, and sociocultural pressures, whereas men face under-acknowledged emotional challenges intensified by masculine ideals and societal expectations.
A thorough, family-oriented approach to postpartum depression encompasses mental health assessments in standard postnatal care, social support networks, collaborative parenting, and culturally sensitive education to mitigate stigma. These strategies will enhance child development in Nigeria, bolster family stability, and promote parental mental well-being.

Ethical Approval

The study was conducted in accordance with the most stringent ethical standards to guarantee the respect, dignity, and protection of all participants. In accordance with the Universal Declaration of Human Rights, the International Code of Medical Ethics, and the WHO Ethical

Guidelines for Health Research, ethical sanction was obtained from the Oyo State Ministry of Health Ethical Review Committee (Ref No: MOH/OY/2024/071). The purpose, procedures, potential hazards, and benefits of the study were fully disclosed to all participants. Prior to participation, written informed assent was obtained, and information sheets were distributed in both English and Yoruba to guarantee comprehension. Respondents were guaranteed the right to withdraw at any point without incurring any penalties, and participation was entirely voluntary. Anonymity and confidentiality were rigorously upheld. All identifiable data was eliminated from the records and substituted with codes. Hard copies were securely stored, and all electronic data was password-protected. In order to prevent identification, transcripts and quotations were anonymised. Participants were treated with empathy, and those who demonstrated distress were informed about available counselling and referral services, as postnatal depression is an emotionally sensitive condition. The investigation refrained from employing any form of coercion, deception, or undue influence. Data security and integrity were prioritised throughout the research process. After completion, all materials will be securely stored and kept confidential. The study was in accordance with the National Health Research Ethics Code of Nigeria (NHREC, 2011) and the Research Ethics Policy of Texila American University.

Conflict of Interest

There are no conflicts of interest.

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Data Availability Statement

The datasets produced and examined in this investigation are available and can be obtained from the corresponding author upon a reasonable request.

Author's Contribution

Adeola Oluwatobi Aminu conceived and designed the project, coordinated fieldwork, supervised data collection, and wrote the initial manuscript draft. Wakili Adelani Tijani provided overall supervision, technical mentorship, and guidance on study design and analysis. Fatimah Omobolanle Azeez facilitated the training of research assistants and oversaw field data gathering activities. Olalekan Amos Oladejo, Michael Oloyede Oladeji and Doubra Aanuoluwapo Onoviron collaboratively engaged in the review, editing, and proofreading of the final text draft to ensure intellectual clarity and consistency. All authors reviewed and sanctioned the final version of the text.

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Willingness of Parents to Pay for Nitrous Oxide and Oxygen Inhalation Sedation During Dental Treatment for Children in Saudi Arabia

Sarah Ali Mubaraki
Division of Pediatric Dentistry, Preventive Dentistry Department, College of Medicine and Dentistry, Riyadh Elm University, 84891 Riyadh-11681, Saudi Arabia

Abstract

This study aimed to evaluate parental willingness to pay (WTP) for nitrous oxide and oxygen inhalation sedation (NOIS) as a behavior management technique during pediatric dental treatment. A total of 293 parents (aged 20–65 years) having children aged 3–14 years were enrolled in this study. All eligible parents completed an online questionnaire comprising two sections. The first section collected informed consent, demographic data, and previous dental history, while the second section included an educational video on NOIS followed by bidding process questions to elicit WTP. All the collected data on WTP was compared across different groups using Mann-Whitney U and Kruskal-Wallis tests. Nearly, 27.60% of parents were willing to pay the average cost of 600 SAR for NOIS for their children, while the majority, 72.40%, found it to be expensive. Father's education (p = 0.014) and monthly income (p = 0.004) were significantly associated with parents' WTP for NOIS for their children during dental treatment. In contrast, no significant difference in child gender (p = 0.825) or child age (p = 0.064) and mothers' education (p = 0.211) was observed with regard to the WTP. The results showed that most parents found the mean cost for NOIS of 600 SAR for their children during dental treatment to be expensive. Monthly income and the father's education level were the only factors that affected the parents' WTP for NOIS.

Keywords: *Behavior Management, Nitrous Oxide, Sedation, Willingness to Pay.*

Introduction

Dental anxiety is widespread among children and adolescents, with 5%–20% suffering from it [1]. This can lead to dental anxiety and fears in adulthood, which have long-lasting effects on health later in life [2]. Behavior management is commonly recognized as a key factor in delivering effective dental care for children [3]. A range of non-pharmacological and pharmacological management techniques has been employed to manage child behavior during dental treatment. Nitrous oxide and oxygen inhalation sedation (NOIS) as pharmacological behavioral management techniques have been used in clinical practice for over 150 years to manage anxiety in pediatric dental patients [4]. The NOIS acts as both an analgesic and an anxiolytic agent [5, 6]. It can also raise the patient's pain threshold, thus enhancing the action of any local anesthetic agent used [7].

The field of dental economics has seen a surge of interest, with researchers endeavoring to ascertain the cost-effectiveness of various treatments [8-11]. The costs associated with dental care can be prohibitive, contributing to household poverty and long-term debts [12]. Healthcare professionals generally regard the willingness to pay (WTP) as a popular approach and a reliable metric for evaluating the acceptability of treatment modalities [13,

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Corresponding Author: saramubarke86@gmail.com ; Sarah.Mubaraki@riyadh.edu.sa

14]. The tool has been effectively utilized to assess patients' perceptions in various medical disciplines [15-18].

The government sector's provision of free healthcare services to both Saudi and non-Saudi employees substantially elevates the cost of healthcare financing in Saudi Arabia. Further exacerbating this situation are the rising costs of medical technology and the rapid population growth [19]. Saudi Arabia is expanding its extensive healthcare system in anticipation of change, as Vision 2030 prioritizes the private sector [20]. Consequently, the Saudi Ministry of Health has encouraged the private sector to increase health expenditure by promoting alternative financing and delivery methods, such as health insurance, and facilitating stakeholder collaboration [21].

WTP for goods and services can be estimated using various methods. Bidding represents the most established and commonly accepted method for evaluating a patient's financial capacity to pay for a specific treatment modality [13, 22, 23]. Hence, this study aimed to assess the parents' WTP for NOIS for their children during dental procedures in Riyadh City, Saudi Arabia. This study tests the hypothesis that parental willingness to pay for NOIS is influenced by the various demographic characteristics of the parents. This study provides healthcare professionals and third-party payers with a reliable estimate of a patient's financial resources for a specific treatment.

Materials and Methods

This study was registered and approved by the Research and Innovation Center of a private university, Riyadh, Saudi Arabia (IRB #:FRP/2024/540/1268/1138). This population-based cross-sectional survey was conducted among parents in Saudi Arabia from December 2024 to February 2025. This study was conducted by inviting parents to participate via an online Google Forms survey shared on social media platforms. Parents consenting to participate in this study were registered using their email addresses to prevent duplicate entries. Before the main study, a pilot study was conducted with 15 parents to evaluate the questionnaire's clarity, validity, and reliability, and adjustments were made based on the feedback received.

Criteria

The parents considered in this study were based on the following inclusion and exclusion criteria:

Inclusion criteria: Saudi father/mother having at least one child aged 3 - 14 years and expressing their willingness to participate in the study.

Exclusion criteria: parents who were unwilling to participate in the survey, and parents with children older than 14 years or younger than 3 years.

The study's participants were parents aged 20 to 65 years, accompanied by a child aged 3 to 14. The participants were assured of the confidentiality of their responses throughout the study.

Sample Size Estimation

The requisite sample size was determined using the G-Power sample size calculator, which indicated that a minimum of 200 participants would be necessary to detect an effect size of 0.5 with a power of 0.95. The present study was conducted on a sample of 293 parents.

Questionnaire

An online questionnaire comprising two main sections was developed. The initial section of the study included a consent form, a concise explanation of the study's objectives, demographic questions assessing the parents' age, educational level, monthly income, relationship to the child, the child's age and gender, and previous dental experiences.

In the second section, participants were presented with an educational video in Arabic that encompassed the definition, advantages, side effects, and clinical applications of NOIS. Subsequently, the subjects were instructed to respond to the bidding process, which was administered in two stages.

Stage 1: The parents were queried about their willingness to incur the average NOIS expense for their child in Riyadh city, which was determined to be 600 SAR.

Stage 2: The parents were allowed to submit bids for the price they were willing to pay. Parents who are unwilling to pay the average price will have the price reduced by 50 SAR until they reach a price they would be willing to pay, or the amount reaches 0 SAR. The parents willing to pay the median price were subjected to a series of price increases. The prices increased until it was indicated that they would no longer be willing to pay. The prices were increased until the maximum price charged for NOIS in Riyadh city reached 2000 SAR.

Statistical Analyses

Descriptive statistics of frequency distribution and percentages were calculated for the categorical variables. While mean, standard deviation, and mean ranks were calculated for the continuous variables. Data showed non-normal distribution. The WTP for the maximum and reasonable amounts was compared between the two groups using the Mann-Whitney U test, while the Kruskal-Wallis test was used to compare the mean ranks across more than two groups. The chi-square test was applied to find the relationship between different questionnaire items and the child age groups. The value of $p<0.05$ was considered significant for all the statistical tests. All statistical analyses were performed using the statistical analysis program SPSS version 25 (IBM SPSS, Armonk, NY, USA).

Results

Sociodemographic Characteristics

Table 1 summarizes the demographic characteristics of the study participants. A total of 293 parents participated in this study, comprising 211 mothers (72.0%), 29 fathers (9.9%), and 53 individuals categorized as others (18.1%). The parents' ages ranged from 20 to 65 years, with the mean age of the mothers being 37.69 years (SD ± 7.27) and that of the fathers being 42.63 years (SD ± 8.22). Regarding the parents' highest level of education, 18.1% of mothers and 21.8% of fathers reported having completed postgraduate studies. Additionally, 65.5% of mothers and 59.7% of fathers held a bachelor's degree, while 16.4% of mothers and 18.4% of fathers had completed high school or less. The study also included 133 boys and 160 girls, aged between 3 and 16 years, with a mean age of 7.26 years (SD ± 3.28).

Table 1. Demographic Information of the Study Participants (n=293)

Variables		**Response**	**n**
Relation to child	Mother	211	72.0%
	Father	29	9.9%
	Others	53	18.1%
Mother's level of education	≤High school	48	16.4%
	Bachelors	192	65.5%
	Postgraduates	53	18.1%
Father's level of education	≤high school	54	18.4%
	Bachelors	175	59.7%
	Postgraduates	64	21.8%
Monthly income (SAR)	>20K	110	37.5%

	10-20K	101	34.5%
	10-5K	61	20.8%
	<5K	21	7.2%
Child age (in years)	< 6	94	32%
	6-12	161	55%
	12-16	38	13%
[SAR] Saudi Arabian Riyal			

Dental History of the Child

Table 2 reveals the dental history of the child patient. Among the children included in the study, 21.5% had never visited a dentist, whereas 78.5% had a previous dental visit. Of those who had undergone dental treatment, 51.2% received care using basic behavior management techniques (BBMT), 14.3% had been treated with NOIS, 4.8% had undergone treatment under general anesthesia, and 8.2% received no treatment during their visit. Nearly 43.1% accepted the treatment willingly, while 22.9% reported being fearful, and 12.3% expressed extreme fear. Additionally, 7.5% required treatment to be completed by force, and 1.75% received treatment under other conditions. Notably, 47.8% of parents reported experiencing difficulty in persuading their children to attend dental appointments.

Table 2. Dental History of the Child

Variables	**Responses**	**n**	**%**
Has the child ever visited a dentist?	Yes	230	78.50
	No	63	21.50
How was your child treated?	Behaviour management technique	150	51.20
	Nitrous oxide	42	14.30
	General anaesthesia	14	4.80
	Not treated	24	8.20
How did your child respond to the treatment provided?	Accepting	100	34.10
	Fearful	67	22.90
	Extreme fear	36	12.30
	Treatment by force	22	7.50
	Could not treat	5	1.70
Did you face any difficulty in convincing your child to visit the dentist?	Yes	140	47.80
	No	90	30.70

Table 3 presents WTP for the maximum and reasonable amounts for NOIS. Parents willing to pay the average cost for NOIS for their children comprised 81 (27.60%), while 212 (72.40%) parents found it expensive and were unwilling to pay. The mean and median amounts parents were WTP for their children were the mean for the maximum amounts was 816.05 (SD ± 297.26), and the mean for the reasonable amounts was 164.86 (SD ± 90.17).

Table 3. WTP for the Maximum and Reasonable Amount for NOIS

Maximum Amount			**Reasonable Amount**		
Amount (SAR)	**n**	**%**	**Amount (SAR)**	**n**	**%**
650.00	43	53.1	50.00	34	16.0
700.00	6	7.4	100.00	53	25
750.00	2	2.5	150.00	39	18.3
800.00	7	8.6	200.00	34	16.0
850.00	2	2.5	250.00	21	9.9
900.00	1	1.2	300.00	20	9.4
1000.00	13	16.0	350.00	9	4.2
1050.00	1	1.2	400.00	1	0.47
1200.00	1	1.2	500.00	1	0.47
1500.00	2	2.5	NA	NA	NA
2000.00	3	3.7	NA	NA	NA
Total	81	100	Total	212	100
[SAR] Saudi Arabian Riyal					

Table 4 presents the potential factors of WTP for the maximum and the reasonable amounts of dental treatment under NOIS. The WTP for a reasonable amount differed significantly based on the father's level of education (p = 0.014) and monthly income (p = 0.004). In contrast, WTP for the maximum amount did not show any significant difference based on different factors (p>0.05). Fathers with lower education demonstrated significantly lower WTP for a reasonable amount of NOIS than those with bachelor's and postgraduate education. Similarly, parents with a monthly income of 10-5K and <5K showed significantly lower WTP for a reasonable amount for NOIS compared to those with >20K and 11-20K. Moreover, parents with income levels >20K showed significantly higher WTP for NOIS. Moreover, there were no statistical differences in parents' WTP in terms of child gender (p=0.825), child age (p = 0.064), and mothers' education (p=0.211) were observed.

Table 4. Comparison of Willingness to Pay Maximum and Reasonable Amount for N2O and Sedation

Variables		**Maximum amount**				**Reasonable amount**			
		Mean	SD	Mean rank	*p*	Mean	SD	Mean rank	*p*
Mother education	</=high school	846.15	424.98	34.27	0.169	147.14	91.51	93.07	0.211
	Bachelors	768.48	182.99	39.68		164.04	85.85	107.03	
	Postgraduates	897.73	386.21	47.73		188.71	105.44	119.16	
Father education	</=high school	727.78	154.34	32.22	0.093	130.00	73.39	83.26[A]	0.014
	Bachelors	772.22	222.48	39.51		174.79	89.94	113.66[B]	
	Postgraduates	991.67	455.44	49.86		172.83	98.72	110.40[B]	
Monthly income (SAR)	>20,000	846.59	329.97	43.22	0.160	193.94	98.65	125.01[A]	0.004
	10001-20000	808.70	296.44	40.96		157.05	78.43	103.30[B]	
	5000-10000	793.75	186.01	43.19		155.66	92.33	98.86[BC]	
	<5000	650.00	.00	22.00		110.00	63.25	68.70[C]	

Child gender	Male	823.44	283.69	44.45	0.246	162.87	87.94	105.54	0.825
	Female	811.22	308.60	38.74		166.67	92.52	107.37	
Child age	< 6 years	827.78	335.79	39.33	0.595	166.42	82.29	109.32	0.064
	6-12	808.00	286.49	41.09		174.32	98.13	111.57	
	12-16	837.50	188.75	51.13		130.88	69.65	84.38	

[SAR] Saudi Arabian Riyals, [SD] Standard Deviation

Discussion

This is the first study to quantify parents' WTP for NOIS for their children's dental procedures. The use of NOIS in the field of dentistry is considered an essential component of pharmacological behavior management techniques, especially for anxious children. Therefore, this study evaluated parents' WTP for NOIS during various dental procedures carried out by dental professionals in Riyadh City, Saudi Arabia. The parents were asked about their WTP for a NOIS for their children during a dental procedure. An effort was made to educate the patients before the bidding process. The reason for doing this was to ensure that a baseline amount on WTP was familiarized with the participants. Bidding is one of the oldest and most widely used methods of WTP among the various approaches, and it has the advantage of providing a realistic guide to the amount.

Pharmacological behavior management techniques are used in dentistry to relieve dental anxiety and are particularly effective for children. Moderate and deep sedation is often used as an alternative to general anesthesia for invasive pediatric dental procedures and has proven safer and cost-effective. [24]. Parents' attitudes and knowledge about the use of sedation vary and may be a significant reason for their WTP.

Several factors influence WTP for oral and dental care, such as gender, age, income, employment status, number of children, previous treatment experiences, [25]. This study examined the premise that multiple demographic factors influence parental WTP for NOIS. The presented hypothesis has been accepted, as the father's education and monthly income were determined to affect the reasonable amount to pay for their children's dental treatment under NOIS.

It has been reported that parents educational level considerably affects their readiness to pay for dental care under sedation. Parents with advanced educational qualifications are more inclined to comprehend the advantages and disadvantages of sedation, resulting in increased acceptance and readiness to finance these services. Education improves parents' understanding of the processes and their ability to make informed decisions about their children's dental care [26, 27].

In line with these findings, the current study observed that fathers with ≤ high school education demonstrated a significantly lower reasonable amount to pay for NOIS than those with a bachelor's and postgraduate level of education. However, parents with bachelor's and master's degrees of education did not differ significantly in paying a reasonable amount for NOIS. Several other studies have reported similar findings in which the education of parents played a significant role in the WTP [28, 29].

Income level is a crucial factor influencing parents' readiness to spend on sedative methods in pediatric dentistry. Research indicates that families with higher incomes are more inclined to accept and finance modern sedation techniques, such as nitrous oxide and oxygen inhalation, owing to their financial capacity to purchase these services [26, 30]. In contrast, families with lower incomes may exhibit greater reluctance due to financial limitations, although recognizing the advantages of sedation (Wanyonyi et al., 2016). It has been noted that the family income significantly influenced the acceptance

of dental general anesthesia (DGA), with parents of higher income demonstrating greater willingness to consent to DGA for their children [30]. A study examining the social gradient of sedation services in England revealed that impoverished areas had a greater number of patients receiving sedation, indicating that socioeconomic position affects both access to and the propensity to pay for these treatments [31]. In line with these findings, the current study showed that the parents with an income level of>20000 SAR were willing to pay a significantly higher reasonable amount for NOIS compared to other income levels. Therefore, it is obvious that monthly income has consistently been a factor influencing WTP reported by several studies [11, 32, 33].

It should be noted that access to dental care is influenced by the extent of dental insurance coverage [34]. Dental insurance coverage may play a significant role in oral health inequalities, as NOIS in most dental care centers is often paid out of pocket. Therefore, policymakers must consider the factors that influence service valuation [11]. When the child's age and gender were investigated in relation to parents' WTP for NOIS, no statistical differences were observed in parents' WTP, consistent with several studies [29, 35, 36].

Strength of the Study

This is the first study to report the parental WTP for NOIS for the dental care of their children in Saudi Arabia. The WTP for the maximum and reasonable amounts for NOIS was assessed through a bidding process, which provided realistic estimates of the payments. Diverse demographic factors influencing WTP were explored in this study. Moreover, the current study provides baseline estimates on WTP for NOIS upon which future studies can be undertaken. This also provides a clue for the clinicians and dental care administrators to determine the cost of dental care for the children under NOIS. Study results may help in the assessment of NOIS services in governmental dental centers.

Limitations of the Study

NOIS is an effective strategy for alleviating anxiety in young dental patients. Nevertheless, this study did not explore parental financial worries, awareness of WTP for NOIS, safety fears of NOIS, and a preference for alternative sedation techniques. Moreover, the limited sample size and cross-sectional nature of the study design may have affected the results. Hence, caution should be exercised while generalizing the study findings to the larger population in Saudi Arabia.

Conclusion

The results showed that 27.60% of parents were willing to pay the mean cost for NOIS for their children during dental treatment. In contrast, most parents found it to be expensive. Monthly income and the father's education level were the only factors that affected the parents' willingness to pay for NOIS. There were no statistically significant differences in child gender, child age, or mothers' education in willingness to pay for NOIS.

Conflict of Interest

Authors declare that they have no conflicts of interest to disclose.

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Stakeholder Perspectives on Maternal Health Service Delivery: Key Performance Indicators and System Challenges in The Gambia

Joy Michael[1*] and Abiodun Olaiya Paul[2]
[1]*United Nations Population Fund, Banjul, The Gambia*
[2]*Texila American University, Guyana, South America*

Abstract

Maternal health is a major public health concern in The Gambia. The aim of this study was to determine the current status of maternal health services in The Gambia. This study applied well-structured questionnaire to obtain information from 217 participants from seven (7) administrative regions in The Gambia. Descriptive statistics was used to analyze the data. The respondent profile was majorly males, aged 25-34 and highly educated. Findings show that 73.8% reported the presence of community awareness programs, and 83.8% affirmed their personal role in maternal health efforts. Also, the most frequently offered services during community-based maternal health outreach included health education (77.5%), family planning (59.9%), antenatal care (58.2%), and immunization (56.6%). The results also showed that family planning and birth spacing initiatives (65.5%) had the highest implementation rates regarding awareness. Resource and system constraints (55.5%), data availability and quality issues (50.9%), limited technical and human capacity (46.2%), and coordination/communication gaps (32.9%) were frequently reported. Based on the findings of this study, ANC and PNC attendance (67.5%), skilled birth attendance (55.6%), and place of delivery (52.7%) were the most monitored key indicators. The significant representation of nurses/midwives and public health officers is very important, as these professionals are at the forefront of implementing community-based maternal health initiatives. Findings show a strong emphasis on community awareness and engagement in maternal health. Meeting national and international health goals and providing equitable, high-quality maternal health services depend on addressing these issues through focused policy changes and capacity building.

Keywords: *Challenges, Health Service, Key Performance Indicator (KPI), Maternal, Stakeholder.*

Introduction

Maternal health remains a vital component of public health and a key determinant of a country's overall progress and the effectiveness of its healthcare system. Medical care given to women throughout pregnancy, childbirth, and the postpartum phase is referred to as maternal healthcare [1]. It is essential for lowering the incidence of maternal morbidity and death. A variety of services, such as prenatal care, skilled attendance during childbirth, and postnatal care, are included in the World Health Organization's (WHO) definition of adequate maternal healthcare [2]. According to Al Amin, [3] approximately 300,000 maternal deaths and 2.5 million neonatal deaths occurred in 2018, with over 94% of these deaths occurring in areas with inadequate resources. The majority of these deaths take place in sub-Saharan Africa, where more than a million babies pass away on their first day of life every year. Furthermore, problems during pregnancy and delivery cause 800 women and 7700 newborns to die every day, and the postnatal period

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****Corresponding Author: michael.ukwojoy@yhaoo.com***

records about 7300 women who report stillbirths [4]. These deaths could be avoided with quality services, robust programs, and interventions prior to and during pregnancy, during labour and delivery, and during the critical postpartum period [1].

The Sustainable Development Goals (SDGs), which seek to lower the global maternal mortality ratio to less than 70 per 100,000 live births by 2030, have made efforts to lower maternal mortality and improve maternal health outcomes a top priority for health agendas around the world [5]. Delivering efficient and fair maternal health services is particularly difficult in sub-Saharan Africa, where maternal death rates are still disproportionately high. This is the case in nations like The Gambia. The Gambia still faces systemic obstacles that make it difficult to provide high-quality maternal care, particularly in marginalised and rural areas, despite significant advancements in recent years [6].

The Gambia, which is one of the smallest nations in mainland Africa, is distinguished by its small geographic profile along the Gambia River, which makes it difficult for rural residents to access healthcare services [7]. The Primary Healthcare Units (PHUs), secondary care facilities, and tertiary care centres make up the majority of the three tiers of the Gambian health system. The cornerstone is primary healthcare, with community health posts acting as the initial point of contact for services related to maternal health. The delivery of maternal health services is severely impacted by the health system's major problems, which include poor infrastructure, a shortage of medical supplies, and a shortage of human resource [8]. At around 1:10,000, the doctor-to-population ratio is significantly lower than what the WHO recommends [9].

There are about 2,221,301 million people living in the Gambia [10, 11] and 101,262 births each year. The Ministry of Health oversees managing these medical institutions and making sure they offer crucial services related to maternal health. With a reported maternal mortality ratio of over 300 deaths per 100,000 live births as of 2020, maternal health is still a major public health concern in The Gambia [12]. This statistic emphasizes how urgently effective initiatives are needed to lower maternal fatalities.

In The Gambia, maternal health-seeking behaviour is also greatly influenced by traditional beliefs. Many cultures still have significant cultural customs surrounding delivery, such as favouring home births and traditional birth attendants [6]. These customs are frequently based on cultural and religious views that consider childbirth to be a natural process that needs little medical assistance [13]. Patriarchal social structures are another sociocultural component that has a big influence on women's autonomy when it comes to making healthcare decisions. Research shows that 65% of women need their spouse's consent to seek medical attention, which inhibits them from using maternal health services promptly and increases their financial reliance on their husbands or partners [14]. The dynamics of a woman's marriage can also impact her access to healthcare and result in different degrees of partner-controlling behaviours, including gender-based violence [15], which has been linked in studies to poor maternal health. Many women have no say in how their husbands' money is spent, even though they may have access to land or maintain control over their own income [16]. This could indicate that women are more reluctant to decide for themselves how much money should be spent on costly expenses like medical care.

Increasing access to competent care during childbirth has been made possible by the training and deployment of Community Health Workers (CHWs) and Traditional Birth Attendants (TBAs), two of the most popular community-based maternal healthcare

interventions [17]. This study concentrated on community-based medical facilities found in a few chosen urban and rural areas of The Gambia. Because of their varied socioeconomic environments and disparities in access to medical care, these regions have been recognized as crucial locations for maternal health interventions. This study also attempted to present a comprehensive picture of how well community-based interventions work to improve maternal health outcomes in The Gambia using qualitative insights from community interactions.

To detect gaps, assess performance, and create relevant solutions, it is crucial to comprehend the viewpoints of important stakeholders, including community leaders, policymakers, healthcare practitioners, and service users. In addition to being the providers and recipients of maternal health services, stakeholders are also key drivers of change whose perspectives can provide light on the reality of service delivery in the field [18]. Their perspectives and experiences offer a comprehensive picture of the current maternal health system's advantages and disadvantages, providing important background information for analysing key performance indicators (KPIs) and directing future programmatic and policy decisions. Key performance indicators serve as vital tools for monitoring and evaluating maternal health outcomes [19]. Key performance indicators such as the Maternal Mortality Ratio (MMR), Antenatal Care Coverage, Skilled Birth Attendance, Postnatal Care Visits, Contraceptive Prevalence Rate, and Community Health Workers Engagements are indicators of the efficacy and impact of maternal health interventions. Aspects of government initiatives (such as policies that support maternal health and efficiently allocate resources), community engagement (including local leaders and community members in health programs), training programs (which provide ongoing training for healthcare providers and community health workers), and partnerships (working with NGOs and international organisations to improve service delivery) also play a part in contributing to its success [20].

With an emphasis on key performance indicators and systemic issues, this study attempts to investigate stakeholder perspectives on the provision of maternal health services in The Gambia. The research aims to give a thorough grasp of the current status of maternal health services and pinpoint practical suggestions for improvement by looking at the opinions of various stakeholders. The specific objectives of this study were to; (i) determine the socio-demographic information of the respondents in the study area; (ii) to determine the prevention and community intervention to maternal health challenges; (iii) determine maternal health awareness programs implemented in the study area between 2010-2020; (iv) to assess community-based maternal health interventions that the respondents have personally participated in between 2010-2020; (v) determined the Key Performance Indices measured during the programs.

Methods

Research Design and Site Description

This study assessed community-based health interventions for maternal health in The Gambia using a retrospective quasi-experimental design. Structured questionnaires and hospital interviews were used to provide qualitative insights for 7 administrative regions (Brikama, Kerewan, Mansakonko, Banjul, Janjanbureh, Kuntaur and Basse) in The Gambia.

Sample Size and Techniques

The population size for this study was 217 participants and stratifying the participants were selected from all the 7 regions, which implies that 31 participants per region. Information on effectiveness of the community-based maternal healthcare interventions were

obtained from Community health workers, midwives, healthcare facilities, traditional birth attendants and healthcare professionals.

Data Collection

Data were extracted from well-structured questionnaires distributed evenly across the seven administrative regions of The Gambia using the three KPIs from the opinion of maternal healthcare service workers within 2010 – 2020. Data were separated into the following categories: Socio-demographic and matrix of three major key performance indicators of community-based maternal healthcare interventions. Each data was manually recorded into a standardized Excel spreadsheet, with separate sheets for each administrative region. For hospital review, it was distributed to healthcare professional.

Data Analysis

Data on the effectiveness of the community-based maternal healthcare interventions using the three KPIs from the opinion of maternal healthcare service workers was analysed to using univariable analysis. Values obtained were compared for the reports. For avoidance of errors in analysis, experts in the field of statistical analysis were employed to first filer the data collected and use appropriate statistical tools such as SPSS. Excel etc.

Results

Socio-demographic Information of the Respondents

The study included 206 respondents, with males comprising the majority at 57.8% compared to females at 42.2%. The largest age group was 25-29 years at 38.6%, followed by 30-34 years at 25.2%, and 20-24 years at 12.9%. The majority of respondents held tertiary education qualifications at 87.9%, while 10.6% had secondary education and 1.4% had vocational training. For marital status, 48.5% were single, 40.7% were married in monogamous relationships, 8.3% were in polygamous marriages, 1.5% were divorced or separated, and 1.0% were widowed. The predominant professional category was nurses/midwives at 62.0%, followed by public health officers at 19.5% (n=40), other categories at 9.3%, heads of facilities at 4.9%, and doctors at 4.4%. Geographically, the Western Coast Region (WCR) had the highest representation at 32.2%, followed by Kanifing Municipal Council (KMC) at 18.3%, Lower River Region (LRR) at 16.3%, Banjul at 11.1%, North Bank Region (NBR) at 8.7%, and both Central River Region (CRR) and Upper River Region (URR) at 6.7% each. The vast majority of respondents, 92.1%, were assigned to the Ministry of Health, while 5.0% were in other institutions, 1.5% were with CSOs, 1.0% were with development partners, and 0.5% were with the Ministry of Gender.

Table 1. Socio-demographic Profile of Respondents

Demographic Information	Frequency (n)	Percent (%)
Sex		
Male	119	57.8
Female	87	42.2
Age		
15-19 years	1	0.5
20-24 years	27	12.9
25-29 years	81	38.6
30-34 years	53	25.2

35-39 years	23	11.0
40-44 years	7	3.3
45-49 years	9	4.3
50+	9	4.3
Highest level of education		
Secondary Education	22	10.6
Tertiary education (college/university)	182	87.9
Vocational Training	3	1.4
Marital Status		
Divorced/ Separated	3	1.5
Married (monogamous)	83	40.7
Married (polygamous)	17	8.3
Single	99	48.5
Widowed	2	1.0
Current level in the Health Facility		
Doctor	9	4.4
Head of the facility	10	4.9
Nurse/ Midwives	127	62.0
Other	19	9.3
Public Health Officer	40	19.5
Region of Assignment		
Banjul	23	11.1
CRR	14	6.7
KMC	38	18.3
LRR	34	16.3
NBR	18	8.7
URR	14	6.7
WCR	67	32.2
Institution of Assignment		
CSO	3	1.5
Development Partners	2	1.0
Ministry of Gender	1	0.5
Ministry of Health	186	92.1
Other	10	5.0

Prevention and Community Intervention to Maternal Health

Table 1 shows respondents' perspective on prevention and community intervention to maternal health. Majority of the respondents (73.8%) indicated that community awareness programs focusing on maternal and child health were present in their communities, while 17.5% of respondents were unsure and 8.7% reported no such programs. The majority of respondents (83.8%), reported having a role in maternal health in The Gambia, while 16.2% indicated they had no role. Community health worker visits to households/health facilities between 2010-2020 occurred monthly for 28.9% of

respondents, followed by once every 3 months at 16.5%, once a year at 16.0%, other frequencies at 13.4%, weekly visits at 12.9%, and once every 6 months at 12.4%. The most commonly offered service during community-based maternal health outreach was health education at 77.5%, followed by family planning at 59.9%, antenatal care at 58.2%, and immunization at 56.6%. Regarding program challenges in tracking or reporting KPIs, resource and system constraints were the most frequently cited at 55.5%, followed by data availability and quality challenges at 50.9%, limited technical and human capacity at 46.2%, and coordination and communication gaps at 32.9%. For community outreach forms, community health volunteers providing health education were most prevalent at 58.3%, followed by radio programs on maternal health at 50.0%, mobile clinics providing antenatal care at 48.9%, religious or traditional leader engagement at 23.3%, and other forms at 3.3%.

Table 2. Prevention and Community Intervention

Questions	**Frequency (n)**	**Percent (%)**
Are there community awareness programs in your community that focusses on maternal and child health?		
Yes	152	73.8
No	18	8.7
I don't know	36	17.5
Do you have a role in maternal health in The Gambia?		
Yes	171	83.8
No	33	16.2
I don't know	0	0
How often have community health workers visited your household/health facilities to provide maternal health education or services between 2010-2020?		
Monthly	56	28.9
Once a year	31	16.0
Once every 3 months	32	16.5
Once every 6 months	24	12.4
Other	26	13.4
Weekly	25	12.9
Which services were offered during the community-based maternal health outreach?		
Antenatal care	106	58.2
Immunization	103	56.6
Health Education	141	77.5
Family Planning	109	59.9
What challenges did the program face in tracking or reporting KPI?		
Data availability and quality challenges	88	50.9
Limited technical and human capacity	80	46.2
Resource and system constraints	96	55.5
Coordination and communication gap	57	32.9
What forms of community outreach for maternal health services are available in your community?		
Mobile clinics providing antenatal care	88	48.9
Community health volunteers providing health education	105	58.3

Religious or traditional leader engagement in maternal health promotion	42	23.3
Radio programs on maternal health	90	50.0
Other	6	3.3

Maternal Health Awareness Programs Implemented in the Study Area between 2010-2020

Figure 1 answers the question of which maternal health awareness programs have been implemented in your community between 2010-2020? As shown in the chart, antenatal and postnatal care programs achieved the highest implementation rate at 66.5%, followed closely by family planning and birth spacing initiatives at 65.5%. Safe childbirth education programs (53.3%) and breastfeeding promotion programs (54.8%) indicating moderate implementation levels, while maternal nutrition education lagged at 50.8%. Notably, "other" programs represented only 7.6% of implementations.

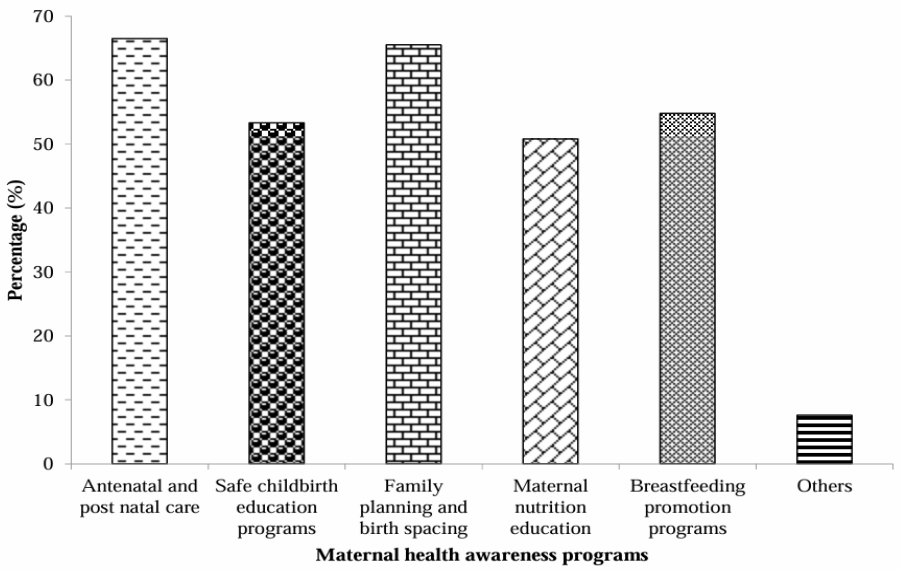


Figure 1. Which Maternal Health Awareness Programs have been Implemented in your Community between 2010-2020?

Assessment of community-based maternal health interventions that the respondents have personally participated in between 2010-2020

Figure 2 answered the question of which community-based maternal health interventions have you personally participated in between 2010-2020? Data showed that women's support groups for maternal health demonstrated the highest participation at 47.2%, indicating strong peer-to-peer engagement mechanisms. However, participation in traditional birth attendant training programs was limited to 26.7% of respondents. Critical emergency and economic support systems showed particularly low engagement: community emergency transport systems (18.8%), home-based maternal care visits (20.5%), and community savings schemes for healthcare costs (15.9%). The 17.6% participation in "other" interventions suggests some diversification in community-level activities beyond the measured categories.

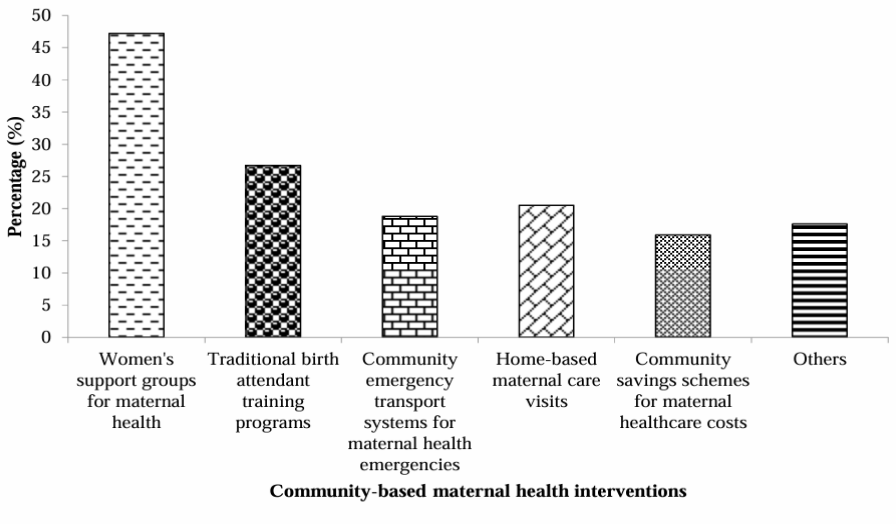


Figure 2. Which Community-based Maternal Health Interventions have you Personally Participated in between 2010-2020?

Key Performance Indices Measured during the Programs

Figure 3 answered the question on which Key Performance Indices (KPIs) were measured. As shown in the chart, ANC and PNC attendance had the highest monitoring rate at 67.5%, followed by skilled birth attendance (55.6%) and place of delivery (52.7%). Family planning indicators showed moderate monitoring, with contraceptive use at 45.6% of programs and birth intervals in 42% of cases. Preventive health measures like tetanus protection were monitored in 31.4% of programs. Concerning gaps emerged in adolescent birth monitoring (18.9%) and measles, mumps, and rubella (MMR) at 14.2%, indicating potential blind spots in comprehensive maternal health surveillance.

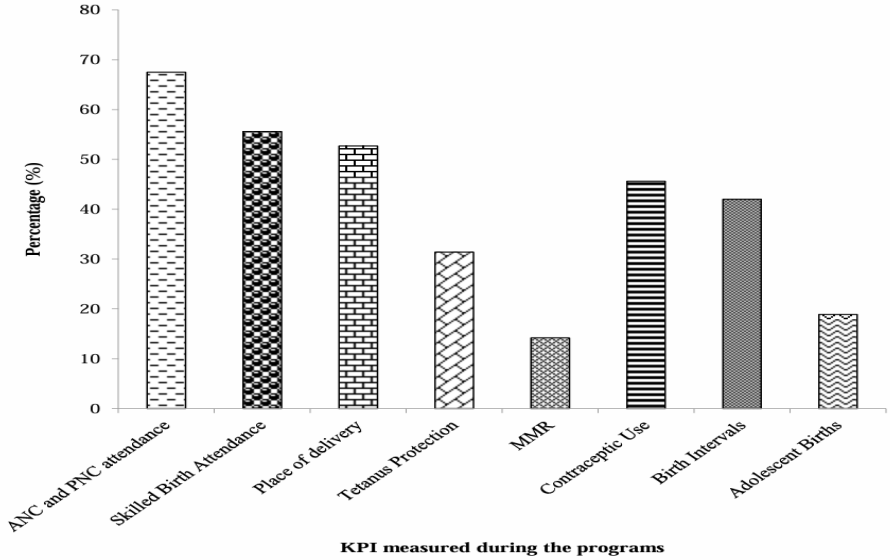


Figure 3. Which Key Performance Indices were Measured during the Programs?

Discussion

The respondent profile which was majorly males, aged 25-34 and highly educated, largely reflects the professional cohort within The Gambian health sector. The significant representation of nurses/midwives and public

health officers is very important, as these professionals are at the forefront of implementing community-based maternal health initiatives. Their geographical distribution, with high representation from the Western Coast Region (WCR) and Kanifing Municipal Council (KMC), agrees with the fact that these areas are densely populated and urbanized areas where health facilities and programs are often concentrated. It is important to note that this information, offers a valuable insight into the perceptions of skilled health cadres regarding systemic challenges and successes [21, 22].

Findings show a strong emphasis on community awareness and engagement in maternal health. A substantial majority of respondents reported the presence of community awareness programs, and affirmed their personal role in maternal health efforts. This high level of engagement among professionals shows the recognition of community-level interventions as fundamental to improving maternal outcomes. Furthermore, the most frequently offered services during community-based maternal health outreach included health education, family planning, antenatal car, and immunization. This broad scope of services suggests a comprehensive approach to maternal and child health at the community level, aligning with integrated primary healthcare models advocated globally [23]. Also, Community Health Worker (CHW) visits, while varied in frequency, showed monthly visits as the most common, indicating a foundational level of routine engagement.

Data from this present study showed that family planning and birth spacing initiatives had the highest implementation rates regarding awareness. This is a positive indicator of focused programming on critical stages of maternal health. However, a significant difference was observed when examining personal participation in community-based interventions. While women's support groups for maternal health showed commendable participation, participation in crucial areas such as traditional birth attendant (TBA) training, community emergency transport systems, home-based maternal care visits, and community savings schemes for healthcare costs was notably low. This differences between program awareness/implementation by health workers and actual community participation in critical support systems points to potential barriers in access, mobilization, or perceived relevance from the perspectives of each the community [24]. In addition, limited engagement in emergency transport and savings schemes is particularly concerning, as these are vital components for addressing delays in accessing care and catastrophic health expenditures, which are major contributors to maternal mortality in low-resource settings [25-26].

A critical finding from the questionnaire was the identification of significant challenges in tracking or reporting KPIs. Resource and system constraints, data availability and quality issues, limited technical and human capacity, and coordination/communication gaps were frequently reported. These challenges directly impact the ability to accurately assess the effectiveness of interventions and make evidence-based adjustments, thereby reducing the efforts to improve maternal health outcomes using technology and efficient data management system [27].

The lack of robust data systems and capacity for analysis can make real progress very difficult in the nation. Based on the findings of this study, ANC and PNC attendance, skilled birth attendance, and place of delivery were the most monitored key performance indicators. This shows how much the nation as well as global agencies in the count prioritizes to promote facility-based deliveries and continuum of care [23].

Conclusion

This comprehensive study of the changes in maternal health indicators and the efficacy of community-based interventions in The Gambia reveals both notable successes and enduring difficulties that define maternal health systems throughout sub-Saharan Africa. Stakeholder perspectives on the delivery of maternal health services in The Gambia provide important insights into performance indicators and systemic challenges. Although there have been improvements in skilled labour and antenatal coverage, ongoing problems like inadequate infrastructure, a lack of workforce, and limited data reliability continue to hinder progress. To achieve more substantial improvements, more intensive efforts are required to reduce the inefficiencies. Stakeholders emphasise the need for community engagement, stronger inter-sectoral collaboration, and investment in health systems to ensure sustainable maternal care. Meeting national and international health goals and providing equitable, high-quality maternal health services depend on addressing these issues through focused policy changes and capacity building.

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Conflict of Interest

The authors declare no conflict of interest.

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Assessment of the Challenges of Emergency Medical Response in Edo State Health Care Delivery

Charles Omheaka Okpere[1*], Christopher Ehis Okaka[2], Innocent Osi Alenoghena[3], Daniel Aromeh Odekina[4]

[1]*School of Public Health, Texila American University, Georgetown, Guyana*
[2]*Department of Animal and Environmental Biology, University of Benin, Benin City, Nigeria*
[3]*Department of Community Medicine, Ambrose Alli University, Ekpoma, Nigeria*
[4]*Primary Health Care Development Agency, Edo State, Nigeria*

Abstract

This article critically evaluates the challenges of Emergency Medical Services/Response within the Edo State healthcare system. The research is premised on the need for an effective Emergency Medical Response call centre and number. Despite the recent launch of an EMR service, public awareness of the existence of a call centre and its number remains unclear, highlighting the need for urgent action. The purpose of this research is to determine the presence of EMS response centres in the study area and also assess public awareness of a designated emergency call number in Edo State. The methodology employed both quantitative and qualitative approaches, using semi-structured questionnaires and in-depth key interviews. Five hundred and twenty-four respondents participated in the research. The study area encompassed the three senatorial districts of Edo State. A multistage sampling technique was applied, and SPSS was ultilized for data analysis. The results and challenges elicited are concerning and entail the following: the absence of an identifiable EMR call centre in the study area, as about four-fifths of the respondents stated they had no knowledge of any EMR team in their locality, and the unawareness of any designated medical emergency phone number; scarce availability of ambulance services and Automated External Defibrillators in the study communities, as over four-fifths of the respondents indicated a non availability of EMR ambulances. Therefore, the Government urgently needs to set up one EMS/ Response centre in every local Government and carry out mass sensitization to encourage use.

Keywords: *Challenges, Edo State, Emergency, Medical-Response.*

Introduction

Emergency medical services (EMS) are seen as a comprehensive system that provides the arrangement of personnel, facilities, and equipment for the effective, coordinated, and timely delivery of health and safety-sensitive services to victims of sudden illness or injury [1], thereby helping to prevent unwanted mortality and morbidity [2, 3].

Emergency Medical Response (EMR) describes the reactions and responses of institutional systems to medical emergencies. Every country has different capacities to deal with these emergent situations, whether developed or less developed. The notion, belief or experience is that developed nations are better equipped to deal with medical emergencies than developing nations [4]. The primary goal of EMR is to mitigate both short-term and long-term negative impacts on

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****Corresponding Author: okpere@hotmail.com***

affected individuals and society. To this end, some notable scholars, including Blackwell and Kaulman, stipulated that those institutional systems always seek ways to improve operational performance on a continuum [5, 6].

In most developed and organized societies where there is an established EMS system, the occurrence of a medical emergency elicits a cascade of a system response which encompasses:

1. Prompt syndrome identification.
2. Immediate action by a bystander.
3. Call for help [7] via a designated, easy-to-remember telephone number. Notable examples include 911, 999, and 112, as coded by the International Telecommunication Union (ITU) helplines [8].
4. First aid by first responders.
5. Prompt transportation to the nearest health facility that can handle the emergent condition [9,10].

On the contrary, Nigeria's emergency response raises many questions, as it falls short of meeting these standards. First and foremost, assume a life-threatening incident occurs; are the bystanders or people in our immediate environment trained to identify it and respond appropriately and effectively? Next, is there any national designated telephone number to call with a standby team that would provide immediate response? Assume there is; what is the level of public awareness of such a number, and how fast is their response? Do we have integrated, effective, and efficient emergency communication centres/ hotlines that provide such services [11]? Furthermore, do we have ready ambulances/ other mobile emergency medical services with trained paramedics that could respond promptly? Next, are bystanders and first responders empowered to provide cardiopulmonary resuscitation (CPR), administer oxygen, use an automated external defibrillator (AED), and use other life support tools?

In Nigeria, the Lagos State Government has taken the lead in EMR compared to other states and the national Government, having established the Lagos State Emergency Medical Services (LASEMS) and Lagos State Ambulance Services (LASAMBUS) [12] since March 2001. They also established a dedicated hotline, 123, and set up 15 ambulance points with Mobile Intensive Care Units (MICU) operated by trained personnel.

Notably, in the same year, 2021, the Edo State Government failed to domesticate the State Emergency Management Agency due to a claimed lack of funds and inflation [13]**.** It is, therefore, doubtful if the state has an existing/ functional EMS or an emergency call number. This narrative, however, is marked by renewed hope, as ThisDay's report of November 30, 2023, reported a collaboration between the Edo state government and Emergency Response Africa (ERA) to launch a technologically driven EMS to foster health emergency response in the state. The project's primary focus is on tackling low public health trust, communication challenges, and inefficient data collection in the three most urban local government areas: Oredo, Egor, and Ikpoba Okhae [14].

Another critical issue is the average emergency response time, from the time of the call to the initiation of rescue action. This is crucial because, for example, in a heart attack, every minute that passes reduces the chance of survival by 7-10% [15]. In the USA, the average arrival time of an EMS team is about seven minutes in urban areas and 14 minutes in rural settings [16, 17]. In Nigeria, institutionalization of a response system is still very primordial. In Edo State, in particular, the goal is to provide an EMR response time of 10 minutes, whereas in Lagos State it varies widely, ranging from 7 to 60 minutes [18]. The response time is influenced by several factors, including location, road traffic, and the initial delay before making emergency call. Other determinants include inadequate ambulances,

data shortages, unrest/ insecurity, gender discrimination, and communication failures [19].

Some barriers impede the implementation of a standardized EMS training programs, as EMS instructors are often in short supply. Another factor is the short duration of training compared to the voluminous information that requires applications in tense situations, which may be life-threatening. Additionally, most EMS training in Nigeria is conducted in person rather than in a more flexible virtual format. Inadequate funding, infrastructure decay, and a lack of a national policy for EMS training and regulation are all contributory factors [20, 21]. Some cultural beliefs negatively impact emergency response behaviour in several dimensions. First is the prevalent belief in alternative medicine in Nigeria, particularly in rural areas [21]. Also remarkable are the communal and extended family influences on decision-making, as well as women relying on their spouses for decisions, even in life-threatening situations. The perception of illness causation is yet another factor, as some hold a strong belief that spirits and supernatural forces cause specific ailments like seizures and mental disorders, and subsequently make them seek alternative medicine [22]. There is also a strong apathy toward the use of ambulances, as some have the notion that ambulances are mainly for transportation of the dead, except when critically ill [23].

The primary purpose of this article is to examine the challenges of emergency medical response in Edo State, with specific objectives to investigate the non-availability of EMS teams and the non-functioning of emergency call number/s.

Methodology

Study Area/ Population

The study was conducted in Edo state, with an estimated population of about five million people and Benin City as its capital. Edo State has a landmass of 19,187 km² and a population density of 168 persons/km². It has 18 Local Government Areas (LGA) with five major ethnic groups: Binis, Esan, Afemai, Etsako, and Owan**.** The state is divided into three senatorial districts: Edo South, Edo Central, and Edo North.



Figure 1. Map of Edo State showing the 18 Local Government Areas and their Capital

Figure 1 shows the map of Edo State, displaying the 18 Local Government Areas and their respective headquarters [24].

Research Design

Both quantitative and qualitative methods were used. In the quantitative method, a

descriptive cross-sectional study was conducted using a semi-structured questionnaire. In the qualitative method, Key Informant Interviews and focus group discussions were used to assess information from the participants.

Exclusion/ Inclusion Criteria

For the quantitative method, the participants were drawn from the general public and households, while in the qualitative method, key informants selected included health workers, ambulance drivers, accident emergency victims and representatives from selected institutions. However, hospital patients and individuals under 15 years of age were excluded from the study.

Sample Size

The sample size was determined by applying the formula:

N = Z2Pq/d2 since the estimated sample size is more than 10,000 [25]

N = desired sample size

Z = standard normal deviate (1.96) at 95% confidence level

P = proportion of target population

q = 1 - P

d = degree of accuracy, assume it is 0.05

N = 1.962x50%x0.5/0.052

N = 400

N = 440. Assume 10% would be void

Based on the above, the minimum number of questionnaires to be distributed is 440. However, 600 questionnaires were distributed.

Sampling Techniques

Multistage sampling methods were applied, with the three ecological zones—Edo North, Edo Central, and Edo South —used. After that, simple random sampling was applied to select the local government area of study, wards, communities, and eventually households using home numbering. About 200 questionnaires were distributed in each senatorial zone, for a total of 600.

Data Collection/ Analysis

This was through a semi-structured questionnaire and personal interviews with key/ group informants. Table tabulations were used for data presentation, and data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software version 26, the Excel package, and relevant statistical tests for associations. Pretesting and validation of the measurement tool were conducted before its field application.

Expected Output

The following expectations would be achieved at the end of the research:

1. It will bring to the fore the challenges/ drawbacks of Emergency Medical Response in the Edo state healthcare system.
2. We will have the needed information and data for advocacy on EMS.
3. It will help accelerate advocacy to the Government to promptly set up an EMR team and emergency call centres, institutionalize a designated national emergency call number, and ensure ambulances are given the needed priority.

Ethical Consideration

The participants were assured of absolute confidentiality. Ethical approval was obtained from the Edo State Ministry of Health Ethical Board. Consent was obtained from the local government authorities and the participants. Verbal consent was also obtained from traditional institutions where necessary.

Results

Table 1 indicates that 524 respondents participated in this study. The largest proportion of respondents, 194 (37.0%), came from the Edo South Senatorial zone. Most respondents live in rural areas (206, 39.3%). Regarding the Local Government Area, the highest proportion of respondents came from Esan North East LGA, with 137 (26.2%),

followed by Akoko-Edo with 92 (17.6%), Ikpoba-Okha with 77 (14.7%), and Orhionmwon with 73 (13.9%). The mean age of respondents was 39.27 ± (11.45) years. The highest proportions of respondents were female (59.5%), married (70.6%), and tertiary educated (71.2%). The highest proportion of respondents, by ethnic group was Esan, at 151 (28.9%), followed by Bini, at 127 (24.2%). The highest proportion of respondents was civil servants, 155 (29.6%).

Table 1. Socio-demographic Characteristics of Respondents (N=524)

Variable	Frequency	Percentage
Senatorial zone		
Edo South	194	37.0
Edo Central	179	34.2
Edo north	151	28.8
Type of Community		
Urban	104	19.8
Semi-urban	214	40.8
Rural	206	39.3
Local Government Area		
Ikpoba-Okha	77	14.7
Esan North East	137	26.2
Oredo	19	3.6
Orhionmwon	73	13.9
Egor	14	2.7
Akoko edo	92	17.6
Esan central	64	12.2
Etsako west	14	2.7
*Others	34	6.4
Age		
15 – 30	125	23.9
31 – 45	253	48.3
46 – 60	137	26.1
61 – 75	8	1.5
≥ 76	1	0.2
Mean age = 39.27 ± (11.45)		
Sex		
Male	212	40.5
Female	312	59.5
Marital Status		
Single	143	27.3
Married	370	70.6
Separated/Divorced	8	1.5
Widow/Widower	3	0.6
Level of Education		
No formal education	6	1.1
Primary	25	4.8

Secondary	120	22.9
Tertiary	373	71.2
Tribe		
Bini	127	24.2
Esan	151	28.9
Etsako	26	4.9
Urhobo	17	3.2
Igbanke	11	2.1
Akoko edo	17	3.2
Igarua	8	1.5
Ekpe	3	0.5
Edo	19	3.6
Ishan	49	9.4
Owan	11	2.1
Afemai	18	3.4
Igbo	7	1.3
Others	60	11.5
Occupation		
Civil servant	155	29.6
Health worker	85	16.2
Doctor/nurse	31	5.9
Self-employed	124	23.7
Student	82	15.6
Teacher	23	4.4
Unemployed	5	1.0
Engineer	5	1.0
Accountant	1	0.2
Electrician	1	0.2
Others	12	2.3

Figure 2 shows that 110 (21%) of the participants reported knowing a phone number to call in the event of a medical emergency. In comparison, 414 (79%) stated they did not know of any medical emergency number to call. This indicates a low level of awareness and utilization of a designated medical emergency number in the study area.

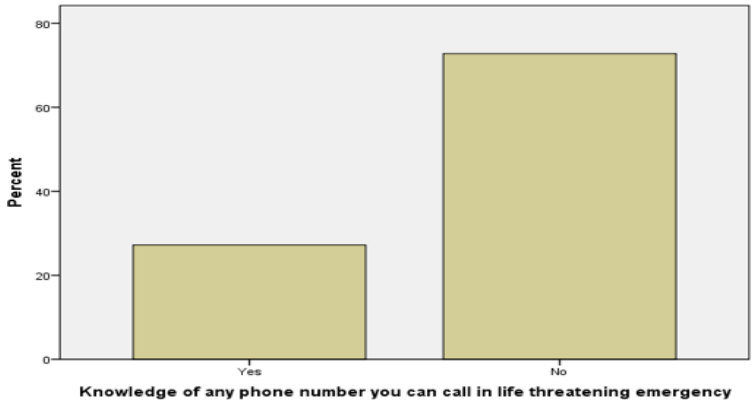


Figure 2. Knowledge of Phone Number to Call during a Medical Emergency

Table 2 depicts respondents' previous experiences with emergency services. Less than half of the respondents, 250 (47.7%), had observed or experienced a sickness that required urgent attention. The highest proportion of respondents went to the hospital when they were sick (207, 39.5%), followed by the health centre (188, 35.9%) and then the Patent Medicine Store (64, 12.2%). Of the 250 respondents who needed urgent medical attention, 207 (82.8%) met health workers and received prompt attention; the proportion of self-reported times of a health facility's response to emergencies was 81 (32.4%), with 81 (32.4%) being immediate and 5-10 minutes. Most respondents, 452 (89.5%), had not heard of any emergency response team in the locality. 414 (79.0%) and do not know any phone number to call in an emergency. Of the 73 respondents aware of an ambulance service in their locality, 44 (60.3%) were privately owned, with the majority of the ambulance types being buses (49, 67.1%). The highest proportion of respondents, 25 (34.3%), reported that the response time of the EMR team was between 10 and 15 minutes. Just 18 (3.4%) respondents had ever been taken to the hospital by ambulance.

Table 2. Previous Experiences of Emergency Services

Variable	Frequency	Percentage
Observed or experienced severe unexpected sickness requiring urgent attention		
Yes	250	47.7
No	274	52.3
During sickness, where do you/your relation go for care?		
Health centre	188	35.9
Hospital	207	39.5
Medicine store	64	12.2
Call the emergency number	3	0.6
Nil	62	11.8
Who called the emergency number (n = 3)		
A friend/relative	3	100.0
Encounter when You observed or experienced a severe, unexpected sickness requiring urgent attention (n = 250)		
Met a health worker, received quick attention	207	82.8
Met a health worker, but did not receive quick attention	26	4.9
Met a health worker, the patient was sent away	2	0.4
Health centre/hospital locked	6	1.2
No response	9	54.0
How quickly the health facility responded to an emergency (n = 207)		
Immediately	81	39.1
Between 5 to 10 minutes	81	39.1
10 to 30 minutes	24	11.6
More than 30 minutes	14	6.8
Can’t recall	7	3.4

Knowledge of any Emergency Medical Response team in the locality?		
Yes	55	10.5
No	452	89.5
State the time to get to you from their location (n = 55)		
1 – 10 minutes	3	5.5
11 – 20 minutes	12	21.8
21 – 30 minutes	10	18.2
Above 30 minutes	30	54.5
Knowledge of any phone number you can call in case of any life-threatening emergency		
Yes	110	21.0
No	414	79.0
Emergency numbers called		
Stated various private GSM nos	77	47.5
Nurse/Doctor/Health worker	78	48.2
Family member/relation	7	4.3
Can you give a cardiopulmonary resuscitation?		
Yes	187	35.7
No	337	64.3
Had any formal training in cardiopulmonary resuscitation (n = 187)		
Yes	143	76.5
No	44	23.5
Can anyone in your house perform CPR (n = 337)		
Yes	26	7.7
No	311	92.3
*** Response in times of sudden collapse**		
Carry out CPR	124	23.7
Rush to the hospital/health centre	205	39.1
Call for help/medical personnel	52	9.9
Increase ventilation	47	9.0
BLS	1	0.2
Prayer	1	0.2
Pour water on the body	26	5.0
Availability of medical ambulance in case of medical emergency		
Yes	71	13.5
No	453	86.5
Contact/phone no. (n = 71)		
Stated various private GSM nos	60	84.5
Do not have the number	11	15.5
Means of transportation to a health facility in case of emergency		
Walking	17	3.2
Bicycle	2	0.4

Motorcycle	172	32.8
Private vehicle	170	32.4
Commercial vehicle	125	23.9
Government ambulance	4	0.8
No response	34	6.8
Availability of Emergency medical response ambulance service in the locality		
Yes	73	13.9
No	451	86.1
Ownership of ambulance (n = 73)		
Government-owned	29	39.7
Private owned	44	60.3
Type of ambulance (n = 73)		
Bus	49	67.1
Keke	14	19.2
Others	10	13.7
How early does the EMR team respond to your emergency call (n = 73)		
Immediately (less than 10 minutes)	6	8.2
10 to 15 minutes	25	34.3
15 to 30 minutes	21	28.8
More than 30 minutes	15	20.5
Can't recall	6	8.2
***Equipment contained in the ambulance (n = 73)**		
Oxygen supply	31	42.5
PPE	53	72.6
Trained driver	31	42.5
At least one trained medical personnel	19	26.0
AED	5	6.8
EMS guide book	6	8.2
Portable stretcher	33	45.2
Splints	7	9.6
Radio communication system member	3	4.1
Automotive safety belt	10	13.7
Have you ever been taken to the hospital in an Ambulance?		
Yes	18	3.4
No	506	96.6
How clean was the ambulance? (n = 18)		
Very clean	2	11.1
Fairly clean	12	66.7
Not very clean	3	16.7
Don't know/can't remember	1	5.6
Did the ambulance come in a crew? (n = 18)		

Yes	14	77.8
No	4	22.2
***Members of the crew (n = 14)**		
Doctor	1	7.1
Nurse	7	50.0
Paramedics	14	100.0
Driver	1	7.1
Treated with respect and dignity by the crew? (n = 14)		
Yes, definitely	3	21.4
Yes, to some extent	7	50.0
Don't know/can't recall	4	28.6
Rate the care you received from the ambulance (n = 18)		
Very good	5	27.8
Good	7	38.9
Fair	6	33.3

** Multiple response type*

Table 3 shows the knowledge/previous training on Emergency Care among respondents. The highest proportion, 277 (52.9%), had previously participated in First Aid training. In comparison, 112 (21.4%) had participated in cardiopulmonary resuscitation, and among the 112 respondents who self-reported CPR training, 73 (65.2%) had received training within the last five years. Only 59 (11.3%) respondents had ever heard of an external defibrillator, and 49 (83.1%) reported that no AED was available in their locality.

Table 3. Knowledge/Previous Training on Emergency Care

Variable	**Frequency**	**Percentage**
***Training you have participated in:**		
First aid	277	52.9
CPR	112	21.4
Basic Life Support	59	11.3
Had training on Cardiopulmonary resuscitation?		
Yes	112	21.4
No	412	78.6
Date of last CPR training (n = 112)		
1 – 2 years	22	19.6
3 – 4 years	17	16.1
> 5 years	73	65.2
Have you heard of an Automated external defibrillator?		
Yes	59	11.3
No	465	88.7
State the nearest location to you: (n = 59)		
3 – 5 minutes away	10	16.9
None available around the location	49	83.1

** Multiple response type*

Focus Group Discussion/ Key Informant Interview Method

Sampling

Focus group discussions were conducted in each of the senatorial regions, and three key informant interviews were held with health workers, ambulance drivers, and selected community leaders to gather critical information on emergency medical services within their respective domains. I recorded the interviews with the participants' permission. For the FGD, participants were drawn from different communities: the Ovbioge community in Benin, Edo South; Irrua and Ubiaja from Edo Central; and Agbede from the Edo North senatorial region.

Specific Objectives of the Qualitative Study

These were similar to those of the quantitative research. The questions were, however, presented informally to allow for robust contributions and a free flow of interaction. The discussions were focused on the specific objectives earlier stipulated.

Quality Assurance

For the FGD, we ensured that each session had no more than ten people, and participants were selected through a simple ballot. A serene environment was used during the session, and the participants put their devices on silent mode to prevent unnecessary interruptions. We also ensured that sessions were moderated to last no more than one hour and avoided deviations from the research objectives.

Problem Encountered/ Limitations

1. Some participants dominated the discussions, especially the more educated ones.
2. Some of the participants kept making requests for monetary compensation before participating in the research.
3. Some participants opted out due to the audio recording.

Findings of the Qualitative Method

EMS Centres in the Study Area

There were no identifiable EMR centres in the study area. None of the participants indicated awareness of any EMR call centre in their community. They stipulated that the first point of care for most persons in their communities was the medicine/ nursing home. However, for communities around tertiary institutions like ISTH, people tend to go straight to the teaching hospital during medical emergencies, usually by private or public transportation, as ambulances are rarely available.

Public awareness of the EMR call number/s: Very few participants had heard of the designated 112 emergency number, and general awareness in their respective communities is limited. In one of the sessions, only two people out of eight knew the 112 call number or other designated emergency numbers. Some of the participants, however, stated they call the private GSM numbers of the health workers they are familiar with in their locality.

Other gaps: The participants identified some other factors leading to delayed medical attention, which are highlighted below:

1. Some of the identified challenges included the common issue of women waiting for their spouses' approval before seeking help, traffic congestion in cities, and poor road conditions.
2. Few ambulances were available, and the majority were privately owned. Most of the 'keke NAPEP' ambulances were moribund and non-functional. Moreover, most PHC centres and other health institutions close to the people are dilapidated and lack basic medical services and human resources.
3. The participants maintained that EMS is currently not in top form due to several factors, including inadequate funding, a lack of political will, and insufficient

budgetary allocation to health from the three levels of Government: federal, state, and local. Other reasons adduced were untrained medical personnel, poor resource management, and the poor attitude of health staff toward their clients.

4. Furthermore, the participants' awareness of AEDs was almost non-existent, except for a few, who were most often senior health workers.

These findings were heartbreaking, as the participants unanimously agreed that the Edo state healthcare system is bewildered by numerous challenges.

Discussion

The study revealed that over three-quarters of the respondents were unaware of any emergency medical response team in their locality. This was significantly higher than a previous study conducted in Abuja, which found that 57.8% of FCT residents were aware of EMS operations and their utilization. In comparison, 42.2% of respondents were unaware of such services in the FCT, Nigeria [26]. In the same vein, a similar proportion of the respondents do not know any phone number to call in the event of a medical emergency. Over three-quarters of the respondents stated there were no medical ambulance services in their communities. The few available ambulances were under-equipped, lacking essential emergency medical supplies and state-of-the-art equipment. To this end, they render little or no medical assistance, including resuscitation and first aid treatment, before conveying the individual to the hospital. It was observed that more than one-third of the respondents patronize either the secondary or tertiary level of healthcare without first visiting the Primary Health Care (PHC) centres. This could be attributed to the fact that most PHC centres are understaffed and lack essential equipment.

Respondents reported no specially designated phone number. All the stated emergency numbers were private GSM numbers of healthcare workers and individuals in their communities. Specifically, no respondents mentioned the 112 emergency number [8]. This indicated that there were no coordinated EMS call centres/ call numbers in the study area. If there are, there is near-zero public awareness regarding their functionality. Therefore, there is an urgent need for the Government to establish an EMS/response centre in every local Government and to equally embark on mass sensitization and mobilization through community engagement, awareness walks, and regular radio and television engagements.

The EMS response time was also a significant concern, as the research revealed that fewer than 1 in 10 people reported an EMS response time of less than 10 minutes, which is a known survival indicator, especially in myocardial infarction (heart attack) [16]. This is similar to previous studies on EMS response time in Nigeria [18]. Furthermore, it was noted that there were no efficient radio communication systems in the ambulances. They instead use their personal GSM phones, which are often unreliable, as stated earlier. Therefore, there is a need for the Government to collaborate with other telecommunication stakeholders to institutionalize a nationally designated, easy-to-remember, and functional EMR call number. The challenges identified in this study align equally with those in similar studies in Africa. Studies carried out in Uganda and some other African countries highlighted similar challenges, which lead to a national dialogue, and subsequently lead to creation of ems department, regulatory impact assessment, improved data indications, creation of ambulance association involving both private and public providers, incorporation of Emergency Care Services (ECS) with National Health Insurance Services for sustainability, and development of an ECS training curriculum for nurses and medical technicians [27]. There is a need to ensure every household is within 5

km of a health facility or an EMS centre. There is also an equal need to strengthen and scale up health insurance, as well as to implement a policy promoting regular training of Community-Based First Responders [28].

Only one-tenth of respondents were aware of AED, and about three-quarters of those who knew stated that none was available in their locality. This is concerning, as previous studies have shown that combining CPR with AED can significantly improve survival during a heart attack [29].

Conclusion/ Recommendation

The highlights of the research are enumerated below:

Over three-quarters of the respondents reported having no information about any existing emergency medical response team in their locality. As a result of this revelation, it is recommended that the Government promptly establish an EMS/ response centre in every local Government in Edo state.

Approximately four-fifths of the respondents stated they were unaware of any designated emergency phone number to call in an emergency. The remaining respondents provided private GSM numbers of health workers or close relatives as emergency numbers. Based on this finding, conducting a public awareness campaign is crucial to inform and educate people about 112 and other emergency call numbers. This is significant, as only 0.6% of respondents call EMR numbers during medical emergencies, indicating very low utilization of the EMR call number.

The possible barriers to implementing recommendations include a lack of political will, particularly regarding PHC and EMS funding, as well as the non-prioritization of emergency care in emergency rooms. We still have emergency centres requesting ID cards and police reports before treatment. Moreover, some cultural beliefs are difficult to change. These, however, can be addressed through continuous community education that utilizes best practices and emerging scientific knowledge, as well as through public-private partnerships for EMS funding.

Conflict of Interest

I, Charles Okpere, hereby state that there was no conflict of interest while conducting this research.

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Adherence to Anti-hypertensive Medication among the Elderly and Associated Factors in Mandeville, Jamaica

Ainsworth M. Reynolds[1*], Antor Odu Ndep[2], Moyosola A. Bamidele[3]
[1]*School of Public Health, Texila American University, Guyana*
[2]*Department of Public Health, Faculty of Allied Medical Sciences, University of Calabar, Nigeria*
[3]*Department of Global Health & Bioethics, EUCLID University, The Gambia*

Abstract

Hypertension remains a leading cause of morbidity and mortality globally, with non-adherence to antihypertensive medication posing a significant barrier to effective control, particularly among older adults. This study assessed adherence levels and associated factors among geriatric hypertensive patients in Mandeville, Jamaica. A mixed-methods design was employed. Quantitatively, a cross-sectional survey of 220 participants aged 65 years and older was conducted using the Morisky Medication Adherence Scale-8 (MMAS-8) and Hill-Bone Compliance Scale. Qualitatively, in-depth interviews were held with 23 patients. Quantitative findings showed that 61% of participants reported moderate adherence and 19% low adherence on the MMAS-8. At the same time, the Hill-Bone scale produced an average adherence score of 55.3 (SD = 30.1). Significant reasons for non-adherence included lack of funds (55%), forgetfulness (19.5%), and limited time for refills (23.2%). Significant associations were observed between adherence and health education ($\chi^2 = 20.40$, $p = 0.008$), possession of a National Health Fund card ($p = 0.004$), physician-patient relationship ($p = 0.005$), and polypharmacy ($\chi^2 = 6.689$, $p = 0.035$). Qualitative insights underscored challenges with medication management, coping strategies, and knowledge gaps regarding hypertension. These findings highlight the urgent need for multifaceted interventions addressing financial, educational, and relational factors to improve adherence and hypertension control in the elderly.

Keywords: *Adherence, Geriatrics, Health Education, Hypertension, Jamaica, Polypharmacy.*

Introduction

Hypertension (HTN), defined as a sustained systolic blood pressure ≥130 mmHg and/or diastolic blood pressure ≥80 mmHg, represents a critical global health epidemic and a leading modifiable risk factor for cardiovascular disease (CVD), stroke, and renal failure [1]. Its insidious, often asymptomatic nature has earned it the ominous moniker "the silent killer," as individuals may remain undiagnosed and untreated for years, accruing irreversible damage to target organs [2]. The global burden of HTN is staggering; the World Health Organization (WHO) estimates that the number of adults living with hypertension has nearly doubled since 1975, rising from 594 million to over 1.13 billion in 2015, affecting approximately 40% of the global adult population [3]. This surge is particularly pronounced in low- and middle-income countries (LMICs), where health systems are often ill-equipped to manage the burgeoning burden of chronic non-communicable diseases.

The clinical management of hypertension is predicated on achieving and maintaining blood

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****Corresponding Author: areynolds184@gmail.com***

pressure within target ranges to prevent catastrophic complications. While non-pharmacological interventions like dietary modification and exercise are foundational, antihypertensive pharmacotherapy is the cornerstone of treatment for the vast majority of patients [4]. The efficacy of these medications in reducing cardiovascular morbidity and mortality is well-established. However, their clinical success is entirely contingent upon one critical factor: patient adherence, defined as "the extent to which a person's behaviour – taking medication, following a diet, and/or executing lifestyle changes – corresponds with agreed recommendations from a healthcare provider" [5]. Despite the availability of highly effective drugs, blood pressure control rates remain dismally low worldwide, with non-adherence to prescribed medication regimens identified as the single most significant contributor to this treatment gap [6].

Studies conducted in various settings indicate that adherence to antihypertensive medication is particularly problematic among the elderly. Estimates suggest that adherence rates among individuals aged 60 and older range from 26% to 59% [7, 8]. This population faces unique challenges, including polypharmacy (the use of multiple medications for co-morbid conditions), age-related cognitive decline leading to forgetfulness, increased sensitivity to medication side effects, and socioeconomic vulnerabilities such as fixed incomes and social isolation [9]. The consequences of non-adherence are severe, leading to uncontrolled hypertension, accelerated progression of cardiovascular and renal disease, increased frequency of hospitalizations, and a significant increase in all-cause mortality [10].

In the Jamaican context, hypertension is a pressing public health concern. The 2016-2017 Jamaica Health and Lifestyle Survey (JHLS III) reported a point prevalence of hypertension of 30.8% among adults aged 15 and over, with the prevalence escalating dramatically with age, reaching 54.1% among those aged 65-74 [11]. Cardiovascular diseases are a leading cause of death in the country, with hypertension being a primary underlying factor. The Caribbean region, including Jamaica, faces distinct challenges in managing HTN, including resource constraints within public health systems, cultural beliefs about illness and treatment, and economic barriers that limit access to consistent care and medication [12]. Previous research in the region has pointed to non-adherence, poverty, lack of knowledge, and inadequate follow-up as significant impediments to effective blood pressure control [13].

However, a comprehensive understanding of the specific factors driving non-adherence among the geriatric population in Jamaica remains limited. Most studies have been predominantly quantitative, potentially missing the nuanced lived experiences and contextual barriers faced by patients. Therefore, this study employed a mixed-methods approach to bridge this gap. The primary objectives were: (1) to quantify the prevalence and level of adherence to antihypertensive medication among geriatric patients in Mandeville, Jamaica; (2) to identify the socio-demographic, economic, clinical, and health-system factors associated with non-adherence; and (3) to explore, in depth, the perceptions, experiences, and contextual barriers to adherence from the perspectives of both patients and healthcare providers. The findings are intended to inform the development of targeted, culturally appropriate interventions to improve adherence and blood pressure control in this vulnerable population.

Methodology and Materials

Study Design and Area

This study employed a mixed-methods approach. The quantitative component used a cross-sectional design, while the qualitative component utilized an interpretivist approach with in-depth interviews. The research was conducted at five Type 5 government health

centers and the Mandeville Regional Hospital in Mandeville, Jamaica, between January and July 2025.

Target Population and Sampling

The study population consisted of hypertensive patients aged ≥65 receiving treatment at the selected facilities. The quantitative sample size was calculated using the Yamane formula, yielding a sample of 220 participants from a population of 489, selected via convenience sampling. For the qualitative part, 23 participants were purposively selected from the Mandeville Regional Hospital clinic to maximize variation in demographics and disease duration.

Data Collection and Analysis

Quantitative data were collected using a semi-structured questionnaire that included the MMAS-8 and the Hill-Bone Compliance Scale. Data analysis involved descriptive statistics, chi-square tests, and Pearson correlation using SPSS, with a significance level of $p<0.05$. Qualitative data from in-depth interviews were analyzed using thematic analysis to identify emergent themes.

Ethical Approval

Ethical approval was obtained from the Southern Regional Health Authority.

Results

Quantitative Findings

Sociodemographic Characteristics

A total of 220 geriatric hypertensive patients participated in the survey. The mean age of respondents was 80.3 years (Standard Deviation [SD] = 9.1), with a range from 65 to 100 years. The majority of participants were male (60%, n=132). A significant proportion had low educational attainment: 32.7% (n=72) had no formal education and 29.5% (n=65) had only a primary-level education. The majority (86.4%, n=180) were residents of Jamaica. Economic status was generally low, with 54.6% (n=65 of 119 reporting) earning a monthly income below JMD 10,000 (approx. USD 65) (Table 1).

Table 1. Demographic Information of Respondents

Variable	Frequency	Percentage
Age		
65-69	40	18.2
70-78	42	19.1
75-79	32	14.5
80-84	45	20.5
85-89	41	18.6
90-100	20	9.1
Gender		
Male	132	60
Female	88	40
Residence of Jamaica		
Residents	180	86.4
Non-residents	30	13.6
Level of Education		
No formal education	72	32.7
Primary	65	29.5
Secondary	46	20.9

Tertiary	37	16.8

Prevalence of Adherence and Hypertension

The assessment of adherence using the Morisky 8-item adherence (MMAS-8) scale revealed suboptimal adherence. Only 16% (n=36) of the participants were classified as having high adherence. The majority (61%, n=136) demonstrated moderate adherence, while 19% (n=42) demonstrated low adherence. The mean score on the Hill-Bone Compliance Scale was 55.3 (SD=30.1), which falls in the range indicative of moderate compliance. However, the significant standard deviation signifies considerable variability in adherence behaviours within the study population, with some patients showing very good adherence and others inferior (Table 2).

Table 2. Hill Bone Compliance Scale for High Blood Pressure, n=220

Question	Response%	Response%	Response%	Response%		
	All the time	Most of the time	Some of the time	None of the time	Mean	SD
Q1	35(16%)	78(35%)	63(28%)	44(20%)	55	19.2
Q2	38(17%)	66(30%)	88(40%)	28(13%)	55	27.25
Q3	48(22%)	53(24%)	108(49%)	26(12%)	58.7	34.8
Q4	37(17%)	42(19%)	91(41%)	50(22%)	55	24.5
Q5	58(26%)	92(41%)	41(18%)	29(13%)	55	27.4
Q6	34(15%)	69(31%)	97(44%)	20(9%)	55	34.7
Q7	26(12%)	116(55%)	72(33%)	6(3%)	55	49.2
Q8	32(15%)	62(28%)	112(51%)	14(6%)	55	42.8
Q9	22(10%)	70(32%)	110(50%)	18(8%)	55	43.6
Q10	39(17%)	64(29%)	102(46%)	15(7%)	55	37.2
Q11	33(15%)	69(31%)	86(39%)	32(15%)	55	26.8
Q12	30(13%)	55(25%)	98(45%)	37(17%)	55	30.5
Q13	25(11%)	48(21%)	104(47%)	43(20%)	55	34.1
Q14	36(16%)	51(23%)	107(48%)	26(12%)	55	36.1

Reasons for Non-adherence

When participants were asked about factors preventing them from taking their prescribed medicines, the most dominant reason was a lack of funds, cited by 55% (n=121) of respondents. This was followed by a lack of time to obtain refills (23.2%, n=51) and simple forgetfulness (19.5%, n=43). A small percentage (2.3%, n=5) reported stopping medication because they believed they were "healed".

Factors Associated with Adherence

Health Education

A strong, statistically significant association was found between receiving health education on hypertension and adherence levels (χ^2 = 20.40, p = 0.008). Patients who received counseling on weight loss, exercise, salt reduction, and the need for lifetime compliance were more likely to be adherent (Table 3).

Table 3. Association between Health Education and Adherence to Treatment

Variables	**Adherent**	**Non-adherent**	**□2(P-value**	**Sources of Health Education**	**Adherent**	**Non-adherent**	**□2(P-value)**
Weight loss	30(67%)	15(33%)	**20.4 0.008**	Nurses	88(77%)	26(23%)	**4.54 0.03**
Exercise	33(63%)	16(36%)	**20.4 0.008**	Doctors	40(65%)	22(35%)	**4.54 0.03**
Reduced salt intake	29(64%)	19(37%)	**20.4 0.008**	Nutrionist	28(64%)	16(36%)	**4.54 0.03**
Dietary modification	37(73%)	14(27%)	**20.4 0.008**	**Total**	**156(71%)**	**64(29%)**	**4.54 0.03**
Lifetime compliance	22(81%)	5(19%)	**20.4 0.008**				
Total	**151(69%)**	**69(31%)**	**20.4 0.008**				

Economic and Health Systems Factors

Possession of an active National Health Fund (NHF) card, which provides subsidies for medication, was significantly associated with better adherence ($p = 0.004$). Furthermore, a positive correlation was observed between higher monthly income and adherence ($r = 0.38$). Barriers such as the cost of medication (34.1%) and limited access to healthcare facilities (33.2%) were frequently reported by non-adherent patients (Table 4).

Therapy-Related Factors

Polypharmacy emerged as a significant barrier (Table 4). A chi-square analysis revealed a statistically significant relationship between the number of prescribed antihypertensive tablets and adherence ($\chi^2 = 6.689$, $p = 0.035$). Patients on three or more medications had lower adherence rates compared to those on monotherapy or two-drug regimens. Side effects from medications were also commonly reported, with 78.3% of those who experienced side effects belonging to the non-adherent group ($p=0.003$).

Table 4. Factors Associated with Adherence

Factor Category	**Specific Factor**	**Finding / Association**	**Statistical Significance / Correlation**
Socioeconomic Factors	Lack of Funds	Primary reason for non-adherence (55%).	
	Lack of Time	Reason for non-adherence (23.2%).	
	Forgetfulness	Reason for non-adherence (19.5%).	
	Monthly Income	Positive correlation with adherence.	r = 0.38

Health System Factors	Receiving Health Education	Significant association with better adherence.	$\chi^2 = 20.40$, $p = 0.008$
	Possession of NHF Card	Associated with better adherence.	$p = 0.004$
	Physician-Patient Relationship	Positive correlation with higher adherence.	$r = 0.375$, $p = 0.005$
Pharmacological Factors	Polypharmacy (≥3 drugs)	Significant barrier: 45% of respondents were in this category.	$\chi^2 = 6.689$, $p = 0.035$
	Side Effects	Reported by 78.3% of respondents on multiple medications.	

Patient-Provider Relationship

The quality of the relationship with the physician, as measured by the Patient-Doctor Relationship Questionnaire (PDRQ-9), was significantly associated with adherence ($\chi^2 = 21.54$, $p = 0.005$). A low positive correlation ($r = 0.375$) suggested that better communication and trust were linked to improved adherence (Table 5).

Table 5. The Patient Physician Relationship and Adherence Questionnaire

Questions	**(Yes) Adherent**	**(No) Nonadherent**	**Total**	**□2(P-value)**
I trust my physician	28	5	33	**0.005**
My physician has enough time for me	32	4	36	
My physician helps me	31	5	36	
My physician is dedicated to helping me	13	3	16	
My physician and I agree on the nature of my symptoms.	15	2	17	
I can talk to my Physician	22	8	30	
I feel content with my physician's treatment	20	4	24	
My physician understands me	8	4	12	
My physician is easily accessible	12	4	16	
Total	**181**	**39**	**220**	

Knowledge, Attitude, and Practices (KAP)

Only 30.5% of participants had adequate knowledge about HTN. However, positive attitudes were observed; 72.7% believed regular medication would control BP, and 70.4% agreed that salt restriction helps. Despite this, practice was poor, with 52.3% not attending regular follow-ups and 81.4% not engaging in recommended physical activity (Tables 6, 7, 8).

Table 6. Knowledge-Related Response n=220

Question	Yes	No
Do you know what high blood pressure is? (BP)≥140/90	148(67.2%)	72(32.8%)
Do you know what the normal blood pressure level is?	102(46.4%)	118(53.6%)
Do you know the symptoms of high blood pressure?	98(44.5%)	122(55.5%)
Do you think smoking and alcohol consumption can cause hypertension?	149(67.7%)	71(32.3%)
Do you know what the complications of hypertension are?	75(34%)	145(66%)

Table 7. Attitude-related Response n=220

Question	Agree	Undecided	Disagree
Regular medications will improve the disease.	160(72.7%)	55(25%)	5(2.3%)
Drugs alone can control hypertension	42(19.1%)	81(36.8%)	97(44.1%)
Diet will improve the condition	101(46%)	115(52.3%)	4(1.8%)
Salt restriction can control hypertension	155(70.4%)	20(9.1%)	45(20.4%)
Regular physical activity of at least 40 minutes/session for 3-4 Eating a balanced diet and exercising at least three days a week is essential for controlling hypertension.	165(75%)	48(21.8%)	7(3.2%)

Table 8. Practice-related Response n=220

Question	Yes	No
Do you regularly measure your blood pressure?	168(76.4%)	52(23.6%)
Do you go for regular follow-ups?	105(47.7%)	115(52.3%)
Did you ever experience any side effects due to drugs?	48(21.8%)	172(78.2%)
Do you limit the amount of salt in your diet?	169(76.8%)	51(23.2%)
Do you exercise for at least 40 minutes per session, 3-4 days/week?	41(18.6%)	179(81.4%)
Do you take your drugs regularly? Reason for non-compliance. a.Forgetfulness 49.1% b. financial burden 38.2% c. Inaccessibility to a treatment facility 6.8% d. Denial of illness 5.9%	123(55.9%)	97(44.1%)

Qualitative Findings

Participant Characteristics

The 23 qualitative interviewees had a mean age of 80.3 years (SD = 9.9). Most were female (61%, n=14), unemployed (60.9%, n=14), and lived with family (73.9%, n=17). A substantial number (39.1%, n=9) had been living with hypertension for over ten years (Table 9).

Table 9. Demographic Characteristics of Participants

Description	N (%)
Gender	
Male	9 (39%)
Female	14 (61%)
Age (years)	
65-69	4 (17.3%)
70-78	3 (13.1%)
75-79	8 (34.8%)
80-84	6 (26.1%)
85-89	1 (4.3%)
95-100	1(4.3%)
Occupation	
Private	9 (39.1%)
Unemployed	14 (60.9%)
Living status	
Alone	6 (26.1%)
With family	17 (73.9%)
Blood pressure level 50 [mmHg]	
Optimal (SBP < 120 and DBP <80)	5 (21.7%)
Normal (SBP < 130 and DBP < 85)	4 (17.4%)
High normal (SBP 130-139 and/ or DBP 85-89)	3(13.1%)
Hypertension stage I (SBP 140-159 and/or DBP 90-99)	6 (26.1%)
Hypertension stage II (SBP 160-179 and/or DBP 100-109)	2(8.7%)
Hypertension stage III (SBP ≥ 180 and/or DBP ≥ 110)	3 (13.1%)
Duration of hypertension (years)	
1-5	8(34.8%)
6-10	6 (26.1%)
>10	9 (39.1%)

Emergent Themes

Thematic analysis of the interview transcripts yielded three overarching themes that captured the patients' experiences.

Theme 1: Medication Adherence: Routines, Barriers, and Coping Strategies

This theme encompassed participants' daily practices and the challenges they faced in taking their medication.

1. **Adherence Routines**: Many participants described established routines. One participant stated, *"I take medicine every day. Never forget" (P1)*. Another highlighted the habit of integrating medication into their daily schedule: *"I take my medicine every day before going to work as a habit" (P5)*.
2. **Barriers to Adherence**: Forgetfulness was a standard issue: *"Sometimes I forgot to take medicine. About 2-3 days a week, I forgot to take medicine" (P4)*. Concerns about side effects were a significant deterrent for some: *"I fear the side effects of the drug and the consequences of causing cancer. I will eat more fruit like apples rather than take antihypertensive medicine every day" (P4)*. Polypharmacy and complexity of regimens also confused: *"I take all medicines early before work, although some should be taken before or after a meal" (P10)*.
3. **Coping Strategies**: Some patients developed personal systems to remember, such as one stroke survivor who said, *"I keep it in a plastic bag. I will write or record in a book when taking medicine to avoid forgetting" (P9)*. Others relied on support from family or non-governmental organization (NGO) workers for reminders and to collect medications.

Theme 2: Self-Management of Hypertension

This theme is related to how patients managed their condition beyond taking prescribed medication.

1. **Symptom Awareness**: Participants identified various signs they associated with high blood pressure, most commonly dizziness and headaches. *"I felt dizzy and had a headache" (P6)*. Some, however, reported being asymptomatic: *"I did not feel anything until the doctor notified me that my blood pressure was not under control" (P7)*.
2. **Personal Management Strategies**: When experiencing symptoms, many turned to over-the-counter pain relievers like paracetamol or rested. A significant sub-theme was the use of alternative medicines. Several participants reported using herbal remedies concurrently with or instead of their prescribed drugs. *"I always eat traditional medication in the form of seeds to control blood pressure" (P9)*. One participant expressed a preference for Chinese tea to "wash" his blood (P1).

Theme 3: Knowledge and Understanding of Hypertension and its Treatment

This theme revealed profound gaps in patients' understanding of their condition.

1. **Knowledge of Hypertension:** There was widespread confusion about basic facts. Many participants could not state what normal blood pressure should be. One incorrectly stated, *"Normal blood pressure level is 190/80 mmHg" (P9)*. Understanding of causes was also limited, with attributions ranging from "cholesterol in the blood" (P3) to "stress and fatigue" (P6).
2. **Knowledge of Medication:** Most participants did not know the names of their medications, identifying them only by physical characteristics: *"I do not know the name of the medicine, but it is a round, white pill" (P1)*. Understanding of how the medications worked was virtually nonexistent. *"I do not know how my high blood pressure medicine works" (P6)*. Fears about long-term consequences, particularly kidney damage, were prevalent: *"I am afraid that the high blood pressure medication will damage my kidneys" (P4)*.

Healthcare Provider Perspectives

Interviews with 10 healthcare staff (doctors, nurses, nutritionists) highlighted systemic challenges. The most frequently cited problem

was the stockout of essential medicines (50%), which directly impacted patients' ability to adhere. Other challenges included low patient knowledge levels (10%), handling excessive patient loads (10%), and patient ignorance leading to poor compliance (30%) . Providers suggested that improved patient counseling, greater availability of drugs and diagnostic equipment, and mobile phone follow-ups could help curb non-adherence.

Discussion

This mixed-methods study provides a comprehensive picture of the complex issue of antihypertensive medication adherence among geriatric patients in Jamaica. The integration of quantitative and qualitative data offers both breadth and depth, confirming the high prevalence of non-adherence and elucidating the underlying reasons from the perspectives of those directly involved.

The quantitative findings clearly demonstrate that suboptimal adherence is the norm rather than the exception in this population. The fact that only 16% of participants had high adherence on the MMAS-8 scale is alarming and consistent with rates reported in other studies involving elderly populations in resource-limited settings [8, 18]. The Hill-Bone scale's moderate mean score, coupled with a large standard deviation, suggests that while the average adherence is middling, there is a wide spectrum of behavior, indicating that interventions need to be tailored to different patient profiles.

The most powerful finding, consistent across both phases of the study, is the overwhelming influence of socioeconomic factors. Finances were the single most significant barrier, with 55% of survey respondents citing "lack of funds" as a primary reason for non-adherence. This was powerfully echoed in the qualitative interviews, where patients described the financial strain of purchasing medications, particularly during stockouts in public facilities. This finding aligns with the concept of "catastrophic health expenditure" common in LMICs, where out-of-pocket payments for chronic conditions can push households into poverty [19]. The significant positive association between possessing an NHF card and adherence underscores the critical role of policies that reduce financial barriers to essential medicines.

The theme of polypharmacy and its negative impact on adherence is another critical finding. The quantitative results showed a clear dose-response relationship, where adherence decreased as the number of prescribed medications increased. The qualitative data provided the "why" behind this statistic: patients expressed feeling overwhelmed, confused about dosing schedules ("I take all medicines early."), and are concerned about the cumulative burden and side effects of multiple drugs. This is a well-documented challenge in geriatric pharmacotherapy [15]. It highlights the need for healthcare providers to regularly review medication regimens and deprescribe where possible, adhering to the principle of simplicity to enhance adherence.

The significant knowledge gaps uncovered in the qualitative phase are particularly concerning. Patients' inability to name their medications, understand their purpose, or state normal blood pressure values points to a fundamental breakdown in patient education and communication within the healthcare encounter. This lack of understanding fosters misconceptions (e.g., fear that medications cause kidney failure) and diminishes the perceived necessity of treatment, which are key determinants in the Necessity-Concerns Framework of adherence [20]. The association between receiving health education and better adherence in the quantitative phase reinforces the vital importance of clear, continuous, and culturally sensitive patient education.

The study also highlights health system failures as major drivers of non-adherence. The frequent stockouts of medicines, reported by both patients and providers, create an

insurmountable barrier. When coupled with transportation costs and long travel distances, the effort to seek care becomes prohibitive for many elderly patients on fixed incomes. Furthermore, the positive association between a good patient-provider relationship and adherence suggests that strengthening communication and trust could yield significant benefits. However, providers cited high patient loads as a barrier to spending adequate time with each patient, creating a vicious cycle.

Conclusion

This study conclusively demonstrates that non-adherence to antihypertensive medication is a pervasive and multifaceted problem among geriatric patients in Mandeville, Jamaica. It is not simply a matter of patient forgetfulness or wilfulness but is deeply rooted in a complex web of socioeconomic deprivation, health system inadequacies, and clinical management challenges. The interplay of poverty, polypharmacy, knowledge deficits, and drug stockouts creates a perfect storm that undermines the effective management of hypertension.

Addressing this critical issue requires a coordinated, multi-level approach that moves beyond blaming the patient. Interventions must be holistic, targeting the structural, systemic, and individual factors identified in this research. Without such comprehensive efforts, the burden of uncontrolled hypertension and its devastating complications will continue to rise, placing an unsustainable strain on individuals, families, and the Jamaican healthcare system.

Limitations

Several limitations should be considered when interpreting these findings. The use of convenience sampling in the quantitative phase may introduce selection bias and limit the generalizability of the results. The cross-sectional design allows for the identification of associations but not causal relationships. Adherence was measured using self-report scales, which are subject to social desirability bias, potentially leading to an overestimation of accurate adherence rates. Finally, the qualitative sample was drawn from a single hospital clinic. While it provides rich insights, the experiences may not fully represent those of patients managed solely in primary care settings.

Recommendations

Based on the Findings, the Following Recommendations are Proposed:

1. **Policy and Health System Level:**
   - The Jamaican Ministry of Health and Wellness should prioritize ensuring a consistent and reliable supply of essential antihypertensive medications across all public health facilities to eliminate stockouts.
   - Enhance the coverage and benefits of the National Health Fund (NHF) to reduce out-of-pocket expenses for elderly patients. Consider waiving costs for the most indigent.
   - Implement and support team-based care models where nurses, community health workers, and pharmacists share responsibility for patient education, follow-up, and adherence counseling, thereby reducing the burden on physicians.
2. **Clinical Practice Level:**
   - Healthcare providers should actively practice medication reconciliation and deprescribing to minimize polypharmacy, aiming for once-daily dosing regimens where clinically appropriate.
   - Implement mandatory, structured, and simple-to-understand education sessions for all newly diagnosed hypertensive patients, with regular reinforcement. Use visual aids and teach-back methods to assess understanding.
   - Train healthcare providers in patient-centered communication skills to build

trust and effectively address patient concerns about side effects and medication necessity.

3. **Community and Patient Level:**
   - Explore the use of low-cost mobile health (mHealth) interventions, such as SMS text message reminders for medication intake and clinic appointments, which have proven effective in other settings [21].
   - Involve family members in the care process, especially for elderly patients with cognitive challenges, to provide support with medication administration and appointment keeping.

Recommendations for Future Research

1. Future studies should employ longitudinal designs to establish causal pathways between the identified factors and adherence outcomes.
2. Research is needed to develop and test the effectiveness of culturally tailored, multi-component interventions (e.g., combining mHealth reminders with pharmacist-led counseling and financial subsidies) in the Jamaican context.
3. Further exploration of the role of traditional medicine beliefs and practices in hypertension management is warranted to develop integrative and respectful approaches to care.

Conflict of Interest Statement

The authors declare that there are no commercial or financial relationships that could be construed as a potential conflict of interest in the research, authorship, or publication of this article.

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Ethical Approval

Ethical approval was obtained from the Southern Regional Health Authority.

Data Availability

The primary data collected and analyzed in this study are available from the corresponding author on reasonable request.

Author Contributions

1. Ainsworth M. Reynolds – Principal investigator. Conceptualization, methodology, data collection, writing original draft
2. Antor Odu Ndep - Applying statistical, mathematical, or computational techniques to interpret data.
3. Moyosola A. Bamidele - Overseeing the project and guiding the research and final editing.

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Assessment of Self-Medication among Healthcare Professionals in Walvis Bay, Namibia

Jean-Paul Mukeba Tshitende
Department of Internal Medicine, State Hospital, Walvis Bay, Namibia

Abstract

Healthcare workers are more likely to self-medicate due to their extensive knowledge and experience with different medical problems and medications. This study aimed to ascertain the prevalence of self-medication and its associated characteristics among healthcare practitioners. One hundred eighty-nine healthcare personnel were selected for this cross-sectional study via random sampling at two hospitals in Walvis Bay, Namibia. Data collection used a researcher-designed questionnaire on self-medication. The gathered data were analyzed using descriptive and inferential statistics in SPSS 25 software, namely the Chi-square test and Fisher's exact test. The prevalence of self-medication among healthcare professionals was 89.98%. Out of the 189 participants, 73.01% were female. Most of them were at least 26 years old (68.3%), unmarried (75.13%), held a bachelor's degree (93.65%) primarily in nursing (49.74%), resided at a considerable distance from a health institution (71.96%), possessed medical insurance (87.3%), and had a monthly income over NAD 20,000 (95.1%). The most prevalent conditions leading to self-medication were the common cold (86.4%), headache (84.7%), and gastrointestinal problems (39.7%). There was no significant difference in self-medication rates across gender, marital status, age, educational level, health insurance, or proximity to a health facility. However, there was a significant difference in self-medication rates between participants earning more than NAD 20000 monthly (95.1%) and those earning less than NAD 20000 monthly (83.7%). Self-medication is common among healthcare professionals in Walvis Bay. It is imperative to actively address the adverse consequences of this practice with them through education, awareness campaigns, and policy changes.

Keywords*: Healthcare, Practice, Professionals, Self-medication, Walvis Bay.*

Introduction

Self-medication is a crucial aspect of daily self-care and a significant issue in healthcare systems [1, 2]. It is obtaining and utilizing medications without consulting a doctor for diagnosis, prescription, or treatment supervision [3]. It can also involve using medicines based on recommendations from pharmacists, relatives, or friends without consulting a medical professional, sharing prescriptions with family or friends, or using leftover medications stored at home [4]. Multiple factors influence it, including age, gender, income, spending patterns, self-care inclinations, level of education, health consciousness, contentment with medical services, and perspective [5-7].

Self-medicating with non-prescription or over-the-counter medications is a widespread practice worldwide, easily accessible in pharmacies and retail stores [8, 9]. It eases pressure on medical facilities, decreases waiting times for doctor visits, and lowers costs, particularly in countries with limited healthcare resources [8]. Over-the-counter medications are usually safe and efficient for self-treatment. However, improper use or abuse

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Corresponding Author: jptshitende@gmail.com

can lead to grave consequences, especially in children, older adults, pregnant women, and breastfeeding mothers [10, 11]. Self-medication presents multiple risks, including inaccurate self-diagnosis, delayed access to appropriate medical advice, improper selection of treatment, failure to recognize potential drug hazards, uncommon but severe side effects, disregarding contraindications, incorrect dosage and administration, the potential for addiction and aggression, all of which can increase rates of illness and death [12].

Many individuals resort to self-medication to alleviate minor health problems, symptoms, and discomfort [3]. In the healthcare setting, self-medication and misuse of medications are prevalent, with doctors and pharmacists being identified as some of the main culprits [13]. Doctors often struggle to assume the role of a patient due to time constraints, the severity of the illness, confidentiality concerns, and professional pride [8]. According to Balbisi et al. [14], easy availability of medications and a prominent level of drug awareness can result in pharmacists self-medicating. Multiple studies have demonstrated substantial rates of illicit drug use among these pharmacists [15, 16]. Self-medication for acute sickness is acceptable, but healthcare professionals have a high rate of engaging in self-medication despite being aware of the harmful consequences and dangers involved [8, 13]. Inappropriate self-medication by healthcare professionals can lead to legal, ethical, health, and quality-of-care issues for patients and the healthcare delivery system.

In Namibia, healthcare professionals have ready access to a wide range of pharmaceuticals, which may contribute to self-medication. Despite this, there is a notable lack of empirical data on the prevalence and patterns of self-medication among healthcare professionals in the country. Addressing this gap is essential for informing public health strategies and regulatory frameworks. This study, therefore, seeks to generate baseline data on self-medication practices among Namibian healthcare professionals. Specifically, it aims to assess the prevalence of self-medication within a randomly selected sample and to identify the key factors influencing this practice, thereby supporting targeted interventions and policy development to promote safe medication practices.

Materials and Methods

Study Design

The study employed a quantitative approach to comprehend the research data and achieve its objectives [17, 18]. This paradigm posits that reality exists as an objective entity that can be identified and acknowledged, enabling observers to accurately measure and make inferences about anything that exists. The epistemological premise was that the researcher did not influence healthcare professionals' decisions to participate in the research or their responses. The data-gathering tool was thoroughly verified for reliability and validity to ensure impartiality and reduce biases. Scientific approaches were used for data collection. The focus was on quantifiable and objective numerical data. The sample was sufficient and representative of healthcare professionals at the study sites. Statistical analysis was beneficial for extrapolating the study findings. This research employed a positivist perspective to investigate aspects related to self-medication among healthcare professionals. The phenomenon is not random, as these components can be analyzed and recognized.

Research Strategy

A quantitative and descriptive cross-sectional study was conducted to fulfil the research objectives. The aim was to analyse self-medication and examine potential correlations between contributing factors and self-medication practices. The study design's strength lies in its potential to generate new hypotheses for further research [17, 19, 20]. It enables meticulous planning, monitoring, and

assessment of strategic initiatives [17]. Various results and factors can be evaluated easily and inexpensively to gain an accurate understanding of the current situation in a short period. These benefits rendered the design suitable for this study.

Study Setting

The study was conducted at Walvis Bay State Hospital and Welwitschia Hospital in Walvis Bay, a seaside town in the Erongo region of Namibia, from February to March 2024 to achieve the set objectives. This town, the largest in the area, has a population of approximately 105,000 residents [21], whom the two hospitals primarily serve. Both facilities are equipped with healthcare personnel from various professions.

Population, Sample Size, and Sampling

The target population consisted of doctors and nurses employed at the two hospitals mentioned during the study period. Altogether, the two sites comprised approximately 426 nursing and medical staff members, who formed the target group. From this group, 197 professionals freely participated in the study by completing and submitting the research questionnaire, making up the source population or sampling frame [17]. Participants who did not complete the questionnaire were excluded from this study. Of the total population, 39% (77 professionals) were from Welwitschia Hospital, and 61% (120 professionals) were from Walvis Bay Hospital. Of the initial group of 197 professionals, only 189 completed the questionnaire in full, forming the sample population.

Data Collection Method

The researcher gathered primary data from study participants by providing them with an anonymous, pre-validated, and structured questionnaire containing both open- and closed-ended items for self-completion. The questionnaire was given to the two health facilities, and a concise presentation detailing the study's objectives and goals was given. The questionnaire was distributed to each institution before the presentation and collected immediately afterwards. One hundred eighty-nine (189) healthcare professionals who voluntarily attended the presentation and completed the questionnaire in full were selected as study participants. This survey collected information from participants regarding their demographic characteristics, reasons for self-medication, and the kind of pharmaceuticals they used for self-medication. The gathered data were stored on a password-protected computer in an encoded file (database) using the IBM Statistical Package for Social Sciences (SPSS) version 25. A double-data-entry process was conducted on 10% of the data, followed by a comparison of the two databases to assess agreement [17].

Data Collection Instrument

The research questionnaire was created in English and modified from a previous study by Ramazani et al. [22]. It consisted of 17 questions, split into two sections. The first section included demographic information regarding age, gender, marital status, academic level and field, income, and residential location. Participants were also asked about their health insurance coverage. The second section focused on self-medication behaviours, both overall and within the last 6 months, and the ailments individuals could treat independently.

Symptoms included bronchospasm, diarrhoea, vomiting, headache, cough, unexplained weight loss, sore throat, backache, indigestion, sleeplessness, tiredness, flu, disorientation, skin issues, toothache, painful menstruation, elevated blood pressure and blood sugar levels. Participants' self-care attitude was evaluated by examining the medications they used for self-medication. They were given a selection of medicines to choose from. The list comprised pain relievers, ulcer treatments, pharmaceuticals for diarrhoea or constipation, herbal remedies such as anise,

chamomile, sage, cinnamon, and cumin, antibiotics, prescriptions for allergies or congestion, topical therapies, sedatives, antihypertensives, antidiabetics, and other items. Participants were also required to choose and justify their self-medication behaviours. They were provided with a list of reasons, including the simplicity of the conditions, the absence of the need for professional medical assistance, prior encounters with similar symptoms, distrust in medical services, cost-cutting, and other factors identified by the participants. They were also asked about the origin of the self-medication recommendation. The options provided were self-determination, family and friends, media, herbalists, or other sources.

Data Analysis

The data were coded, entered, and analyzed using the Statistical Package for Social Sciences (SPSS) version 25. The descriptive findings were presented as frequencies and percentages. P-values less than 0.05 were considered statistically significant. Pearson's Chi-squared Test was employed to assess the presence of a substantial correlation between self-medication and dichotomous variables. Fisher's Exact Test was used in 2x2 contingency tables to complement the Chi-squared Test when expected frequency counts were below 5.

Ethical Issues

Permission was granted by the management of Welwitschia Hospital and Walvis Bay Hospital to deliver a brief overview outlining the study's aims and goals and to administer the questionnaire to participants. All participants completed the consent form before submitting the necessary information, acknowledging the research goals, the voluntary nature of participation, and their right to withdraw from the study at any time. The questionnaire did not include participants' names to maintain anonymity and confidentiality. Respondents did not experience any procedures or processes that could cause discomfort. All healthcare professionals who attended the brief presentation on the study's goals were given an equal opportunity to participate in the research. The completed surveys were stored in a secure, lockable cabinet, and the electronic databases were saved on a password-protected laptop accessible only to the researcher.

Study Limitations

Using a self-completed data-gathering instrument may lead to recall bias. Estimating the degree to which selection bias arises and affects the interpretation of results is arduous.

Results

Of the 189 participants recruited for this study, 170 used self-medication, giving a self-medication prevalence of 89.94%. In Table 1, out of 189 survey participants, 138 were female, or 73.01% of the total. Most of them were 26 years old (n=129, 68.3%), unmarried (n=142, 75.13%), held a bachelor's degree (n=177, 93.65%) primarily in nursing (n=94, 49.74%), resided a considerable distance from a health institution (n=136, 71.96%), possessed medical insurance (n=165, 87.3%), and had a monthly income over NAD 20,000 (n=97, 95.1%).

Table 1. Sociodemographic Characteristics of Respondents by Self-medication

Variables		**Total N**	**Self-medicating N (%)**	**Non-self-medicating N (%)**	**Pearson's Chi-squared Test (X^2)**	**Df**	***p*-value (2-tailed)**
Gender	Male	51	46 (90.2)	5 (9.8)	0.0048	1	0.9448 > 0.05
	Female	138	124(89.9)	14 (10.1)			
Age	20-25	60	54 (90)	6 (10)	0.0003	1	0.9868 > 0.05
	≥26	129	116 (89.9)	13 (10.1)			

Marital state	Single	142	128 (90.1)	15 (9.9)	0.1239	1	1 > 0.05 (Fisher's Exact Test)
	Married	46	42 (91.3)	4 (8.7)			
Field of study	Medicine	36	35 (97.2)	1 (2.8)	N/A	N/A	N/A
	Nursing	94	91 (96.8)	3 (3.2)			
	Midwifery	27	21 (77.8)	6 (22.2)			
	Dentistry	9	3 (33.3)	6 (66.7)			
	Pharmacy	14	13 (92.9)	1(7.1)			
	Paramedics	9	7 (77.7)	2 (22.2)			
Graduation level	BSc	177	159 (89.8)	18 (10.2)	0.0419	1	1 > 0.05 (Fisher's Exact Test)
	Masters	12	11 (91.7)	1 (8.3)			
Location	Near a health facility	53	45 (84.9)	8 (15.1)	2.0703	1	0.1502 > 0.05
	Far from HF	136	125 (91.9)	11 (8.1)			
Insurance	Yes	165	147 (89.1)	18 (10.9)	1.0534	1	0.4760 > 0.05 (Fisher's Exact Test)
	No	24	23 (95.8)	1 (4.2)			
Monthly income (NAD)	≤20,000	87	73(83.7)	14 (16.3)	6.5019	1	0.0108 < 0.05
	>20,000	102	97 (95.1)	5 (4.9)			

The data in Table 2 show that the most prevalent conditions leading to self-medication were a common cold (n = 163, 86.4%), headache (n = 160, 84.7%), gastrointestinal problems (n = 75, 39.7%), and hematological diseases (n = 64, 33.9%).

There was no significant difference in self-medication rates between male participants (90.2%) and female participants (89.9%), married participants (91.3%) and single ones (90.1%), and participants below 26 years old (90%) and those above 26 years of age (89.9%). Similarly, there was no notable disparity in self-medication rates among participants who graduated with a master's degree (91.7%) and those with a BSc degree (89.8%), participants living far from a health facility (91.9%) and those living near a health facility (84.9%), and those who are insured (89.1%) and those who are not insured (95.8%). The prerequisites for conducting the chi-square test were not satisfied to examine the association between self-medication and the field of study. There was a significant difference in self-medication rates between participants earning more than NAD 20000 monthly (95.1%) and those earning less than NAD 20000 monthly (83.7%).

Table 2. Reported Diseases/Conditions which lead to Self-medication

Disease/Symptoms	**Number (%)**
Common clod	163 (86.4)
Headache	160 (84.7)
Gastrointestinal disorders	75 (39.7)
Hematological disorders	64 (33.9)
Cardiovascular diseases	55 (29.1)
Skin disease	39 (20.6)
Menstrual disorders*	29 (21)

Prevention of osteoporosis	27 (14.29)
Musculoskeletal disorders	25 (13.2)
Metabolic disorders	17 (9)
Joint disorders	15 (7.3)
Neurologic diseases	13 (6.9)

*(*Only females)*

The participants identified the main reasons for self-medication as their previous knowledge of the condition (n = 149, 78.8%), the perception that the illness was not serious (n = 143, 75.7%), and the accessibility of drugs (n = 133, 70.4%), as indicated in Table 3. The data in this section did not meet the requirements for doing the chi-square test.

Table 3. Reasons for Self-medication

Reasons	**Number (%)**
Prior experience with the illness	149 (78.8)
Non-seriousness of the illness	143 (75.7)
Availability	133 (70.4)
Prior experience with the drug	122 (64.6)
Inadequate time to attend the doctor's office	92 (48.7)
Saving time	81 (42.9)

The most utilized pharmacological groups were common cold remedies (n = 163, 86.2%), analgesics (n = 139, 73.5%), and antibiotics (n = 138, 73.0%), as shown in Table 4 below.

Table 4. Classes of Drugs used for Self-medication

Class	**Number (%)**
Common cold	163 (86.2)
Analgesics	139 (73.5)
Antibiotics	138 (73)
Vitamins	129 (68.3)
Anti-allergic	123 (65.1)
Gastrointestinal drugs	117 (61.9)
Antipyretics	116 (61.4)
Skin	110 (58.2)
Tranquillizers	49 (25.9)
Psychoactive	47 (24.9)
Antihypertensives	45 (23.8)
Ophthalmic	43 (22.8)
Antidiabetics	38 (19.6)
Hypnotics	14 (7.4)
Herbal remedies	13 (6.9)

Discussion

This study revealed an extremely high prevalence of self-medication among healthcare professionals (89.94%), consistent with findings across comparable populations. Previous studies have reported self-medication rates of 89.3% in southern Nigeria [23], 79.2% among healthcare students in Eritrea [24], and 79.6% in tertiary hospitals in the South-South region of Nigeria [25]. Such persistently elevated rates indicate that self-medication is a normative practice among health professionals worldwide.

Demographic and Socioeconomic Factors

Interestingly, there were no significant differences in self-medication prevalence based on gender, marital status, or age. Males (90.2%) and females (89.9%) exhibited nearly identical rates, as did married (91.3%) and unmarried participants (90.1%) and those below (90%) and above 26 years of age (89.9%). These findings align with previous research suggesting that demographic characteristics may have limited influence on self-medication behaviors in healthcare populations [24, 25]. Similarly, no substantial variation was found in self-medication between bachelor's degree (89.8%) and master's degree holders (91.7%), those insured (89.1%) versus uninsured (95.8%), or those living far from (91.9%) versus near a health facility (84.9%). These findings reinforce prior assertions that self-medicating is driven more by professional confidence and practical considerations than by socioeconomic or educational disparities [23, 26].

However, a significant difference in self-medication behaviour was observed by income level. Those earning over NAD 20,000 monthly reported a higher prevalence (95.1%) than those earning below NAD 20,000 (83.7%). This may reflect the influence of financial empowerment on access to medications, as higher-income individuals may be more likely to purchase pharmaceuticals without consulting a doctor [26].

Motivations for Self-Medication

Participants most frequently cited their prior knowledge of the condition (78.8%), the perception that the illness was not serious (75.7%), and the ease of access to drugs (70.4%) as the primary reasons for self-medication. These motivations are consistent with prior research, which found that health professionals cited familiarity with symptoms, confidence in diagnosis, and busy schedules as reasons for bypassing formal consultations [24, 25, 27]. Despite 87.3% having health insurance and the majority earning above NAD 20,000 (95.1%), 71.96% lived far from healthcare facilities. Similar studies identified convenience, provider distance, and busy schedules as key motivators of self-medication [23, 25, 29], indicating that logistical rather than economic barriers play a crucial role.

Drug Classes and Conditions

The most frequently used drug classes were common cold remedies (86.2%), analgesics (73.5%), and antibiotics (73.0%). These closely parallel findings in prior studies from Nigeria and India, which highlight analgesics and antibiotics as the dominant categories of self-medicated drugs among healthcare workers [23, 26]. The high use of antibiotics is particularly concerning, given the global threat of antimicrobial resistance and the well-documented risks associated with non-prescription antibiotic use [28]. The main illnesses prompting self-treatment included the common cold (86.4%), headache (84.7%), gastrointestinal problems (39.7%), and hematological conditions (33.9%). This reflects a trend in the literature showing that mild, recurring symptoms are most often managed through self-medication [24, 27]. It mirrors patterns observed among healthcare personnel in Nigeria [23, 25] and Eritrea [24], where non-

serious, recurring symptoms are often treated independently.

Risks and Implications

While self-medication can reduce strain on healthcare services, inappropriate use risks misdiagnosis, polypharmacy, and antimicrobial resistance, particularly with prescription drugs [23-25]. The high engagement of knowledgeable individuals highlights the normalization of this behaviour, raising concerns about its public health and ethical implications for professionals involved.

Statistical Limitations

Some associations, such as those involving the field of study and perceptions of illness seriousness, could not be statistically assessed due to the violation of chi-square test assumptions. This suggests the need for larger and more stratified samples in future studies to enable more robust inferential analyses.

Conclusion

This study reveals a widespread practice of self-medication among healthcare professionals in Walvis Bay, driven by factors such as prior medical knowledge, perceived minor illnesses or triviality of symptoms, easy access to medications, affordability, and time constraints. Frequently used medicines included cold remedies, analgesics, and antibiotics. While knowledge of pharmacology may support safe use, these findings highlight the importance of developing targeted public health interventions and educational strategies to promote responsible medication use and mitigate the risks associated with self-medication among this professional group. Further research is warranted to explore the broader implications for patient safety and healthcare systems.

Conflict of Interest

There is no conflict of interest.

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Impact of Conflict on Under-Five Children's Health and Nutrition in Gogrial West, South Sudan

Odette Kum Chou
Department of Public Health, Texila American University, Nicaragua

Abstract

This study explores the consequences of conflict on the health and nutrition of children under five years in Gogrial West County, Warrap State, South Sudan. Conflict has disrupted essential health services, food security, and community livelihoods, placing young children at heightened risk of malnutrition and disease. Using a mixed-methods approach, the research combines findings from a 2021 SMART Survey and a 2024–2025 household-based survey (Gogrial Child Health and Nutrition Conflict Assessment) to analyze how conflict correlates with displacement, poor Infant and Young Child Feeding (IYCF) practices, healthcare access, and acute malnutrition. Quantitative data from 603 children were analyzed alongside qualitative caregiver interviews to understand community coping strategies and urgent needs. Results show that 66.87% of families were displaced, 86.75% experienced food shortages, and 80% of caregivers reported stress-related disruptions in feeding practices. The study concludes with recommendations for integrated interventions combining emergency nutrition and healthcare with long-term peacebuilding and development efforts.

Keywords: *Conflict, Food Security, Gogrial West, Health Access, Malnutrition, South Sudan, Under-Five Children.*

Introduction

Armed conflict [6] remains one of the most devastating disruptors of public health and nutrition, particularly for vulnerable populations such as children under five. In many low-income and fragile states, conflict leads to the collapse of essential systems, including healthcare, food distribution networks, and clean water supply. South Sudan, the world's youngest nation, has endured chronic instability since its independence in 2011, marked by civil war, ethnic clashes, and widespread displacement. Gogrial West County, located in Warrap State, exemplifies the dire consequences of these crises. The region has suffered from severe food insecurity, damaged infrastructure, and minimal access to health services, conditions that have significantly compromised child survival and development [1, 22].

Children under the age of five are biologically vulnerable and highly dependent on caregivers, adequate nutrition, and access to timely healthcare. In Gogrial West County, conflict has severely undermined these protective factors. Armed confrontations have displaced thousands of families, reducing access to agricultural livelihoods and increasing dependency on food aid. Health facilities have been looted, destroyed, or rendered inoperative due to a lack of supplies and personnel [22, 21]. Immunization programs have been interrupted, and clean water sources have been contaminated or destroyed, elevating the risk of disease outbreaks [11]. Meanwhile, psychosocial stress among caregivers—many of whom are women facing gender-based

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Corresponding Author: odettechou@gmail.com

violence or the loss of partners—has disrupted infant and young child feeding (IYCF) practices [26].

Despite numerous humanitarian interventions, indicators of malnutrition and disease burden remain alarmingly high. Global Acute Malnutrition (GAM) rates consistently exceed emergency thresholds, while diseases such as diarrhea, respiratory infections, and malaria are prevalent [5]. The compounded effects of poverty, insecurity, and systemic collapse continue to shape the everyday realities of children in the region [10].

This article investigates the intricate relationship between conflict and child health outcomes in Gogrial West County. It presents evidence drawn from the 2021 SMART Survey and a follow-up G-CHNCA (Gogrial Child Health and Nutrition Conflict Assessment) conducted between 2024 and 2025 [22, 25]. By triangulating quantitative data with qualitative insights from caregivers, the study aims to provide a holistic understanding of how conflict has reshaped household dynamics, access to essential services, and child nutrition and morbidity patterns. The findings will support evidence-based policymaking and program design to safeguard the well-being of children in South Sudan's conflict-affected communities [17, 28].

Literature Review

Conflict and Child Health

Numerous studies underscore the catastrophic effects of conflict on child health outcomes, particularly in fragile states like South Sudan. Armed conflict not only leads to physical destruction and displacement but also to the disruption of healthcare infrastructure, limited access to medical care, and a breakdown in routine public health services. Akik et al. [3] emphasized that conflict-affected areas require adaptable and context-specific public health interventions, particularly in regions [20, 16] where health system capacity is already limited. The World Health Organization (2023) further supports this, noting that armed conflict is one of the leading contributors to under-five mortality, as it limits access to maternal healthcare, immunization coverage, and timely treatment of infectious diseases [28, 29]. Complementary evidence from humanitarian crises indicates that tailored intervention packages improve outcomes when aligned with local health system constraints [6, 19, 15].

Food Systems Disruption and Malnutrition

According to [8], conflict displaces farmers, destroys harvests, and interrupts food supply chains, resulting in inflation, scarcity, and widespread hunger. In Gogrial West County, households that relied on subsistence farming have become increasingly dependent on food aid and irregular market supplies, which are often unaffordable or inaccessible [12]. The Integrated Food Security Phase Classification (IPC) [12] reported that over 1.4 million children under five in South Sudan were projected to suffer from acute malnutrition, and that regions like Warrap State consistently report Global Acute Malnutrition (GAM) rates above the emergency threshold of 15% [27]. These dynamics are consistent with entitlement failures and access constraints during crises [4].

Displacement and Healthcare Access

The United Nations High Commissioner for Refugees [29] notes that displaced families face not only physical but also psychological barriers to accessing care, mainly when health centers are located far from displacement camps or lack sufficient personnel and medical supplies [21]. Disruption of service delivery in insecure settings further compounds mortality risks among under-fives [7].

IYCF Practices and Psychosocial Stress

The Sphere Handbook [26] and the Inter-Agency Standing Committee (IASC) Guidelines provide frameworks for nutrition in emergencies but acknowledge that mental health support and contextual adaptation are

essential for these guidelines to be effective [20]. In Gogrial West County, qualitative interviews from the G-CHNCA (2024–2025) revealed that 80% of caregivers reported that stress and trauma directly affected their ability to feed their children adequately. Similar associations between caregiver stress and suboptimal feeding have been documented in conflict settings [2, 18].

Gaps in Literature and the Need for Localized Evidence

While global studies offer valuable frameworks and macro-level trends, there is a critical lack of localized data from conflict-affected regions like Gogrial West County. Most research aggregates data at the national or state level, missing the nuanced effects of conflict at the community and household levels [23]. This study addresses this gap by providing a comparative analysis of the 2021 SMART survey and a more recent 2024–2025 G-CHNCA, offering context-rich insights into the lived realities of under-five children and their families [25, 16].

Statement of the Problem

South Sudan has faced protracted conflict since its independence in 2011, [14] leading to significant humanitarian crises and systemic collapse in multiple sectors, especially public health and nutrition. Gogrial West County in Warrap State exemplifies these challenges. The region has experienced repeated cycles of violence, massive population displacement, destruction of infrastructure, and the breakdown of essential services. These conditions have had a disproportionate impact on children under five, a population that is critically vulnerable to malnutrition, illness, and death in crisis contexts. In conflict-affected communities, basic needs such as food, healthcare, clean water, and shelter are severely disrupted. Families are often forced to flee their homes, leaving behind their livelihoods and agricultural sources of food. Consequently, households in Gogrial West County experience recurrent food shortages, forcing them to rely on irregular humanitarian aid or adopt harmful coping mechanisms. Children who depend on stable caregiving environments and regular nutrition suffer the most from this instability [11, 13].

Although humanitarian organizations have conducted interventions in Warrap State, including nutrition supplementation programs, disease treatment campaigns, and immunization drives, the overall health and nutritional indicators for children under five remain alarming. Reports from the 2021 SMART survey [1] revealed that the prevalence of Global Acute Malnutrition (GAM) exceeded the WHO emergency threshold of 15%, while qualitative data from more recent local surveys (2024–2025) showed high rates of caregiver-reported illness, such as diarrhea (78.3%), fever/malaria (77.7%), and respiratory infections (55.4%) [23, 25].

Moreover, there is limited context-specific data that integrates both quantitative and qualitative insights on how conflict shapes child health and nutritional outcomes. The available evidence often generalizes the conflict's impact across South Sudan, failing to capture localized patterns or community-specific coping strategies. There is also a lack of detailed analysis on how psychological stress among caregivers affects Infant and Young Child Feeding (IYCF) practices, which are essential to early childhood nutrition [17]. This gap persists despite extensive documentation of risk factors affecting child survival in LMICs [9, 12].

This research addresses these gaps by conducting a mixed-methods study that combines secondary data from the 2021 SMART survey with a primary assessment carried out between 2024 and 2025 (Gogrial Child Health and Nutrition Conflict Assessment) [25]. The goal is to evaluate the direct and indirect consequences of conflict on child health and nutrition in Gogrial West County and to inform future interventions with

evidence that reflects the realities on the ground. Without this kind of focused investigation, policies and programs risk being misaligned with community needs and may fail to achieve sustainable health outcomes for children [19].

Objectives of the Study

The primary objective of this study is to examine the multifaceted impact of armed conflict on the health and nutritional status of children under five in Gogrial West County, Warrap State, South Sudan [28]. This investigation is structured around the following specific objectives:

1. To assess the demographic profile and direct impact of conflict on households and food security in Gogrial West County, with particular attention to the socioeconomic conditions influencing child health and nutritional status [16].
2. To evaluate the health and nutritional status of children under five (such as diarrhea, malaria, and respiratory infections) among under-five children, using both anthropometric and self-reported health data [5].
3. To analyze healthcare access and Infant and Young Child Feeding (IYCF) practices (including availability of essential drugs, vaccination coverage, and barriers to healthcare access in conflict-affected communities, displacement, and food insecurity disrupt optimal feeding behaviors and care practices [26].
4. To identify community perceptions regarding urgent needs for child health and nutrition (To compare trends and outcomes from two different survey periods (SMART 2021 and G-CHNCA 2024–2025), to highlight shifts in health indicators and inform targeted, time-sensitive interventions) [21, 27].

Scope of the Study

The scope of this study focuses on evaluating the impact of armed conflict on the health and nutritional status of children under the age of five in Gogrial West County, located in Warrap State, South Sudan [12]. The research is geographically confined to this specific county, which is representative of conflict-affected areas in the country, and temporally spans two key data collection periods: the SMART Survey [1] conducted in July 2021 and a G-CHNCA follow-up survey conducted between late 2024 and early 2025 [25]. This dual-survey approach enables a comparative analysis of trends in child health and nutrition over a multi-year period, providing insights into the evolving humanitarian situation and the effectiveness of ongoing interventions [17].

In terms of the demographic scope, the study targeted households with at least one child under age 5. During data collection, a total of 603 children were assessed: 437 during the 2021 SMART survey and 382 during the 2024–2025 G-CHNCA. However, after rigorous data cleaning and quality control procedures, only 166 records from the local G-CHNCA survey were deemed complete and valid for comprehensive analysis. These records contained all the essential variables needed to meet the study's objectives. In addition to quantitative data on malnutrition, morbidity, and healthcare access, the study also included qualitative data from semi-structured interviews with caregivers. This mixed-methods approach provided more profound insights into the psychosocial, behavioral, and environmental factors influencing child health outcomes in the conflict-affected setting of Gogrial West County [2, 13].

Thematically, the study covers several key dimensions: displacement and household vulnerability; food insecurity and access to nutrition; disease prevalence and healthcare utilization; infant and young child feeding (IYCF) practices; and caregiver perceptions of their most urgent needs. The research examines

how these dimensions interact, are influenced by conflict, and collectively shape the well-being of children under five in the study area [6, 7].

The study also investigates systemic challenges such as the availability of health infrastructure, accessibility of medical supplies, and delivery of humanitarian aid. It considers the broader socio-economic context, including livelihood disruptions, psychological stress, and community coping mechanisms, offering a holistic view of how conflict permeates every aspect of child health and nutrition. According to national IPC classifications [12] and the 2021 SMART survey conducted by Action Against Hunger [1], the county recorded Global Acute Malnutrition (GAM) rates exceeding the emergency threshold of 15%. By triangulating quantitative and qualitative data, the study not only provides statistical insights but also captures the lived experiences of caregivers and community members. This enables the formulation of evidence-based and context-specific recommendations that are both responsive to community needs and aligned with broader public health objectives [28].

However, the study does not extend to other counties within Warrap State or to South Sudan as a whole, and its findings should not be generalized without consideration of local contexts. Furthermore, the research does not include children over the age of five or non-displaced populations not residing within the sampled households. While the inclusion of multiple data sources enhances validity, the scope is inherently limited by logistical, security, and resource constraints typical of fieldwork in conflict-affected settings [24]. Ultimately, the scope of this study enables a focused, in-depth investigation of the intersection of conflict and child health in Gogrial West County, serving as a critical evidence base for humanitarian response planning, policy formulation, and future research [17].

Research Questions

This study was guided by the following research questions aimed at exploring the multifaceted effects of conflict on the health and nutritional status of children under five in Gogrial West County:

1. What is the demographic profile of conflict-affected households in Gogrial West County, and how has conflict influenced their food security? [8]
2. What is the current health and nutritional status of children under five in the region? [1]
3. How have conflict and displacement affected access to healthcare services and IYCF practices? [26]
4. What are the perceptions of caregivers and community members regarding the most urgent child health and nutrition needs? [23]

Methodology

Study Area

The study was conducted in Gogrial West County, located in Warrap State, in the northwestern region of South Sudan. Gogrial West is a predominantly rural county, characterized by widespread poverty, underdevelopment, and chronic food insecurity. The area has been heavily affected by recurrent episodes of armed conflict, intercommunal violence, cattle raiding, and political instability since the onset of South Sudan's independence in 2011[7]. As a result, the population has suffered frequent displacements, destruction of essential infrastructure, and breakdowns in social service delivery [24]. The geography of Gogrial West is characterized by savannah grasslands, seasonal rivers, and a limited road network that becomes impassable during the rainy season. This presents substantial logistical challenges to the delivery of humanitarian aid and health services. The population primarily relies on subsistence agriculture and livestock rearing for

livelihood, which are often disrupted by conflict and climate shocks, including droughts and floods [22].

Health infrastructure in the county is severely limited. Most healthcare facilities are under-equipped, understaffed, and located far from many villages. Long travel distances, lack of transportation, frequent stock-outs of medicines and vaccines, and a shortage of trained healthcare personnel constrain access to maternal and child health services. This has resulted in low coverage of routine immunizations and other essential child health services. Gogrial West has also been identified as one of the most nutritionally vulnerable regions in South Sudan. According to national IPC classifications [12] and the 2021 SMART survey conducted by Action Against Hunger [1], the county recorded Global Acute Malnutrition (GAM) rates exceeding the emergency threshold of 15%. The combination of food insecurity, poor health service coverage, inadequate water and sanitation, and continuous displacement contributes to poor health outcomes among children under five. The county was chosen as the study site due to its representativeness of conflict-affected areas in South Sudan and the availability of both past and recent nutrition and health data [16]. This allows for a comparative analysis of trends over time and provides valuable insights into how protracted conflict conditions shape child health outcomes. Data collected from Gogrial West is crucial for understanding the localized needs and informing targeted interventions within the broader context of South Sudan's humanitarian crisis [17].

Study Design

This study adopted a mixed-methods approach to capture both the breadth and depth of the impact of conflict on the health and nutritional status of children under 5 years old. The quantitative component consisted of data from two distinct sources: the 2021 SMART (Standardized Monitoring and Assessment of Relief and Transitions) Survey, which included 437 children aged 6–59 months, and a follow-up G-CHNCA conducted between 2024 and 2025, which collected data from 166 children under 5 years old. The SMART survey, facilitated by Action Against Hunger [1], used standard anthropometric and household questionnaires to assess malnutrition rates, disease prevalence, and household food security. Meanwhile, the 2024–2025 G-CHNCA extended the analysis by incorporating additional context-specific indicators, including displacement, access to healthcare services, Infant and Young Child Feeding (IYCF) practices, and perceived community needs [21].

In addition to the quantitative data, a qualitative component was integrated through semi-structured interviews with caregivers of children under five. These interviews aimed to capture caregivers' perceptions of how conflict affected their ability to provide proper nutrition and healthcare for their children. This qualitative aspect enriched the understanding of the contextual, psychological, and social dimensions that influence child health and food [2].

This dual methodology ensured a more holistic perspective—quantitative data provided measurable trends, while qualitative insights highlighted the lived experiences behind those numbers. Together, these methods enabled a comprehensive examination of both immediate indicators (e.g., malnutrition rates) and systemic challenges (e.g., psychosocial stress and service access), informing actionable recommendations [6, 20].

Sampling and Data Collection

This study employed robust sampling methods to ensure the representativeness and reliability of the collected data. For the 2021 SMART Survey, a cluster sampling technique was used, in accordance with international guidelines for nutrition and mortality assessments in emergency contexts [26]. A total

of 437 children aged 6–59 months were surveyed across multiple clusters in Gogrial West County. The SMART survey employed standardized tools to collect anthropometric data—specifically, weight-for-height (WHZ), mid-upper arm circumference (MUAC), and the presence of bilateral pitting edema. In addition to nutritional status, the survey included modules on child morbidity, immunization status, household food consumption scores, and Water, Sanitation, and Hygiene (WASH) indicators [22].

For the 2024–2025 G-CHNCA, a random household sampling approach was used to collect data from households with children under 5 in Gogrial West County. A total of 382 household interviews were initially conducted. However, during data cleaning and validation, only 166 household records were found to contain all the necessary information for the research objectives. These included consistent responses and non-missing data for key indicators such as displacement history, healthcare access, and child nutritional status. The remaining responses were excluded from analysis due to incomplete, inconsistent, or missing entries that would have undermined the reliability of the statistical interpretations [25].

To ensure data quality and comparability, trained field data collectors administered structured questionnaires to primary caregivers. In addition to the survey questions, direct anthropometric measurements were conducted, including Mid-Upper Arm Circumference (MUAC), weight, and height of children aged 6–59 months, following standardized WHO procedures. This rigorous sampling and data collection approach ensured that the dataset was both representative and contextually relevant, thereby enabling meaningful analysis of the effects of conflict on under-five health and nutrition in Gogrial West County [5].

Both surveys ensured standardized measurement techniques and equipment calibration before data collection. Enumerators were trained in ethical data collection, informed consent procedures, and cultural sensitivity [26]. For the qualitative component, semi-structured interviews were conducted with caregivers to explore the impact of conflict on childcare practices, mental health, and household nutrition strategies. These interviews provided nuanced insights that complemented the quantitative trends, enriching the overall understanding of the community's lived experiences [2].

The combined data from the SMART and local surveys allowed for triangulation of findings, increasing the validity of the results and enabling detailed comparative analysis across different time points and population subsets [13].

Method of Data Collection

Data were collected using both primary and secondary sources. Primary data collection involved field surveys using structured household questionnaires, anthropometric measurements (MUAC, weight, and height), and semi-structured interviews with caregivers. Data collectors were trained in ethical procedures and technical measurements to ensure accuracy. Standard tools aligned with the SMART methodology [1] were used in the 2021 survey, while the 2024–2025 G-CHNCA tools were adapted to reflect the dynamic conflict-affected environment in Gogrial West County [21].

Secondary data sources included published reports from the 2021 SMART Survey [1], IPC nutrition analyses [12], UNHCR [29], and relevant government documents [14]. These sources were reviewed to validate findings and provide a broader context [10].

Method of Data Analysis

Quantitative data were entered and analyzed using Microsoft Excel Pivot Tables. Descriptive statistics (means, percentages, and frequencies) [9] were used to summarize household characteristics, health indicators, and nutrition metrics. A comparative analysis

of the SMART 2021 and 2024–2025 G-CHNCA was conducted to identify trends and differences in child health and nutrition status over time. Cross-tabulations and correlation tests were used to examine relationships between variables such as displacement status and food insecurity or caregiver stress and child feeding practices. Qualitative data from interviews were transcribed and analyzed thematically. Recurring themes were coded, categorized, and interpreted to complement and contextualize quantitative findings, thereby offering a more holistic understanding of the impact of conflict on children under five in Gogrial West County [7]. Data were analyzed using Excel Pivot Tables. Descriptive statistics summarized household characteristics, morbidity rates, and malnutrition prevalence. Thematic analysis was used for qualitative responses [20].

Results

This section presents the findings derived from both the SMART 2021 survey and the 2024–2025 G-CHNCA (Gogrial Child Health and Nutrition Conflict Assessment), illustrated with tables and visual charts to enhance understanding.

Research Question 1: *What is the demographic profile of conflict-affected households in Gogrial West County, and how has conflict influenced their food security?*

Table 1. Displacement and Food Shortage Status of Households in Gogrial West County

Indicators	Percentage (%)
Households Displaced	66.87%
Households with Food Shortages	86.75%
Households Facing Frequent Hunger	33.30%

Table 1 outlines the indicators of displacement and food insecurity among the surveyed households. The data reveal that 66.87% of households were displaced by conflict, resulting in significant livelihood losses and diminished food access. Furthermore, 86.75% of households reported food shortages, with 33.30% experiencing frequent episodes of hunger. These findings suggest a direct correlation between displacement and severe food insecurity, which may have detrimental implications for child nutrition and overall well-being. The conflict in Gogrial West County has profoundly disrupted household stability and access to essential food resources.

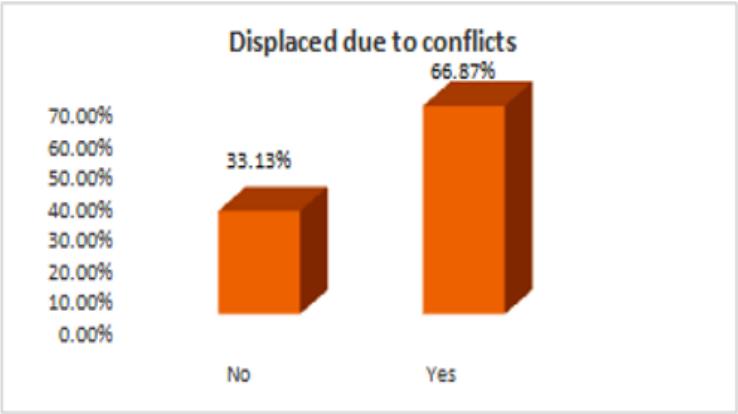


Figure 1. Displacement Status

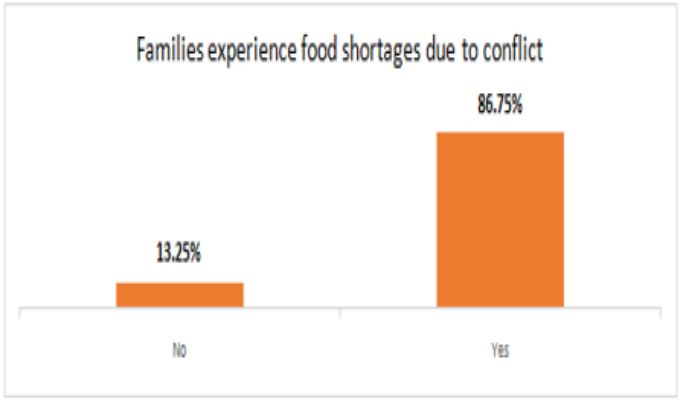


Figure 2. Food Shortage Experience

Visual patterns reinforce these findings. Figure 1 shows the proportion of households displaced, while Figure 2 depicts the prevalence of food shortages. Both figures emphasize that displacement is closely associated with diminished household food availability and increased vulnerability.

Research Question 2: *What is the current health and nutritional status of children under five in the region?*

Table 2. Prevalence of Common Childhood Illnesses in Gogrial West County

Illness	**Prevalence (%)**
Diarrhea	78.3%
Fever/Malaria	77.7%
Respiratory Infection	55.4%

Table 2 highlights the prevalence of common childhood illnesses, revealing alarmingly high rates of morbidity. Diarrhea was reported in 78.3% of cases, fever or malaria in 77.7%, and respiratory infections in 55.4% of children. These statistics indicate a significant disease burden, exacerbated by inadequate sanitation, limited healthcare services, and the enduring impacts of conflict. Consequently, the health and nutritional status of children under five in Gogrial West County is severely compromised.

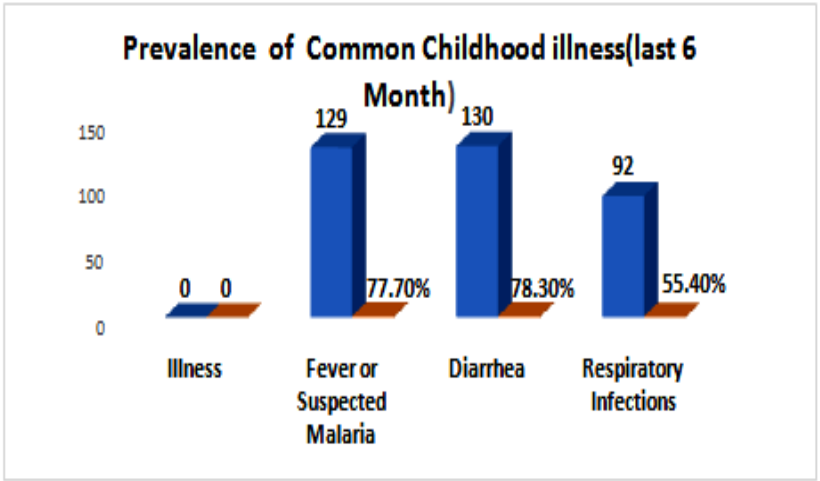


Figure 3. Prevalence of Common Illnesses

The patterns in Figure 3 further illustrate the widespread occurrence of these illnesses. The consistently high percentages across all three conditions highlight the urgent need for targeted health interventions to improve child survival and well-being in the conflict-affected region.

Research Question 3: *How has conflict and displacement affected access to healthcare services and Infant and Young Child Feeding (IYCF) practices?*

Table 3. Infant and Young Child Feeding (IYCF) Practices in Gogrial West County

IYCF Indicator	Percentage (%)
Awareness of Colostrum Importance	92.8
Stress Impacting Feeding Practices	80.0

Table 3 indicates that 92.8% of caregivers are aware of the importance of colostrum, reflecting a strong understanding of breastfeeding practices. However, 80% identified stress as a barrier to feeding, suggesting that psychosocial challenges, which often intensify during periods of conflict, negatively affect infant and young child feeding (IYCF) practices. The findings from Gogrial West County reveal that while knowledge of optimal breastfeeding practices is widespread, conflict-related stress significantly hinders their effective implementation.

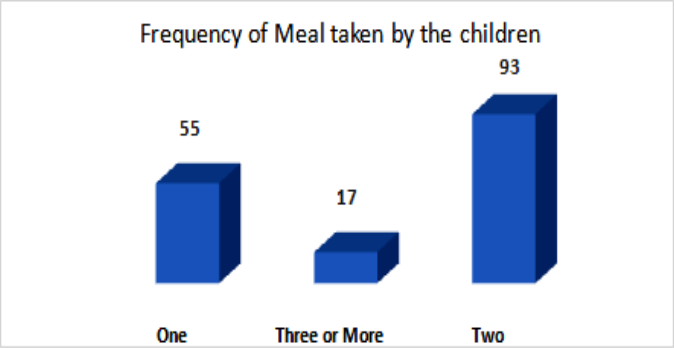


Figure 4. Meal Frequency Distribution

Meal frequency patterns are illustrated in Figure 4. The chart shows that the majority of children (93) consume 2 meals daily, while 55 children take only 1 meal, and just 17 manage 3 or more meals**.** This highlights limited meal frequency, reflecting household food insecurity and compromised child nutrition.

Research Question 4: *What are the perceptions of caregivers and community members regarding the most urgent child health and nutrition needs?*

Table 4. Healthcare Access Indicators in Gogrial West County

Indicator	Percentage (%)
Full Vaccination Coverage (perceived)	92.2
Instances of Vaccine Unavailability	80.1
Reported Disruption of Healthcare Access	70.0

Table 4 shows that while 92.2% of respondents perceive their children as fully vaccinated, 80.1% have experienced vaccine unavailability, and 70% have reported disruptions in healthcare services. These findings highlight a significant disparity between perceived vaccination coverage and the actual reliability of services. Caregivers and community members in Gogrial West County have reported that access to healthcare is highly unreliable, characterized by frequent service interruptions and shortages of essential vaccines.

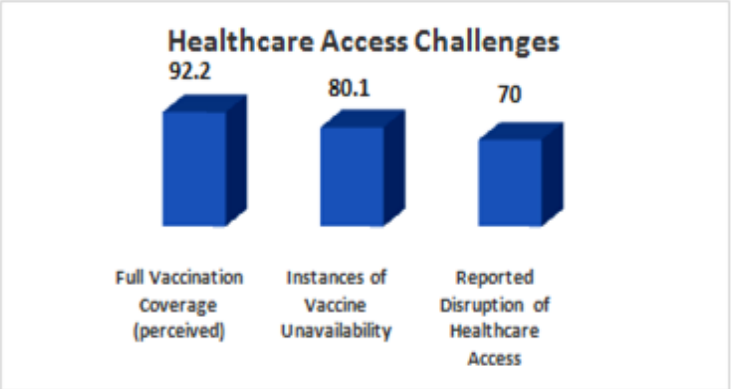


Figure 5. Healthcare Access Challenges

Figure 5 further illustrates the extent of healthcare access challenges, underscoring systemic weaknesses that leave children vulnerable to preventable illnesses and undermine public health efforts.

These findings underscore a health and nutrition crisis driven by a complex interaction of conflict, displacement, food insecurity, disease burden, and systemic failures in healthcare delivery. Comprehensive, integrated solutions are urgently needed to address these multidimensional challenges.

Summary of Findings

The study revealed that conflict in Gogrial West County has had severe impacts on the health and nutrition of children under five. Nearly two-thirds (66.87%) of households had been displaced, and food insecurity was widespread: 86.75% reported shortages and 33.30% reported frequent hunger. Malnutrition rates exceeded WHO emergency thresholds, with Global Acute Malnutrition at 17% (WHZ) and 7.6% (MUAC) [1]. Common illnesses were highly prevalent, particularly diarrhea (78.3%), fever/malaria (77.7%), and respiratory infections (55.4%) [27].

Despite 92.8% awareness of colostrum's benefits, 80% of caregivers reported stress as a barrier to optimal feeding. While perceived vaccination coverage was high (92.2%), supply chain issues persisted: 80.1% reported vaccine unavailability and 70% experienced healthcare service disruptions [21]. These findings demonstrate a complex crisis driven by displacement, food insecurity, disease burden, and weakened healthcare systems, highlighting the urgent need for integrated, multi-sectoral interventions [26].

These findings establish that the intersection of conflict, displacement, food insecurity, poor WASH conditions, caregiver stress, and health system breakdowns is driving a crisis in child health and nutrition in Gogrial West [22, 12].

Discussion

The results of this research strongly reaffirm the profound and multifaceted impact of conflict on child health and nutrition in Gogrial West County, Warrap State, South Sudan. The findings clearly illustrate how conflict-driven displacement, food insecurity, poor WASH conditions, and disrupted healthcare systems combine to produce an environment that is

highly hostile to child survival and development.

One of the most striking findings was that approximately 66.87% of surveyed households experienced displacement due to conflict. Displacement not only disrupts stable income and access to land and food but also affects social support systems and healthcare access. When compared with data from [12], which classifies the region as high-risk for food insecurity, our results reinforce the reality that Gogrial West remains critically vulnerable.

Food insecurity in the surveyed households was alarmingly high. Over 86.75% of families reported food shortages, and 33.3% experienced persistent hunger. These figures highlight the urgent need for both short-term humanitarian aid and long-term food security programming. The data align with global findings that displacement often leads to agricultural disruption, livelihood loss, and increased market dependence, thereby elevating food insecurity [8, 11].

Health outcomes were equally distressing. According to [1], Global Acute Malnutrition (GAM) was 17.0% based on weight-for-height Z-scores and 7.6% based on MUAC. These figures exceed the WHO emergency threshold of 15% and confirm an ongoing nutrition crisis. Additionally, high rates of childhood illnesses were observed: 78.3% of children had experienced diarrhea, 77.7% had suffered from fever/malaria, and 55.4% were diagnosed with respiratory infections. These conditions, common in conflict settings, are exacerbated by overcrowding, poor sanitation, and inadequate access to clean water [22, 26].

Furthermore, the psychological impact of conflict on caregivers was also evident. While 92.8% of respondents were aware of the benefits of colostrum, a strong indicator of IYCF knowledge 80% reported that stress significantly hindered child feeding practices. This underscores the indirect, yet critical, link between caregiver mental health and child nutrition. Programs focusing on Infant and Young Child Feeding (IYCF) must therefore integrate psychosocial support to be effective [2]. Vaccination coverage presented an interesting paradox. While 92.2% of caregivers claimed their children had received complete vaccinations, 80.1% reported vaccine unavailability at some point. This discrepancy suggests that while demand for immunization is high, the supply chain is unreliable—a frequent issue in conflict-affected areas [21]. Additionally, over 70% of respondents acknowledged disruptions in healthcare service delivery, further confirming the systemic breakdown in healthcare infrastructure [15].

In comparison with global literature, these findings are consistent with evidence from other conflict zones where child morbidity and malnutrition rates rise sharply due to the collapse of essential services [6, 9]. This study contributes a localized, detailed dataset that can guide targeted interventions. It not only corroborates existing global trends but also underscores the importance of context-specific approaches to child health programming in fragile states such as South Sudan [30, 17].

Conclusion

This study illustrates the dire consequences of protracted conflict on the most vulnerable population: children under five in Gogrial West County, Warrap State [28]. The data clearly show that conflict exacerbates existing vulnerabilities in nutrition, healthcare access, and disease prevention. While caregivers demonstrate commendable knowledge and commitment, they are overwhelmed by structural and psychosocial barriers. The findings not only reflect the urgency of the humanitarian situation in South Sudan but also highlight the need for multi-sectoral, context-specific responses. By combining quantitative data with qualitative insights, this research fills a critical knowledge gap and provides practical recommendations for humanitarian organizations, government bodies, and international stakeholders. Unless swift and

coordinated action is taken, the gains in child health and nutrition achieved through past efforts may be reversed, with long-term consequences for South Sudan's development [17, 28].

Recommendations

Based on the findings, the following recommendations are made for humanitarian agencies, policy makers, and health system planners:

1. **Integrated Emergency Response:** Urgent delivery of food aid, nutrition services, and essential medical supplies to displaced and food-insecure households [11].
2. **Strengthening Health Infrastructure:** Improve cold chain management and regular supply of vaccines and essential drugs. Increase staffing in health centers, particularly in conflict-affected areas [15].
3. **WASH Interventions:** Scale up access to clean water, sanitation facilities, and hygiene promotion to reduce the burden of infectious diseases [22].
4. **Mental Health and Psychosocial Support (MHPSS):** Integrate MHPSS services into IYCF and maternal health programs to address the impact of stress on caregiving [2, 26].
5. **Livelihoods and Resilience Building:** Introduce agricultural recovery programs, vocational training, and microfinancing opportunities to restore economic stability in affected communities [28].
6. **Data-Driven Decision Making:** Regular monitoring through household surveys and community feedback mechanisms to adapt interventions in real-time [13].
7. **Peacebuilding and Conflict Resolution:** Collaborate with local leaders and international bodies to mediate and resolve conflicts, as long-term health solutions are not feasible without lasting peace [10, 24].

Ethical Considerations

Ethical clearance was obtained from the Ministry of Health, South Sudan [14]. Informed consent was received from all participants.

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Conflict of Interest

The author, Odette Kum Chou, declares no conflict of interest.

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Early Postoperative Complications of Open-Heart Surgery

Tameem Thamir
College of Nursing, University of Mosul, Mosul, Iraq

Abstract

Cardiovascular illnesses continue to be the primary cause of worldwide death. Heart transplantation is regarded as the only treatment intervention recognized as the gold standard for managing end-stage heart failure. Nonetheless, the persistent postoperative problems adversely affect both the survival rate and quality of life in heart transplant patients. This study aimed to detect the earliest complications after open-heart surgery at the Mosul center, using a prospective cohort design during the period from 1st May to 1st June 2025. The study includes 47 patients who had undergone CABG and valve replacement for the first time in intensive care units and wards, in Mosul Open Heart Center. Descriptive statistics were used to summarize baseline characteristics and complication rates. Comparative analyses: Chi-square tests for categorical variables and t-tests for continuous variables will be used to assess differences in complications across demographic factors, comorbidities, and surgical variables. The study shows that approximately 59.5% of the patients are experiencing moderate pain. Low urine output occurred in (40%) according to gender. Acute renal dysfunctions occurred in (27.6%), gastrointestinal dysfunctions occurred in (57.4%), according to age. Respiratory dysfunctions, acute renal dysfunctions, and low urine output had a significant relationship in the patients according to the chronic diseases. The study concluded that several complications occurred in open-heart surgery patients at the Mosul Surgery Center, including pain, respiratory distress, renal, and gastrointestinal problems. The results indicated that there is a statistically significant relationship between patients' age and kidney dysfunction and lack of gastrointestinal function, as well as a relationship between chronic diseases, kidney dysfunction, and gastrointestinal dysfunction. It also showed a relationship between most of the variables and the occurrence of complications in terms of the type of operation (CABG).

Keywords: *Coronary Artery Bypass Grafting, Mitral Valve Replacement, Open Heart Surgery, Postoperative Complications.*

Introduction

Open-heart surgery is typically reserved for severe or life-threatening heart conditions that cannot be managed through less invasive methods. While risks are associated with surgery, improvements in medical and surgical technology, and post-operative care have markedly enhanced outcomes, so it will be a critical intervention in the treatment of heart disease [1]. Saving life for many patients through open heart surgery which can relief symptoms, prevent additional cardiac damage, and extended life. Coronary artery bypass grafting is considered as the surgical intervention that is designed to enhance myocardial perfusion in individuals with advanced coronary artery disease (CAD). [2]. Using grafts, which may be harvested from the patient's own veins or arteries (such as saphenous veins or internal mammary arteries), the procedure reroutes blood past constricted or

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Corresponding Author: tameem.thamir@uomosul.edu.iq

obstructed coronary arteries. Patients with severe CAD have a far better chance of survival and quality of life after CABG, but there is a risk of both short-term and long-term problems, especially in the early postoperative period. Coronary artery bypass grafting (CABG) patients are at increased risk for problems in the first 30 days after surgery, which might delay recovery or even be fatal. [3]. Possible causes of early postoperative complications include preexisting conditions, the complexity of the operation, and the body's response to stress and shock. Delayed rehabilitation and recovery due to these issues may have an impact on several bodily systems, including the cardiovascular system and the respiratory system. [4]. Patients frequently encounter arrhythmias, atrial fibrillation, myocardial infarctions, infections including those in deep sternal wounds, hemorrhage, renal complications such as acute kidney injury and respiratory disorders such as pneumonia in the initial days post-surgery. Usually, these complications need quick diagnosis, watched closely, and in rare cases, treated with medicine or surgery [5, 6]. To improve the results of coronary artery bypass grafting surgery, it is important to find risk factors and make a diagnosis as soon as possible and then use the right care methods. Multidisciplinary care teams are very important for improving surgical procedures and rehabilitation, as well as for increasing survival rates and lowering the risk of complications. [7-11]. This study aims to investigate potential problems that may arise after coronary artery bypass grafting (CABG) and identify the variables that contribute to their occurrence.

Materials and Methods

The study will adhere to the ethical principles outlined in the Declaration of Helsinki. Written informed consent will be obtained from all participants before inclusion in the study.

Study Design

This research will use a prospective cohort study design from 1st May 2025 to 30th June. The study will follow patients undergoing CABG over a specified period post-surgery to observe and document early postoperative complications.

Study Population

The study includes 47 patients who had undergone CABG and valve replacement for the first time in intensive care units and wards in the Mosul Open Heart Center. Both male and female patients with varying levels of comorbidities (e.g., hypertension, diabetes, chronic kidney disease) will be included.

Exclusion criteria will include:

1. The study will not include patients who are concurrently undergoing other major surgeries.
2. At the time of surgery, patients with active infections will be excluded.
3. Patients who refuse participation or are unable to provide informed consent.

Data Collection and Instrument

The instrument of the study was a questionnaire composed of two parts. Part one covered demographic characteristics of the nurses, including age, gender, years of service, educational levels, place of work, and shifting time of work [12]. Part Two: It consisted of eight problems (complications) that may happen after open heart surgery.

Data will be collected at multiple time points [13-17]:

1. Preoperative Data: Demographic information, preoperative risk factors (e.g., left ventricular ejection fraction, presence of diabetes, smoking history), and baseline lab results (e.g., renal function, complete blood count).
2. Intraoperative Data: Surgical technique (e.g., use of cardiopulmonary bypass, graft

type), duration of surgery, and anesthesia information.

3. Postoperative Data: Early postoperative complications will be documented daily for the first 30 days.

Statistical Analysis

Descriptive statistics (mean, standard deviation, percentages) will be used to summarize baseline characteristics and complication rates. Comparative analyses (e.g., chi-square tests for categorical variables and t-tests for continuous variables) will be performed to assess differences in complications based on demographic factors, comorbidities, and surgical variables. Kaplan-Meier survival analysis will be used to determine time to complication occurrence.

Results

The study included 47 patients undergoing cardiac surgery, with more than half under 60 years old, nearly 36% between 60-69 years, and nearly 10% 70 years or older. The gender distribution showed a moderate male predominance, with 59.5% male patients. Regarding compiling diseases association, diabetes was not frequent (17%), 93.6% having hypertension, and 38.2% were smokers. Surgical history represented in the form of CABG (70.2%), MVR (23.4%), while (6.3%) underwent combined CABG/MVR. Most surgical operations were planned as elective procedures (57.4%) (Table 1).

Table 1. Basic Demographic Features and Preoperative Factors of the Study Sample N= 47

Basic Demographic Features and Preoperative Factors		**F**	**%**
Age group (in years)	< 60 years	25	53.1%
	60-69 years	17	36.1%
	< 70 years	5	10.6%
Gender	Male	28	59.5%
	Female	19	40.4%
D.M	Yes	8	17%
	No	39	82.9%
H.T	Yes	44	93.6%
	No	3	6.3%
Smoking	Smoker	18	38.2%
	Non-Smoker	29	61.7
Types of Operation	CABG	33	70.2%
	Mital Valve replacement	11	23.4%
	CABG+ Mital Valve replacement	3	6.3%
Status of Operation	Elective	27	57.4%
	Urgent	13	27.6%
	Emergent	7	14.8%

The distribution of postoperative complications by gender among the 47 patients undergoing cardiac surgery showed interesting variations (Table 2). Pain association with gender demonstrated a significant (p=0.025) difference; moderate to severe pain was primarily associated with females, and no pain or mild-to-moderate pain was reported by males. Gastrointestinal dysfunction association with gender demonstrated a non-significant (p=0.0781) difference (14 males and 13 females affected, while 14 males and 6 females were

free from gastrointestinal dysfunction). Wound infection association with gender demonstrated a significant (p=0.044) difference (3 males and two females affected, while the remaining from both groups were free from wound infection.

Renal complications associated with gender demonstrated a significant (p=0.008) difference (9 males compared to 4 females affected, while 19 males and 15 females had normal renal function). Correspondingly, low urine output association with gender demonstrated a significant (p=0.037) difference (11 males and eight females affected, with 17 males and 11 females maintained normal urine output). Respiratory dysfunction, cardiac arrest, and atrial fibrillation have shown non-significant differences.

Table 2. The Incidence of Postoperative Complications According to Gender

Postoperative Complications		**Male**	**Female**	**P-value**
Pain	No pain	2	0	0.025
	Mild to moderate	20	8	
	Moderate to severe	6	11	
Gastrointestinal dysfunctions	Yes	14	13	0.0781
	No	14	6	
Wound infection	Yes	3	2	0.044
	No	25	17	
Acute renal dysfunctions	Yes	9	4	0.008
	No	19	15	
Respiratory dysfunctions	Yes	9	6	0.413
	No	19	13	
Low urine output	Yes	11	8	0.037
	No	17	11	
Cardiac arrest	Yes	1	1	0.831
	No	27	18	
Atrial fibrillation	Yes	4	2	0.786
	No	24	17	

The distribution of postoperative complications by age association among the 47 patients undergoing cardiac surgery showed interesting variations (Table 3). Pain association with age demonstrated significant (p=0.0141) variation: moderate to severe pain mainly was associated with younger patients (<60 years), with 6 patients in the 60-69 age group and 2 in the (<70 years) group. Similarly, gastrointestinal dysfunction was significantly associated with ageing (p=0.0213) (<70 years: 4 out of 5 patients affected, 60-69 years: 13 out of 17 patients affected, < 60 years: 10 out of 25 affected).

Renal complications were significantly p=0.017 associated with ageing (<70), with 4 out of 5 patients affected under 60 69 years, 5 out of 17 patients affected in those < 60 years, and 7 out of 25 patients affected in those under 60 years. Low urin output significantly (p=0.004) associated with ageing (<70 years: 1 out of 5 patients affected, 60-69 years: 11 out of 17 patients affected, < 60 years: 4 out of 25 affected). Surprisingly, wound infection has shown non-significant (p=0.661) association with ageing (<70 years: none affected, 60-69 years: 2 out of 17 patients affected, < 60 years: none affected). Respiratory complications non-significantly (p=0.402) associated with ageing (<70 years: 2 out of 5 patients affected, 60-69 years: 4 out of 17 patients affected, < 60 years: 9 out of 25 affected). Despite these

complications, the most serious cardiac complications (cardiac arrest and atrial fibrillation) demonstrated no significant age-related differences.

Table 3. The Incidence of Postoperative Complications According to the Patient's Age

Postoperative complications		**< 60 years**	**60-69 years**	**< 70 years**	**P-value**
Pain	No pain	0	2	0	0.0141
	Mild to moderate	16	9	3	
	Moderate to severe	9	6	2	
Gastrointestinal dysfunctions	Yes	10	13	4	0.0213
	No	15	4	1	
Wound infection	Yes	0	2	0	0.661
	No	25	15	5	
Acute renal dysfunctions	Yes	7	5	1	0.017
	No	18	12	4	
Respiratory dysfunctions	Yes	9	4	2	0.402
	No	16	13	3	
Low urine output	Yes	4	11	4	0.004
	No	21	6	1	
Cardiac arrest	Yes	0	1	1	0.328
	No	25	16	4	
Atrial fibrillation	Yes	1	4	1	0.653
	No	24	13	4	

The results of postoperative complications distribution based on association with diabetes mellitus (8 patients) and hypertension (44 patients) among the 47 patients undergoing cardiac surgery. Pain has a non-significant (p=0.478) association with diabetes (2 patients: no pain, 5: mild to moderate pain, and 1: moderate to severe pain), versus 0, 23, and 16 non-diabetic patients, respectively. Correspondingly, Pain has a non-significant (p=0.224) association with hypertension (2 patients: no pain, 26: mild to moderate pain, and 16: moderate to severe pain), versus 0, 2, and 1 normotensive subjects, respectively.

Diabetic subjects undergoing surgery have a significant (p=0.015) association with gastrointestinal dysfunction (2 out of 8 diabetic patients affected versus 25 out of 39 non-diabetic patients). Hypertension demonstrated a significant (p=0.053) association with gastrointestinal dysfunction (24 out of 44 hypertensive versus three normotensive patients).

Diabetic subjects undergoing surgery have a significant (p=0.0001) association with wound infection (5 cases of wound infection in diabetic patients versus 0 out of 39 non-diabetic patients). Hypertension demonstrated a significant (p=0.030) association with wound infection (4 out of 44 hypertensive versus 1 out of 3 normotensive patients).

Diabetic subjects undergoing surgery have a significant (p=0.002) association with renal complications (6 out of 8 diabetic cases versus 7 out of 39 non-diabetic patients). Hypertension demonstrated a significant (p=0.0001) association with renal complications (12 out of 44 hypertensive versus 1 out of 3 normotensive patients). Diabetic subjects undergoing surgery have an important (p=0.005) association with low urine output (7 out of 8 diabetic cases versus 12 out of 39 non-diabetic patients).

Hypertension demonstrated a significant (p=0.0001) association with renal complications (18 out of 44 hypertensive versus 1 out of 3 normotensive patients).

Diabetic subjects undergoing surgery have a non-significant (p=0.365) association with respiratory dysfunction (5 out of 8 diabetic cases versus 10 out of 39 non-diabetic patients). Hypertension demonstrated a borderline non-significant (p=0.058) association with renal complications (12 out of 44 hypertensive versus three normotensive patients experiencing respiratory dysfunction).

Diabetic subjects undergoing surgery have a non-significant (p=0.691) association with cardiac arrest (1 out of 8 diabetic cases versus 1 out of 39 non-diabetic patients). Hypertension demonstrated a significant association with cardiac arrest (p=0.0001). Atrial fibrillation demonstrated a non-significant association with diabetes (p=0.225) and hypertension (p=0.433), impacting four diabetic versus two non-diabetic patients, six hypertensive versus zero normotensive patients (Table 4).

Table 4. The Incidence of Postoperative Complications According to Chronic Diseases

Postoperative complications		**DM**		**P value**	**HT**		**P value**
		Yes 8	**No 39**		**Yes 44**	**NO 3**	
Pain	No pain	2	0	0.478	2	0	0.224
	Mild to moderate	5	23		26	2	
	Moderate to severe	1	16		16	1	
Gastrointestinal dysfunctions	Yes	2	25	0.015	24	3	0.053
	No	6	14		20	0	
Wound infection	Yes	5	0	0.000	4	1	0.030
	No	3	39		40	2	
Acute renal dysfunctions	Yes	6	7	0.002	12	1	0.0001
	No	2	32		32	2	
Respiratory dysfunctions	Yes	5	10	0.365	12	3	0.058
	No	3	29		32	0	
Low urine output	Yes	7	12	0.005	18	1	0.001
	No	1	27		26	2	
Cardiac arrest	Yes	1	1	0.691	2	0	0.0001
	No	7	38		42	3	
Atrial fibrillation	Yes	4	2	0.225	6	0	0.433
	No	4	37		38	3	

DM=Diabetes mellitus, HT=Hypertension

Postoperative complications following surgical operations demonstrated marked differences, including pain, wound infection, renal, gastrointestinal, cardiovascular, and respiratory complications (Table 5). Pain control showed a marked difference across procedure types (p=0.007), with distinct patterns emerging for each surgical approach. CABG patients showed the most promising pain profile (2 patients: no pain, 21 patients: mild-to-moderate pain, 10 patients: moderate-to-severe pain). MVR patients demonstrated no cases of complete pain relief (7 patients: mild to moderate pain; 4 patients: moderate to severe pain). In the combined CABG/MVR group, no patients had mild to moderate pain, and all 3 patients presented with moderate to severe pain.

Gastrointestinal dysfunction is common across all operations with no significant difference (p=0.556). CABG operation associated with neutral gastrointestinal dysfunction (17 affected and 16 unaffected) patients. MVR patients demonstrated a higher incidence rate (9 out of 11 patients affected versus two unaffected). The combined CABG/MVR group demonstrated 1 affected patient and two unaffected patients. Wound infection significantly (p=0.045) associated with procedure type, despite the relatively low incidence in all groups (CABG patients: 3 cases out of 33 wound infections, MRV: 1 case out of 11 operations, and the combined CABG/MVR group: 1 case out of 3 operations.

Renal complications demonstrated significant (p=0.002) variations among operative subjects (CABG patients: 10 cases out of 33 operations, no MVR patients developed acute renal dysfunction. However, the three patients demonstrating combined CABG/MVR showed acute renal dysfunction. Low urine output demonstrated a similar pattern (p=0.077), with 9 CABG patients affected, 7 MVR patients, and all three combined CABG/MVR patients associated with low urine output.

Respiratory dysfunction demonstrated a significant (p=0.006) link with type of operation, with MVR patients affecting 8 out of 11 versus only 5 out of 33 CABG patients. In combined CABG/MVR group, 2 out of 3 patients affected. The most striking complications, cardiac arrest, were highly correlated (p=0.004) with operation type, with no cases in CABG patients, while 1 MVR patient, and 1 CABG/MVR patient experienced this life-threatening complication. Atrial fibrillation demonstrated significant (p=0.004) differences (CABG patients having 1 out of 33 cases, MVR patients 3 out of 11 cases, and CABG/MVR patients having 2 out of 3 cases).

Table 5. The Incidence of Postoperative Complications According to the Types of Operation

Postoperative complications		**Types of Operation**			**P value**
		CABG	**MVR**	**CABG+MVR**	
Pain	No pain	2	0	0	0.007
	Mild to moderate	21	7	0	
	Moderate to severe	10	4	3	
Gastrointestinal dysfunctions	Yes	17	9	1	0.556
	No	16	2	2	
Wound infection	Yes	3	1	1	0.045
	No	30	10	2	
Acute renal dysfunctions	Yes	10	0	3	0.002
	No	23	11	0	
Respiratory dysfunctions	Yes	5	8	2	0.006
	No	29	3	1	
Low urine output	Yes	9	7	3	0.077
	No	24	4	0	
Cardiac arrest	Yes	0	1	1	0.004
	No	33	10	2	
Atrial fibrillation	Yes	1	3	2	0.004
	No	32	8	1	

CABG=Coronary artery bypass graft, MVR=mitral valve replacement

Discussion

The average age of the samples was 64.3, with more men than women. The majority of patients demonstrated hypertension, while most were not diabetic. Smoking did not affect the patients, as the majority were non-smokers; additionally, most procedures performed were elective, while emergency cases were the least common. Nearly half of the patients experiencing moderate discomfort were men, according to the sex distribution of complications. There were statistically significant variations between the sexes in cases of bursitis associated with renal failure, with men being more likely to suffer from this condition. Patients younger than 60 years old had moderate pain intensity 34% more often, suggesting a statistically significant association with other age groups. Patients between the ages of 60 and 69 had the highest prevalence of gastrointestinal problems, which was strongly linked to different age brackets. Notwithstanding their modest incidence rates, kidney function problems marked by decreased urine flow show a statistically significant connection with age groups. Diabetes was shown to be statistically significantly associated with the gastrointestinal systemic illness. Wound infections occurred in five diabetic individuals and four hypertensive patients. About a quarter of those with hypertension also had renal impairment, making it a more prevalent complication of the condition than diabetes. Patients with hypertension were more likely to have cardiac arrest compared to those with diabetes. There was a statistically significant relationship between the average pain severity and the operation type; patients undergoing open heart surgery reported the greatest pain intensity, while those undergoing mitral valve replacement reported the least. The study revealed a statistically significant association between various types of open-heart surgery and the incidence of respiratory and urinary disorders, with 21% of patients experiencing renal complications post-surgery. Conversely, patients undergoing mitral valve replacement surgery did not encounter any such disorders. Consistent with prior studies on postoperative complications following open heart surgery, the findings of the Negargar and Sadeghi study [1] indicate early graft dysfunction, arrhythmia, atrial fibrillation, low cardiac output syndrome, deep sternal wound infection, and an increased early mortality rate post-transplantation. Peretto et al. [18] reported that atrial fibrillation occurs in 15% to 40% of patients undergoing coronary artery bypass graft (CABG) surgery, in 37% to 50% following valve surgery, and up to 60% during combined procedures (bypass and valve intervention). It typically occurs within three days of post-operation. Huen and Parikh [19] indicated in their study that renal failure is frequently characterized by a three-fold elevation in baseline creatinine or the initiation of dialysis. Literature suggests that the incidence of acute renal injury following cardiac surgery ranges from 3% to 30% (10). Bachvarov [20] indicated in his research that open-heart surgery continues to present a significant risk for postoperative complications. Cardiovascular complications, especially rhythm and conduction disorders, are the most prevalent. Complications such as graft failure, considerable hemorrhage, cerebrovascular accident, and extended mechanical ventilation are correlated with the highest mortality risk [20].

Conclusion

The study concluded that several complications occurred in open-heart surgery patients at the Mosul Surgery Center, including pain, respiratory distress, renal, and gastrointestinal problems. The results indicated that there is a statistically significant relationship between patients' age and kidney dysfunction and lack of gastrointestinal function, as well as a relationship between chronic diseases, wound infection, kidney dysfunction, and gastrointestinal dysfunction. It

also showed a relationship between most of the variables and the occurrence of complications in terms of the type of operation (CABG).

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Cost Analysis of Conventional Antimicrobial Resistance Diagnostics in Zambia: Evidence for Sustainable Laboratory Investment in Resource-Limited Settings

Lutinala Nachilembo Nalomba[1*], Mox Kalumbi[2], Baron Yankonde[3], Pascalina Chanda-Kapata[4]

[1]*Family Health and Infectious Diseases/MPH, East, Central, and Southern Africa Health Community, Tanzania*

[2]*Microbiology Department/MSc Micro, Levy Mwanawasa Medical University, Zambia*

[3]*Laboratory Department/BSc, Churches Health Association of Zambia, Zambia*

[4]*Independent Consultant, Zambia*

Abstract

Antimicrobial resistance (AMR) is a growing global health threat, particularly in low- and middle-income countries (LMICs) like Zambia, where diagnostic capacity is limited, and funding constraints hinder effective response. This study aimed to assess the per-test cost of conventional AMR diagnostic methods, Gram stain, culture, and antimicrobial susceptibility testing (AST), to support sustainable investments and policy decisions. Between December 2024 and March 2025, data were collected from 13 laboratories across nine provinces in Zambia using structured questionnaires. Inputs related to labour, reagents, and equipment were analysed using the WHO Laboratory Testing Costing Tool (LTCT) and Julius AI. Pricing adhered to Zambia's Public Procurement Act, and ethical approvals were obtained from UNZABREC and NHRA. Results showed that test costs varied widely by input type. Gram stains were the least expensive at $3.15 per test, while enriched media like Blood/Chocolate agar reached $4.92 due to high labour and reagent requirements. Biochemical test costs ranged from $4.25 to $7.99, with Coagulase being the most expensive due to reagent costs. Testing for WHO-priority pathogens, such as E. coli and K. pneumoniae, costs approximately $37–38 per test, while testing for Neisseria gonorrhoeae costs $42. Sensitivity analysis identified reagents as the primary cost driver across all test types. Batch testing was cost-effective only for tests with high fixed costs, such as Blood Culture. This study underscores the importance of standardized costing, context-specific planning, and bulk procurement in sustaining affordable diagnostics in resource-limited settings. Future research should incorporate indirect costs to provide a comprehensive understanding of laboratory financial needs.

Keywords: *Costs and Cost Analysis, Drug Resistance, Laboratories, World Health Organization, Zambia.*

Introduction

Antimicrobial resistance (AMR) has emerged as one of the most pressing global health challenges of the 21st century, threatening to reverse decades of medical progress [1, 2]. The World Health Organization (WHO) recognizes AMR as a top global public health threat, capable of rendering common infections untreatable and increasing mortality, morbidity, and healthcare costs worldwide [3]. The massive burden of

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****Corresponding Author: lnmulenga@gmail.com***

AMR is attributable to a list of bacteria referred to as the WHO Bacterial Priority Pathogen List (BPPL) [4]. While the burden of AMR is global, it disproportionately affects low- and middle-income countries (LMICs) like Zambia, where diagnostic capacity is limited, surveillance systems are weak, and access to appropriate antimicrobial therapies is inconsistent [5, 6]. In 2019 alone, AMR caused an estimated 255,000 deaths in Africa, mainly due to antimicrobial misuse, poor vaccination coverage, environmental contamination, limited access to quality diagnostics and medicines, and insufficient public and healthcare worker awareness [6].

In Zambia, bacteriology testing remains critically limited, with only 1% of public health laboratories equipped for such diagnostics [7, 8]. Health investments have historically focused on vertical programs like HIV, TB, and malaria, leaving diagnostic infrastructure underdeveloped [1, 7]. As a result, only 55% of second-level and 23% of third-level hospitals provide culture and AST, with negligible access at the primary care level [8, 41]. Of over 3,400 health facilities nationwide, just 19 offer these essential services. This diagnostic gap promotes empirical antibiotic use, undermining antimicrobial stewardship and accelerating the spread of antimicrobial resistance (AMR). AMR surveillance capacity is also low, present in only 19% of public and 34% of faith-based facilities [10]. A study across seven mission hospitals reported an average laboratory capacity score of 39%, echoing a broader assessment by ASLM, which found only 14% of Zambian laboratories had adequate testing capacity, highlighting a pressing need to strengthen AMR diagnostic systems nationwide [41].

Health costing, the estimation and analysis of healthcare service expenses [35, 36], is essential in Africa, particularly amid declining donor aid. Accurate costing informs strategic decisions on resource allocation and service delivery, especially for critical services like AMR laboratories. Standardization of costing methods, as recommended by [36, 37], is vital for transparency and policy uptake.

Economic evaluation strengthens this process by comparing costs and outcomes of alternative interventions [32]. It provides the evidence base for investment decisions, highlighting opportunity costs and value-for-money. With overstretched government budgets and limited donor funding, prioritizing affordable, equitable, and impactful health services is critical [33, 34, 38]. Laboratory investments, though often undervalued, yield broader public health benefits, yet traditional evaluations usually miss cross-sectoral impacts [32, 33].

Health services in Africa are often subsidized, but access remains limited due to cost and distance [8, 40]. The African Union has also recognized socio-economic barriers as a driver of rising AMR [39]. Therefore, robust health costing is crucial for advocating sustainable laboratory systems and ensuring efficient, equitable health investments.

The economic impact of AMR is immense, with the World Bank projecting a 3.8% annual loss in global GDP by 2050, amounting to nearly $100 trillion if unaddressed [7]. Health cost analysis helps quantify this burden and supports advocacy for integrating AMR diagnostics into essential health packages [11]. Despite higher upfront costs, diagnostic-driven treatment improves outcomes and curbs unnecessary drug use [12]. Microscopy, culture, and AST remain vital for appropriate antimicrobial therapy in resource-limited settings [13, 14]. However, few cost studies focus on microbiology diagnostics, as most existing data emphasize clinical chemistry and newer diagnostic tests [15].

This study aims to assess the cost per test of Gram stain, culture, and AST to detect AMR and to generate a cost analysis, particularly for WHO-priority bacterial pathogens in Zambia. The need to establish the cost of testing

tailored to geographical settings is now more urgent than ever. Over the past two decades, PEPFAR has invested approximately $120 billion, with annual funding rising from $1.9 billion in FY2004 to $6.5 billion in FY2024. This support has significantly strengthened laboratory systems across Africa through technical training, mentorship, data management, and direct service delivery, including equipment procurement and personnel hiring [31]. However, the U.S. Government and other funding agencies are reviewing their funding support to Africa and other developing countries, potentially disrupting critical public health laboratory services.

Despite being time-consuming and having longer turnaround times than newer methods such as sequencing and molecular testing, conventional methods remain the gold standard for testing for AMR [29]. This study focuses on these methods as a recommendation for potential scale-up in laboratories with less advanced infrastructure and equipment, compared with newer tests that require specialized instruments and trained personnel [29, 30] in Zambia.

The findings are expected to inform and influence policy on financing and insurance reimbursement for AMR testing scale-up using conventional methods, and on promoting testing before antibiotic prescription and use. Culture and antimicrobial susceptibility testing (AST) are available in only a small proportion of health facilities, forcing empirical prescribing and accelerating AMR. Yet, there is little evidence on the actual costs of implementing these diagnostics to guide policy and investment. This study provides Zambia's first comprehensive costing analysis of Gram stain, culture, and AST, identifying cost drivers and efficiencies to inform sustainable financing, strengthen stewardship, and expand equitable access to diagnostics.

The study's limitation is that it focused narrowly on direct operational costs, excluding indirect expenses such as infrastructure, utilities, maintenance, and regulatory compliance. While useful for lab-level budgeting and procurement, the findings should be considered in light of these limitations. Infrastructure design, driven by risk and needs assessments, significantly impacts costs and may hinder lab operations despite investments in reagents, equipment, and training [42].

This study presents the first comprehensive micro-costing analysis of conventional antimicrobial resistance (AMR) diagnostics, Gram stain, culture, biochemical, and AST, in Zambia. Using data from local supplies and 13 laboratories across nine provinces, it provides context-specific cost estimates essential for national planning and sustainable investment. The integration of WHO's LTCT and Julius AI enhances analytical rigor. Unlike prior studies, this research disaggregates cost drivers, highlights the dominant role of reagents, and assesses the impact of batch testing on cost efficiency. These findings offer actionable insights for optimizing laboratory workflows, informing procurement strategies, and guiding evidence-based policy for AMR diagnostic scale-up in resource-limited settings.

Materials and Methods

Data for this study were collected between December 2024 and March 2025 from 13 laboratories performing culture and antimicrobial susceptibility testing (AST) across nine provinces in Zambia: Muchinga (2), Lusaka (4), Northwestern (1), Southern (1), Northern (1), Eastern (1), Central (1), Western (1), and Luapula (1). Of these, five are rural, and 3 are urban provinces. A structured questionnaire was administered to collect standardized data on the human and material resources required for microbiological testing from the 13 laboratories. Specifically, the questionnaire captured detailed information on the time

spent during key steps of bacteriological testing, including media preparation, culture, and AST inoculation and reading. In addition, data were collected on Gram stain procedures, including the average time spent reading smears and the volume of staining reagents used per test. Data on staff wages are based on the Ministry of Health full-time salaried staff for a Biomedical technologist and hence did not vary from laboratory to laboratory. Once data saturation was reached, defined as the point at which no new significant information [16, 17] emerged across facilities, the responses were averaged and summarized. These consolidated values were then entered into WHO LTCT [21] to compute the unit cost per microbiological test. The use of WHO LTCT enabled standardized calculation of direct and indirect costs, ensuring comparability and reliability in estimating the cost per diagnostic procedure in resource-limited settings.

Information on the testing requirements for microscopy, culture, and AST was collected from various sources, including standard operating procedures (SOPs) from local laboratories, the American Society for Microbiology [18], and manufacturer protocols from Himedia [19], the latter chosen to align with quotations from local suppliers. Three Zambian vendors provided detailed cost estimates in Zambian Kwacha, converted to U.S. dollars using OANDA exchange rates [20]. All reported costs exclude tax to ensure consistency in the financial analysis.

The request for quotations process for laboratory reagents and equipment was conducted in accordance with the Zambia Public Procurement Act of 2020, which defines “simplified bidding and selection” as a method that invites bids from a minimum of three bidders [40]. Based on the testing requirements, requests for quotations were sent to eight pre-identified laboratory supplier companies. Of these, three companies submitted quotations for laboratory reagents and consumables, thereby satisfying the simplified bidding threshold. However, only one company submitted a quotation for laboratory equipment, highlighting the limited number of suppliers operating in this market segment. In such cases, the Act permits the use of limited selection, which may be applied where goods or services are only available from a few suppliers [40]. Furthermore, single sourcing is also permitted under the Act when there is only one known supplier available, particularly in cases where no reasonable alternatives or substitutes exist [40]. The reliance on a single quotation for laboratory equipment was therefore both necessary and legally compliant, ensuring adherence to procurement principles while acknowledging the constraints of a limited supplier landscape. These structural limitations are important contextual factors in interpreting the scope and completeness of the study’s data. The above information was used to calculate the cost per test using the current market prices.

Data Analysis

Data were analyzed using the WHO Laboratory Testing Costing Tool (LTCT) [21] to estimate costs per test for microscopy, culture, biochemical tests, and AST, including those used to diagnose organisms on the WHO Bacterial Priority Pathogen List (BPPL) [4]. Key cost components included reagents and consumables, equipment (based on depreciation and usage), and staff time (converted from minutes to wage costs) for test preparation, inoculation, and test reading. Additional descriptive analyses were conducted using Julius AI [22]. Julius is an AI assistant specializing in statistical analysis, data science, and computations [22]. It selects the most suitable large language model (LLM) for each task and generates code to analyze the data based on the given prompts [22]. The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request. Figure 1

outlines the flow of events during data collection and analysis, highlighting the sequential steps followed in the study.

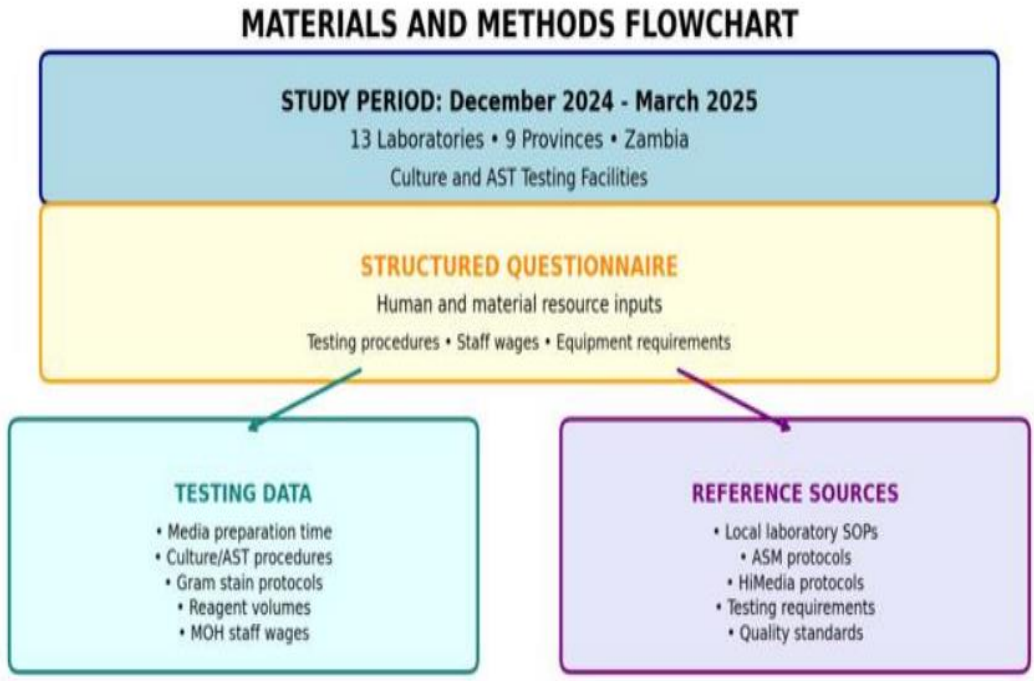


Figure 1. Outlines the Flow of Events during Data Collection and Analysis

Results

Per Test Cost Analysis by Type of Input

The per-test cost analysis of microbiological tests calculated the amount of money needed to conduct one test. The per-test costs analysed include costs associated with preparation, inoculation, reading of gram stains, different types of primary media, identification tests, and a battery of ASTs per organism, as shown in table 1. The per-test cost analysis revealed significant variation across input types. Time inputs differed widely, with Blood/Chocolate agar preparation requiring 117 staff minutes per test, the highest, while Gram staining needed only 39 minutes. Reagent and consumable costs were higher for enriched media, such as Blood/Chocolate agar, due to additives like sheep blood, compared to simpler media such as MacConkey or DCA. Equipment costs varied by frequency of use and equipment lifespan, with media preparation needing autoclaves, fridges, and incubators, unlike Gram staining, which required minimal equipment. Staff costs mirrored time requirements; tests with longer preparation times incurred higher labor costs. Total test costs ranged from $3.15 for Gram stain to $4.92 for Blood/Chocolate agar. Intermediate costs were observed for DCA, MacConkey, SS, and XLD media, depending on complexity and resource use. Overall, enriched media had the highest costs, driven by reagent, equipment, and labor requirements. Table 1 outlines the various cost-per-test contributions of microbiological testing stains and culture, providing a breakdown of the main cost drivers. At the same time, Figure 2 illustrates the percentage distribution of these components across the Gram stain and different culture media.

Table 1. Various Cost per Test Contributions of Microbiological Testing Stains and Culture Media

Description	Gram stain	Blood/ Chocolate Media	Deoxycholate Citrate media	MacConkey	Salmonella/ Shigella media	Xylose Lysine Deoxycholate media
Laboratory Financial Minutes per test	39.00	117.00	78.00	78.00	78.00	78.00
Reagents and consumables cost per test	$2.94	$3.76	$3.89	$3.84	$3.85	$3.90
Equipment cost per test	0.00	$0.53	$0.35	$0.35	$0.35	$0.35
Staff cost per test	$0.21	$0.63	$0.42	$0.42	$0.42	$0.42
Total cost of 1 test	$3.15	$4.92	$4.66	$4.62	$4.63	$4.68

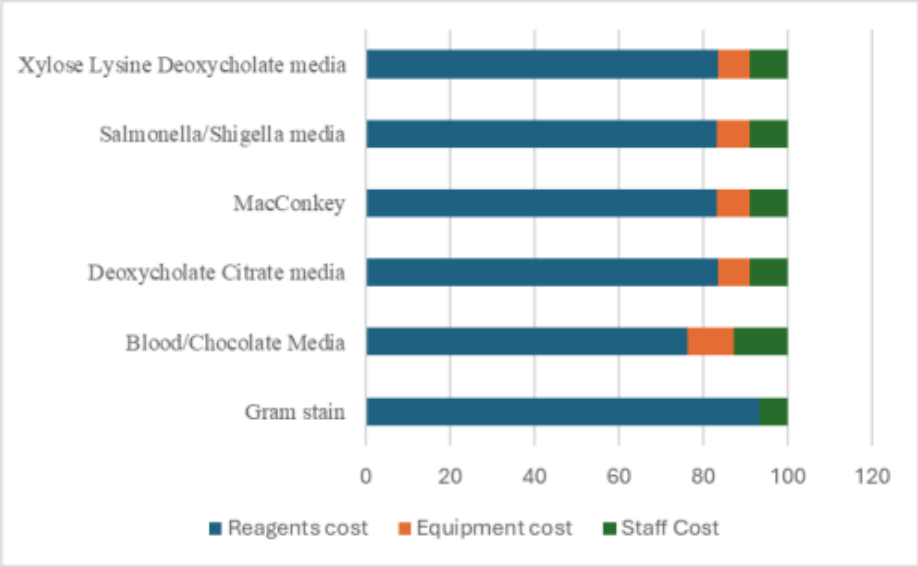


Figure 2. Per Test Cost Components of the Gram Stain and Various Culture Media (In Percentage)

Dissecting Time and Cost Per Test Structures of Common Biochemical Tests

A detailed analysis was conducted to assess both time and cost components of various biochemical tests, to understand test complexity, labour input, and cost efficiency. The tests were grouped into two clusters based on Laboratory Financial Minutes (LFMs), which reflect the technician's time investment.

High Time Intensive Tests (average 78 minutes) included Triple Sugar Iron (TSI), Kligler Iron Agar, SIM Medium, Simmon's Citrate, and Urease. These tests involve complex procedures such as solid media preparation, inoculation, and stepwise interpretation. Despite their higher time demands, they showed consistent cost per test, ranging between $4.25 and $4.49. The cost structure was stable: reagents and consumables ($3.48–$3.72), equipment ($0.35), and staff time ($0.42).

Quick Tests (average 13 minutes) included Catalase, Coagulase, and Kovac's Oxidase. These are rapid enzymatic or biochemical tests with minimal preparation and no incubation time. However, they showed greater cost variability, ranging from $4.30 to $7.99. Equipment costs were zero, staff costs were low ($0.07), but reagent costs ranged

significantly ($4.23–$7.92), with the Coagulase test emerging as a cost outlier at $7.99, due to high reagent expenses.

Among all tests, Simmon's Citrate was the most economical at $4.25, despite being time-intensive, highlighting the cost efficiency of traditional in-house biochemical media. In contrast, the Coagulase test was the most expensive, driven almost entirely by the cost of proprietary reagents rather than time or equipment. The per-test cost comparison of the biochemical tests is presented in Figure 3.

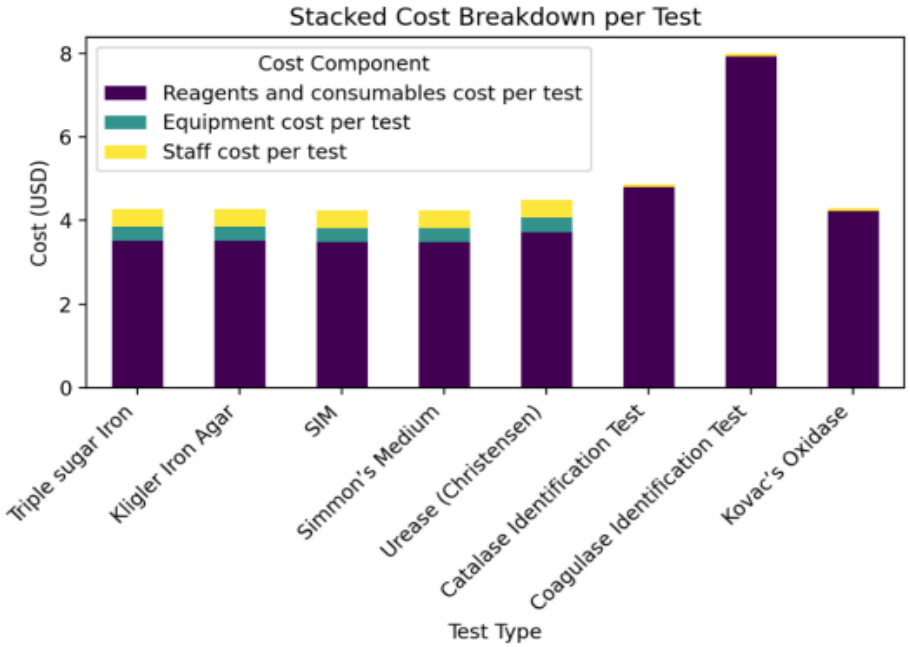


Figure 3. Per-Test Cost Comparison of Biochemical Test

Per Test Costing of WHO Bacterial Priority Pathogens Testing

The selection of pathogens for this cost analysis was informed by two main criteria: the frequency of diagnostic testing performed in Zambia and alignment with the BPPL4. The cost analysis focused on high-priority and critical pathogens identified by the WHO, including *Acinetobacter baumannii*, Enterobacterales (notably *Escherichia coli* and *Klebsiella pneumoniae*), Salmonella spp., and Shigella spp., four all of which are prevalent in the Zambian context. Additional high-priority organisms incorporated into the costing framework included *Pseudomonas aeruginosa, Staphylococcus aureus, Streptococcus pneumoniae, Neisseria gonorrhoeae,* and *Enterococcus faecium*

The per test cost analysis integrates the individual costs of media, Gram staining, biochemical identification tests (Triple Sugar Iron [TSI], Kligler Iron Agar [KIA], Sulfide Indole Motility [SIM], Simmons Citrate, Urease), and antimicrobial susceptibility testing (AST), including the cost of labour for inoculation and reading of the tests. Specific diagnostic workflows were applied for each organism, considering the tests commonly used for identification and resistance profiling in local laboratory practice.

The per test key findings from the analysis reveal consistent consolidated costs for *E. coli, K. pneumoniae, Acinetobacter baumannii,* Salmonella spp., and Shigella spp., all ranging around $37–38 per test. In contrast, *Neisseria gonorrhoeae* exhibited a higher total cost of approximately $42.30 due to higher cost of biochemical tests. *Staphylococcus aureus* and *Streptococcus pneumoniae* had comparatively lower testing costs of approximately $29.46. Figure 4 below delineates the proportion of expenses attributed to media, gram staining, biochemical tests, and AST. Figure 4 presents the cost breakdown by media, biochemical

tests, and antimicrobial susceptibility testing (AST) for each organism, providing a detailed comparison across the different diagnostic components.

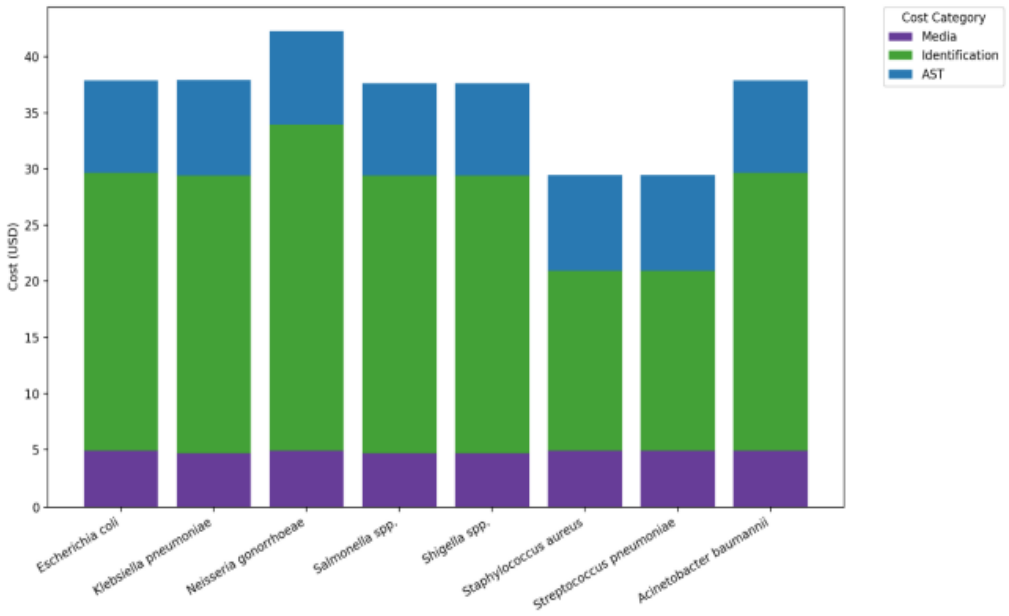


Figure 4. Cost Breakdown by Media, Biochemical Tests and AST for Each Organism

Sensitivity Analysis of Per Test Cost Components in Microbiological Testing

Reagents were the primary driver of cost variability across all test types, with particularly pronounced impact in rapid-turnaround assays, where they accounted for over 95% of the baseline cost. Equipment costs were only noteworthy for the five 78-minute agar/biochemical tests, contributing approximately 8% to the baseline. A 20% increase in equipment pricing would raise the per-test cost by approximately USD 0.06–0.08, a modest increment, though not negligible when scaled across large volumes. In contrast, changes in labour costs have minimal effect, shifting total costs by no more than USD 0.10 even under ±20% variation scenarios.

The data for each test were analysed at ±10 % and ±20 % on each cost component (reagents, equipment, staff) for the biochemical tests. Because Catalase, Coagulase and Kovac's Oxidase have zero equipment cost, changes in Equipment have no effect on their totals (the numbers stay fixed). Coagulase is most sensitive to reagent swings (moves from 6.41 → 9.57 USD over –20 % to +20 %). The longer 78-minute agar/biochemical tests show moderate dual sensitivity to both reagents and equipment because both components contribute materially to their baseline totals. Staff shifts are modest because labour is a small slice of cost.

A sensitivity analysis for E. coli showed that altering AST costs by ±20% shifted the total price to between 36.22–39.50 USD. Reagent heavy components like AST and media had the greatest impact, each ±20% change affecting the total by approximately1 USD. Staff and equipment changes had smaller, embedded effects. Figures 5 and 6 below depict every scenario's dollar change for Triple sugar Iron and *E. coli*, relative to its baseline cost.

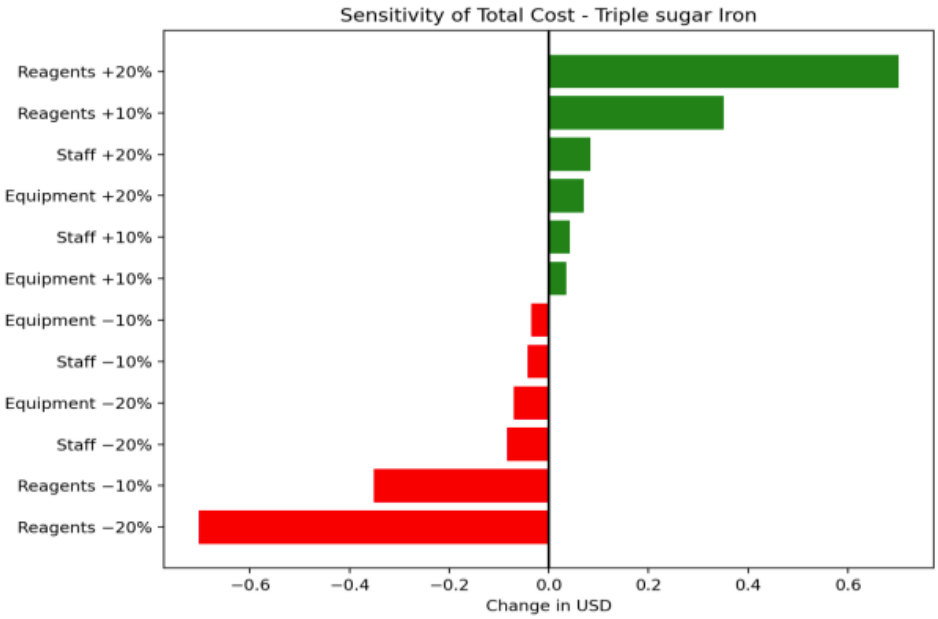


Figure 5. Sensitivity Analysis of Total Cost for Triple Iron Sugar

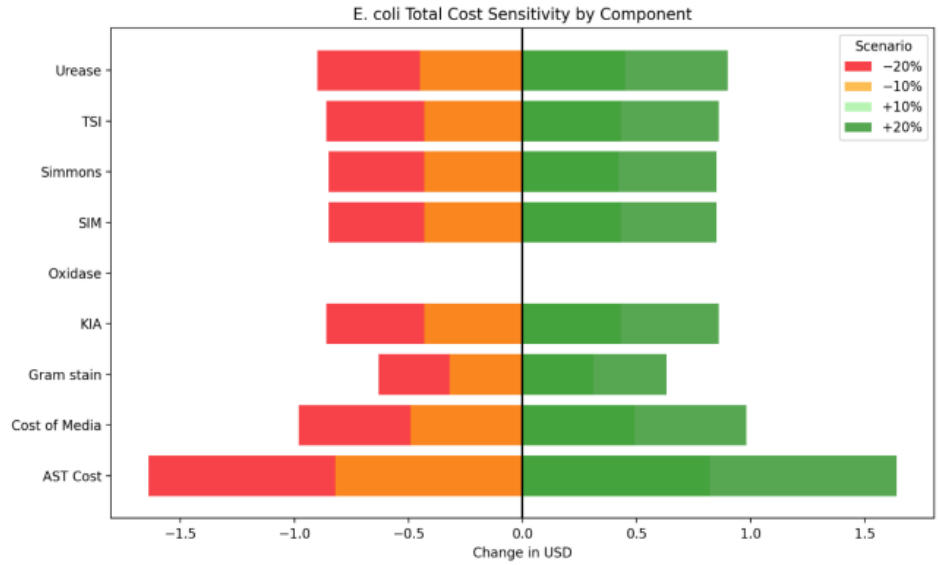


Figure 6. Sensitivity Analysis for *E. coli*

Impact of Batch Testing on Cost Efficiency: *E. coli* Case Study

Batch testing modelling demonstrated variable impact on cost efficiency across different diagnostic procedures for *E. coli*, depending on the proportion of fixed versus variable cost components. Analysis revealed that most *E. coli* diagnostic tests are heavily weighted toward variable costs, particularly reagents and consumables, which accounted for up to 95.6% of the total cost in tests such as antimicrobial susceptibility testing (AST). In such cases, batch testing provided limited cost reductions, as variable costs remain constant regardless of test volume.

In contrast, diagnostic procedures with a higher proportion of fixed costs, such as Blood Culture (fixed cost share: 23.6%), showed greater responsiveness to batching. Increasing batch sizes led to a noticeable reduction in per-test costs by distributing overheads, namely equipment usage and staff time, across multiple samples. Cost reductions were most pronounced when increasing batch size from 1

to 10, after which the benefit plateaued due to the dominance of variable costs.

Graphical analysis supported these findings. The cost-per-test curve showed a steep decline with small increases in batch size for tests with significant fixed cost components, whereas tests like AST exhibited minimal change. A corresponding percentage reduction curve confirmed that Blood Culture achieved up to 23% cost savings, while AST showed less than 10% even at maximum batching levels.

These results highlight that batch testing is most cost-effective for diagnostics with substantial fixed cost elements. For reagent-intensive tests, batching offers limited financial advantage. These insights are critical for laboratory planning, particularly in resource-constrained settings, where optimizing test throughput and minimizing cost per result are essential for sustainability. Figure 7 provides a visualization of batch testing for *E. coli*, illustrating how costs are distributed when multiple samples are processed together.

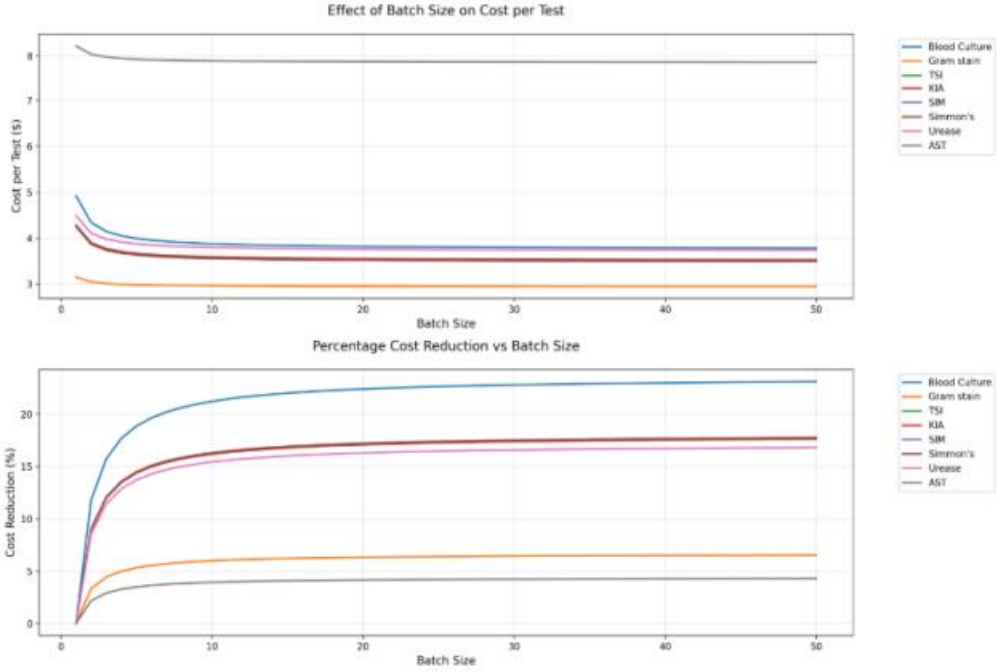


Figure 7. Visualization of batch testing for *E. coli*

Discussion

This costing analysis provides a detailed examination of microbiological diagnostic workflows, emphasizing Gram stain, culture media, biochemical, and AST as the main diagnostics for WHO designated priority pathogens [4]. The study reveals subtle cost structures, operational bottlenecks, and opportunities for efficiency in laboratory settings, especially in resource constrained environments.

1. Cost Structures and Drivers

Reagents were the dominant cost driver across all tests, contributing up to 90% in AST, while equipment and labor varied by procedure. Blood/Chocolate agar showed disproportionately high labor demand, reflected in elevated Lab Financial Minutes (LFM) relative to cost, underscoring the need for workflow optimization through batch processing and efficient staff scheduling [46]. Conversely, some rapid biochemical tests, though less labor-intensive, remained costly due to reliance on proprietary or imported

reagents. These findings emphasize the strategic importance of local reagent production and centralized procurement. Similar studies confirm reagents, consumables, equipment, and labor as key laboratory cost drivers [9, 15, 16, 23, 27].

Proper specimen management improves diagnostic accuracy, reduces unnecessary testing, and enhances workflow efficiency, leading to lower laboratory and hospital costs while supporting overall healthcare cost-effectiveness [13, 23]. Micro-costing is essential for evaluating intervention cost-effectiveness in LMICs, though challenges such as unreliable cost records, staff recall bias, wage disparities, and donated equipment complicate estimates [24]. Hamoudi's study showed automated urine analysis had higher reagent and equipment costs but reduced labor expenses due to faster testing [25]. Additionally, the underutilization of services increases per-test costs, emphasizing the need for demand-aligned resource planning to control reagent and equipment expenses [26].

2. AST, A Standardized, Scalable Test

AST procedures exhibited highly consistent cost profiles, with minimal variation in labor and equipment inputs across test types. This standardization simplifies budgeting, enables easier comparison between diagnostic options, and supports strategic decisions for service expansion. Notably, the uniformity in AST costs promotes equitable access to essential diagnostics across infection types, aligning with public health priorities for antimicrobial resistance (AMR) control. However, due to the dominant role of reagent costs, ensuring financial sustainability in AST hinges on bulk procurement, effective inventory management, and leveraging locally produced media, findings echoed in prior studies [15, 27]. Other studies emphasize that test implementation decisions should extend beyond cost alone; despite higher testing expenses, benefits such as faster turnaround times, shorter hospital stays, and reduced antibiotic use can significantly improve patient outcomes and healthcare efficiency [28, 23].

3. Pathogen Specific Insights

Cost analysis of high priority pathogens, including *E. coli, K. pneumoniae, P. aeruginosa* among others, demonstrated variability based on the diagnostic pathway. Some organisms followed a relatively fixed and predictable cost structure, while others incurred higher expenditure due to test complexity. For example, *E. coli* individual diagnostics tests ranged from $3.15 to $8.22, with cost distribution skewed rightward by procedures such as AST. Variable costs (mainly reagents and consumables) were the primary expenditure drivers, while fixed costs (equipment and permanent staff) were relatively stable. This finding is consistent with findings from other studies. One study found that apart from cost of reagents and consumables, other factors such as organism characteristics, number of samples tested per day, capital equipment and labor intensity were major cost drivers [27].

Health costing of laboratory procedures supports sustainable diagnostics by enabling accurate budgeting and efficient resource use. Context-specific planning, workload alignment, and coordinated bulk procurement are essential to control per-test costs, prevent stockouts, and ensure cost-effective, uninterrupted service delivery, especially in resource-limited settings with variable supply chains and infrastructure constraints [31].

4. Batch Testing Where Feasible

Tests with higher fixed cost components benefit most from batch processing, improving per test affordability. In the 1959 paper "Economic Batch-Size Determination for Multi-Product Scheduling' explores how to determine the most cost-effective batch size when producing multiple products on the same equipment or production line [43]. The goal

was to reduce overall costs by finding the right batch size for each product while managing machine time efficiently [43]. This principle highlighted by Eilon holds true for this study as well, especially in reagent preparation, where the greatest time investment was noted. When producing many different items using the same resources, making the right amount of each product at the right time helps reduce costs and improve efficiency [43]. This principle applies to, for example, all media that need to use the autoclave, incubator and fridges. All these tests can be done at the same cost because of batching, especially when done according to schedules and plans. Batch testing can also be optimized through centralizing testing and consolidating samples via referral networks, reducing the need for new equipment and lowering costs [26].

Conclusion

This study provides the first comprehensive cost analysis of conventional antimicrobial resistance (AMR) diagnostics in Zambia, offering critical insights into the financial and operational dimensions of Gram stain, culture, biochemical tests, and AST. Findings reveal significant variability in per-test costs, with reagents as the primary cost driver and limited gains from batch testing except in high fixed-cost procedures. The study emphasizes the need for context-specific planning, efficient procurement, standardization across laboratories, and strategic resource allocation to ensure sustainable and equitable access to AMR diagnostics. These insights can inform national laboratory policy, guide investment decisions, and support Zambia's broader efforts to combat AMR.

Ethical Consideration

Ethical approval was obtained from the University of Zambia Biomedical Research Ethics Committee (UNZABREC), 6016-2024 and the National Health Research Authority (NHRA), approval number NHRA-1802/18/12/2024. Informed consent was secured from all participants.

Data Availability

The datasets generated and analysed during this study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare no conflict of interest.

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Author Contribution

All authors contributed to the study in specific ways as outlined below:

1. **Lutinala Nachilembo Nalomba:** Lutinala led the conceptualization and design of the study and was primarily responsible for developing the research proposal. She took the lead in reviewing the data analysis and drafting the report and also spearheaded the writing and critical revision of the manuscript.
2. **Pascalina Chanda-Kapata:** Pascalina contributed to the study's conceptualization and design and supported the development of the proposal. She also participated in reviewing the data analysis, report, and manuscript.
3. **Mox Kalumbi:** Mox played a key role in developing the data collection tool and

provided practical insights into on-site microbiology practices. He participated in data collection and contributed to reviewing both the proposal and the manuscript.

4. **Baron Yankonde:** Baron contributed to the development of the data collection tool and offered practical input on microbiology practices during fieldwork. He participated in data collection, reviewed the proposal and manuscript, and supported the compilation of technical requirements and distribution of vendor quotation requests.

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Regression Analysis of Determinants of Breast Self-Examination and Practices Among Midwifery Students in a Teaching Hospital, Nigeria

Umar N. Jibril[1*], Ali Hajara[2], Aminat G. Umar[3], Ibraheem M. Ayoade[4], Baba D. Abubakar[5], Aliyu Umar[6], Abdulmalik, N. Ajoke[7], Imam A. Abubakar[4], Lawal F.A. Ibrahim[1]

[1]*Department of Nursing Sciences, College of Health Sciences, University of Ilorin, Ilorin Nigeria*

[2]*College of Nursing Sciences, Abubakar Tafawa Balewa University Teaching Hospital, Bauchi Nigeria*

[3]*Department of Mathematics, College of Education (Technical) Lafiagi, Kwara State, Nigeria*

[4]*Department of Nursing Sciences, Al-hikma University Ilorin, Ilorin Nigeria*

[5]*Department of Health Promotion and Environmental Health Education, Faculty of Education, University of Ilorin, Nigeria*

[6]*Department of Nursing Services, National Hospital Abuja, Federal Capital Territory Nigeria*

[7]*Department of Nursing Sciences, College of Nursing Sciences, University of Ilorin Teaching Hospital, Nigeria*

Abstract

Globally, women are exposed to various forms of breast diseases, of which breast cancer poses a serious, devastating state of ill health. Efforts to control breast cancer focus on early detection through periodic breast examination for early diagnosis. This study assessed the Regression analysis of determinants of Breast Self-Examination and practices among 209 midwifery students at Tafawa Balewa University Teaching Hospital, Bauchi. A descriptive cross-sectional survey design was adopted using mixed methods for data collection. The data collected was analysed using descriptive statistics, chi-square, logistic regression and thematic analysis. Findings revealed that 61.0% students practiced BSE, and 66.0% of them opined that BSE enables the detection of breast abnormalities such as discharges and lumps. While students' barriers to consistent BSE were: poor knowledge about BSE (48.0%), lack of time (60.0%), and privacy (48.0%) in practicing BSE. Furthermore, exercise (OR = 1.844, $p < 0.05$) and family history of cancer (OR = 1.572, $p < 0.05$) significantly decreases the odd to practice BSE among students. This study concluded that students expressed reduction in breast cancer anxiety with mean = 2.51, std = 0.705, which explained a better understanding of BSE (mean = 2.61; std dev. = 0.623), while some perceived BSE as an effective means of early detection of breast cancers. We recommended that BSE practices should be given a high priority by students' midwives, as they are major health educators to females and women in the communities.

***Keyword**: Breast Self-examination, Midwifery Students, Practice of Breast Self-examination, Regression Analysis of Determinants of Breast Self-examination.*

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Corresponding Author: umaribna@gmail.com: umar.nj@unilorin.edu.ng

Introduction

Breast Self-Examination (BSE) is highly rewarding but yet commonly neglected by women, even though it is considered to be one of the screening methods in detecting early stage of breast cancer, breast self-examination is a useful technique recommended for practiced every month by women above 20 years, considering that breast cancer globally contributed to 685,000 deaths among women [1]. The WHO reported that out of 2.3 million women diagnosed of breast cancer, 670,000 women died worldwide making it a devastating disease that has no vaccine yet, but can be prevented through early diagnosis and treatment with the help of Breast Self-Examination [2]. There is evidence that women who correctly practice BSE monthly are more likely to detect breast abnormalities, especially the lump, at the early stages of its development, and which lead to early diagnosis of breast cancer for better prognosis [3].

Breast self-examination is a screening method that can help empower, raise awareness, and detect breast abnormalities among females, and it is a convenient and effective way to detect breast abnormalities. Regular BSE practice has been found to improve breast cancer awareness, early diagnosis, and treatment results [4]. Despite efforts to increase awareness for early detection, many females still face challenges of performing regular breast self-examinations [5]. A study in Saudi Arabia found a need to implement a women's health information campaign among adolescent females to expand their awareness of BSEs. Proper education of females, especially midwifery students, about early detection methods for breast cancer, including BSEs, could assist in increasing their awareness and participation in preventive measures before they reach the age group for mammography screening [6].

Midwifery students who are future healthcare providers, in the communities have an important role to play in female reproductive health especially in providing breast health education to improve breast cancer prevention and early detection among women in communities [7]. Therefore, practicing regular BSE among midwifery students can help them become familiar with examination of breasts to detect any abnormalities early, and subsequently leading to earlier detection of breast cancer for improved breast care outcomes [8]. Studies have shown that many healthcare professionals including midwifery students, lack adequate training and confidence in performing breast self-examination especially, on a study which reported that, nursing students were aware of breast self-examination. Still, their actual rates of practice were low [9, 10]. This raises concerns about whether midwifery students who possess similar knowledge but lack the skills to perform regular breast self-examination [11].

Midwifery students in Abubakar Tafawa Balewa University Teaching Hospital (ATBUTH) Bauchi, have severally complained about their breast abnormalities, and many reported at the teaching hospital Bauchi for breast examinations. On our direct contact with some midwifery students at their different level of academic programme, it was observed that most could not clearly explain their involvement in practicing BSE using various methods which we felt might be due to their low levels of BSE practice and perception effect of BSE, despite their professional training. In this regard we attempted to conduct a study aimed to assess the relationship between determinants of Breast Self-Examination and practices among Midwifery Students at University Teaching Hospital, Bauchi.

Objectives are to:

1. Examine the breast Self-Examination practices among Midwifery Students in ATBUTH Bauchi.
2. Assess the determinants of BSE practices among midwifery students in ATBUTH Bauchi.

3. Explore the perceived effects of BSE among midwifery students in ATBUTH Bauchi.

Research Hypothesis

$H0_1$: There is no significant relationship between social demographic characteristics and practices of breast self-examination among midwifery students in ATBUTH Bauchi

$H0_2$: There is no significant linear relationship between factors influencing BSE and its Practice among Midwifery Students in ATBUTH, Bauchi

Methodology

This study is a cross-sectional research design using a mixed-method approach, amongst students selected from ATBU Teaching Hospital Bauchi. The population for this study comprises of students drawn from the Teaching Hospital School of midwifery Bauchi. The study population distribution was based on their levels of study; year three students 122, year two 115, and year one 124, giving a total population of 361 student midwives (School Registrar; 2024).[12] The sample size of 190 students was determined using Taro Yamane's formula, however, allowance for 10 percent attrition rate was made, given study population of 209. A purposive sampling technique was used to select students that constituted the study population, and researchers designed questionnaire was the instrument used for data collection based on the study objectives. A mixed method of descriptive quantitative using questionnaire while collection of qualitative data was done through the use of A question guide checklist for focus group discussions respectively.

The questionnaire consisted of four sections (A-D). Section A contained social demographic characteristics; B, breast self-examination practice and techniques; C, factors that determine the practice of breast self-examination; and D, perceived effects of BSE among students. Sections C and D adopted a 5point Likert scales type format for data gathering. While the Focus Group Discussion (FGD) was used to collect qualitative data, each session of FGD was conducted in three separate quiet classrooms. three groups with 8 participants each was selected from different levels of study. A question guide check list based on the research objectives was used to facilitate the discussions and the discussions were audio-recorded following informed consent sort from the participants.

Data Collection

Following the ethical approval from Human Research Ethical Committee of ATBU teaching hospital Bauchi, with approval REC NO. 001/2024, two research assistants were recruited and trained on the methods of data collection process and procedure at study setting. The research objectives were explained to the participants and they were assured of privacy and confidentiality of their responses and their participation is voluntarily as they can withdraw at any stage of the study. A convenient date and venue for meeting with the participants at the selected classes was scheduled. All information on the data collection procedure was discussed and an informed consent was obtained from students. On each day of data collection, we and trained research assistants met with the participants in each selected classroom at a scheduled time for the administration of questionnaire to the participants. The students were allowed appropriate time for responses. The completed questionnaires were duly checked for completeness to ensure no omission of any question item and sheet.

On the FGD, the discussion began with a self-introduction and the purpose of the research was explained to the students. The methods of data collection were explained to the students, the question item, which consisted of open-ended questions, was read out to the students, and they were given enough time to

respond to each question freely. The discussion was recorded with their consent and confidentiality was ensured with each session lasted an hour and the all process of data collection took a period of two weeks.

Data Analysis

A total of 209 questionnaires were administered, and 188 were correctly completed and used for analysis, yielding a response rate of 90%. The retrieved questionnaires were sorted, coded, and checked for errors in completion, and the analyses of the question items were subsequently conducted using Statistical Package for the Social Sciences (SPSS) version 25. Mean, frequency counts, percentage, and standard deviation, as well as Chi-square statistic, were employed for both descriptive and inferential analyses, respectively. While the qualitative data collected through focus group discussions was transcribed using thematic analysis in the following techniques;

Transcription and Coding: Audio recordings from the FGD were transcribed verbatim and transcripts were carefully read and coded based on the research questions.

Thematic Analysis: The coded data were organised and analysed to identify recurring patterns in participants' experiences and perceptions of the effects of BSE practices. Constant comparative analysis was employed to compare themes across groups (e.g., different levels of study and varying levels of BSE practice), and relevant quotes and excerpts from the transcripts were used to support and illustrate the identified themes.

Results

Table 1. Relationship between Social Demographic Characteristics and Practices of BSE among Midwifery Students in ATBUTH Bauchi

Demographic variables	**Categories**	**BSE Practice**		χ^2	**p-value**
		Yes	No		
Age of Respondents	17 – 20	34(18.1%)	23(12.2%0	2.042	0.360
	21 – 25	59(31.4%)	43(22.9%)		
	26 +	21(11.2%)	8(4.3%0		
Marital Status	Single	81(43.1%)	57(30.3%)		
	Married	32(17.0%)	16(8.5%)	1.044	0.593
	Divorced	1(0.5%)	1(0.5%)		
Current year of Study	First Year	40(21.3%)	25(13.3%)		
	Second Year	13(6.9%)	14(7.4%)	2.126	0.345
	Third Year	61(32.4%)	35(18.6%)		
Current Living Arrangement	On-campus housing	55(29.3%)	42(22.3%)	8.302	0.022*
	Off-Campus Housing (Rented	13(6.9%)	7(3.7%)		
	With family	46(24.5%)	25(13.3%)		
Ethnicity	Hausa	65(34.6%)	39(20.7%)	6.513	0.013*
	Yoruba	11(5.9%)	12(6.4%)		
	Igbo	7(3.7%)	6(3.2%)		
	Fulani	31(16.5%)	17(9.0%)		
Religious Affiliation	Islam	76(40.4%)	47(25.0%)	7.197	0.047*
	Christianity	38(20.2%)	27(14.4%)		
	Yes, Full time	4(2.1%)	3(1.6%)	0.328	0.849

Current Employment Status	Yes, Part time	12(6.4%)	6(3.2%)		
	No	98(52.1%)	65(34.6%)		
Approximate Monthly Salary	Below N20,000	6(24.0%)	1(4.0%)	2.265	0.519
	N20,000 – N50,000	4(16.0%)	4(16.0%)		
	N50,000 – N100,000	2(8.0%)	1(4.0%)		
	N100,000 +	4(16.0%)	3(12.0%)		

Source: Field Survey, 2024

Table 1 shows the socio-demographic characteristics of respondents, with a mean age of 33.5 years and the majority in the 21-25 age interval (54.3%). Most of the respondents (73.4%) are single and 52.0% of them live on campus. About 55.0% of students speak Hausa dialects, and 65.4% practice are Muslims. A larger proportion (86.7%) of them are unemployed, with only 28.0% earning N100,000 monthly under employment of government or private institutions. The table further shows the relationships between social demographic characteristics and BSE practices among the respondents. It is evident in the chi-square result that there exists a significant relationship between BSE practices and the current place of residence ($\chi^2 = 8.302, sig. = 0.022$), ethnicity ($\chi^2 = 6.513, sig. = 0.013$) and religion affiliation ($\chi^2 = 7.197, sig. = 0.047$)The three demographic variables are significant. The p-values are less than 0.05.

Table 2. Practices of BSE among Midwifery Students in ATBUTH Bauchi

Statement	**Options**	**Frequency**	**Percentage**
Have you ever practiced BSE?	Yes	114	60.6
	No	74	39.4
	Total	**188**	**100.0**
If yes, how often do you practice BSE?	Monthly	30	26.3
	Occasionally	58	50.9
	Rarely	26	22.8
	Total	**114**	**100.0**
if you have been practising BSE have you ever discovered any abnormality in your breast?	Yes	75	65.8
	No	39	34.2
	Total	**114**	**100.0**
What type of abnormality did you noticed?	Discharge	38	50.7
	Lump	37	49.3
	Total	**75**	**100.0**
If yes in the above, what did you do?	Prayed Over it	28	37.3
	Consult a medical practitioner	18	24.0
	Did nothing	29	38.7
	Total	**75**	**100.0**
When was the last time you performed BSE?	Less than two months ago	57	30.3

	Less than three months	67	35.6
	Six months	37	19.7
	One year ago,	18	9.6
	More than one year	9	4.8
	Total	**188**	**100.0**
What time of the day do you normally perform BSE?	Morning	66	35.1
	Evening	84	44.7
	Afternoon	38	20.2
	Total	**188**	**100.0**
Are you afraid to perform BSE?	Yes	135	71.8
	No	53	28.2
	Total	**188**	**100.0**

Source: Field Survey; 2024

Table 2 shows practice of BSE among students' midwives**,** 61.0% of students practiced breast Self-examination practices, 51% of them occasionally practiced BSE as against fewer number who practice BSE monthly. Little above average of students who practiced BSE, 51.0% of them noticed discharges and 49.3% observes lump in their breast respectively. In relation to the findings of FGD, all participants (8) in each of the 3 groups have knowledge about standard recommendation for BSE however, only 9 practice BSE and 18 did not, as 3 did not examined their breast consistently.

Table 3. Perceived Effect of BSE among Midwifery Students in the University Teaching Hospital, Bauchi

Statement	Disagreed	Unsure	Agreed	Mean	Std. Dev.	Remark
I feel more confident in my ability to detect breast abnormalities since starting BSE	38 (20.2%)	76 (40.4%)	74 (39.4%)	2.19	.750	Unsure
I have noticed any changes in my breast health since I started performing regular BSE	30 (16.0%)	46 (24.5%)	112 (59.6%)	2.44	.754	Unsure
I feel more in control of my breast health since I started BSE	31 (16.5%)	76 (40.45)	81 (43.1%)	2.27	.727	Unsure
I have experienced some reduction in breast cancer anxiety or worry since I started performing BSE	23 (12.2%)	46 (24.5%)	119 (63.3%)	2.51	.705	Agreed
I believe that BSE will help me develop a better understanding of my breast health	14 (7.4%)	45 (23.9%)	129 (68.6%)	2.61	.623	Agreed
I feel more empowered to take charge of my breast health since I started performing BSE	37 (19.7%0	107 (56.9%)	44 (23.4%)	2.04	.657	Unsure

Do you believe that BSE has helped you detect any breast abnormalities earlier than you would have otherwise?	39 (20.7%)	75 (39.9%)	74 (39.4%)	2.19	.755	Unsure

Source: Field Survey, 2024.

NB: Item with mean score within the range: 0 – 1.49 = Disagreed; 1.50 – 2.49 = unsure; 2.50 - 3.0 = Agreed

The table above reveals that a large proportion of students have a positive perception of BSE as it affects their breasts. This was supported by 63.3% of students who expressed less worry and anxiety about breast cancer prevalence (mean = 2.51, std = 0.705), while about 67.0% agreed that BSE further facilitates a better understanding of their breasts (mean = 2.61, std dev. = 0.623). Subsequently, in focus group discussions, students observed that BSE gave them confidence and courage to examine their breasts, which reduces anxiety associated with practicing BSE.

Table 4. Logistic Regression Results of Factors Influencing BSE Practice among Midwifery Students

Factors	**Coeff.**	**S.E.**	**Wald**	**DF**	**Sig.**	**OR**
Family history of cancer	.452	.460	.968	1	.025	1.572
Lack of confidence	-.205	.415	.244	1	.622	.815
Limited guidance from healthcare providers	-.757	.503	2.260	1	.133	2.132
Forgetfulness	-.821	.483	2.886	1	.049	.440
Anxiety	-.532	.417	1.631	1	.202	.587
Cultural belief	.306	.425	.519	1	.471	1.358
Age	-.013	.038	6.109	1	.041	.987

Source: Field Survey, 2024.

The table above shows various factors that influence the practice of BSE among midwifery students in ATBUTH Bauchi, principal among these is family history of cancer, lack of confidence in BSE, limited guidance from healthcare providers, forgetfulness, anxiety, cultural beliefs, and age. In the FGD findings, cultural factors, privacy, lack of a standing mirror, time, and knowledge of the normal and abnormal breast top factors influencing practices of BSE are discussed. The students' ability to identify these factors could probably be linked to their educational exposure and knowledge level about practice of BSE. Furthermore, the logistic regression analyses of factors influencing BSE Practice among Midwifery reveals that family history of cancer (OR = 1.572, $p < 0.05$), forgetfulness (OR = 0.440, $p < 0.05$) and age (OR = 0.987, $p < 0.05$) are the significant factors among other factors that influence BSE practiced among midwifery students in this current study.

Discussion

This study on the relationship between determinants of Breast Self-Examination and practices among Midwifery Students at University Teaching Hospital, Bauchi, involved midwifery students with a mean age of 33.5 years, who constituted the majority (73.4%) and were not married, with an average of living in on-campus accommodation. this implies that this category of students is in their active reproductive age group. The majority of

students were of Hausa-speaking dialect who were Muslims, which is a reflection of the geographical location of the study setting (Northern part of Nigeria), where the majority of inhabitants are Muslims and speak Hausa language. The larger percentage of student were unemployed, due to their current educational status, however, few (28.0%) that are employed and earned N100,000 equivalent to 64 US Dollas as at the time of this study. This finding implies that the student's age, educational status, place of birth/school setting, ethnicity, religion, and employment status, determine their participation in BSE. This is similar to a study on the stages of behavioural adoption of breast self-examination among Malaysian women, with the largest age group being 35 to 40 years old (46.5%) and the least being 66 to 70 years old (2.1%) [11].

The breast self-examination practices among midwifery Students**,** in this study, also reveal that among 61.0% of students who practiced BSE, 41.2% practiced it occasionally, against 26.3% who practiced it monthly, which shows a low level of students' participation in BSE. Furthermore, about 68.0% of students who practiced BSE claimed to have identified abnormality in their breast, and others observed breast discharges and lumps in their breast. Similarly, the finding from FGD also shows very little students who practiced BSE, did not examine their breast consistently. This implied that despite the large number of student midwives with knowledge of WHO standard recommendation of BSE**,** only few were able to identified abnormality in their breast and consulted a medical practitioner after noticing this abnormality. Based on this recent finding, one will wonder why students' educational status does not positively influence their BSE practices. This current study finding was contrary to findings from a previous study on BSE practices among nurses, which found that a significant proportion were not consistent in BSE practice, contrary to a study in Aminu Kanu Teaching Hospitals, which found that 91% of nurses practiced BSE, and only 44 % of them practiced BSE monthly [12, 13]. But study conducted among Malaysian women disagreed with our current findings in terms of women awareness of symptoms of breast cancer, risk factors of breast cancer, methods of breast screening, best time for breast screening and perception of breast lump respectively [11].

On the factors influencing the practice of BSE among midwifery students in ATBUTH Bauchi, this study identified family history of cancer, lack of confidence, limited guidance from healthcare providers with the same proportion. However, forgetfulness (63.8%), anxiety (72.3%), and cultural beliefs (59.6%) were the most influential factors in students' practice of BSE. Relatively, the logistic regression identified factors influencing BSE Practice among Midwifery Students revealed that family history of cancer (OR = 1.572, $p < 0.05$), forgetfulness (OR = 0.440, $p < 0.05$) and age (OR = 0.987, $p < 0.05$) were the significant factors that influenced BSE practiced among midwifery students in this current study. This current study corroborates findings of other study on factors that influence the practice of BSE, in terms of academic level, knowledge of BSE, and perception of BSE. Specifically, respondents in third year were 5.58 times more likely to practice BSE than respondents in the first year (95% CI = 2.17–14.32).[14] This study Further identified cultural factors, privacy, lack of standing mirror in the toilet, lack of time and knowledge of the normal and abnormal breast as factors influencing the practice of BSE. These current findings agreed with findings by Al-Naggar et al (2011) who revealed age, exercise and family history of cancer significantly influenced the practice of BSE [11].

The perceived effects of BSE in this study reveal that the majority of students agreed to have experienced a reduction in anxiety level about the diagnosis of breast cancer (mean = 2.51, std = 0.705) following their BSE, which also helped in better understanding of their

breast condition (mean = 2.61; std dev. = 0.623). This finding was similar to students in focus group discussion who expressed their feelings of confident and willingness to examine their breast which was supported findings from previous study [15]. The findings from the current study also supported study findings which reported that younger women often face more aggressive and fast-growing breast cancers, and emphasized the need for early detection for breast lumps or cancer [8].

Practices of BSE in focus group discussion among 8 midwifery students three themes emerged from the discussion based on the research questions:

Theme 1: knowledge and skills on BSE practice

Two participants practice breast self-examination, while 6 participants claimed not practicing breast self-examination. Out of the 2 participants who practice breast self-examination, 1 did not examine her breasts consistently on a monthly basis. However, the group of 8 participants had the knowledge of standard recommendation of BSE. One of the 2 that practice breast self-examination stated that;

> *"I always examined my breast every month by standing in front of a mirror to assess for any abnormality as recommended".*

Theme 2: Educational Gaps

Based on the FGD with the group of 8 participants, cultural factors, privacy, lack of a standing mirror in the toilet, lack of time, and knowledge of the normal and abnormal breast are factors influencing the practice of breast self-examination. As stated by five (5) participants

> "*My culture frowned at exposure of breast in the presence of other people (colleagues) as an immoral act"*

Theme 3: confidence and empowerments on BSE

Based on the focus group discussion held with midwifery students, the identified perceived effects of breast self-examination include 2 participants indicate that;

> *"I feel more confident and encouraged while examine my breast, and I did that with minimal anxiety. Since I started practicing breast self-examination, I noticed changes in my breast during self-examination".* Another one of the students stated that; *"I feel more confident and encouraged in examining my breast because it is easy and less stress to me"*

The findings highlight the need for comprehensive breast self-examination education on the importance of periodic BSE practice and perception on cultural belief on breast self-examination among midwifery students at Abubakar Tafawa Balewa University Teaching Hospital Bauchi.

Conclusion

In this study, findings indicate that despite the high knowledge level of students about BSE, the practice of breast self-examination among midwifery students was not encouraging, even though the average number of students indicated their practices of BSE However, a very small number of students did not do so at frequent intervals as recommended by the WHO. This current study however showed significant relationship between BSE practice and current living arrangement of students' ethnicity and religion affiliation, while other socio-demographic characteristics has no significant relationship with BSE practice. This study further concluded that exercise, family history of cancer, forgetfulness and age were the significant factors that influenced BSE practiced among midwifery students respectively.

Recommendations

Based on the findings and conclusions of this study, the following recommendations were made:

1. Provide midwifery students with comprehensive training and hands-on experience on breast self-examination, and encourage feedback and support from instructors to enhance confidence.
2. Encourage midwifery students to practice breast self-examination regularly.
3. Incorporate cultural diversity training into the curriculum to address cultural beliefs, values, and encourage open discussions and address misconceptions about breast self-examination.
4. Develop strategies to help the students form habits, such as reminders or tracking systems.

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Conflict of Interest

There was no conflict of interest among the authors or any organization regarding the conduct of this study.

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Systemic Biochemical Disruptions from Chronic Generator Exhaust Exposure: Oxidative, Hematologic, and Heavy Metal Biomarkers in Urban Nineveh, Iraq

Shahla Mohammed Farhan, Yusra M.S. Al-Shaker, Liqaa Saeed Alkhalidy*
College of Environmental Sciences, University of Mosul, Mosul, Iraq

Abstract

In urban regions with chronic power instability—such as Mosul, Iraq—diesel generators are essential yet environmentally hazardous. Prolonged exposure to generator exhaust introduces a spectrum of toxicants, including carbon monoxide, nitrogen oxides, and heavy metals, raising significant concerns for long-term systemic health effects. This research aimed to explore changes in body systems and blood composition resulting from long-term exposure to diesel generator fumes among community members. The study used a cross-sectional comparative design with 260 participants, divided into exposed (150) and control (110). The analysis included blood gases; oxidative stress indicators like MDA and GSH; inflammatory markers such as CRP and CA; hematological parameters like HgB, and PCVs; and serum levels of trace metals including Zink, Zn, Cadmium, Nickel. The significance is at p≤0.05. Exposed Individuals showed decreases in oxygen (lower Pa02 and Sa02, and higher COHa levels), an increase in red blood cell production and hemoglobin, and a significant increase in MDA and a decrease in GSH. Also, C protein (CRP) levels increased significantly at p < 0·001). Trace metal analysis following exposure showed a buildup of lead (Pb) alongside cadmium (Cd), Copper (Cu), and Nickel (Ni), with a simultaneous decrease in zinc content, further weakening the body's antioxidant defenses. The results show that long-term exposure to generator fumes leads to health issues, including breathing problems, imbalances in the body's oxidation processes, and the accumulation of harmful metals in the system.

Keywords: *Carbon Monoxide Toxicity, Diesel Generator, Erythropoiesis, Heavy Metals, Oxidative Stress, Pollution.*

Introduction

The growing dependence on diesel generators in low-resource and post-conflict regions has emerged as a silent yet pervasive environmental and public health challenge. In cities like Mosul, Iraq, where chronic power outages have rendered generators an infrastructural necessity, the unintended consequence has been sustained exposure to airborne pollutants, notably carbon monoxide (CO), nitrogen oxides (NO_x), polycyclic aromatic hydrocarbons (PAHs), and heavy metals—all by-products of incomplete fossil fuel combustion [1, 2]. Prolonged inhalation of such toxicants is known to impair pulmonary function, disrupt hematological homeostasis, and instigate systemic oxidative stress, thereby increasing the risk of chronic respiratory, cardiovascular, and neurological disorders [3–5]. Mechanistically, generator emissions exert their biological toxicity through multiple converging pathways. Carbon monoxide competitively binds to hemoglobin, forming carboxyhemoglobin (COHb), thereby reducing oxygen delivery and precipitating tissue

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****Corresponding Author: liqaasaeed@uomosul.edu.iq***

hypoxia [6, 7]. In tandem, reactive oxygen species (ROS) generated by heavy metals such as lead (Pb) and cadmium (Cd) overwhelm endogenous antioxidant defenses, including glutathione (GSH) and zinc-dependent enzymes, resulting in lipid peroxidation, DNA damage, and mitochondrial dysfunction [8-10].

Materials and Methods

Study Design and Population Sampling

A research project comparing two populations was conducted in Mosul from September 8th to January 6th in 2024 and 2025—the widespread use of diesel generators has heavily impacted the city due to ongoing electricity shortages in the region. The primary goal of this study was to investigate the effects of long-term exposure to generator emissions on changes within the population groups under study.

The study included 110 people in the control group living in areas without electric generators in villages like Tal Khazaf, Al Kabir, Al Mawali and 150 individuals in the exposed group who either operated generators or resided near densely populated generator locations, in urban neighborhoods People were categorized based on gender and age (ranging from 10 to 80 years) and their consent was sought before participation.

Pulse Oximetry and Pre-screening

Prior to venipuncture or arterial sampling, each subject underwent non-invasive evaluation using a calibrated pulse oximeter (Cataldo et al., 2025. This assessment included peripheral oxygen saturation (SpO_2) and pulse rate (PR), which served as preliminary indicators of hypoxemia and cardiovascular strain. SpO_2 values below 92% were flagged for potential oxygen desaturation and documented accordingly.

Blood Collection Protocol

Venous and arterial blood samples were collected under standardized aseptic conditions by trained medical personnel. Arterial blood (1 mL) was obtained from the radial artery using heparinized syringes and analyzed for arterial blood gases (ABG), using the ABL800 FLEX analyzer (Radiometer, USA) at Al-Jumhuri and Ibn Sina Teaching Hospitals. Simultaneously, 5 mL of venous blood was drawn from the antecubital vein and fractionated as follows:

2 mL was transferred to EDTA-coated lavender-top tubes for complete blood count (CBC) analysis, measured using Sysmex XP-300 and Nihon Kohden MEK-6510K analyzers.

The remaining 3 mL was placed in dry gel-separator tubes (yellow-top) for serum separation. Samples were centrifuged at 4000 g for 10 minutes, and the resulting serum was aliquoted and stored at −20°C for biochemical assays.

Biochemical and Oxidative Stress Assays

The oxidative stress markers were measured using enzyme-linked immunosorbent assay (ELISA) kits according to manufacturers' protocols:

Malondialdehyde (MDA): Reed Biotech Ltd. (China), read by Bio-Tek ELISA microplate reader.

Reduced Glutathione (GSH): ELK Biotechnology (China).

Uric Acid (UA): Quantified spectrophotometrically using BIOLABO S.A.S (France) kits and Jenway 7200 and JK-VS-722N instruments.

Enzyme and Inflammatory Marker Estimation

To assess enzymatic function and systemic inflammation:

Carbonic Anhydrase (CA) was measured via FineTest ELISA kits.

C-Reactive Protein (CRP) levels were determined using turbidimetric immunoassay kits from LTA S.r.l. (Italy), Given its relevance as a biomarker of the acute-phase inflammatory response triggered by environmental pollutants.

Heavy Metal Analysis

To quantify bioaccumulated trace metals (Zn, Cu, Pb, Cd, Ni), atomic absorption spectrophotometry (AAS) was performed at the Central Laboratory of the College of Agriculture and Forestry, University of Mosul, using validated calibration standards and internal controls to ensure analytical reliability.

Statistical Analysis

Descriptive data were expressed as mean ± standard error (SE). A comparative analysis between the exposed and control groups was conducted using the independent Student's t-test, with statistical significance set at $p \leq 0.05$.

Results

The comparison of blood gas (ABG) measurements between people exposed to generator smoke and the control group showed clear differences, indicating compromised respiratory function and altered coping mechanisms under stress. It was observed that the levels of oxygen pressure (Pa O_2), oxygen saturation (Sa O_2%) and oxyhemoglobin (O_2 Hb%) were notably lower in the exposed group (with a p value < 0.001), suggesting a disturbance in gas exchange likely caused by prolonged exposure to carbon monoxide and other pollutants, from combustion.

The levels of deoxyhemoglobin (HHB%) and carboxyhemeoglobin (COHB%) significantly increased simultaneously which supports the idea of carbon monoxide displacing oxygen at hemoglobin binding sites.The notable increase, in HHB % aligns with decreased oxygen supply and the bodys effort to compensate with desaturation.

The results support indicators of low oxygen levels in the blood and could contribute to the adverse effects on metabolism and oxidative stress observed in long-term exposure to diesel generator emissions. In total, this collection of data provides biochemical evidence of the harmful respiratory effects of prolonged exposure to diesel generator emissions (Table 1, Figure 1).

Table 1. Comparative Analysis of Arterial Blood Gas Parameters

Parameter	Control (Mean ± SD)	Exposed (Mean ± SD)	p-value	Significance
PaO_2 (mmHg)	96.84 ± 1.07	79.12 ± 2.05	0.0000	*
SaO_2 (%)	97.03 ± 0.12	94.97 ± 0.51	0.0000	*
O_2Hb (%)	94.20 ± 0.47	91.40 ± 0.81	0.0000	*
HHb (%)	2.85 ± 0.12	4.84 ± 0.48	0.0000	*
COHb (%)	1.27 ± 0.43	1.93 ± 0.43	0.0000	*
pH	7.41 ± 0.012	7.27 ± 0.028	0.0000	*
$PaCO_2$ (mmHg)	35.69 ± 1.15	46.11 ± 1.55	0.0000	*
MetHb (%)	1.45 ± 0.09	1.59 ± 0.08	0.0252	*
Lac (mmol/L)	1.32 ± 0.09	1.85 ± 0.12	0.0000	*
HCO_3 (mmol/L)	22.50 ± 0.57	17.96 ± 0.77	0.0000	*
Glu (mg/dL)	105.03 ± 17.63	135.70 ± 23.32	0.1081	ns
Na (mmol/L)	136.82 ± 1.50	137.80 ± 1.51	0.4978	ns
Ca (mmol/L)	1.17 ± 0.04	1.15 ± 0.04	0.0016	*
K (mmol/L)	3.52 ± 0.18	3.45 ± 0.14	0.6317	ns
Cl (mmol/L)	105.94 ± 1.67	104.55 ± 1.90	0.1629	ns

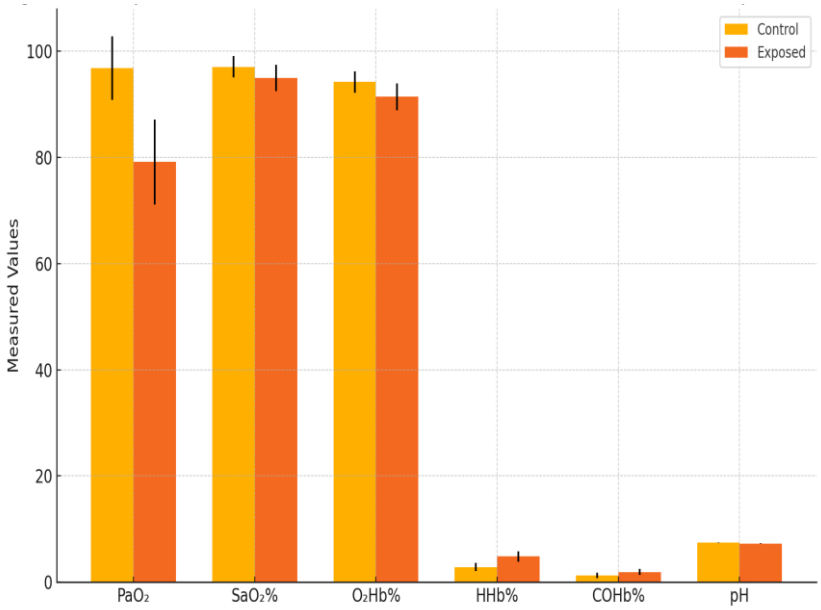


Figure 1. Comparison of Arterial Blood Gas Parameters between Control and Exposed Groups

The blood tests showed increases in hemoglobin levels (Hb) red blood cell count (RBCs) and packed cell volume (PCV) in people exposed to generator fumes. These results suggest a response from the body to produce red blood cells likely due to prolonged exposure to low oxygen levels caused by carbon monoxide, in the environment.

The increased Hb and RBC levels may reflect upregulated erythropoietin activity, a known adaptive mechanism that enhances the oxygen-carrying capacity of blood under sustained oxygen deprivation. Furthermore, the elevated PCV values support the evidence of hemoconcentration and an increased hematocrit fraction, reinforcing the impact of chronic environmental stress on hematopoietic dynamics.

Collectively, these hematologic alterations underscore a biologically significant shift toward oxygen delivery optimization in response to airborne pollutants, aligning with the pathophysiological profile of chronic low-grade hypoxia (Figure 2, Table 2).

As illustrated in Figure 2, significant oxidative alterations were evident in the exposed group, with elevated MDA and CA levels and reduced GSH and CRP levels, reflecting redox imbalance and a systemic inflammatory response (Table 2).

Table 2. Comparative Analysis of Hematological Parameters

Parameter	**Control (Mean ± SD)**	**Exposed (Mean ± SD)**	**p-value**	**Significance**
Hemoglobin (Hb, g/dL)	13.10 ± 0.43	14.52 ± 0.34	0.0000	*
Red Blood Cells (RBCs, 10^6/µL)	5.07 ± 0.18	5.54 ± 0.06	0.0000	*
Packed Cell Volume (PCV, %)	40.97 ± 1.82	46.92 ± 0.64	0.0000	*

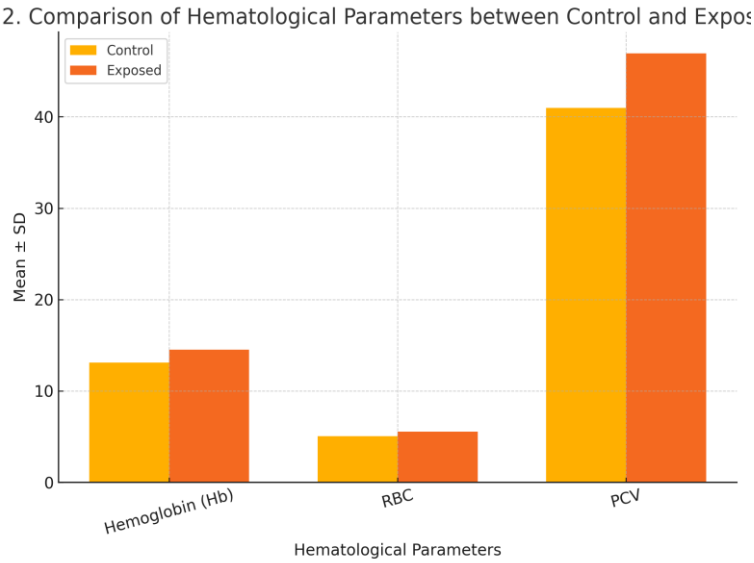


Figure 2. Comparison of Hematological Parameters between Control and Exposed Groups

The integrated interpretation of Table 3 reveals a striking biochemical scenario in individuals exposed to chronic generator exhaust, highlighting a multifaceted disruption of redox homeostasis and elemental balance. Notably, the marked elevation in malondialdehyde (MDA) levels, a decisive indicator of lipid peroxidation, unequivocally reflects extensive membrane lipid injury, which, in turn, suggests widespread propagation of oxidative damage across various cellular compartments. In contrast, the substantial reduction in glutathione (GSH), a principal intracellular antioxidant, illustrates a state of defensive depletion, thereby confirming that endogenous antioxidant systems are profoundly overwhelmed under persistent reactive oxygen species (ROS) pressure.

Moreover, the remarkable increase in carbonic anhydrase (CA), an enzyme fundamental to acid-base equilibrium, suggests an adaptive respiratory response to prolonged oxidative and metabolic stress, potentially serving as a compensatory mechanism to maintain systemic pH stability despite ongoing cellular insults. The parallel rise in C-reactive protein (CRP) levels, often considered a hallmark of systemic inflammation, further corroborates the presence of a sustained inflammatory milieu, which might reflect a chronic rather than merely acute immunological challenge in these individuals.

The significant decline in uric acid (UA) levels also warrants attention, as it may signal increased utilization of this secondary antioxidant reserve to buffer ongoing oxidative stress. In examining the heavy metal profile, the conspicuous accumulation of copper (Cu), lead (Pb), cadmium (Cd), and nickel (Ni) clearly indicates an exogenous toxicological load, one that not only exacerbates ROS generation but also interferes with essential mitochondrial and enzymatic functions, further amplifying oxidative and inflammatory cascades.

Conversely, the sharp decrease in zinc (Zn), an indispensable cofactor for antioxidant enzymes such as superoxide dismutase, profoundly compromises cellular defense mechanisms, rendering the organism more susceptible to cumulative oxidative injuries. Collectively, these interrelated biochemical deviations delineated in Table 3 construct a coherent narrative of systemic vulnerability, emphasizing the hidden yet potent health risks posed by continuous exposure to environmental pollutants and underscoring the critical need for preventive and mitigative strategies.

Conversely, the profound reduction in zinc (Zn), a critical cofactor for antioxidant enzymes such as superoxide dismutase, further amplifies systemic vulnerability to oxidative injury, thereby fostering a microenvironment conducive to chronic degenerative processes. Taken together, these multifaceted biochemical perturbations provide compelling evidence of the covert yet substantial health risks posed by prolonged exposure to generator emissions, underscoring an urgent imperative for robust public health interventions to curb environmental pollutant exposure and safeguard community health (Table 3, Figure 3).

Table 3. Comparative Analysis of Oxidative Stress, Inflammatory, and Heavy Metal Biomarkers in Control and Exposed Groups

Parameter	Control (Mean ± SD)	Exposed (Mean ± SD)	p-value	Significance
MDA (ng/mL)	313.93 ± 10.17	554.11 ± 73.13	0.0000	*
GSH (ng/mL)	94.81 ± 3.26	72.70 ± 4.77	0.0000	*
Uric acid (mg/dL)	7.19 ± 0.65	5.22 ± 0.47	0.0000	*
Carbonic Anhydrase (pg/mL)	447.66 ± 38.47	1137.01 ± 56.36	0.0000	*
CRP (mg/L)	0.002 ± 0.001	8.29 ± 2.16	0.0000	*
Zinc (ppm)	0.20 ± 0.03	0.04 ± 0.006	0.0000	*
Copper (ppm)	0.009 ± 0.0007	0.17 ± 0.0199	0.0000	*
Lead (ppm)	0.02 ± 0.005	0.13 ± 0.008	0.0000	*
Cadmium (ppm)	0.008 ± 0.0011	0.024 ± 0.0008	0.0000	*
Nickel (ppm)	0.03 ± 0.0022	0.04 ± 0.0018	0.0000	*

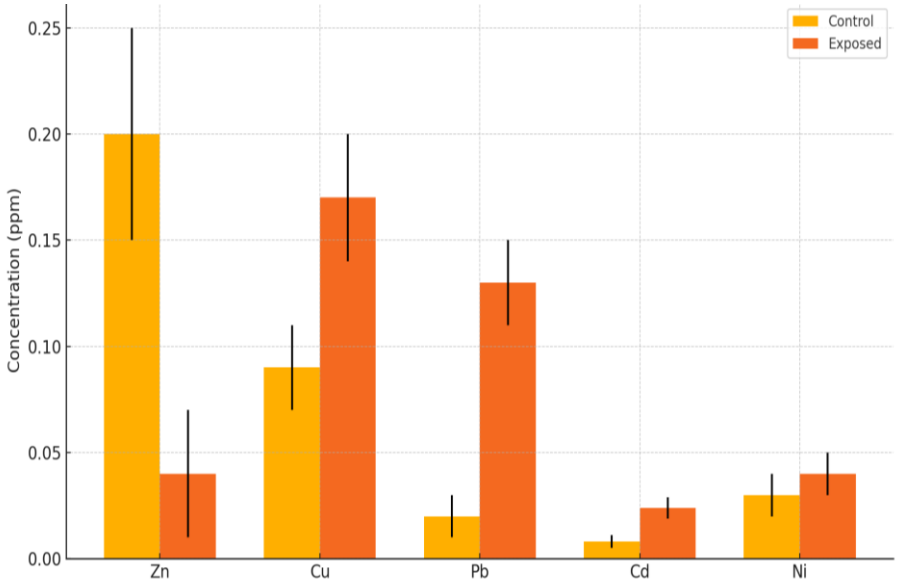


Figure 3. Serum Heavy Metal Concentrations in Control vs Exposed Groups

In Figure 4 of the study shows a connection where lower levels of glutathione are linked to higher malondialdehyde levels in people constantly exposed to generator fumes. It indicates a relationship between antioxidant reduction and lipid oxidation in individuals facing long-term exposure to generator exhaust fumes.

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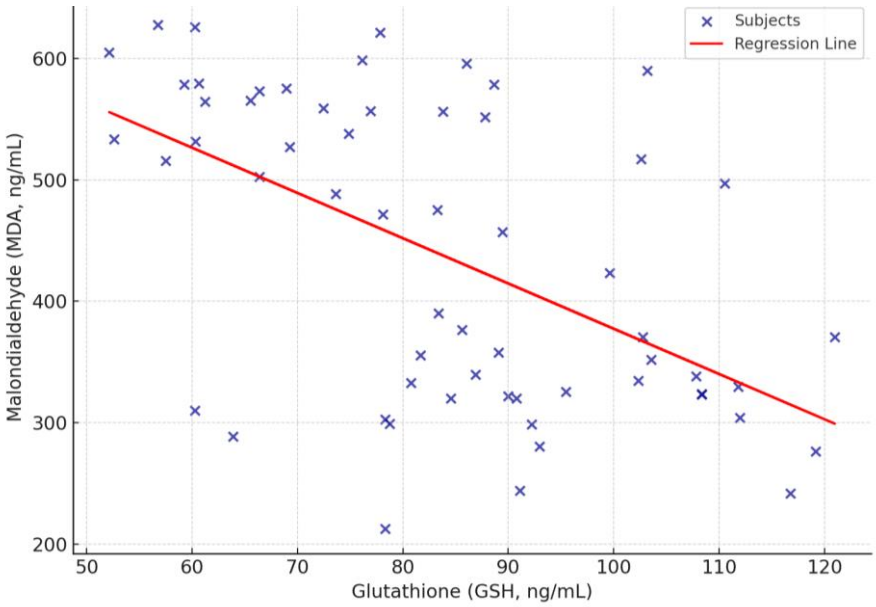


Figure 4. Negative Correlation between GSH and MDA Levels

Discussion

The current investigation delineates a compelling biochemical and hematophysiological portrait of individuals chronically exposed to diesel generator emissions—an exposure pattern increasingly prevalent in post-conflict, infrastructure-deficient urban regions such as Mosul. Notably, the observed decrements in PaO_2, SaO_2, and $O_2Hb\%$ in the exposed group ($p<0.001$) underscore a disruption in alveolar-capillary gas exchange, plausibly mediated by the sustained inhalation of carbon monoxide (CO) and nitrogen oxides (NO_x), both of which competitively bind to hemoglobin and impair oxygen transport efficiency [11, 12].

Thus, the concomitant rise in COHb and HHb levels in exposed individuals is not merely statistically significant but mechanistically indicative of systemic hypoxemia, triggering compensatory erythropoietic activation, as evidenced by elevated hemoglobin, RBC count, and PCV. These hematological shifts likely reflect upregulation of erythropoietin, a hypoxia-sensitive hormone, in a physiological attempt to restore tissue oxygenation [13, 14].

This adaptation, while compensatory in the short term, may predispose individuals to hyperviscosity syndromes and cardiovascular strain under prolonged exposure scenarios.

The notable increase in malondialdehyde (MDA), a product of lipid peroxidation, along with the decrease in reduced glutathione (GSH), indicates a significant imbalance in redox levels within the system. This characteristic is representative of damage caused by oxidative stress, where reactive oxygen species (ROS) surpass the body's natural antioxidant defenses, leading to impairment of cell membranes and mitochondrial activity, as highlighted by Napolitano et al. [15], Al-Abdaly [16], and Zayani et al. [17].

The relationship observed between GSH and MDA levels in the research (as shown in Figure 4) supports the idea that glutathione reduction may indicate and contribute to lipid damage. Furthermore, the significant increase in carbonic anhydrase (CA), a metalloenzyme essential for the transport of CO_2 and the

regulation of pH levels in the body, could be a response to maintaining balance in cases of lung acidosis or reduced alveolar ventilation. Studies have suggested that an elevated level of CA is linked to conditions such as obstructive pulmonary disease and pulmonary hypertension induced by hypoxia [18, 19], which might have similarities in how they affect the body with exposure to smoke from generators.

The notable rise in C-reactive protein (CRP) levels among individuals exposed to generator emissions (8.29 ± 2.16 mg/L) clearly indicates an active and ongoing inflammatory response. This elevation aligns with the well-documented role of CRP as a sensitive marker for systemic inflammation, often seen in cases of chronic exposure to environmental toxins. The increase suggests that the liver's acute-phase response has been robustly activated, most likely driven by the release of pro-inflammatory cytokines such as interleukin-6 and tumor necrosis factor-alpha. This systemic reaction not only confirms the presence of oxidative stress but also highlights a state of chronic immune activation that may predispose exposed individuals to further vascular and metabolic complications [20, 21].

The detected metal composition in the group exposed indicates a biochemical hazard. High blood levels of lead, copper, and nickel—all confirmed to trigger the formation of oxygen species and interfere with enzymatic redox cycles—suggest a continual accumulation of toxic substances, with the potential to harm multiple organs [22].

The noticeable reduction in zinc levels is concerning, as zinc supports superoxide dismutase and metallothioneins, which are essential for managing oxidative stress in the body's natural state. A lack of zinc could worsen vulnerability and hinder DNA repair over time, increasing the risk of genetic damage in the long run [23].

From a public health perspective, these results align with the concept of environmental fairness. This suggests that urban communities facing challenges are more likely to be exposed to environmental risks without adequate ways to reduce them. The combined biological disruptions mentioned here—including acidosis, oxidative stress, compensation by red blood cells, and accumulation of heavy metals—may lead to an increased vulnerability among these people toward long-term heart and lung diseases, degenerative neurological disorders, and cancer.

In summary, the information presented here offers a basis for understanding the impact of diesel generator emissions on environmental health in a discreet yet significant manner. It is crucial to take action at the policy level to reduce generator use, improve urban electricity provision, and establish community-based screening initiatives to detect early health issues caused by pollutants.

The discoveries have two implications—one related to health and the other to the environment—that go beyond just Mosul's specific situation. On the health front, the combination of low oxygen levels in the blood, imbalanced oxidative processes, and the accumulation of harmful metals can serve as an early indication needing regular medical checkups in people relying on generators for power. It's crucial to check blood oxygen levels, markers of oxidative stress such as MDA and GSH, and trace metal levels to intervene promptly before irreversible harm sets in [24].

The research underscores the importance of shifting away from diesel-powered energy sources in densely populated urban areas due to environmental concerns. To tackle this issue effectively and prevent long-term exposure to emissions in these areas, it is essential to implement policies such as controlled zoning for generator locations, raising public awareness of exhaust fume exposure, and providing incentives to switch to renewable energy sources. Neglecting these foundational

issues could lead to environmental inequality and worsen health challenges for vulnerable populations [25–27].

Conclusion

This research uncovers physical and chemical changes associated with ongoing exposure to diesel generator emissions. Decreased oxygen levels in the body and increased oxidative stress markers, such as MDA levels and lower GSH levels, indicate potential health issues related to the exposure. Moreover, elevated blood hemoglobin levels and red blood cell count suggest a response by the body, while the accumulation of heavy metals such as lead, cadmium, and nickel, along with reduced zinc levels, hints at a broader health impact on individuals living in urban areas reliant on generators for power. The findings indicate the need for continuous health monitoring of residents living near generators, as well as for implementing policies and regulations to limit their use.

Limitations

Although the results of this study are both statistically and biologically convincing, its sectional design limits the ability to establish causal relationships definitively. The use of proximity-based exposure classification without measuring airborne pollutant levels like CO, NOx and PM2.5 could lead to misclassification bias in exposure assessment. Additionally, the study was conducted within an urban area, geographically potentially restricting how broadly the findings can be applied to other regions, with similar post-conflict or low-resource settings.

The absence of follow-up information hinders our ability to grasp the ongoing progression of pollutant-triggered biochemical alterations over time. It is essential for upcoming studies to incorporate long-term research plans, exposure monitoring devices, and diverse functional tests across multiple organs, such as cognitive function and liver profiling, to confirm and build upon these preliminary findings.

Conflict of Interest

The authors declare that there is no conflict of interest.

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The Prevalence and Pattern of Adverse Drug Reaction in HIV/AIDS Patients on Antiretroviral Therapy in Kaduna State, Nigeria: Case Review Study

Abubakar Suleiman[1*], Olusegun Afolabi[2], Bolanle Oyeledun[3]
[1]*Department of Defense, Abuja, Nigeria*
[2]*Department of Community Health, Obafemi Awolowo University, Ile-Ife, Osun, Nigeria*
[3]*Center for Integrated Health Program, Abuja, Nigeria*

Abstract

In Nigeria, Human immunodeficiency virus (HIV) infected patients on highly active antiretroviral therapy (HAART) are at higher risk of developing adverse drug reactions (ADRs). Objective: To assess the prevalence and pattern of ADR in HIV/AIDS patients on antiretroviral therapy. A Case review of 170 patients initiated on ARVs between July 2010 and July 2014 was carried out in eight health facilities in Kaduna state, Nigeria. Regimens prescribed include zidovudine /lamivudine, tenofovir/lamivudine, abacavir/lamivudine in combination with either nevirapine, efavirenz or lopinavir/ritonavir. Patient adverse drug reactions and offending drugs were noted and categorized using descriptive statistics. The prevalence of adverse drug reactions is 0.9%. Out of 170 documented cases of reported adverse drug reactions, 11.8% were male and 88.2% were female. The most reported ADR is anaemia (37.2%) associated with zidovudine (42.9%). ADR is most prevalent between the ages of 30 – 39, with reported cases of (46.4%). 91.8% of all patients with reported ADR recovered fully, 1.2% recovered with disability, 3.5% experienced life-threatening conditions, and 3.5% died. 22.4% of the patients are admitted. Adverse drug reaction occurred most (61.4%) among patients weighing between 41 and 61 kg. The 0.9% prevalence of adverse drug reactions among the study population is markedly lower than what has been reported in the USA, India, South Africa, Ethiopia, and Cameroon, but higher than the expected national target of 100/100000 (0.01 prevalence).

Keywords: *Adverse Drug Reaction (ADR), Antiretroviral Therapy (ART), Acquired Immune Deficiency Syndrome (AIDS), Human Immunodeficiency Virus (HIV).*

Introduction

Nigeria carries the second heaviest burden of HIV in Africa and has an expanding population of People Living with HIV (PLHIV). Despite challenges in scaling up access, institutional reforms, and political commitment to tackle the diseases, the country has seen more citizens placed on life-saving medication [1, 19].

Even though appreciable progress has been made in control of the pandemic and the treatment, care, and support for PLHIV, the preponderance of unwanted effects, side effects, adverse drug events, adverse drug reactions, and/or toxicities has tended to be a significant drawback to the use of ARVs. This is not different from the experience with many other chronic diseases, for which drugs are administered for prolonged periods [2, 15].

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****Corresponding Author: bukar0703@gmail.com***

The increasing development and availability of new medicines during the dawn of the 20th century resulted in the emergence of adverse drug reactions and other drug-related problems. This is typified by the thalidomide tragedy of the early 60s, where pregnant women exposed to the drug for morning sickness gave birth to phocomelic babies. The resultant uproar necessitated active monitoring of medicines by some developed countries, such as the United Kingdom, Australia, Canada, Sweden, and others. This reporting activity included the USA, which, fortunately, was spared the tragedy due to the diligence of the regulatory authority in requiring additional data before granting marketing authorization for the medicine [4, 7, 9, 20, 21].

The introduction of highly active antiretroviral therapy (HAART) in developed countries in the late 90s has been associated with a remarkable decrease in AIDS-related mortality. This decrease in mortality has changed the perspective of HIV infection from that of a rapidly fatal to a chronic, manageable infection. Clinical benefits of HAART are due to its effectiveness in decreasing disease progression in HIV infected patients by sustained suppression of viral replication. These clinical benefits, however, are not without adverse drug reactions (ADRs). An ADR is defined as an appreciably harmful or unpleasant reaction, resulting from an intervention related to the use of a medicinal product (which in this case is HAART), which predicts hazard from future administration and warrants prevention or specific treatment, or alteration of the dosage regimen, or withdrawal of the product. ADRs have been one of the most critical limiting factors to the success of HAART because they are responsible for new co-morbidities noticeable by the patients or their families and may result in decreased adherence to treatment, which consequently might lead to virologic failure and poor prognosis. ADRs due to continuous exposure to antiretroviral drugs leave the caregiver with few options: decreasing the dosage of antiretroviral drugs, thus compromising efficacy, withdrawing the offending drug and substituting it with another drug, or symptomatically treating the ADR. However, substituting the offending drug by the caregiver is difficult, especially in resource-limited settings, because most HAART regimens exist as fixed-dose combinations (FDC) of different drugs, most of which are first-line drugs with high toxicity profiles. The advent of new generation drugs with relatively low toxicity into the antiretroviral armamentarium is some hope that the deleterious effects of HAART-related ADRs in HIV patients would decrease. This hope remains far-fetched in resource-limited settings, where, although the highest global HIV burden, HAART still relies on first-line treatment because new-generation drugs are still costly to be afforded by most national HIV control programs. More so, the inexistence of adequate drug toxicity monitoring and reporting schemes underestimates the burden of HAART-associated ADRs.

Several studies documented how ADRs contribute to patient morbidity and hospitalization in Africa. 4.5–8.4 percent of all hospital admissions were related to ADRs, 1.5–6.3% of patients were admitted as a direct result of ADRs, and 6.3–49.5% of all hospitalized patients developed ADRs. Moreover, ADRs accounted for the most frequent reason (45.5%) for treatment modification and interruptions in patients on ART [3, 5, 6, 8, 10, 11, 14, 15, 17, 18].

Counterfeit medicine is a growing threat worldwide, accounting for up to USD 75 billion in sales in 2010. WHO estimates that more than 30% of the medicines sold in some areas of Africa are counterfeit. In Kenya alone, about USD 65 to 130 million worth of counterfeit medicines are being sold each year. The use of substandard and counterfeit

medicines can lead to therapeutic failure, drug resistance, or even death [2, 4, 7].

In Nigeria in 2008, more than 80 children died, and many others were hospitalized after being given My Pikin Baby Teething Mixture®, a syrup containing a high level of the poisonous solvent diethylene glycol (DEG) [7].

In 2005, more than 60,000 people in Nigeria were inoculated with a counterfeit meningitis vaccine, resulting in about 3,000 deaths. The extent of morbidity and mortality caused by counterfeit medicines is unknown, as most events go undetected and unreported due to weak regulatory systems, inadequate enforcement, and the presence of unregulated markets [7, 9].

Medication error is defined as "any preventable event that may cause or lead to inappropriate medication use or patient harm while medication is in the control of the health care professional, patient, or consumer." The US Institute of Medicine in 2006 estimated that more than 1.5 million Americans are injured every year by medication errors. Analysis of a Moroccan database shows that 14% of all suspected ADRs were associated with preventable medication errors [4, 9].

Insufficient and inadequate resources to monitor the safety of medicines; the unreliable supply of quality, safety, and effective drugs; the lack of trained health workers; and the weak state of the health systems in Africa are likely to contribute to significant medicines-related harm.

Statement of Problem

Considerable progress has been made in providing global access to antiretroviral therapy, with 7.6 million people receiving antiretroviral therapy in Africa as of December 2012 [1, 19]. However, the

effectiveness of treatment programs is being compromised by problems related to toxicity,

Intolerance and drug-drug interactions. These adverse events, whether acute or chronic, mild or severe, are relatively common phenomena affecting both individual patients and public health, but are being only intermittently identified and scarcely systematically reported, especially in low- and middle-income settings.

It has been estimated that adverse drug reactions (ADRs) are the 4th to 6th largest cause of mortality in the USA. They result in the death of several thousand patients each year, and many more suffer from ADRs. The percentage of hospital admissions due to adverse drug reactions in some countries is about or more than 10%. Norway 11.5%, France 13.0% and the UK 16.0% [16, 17, 20].

In addition, suitable services to treat ADRs impose a high financial burden on health care due to the hospital care of patients with drug-related problems. Some countries spend up to 15-20% of their hospital budget on dealing with drug complications [17].

There is minimal information available on ADRs in developing countries and countries in transition. However, one might expect the situation to be worse rather than better. This problem is also caused by a lack, in some countries, of legislation and proper drug regulations, including ADR reporting, many substandard and counterfeit products circulating in their markets, a lack of independent information, and the irrational use of drugs [16].

Hospital admissions due to ADRs between 1970 and 1975 ranged from 4.2% to 6.0%, with a median of 5.8%. In 2000, drug-related morbidity and mortality cost the US an estimated 177.4 billion USD. In England, ADRs accounted for 6.5% of hospital admissions with a fatality rate of 0.15% and cost the National Health Service (NHS) £466 million/year. In contrast, the total estimated annual cost to society due to ADRs in the European Union (EU) is 79 billion euros. 70% of ADRs were considered avoidable. It is worthy to note, however, that these startling figures do not represent the whole picture as

they exclude ADRs caused by other drug-related problems such as overdose, drug abuse, misuse, poisoning, medication errors, and therapeutic failures [17, 20, 21].

Unfortunately, due to the dearth of research in this area in Nigeria, we do not have information on the extent of the burden of ADRs, including morbidity, mortality, and the financial drain on the health system. We can only presume that it is worse than what is reported in developed countries due to widespread irrational use of medicines in our environment.

New adverse events and toxicities are identified as people live longer on ART. The availability of numerous new drugs and drug combinations makes it critical to monitor more systematically adverse events linked to ARVs [12, 13].

Justification for the Study

Adverse drug reactions are a significant cause of morbidity and mortality and can affect adherence to treatment schedules and increase the risk of resistance and relapse of the disease.

Every medicinal product poses a safety challenge which may be due to its pharmacological properties, genetic disposition, diet and culture of patient, disease pattern, drug manufacture, distribution and use practices as well as inherent limitations of clinical trials. These justify the setting up of systems for safety monitoring of medicines.

Limitation of Study

This was a case review study which could not associate the causal-effect relationship.

The CNS effects attributable to efavirenz may have been due to drug interaction or patient lifestyle which our study did not control for.

The death experienced in this study could be due to other possible causes such as HIV/AIDS, TB/HIV co-infection, and other co-morbid conditions, which the study also did not control for.

Objective

To assess the prevalence and pattern of adverse drug reaction in HIV/AIDS patient on antiretroviral therapy.

Materials and Methods

Study Design

This is a case review study of documented adverse drug reaction of antiretroviral.

Study Site

The study was conducted at eight facilities (General Hospitals (GH) Kafanchan, GH Gwantu, GH Makarfi, GH Giwa, GH Kwoi, Yusuf Dantsoho Memorial Hospital, Barau Dikko Specialist Hospital and Hajiya Gambo Sawaba Hospital in Kaduna, Nigeria. They are public health facilities owned and managed by the Kaduna State Government, while HIV/AIDS services are supported by the Center for Integrated Health Programs (CIHP) through the Presidential Emergency Plan for AIDS Relief (PEPFAR).

The eight facilities provide ambulatory HIV/AIDS treatment to 17,440 patients with an average of 180 patients attended to daily, and the clinics run from Monday to Friday at GH Kafanchan while, the remaining facilities runs clinics from Monday through Thursday with exception of GH Giwa which has an average of 25 patient attended to daily and the clinic runs on Mondays and Wednesday.

Study Population and Sample Size

The cohort included 170 patients initiated on antiretroviral therapy (ART) with documented ADR between July 2010 and July 2014 and had at least one follow-up clinical visit after commencing antiretrovirals (ARVs).

Once eligible for ARVs, all patients are initiated on combination antiretroviral therapy consisting of two nucleoside reverse transcriptase inhibitor and a non-nucleoside

reverse transcriptase inhibitor or protease inhibitor for second line patients. All newly imitated patients are reviewed monthly for one year. Thereafter patients are dispensed two monthly prescriptions, if found tolerant and adherent to their medication. At each appointment, adherence was assessed and counselling provided. All ADR cases identified irrespective of the severity grades were documented in the National Agency for Foods, Drug Administration and Control (NAFDAC) pharmacovigilance forms. Socio-demographic and clinical information of patients including name, age, sex, weight, hospital number, suspected drug, reported ADR, concomitant drugs and outcome are transferred to an excel spread sheet. Reports of ADRs based on patients' complaints and/or morphological changes as noticed by physicians and pharmacists during routine drug pick-ups are documented using the NAFDAC pharmacovigilance forms and sent to the National pharmacovigilance centre under the jurisdiction of the NAFDAC.

Data Analysis

EPI INFO statistical software was used for data analysis. Descriptive statistics were conducted, including the frequency distributions of key variables. Patients noted in the ART register as having transferred out, died, stopped treatment, or lost to follow-up contributed to the analysis if they had reported ADRs, before been lost to follow up at the facility because, there were yellow form filled for them

Results

Table 1 below shows that the most prevalent adverse drug reaction by organ system is skin reaction accounting for 42.7% of all the reported cases followed by haematology 37.2% then, others 12.9% and the least is central nervous system 7.2%.

Types of Adverse Drug Reactions and Distribution by Organ System

Table 1. Types of ADR

Adverse Drug Reaction by Organ System		**Frequency/Percentage**
Haematology	Anaemia	37.2%
Skin Reaction	Rash	31.4%
	SJS	5.9%
	Pigmentation of palm & nail	5.4%
Sub Total		**42.7%**
Central Nervous System	Insomnia	3.0%
	Nightmares	1.8%
	Dizziness	1.2%
	hallucination	1.2%
Sub Total		**7.2%**
Others	Nausea, Vomiting, Diarrhea, elevated lft, jaundice, peripheral neuropathy, oedamatous face, arm & feet, weakness, unusual fatigue.	12.9%
Sum Total		**100%**

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Table 2 below shows that the most suspected drug causing adverse drug reaction is azt/3tc/nvp accounting for 76.5% of all the implicated drugs while all the other drugs combine accounted for 23.5%.

Percentage Distribution of Suspected Drugs causing Adverse Drug Reaction

Table 2. Suspected Drug Causing ADR

Suspected drug	Percent
abc/3tc/nvp	0.6%
azt/3tc/efv	5.9%
azt/3tc/lpv/r	0.6%
azt/3tc/nvp	76.5%
cotrim	4.1%
d4t/3rc/nvp	0.6%
d4t/3tc/nvp	1.2%
heamatinic	0.6%
Suiphadoxine/pyrimethamine	0.6%
tdf/3tc/efv	5.3%
tdf/3tc/nvp	2.9%
tdf/3tc/lpv/r	0.6%
tramadol	0.6%
Total	**100.0%**

From table 3 and the statistical analysis below, the median duration of admission due to adverse drug reaction is seven (7) days.

The Median Duration of Admission as a Result of Adverse Drug Reaction

Table 3. Median Duration of Admission due to ADR (days)

Duration of admission (days)	Percent
2	12.0%
3	4.0%
5	8.0%
7	40.0%
10	4.0%
12	4.0%
14	20.0%
15	4.0%
21	4.0%
Total	**100.0%**

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****Corresponding Author: bukar0703@gmail.com***

Socio-demographic Characteristics of the Patient

Figure 1 below, adverse drug reaction is more prevalent among adults age 30 – 39 years accounting for 46.7% of total population followed by young adult age 18 – 29 year accounting for 27%, them adult ages 40- 49 year (15.4%), children age 1 – 9 year (1.5%), then adult age 50 years and above (4.8%) and least among adolescent age 10 – 17 year (1.2%)

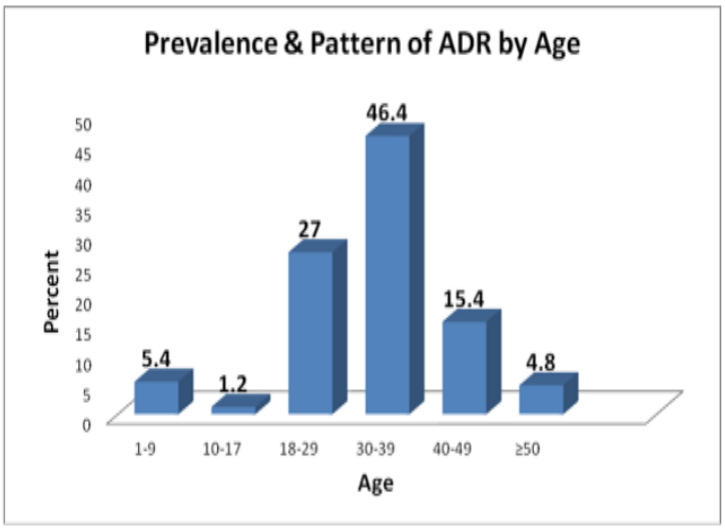


Figure 1. Prevalence & Patterns of ADR by Age

Socio-demographic Characteristics of the Patient

Figure 2 below, adverse drug reaction is more prevalent among females, contributing 88.2 % of reported cases than males contributing only 11.8% of the reported cases of adverse drug reaction.

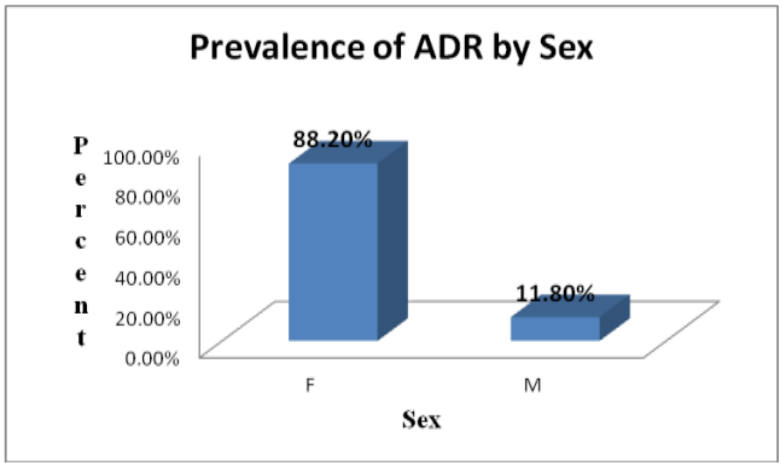


Figure 2. Prevalence of ADR by Sex

Prevalence of Adverse Drug Reaction by Weight Distribution

Figure 3 below shows that adverse drug reaction is most prevalent among patients weighing 41 – 60kg accounting for 61.4% of the reported cases followed by those weighing 61 – 80kg (21.6%) then, those weighing 21 – 40kg (11.4%), next those weighing 1 – 20kg (4.2%) and least among patient weighing above 80kg (2.4%).

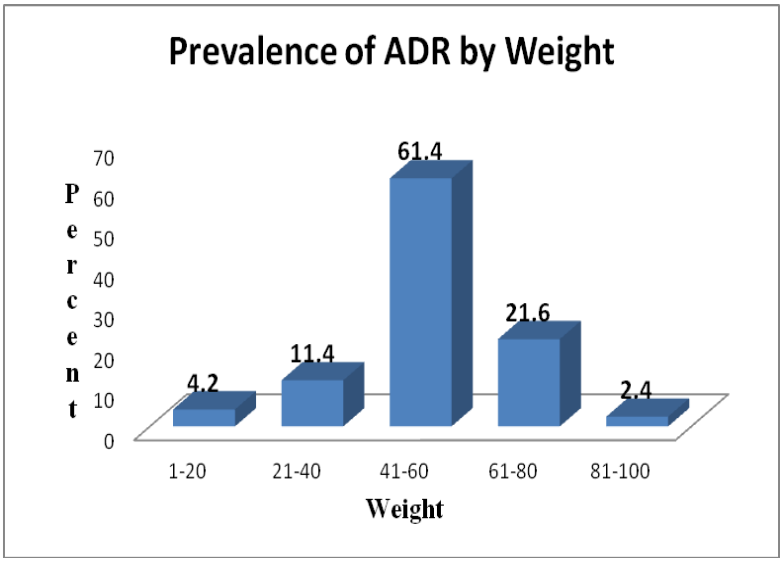


Figure 3. Prevalence of ADR by Weight

Figure 4 below shows that only 22.4% of the patients experiencing adverse drug reactions were admitted, while most of the patients, 77.6% were not admitted.

Admission Resulting from Adverse Drug Reaction

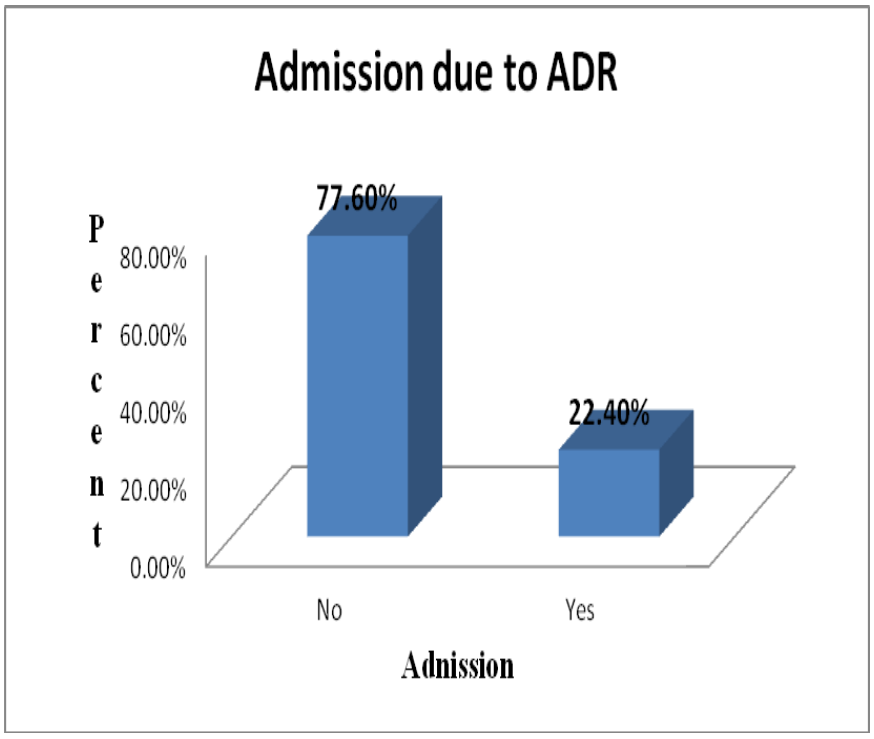


Figure 4. Admission due to ADR

Treatment of Adverse Drug Reaction with Resultant Continuation or Discontinuation of Suspected Drug

Figure 5 below shows that, 51.8% of the patients were counsel to continue suspected drug and treated of adverse drug reaction while. 48.2% of the patient discontinued their medication and also treated of the resultant adverse drug reaction.

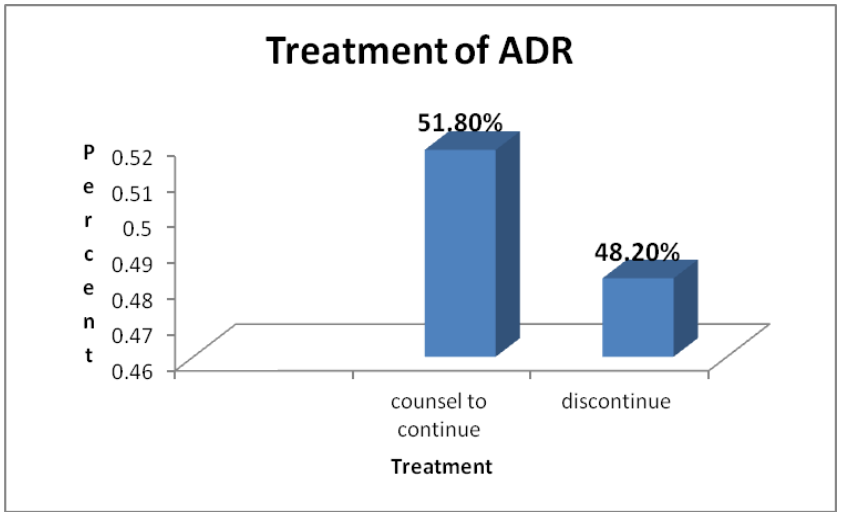


Figure 5. Treatment of ADR

Figure 6 below shows that most of the patients 91.8% recovered fully from their adverse drug reaction while, 3.5% died as a result of adverse drug reaction, another 3.5% experienced life-threatening adverse drug reaction with only 1.2% of the patient that, recovered with disability.

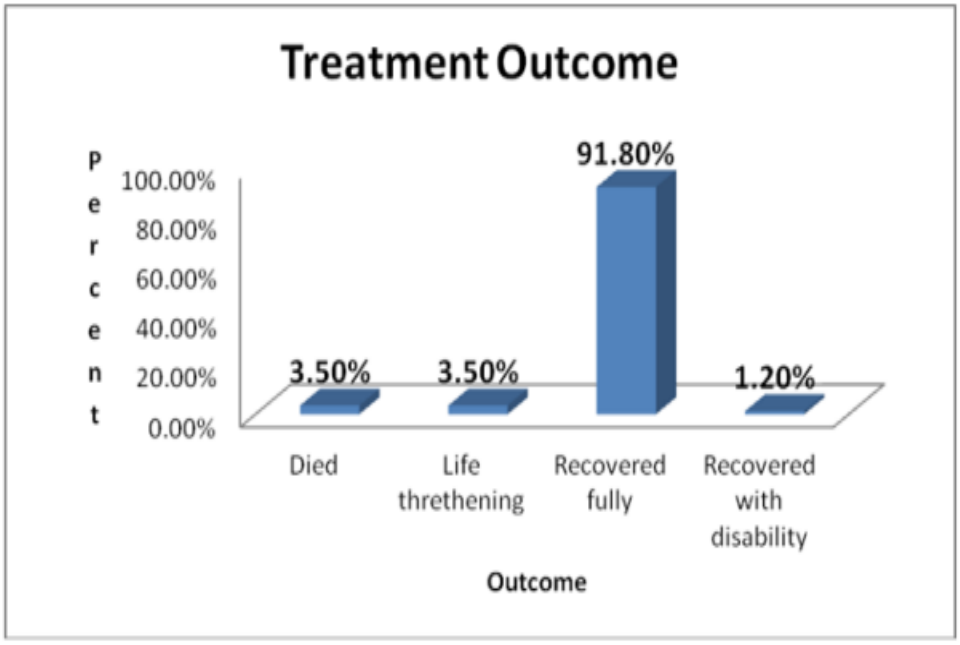


Figure 6. Treatment Outcome

Discussion

This study shows that 170 of the 17,440 patients on HAART reported ADRs, with a prevalence of 0.9%. This is markedly lower than what was reported in the USA, India, South Africa, Ethiopia, and Cameroon, but more than the expected national target of 100/100000 (0.01 prevalence). Reported ADR was highest among adults aged 30-39 years (Fig. 1), accounting for 46.4% of the reported ADR, and lowest, 1.2%, among adolescents aged 10-19 years. This aligns with the Ethiopian study. Figure 2 shows that more females (88.2%) reported ADRs than males (11.8%), just as in similar studies in India and Nigeria. This is statistically significant and could suggest hormonal factors in the development of ADR. Prevalence of ADR by

weight (Fig. 3) is highest among study population weighing between 41 – 60kg (61.4%). This is similar to the Ethiopian study, with 63% of the study population weighing between 40 and 59kg. This is statistically significant and could suggest hormonal factors in the development of ADR. This could be because adverse drug reactions are more prevalent among adults aged 30 – 39 years in this study. The most reported ADR by organ system (Table 1), skin reaction contributing 42.7% of the total ADRs, this is closely followed by heamatology (37.3%), others (12.9%) and central nervous system (7,2%). The most common ADR (Table 1) is anaemia (37.2%), which could be majorly attributable to zidovudine and this is closely followed by rash (31.4%). This could be attributed mainly to Nevirapine, as in Table 2, where zidovudine/lamivudine/nevirapine was the most implicated drug (76.5%). This is in line with a similar study in Nigeria with 23.4% and 15.9% of ADRs were anaemia and rash. Additional ADRs attributable to zidovudine include darkened or hyperpigmented nails (5.4%), while those attributable to nevirapine include Stevens-Johnson syndrome (5.9%). This outcome of Stevens-Johnson syndrome was higher than Nigeria and Indian studies (1%). The central nervous system represented 7.2% of reported ADR and was primarily associated with Efavirenz. This is lower than the results of a similar Nigerian study (13.6%) and an Ethiopian study (35.7%). However, fewer ADRs are associated with tenofovir and efavirenz; this may be because fewer patients are on this regimen than on zidovudine and nevirapine. Hospital admission (Fig. 4) due to ADR is 22.4% with the majority of the patients, 77.6% not admitted, and the median duration of admission (Table 3) is 7 days. This result is in line with similar studies in U.S.A(5.8%) and U.K (6.5). Figure 6 on treatment of ADR shows that, 51.8% of the patients are counseled to continue their ARVs, while, 48.2% of the patients discontinued their medication due to associated ADRs that become unbearable even after counseling and treatment. The result of this study was lower than that of Cameroonians, where discontinuation of medication was 68.2%. However, 91.8% of the patients recovered fully, 1.2% recovered with disability, 3.5% experienced a life-threatening reaction, and 3.5% of the patients died (Fig. 6), probably as a result of ADR or co-infection. This was a higher rate than a similar study in Nigeria, with 1% life-threatening adverse drug reaction. Research on zidovudine associated adverse drug reactions, such as palm and nail pigmentation, needs to be explored.

Conclusion

Adverse reactions due to the use of ARVs, if not closely monitored and promptly treated, may severely jeopardize confidence in the safety of ARVs and alter patient adherence to therapy, reduce the treatment efficacy, and ultimately increase morbidity and mortality, as well as increase the risk for the emergence of secondary drug resistance. It is important that in disease conditions such as HIV/AIDS, where drugs are to be taken for a prolonged period of time, patients and caregivers need to be conversant with adverse ADRs that are to be expected in the course of treatment. This will help implement treatment strategies that reduce or ameliorate these issues, improve medication adherence, prevent treatment failure, minimize the waste of other resources, and preserve future treatment options.

Conflict of Interest

There is no conflict of interest.

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A Comparative Analysis of the Academic Performance of Nursing Students in Three Selected Nursing Institutions in Sierra Leone

Christiana Baindu Massally[1*] and Alhaji Brima Gogra[2]
[1]*Texila American University, Georgetown, Guyana*
[2]*Port Loko Campus, Ernest Bai Koroma University of Science and Technology, Sierra Leone*

Abstract

As the number of trained and qualified nurses continues to increase in clinical settings, concerns about nursing students' academic performance, which translates into their output in patient care, emerge. Sierra Leone has seen high failure rates among nursing students in state council examinations. This study compares nursing students' academic performance across public, faith-based, and private institutions in Sierra Leone. A descriptive cross-sectional research design using mixed methods was used to evaluate and compare the academic performance of nursing students at the selected nursing institutions in the council exams conducted for first-timers in November 2022. Thematic analysis was also used to explore factors associated with students' performance. In total, 235 candidates were presented to the State Board Examination in November 2022 by the Institutions under review. 125 students from the Faculty of Nursing-(COMAHS),61 from Tonkolili District College of Health Sciences (TDCHS), and 49 from St John of God - University of Makeni (UNIMAK). From the findings, UNIMAK had a 100% pass rate; COMAHS had a 69.6% pass rate and a 30.4% failure rate; Tonkolili District College Health Sciences (TDCHS) had an 88.5% pass rate and 11.5% failure rate. Factors influencing the Academic Performance of students were large class size, unharmonized Curricula, inappropriate teaching methods, and poor preparation for state council exams. The study concludes that exceptional performance is associated with nursing institutions with smaller class sizes. Factors that affected the students' academic performance were teacher-student and institutional influences.

Keywords: *Academic Performance, Education, Nursing, Students.*

Introduction

Education is a significant issue as it is one of the critical aspects that include essential skills, abilities, and knowledge that help to improve the overall growth, progress, and development of an individual, community, and nations. Education is associated with success and achievement, which are accomplished through desired goals and objectives [1, 2].

Nursing is considered the backbone of the global healthcare system, and nursing education plays a vital role in preparing nurses [3]. Nursing education aims to prepare nursing students with the appropriate level of competency to subsequently promote the quality of life of individuals, families, and the public by executing their duties in line with the changing needs of people and also within the health system. The World Health Organisation (WHO) has formulated global education standards for professional nurses and midwives. Despite various initiatives to standardize and improve nursing education, discrepancies persist across programs worldwide.

When educating nursing students, they need a balance between the knowledge and theories

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****Corresponding Author: slnursesmidwivesboard@gmail.com***

that are obtained in the classroom, applying and transferring these theories in the clinical setting, and dealing with real situations [4].

Academic performance is key in education, especially in nursing students, and becoming a registered nurse is a significant milestone marked by passing the state Board Examination. This Academic performance refers to the academic grades attained through various educational instructions in the learning environment. If students achieve good grades, it means they have managed their studies, completed the tasks assigned by teachers within the programme's stipulated duration, and understood the programme's impact on their academic performance [5]. Also, academic performance is a complex student behavior in which students try to remember facts and express what they have learned, either verbally or in writing [6].

The State Board Examination is a comprehensive and standardized exam that covers critical areas of nursing. The goal is to ensure that nursing professionals are ready for the responsibilities that come with the job [7].

According to Tosevski, Milovancevic, and Gajic [8], there are many factors that can affect students' performance, including school-related factors, personal conditions, study habits, home-related, and teacher-related factors. These factors have a strong negative influence on students' performance, and they vary by personality and culture. The school-related factors include the quality and quantity of teachers, the unavailability of needed supplies, while non-school-related factors include Socio-Economic Status, low educational level or illiterate parents, weak students, poor nutritional condition of the students, or even students with health conditions.

In addition, Izuchi Onyekuru [9], also stated that academic motivation, effort required, competition, social power, affiliation, social concern, praise, and previous academic achievements can influence students' academic achievement.

To achieve in Academia, a series of assessments are planned and prepared by staff and undertaken by students in a well-structured facility to determine the student's ability and capability for the particular programme of studies. This will be implemented through a well-designed and developed curriculum for that particular Programme. The students will be taught to manage their study load effectively using the study material in the curriculum. It also provides an indicator of an engaging curriculum that helps students enjoy their classes. Students' academic success depends on their active involvement in the learning process, achieving the highest degrees, and producing high-quality work in a particular field [10]. Also, academic achievement is defined as the student's subjective assessment of his or her grades, expressed as excellent, very good, good, fair, or poor. In this current study, the academic achievement of students is measured by a student's grade point average [11].

Nursing students need good preparation for the rapid changes and complexity of the health care demands through closing the gap which may arise between the clinical practices and the nursing theory, providing suitable opportunities for performing the required skills effectively, facing any challenges in the nursing work, and well academic preparation [12]. To meet the needs of the population and future demands of this generation and subsequent generations, every nurse must succeed in their education, close the gap between supply and demand, and avoid academic failure [13].

Academic achievement is a critical element in education. It is therefore essential that educational institutions assist students to develop emotionally and academically [14]. This success is crucial because it is strongly linked to positive outcomes: academically successful nursing students are more likely to be employed and to have more opportunities for promotion in the future [15].

Studies have shown the impact of poor academic performance, with adverse outcomes. Low grade point average achievements may lead to further anxiety, anger, and depression, discouragement, absenteeism, and even withdrawal from the college and/or from the profession, impaired role transition, burnout, and poor job performance [16].

Presently, there are no empirical reports on the academic performance of nursing students who take the state board examination in Sierra Leone. Thus, it is necessary to fill the gap related to the assessment of the educational performance of nursing students after this examination, as well as determining the factors affecting their academic performance. The findings of this study will provide valuable guidance for the state board examination and educational institutions in designing future programs to address obstacles and support the development of students' performance. Findings will also guide Training Institutions in modifying their teaching methods, thereby improving their teaching procedures.

Aim of the Study

This study aimed to compare the academic performance of nursing students in the state council examination among selected nursing institutions in Sierra Leone.

Research Objectives

1. To determine the success and failure rates of nursing students in the board examination from the selected institutions.
2. To assess factors influencing the academic performance of the students in the selected institutions

Null Hypotheses

There is no difference in the academic performance at the state council exams in the selected nursing institutions.

Methodology

Research Design

A descriptive cross-sectional research design using mixed methods was used to evaluate the academic performance of nursing students at selected nursing institutions in the council exams conducted in November 2022.

Study Settings

The study was conducted in three selected Nursing institutions in Sierra Leone.

Study Sites

1. Faculty of Nursing and Midwifery, College of Medicine and Allied Health Sciences

The College of Medicine and Allied Health Sciences (COMAHS) is a constituent college of the University of Sierra Leone, and nursing is one of the four faculties offered at COMAHS. A dean heads the Faculty of Nursing and Midwifery. There are also heads of various disciplines: Medical-Surgical, Basic Nursing, Community Health, Pediatric and Neonatal Nursing, Midwifery and Obstetric Education, Nursing Education, and Specialized Nursing. This Faculty has served the nation, especially in secondary health (Hospitals), and its support has been recorded in both public and private hospitals across the country. It offers the following courses: Diploma for the State Registered Nurse (SRN), Bachelor of Science in Nursing (BSc), Mental Health Nursing, Ophthalmic Nursing and the Nurse Educator Training programme.

2. University of Makeni, Saint John of God Campus

The Department of Nursing at the University of Makeni is a faith-based nursing institution. The Catholic Mission owns it; the Hospitaller Brothers of St. John of God Order. The institution was established in 2007 as a School of Nursing and, in October 2022, transformed into the Department of Nursing, Faculty of Nursing and Allied Health Sciences, Unimak. The institution is currently managed by a

provost, with 12 full-time and 7 part-time staff. The campus is equipped with four lecture classrooms, two staff rooms, a computer lab, a nursing skills laboratory, a Research Centre, and internet service to enhance learning. The institution has produced five cohorts of diploma in nursing students.

3. Tonkolili District College of Health Sciences (TDCHS)

Tonkolili District College of Health Sciences (TDCHS) was founded by the Masanga Hospital Rehabilitation Project (MHRP) in September 2012. This institution is accredited by the Sierra Leone Tertiary Education Commission and approved by the Nurses and Midwives Board of Sierra Leone.

It is situated at Masanga Hospital Campus, Masanga Town, Kholifa Rowala Chiefdom, Tonkolili District.

Study Population and Study Sample

The study population consisted of nursing students, who sat for the State Council Examination in November 2022 in three selected nursing institutions: the Faculty of Nursing, the College of Medicine and Allied Health Sciences, the University of Sierra Leone, the Saint John of God Nursing School, and the Tonkolili District College of Health Sciences.

Sample Selection Technique

The selection of study participants was done at two stages. In the first stage, three nursing institutions were selected purposively to ensure fair comparison:

Faculty of Nursing, College of Medicine and Allied Health Sciences, University of Sierra Leone, is a public institution, University of Makeni, Saint John of God Nursing School is a faith-based institution, and Tonkolili District College of Health Sciences is a private institution.

In the second stage, eligible students were selected. In the first instance, all the candidates (235) who were presented for the State Council Examination from the selected institutions were included in the study for assessment of their results.

Secondly, six (6) to eight (8) students were randomly selected from each of the chosen institutions who were willing to participate in the study.

Table 1. Participants' Background Variables *State Council Re-Sit Exam 2022*

	Gender		**Age**			**Years of previous relevant work experience**	
	Male	**Female**	**≤ 20**	**21-30**	**31-40**	**Gen**	**Post basic**
COMAHS	2	6	0	6	2	4	5-10 years
Saint John	1	5	2	3	1	0	0
TDCHS	2	4	1	5	0	0	0

Inclusion and Exclusion Criteria

The inclusion criteria for this study were nursing students who were currently sitting for the State Council Exams at the selected institutions in Sierra Leone. Exclusion criteria included nursing students who did not attempt the State Council Exams at the time of the study or who refused to participate. We also excluded students who were not in the three selected training institutions.

Study Variables

The study variables included pass and failure rates in the selected institutions, demographic characteristics of nursing students, Institutional factors influencing academic performance (Learning environment, availability of teaching and learning resources, teaching methods), and

student-related factors (sociodemographic characteristics) influencing academic performance.

Data Collection Instrument and Methods

Data was collected using a checklist and a focus group discussion guide. The Checklist consisted of items to determine the academic performance of students from records of the November 2022 State Council results. The focus group guide consisted of items to elicit information on factors influencing the academic performance of students. This was done through focus group discussions held at each selected institution during the study period (March and June 2023). A focus group discussion was held in each institution. A total number of 6 or 8 participants were randomly selected from each institution among the students who were willing to participate in the study (see Figure 1).

Measures to Ensure Trustworthiness

The reliability of the study was ensured in accordance with Lincoln and Guba [17], the determinants of rigor for qualitative studies. These include credibility, transferability, dependability, and conformability. To ensure credibility and dependability the researchers visited the study sites. A planned two-week visit was organized for both research teams to familiarize them*selves* with the three universities in which the study was conducted. The researchers visited the study sites twice to build relationships and understand the culture of the study area. Data was collected from the study sites.

To permit transferability, detailed descriptions of the research settings have been provided. Purposive sampling was used to focus on key participants with sufficient experience with the circumstances under investigation. Decisions made throughout the study have been described in detail, together with the data collection methods. This will allow the reader to decide to what extent they can transfer the study to other contexts.

Conformability refers to the objectivity, that is, the potential for congruence between two or more independent people about the data's accuracy, relevance, or meaning [18]. To achieve conformability, the researchers have documented the procedures for rechecking the data and ensure that negative instances that might contradict prior observations are addressed.

Table 2. Background Characteristics of Respondents *State Council Re-Sit Exam 2022*

Attribute	**Frequency (N=235)**	**Percentage (%)**
Age of participant (in years)		
15-25	68	29.0
26-36	150	63.8
37-47	17	7.2
Gender of participant		
Male	35	14.9
Female	200	85.1
Marital status		
Married	80	34.0
Not married	155	66.0
Nursing background of participant		
Had Nursing Background and employed	48	20.4
Had nursing background & unemployed	15	6.4

No nursing background & unemployed	172	73.2

The research team were actively involved tThroughout the study, to be aware of bias and to discuss and address any inconsistencies that arose.

A Pilot study was carried out among six students, two from each of the study subjects. The purpose of the pilot study was to test the applicability, feasibility, and objectivity of the study tools before data collection, and to estimate the time needed to complete the questionnaire, which was excluded from the original sample due to modifications. The pilot study was conducted for two weeks; 30 to 40 minutes was the time needed to complete the discussion.

Data Analysis

Descriptive Analysis

Data was entered and coded using Statistical Package for Social Sciences (SPSS) version 26.0. SPSS was also used for data analysis. Descriptive statistics such as mean, median and standard deviations were used to describe the study population; while for categorical variables, frequencies and percentages were recorded. The data were presented using figures and tables.

To gain deeper insight into the phenomenon, Thematic Analysis (TA) was used to interpret the qualitative findings. The researchers transcribed the focus group discussions verbatim, manually coded the data, and identified potential themes through repeated readings

Presentation of Results

Background Characteristics of Respondents for The Quantitative Arm of The Study

A total of 235 participants were sampled for this study. In total, most (63.8%) of the participants were between the ages of 26 and 36. Those who were between ages 37 to 47 represented 7.2% and those between ages 15 to 25 were 29.%. The majority (85.1%) of participants were female, and more than half (66%) were single. 20.4% had a certificate-level nursing education and were employed, and 73.2% had no nursing education. *See Table 2 Above.*

Pass and Failure Rates of Students Presented for the November 2022 State Council Examination in the Selected Institutions

In total, 235 candidates from the institutions under review were presented for the state council exams in November 2022. From Figure 1 below, the pass rate at COMAHS was 69.6% and the failure rate was 30.4%, UNIMAK had a 100% pass rate, and at TDCHS, the pass rate was 88.5% while the failure rate was 11.5%

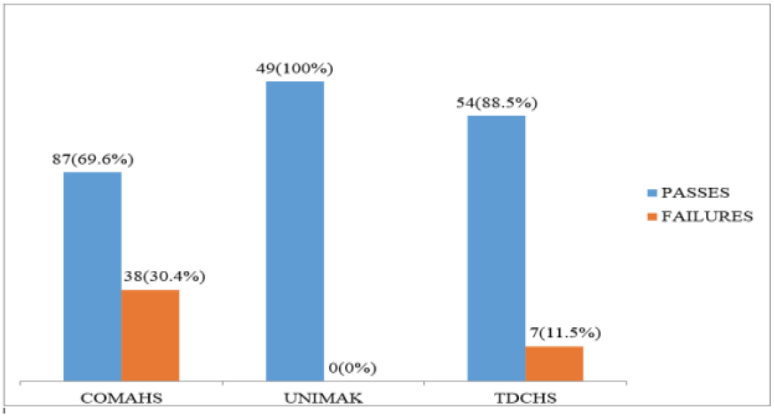


Figure 1. Showing Pass and Failure Rates of Students During the State Council Exams, November 2022 State Council Re-Sit Exam 2022

Distribution of Pass and Failure Rate of Students Per Subject Examined

Table 3 below displays the distribution of success and failure rates for candidates in the State Council Exams, by subject. Students were examined in 5 subjects, namely: Medical Nursing, Surgical Nursing, Pediatric Nursing, Community Health Nursing, and Mental Health Nursing. In Medical Nursing, UNIMAK had a 100% pass rate, TDCHS had over 90.2%, and COMAHS had 88.8%. Out of 125 candidates from COMAHS, 49 candidates from UNIMAK, and 61 candidates from TDCHS, only one candidate failed at COMAHS with no failure in the other nursing institutions. There is no failure in Community Health Nursing in all the institutions. Mental Health Nursing had 16 candidates who failed at COMAHS, no failures at UNIMAK, and five failures at TDCHS.

Qualitative Results

Focus Group Discussion

The study also conducted three focus group discussions to investigate the factors influencing students' academic performance in state council exams.

Table 3. Distribution of Pass and Failure Rate of Students Per Subject Examined State Council Re-sit Exam 2022

Subject	COMAHS (n=125)		UNIMAK (n=49)		TDCHS (n=61)	
	PASS	FAIL	PASS	FAIL	PASS	FAIL
Medical Nursing	111 (88.8%)	14(11.2%	49 (100%)	0 (0%)	550 (90.2%)	6 (9.8%)
Surgical Nursing	124 (99.2%)	1 (0.8%)	49 (100%)	0 (0%)	61 (100%)	0 (0%)
Paediatric Nursing	118 (94.4%)	7 (5.6%)	49 (100%)	0 (0%)	60 (98.4%)	1 (1.6%)
Mental Health Nursing	109 (87.2%)	16 (12.8%)	49 (100%)	0 (0%)	56 (91.8%)	5 (8.2%)
Community Health Nursing	125 (100%)	0(0%)	49 (100%)	0 (0%)	61 (100%)	0 (0%)

The analysis revealed three closely related themes for nursing students at COMAHS, Saint John and TDCHS. The three themes were: *large class size, non-harmonization of curricula, and Student' attitude to their learning*. Main themes and sub-themes are outlined in Table 4.

Institutional Factors

Some institutional factors were evident in our data regarding how they influenced academic performance. Two institutional factors that emerged were large class sizes and non-harmonization of curricula among nursing institutions.

Large Class Size

It was revealed that the number of students per class was exceptionally large as reported by students at COMASH compared to the at the UNIMAK and TDCHS. They state that the class size affected their learning, as some of them hardly hear the lecturer during lectures, and it is hard for them to be assigned to a patient to perform procedures in the clinical setting due to the large class size. Participants also said that lecturers seldom give formative assessment or if some do, it is never marked before the summative (final) examination and therefore

feedback are not given on their performance. Furthermore, the students stated that they lack supports from lecturers at school and clinical teachers in the clinical settings.

As stressed by the students "you hardly hear or understand what the lecturer is teaching especially when you are seated at the back and also it is difficult for us to have opportunity to practice on a patient on the wards because we are many in the clinical site".

Again, we are never given feedback from class tests, in fact some lecturers never give class test, they only give assignments which they don't mark.

Participants at UNIMAK and TDCHS stated that the classrooms were adequate and conducive for learning and for us, the classrooms are large and spacious. We only occupy the frontage, and we hear the lecturer's voice clearly. Same for us, the class size is okay, re-echoed by students from TDCHS.

Table 4. Main and Sub Themes

Main theme	Sub-themes
Institutional factors	1.Large class size 2.No harmonization of curricula 3.Inappropriate teaching methods
Students related factors	1.Poor preparation for state council exams

Curricula not harmonized

Findings from the discussions show that all the three institutions implement different curricula for their students because the nursing curricula was not harmonized during their time. The contents, method of instruction and assessment for the modules taught in these institutions may differ in terms of adequacy and quality.

When we interacted with students from other colleges, we realized they had covered topics we had not, especially in modules like medical and mental health nursing. We are also taught modules that are not offered at other nursing colleges.

Inappropriate teaching method

The study also revealed inappropriate teaching method used by some lecturers. They needed the teachers to provide more time to support or listen to them at school and provide clinical learning sessions in the clinical settings. Some lecturers do not give us lecture notes or reading materials; instead, they divide the topics in the module for students to take notes and give a presentation. Yes, I agree with what you said. We are novice and we should be taught everything. Some lecturers don't have patience to help students to understand their lectures, That's true even in the clinical site, the preceptors don't have time for us, and they are responsible for our academic success.

Students related factors

This talks about the student's personal attributes that can affect their academic achievements. Poor preparation for state board exams. The participants attested that most of the failures at state exams are because of absenteeism and poor preparation for state council exams. Reasons for absenteeism were transportation issue due to long distance from the institution, and for some, their work schedules clash with lecture hours. Some of us stay far away from the colleges and the costs of transportation are high so sometimes we do not attend classes. Some students are already nurses and are employed. Sometimes lectures are called when we are on duty.

Discussion

The study sought to compare the academic performance of students at state board examination conducted for first timers in November 2022 among students in a public nursing institution, a faith-based nursing institution and a private nursing institution in Sierra Leone.

The study assessed the situation from the perspective of students. The results of a total of 235 students who sat to the state council exams was analyzed. The study also used qualitative methods to assess the opinion of the students on factors influencing their academic performance.

Pass and Failure Rates

Among the 3 institutions examined, UNIMAK had the highest (100%) pass rate followed by TDCHS who took the second position with a pass rate of 88.5%, and COMAHS had the least pass rate with a score of 69.6% and automatically having the highest failure rate. This finding is surprising because COMAHS is regarded as the anthem of excellence for nursing education with a well-established state-of-the-art skills laboratory for nursing practice in the country and a larger number of candidates for council exams. However, UNIMAK being a faith-based institution with fewer candidates had exceptional scores across the nation. This finding is similar to the report of Lehtinen-Vela [19] on the National Council Licensure Examination (NCLEX) in the United States where a state with fewer (New Hampshire) population had the highest NCLEX pass rate of 90% in the United States and states (New York and Florida) with larger population which may translate into the student population had lower scores of pass rates of 74% and 64% respectively.

Another glaring issue of note in our study was that the faith-based and private institutions performed better than the public institution. A contrary finding was reported in an earlier study by [20], which used multilevel modeling (MLM) to examine the association between the NCLEX-RN First Timer Pass Rate (FTPR) and institutional characteristics, as well as faculty, admission, progression, and program and curricular characteristics. FTPR was associated with public schools (*OR* = 1.65, 95% CI [1.12, 2.43], $p = 0.03$).

Factors Influencing Academic Performance of Students at State Council Examination

In the qualitative arm of the study, the researchers explored the factors influencing academic performance of students.

Findings indicate that institutional and student related factors have major effects on the academic performance of the student. Results further revealed that among these given factors, large class size, diverse curricula for nurse training, and students not owning their learning and poor preparation for state council examination were the most significant factors influencing student academic performance. This further indicates that the participants felt that teaching strategies, student teacher relationship and communication barrier hinder their academic performance.

Previous studies likewise posit that teachers have the greatest influence on the academic performance of students. The study of Teaching methods and students' performance [21] emphasizes that teachers should create an atmosphere conducive to learning to enhance students' learning experiences. According to Pinehas L.N, Mulenga E., Amadhila J., [22], in a study conducted in Oshana, Namibia, participants found that poor teaching strategies, poor student-teacher relationships, and communication.

Participants in our study also reported that inadequate support from lecturers affected their performance. Lecturers must make time for tutorials to support weak students because some of them find it difficult to understand complex lectures in a large sized class [23], also reported

similar findings that lack of remedial classes to support students who did not understand the content contributed to failure. To affirm this, as in the study by [24], which found that students' performance improved when they participated in after-class sessions on academic concepts and general academic and writing skills and were provided with feedback on assignments. Also, in their study [25], reported that students gave positive feedback, and described individual class sessions as one of the most useful aspects of the programme.

Participants in this current study believed the lecturers are responsible for their academic success. This assertion may hinder the enquiry aspect of learning. It is worth noting that students who do their own reading and research at lower levels of learning are better prepared for a better understanding of nursing concepts and are more ready and confident to pursue independence in their own research at higher levels of education. Ownership of learning is an essential element of knowledge construction. Also, student motivation to learn increases when they take ownership and responsibility of their learning

A common finding across all institutions was the use of different curricula for nursing education. This may be responsible for the poor performance of some schools of nursing as these students can be disadvantaged. Ongoing curricular renewal or harmonization is a necessary phenomenon in nursing education to align learning with ever-changing professional practice demands. Curricula enhance planned instruction and efficient assessment of student learning.

Conclusion

Curriculum renewal can serve as a starting point for educational research. Indeed, all curriculum renewal should be carefully evaluated. A tailored, detailed educational study can provide one aspect of overall program evaluation, leading to a full circle of the scholarship of teaching and learning: using results of the research for constant quality improvement in nursing education

Recommendation

The Researcher put forward the following recommendations:

1. That stipulated class enrollments by the Nurses and Midwives Board should be adhered to henceforth.
2. That curriculum for the Registered Nursing programme is harmonized.
3. That the board is strengthened to monitor training institutions.
4. That capacity building opportunities are opened to Nursing educators regularly.

Conflict of Interest

The author declares no conflict of interest.

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Ethical Considerations

Ethical approval was granted by Sierra Leone’s Ethics and Scientific Review Committee, and permission was obtained from the selected institutions. Informed consent was obtained from each participant, and confidentiality of the data was ensured by using anonymous questionnaires and secure data storage.

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Implementation of Food Service Management Standards at Orphanages A and B in Palangka Raya, Indonesia

Dhini Anden*, Munifa, Resna Maulia
Department of Nutrition, Health Polytechnic of Palangka Raya, Palangka Raya-73111, Indonesia

Abstract

Orphanages are social institutions that play a crucial role in providing protection, care, and education to children who have lost their parents or families. According to the Indonesian government, the number of abandoned children in Indonesia has reached 67,368, although only a portion of them receive care in orphanages. Currently, there are approximately 12,000 orphanages in Indonesia. One of the critical services provided in orphanages is food service management, which aims to meet children's nutritional needs. This study aims to evaluate the implementation of food service management standards at orphanages in Palangka Raya City and to intervene in the food service process to align it with applicable standards. This research used a quasi-experimental method with a non-equivalent control group design in a two-group pre-test-post-test design. The study sample comprised the entire populations of Orphanage A and Orphanage B, selected using purposive sampling. The respondents in Orphanage A were predominantly male (82%) with an average age of 18 years, while in Orphanage B, the majority were also male (63%) with an average age of 13 years. The score for the implementation of management standards increased from 55 to 77 in Orphanage A and from 58 to 85 in Orphanage B after the intervention. There was a significant improvement in the implementation of food-service management standards across both orphanages. These results indicate that proper implementation of standards can enhance the quality of food services, which ultimately fulfill the nutritional needs of orphans.

Keywords: *Abandoned Children, Food Service Standards, Nutrition, Orphanage.*

Introduction

Orphanages are one of the social institutions that aim to provide protection, care, and education for children who have lost their parents or families. According to Law Number 35 of 2014 concerning Child Protection, every child has the right to life, to grow and develop properly, and the right to be protected from all forms of violence and discrimination [1]. In addition, Article 34, Paragraph 1 of the 1945 Constitution of the Republic of Indonesia states that the poor and abandoned children are the responsibility of the state [2].

The number of abandoned children in Indonesia is quite significant. According to data from the Ministry of Social Affairs as of 2020, there were approximately 67,368 abandoned children in Indonesia. However, not all of these children have access to orphanages or appropriate protection services. Currently, the number of orphanages in Indonesia has increased significantly, from around 5,000–8,000 orphanages in 2010 to about 12,000 orphanages in 2020. This reflects the growth of social service facilities, but there remains a gap in meeting the needs of abandoned children [3, 4].

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****Corresponding Author: dhini.anden@polkesraya.ac.id***

The Ministry of Social Affairs states that one of the main functions of orphanages is to provide physical services, including food service. Food service is a crucial element in meeting children's basic needs, particularly in ensuring adequate nutrition. The food service system involves six main components:

1. Input, which includes manpower, costs, food ingredients, equipment, and institutional policies
2. Process, which covers menu planning, procurement of food ingredients, storage, food production, distribution, as well as the application of hygiene, sanitation, and occupational safety
3. Output, which refers to quality food that meets the needs of consumers
4. Outcome, in the form of assessing the nutritional status of consumers
5. Control, which involves supervision of work procedures and programs being implemented
6. Environment, which includes the cleanliness of the kitchen and its surroundings [5].

Ensuring proper nutrition in early life is especially important, as inadequate intake during this critical period may increase the risk of chronic illnesses in adulthood [6].

Previous studies have shown that the quality of food service in orphanages largely depends on the orphanage management. One way to improve food service quality is to apply food service management standards [7] consistently. This study aims to evaluate the implementation of food service management standards at Orphanage A and Orphanage B in Palangka Raya City. In addition, this research provides an intervention to improve the quality of food service in accordance with applicable standards. The results of this study are expected to contribute to the management of orphanages in Palangka Raya, particularly by optimizing the nutritional needs of abandoned children.

Materials and Methods

Research location

This study was conducted in two orphanages located in Palangka Raya City, Indonesia. The Central Kalimantan Social Services Office manages Orphanage A, while Orphanage B is managed under the auspices of the Evangelical Kalimantan Church (GKE).

Research Design

The research employed a quasi-experimental design with a non-equivalent control group pre-post test and an analytical research type. The research objects covered the aspects of input, process, output, control, environment, and outcome. The research sample included the entire population at Orphanage A (22 individuals) and adolescents at Orphanage B (19 individuals).

Data Collection

Data on food service management were collected through in-depth interviews, focus group discussions (FGD), and direct observation. The assessment of food service standards in Orphanage A and Orphanage B used the following indicators as mentioned in Table 1.

Table 1. Food Service Standard Indicators in Orphanage A and Orphanage B

Element	Activity	Details
Input	Man (Labor)	Calculation of labor includes working time
	Money (Cost)	Food cost per person
	Regulation/Policy	Regulations related to menu cycles and meal service funding

	Facilities & Infrastructure	Receipt, storage of materials, preparation, processing, serving, dishwashing area, and equipment storage
Process	Menu planning	Portion standards, recipe standards, and menu cycles
	Procurement	Standard process
	Receiving	Standard process
	Storage	Standard process
	Processing	Standard process
	Distribution	Standard process
Output	Macronutrient intake	Categories based on the Ministry of Health of the Republic of Indonesia, 1996
	Acceptability	Organoleptic test according to the 2013 guidelines
Control	Supervision of work procedures	Evaluation of food service procedures
Environment	Environmental sanitation	Assessment of food service sanitation according to standards
Outcome	Nutritional status measurement	Categories based on Ministry of Health Regulation No. 2 of 2020
	Hemoglobin (Hb) test	Categories according to the Ministry of Health of the Republic of Indonesia, 2018

Nutritional intake data were obtained using the food weighing and food record methods. Food acceptability was measured using a Hedonic Test form, while hemoglobin (Hb) levels were measured using a Hematology Analyzer (HA).

Data Analysis

Univariate data analysis was conducted using frequency and percentage distributions presented in a single table. For bivariate analysis, a paired t-test was used for normally distributed data. If the data were not normally distributed, the Wilcoxon test was used to assess the differences before and after the intervention.

Ethical Clearance

This study received ethical approval from Komisi Etik Penelitian Kesehatan, Poltekeks Kemeskes Palangka Raya, with approval no. 260/V/KE.PE/2024.

Results and Discussion

Respondent Characteristics

The characteristics of respondents at Orphanage A and Orphanage B based on gender and age are presented in Table 2 below.

Table 2. Respondent Characteristics at Orphanage A and Orphanage B by Gender and Age

Characteristics		**Orphanage A**		**Orphanage B**	
		N	**%**	**N**	**%**
Gender	Male	18	82	12	63
	Female	4	18	7	37
Age	10-11 years	-	-	3	16
	12-13 years	-	-	6	31
	14-15 years	2	10	5	26
	16-17 years	8	37	4	21

	18-19 years	8	37	1	5
	20-21 years	4	16	-	-
	Total	22	100	19	100

Source: Primary data, 2024

Based on Table 2, the majority of respondents at Orphanage A were male (82%), and most were 18 years old (23%). This indicates that Orphanage A tends to accommodate male adolescents, which is likely related to admission policies focused on the adolescent age group. According to Table 2, most respondents at Orphanage B were male (63%), with the dominant age being 13 years (26%). This distribution shows that Orphanage B has a more diverse age distribution than Orphanage A, reflecting an institutional policy that may be more inclusive of both young children and adolescents.

The differing distributions of gender and age across the two orphanages indicate variations in caregiving approaches and specific needs that must be addressed. Orphanage A, which is predominantly male, requires a caregiving approach focused on character development, vocational education, and preparation for independence. Meanwhile, Orphanage B requires a more diverse approach to accommodate the needs of both younger children and adolescents, including caregiving programs tailored to developmental stages. A study by Wrottesley et al. showed that children's nutritional needs and caregiving patterns are greatly influenced by age and gender [8]. Younger children need more attention to cognitive and emotional development, whereas adolescents require support in identity development and independence [4, 9].

Input of Respondents at Orphanage A and Orphanage B

Table 3 illustrates the input elements at Orphanage A and Orphanage B before and after the intervention, including aspects of manpower (man), cost (money), facilities/infrastructure, and regulations/policies.

Table 3. Input Elements at Orphanage A and Orphanage B

Element	**Indicator**	**Orphanage A**		**Orphanage B**	
		Before	**After**	**Before**	**After**
Man (Labor)	Number of Food Handlers	2 persons	3 persons	1 person	2 persons
	Working Hours	8 hrs x 7 days	5 hrs x 7 days	10 hrs x 7 days	6 hrs x 7 days
	Use of PPE	No	Yes	No	Yes
Money (Cost)	Meal Cost per Person	< Rp 30,000	Rp 30,000	< Rp 30,000	Rp 30,000
Facilities / Infrastructure	Receiving Area	No dedicated room	No dedicated room	No dedicated room	No dedicated room
	Storage Area	Dedicated room (FIFO & FEFO)	Dedicated room (FIFO & FEFO)	Dedicated room (FIFO & FEFO)	Dedicated room (FIFO & FEFO)
	Preparation Area	No dedicated room	No dedicated room	No dedicated room	No dedicated room

	Cooking Area	No kitchen room	No kitchen room	Kitchen room	Kitchen room
	Serving Area	Dedicated room	Dedicated room	Dedicated room	Dedicated room
	Sink	None	Available	None	Available
Policy / Regulation	Menu Cycle	Available	Available	Available	Available
	Portion Standard	None	Available	None	Available
	Recipe Standard	None	Available	None	Available

FIFO: First in first out; FEFO: First expired first out

Based on Table 3, there was a significant improvement in the input elements in both orphanages after the intervention. In the labor aspect, the number of food handlers at Orphanage A increased from 2 to 3, and at Orphanage B from 1 to 2. This increase was accompanied by a reduction in working hours, which contributed to improved work efficiency and reduced fatigue risk [10]. The use of Personal Protective Equipment (PPE), which was previously absent, is now implemented in both orphanages after the intervention. This is essential to enhance food hygiene and safety standards, in accordance with WHO recommendations [11].

In terms of cost, the per-person allocation of meal funds increased to Rp 30,000 at both orphanages. This increase allows for the provision of more nutritious and varied food, supporting the nutritional needs of orphanage residents [12]. Regarding facilities and infrastructure, a significant change occurred with the provision of sinks, which were previously unavailable. The presence of sinks supports better hygiene practices [13]. Moreover, the use of FIFO (First In First Out) and FEFO (First Expired First Out) systems in food storage reflects improved food logistics management.

In terms of regulations/policies, portions, and recipe standards that were previously absent, are now implemented in both orphanages. This implementation aims to ensure consistency in food service and fulfillment of the nutritional needs of the orphanage residents [14]. The interventions included training for food handlers and the provision of supporting equipment, such as PPE, blenders, dispensers, cabinets, racks, trash bins, and cleaning tools. Additionally, the increase in the number of food handlers, along with improvements in food quality and variety, supported enhancements in the food service system.

Food service process at Orphanage A and Orphanage B

1. Menu Patterns and Plate Waste Percentage at Orphanage A and Orphanage B

The intervention in the food service process at Orphanage A and Orphanage B aimed to complete the menu to meet the daily per-person meal budget allocation, in accordance with government regulations, set at IDR 30,000. The provided food ingredients were used to prepare daily menus tailored to the nutritional needs of the children in both orphanages. At Orphanage A, the intervention included one portion of animal-based dishes, 2 portions of plant-based dishes, fruit, and 1 snack per day. Meanwhile, at Orphanage B, the intervention consisted of 2 portions of animal-based dishes, two portions of plant-based dishes, fruit, and one snack per day. Table 4 shows the menu pattern and food service frequency before and after the intervention. The intervention increased the frequency of plant-based dishes, fruit, and snacks in both orphanages. The dietary pattern became more varied, contributing to improved nutrient intake among the children.

Table 4. Daily Menu Pattern and Plate Waste Percentage at Orphanage A and Orphanage B before and after the Intervention

Menu	Daily menu pattern				Plate waste percentage			
	Orphanage A		Orphanage B		Orphanage A		Orphanage B	
	Before	After	Before	After	Before	After	Before	After
Staple food	3x	3x	3x	3x	1%	6%	1%	0%
Animal-based dish	3x	3x	3x	3x	6%	6%	2%	0%
Plant-based dish	1x	2x	1x	2x	0%	11%	1%	0%
Vegetables	3x	3x	2x	3x	15%	11%	1%	0%
Fruit	1x	2x	1x	2x	0%	0%	0%	0%
Snacks	1x	2x	1x	2x	0%	0%	0%	0%

Source: Primary data, 2024

The increase in plate waste at Orphanage A, especially for staple food and plant-based dishes, was due to changes in food types that respondents less favored, such as switching from rice to noodles, yellow rice, and rice cakes. This aligns with the study of Appleton et al., which shows that taste, texture, and serving method affect food acceptability [15]. At Orphanage B, plate waste drastically dropped to zero after the intervention. The self-service method allowed children to take food in the desired portion, supporting other study findings that self-service can reduce food waste [16,17].

2. Macronutrient Intake

The macronutrient intake at Orphanage A and Orphanage B before and after the intervention is represented in Table 5. The intervention increased energy, protein, fat, and carbohydrate intake in both orphanages. These findings are in line with the study by Struszczak et al., which showed that high-energy and high-protein diet interventions significantly improved nutrient intake [18].

Table 5. Macronutrient Intake at Orphanage A and Orphanage B before and after the Intervention

Nutrient	Orphanage A		Orphanage B	
	Before	After	Before	After
Energy	84.5%	91.5%	69%	99%
Protein	98.0%	106.4%	76%	105%
Fat	90.8%	100.4%	66%	102%
Carbohydrates	67.4%	90.2%	65%	93%

3. Menu preference level

Menu preference increased after the intervention, especially for plant-based dishes (Table 6). This was due to more attractive menu variations, consistent with the study of Crixell et al., which showed that menu variety improves children's food preferences in orphanages [19].

Table 6. Percentage of Menu Preference at Orphanage A and Orphanage B before and after the Intervention

Menu	Appearance				Taste			
	Orphanage A		Orphanage B		Orphanage A		Orphanage B	
	Before	After	Before	After	Before	After	Before	After
Staple food	99%	99%	95%	94%	100%	100%	91%	94%
Animal-based dish	88%	90%	88%	90%	90%	90%	87%	93%
Plant-based dish	12%	57%	31%	81%	10%	60%	41%	84%
Vegetables	77%	78%	60%	74%	73%	75%	61%	79%
Fruit	95%	90%	95%	95%	100%	100%	100%	100%
Average	74%	83%	74%	87%	75%	85%	76%	90%

Control

Based on Table 7, there was a significant change in the implementation of monitoring and evaluation activities as a form of oversight in Orphanages A and B before and after the intervention.

Table 7. Monitoring and Evaluation Activities in Orphanage A and Orphanage B before and after the Intervention

	Before	After
Orphanage A	Not available	Available
Orphanage B	Not available	Available

Source: Primary data, 2024

Before the intervention, neither Orphanage A nor B had structured monitoring and evaluation activities. This indicates that there was previously no organized supervision system in place to control the quality of food service management. After the intervention, both orphanages began implementing regular monitoring and evaluation activities. These included assessing food taste, food quality, and the use of production factors, carried out periodically by orphanage administrators and external personnel.

The implementation of monitoring and evaluation is crucial to ensure the nutritional quality and safety of food are maintained. According to Chen et al., routine supervision in food service management can improve service quality and reduce the risk of foodborne illness from contamination [20]. Furthermore, these activities help identify areas that require improvement to ensure the optimal fulfillment of children's nutritional needs in orphanages.

Monitoring is not only focused on the technical aspects of food service but also includes the evaluation of kitchen work procedures, such as equipment cleanliness, kitchen sanitation, and compliance with standard operating procedures (SOPs) for food preparation. Another study showed that consistent monitoring contributes positively to improved kitchen efficiency and the quality of food produced [21]. Overall, the presence of monitoring and evaluation activities after the intervention in Orphanages A and B signifies a significant improvement in food service management, ultimately contributing to better nutritional and health outcomes for children in the orphanages.

Environment

The environmental conditions of food service operations in Orphanages A and B showed significant differences before and after the intervention. The physical kitchen environment plays a vital role in ensuring food safety and the efficiency of food processing.

Orphanage A

At Orphanage A, food service still used a temporary kitchen, with several issues that could have affected the quality of food provision. The kitchen workflow was not organized in a one-way direction, increasing the risk of cross-contamination between raw and cooked ingredients. Additionally, there was no adequate dish rack for maintaining utensil cleanliness. The existing ventilation was mainly blocked with wire mesh, which, although effective in preventing insect entry, hindered proper air circulation necessary for kitchen hygiene and comfort. This condition aligns with findings from Annashr et al., which reported that kitchens lacking unidirectional workflow and adequate air circulation are at higher risk for food contamination [22]. To uphold the strict hygiene and safety standards required throughout the food supply chain, it is essential to upgrade the kitchen layout and ventilation [23]. Therefore, improvements to the kitchen layout and ventilation systems are needed to enhance food safety at Orphanage A.

Orphanage B

Before the intervention, the kitchen at Orphanage B had several deficiencies, including an uncovered trash bin, no tiled flooring, no handwashing sink, and no cabinet for storing cooked food. These conditions posed hygiene and food safety risks. Following the intervention, significant improvements were made in Orphanage B's kitchen. The kitchen was equipped with tiled flooring for easy cleaning, a dedicated cabinet for storing cooked food, a fire extinguisher (APAR) for safety, a handwashing sink to support hygiene practices, and a covered trash bin to reduce the risk of contamination from exposed waste. These improvements help the study by Bulochova et al., which found that adequate kitchen facilities can enhance food service quality and reduce the risk of contamination [24].

Outcome

Based on Table 8, the nutritional status of respondents in Orphanage A before the intervention was mainly well-nourished (60%) for those under 18, while for those over 18, the majority were mildly overweight (43%). After the intervention, the proportion of adolescents under 18 with good nutritional status increased to 66%. For those over 18, the mildly overweight category decreased from 43% to 14%, while the normal nutritional status increased to 57%. This suggests an improvement in dietary patterns following the intervention. In Orphanage B, the nutritional status across all age groups mainly remained in the well-nourished category (78%) both before and after the intervention, indicating that the intervention helped maintain an already good nutritional status.

Table 8. Nutritional Status of Respondents in Orphanage A and Orphanage B before and after the Intervention

BMI-for-age (<18 years)					**BMI (>18 years)**				
Category	**Orphanage A**		**Orphanage B**		**Category**	**Orphanage A**		**Orphanage A**	
	Before	**After**	**Before**	**After**		**Before**	**After**	**Before**	**After**
Severely malnourished	1 (7%)	1 (7%)	0	0	Severely thin	0	0	0	0
Underweight	2 (13%)	1 (7%)	0	0	Mildly thin	1 (14%)	0	0	0

Well-nourished	9 (60%)	10 (66%)	14 (78%)	14 (78%)	Normal	2 (29%)	4 (57%)	1 (100%)	1 (100%)
Overweight	2 (13%)	2 (13%)	4 (22%)	4 (22%)	Mildly overweight	3 (43%)	1 (14%)	0	0
Obese	1 (7%)	1 (7%)	1 (4%)	1 (4%)	Severely overweight	1 (14%)	2 (29%)	0	0

Source: Primary Data, 2024

Based on Table 9, there was a decrease in the percentage of normal hemoglobin (Hb) levels among adolescent girls in Orphanage A after the intervention, from 75% to 25%. This decline may have been caused by increased physical activity during internships/fieldwork and menstruation at the time of Hb measurement. Arini et al. showed that intense physical activity can lead to decreased Hb levels among adolescent girls [25]. Additionally, Cahyani and Sulastri found that menstruation significantly contributes to Hb reduction, particularly among adolescent girls with inadequate iron intake [26]. In contrast, no change occurred in Orphanage B, where Hb levels remained at 100% normal before and after the intervention. This indicates that risk factors affecting Hb levels in Orphanage A were not present in Orphanage B.

Table 9. Hemoglobin (Hb) Levels of Adolescent Girls in Orphanage A and B before and after the Intervention

Orphanage	Before	After
A	75% (Normal)	25% (Normal)
B	100% (Normal)	100% (Normal)

Implementation of Food Service Management Standards in Orphanage A and B

The application of food service management standard assessments in Orphanage A and Orphanage B before and after the intervention is shown in Table 10.

Table 10. Score of Food Service Management Standard Implementation in Orphanage A and B before and after the Intervention

No.	Description	Max. Score	Orphanage A		Orphanage B	
			Before	After	Before	After
1.	Input (Labor)	6	2	5	2	5
2.	Input (Cost)	3	3	3	2	3
3.	Input (Materials)	9	6	8	6	8
4.	Input (Method)	5	2	4	1	4
5.	Process	15	5	10	3	9
6.	Output	25	20	25	18	25
7.	Control	5	2	2	1	3
8.	Environment	17	8	9	13	13
9.	Outcome	15	7	11	15	13
	Total Score	100	55	77	58	85

Source: Primary data, 2024

Based on the analysis of food service management standards implementation in Orphanages A and B, there was a noticeable increase in scores after the intervention. In Orphanage A, the score improved from 55 to 77, while Orphanage B saw an increase from 58 to 85. These improvements were due to various interventions, including adding food handlers, training food handlers, meeting food material needs (animal-based dishes, plant-based dishes, fruit, and snacks), and providing support infrastructure such as aprons, head coverings, covered trash bins, and cleaning tools. Additionally, efforts by the orphanages to meet sanitation standards, such as installing handwashing sinks, also contributed to this progress.

Analysis of the Effect of Food Service Management Standards Implementation on Output

1. Preference Level

Based on the analysis (Table 11), the implementation of food service management standards had a significant effect on the preference level for plant-based dishes in Orphanage A ($p = 0.004$) and Orphanage B ($p = 0.008$). Before the intervention, plant-based dishes were not routinely served and lacked variety. The intervention involved providing a wider range of plant-based dishes, which increased residents' preference for this food type. Meanwhile, no significant effects were observed for staple foods, animal-based dishes, vegetables, or fruits in either orphanage.

Table 11. Results of Analysis on the Effect of Food Service Management Standards Implementation on Output (Preference Level)

	Orphanage A (*p*-value)	**Orphanage B (*p*-value)**
Staple food	1.000	0.371
Animal protein	1.000	1.000
Plant protein	0.004	0.008
Vegetables	0.317	0.059
Fruits	1.000	0.157

Source: Primary data, 2024

2. Nutrient Intake

The implementation of food service management standards also affected nutrient intake (Table 12). In Orphanage A, there was a significant effect on protein ($p = 0.019$), fat ($p = 0.006$), and carbohydrate ($p = 0.001$) intake, but not on energy intake ($p = 0.108$). In contrast, in Orphanage B, the implementation significantly affected all intake parameters—energy, protein, fat, and carbohydrates ($p = 0.001$). This increase in intake was due to the provision of animal- and plant-based dishes as protein sources, the use of cooking methods such as sautéing and frying, which increased fat intake, and the provision of fruit and snacks, which boosted carbohydrate intake.

Table 12. Results of Analysis on the Effect of Food Service Management Standards Implementation on Output (Nutrient Intake)

	Orphanage A (*p*-value)	**Orphanage B (*p*-value)**
Energy	0.108	0.001
Protein	0.019	0.001
Fat	0.006	0.001
Carbohydrates	0.001	0.001

Source: Primary data, 2024

Analysis of the Effect of Food Service Management Standards Implementation on Outcome

1. Hemoglobin (Hb) Levels

The analysis results (Table 13) show that the implementation of food service management standards did not significantly affect hemoglobin (Hb) levels in Orphanage A (p = 0.715) or Orphanage B (p = 0.231). Several factors influenced this outcome, including the menstrual cycle, fatigue during measurement, and non-compliance with iron tablet (TTD) intake due to reasons such as forgetfulness or nausea. Additionally, the intake of anti-nutritional substances, such as tannins in tea, can inhibit iron absorption, thereby affecting Hb levels.

Table 13. Results of Analysis on the Effect of Food Service Management Standards Implementation on Outcome (Hb levels)

Orphanage	Hb levels (*p*-value)
A	0.715
B	0.231

Source: Primary data, 2024

2. Nutritional Status

According to Table 14, the implementation of food service management standards significantly affected nutritional status in Orphanage A (p = 0.012), but not in Orphanage B (p = 0.198). In Orphanage A, the implementation improved nutritional status, as reflected in weight and height gains, indicating increased adequate intake. Some adolescents who were previously undernourished improved to good nutritional status. In contrast, Orphanage B showed no significant changes in nutritional status, indicating a balance between nutrient intake and energy expenditure from physical activity.

Table 14. Results of Analysis on the Effect of Food Service Management Standards Implementation on Outcome (Nutritional Status)

Orphanage	Hb levels (*p*-value)
A	0.012
B	0.198

Source: Primary data, 2024

In Orphanage A, the intervention led to measurable improvements in weight and height, shifting some participants from undernutrition to normal nutritional status, likely due to enhanced dietary intake from more balanced, varied meals [27]. In contrast, Orphanage B showed no significant change, possibly due to an already stable baseline nutritional status and a younger age group whose growth may not yet reflect in standard indicators [28,29]. Differences in physical activity levels may also have influenced outcomes, as higher energy expenditure could offset nutritional gains [30]. These findings highlight the need for nutrition interventions to be tailored to individual and contextual factors—including age, activity, and baseline health—and supported by multi-sectoral strategies such as education, health integration, and regular monitoring to optimize and sustain nutritional improvements.

Conclusion

This study concludes that the application of standardized food management, encompassing components such as input, process, control,

environment, and outcome, can significantly improve the quality of food service in orphanages. The intervention led to enhanced menu planning, increased macronutrient intake, improved food acceptability, and better adherence to hygiene and safety standards. In Orphanage A, these improvements translated into measurable gains in nutritional status, while Orphanage B maintained its already favorable status. Although changes in hemoglobin levels were not statistically significant, the intervention highlighted the importance of integrating nutrition programs with regular health monitoring and behavior-based strategies. Overall, implementing standardized food management practices is essential to ensuring adequate nutrition, promoting child health, and supporting optimal growth and development in institutional care settings.

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Conflicts of Interest

All the authors declare that there are no conflicts of interest.

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Macrolide Resistance Among Group B Streptococcus Isolated from Clinical Samples In and Around Kanchipuram

Evangeline Pretty Gnanamani[1*], Sivasankari Selvaraj[2], Senthamarai Srinivasan[2], Arumugam Suresh[2], Kamalraj Mohan[2], Akila Krishnamoorthy[2], Subha Vajiravelu Jaganath[2], Anitha Srinivasagalu[2], Ambuja Sekhar[2], Sijimol Shanmugam[2]

[1]Department of Microbiology, Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy of Higher Education and Research, Kanchipuram, Tamil Nadu, India.

[2] Central Research Laboratory, Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy of Higher Education and Research, Kanchipuram, Tamil Nadu, India.

Abstract

Streptococcus agalactiae (Group B Streptococcus, GBS) remains a significant cause of invasive infections, particularly in pregnant women, neonates, and immunocompromised individuals. Rising resistance to macrolides and lincosamides, especially among penicillin-allergic patients, is a growing concern. This study aimed to determine the prevalence and patterns of macrolide resistance in clinical GBS isolates, evaluate inducible clindamycin resistance, and assess associated demographic and clinical variables in a tertiary care setting in South India. A cross-sectional study was conducted at Meenakshi Medical College Hospital and Research Institute, Kanchipuram, from January 2023 to June 2024. A total of 600 clinical samples—including high vaginal swabs, urine, pus, blood, and cerebrospinal fluid—were processed. GBS isolates were identified using standard microbiological and automated methods. Antimicrobial susceptibility testing was performed according to CLSI 2023 guidelines, and inducible clindamycin resistance was detected using the D-zone test. GBS was isolated from 130 samples (21.7%), predominantly from females (78.5%) and high vaginal swabs (32.4%). All isolates were susceptible to penicillin, vancomycin, and linezolid. Resistance to erythromycin and clindamycin was observed in 43.1% and 37.7% of isolates, respectively. Among erythromycin-resistant strains, the M phenotype was most prevalent (39.3%), followed by inducible MLSB (32.1%) and constitutive MLSB (25.0%). No significant associations were found with age, sex, or specimen type. These findings underscore the need for routine susceptibility testing and support penicillin as the first-line therapy.

Keywords: *Antimicrobial Susceptibility, Group B Streptococcus, Inducible Clindamycin Resistance, Macrolide Resistance, South India, Streptococcus Agalactiae.*

Introduction

Group B *Streptococcus* (*Streptococcus agalactiae*) is a β-hemolytic, Gram-positive bacterium that has emerged as a significant cause of morbidity and mortality, particularly in neonates, pregnant women, and immunocompromised individuals. While often part of the commensal flora of the gastrointestinal and genitourinary tracts, GBS can transition into a pathogen under certain conditions, causing invasive diseases such as sepsis, meningitis, endometritis, and urinary tract infections [1, 2]. Notably, the vertical transmission of GBS from colonized mothers to

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****Corresponding Author: evapretty.rpg98@gmail.com***

neonates during delivery remains a major public health concern globally.

Penicillin remains the antibiotic of choice for prophylaxis and treatment of GBS infections. However, in penicillin-allergic individuals—especially those at high risk of anaphylaxis—macrolides such as erythromycin and lincosamides like clindamycin are commonly used as alternative agents [3, 4]. This shift has led to the increasing reliance on macrolides and subsequent reports of rising macrolide resistance in clinical GBS isolates. The trend poses serious implications for the effective management of GBS infections, particularly in resource-limited settings where sensitivity-guided therapy may not be routinely available [5].

Global surveillance has shown significant geographical variation in macrolide and clindamycin resistance among GBS strains. Studies from North America and Europe have documented macrolide resistance rates ranging from 10% to over 50% depending on the population and healthcare setting [6]. In Asian countries, including India, resistance rates are also on the rise, with several recent investigations highlighting clindamycin and erythromycin resistance levels between 30% and 60% among GBS isolates from pregnant women and neonates [7–9]. Such trends threaten the efficacy of second-line therapeutic options and complicate the prophylactic strategies currently recommended by the CDC and other health bodies [10].

In addition to intrinsic resistance mechanisms, the phenomenon of **inducible clindamycin resistance**—detectable only via the D-test—further complicates the antimicrobial landscape. Isolates may appear susceptible to clindamycin during routine testing but demonstrate resistance when exposed to erythromycin, leading to potential treatment failure if not properly detected [11]. Therefore, D-zone testing has become an essential component of clinical microbiology workflows when evaluating GBS susceptibility patterns.

Compounding this issue is the emergence of **multi-drug resistance (MDR)** among GBS strains. While resistance to penicillin remains rare, concurrent resistance to macrolides, tetracyclines, and fluoroquinolones has been increasingly reported, especially in isolates from hospital environments and high-risk populations [12]. These patterns underscore the necessity for localized antimicrobial stewardship strategies and periodic antibiogram updates to inform empiric therapy, particularly in regions with limited access to molecular diagnostic tools [13-15].

Despite these concerns, few studies have focused on the **epidemiological and clinical correlates** of macrolide resistance in GBS from Indian settings. Most available data are either limited to colonization studies in antenatal women or derive from isolated case series, thereby failing to capture the broader spectrum of GBS infections and resistance trends across age groups and clinical syndromes. A comprehensive understanding of demographic distribution, resistance prevalence, and co-resistance patterns is urgently needed to inform both preventive and therapeutic strategies.

Against this backdrop, the present study was undertaken with the following objectives: (i) to determine the prevalence of macrolide resistance among GBS isolates from various clinical samples; (ii) to evaluate the susceptibility pattern of GBS to commonly used antibiotics including erythromycin and clindamycin; (iii) to assess the incidence of inducible clindamycin resistance through D-test; and (iv) to analyze demographic and clinical characteristics associated with macrolide-resistant GBS infections. In addition, we sought to examine co-resistance trends, multi-drug resistance profiles, and temporal patterns of resistance, thereby generating data critical for revising local antimicrobial guidelines [16].

Understanding the prevalence and clinical implications of macrolide resistance in GBS is essential for guiding empiric therapy, especially in vulnerable populations such as pregnant women and neonates where treatment choices are limited. This study aims to fill critical gaps in regional surveillance data, promote awareness of emerging resistance trends, and contribute to the development of effective antimicrobial policies tailored to the needs of the local healthcare ecosystem.

Materials and Methods

Study Design and Setting

A cross-sectional observational study was conducted over a period of 18 months (January 2023 to June 2024) at the Central Research Laboratory, Meenakshi medical college hospital and research institute, in the Department of Microbiology. The study was approved by the Institutional Ethics Committee (Ref. No: CRL/IEC/2023/09), and all procedures were carried out following ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Sample Collection and Inclusion Criteria

Clinical samples were collected from both inpatients and outpatients presenting to the hospital with suspected bacterial infections. The study included a variety of sample types such as high vaginal swabs (HVS), urine, pus, blood, and cerebrospinal fluid (CSF). All patients with confirmed *Streptococcus agalactiae* infections were included, irrespective of age and sex. Repeat isolates from the same patient and those with incomplete clinical data were excluded.

Samples from pregnant women were specifically collected between 35–37 weeks of gestation as part of routine antenatal screening, following CDC guidelines for GBS colonization [1].

Isolation and Identification of GBS

Samples were processed using standard microbiological techniques. High vaginal and rectal swabs were inoculated onto selective media—5% sheep blood agar and Columbia CNA agar—and incubated at 35–37°C for 24–48 hours under 5% CO_2 (2). Colonies showing β-hemolysis were subjected to Gram staining, catalase test, and confirmed using the CAMP test and latex agglutination for Group B antigen (3). Identification was further validated using automated systems such as VITEK 2 Compact (bioMérieux, France), where applicable [13].

Antimicrobial Susceptibility Testing (AST)

Antibiotic susceptibility testing of GBS isolates was performed by the **Kirby-Bauer disk diffusion method** on Mueller–Hinton agar supplemented with 5% defibrinated sheep blood, following **CLSI guidelines** (2023) (4). The antibiotics tested included: Penicillin (10 units); Erythromycin (15 µg); Clindamycin (2 µg); Tetracycline (30 µg); Levofloxacin (5 µg); Linezolid (30 µg); Vancomycin (30 µg) [3-5, 14].

The minimum inhibitory concentrations (MICs) of penicillin, erythromycin, and clindamycin were determined using the **MIC gradient strip method** (Lingam Microbiological Laboratory) for selected resistant isolates [13].



Figure 1. Antibiotic susceptibility testing by disk diffusion method [14]

Detection of Inducible Clindamycin Resistance (D-test)

Inducible clindamycin resistance was identified in erythromycin-resistant, clindamycin-sensitive isolates using the D-zone test. Erythromycin and clindamycin discs were placed 15–20 mm apart on a blood agar plate inoculated with the test organism. Flattening of the clindamycin inhibition zone adjacent to the erythromycin disc (D-shaped zone) was interpreted as inducible resistance (iMLSB phenotype) (5).

Phenotypic Classification of Resistance Patterns

Based on the resistance profiles, isolates were categorized into the following phenotypes:

1. **M phenotype**: Resistance to erythromycin only, clindamycin sensitive, D-test negative.
2. **iMLS^{B}phenotype**: Resistance to erythromycin, susceptible to clindamycin, D-test positive.
3. **cMLS^{B}phenotype**: Resistance to both erythromycin and clindamycin, D-test positive or negative.
4. **L phenotype**: Isolated clindamycin resistance, erythromycin sensitive (rare).

Data Collection and Statistical Analysis

Clinical data, including patient demographics (age, sex), clinical diagnosis, inpatient/outpatient status, and comorbidities, were recorded. Data were compiled in Microsoft Excel and analyzed using **SPSS version 26.0** (IBM Corp., Armonk, NY).

1. Prevalence of macrolide resistance was calculated as a percentage of total GBS isolates.
2. Chi-square or Fisher's exact test was used to determine the association between resistance and clinical variables.
3. Trends in resistance over the study period were assessed using linear regression analysis.
4. A p-value <0.05 was considered statistically significant.

Quality Control

The reference strain *Streptococcus agalactiae* ATCC 12386 was used as a control for AST procedures. All media, reagents, and antibiotic discs were quality-checked according to the manufacturer's instructions.

Results

A total of 600 clinical specimens were processed for the isolation of Group B Streptococcus (GBS). The distribution of GBS isolates across various specimen types is presented in Table 1. Among the specimen types, high vaginal swabs (HVS) yielded the highest number of GBS isolates (n = 68), representing an isolation rate of 32.4%. Urine samples followed with a rate of 19.4% (n = 32), while pus, blood, and cerebrospinal fluid (CSF) samples showed lower rates of 15.5% (n = 17), 12.6% (n = 11), and 7.1% (n = 2), respectively. The overall isolation rate of GBS across all specimens was 21.7%, indicating a notable burden of colonization and infection, particularly in genitourinary and obstetric settings.

Table 1. Distribution of Clinical Specimens from Which Group B Streptococcus (GBS) Was Isolated.

Specimen Type	No. of Samples Collected (n)	No. of GBS Isolates (n)	Isolation Rate (%)
High Vaginal Swabs	210	68	32.4
Urine	165	32	19.4
Pus	110	17	15.5

Blood	87	11	12.6
CSF	28	2	7.1
Total	**600**	**130**	**21.7**

The highest isolation rate of GBS was observed in high vaginal swabs, followed by urine samples. This reflects the prevalence in pregnant women and urinary tract infections.

The demographic characteristics of patients from whom GBS was isolated are summarized in Table-2. Of the 130 patients, 78.5% were female (n = 102), and the majority of isolates were obtained from the 21–30 year (32.3%) and 31–40-year (27.7%) age groups, aligning with the reproductive age range typically targeted for antenatal screening. In terms of patient type, 63.1% were inpatients and 36.9% were outpatients, indicating a greater frequency of GBS detection in hospitalized individuals, potentially due to increased sampling and clinical indications.

Table 2. Demographic Distribution of Patients with GBS Isolates.

Variable	**Category**	**No. of Patients (n = 130)**	**Percentage (%)**
Sex	Female	102	78.5
	Male	28	21.5
Age Group (years)	<20	9	6.9
	21–30	42	32.3
	31–40	36	27.7
	41–50	21	16.2
	>50	22	16.9
Patient Type	Inpatient	82	63.1
	Outpatient	48	36.9

Most GBS isolates were from females aged 21–40 years, correlating with antenatal screening data.

The antimicrobial susceptibility profile of the 130 GBS isolates is depicted in Table 3. All isolates (100%) were uniformly sensitive to penicillin, linezolid, and vancomycin, underscoring the continued efficacy of these agents for GBS infections. However, significant resistance was observed against tetracycline (70.8%), erythromycin (43.1%), and clindamycin (37.7%), suggesting substantial resistance to macrolides and lincosamides. Levofloxacin remained broadly effective, with a sensitivity rate of 96.2%, though 2 isolates showed intermediate susceptibility and 3 were resistant.

Table 3. Antimicrobial Susceptibility Profile of GBS Isolates (n = 130).

Antibiotic	**Sensitive n (%)**	**Intermediate n (%)**	**Resistant n (%)**
Penicillin	130 (100)	0 (0)	0 (0)
Erythromycin	74 (56.9)	–	56 (43.1)
Clindamycin	81 (62.3)	–	49 (37.7)

Tetracycline	38 (29.2)	–	92 (70.8)
Levofloxacin	125 (96.2)	2 (1.5)	3 (2.3)
Linezolid	130 (100)	0 (0)	0 (0)
Vancomycin	130 (100)	0 (0)	0 (0)

High resistance was observed against tetracycline and macrolides (erythromycin and clindamycin), while all isolates remained susceptible to penicillin, vancomycin, and linezolid.

Further characterization of erythromycin-resistant isolates (n = 56) revealed distinct resistance phenotypes as detailed in Table 4. The M phenotype, indicative of an active efflux mechanism, was predominant (39.3%), followed by the iMLSB phenotype (32.1%), which shows inducible clindamycin resistance confirmed via D-test. The constitutive MLSB (cMLSB) phenotype, denoting resistance to both erythromycin and clindamycin, accounted for 25.0%, while the rare L phenotype (3.6%) exhibited isolated clindamycin resistance. The distribution of these resistance phenotypes provides insight into underlying genetic mechanisms and guides empirical treatment decisions.

Table 4. Distribution of Resistance Phenotypes Among Erythromycin-Resistant GBS Isolates (n = 56).

Phenotypic Pattern	**Description**	**No. of Isolates**	**Percentage (%)**
iMLSB	Inducible clindamycin resistance (D-test positive)	18	32.1
cMLSB	Constitutive resistance to erythromycin and clindamycin	14	25.0
M phenotype	Erythromycin resistant, clindamycin susceptible, D–test negative	22	39.3
L phenotype	Clindamycin resistant, erythromycin susceptible	2	3.6

The M phenotype was the most prevalent among macrolide-resistant isolates, indicating the presence of active efflux mechanisms.

The association between macrolide resistance and selected clinical and demographic variables is explored in Table 5. No statistically significant differences were observed when comparing resistance rates across sex, patient type (inpatient vs. outpatient), or sample source categories (HVS, urine, others), as determined by Chi-square analysis ($p > 0.05$ in all comparisons). This suggests that macrolide resistance is widespread and not confined to a specific demographic or clinical group within this study population.

Table 5. Association Between Resistance to Macrolides and Clinical Parameters.

Variable	**Category**	**Macrolide-Resistant (n = 56)**	**Macrolide-Sensitive (n = 74)**	**p-value**
Sex	Female	42	60	0.735
	Male	14	14	

Patient Type	Inpatient	37	45	0.812
	Outpatient	19	29	
Sample Type	HVS	31	37	0.401
	Urine	12	20	
	Others	13	17	

Statistical analysis using the Chi-square test revealed no significant association between macrolide resistance and the demographic or clinical parameters analyzed ($p > 0.05$).

Table 6 provides the Minimum Inhibitory Concentration (MIC) values for penicillin, erythromycin, and clindamycin. All isolates had low MICs for penicillin, with MIC50 and MIC90 values of 0.03 µg/mL and 0.06 µg/mL, respectively, consistent with full susceptibility. In contrast, erythromycin showed a broad MIC range (0.5–32 µg/mL), and an elevated MIC90 of 16 µg/mL, reflecting a substantial proportion of high-level resistance. Clindamycin displayed a MIC range of 0.06–8.0 µg/mL, with a MIC50 of 0.25 µg/mL and MIC90 of 4.0 µg/mL, consistent with moderate resistance levels.

Table 6. Summary of Minimum Inhibitory Concentration (MIC) Range and MIC50/MIC90 Values for Selected Antibiotics.

Antibiotic	**MIC Range (µg/mL)**	**MIC50 (µg/mL)**	**MIC90 (µg/mL)**
Penicillin	0.03 – 0.06	0.03	0.06
Erythromycin	0.5 – 32	2.0	16.0
Clindamycin	0.06 – 8.0	0.25	4.0

MIC50 and MIC90 represent the minimum inhibitory concentration required to inhibit 50% and 90% of isolates, respectively. Resistance to erythromycin was reflected by elevated MIC90 values.

Taken together, the findings highlight a concerning prevalence of resistance to macrolide and tetracycline antibiotics among GBS isolates, particularly in women of reproductive age, while maintaining full susceptibility to penicillin, vancomycin, and linezolid. The detection of multiple resistance phenotypes among erythromycin-resistant isolates emphasizes the need for routine phenotypic characterization and susceptibility testing to inform optimal treatment regimens.

This study provides critical insight into the antimicrobial susceptibility patterns and macrolide resistance phenotypes of Group B Streptococcus (GBS) isolates recovered from clinical specimens in and around a tertiary care setting in South India. The results align with global observations in some respects while diverging significantly in others, particularly regarding resistance to alternative antibiotics like erythromycin and clindamycin. These discrepancies highlight the importance of local epidemiological surveillance to guide empirical therapy and prophylactic protocols.

Discussion

GBS isolates in this investigation retained complete susceptibility to beta-lactam antibiotics such as penicillin, as well as to vancomycin and linezolid. This mirrors long-standing global findings; penicillin has remained universally effective against GBS for decades. For example, a large-scale, longitudinal study conducted by the CDC (Centers for Disease Control and Prevention) reported no penicillin resistance among GBS

isolates over a 20-year period [1-5]. Likewise, more recent surveillance from a tertiary care hospital in South India confirmed that all invasive GBS isolates were penicillin susceptible [1]. These consistent findings reinforce current guidelines, which continue to recommend penicillin or ampicillin as the first-line treatment for GBS infections [6].

However, emerging reports of penicillin non-susceptibility are not entirely absent. For instance, one Indian study by McGuire et al. (2025) cited up to 27% penicillin resistance based on altered penicillin-binding protein profiles. Although our study did not encounter any such resistant strains, the existence of these anomalies should serve as a cautionary note. They emphasize the need for vigilant monitoring and confirmatory testing using MIC methods, especially in high-risk or treatment-failure cases [10].

Our findings indicate an alarming rate of resistance to erythromycin (43.1%) and clindamycin (37.7%) [17, 18]. These figures are significantly elevated compared to earlier Indian studies, which reported erythromycin resistance in the range of 20–30% [19, 20]. In global contexts, studies conducted in Saudi Arabia [21] and China [22] have reported erythromycin resistance rates ranging from 25% to over 75%, reflecting wide geographical variation in antibiotic usage patterns and selective pressure.

The implications of this resistance are particularly severe for penicillin-allergic individuals, for whom erythromycin and clindamycin have traditionally served as alternative prophylactic and therapeutic options. The current findings suggest that reliance on these agents without routine susceptibility testing may lead to treatment failure, especially in intrapartum prophylaxis scenarios.

Phenotypic characterization revealed that among erythromycin-resistant isolates, the most prevalent resistance phenotype was M-type (39.3%), followed by inducible MLSB (iMLSB, 32.1%) and constitutive MLSB (cMLSB, 25%). These findings align with those of Aldawsari et al. (2023), who also reported a predominance of the M phenotype among erythromycin-resistant GBS isolates. The M phenotype, typically associated with the *mefA/E* genes, is mediated by efflux pumps and generally does not confer resistance to clindamycin. However, iMLSB phenotypes, caused by *erm* genes, can result in therapeutic failure due to the ability to induce resistance during treatment.

The identification of iMLSB phenotypes underscores the necessity of performing D-zone testing alongside routine susceptibility profiling. Studies from Korea and Japan have emphasized that failure to detect inducible clindamycin resistance can lead to serious clinical consequences, particularly in neonatal sepsis and postpartum infections [20, 21]. Therefore, D-zone testing should be integrated into routine laboratory practice, especially in regions where macrolide resistance is rising.

The exceptionally high resistance to tetracycline (70.8%) observed in our study aligns with both national and international findings. Tetracycline resistance in GBS is often stable and genetically mediated through the *tetM*, *tetO*, or *tetL* genes, which encode ribosomal protection proteins or efflux pumps [10]. A pan-European study found tetracycline resistance rates exceeding 80%, reinforcing the notion that this antibiotic class has limited clinical relevance in GBS management today [15]. While not commonly used for GBS treatment, tetracycline resistance serves as a proxy for horizontal gene transfer and overall resistance gene burden within the GBS genome. It may also signal increased selective pressure in community-acquired strains. Thus, tetracycline resistance data, although perhaps not directly impacting therapeutic choice, remains crucial from an epidemiological and surveillance perspective.

The elevated MIC90 values for erythromycin (16 µg/mL) and clindamycin (4

µg/mL) observed in this study support phenotypic findings. These high MIC values are indicative of clinically significant resistance and correlate with reduced efficacy, especially in systemic or deep-seated infections. A Chinese multicenter study similarly reported MIC90 values >8 µg/mL for erythromycin, which were associated with higher rates of treatment failure in neonatal meningitis.

The MIC data substantiate the clinical imperative for routine susceptibility testing rather than reliance on empirical macrolide therapy, particularly in penicillin-allergic cases.

Statistical analysis showed no significant association between resistance phenotypes and patient demographics such as sex, age, or sample type. This finding supports the hypothesis that macrolide resistance is widespread and likely due to community-level antibiotic exposure rather than localized nosocomial transmission. A study from Brazil [21] reached similar conclusions, suggesting that clonal expansion of resistant GBS strains in the community may be a primary driver of observed patterns.

These findings have several important clinical and public health implications. First, they emphasize the critical need to maintain penicillin as the cornerstone of GBS prophylaxis and therapy, supported by susceptibility confirmation in high-risk scenarios. Second, they advocate for the incorporation of D-zone testing and routine erythromycin/clindamycin susceptibility profiling, especially for obstetric patients. Third, they underscore the importance of local epidemiological surveillance to monitor evolving resistance trends.

In the future, whole-genome sequencing (WGS) and molecular resistance gene profiling should be considered to unravel the clonal relationships and resistance mechanisms in GBS isolates. Moreover, with vaccine candidates against GBS advancing to late-stage trials, such as the hexavalent GBS polysaccharide conjugate vaccine [21], there is hope for long-term preventive strategies, particularly for pregnant women and neonates.

Conclusion

Our study highlights the importance of routine antibiotic susceptibility testing for beta hemolytic streptococci as well as detection of inducible resistance to prevent therapeutic failure. Inducible clindamycin resistance should be included in the routine antimicrobial susceptibility testing. Extensive use and over usage of antibiotics has been the reason for emergence of antibiotic resistance which is a global concern and this has now emphasized the importance of antibiotic resistance monitoring.

Conflicts of Interest

There isn’t any conflicts of interest in this study.

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Evaluation The Correlation between Bmal1 and Clock Genes Expression with miRNA In kids With Bipolar Disorder

Zahra J. Ramadan[1], Owayes M. Hamed[1*], Elham kh. Abdullah[2]
[1]*Department of Biology, College of Science, University of Mosul, Mosul, Iraq*
[2]*Collage of Medicine, University of Ninevah, Mosul, Iraq*

Abstract

The study aimed to explore the influence of methylation levels of two clock genes, Bmal1 and Clock, and the association between gene expression and miRNA molecules (miRNA155 and miRNA211) in bipolar disorder. The study sample contains 40 kids whose ages ranged from 2 to 12 years with bipolar disorders, and 20 healthy kids as a control group. The study axes were divided into three parts. The first part involved determining the levels of gene expression for the Bmal1 and Clock genes using qRT-PCR. The second part is the determination of the levels of miRNA and snoRNA molecules that regulate Bmal1 and Clock genes using qRT-PCR. Third part: measuring methylation levels in the promoters of Bmal1 and clock genes using PCR. The results showed a significant decrease in the Bmal1 gene expression; it was the value of folding expression Bmal1 gene = 0.73, and a significant increase in the Clock gene; it was the value of folding expression Clock gene = 1.23. and the results showed a significant increase in miRNA gene expression; the value of folding expression for miRNA155/Bmal1 = 1.76, and a significant decrease in miRNA gene expression; the value of folding expression for miRNA211/Clock = 0.26. while the gene expression level for snoRNA molecule = 1.76 compared with control = 1. Conclusion: The results of this study demonstrate increases in the gene expression folding of the Clock gene and a significant decrease in miRNA211 gene expression which regulates the Clock gene.

Keywords: *Bmal1 gene, Clock gene, miRNA, mRNA, snoRNA and Methylation.*

Introduction

Circadian rhythms are generated through oscillatory physiological processes and couple biological function to the 24 h light-dark cycle. The original sensitivity to light mediates this synchronization [1]. Light-dark cues modify circadian rhythms by triggering an internal signaling cascade that includes several endogenously produced molecules, including proteins and neurotransmitters. These molecules can then create a signaling flood of their own, which may increase the initial light-dark cue [2]. Howbeit, because the participation of a wide diversity of signaling flood and their particular components, According to recent research, the transcriptional/translational feedback loops of many clock genes, inclusive of Period (Per) 1-3, form the circadian clock system, Cryptochrome (Cry) 1–2, Clock (circadian locomotor output cycles kaput), BMAL1 (brain and muscle aryl hydrocarbon receptor nuclear translocator–like protein 1), and Casein Kinase I epsilon (CKIε) [3]. Circadian rhythmicity is an essential biological characteristic that has recently accumulated greater interest in neuroscience and psychiatry [4]. On the other hand, it might be possible to predict future diseases if the causative

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****Corresponding Author: owsbio31@uomosul.edu.iq***

miRNAs and clock genes general to patients with bipolar disorder and patients with severe diseases could be identified [5]. Studies on circadian rhythm bipolar disorders, in the line of epigenetic research, have exposed the pathogenic mechanisms of a rising number of diseases, which have expedited the evolution of new diagnostic and therapeutic applications in recent years [6]. It has been given that endogenous operators, such as malfunctions of the circadian clock and its entrainment acquired by disorders of the brainstem and/or hypothalamus, and exogenous operators, such as psychological tension, extreme light at night, and shortage of light through the day, are the cause of these bipolar disorders [7]. Also, a variety of operators may participate to circadian rhythm bipolar disorders [8-9]. Even though they work to adapt to social situations, patients with circadian rhythm bipolar disorders have defects with social problems like tardiness, absence, truancy, and withdrawal [10-11]. First epigenetic process occurs through many non-coding RNAs, which are very efficient in biological systems and compensate for their disability to be translated into proteins through alternative mechanisms [12-13]. Another epigenetic process is methylation, which is one of the most commonly studied and dominant epigenetic modifications. In contrast to other mechanisms (such as histone modification), it is highly stable and can be transmitted from parents to offspring [14]. DNA methylation profiling and epigenetic marking technologies can be used to detect and demonstrate differences in DNA methylation between patients and healthy controls, and thus to discuss the molecular biological mechanisms of disease evolution [15]. Therefore, some studies have been conducted to explore the possible roles of DNA methylation in bipolar disorder by using different designs or methods [16]. Inclusive of global DNA methylation, genome-wide DNA methylation, and site-specific/regional DNA methylation profiling, DNA methylation-related multi-omics data integration analysis and DNA methylation-related experiments [17].

Many recent research fields show that miRNAs also regulate clock components. The Period genes, Per1, Per2 and Per3, which are controlled in mammals by popular miRNAs, such as miR-24 [15]. Further, Per2 is likely to be controlled by miR-449a [18]. In addition, the studies display that Per3 is regulated by miR-103, moreover the rhythmic expression of miR-27b-3p and miR-155 performed a role in maintaining the rhythmic expression of Bmal1 mRNA and protein levels. Furthermore, miR-211 directly controlles Bmal1 and Clock by special mechanisms [19].

However, some snoRNAs act as RNA protect in pre-rRNA maturation, not as evidence for RNA modulation [20]. snoRNAs were first found in the 1960s during studies on ribosome biogenesis [21]. Further research detected that snoRNAs are contribute in modulate other types of RNA and widly role in RNA processing and the controlling of gene expression [22].

Materials and Methods

Case study: The current study included (40) male children suffering from bipolar disorder and (20) healthy male children who do not suffer from any problems and in the same age group, ranging from (2-12) years, who visited the “Rufaidah Medical Clinic” in a period of (3 months)

Blood sample collection and storage:(5.0) ml of venous blood was drawn from children with bipolar disorder and was divided into three parts:

1. The first part was placed in 1.5 ml Eppendorf tubes pre-filled with 750 µl Trizol for mRNA and non-coding RNA extraction.
2. The second part was placed in tubes containing an anticoagulant EDTA for DNA extraction for DNA Methylation test.

The gene expression levels of circadian rhythm genes, miRNAs, and snoRNAs were analyzed using qPCR.

RNA and non-coding RNA Extraction: Mixing 250 ml of the blood sample with 750 ml of Trizol solution, then using an RNA extraction kit supplied by the Transgenbiotech company, and then using a Nanodrop device to measure the purity of the extracted RNA.

Detecting the Gene Expression Levels for mRNA Molecules of Circadian Rhythm Genes by using the qPCR Technique

Specific primers of circadian rhythm genes and housekeeping gene used to detect the gene expression levels of mRNA molecules for circadian rhythm genes by Quantitative PCR as shown in Table 1:

Table 1. Primers of circadian rhythm genes and housekeeping gene for mRNA molecules:

Primer	Sequence
BMAL1-RT-F	GCCTACTATCAGGCCAGGCTCA
BMAL1-RT-R	AGCCATTGCTGCCTCATCATTAC
Clock-RT-F	TTGGCAAAATGTCATGAGCAC
Clock-RT-R	TTGCCCCTTAGTCAGGAACCT
PER1-RT-F	GGACACTCCTGCGACCAGGTACTG
PER1-RT-R	GGCAGAGAGGCCACCACGGAT
PER2-RT-F	CGCAGGGTGCGCTCGTTTGA
PER2-RT-R	GGGCTCTGGAACGAAGCTTTCG
PER3-RT-F	GGTCGGGCATAAGCCAATG
PER3-RT-R	GTGTTTAAATTCTTCCGAGGTCAAA
H.K-F	TGACCCAGATCATGTTTGAG
H.K-R	CGTACAGGGATAGCACAG

Detection the Gene Expression Levels for micRNA Molecules and snoRNA of Circadian Rhythm Genes by using the qPCR Technique

Specific primers of micRNA and snoRNA molecules (which regulated the circadian rhythm genes) and housekeeping gene used to detect the gene expression levels of micRNA and snoRNA molecules for circadian rhythm genes by Quantitative PCR as shown in the table (2):

Table 2. Primers of micRNA and snoRNA molecules and the housekeeping gene

micRNA	specific gene	Primers Sequence
micRNA 155 -F	Bmal1 gene	AAGCGACCTTAATGCTAATCGTGAT
micRNA 211 -F	Clock Gene	AACACGTGTTCCCTTTGTCATCC
micRNA 24 -F	Per1 Gene	AACACGTGTGCCTACTGAGCT
micRNA 449a-F	Per2 Gene	AACACGCTGGCAGTGTATTGTTAG
micRNA 103 -F	Per3 Gene	AACAAGAGCAGCATTGTACAGGG
snoRNA21 -F	All genes	AGCAGTCAGTAGTTGGTCCTTTG
snoRNA21 -R	All genes	CCATCAGTCCCGTCTTGAAAC
U –R	All gene	CAGTGCAGGGTCCGAGGT
U6 –F	H.K	GTGCTCGCTTCGGCAGCA
U6 –R	H.K	CAAAATATGGAACGCTTC

Calculating Gene Expression Folding

The following equation was used to determine the gene expression folding of the genes under study depending on the target gene's CT value [23] :

Gene Expression folding = 2 ΔΔCT

DNA Extraction for methylation: DNA was isolated from the blood of all (60) samples contained in the study using the DNA extraction kit provided by Transgenbiotech company, and then a Nanodrop device was used to measure the purity of extracted DNA .

Methylation-specific PCR in Promoters of the Bmal1 and Clock Genes

Bmal1 and clock Genomic DNA methylation-specific PCR analysis was altered using sodium bisulfite, We created a pair of primers for methylation alleles in the Bmal1 and Clock genes. Primer pairs for detection of the methylated sequences in the promoter of Bmal1 and Clock are shown in Table (3) [6].

Table 3. Primers of Bmal and Clock genes for methylation reaction

Gene	Primer	Sequence	Annealing	Band size
Bmal1 gene	F	ACTACTTTCCTACCACCAATCATTTAAC	55	376bp
	R	TGAGATTTTGGTAAATTAGGGATTTT		
Clock gene	F	CCTAAAAACTCTTTAACTTTCCCCC	55	271bp
	R	TTTTTTTAGGAGATGGGAGAAGATG		

The Modified DNA was amplified in a total volume of 20 ml . After the Methyl ion-specific PCR program was done, the PCR products were then loaded and electrophoresed on 2% agarose gels, stained with red safe dye, and visualized under UV illumination.

Results

Measuring the gene expression level of circadian rhythm genes

The result of the study shows there are changes in the level of gene expression for Bmal1, Clock , PER1, PER2, and PER3 genes in the patients compared to the control group, as shown in the following tables.

Table 4. The values of CT and the level of gene expression for the Bmal1 gene and the housekeeping gene for patients with bipolar disorder compare with the control group

No.	CT. target	CT. H.K	ΔCT. Target	ΔCT. Control	ΔΔCT	Folding
Control	28.43	22.78	5.65	5.65	0	1
Patients	31.19	24.88	6.3	5.65	0.65	0.73

The results of study showed increase CT value of patients compared with CT value of control, also increase ΔCT value of patients compared with control, the gene expression folding of patients value was 0.73 compared with control value 1, this decrease caused decrease in *Bmal1* activity and this cause the bipolar disorder.

Table 5. The values of CT and the level of gene expression for the Clock gene and the housekeeping gene for patients with bipolar disorder compare with the control group

No.	CT. target	CT. H.K	ΔCT. Target	ΔCT. Control	ΔΔCT	Folding
Control	29.53	22.78	6.75	6.75	0	1
Patients	31.52	24.88	6.64	6.75	- 0.10	1.23

The results of study showed increase CT value of patients compared with CT value of control, also increase ΔCT value of control compared with patients, the gene expression

folding of patients value was 1.23 compared with control value 1, this increase caused increase in *clock* gene activity and participate in bipolar disorder developments.

Table 6. The value of CT and the gene expression level for the Per1 gene and the Housekeeping gene in children with bipolar disorder compared to the control group.

No.	CT. target	CT. H.K	ΔCT. Target	ΔCT. Control	ΔΔCT	Folding
Control	27.14	22.71	4.43	4.43	0	1
Patients	30.72	24.39	6.32	4.43	1.89	0.33

The results of study showed increase CT value of patients compared with CT value of control, also increase ΔCT value of patients compared with control, the gene expression folding of patients value was 0.33 compared with control value 1, this decrease caused decrease in *PER1* activity and represent the main reason for bipolar disorder development.

Table 7. The value of CT and the gene expression level for the Per2 gene and the Housekeeping gene in children with bipolar disorder compared to the control group.

No.	CT. target	CT. H.K	ΔCT. Target	ΔCT. Control	ΔΔCT	Folding
Control	30.31	22.71	7.6	7.6	0	1
Patients	30.70	24.39	6.31	7.6	- 1.28	1.76

The results of study showed increase CT value of patients compared with CT value of control, also decrease ΔCT value of patients compared with control, the gene expression folding of patients value was 1.76 compared with control value 1, this increase caused increase in *PER2* activity and represent the main cause for bipolar disorder development.

Table 8. The value of CT and the gene expression level for the Per3 gene and the Housekeeping gene in children with bipolar disorder compared to the control group.

No.	CT. target	CT. H.K	ΔCT. Target	ΔCT. Control	ΔΔCT	Folding
Control	31.71	22.71	9	9	0	1
Patients	32.35	24.39	7.96	9	- 1.04	1.58

The results of study showed increase CT value of patients compared with CT value of control, also decrease ΔCT value of patients compared with control, the gene expression folding of patients value was 1.58 compared with control value 1, this increase caused increase in *PER3* activity and represent the main reason for bipolar disorder development.

Measuring the Gene Expression Level of Non-coding RNA Regulate the Circadian Rhythm Genes

The result of the study shown there are change in the level of expression for mi-RNA and snoRNA that regulate the circadian rhythm genes in the patients compared within control group as shown in the following tables.

Table 9. The value of CT and the gene expression level for micRNA molecules and the Housekeeping gene in children with bipolar disorder compared to the control group.

micRNA molecules	Gene target	No.	CT. target	CT. H.K	ΔCT. Target	ΔCT. Control	ΔΔCT	Folding micRNA	Folding Target gene
micRNA 155	BMAL1 gene	Control	26.73	18.29	8.44	8.44	0	1	1
		Patients	25.22	18.06	7.15	8.44	- 1.28	1.76	0.73
micRNA 211	Clock gene	Control	26.71	18.76	7.95	7.95	0	1	1
		Patients	28.83	19.11	9.72	7.95	1.77	0.26	1.23

micRNA 24	PER1	Control	22.61	18.29	4.32	4.32	0	1	1
		Patients	24.65	18.06	6.62	4.32	2.30	0.41	0.33
micRNA 449a	PER2	Control	25.59	18.76	6.83	6.83	0	1	1
		Patients	28.24	19.11	9.13	6.83	2.30	0.20	1.76
micRNA 103	PER3	Control	15.13	18.29	- 3.16	- 3.16	0	1	1
		Patients	15.46	18.06	- 2.59	-3.16	0.59	0.56	1.58

The results of the study, as shown in figure (1), approved increase in the expression folding for miRNA155 in patients group, value was 1.76 as red column, this molecule will inhibit the expression of BMAL1 gene which value was 0.73, also show decrease in the expression folding for micRNA-211 in patients group, value was 0.26 as green column, this molecule will stimulate the expression of CLOCK gene which value was 1.23, and show decrease in the expression folding for micRNA-24 in patients group, value was 0.41 as purple column, this molecule will not show significant effect in the expression of PER1 gene which value was 0.33, and show decrease in the expression folding for micRNA-449a in patients group, value was 0.20 as blue column, this molecule will stimulate the expression of PER2 gene which value was 1.76, finally show decrease in the expression folding for micRNA-103 in patients group, value was 0.56 as blue column, this molecule will stimulate the expression of PER3 gene which value was 1.58.

Table 10. The values of CT and the level of gene expression for snoRNA and the housekeeping gene for patients with bipolar disorder compare with the control group

No.	CT. target	CT. H.K	ΔCT. Target	ΔCT. Control	ΔΔCT	Folding
Control	17.04	14.19	2.85	2.85	0	1
Patients	17.25	15.22	2.03	2.85	-0.82	1.76

The results of study showed increase CT value of patients compared with CT value of control, also decrease ΔCT value of patients compared with control, the gene expression folding of patients value was 1.76 compared with control value 1, this increase caused increase in genes activity for all genes and this represent the main reason for bipolar disorders development.

Results of Methylation-specific PCR for the Bmal1 and Clock Genes

The results of the test for the DNA methylation process in the promoter of the *Bmal1* and *Clock* gene, (100%) hyper-methylation in Bmal1 gene and (0%) no methylation in Clock gene, shown in the following Figures (1, 2).

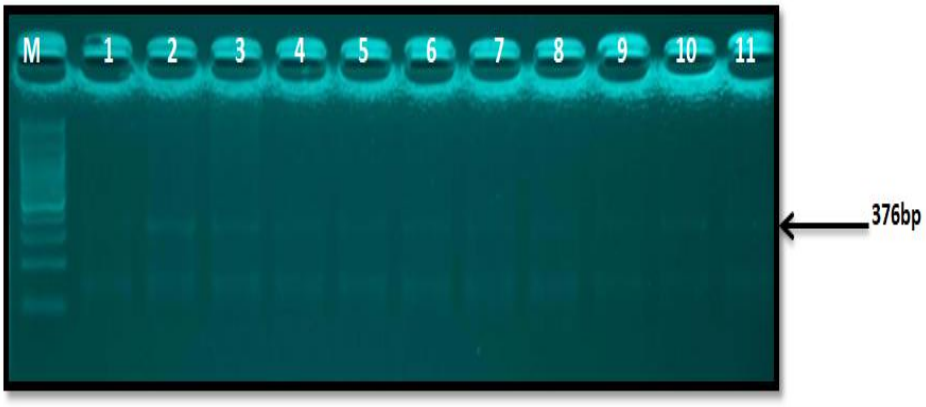


Figure 1. Results of Methylation-specific PCR reaction of Bmal1 gene



Figure 2. Results of Methylation-specific PCR reaction of Clock gene

Our results may provide a molecular basis for designing clinical protocols for Early diagnosis for bipolar disorders based on differences in the circadian clock between patient kids and healthy. On the hand, It has been shown that CpG methylation of promoter sequences, an epigenetic alteration, can inactivate promoter functions leading to dys-regulation and inhibition of gene expression, We further explored whether CpG methylation had occurred in the Bmal1 and Clock gene. The DNA methylation in the promoter of the Bmal1 gene was present in 100% of the samples and in the promoter of the Clock gene in 0% of the samples.

Discussion

The results of gene expression for circadian rhythm genes show significant changes in the level of folding expression, this variations could explain some phenotypic consequence, such as duration of sleep, waketime, addiction, insomnia, day preferences, etc. In our work, we noticed that the gene expression of BMAL1 gene were associated with sleep duration and waketime Heritability of sleep duration has been estimated as 46% of the variability and 44% for sleep quality. However, these values vary substantially with age, being less influential at younger ages. While the increase in expression of CLOCK gene will cause disruption in regulation of circadian rhythm genes and caused sleep disorder, on other hand, This cyclic process repeats, generating the characteristic oscillations of CLOCK and BMAL1 gene expression that underlie the circadian rhythm and the disruption in expression of CLOCK and BMAL1 genes will disruption this cyclic process and caused many disorders in sleep. By contrast, the variant in gene expression levels for period family genes approved comparable 24 h rhythmicity for PER1 gene under sleep/wake and stable routine sleep deprivation conditions, which agrees our information on PER1 gene expression. Also the daily expression of PER2 gene in whole blood cells in healthy men subjects. The peak phase of PER2 appeared in the early morning, while that of other circadian rhythm genes in the midnight. This study suggested that the keep under observation of PER2 gene in whole blood cells, which may be functionally necessary for the molecular control of the circadian pacemaker as well as in SCN, and be benefit to estimate internal synchronization.and the variant in PER3 gene expression correlated mental health and sleep disorder. In 2021, a study proved that PER3 expression strongly increase in ADHD group and the expression profile of circadian rhythm genes will variant in study samples. On other hand, many circadian-related miRNAs are change in both sleep disorders and neurodegenerative diseases, so these facts implicate that disruption in the expression of circadian miRNAs in individual with sleep disorder considered as biomarker for another mental disorder, in addition, control of the expression of miRNAs in the early stage of disease will be considered as treatment of mental disorders. Also the snoRNAs facilitate

modifications such as 2′-O-methylation, N-4-acetylation, and pseudouridylation, which impact not only ribosomal RNA (rRNA)andtheir synthesis but also different RNAs. The results of methylation process in promoter of BMAL1 and CLOCK gene approved that hyper methylation of BMAL1 gene will suprresed the expression of this gene and the hypomethylation of CLOCK gene will cause increase in xxpression level of this gene.

Conclusion

This studt suggested the mental disorders will related to disruption in gene expression for BMAL1, CLOCK, PER1, PER2 and PER3 genes and noncoding RNA molecules wich regulate the gene expression by stimulate or inhabite expression, also the epigenetic regulation by methylation at promoters of BMAL1 and CLOCK genes, all this factores coordinate the circadian rhythm genes and so cause mental disorders.

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Conflict of Interest

I hereby declare that I have no financial or commercial stake in any firm that the study described in the attached paper may have an impact on.

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The Role of Stigma in HIV Prevention: A Focused Analysis of PrEP Hesitancy in Guyana

Samuel Anthony Pellew*, Michael Anthony Tomori
Department of Public Health, Texila American University, Georgetown, Guyana

Abstract

Human immunodeficiency virus (HIV) remains a major global health challenge, responsible for more than 42.3 million deaths as of July 2024. Despite the proven efficacy of pre-exposure prophylaxis (PrEP), uptake in Guyana remains limited, particularly among high-risk populations. This mixed-methods study investigated barriers to PrEP uptake in Guyana, focusing on stigma. A total of 280 participants completed structured questionnaires and 10 took part in in-depth interviews. Quantitative data were analyzed descriptively to determine prevalence of awareness and barriers, while thematic analysis using NVivo was employed for qualitative data. Findings revealed that 60% of participants had considered PrEP; however, stigma (50%), lack of awareness (36%), affordability (32%), side-effect concerns (29%), and confidentiality fears (21%) emerged as key barriers. Stigma was consistently described in interviews as fear of being labeled promiscuous or HIV-positive, leading to reluctance to seek PrEP services. Younger participants and LGBTQ+ individuals reported higher stigma experiences. Integration of both strands demonstrated how stigma interacts with structural issues such as cost and clinic availability, creating cumulative deterrents. Recommendations include provider training, culturally sensitive anti-stigma campaigns, community outreach, and decentralized service delivery. These findings underscore the urgent need for Guyana to address stigma as part of national HIV prevention strategies and to achieve UNAIDS 95-95-95 targets. Limitations include reliance on convenience sampling and descriptive statistics, which may restrict representativeness and generalizability.

Keywords: *Guyana, HIV Prevention, PrEP, Public Health, Stigma, Uptake Barriers*

Introduction

Human immunodeficiency virus (HIV) remains one of the most significant global public health challenges, impacting millions of lives [1]. As of July 2024, an estimated 42.3 million people worldwide had died due to HIV-related illnesses, with over 630,000 additional deaths recorded in 2023 alone [2]. In Guyana, the epidemic continues to exact a substantial toll. In 2023, the national HIV prevalence rate among individuals aged 15 to 49 was approximately 1.6% [3]. An estimated 10,000 [7,500–15,000] adults and children were living with HIV, with more than 1,000 new infections reported that year [3].

In July 2012, the United States Food and Drug Administration approved PrEP. The two-drug oral combination is central to this approach: Emtricitabine/Tenofovir disoproxil fumarate (FTC/TDF), branded as Truvada®, and Emtricitabine/Tenofovir Alafenamide (FTC/TAF), branded as Descovy® [4]. In 2021, the World Health Organization (WHO) recommended the use of the Dapivirine ring as an additional prevention option for women at substantial risk of HIV. Additionally, in 2022, WHO endorsed the long-acting injectable

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****Corresponding Author: samuelpellew@gmail.com***

cabotegravir (CAB-LA) as another choice for people facing substantial HIV risk [4]. Ongoing research is also exploring other products, such as multipurpose prevention options that combine antiretroviral drugs with contraception, to expand the range of PrEP choices.

The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) have unequivocally endorsed PrEP as a powerful tool for preventing HIV transmission among high-risk individuals [5]. When taken consistently by HIV-negative individuals, the fixed-dose combinations of FTC/TDF or FTC/TAF can reduce the risk of acquiring the virus by up to 90% [6, 7].

To combat the spread of HIV, Guyana has promoted the use of PrEP—a biomedical prevention strategy that involves the daily use of antiretroviral medication by HIV-negative individuals at substantial risk of infection [8]. According to the World Health Organization and supporting literature, PrEP is up to 99% effective in preventing sexual transmission of HIV when taken consistently. Despite its proven efficacy, however, PrEP uptake in Guyana, particularly in Regions 3, 4, and 10, remains low [8].

In 2023, only 692 individuals accessed PrEP nationwide, a stark contrast to the estimated population at risk. This gap is not merely a matter of availability, but is deeply rooted in socio-cultural and structural barriers, foremost among them, stigma [9]. Stigma surrounding HIV, sexuality, and PrEP use impedes access by fueling fear, misinformation, and social judgment [9]. It affects not only key populations, such as men who have sex with men (MSM), transgender individuals, and sex workers, but also discourages the general population from seeking preventive care [9, 10].

This study explores the influence of stigma on PrEP hesitancy in Guyana. Drawing on a large-scale mixed-methods investigation, it examines the psychosocial and structural factors that inhibit PrEP uptake, with the aim of informing targeted, evidence-based interventions for improving HIV prevention outcomes.

Problem Statement

Despite the availability of PrEP in Guyana since 2015 and its high clinical efficacy, uptake remains disproportionately low, with only 692 individuals reported to be on PrEP in 2023. This gap between availability and use highlights a critical public health challenge, where stigma—rooted in fear of discrimination, association with HIV, and cultural misconceptions—remains an underexplored barrier to effective HIV prevention.

The objectives of the Study are to assess the extent of PrEP hesitancy among high-risk and general populations in Regions 3, 4, and 10 of Guyana. To identify the stigma-related and structural barriers influencing PrEP uptake. To analyze the meanings and perceptions of stigma from participants' lived experiences and to recommend evidence-based strategies to reduce stigma and improve PrEP accessibility.

Novelty of the Study

While previous research in Guyana has focused broadly on HIV prevention and treatment, few studies have specifically examined stigma as the central factor influencing PrEP hesitancy in both key and general populations. By combining quantitative and qualitative methods, this study offers novel, context-specific insights into how stigma operates at individual, community, and institutional levels. The findings provide practical recommendations for targeted policy, healthcare, and community-based interventions, thereby advancing both scientific understanding and public health practice in Guyana.

Materials and Methods

Study Site

The study was conducted in Guyana, with participants recruited from Regions 3, 4, and 10. These regions were selected due to their relatively high HIV prevalence and the availability of PrEP services across 24 healthcare facilities [11]. The sites represented a mix of regional hospitals and community health centres offering "Family Health Services," which provide HIV testing, care, and treatment, as well as management of other sexually transmitted infections (STIs). These facilities were strategically chosen because they serve both high-risk and general populations, ensuring diversity in participant recruitment and capturing the contextual realities of PrEP delivery within Guyana's public health system.

Study Design

A mixed-methods approach was employed, using an explanatory sequential design to capture both numerical and contextual data [12]. The study was conducted in two phases. The first phase involved quantitative data collection through structured questionnaires, followed by analysis. The second phase entailed qualitative interviews designed to provide in-depth insights into barriers and facilitators of PrEP uptake, informed by the quantitative findings. The mixed-methods approach enabled triangulation of data to ensure both breadth and depth of understanding.

Sampling and Recruitment

An explanatory sequential mixed-methods design was used. For the quantitative phase, convenience sampling was employed to recruit participants from the selected facilities, as this method allowed efficient access to individuals already engaged with healthcare services. Eligibility criteria included being 18 years or older, HIV-negative, and belonging either to the general population or to a high-risk group.

Operational Definition of High Risk. In this study, "high risk" referred to HIV-negative individuals who met one or more of the following criteria: men who have sex with men (MSM), transgender women, sex workers, persons in serodifferent partnerships, individuals with a history of bacterial sexually transmitted infections (STIs) in the past 12 months, those with multiple sexual partners in the past six months, individuals reporting inconsistent condom use, or persons engaging in transactional sex.

Individuals were excluded if they lived outside Regions 3, 4, or 10, were unable to provide informed consent, were under 18 years old, or had cognitive impairment. A total of 280 participants were successfully enrolled in the quantitative phase.

For the qualitative phase, purposeful sampling was applied to select a subset of participants from the survey cohort who could provide deeper insight into barriers and facilitators of PrEP uptake. Fifteen participants were invited to participate in interviews; however, data saturation was achieved at the 10th interview.

Data Collection Tools

In the quantitative phase, data were collected using a structured questionnaire that captured demographic characteristics, awareness of PrEP, prior use, and perceived barriers to uptake. The questionnaire was administered in English by trained research assistants and responses were entered into Microsoft Excel for analysis.

In the qualitative phase, semi-structured interview guides were used to explore participants' perceptions of stigma, personal and social experiences with PrEP, and recommendations for improving service delivery. Interviews were conducted in private settings within the health facilities or, where preferred, virtually through secure video conferencing platforms. Each interview lasted approximately 30–45 minutes. All interviews were transcribed verbatim and shared with

participants for verification (member checking).

Data Analysis

Quantitative data were analyzed using descriptive statistics, including frequencies and percentages, to summarize demographic characteristics, PrEP awareness, and barriers to uptake. Results were presented in Table 1 and Figure 1 to improve clarity. No inferential statistical tests were conducted, which limits the ability to determine associations between variables; this is acknowledged in the Limitations.

Qualitative data were analyzed using a six-step thematic analysis approach, guided by Braun and Clarke's framework [12]. Transcripts were first read repeatedly for familiarization, and initial codes were generated systematically. Codes were then grouped into broader themes, which were reviewed, refined, and defined in relation to the research questions. NVivo software was used to support data management and coding.

Trustworthiness and Reflexivity. To enhance credibility, transcripts were returned to participants for verification. An audit trail, including coding logs and analytic memos, was maintained to support dependability. The researcher used reflexive journaling to document assumptions and decision-making processes. Peer debriefing with a senior qualitative researcher was also conducted to reduce single-researcher bias and strengthen confirmability.

Data Saturation. For the qualitative phase, saturation was defined as the point at which two consecutive interviews yielded no new codes or themes. This threshold was reached after the 10th interview, indicating that additional interviews were unlikely to generate novel insights.

Results

Demographic Characteristics

In the quantitative phase, the demographic data collected included health facility/ treatment site, age of the participant, gender, sex orientation, region where PrEP services were provided, marital status, level of education, and employment status. However, for confidentiality reasons, data on health facilities or sites where PrEP services were accessed will not be included. The majority of the individuals involved in the study were aged 18 to 30 years (n = 178, 64%). Followed by individuals aged between 31 to 60 years old (n = 57, 20%), 61 to 80 years old (n = 44, 16%), and only one participant in the sample aged between 81 to 100 years (n = 1, 0.4%).

The majority of the participants were male (n = 143, 51%), followed by female (n = 97, 35%), non-binary (n = 30, 11%), five individuals preferred not to disclose (n=5, 2%) and five individuals identified themselves as others (n=5, 2%).

In terms of sexual orientation, the majority of the participants identified themselves as heterosexual (n = 121, 43%), followed by homosexual or gay (n = 49, 18%), bisexual (n = 40, 14%), lesbian (n = 30, 11%), pansexual (n = 19, 7%), queer (n = 9, 3%), asexual (n = 6, 2%), and 6 individuals identified themselves as others (2%).

In marital status, most of the participants were single (n = 138, 49%), common-law (n = 83, 30%), married (n = 50, 18%), separated (n = 5, 1.8%), divorced (n = 3, 1%) and widowed (n = 1, 0.4%). The majority of the participants attained secondary education (n = 143, 51%), followed by tertiary (n = 87, 31%) and primary (n = 50, 18%).

Additionally, 165 participants (59%) were employed, while 115 (41%) were unemployed. In the qualitative phase, the participants who were selected for the study were five males, three females, and two transgender women. Sexual orientation varied including

heterosexual, gay, bisexual, and queer. The educational background ranged from primary to tertiary. The employment status included formal employment, self-employment, part-time work, and student status. The age ranged from 22 to 42 years. The participants' diversity provided a broad perspective of the study.

Table 1. Demographic Characteristics of Participants

Demographic Characteristic	**Frequency (n)**	**Percentage (%)**
Male	143	51
Female	97	35
Non-binary/Third gender	30	11
Prefer not to say	5	2
Other	5	2
Heterosexual	121	43
Homosexual or Gay	49	18
Lesbian	30	11
Bisexual	40	14
Pansexual	19	7
Asexual	6	2
Queer	9	3
Other	6	2
Married	50	18
Divorced	3	1
Separated	5	1.8
Single	138	49
Common-law	83	30
Widowed	1	0.4
18–30	178	64
31–60	57	20
61–80	44	16
81–100	1	0.36
Primary	50	18
Secondary	143	51
Tertiary	87	31
Employed	165	59
Unemployed	115	41

Awareness and Consideration of PrEP

Regarding the awareness about the existence and effectiveness of HIV PrEP, the majority of the participants (n = 169, 60%) reported having considered taking PrEP medication. Factors such as desire for asset protection against HIV (n = 41, 24%), recommendation from healthcare professionals (n =38, 22%), suggestions from friends, family members or peers (n = 24, 14%), life experiences or knowledge of HIV (n =18, 10%) and educational materials (n = 15, 8%) were considered to influence participants decisions on the PrEP uptake.

Barriers to PrEP Uptake

Among the 280 participants surveyed, stigma was the most frequently reported barrier overall (50%); however, lack of awareness (36%) and affordability (32%) were also substantial and may be equally influential for specific subgroups. Other commonly reported barriers included limited clinic availability (n = 70, 25%) and confidentiality concerns (n = 60, 21%). Participants feared being labeled as promiscuous or HIV-positive, especially in tight-knit communities. Healthcare providers were often perceived as judgmental, discouraging open dialogue. Additionally, misconceptions about PrEP being solely for HIV-positive individuals exacerbated fears.

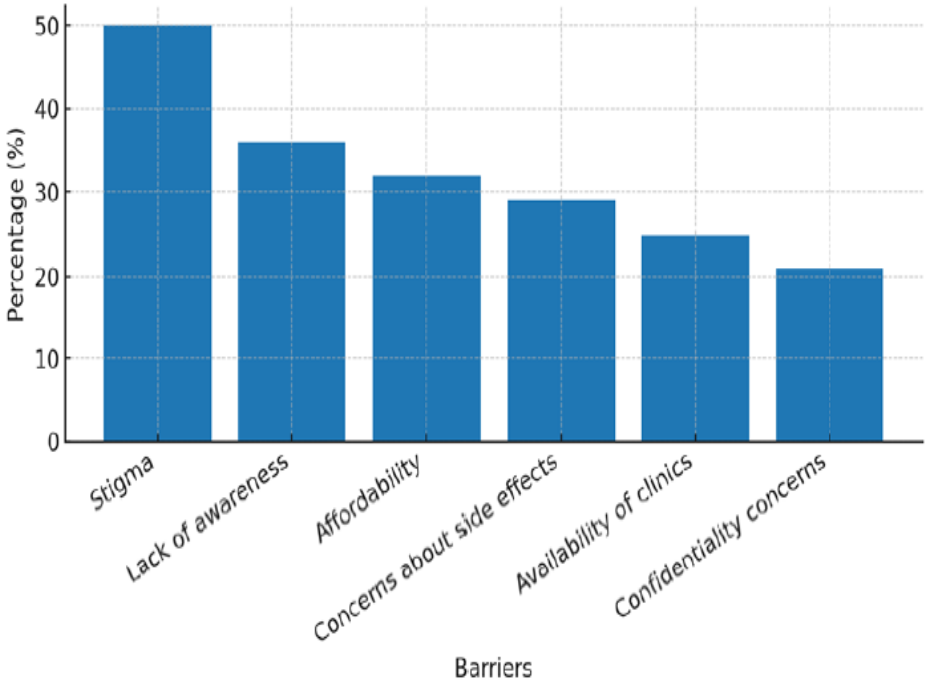


Figure 1. Reported Barriers to PrEP Uptake

Qualitative Insights

Qualitative accounts illustrated the quantitative trends: for example, while 50% cited stigma, interviewees explained how stigma combined with provider discrimination and confidentiality fears to magnify deterrents. One participant shared, “When you ask for PrEP, people assume you already have HIV. It's easier to avoid it than deal with shame.”

Discussion

This study examined the influence of stigma on PrEP hesitancy in Guyana, guided by four objectives: (1) to assess the extent of PrEP hesitancy; (2) to identify stigma-related and structural barriers; (3) to analyze perceptions and lived experiences of stigma; and (4) to recommend evidence-based strategies for improving uptake.

Findings confirm that while awareness of PrEP exists among certain populations, actual uptake remains limited. Fear of judgment, mislabeling, and healthcare bias significantly undermine willingness to access and adhere to PrEP. This confirms a gap between awareness and use, consistent with global reports [9].

Stigma was found to manifest at multiple levels. At the individual level, internalized stigma fosters shame, fear of being labeled promiscuous or HIV-positive, and reluctance to associate with HIV-related services. Interpersonally, the fear of disclosure to partners, families, or social networks serves as a psychological barrier, particularly among LGBTQ+ individuals and sex workers. Structurally, health systems may perpetuate stigma through judgmental provider attitudes, inadequate privacy, and weak integration of PrEP into routine care pathways. These findings mirror trends observed in other Caribbean and African contexts [13].

Qualitative insights highlighted the cumulative effect of stigma, interacting with other barriers such as cost, clinic availability, and confidentiality concerns. Even when individuals were aware of PrEP and motivated to protect themselves, layered stigma across social, institutional, and policy spheres prevented them from translating awareness into action. Regional comparisons, such as studies in Jamaica and South Africa, revealed similar dynamics where stigma intersects with poverty, lack of education, and rural isolation, further marginalizing vulnerable groups [18, 19].

The findings point to the need for multi-level interventions. Community-level campaigns involving influencers, faith leaders, and peer educators may help normalize PrEP and reframe it as an empowerment tool. At the clinical level, provider sensitization and structured training are essential for dismantling discriminatory attitudes and fostering affirming environments. Structural solutions such as mobile clinics, telehealth services, and integration of PrEP into family planning and STI programs can create discreet and normalized access points [14, 15]. Furthermore, mental health support should be incorporated into PrEP services to mitigate internalized stigma and support adherence.

Stigma remains not only a psychosocial issue but also a public health challenge that undermines Guyana's ability to achieve the UNAIDS 95-95-95 targets by 2030. Addressing stigma requires cross-sectoral collaboration, inclusive messaging, and policy reform—including decriminalization advocacy and investment in community-led monitoring [16, 17]. Healthcare provider attitudes play a pivotal role; without proper training and accountability, providers risk reinforcing stigma instead of alleviating it.

Future research should apply inferential statistics to assess associations between stigma and demographic subgroups and conduct longitudinal studies to evaluate the effectiveness of stigma-reduction interventions over time.

Limitations

This study has several limitations. First, the use of convenience sampling in the quantitative phase restricts representativeness and generalizability of the findings. Second, although "high risk" was operationalized to include groups such as MSM, transgender women, and sex workers, other at-risk populations may have been underrepresented. Third, the analysis relied primarily on descriptive statistics; the absence of inferential or multivariable analyses limits the ability to assess associations between stigma and participant demographics. Fourth, qualitative coding was conducted by a single researcher, which raises the possibility of interpretive bias; however, credibility was enhanced through member checking, reflexive journaling, and peer debriefing. Finally, saturation was judged pragmatically after the tenth interview, but additional interviews from other settings might have yielded further nuance.

Recommendations

PrEP should be integrated into routine services such as maternal and child health clinics, STI units, and community health centres to normalize its use and reduce stigma by presenting it as part of standard preventive care.

National training programs are required to improve healthcare providers' knowledge, attitudes, and practices toward PrEP. Emphasis should be placed on ensuring confidentiality, empathy, and non-judgmental service delivery.

Community-led interventions, including peer navigation, mobile outreach, and culturally sensitive education campaigns, should be prioritized to build trust, dismantle harmful myths, and improve uptake among marginalized groups.

Finally, policy reform and collaboration with international partners such as UNAIDS, PEPFAR, and the Global Fund are necessary to strengthen national capacity, expand stigma-free services, and ensure equitable access across both rural and urban settings.

Further Research

Future studies should evaluate the effectiveness of stigma-reduction interventions in improving PrEP uptake, with a particular focus on high-risk subgroups such as transgender women, sex workers, and MSM. Longitudinal research is also needed to assess whether stigma-mitigation strategies result in sustained improvements in PrEP adherence and persistence. Comparative studies across Caribbean and South American countries could provide additional insights into cultural factors shaping stigma and prevention strategies.

Conclusion

Stigma remains the most persistent barrier to the uptake of PrEP in Guyana, profoundly undermining the country's HIV prevention efforts. The findings of this study underscore how stigma—manifesting at the individual, interpersonal, and structural levels—discourages individuals from accessing PrEP, even when they are aware of its benefits. This stigma is often reinforced by misconceptions, cultural conservatism, healthcare discrimination, and fear of being socially labeled as promiscuous or HIV-positive.

To counter these entrenched barriers, a comprehensive, multi-sectoral response is essential. Guyana must implement interventions that not only address knowledge gaps but also confront the social norms and institutional practices that perpetuate stigma and misinformation. These efforts should include targeted anti-stigma campaigns, culturally relevant community outreach, and sustained healthcare provider training focused on empathy, confidentiality, and non-judgmental service delivery.

The expansion of decentralized PrEP services, particularly in underserved and rural areas, should be prioritized. Such services must ensure confidentiality and convenience, enabling individuals to access care without fear of exposure or judgment. Engaging civil society organizations and leaders of key populations as partners in awareness-building can further enhance trust and improve service reach.

Beyond immediate programmatic efforts, this research highlights the importance of establishing monitoring and evaluation frameworks to track PrEP uptake, stigma reduction, and client satisfaction. Future research should adopt longitudinal designs to assess whether anti-stigma interventions produce lasting effects and whether health policy reforms translate into improved uptake and adherence.

Ultimately, addressing stigma is not only about improving access to a preventive tool; it is about upholding the dignity and rights of vulnerable populations and ensuring equitable access to health. By confronting stigma directly through informed policy, community engagement, and inclusive healthcare reform, Guyana can make significant progress toward

ending the HIV epidemic and meeting its national and global prevention targets.

Justification and Extension

This study justifies the urgent need for stigma-reduction strategies as a prerequisite for scaling up PrEP and achieving Guyana's HIV prevention goals. The findings are directly applicable to policymakers, healthcare leaders, and program managers responsible for designing equitable HIV services. Furthermore, the insights generated carry broader regional significance, providing a framework that can be adapted across Caribbean and Latin American settings facing similar socio-cultural and structural barriers.

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Conflict of Interest

The author declares no conflict of interest.

Ethical Approval

The Institutional Review Board of the Ministry of Health, Guyana, and the National AIDS Program Secretariat of the Ministry of Health approved this study. Authorization was also received from the participating healthcare facilities before recruitment. Informed consent was obtained from all participants. To maintain confidentiality, no identifying information was collected. Data was securely stored in password-protected files, with plans to permanently delete it after 7 years.

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Factors Influencing Health and Environmental Conditions in Hwiida, A Community Near Landfill Site in Gomoa West, Central Region, Ghana

Anita Asante[1*], Wombeogo Michael[2]
[1]*Department of Public Health, Texila American University, Georgetown, Guyana*
[2]*Department of Nursing, Faculty of Health and Allied Sciences, Regentropfen University College -Kansoe, Bolgatanga, UER, Ghana*

Abstract

Municipal solid waste management remains a significant challenge in low- and middle-income countries (LMICs), particularly in rapidly urbanizing areas like Ghana's Central Region. This study examines the health and environmental impacts of the Hwiida Landfill Site on nearby communities in Gomoa West District. Using a cross-sectional correlational design, data were collected from 100 systematically selected residents within a 1-kilometre radius of the landfill via a structured questionnaire. Descriptive and binary logistic regression analyses were conducted. Results show that 81% of respondents reported health problems potentially linked to landfill exposure, including respiratory issues, skin conditions, and diarrhoea, and 73% indicated that at least one household member was affected in the past year. Environmental concerns were widespread: 72% cited air pollution (notably odour) and 48% reported pest and rodent infestations. Most participants (92%) lived within 300 metres of the site and lacked access to improved sanitation or formal waste collection. Inadequate landfill management especially the absence of leachate containment and minimal waste segregation was identified as a key contributor to pollution. These findings highlight the urgent need for engineered landfill upgrades, community health education, and targeted policy interventions. Context-specific evidence such as this can inform sustainable waste management strategies and reduce the health burden on vulnerable populations near landfills.

Keywords: *Community Exposure, Environmental Pollution, Landfill Sites, Leachate, Municipal Solid Waste Management, Public Health Impact.*

Introduction

Municipal solid waste management is a global challenge driven by rapid urbanization, population growth, and increasing consumption patterns [1, 2]. As cities expand, waste generation escalates, placing immense pressure on urban infrastructure. Globally, landfills remain the most commonly used method for waste disposal, accommodating nearly 70% of municipal solid waste, particularly in low-and middle-income countries (LMICs) [3]. Despite their widespread use, landfills are associated with significant environmental and public health risks [4]. Epidemiological evidence consistently links residential proximity to landfill sites with adverse health outcomes, including respiratory illnesses, waterborne diseases, and congenital anomalies [5].

The environmental impacts of landfills are well documented. Leachate, landfill gases, and particulate emissions are recognized as major pollutants [6, 7]. Leachate often containing heavy metals and hazardous organic compounds can infiltrate groundwater and surface water bodies, threatening both

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****Corresponding Author: yaasika58@gmail.com***

ecosystems and human health [7]. Methane and hydrogen sulphide, generated during anaerobic decomposition of organic waste, contribute to greenhouse gas emissions, air pollution, and persistent odour nuisance [8]. These effects are exacerbated in poorly managed landfills that lack engineered containment systems and waste segregation practices. While high-income countries have adopted advanced technologies to mitigate these impacts, LMICs continue to struggle with limited financial resources, inadequate infrastructure, and weak regulatory enforcement, resulting in severe environmental and health consequences [9].

In Africa, urbanization and population growth have outpaced waste management capacity, resulting in widespread environmental degradation and public health crises [10, 11]. The continent generates approximately 626,301 metric tons of waste annually, yet only 40% is collected and less than 5% recycled [12]. The remainder is frequently disposed of in unregulated open dumps or poorly managed landfill sites, which disproportionately affect marginalized and low-income communities [13]. Studies from South Africa and Nigeria report elevated rates of respiratory diseases, skin irritations, and gastrointestinal illnesses among residents living near landfills, symptoms attributed to exposure to airborne pollutants, contaminated water, and vector proliferation [14–16]. These health risks are further intensified by socioeconomic vulnerabilities, including poverty, limited access to clean water, and inadequate healthcare [13, 16].

Ghana faces similar challenges. The country generates over 7 million tons of waste annually, with significant contributions from both urban and peri-urban areas such as Hwiida [17, 18]. Although efforts to improve waste collection have been made, the majority of waste is still disposed of in landfill sites, many of which operate without basic environmental safeguards [19]. Critically, these landfills often lack impermeable liners to prevent leachate seepage, resulting in contamination of local water sources [20–22]. Minimal waste segregation further enables the uncontrolled release of hazardous chemicals and toxic gases [23, 24]. Compounding these issues are weak enforcement of environmental regulations, insufficient public awareness, and underdeveloped sanitation infrastructure [25–27].

The Central Region of Ghana exemplifies these systemic failures. With a population exceeding 2 million [28], the region generates approximately 1,716 tons of waste daily, much of it disposed of in landfill sites located alarmingly close to residential areas [12]. These sites pose significant risks to environmental quality and public health [29]. Residents in proximity report higher incidences of asthma, bronchitis, and waterborne diseases linked to contaminated groundwater [30]. Environmental degradation extends to soil and air pollution, with observable impacts such as reduced agricultural productivity and loss of biodiversity [31].

Despite these pressing concerns, there is a notable gap in localized, context-specific research in Ghana that examines how socioeconomic, behavioral, and geographic factors jointly influence health and environmental outcomes near landfills. Existing studies often generalize risks without accounting for Ghana's unique institutional, cultural, and infrastructural realities. For instance, while international literature associates landfill proximity with low birth weight, congenital anomalies, and certain cancers [5], comparable evidence from Ghana remains scarce [32]. Moreover, many studies conflate health and environmental impacts rather than analyzing the distinct drivers of each.

Communities near landfills in the Central Region are typically socioeconomically disadvantaged, heightening their vulnerability to pollution-related hazards. Limited access to clean water, healthcare, and formal waste

services increases their exposure and reduces adaptive capacity. Equally important is the lack of data on community perceptions and coping strategies, information essential for designing equitable and effective interventions. Without such localized evidence, policymakers and urban planners lack the empirical basis needed to address the dual burden of environmental degradation and public health risk.

This study therefore investigates the factors influencing health and environmental conditions in communities adjacent to the Hwiida Landfill Site in Ghana's Central Region. By generating context-specific data, the research aims to inform targeted policy interventions and contribute to the broader understanding of landfill impacts in LMIC settings. Specifically, the study addresses the following research questions:

1. What factors influence health conditions (e.g., respiratory issues, waterborne diseases) in communities near landfill sites in the Central Region?
2. What factors influence environmental conditions (e.g., air quality, water contamination, odour) in these communities?

Methods and Participants

Study Design and Setting

This study employed a cross-sectional correlational survey design to examine the factors influencing health and environmental conditions among residents living in proximity to the Hwiida Landfill Site in the Gomoa West District of Ghana's Central Region. Commissioned in 2015, the Hwiida landfill occupies a 65.5-acre parcel and was developed as an engineered facility to replace the previously used Dawurampong dumpsite. It serves as the primary municipal solid waste disposal site for the district, incorporating design features such as controlled waste placement and basic containment measures intended to reduce environmental impacts. Despite these upgrades, the site has been associated with recurring ecological concerns—including leachate seepage, persistent odour emissions, and community complaints—that have led to multiple legal disputes. Surrounding communities within a 1-kilometre radius include Mumford, Dago, Apam, Obiri, Otuam, and Kyiren Nkwanta.

Participants and Sampling

The target population consisted of adults aged 18 years or older who had resided within a 1-kilometre (1000-metre) radius of the Hwiida landfill for at least 12 months. The 1-kilometre radius was selected based on evidence that most adverse health and environmental impacts from landfill sites are concentrated within this radius due to the dispersion of pollutants, such as leachate and gases [33]. Although an earlier draft mentioned a five-year residency requirement, the final inclusion criterion was a minimum of 12 months' residence to ensure recent and relevant exposure while maximizing participation feasibility. Limiting the sample to adults ensured participants could provide informed consent and offer reliable self-reported data.

A systematic random sampling approach was used to select 100 participants. Starting from predetermined entry points around the landfill perimeter, every fifth household along radial transects was approached until the target sample size was achieved. Only one eligible adult per household was interviewed. This approach balances adequate representation and statistical power with logistical feasibility [34].

Instrument Development and Data Collection

Data were collected using a structured, self-developed questionnaire informed by established public health and environmental exposure assessment tools. To ensure content validity and cultural appropriateness, the instrument was pilot-tested with 10 residents from a non-study community in the Central Region that shares similar socioeconomic and

environmental characteristics with Hwiida. Feedback from the pilot phase was used to refine wording, sequence, and clarity.

The final questionnaire comprised three sections:

1. Sociodemographic and household characteristics, including age, gender, education level, occupation, household size, housing type, distance from residence to the landfill (categorized as <100 m, 100–300 m, 400–600 m, or >700 m), source of drinking water, type of sanitation facility, and primary method of household waste disposal.
2. Self-reported health conditions experienced in the past 12 months, such as respiratory symptoms (e.g., coughing, wheezing), skin irritations, diarrhoea, headaches, and eye discomfort.
3. Perceived environmental conditions, including observations of air pollution (e.g., foul odour, smoke), pest and rodent infestations, suspected water contamination, and overall perceptions of the landfill's impact on local environmental quality.

Printed questionnaires were administered in person by five trained data collection assistants. Prior to administration, participants were briefed on the study's purpose, procedures, potential risks (minimal), and benefits (none beyond contributing to community knowledge). Written or verbal informed consent was obtained from all participants, with emphasis on voluntary participation, confidentiality, and the right to withdraw at any time without penalty.

Data Analysis

Data analysis began with descriptive statistics to summarize participant demographics and provide an overview of reported health outcomes and environmental conditions. To address the first research question which was identifying factors influencing health conditions, binary logistic regression was conducted (note: revised from "multiple regression" for appropriateness to dichotomous outcomes). The model examined the relationships among independent variables (proximity to the landfill, socioeconomic factors, drinking water source, toilet facility, waste disposal method, and perceived exposure) and the dependent variable (self-reported health conditions among the participant or a household member). This approach allows for quantification of the relative contribution of each predictor while controlling for potential confounders, offering nuanced insights into the drivers of health outcomes [35-38].

For the second research question, factors influencing environmental conditions, descriptive and inferential analyses were used to explore associations between household practices, proximity, and perceived environmental impacts (e.g., odour, pests, water quality). Together, these analyses provide evidence-based insights into the dual health and environmental impacts of landfill sites, informing policy and waste management practices in similar settings.

Results and Discussion

Preliminary Analysis

A total of 100 residents living within a 1-kilometre radius of the Hwiida Landfill Site in Gomoa West District, Central Region, Ghana, participated in the study. Their sociodemographic, household, and environmental characteristics are summarized in Table 1 below.

The majority of respondents were female (64%), and the largest age group was 31–40 years (27%), followed by those aged 20–30 (22%) and above 61 years (14%). Only 5% of participants were aged 51–60. Educational attainment was generally low: 25% reported no formal education, while 24% had completed Junior High School. Only 13% had attained tertiary-level education. Economically, the sample reflected a predominantly informal and

precarious livelihood structure: 42% engaged in self-employment (e.g., petty trading or small-scale farming), 40% were not currently working, and just 15% were employed in the public sector; only 3% worked in the private sector. Household size was substantial, with 36% of respondents living in households of 3–6 persons and 30% in households with 10 or more members. The majority (83%) resided in modern housing structures, while 17% lived in traditional dwellings. Critically, 92% of participants lived within 300 m of the landfill: 46% resided less than 100 m away, and another 46% lived between 100 and 300 m from the site. Only 8% lived beyond 400 m, with just one participant residing more than 700 m away.

Access to basic services was mixed. While 50% relied on pipe-borne water as their primary drinking source, 31% consumed sachet water, 14% used public standpipes, 6% depended on boreholes or tube wells, and 5% sourced water from surface bodies such as rivers or dams. Sanitation facilities were largely unimproved: 40% used KVIPs (a form of improved pit latrine), 31% relied on public toilets, and 10% used basic pit latrines. Notably, 4% still practiced open defecation, though no respondents reported using bucket/pan systems. Waste disposal practices were overwhelmingly unsanitary: 67% reported open dumping of household waste, 27% practiced open burning, and only 4% had access to formal waste collection services. Composting and burying were rare (1% each).

These findings illustrate a community characterized by high residential proximity to a landfill, limited formal employment, large household sizes, and inadequate waste management infrastructure, all of which may compound exposure to landfill-related environmental hazards.

Table 1. Sociodemographic, Household, and Environmental Characteristics of Participants

Variable	Category	Frequency
Gender	Male	36
	Female	64
Age (years)	<20	12
	20–30	22
	31–40	27
	41–50	20
	51–60	5
	>61	14
Education Level	No formal education	25
	Primary	21
	Junior High School	24
	Senior High School	17
	Tertiary	13
Occupation	Government worker	15
	Private sector employee	3
	Own business	42
	Not currently working	40
Household Size	<3 persons	16

	3–6 persons	36
	7–10 persons	18
	>10 persons	30
Housing Type	Traditional home	17
	Modern home	83
Distance to Landfill	<100 m	46
	100–300 m	46
	400–600 m	7
	>700 m	1
Drinking Water Source	Sachet water	31
	Pipe-borne water	50
	Borehole/tube well	6
	Public tap/standpipe	14
	Dam/river/lake/rainfall	5
Toilet Facility	Sewer	10
	Septic tank	5
	KVIP	40
	Pit latrine	10
	Public toilet	31
	Open defecation	4
Waste Disposal Method	Open dumping	67
	Open burning	27
	Burying	1
	Composting	1
	Arranged service	4

Source: Field Work (2025)

Self-Reported Health Impacts Attributed to Landfill Proximity

A high prevalence of self-reported health effects was observed among residents living near the Hwiida Landfill Site. Of the 100 participants, 81% (n = 81) indicated that they personally experienced one or more adverse health symptoms in the past 12 months that they associated with the landfill. Additionally, 73% (n = 73) reported that at least one other member of their household had suffered similar health issues during the same period, suggesting that the perceived health burden extends beyond individual respondents to affect entire families. Two participants did not respond to this section of the questionnaire.

These findings align with patterns documented in the global epidemiologic literature on landfill exposure. As noted by [5], residents near waste sites consistently report non-specific symptoms including headaches, fatigue, respiratory irritation, and gastrointestinal discomfort even in the absence of clinical confirmation. While such symptoms may result from direct toxicological exposure, stress related to odours and environmental concerns, or reporting bias, their high prevalence in this community underscores a

significant perceived health risk associated with landfill proximity (Table 2).

Table 2. Household and Individual Reports of Landfill-Associated Health Effects in the Past 12 Months

Outcome	N	%
Individual reported ≥1 health symptom	81	81.0
Household had ≥1 affected member (including respondent)	73	73.0
No health effects reported	17	17.0
Missing response	2	2.0

Note: Percentages are based on total sample (N = 100). The household-level figure reflects respondents who indicated that any household member (not necessarily themselves) was affected.

Discussion

The high prevalence of self-reported health symptoms, 81% of individuals and 73% of households among residents living within 1 km of the Hwiida Landfill Site, aligns with a well-documented global pattern. Epidemiologic reviews consistently report elevated rates of nonspecific symptoms, such as headaches, fatigue, respiratory irritation, and gastrointestinal distress, among populations residing near landfill sites [5]. While these symptoms may arise from direct toxicological exposure to landfill emissions, [5] cautions that they could also reflect stress, anxiety, or reporting bias triggered by persistent odour, visual blight, or fear of contamination, factors often amplified in the absence of transparent risk communication.

The environmental conditions reported by participants further support plausible exposure pathways. Air pollution complaints (72%), primarily due to foul odours, are consistent with the emission of hydrogen sulphide and ammonia gases generated during anaerobic decomposition of organic waste, which are known to cause mucosal and respiratory irritation [6, 8]. Pest and rodent infestations (48%) likely stem from inadequate waste containment and the open dumping practices observed both at the landfill and household levels [10]. Such conditions not only degrade the quality of life but also increase the risks of vector-borne and zoonotic diseases.

Of particular concern is the potential for water contamination. The Hwiida landfill, like many in Ghana, reportedly lacks engineered leachate containment systems [20–22]. Leachate, a toxic cocktail of heavy metals, organic pollutants, and pathogens can infiltrate groundwater, especially in areas with shallow aquifers and high rainfall, as is common in the Central Region. This risk is compounded by the fact that 25% of respondents rely on boreholes, rivers, or unprotected surface water for drinking [20]. Contamination of these sources provides a credible pathway for the diarrhoea and gastrointestinal illnesses reported by participants.

Moreover, the near-universal practice of open dumping (67%) and burning (27%) at the household level exacerbates local pollution [10]. Waste burning releases dioxins, furans, and fine particulate matter, which are linked to respiratory and cardiovascular morbidity [23, 25]. The absence of waste segregation, both at source and at the landfill means hazardous materials (e.g., batteries, plastics, medical waste) are commingled with organic refuse, increasing the toxicity of both leachate and emissions [23].

Critically, 92% of participants reside within 300 m of the landfill, a proximity that

intensifies exposure to gaseous and particulate pollutants. Although this study did not include ambient air or water monitoring, the distance-dependent gradient in symptom reporting (higher prevalence closer to the site) suggests a potential exposure–response relationship, a pattern observed in other landfill studies [5, 29].

Nevertheless, limitations must be acknowledged. As with most community-based landfill investigations, our data rely on self-reported outcomes without clinical or environmental validation [5]. The lack of direct exposure metrics (e.g., H_2S concentrations, water quality tests) precludes definitive causal inference. However, the consistency of symptom patterns with known landfill hazards and their alignment with findings from Nigeria, South Africa, and Europe [5, 14–16] strengthens the plausibility of an association.

Ultimately, the burden borne by the Hwiida community reflects a broader failure of environmental governance in rapidly urbanizing LMICs. Landfills are frequently sited near marginalized settlements with limited political voice [13], creating environmental injustice where the costs of waste disposal are externalized onto the most vulnerable [16]. Addressing this requires more than technical fixes; it demands inclusive planning, regulatory enforcement, and investment in safe water, sanitation, and alternative waste treatment systems that prioritize public health over convenience.

Conclusion

This study provides evidence that residential proximity to the Hwiida Landfill Site is associated with substantial environmental degradation and a high burden of self-reported health symptoms among nearby communities. The co-occurrence of inadequate landfill engineering (e.g., lack of leachate containment), poor household waste practices (e.g., open dumping and burning), and limited access to safe water and sanitation creates a synergistic exposure environment that heightens vulnerability, particularly among socioeconomically disadvantaged residents.

Recommendations

1. The District Assembly should improve landfill engineering, including lining systems to prevent leachate seepage. Strengthen community education on waste segregation and hygiene.
2. The Government of Ghana, through the Ministry of Science and Environment, enhances monitoring and enforcement of environmental regulations.
3. The Ghana Government must expand access to safe water and sanitation facilities for affected communities.
4. The District Assembly should relocate or buffer residential areas from active landfill zones.
5. The government should build a health facility for the people so that they can get access to healthcare when they get infected.
6. Non-Governmental Organizations (NGOs), organizations, and philanthropists can help establish Health facilities.

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Conflict of Interest

The Authors of this manuscript declare no conflict of interest.

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Cost-Effectiveness Analysis of the Piloting of Malaria Rapid Diagnostic Test kits within Region 8, Guyana

Tatkan. G
School of Public Health, Texila American University, Georgetown, Guyana

Abstract

The objective of this study was to conduct a Cost-Effectiveness Analysis (CEA) of piloting Rapid Diagnostic Test (RDT) kits in Region 8 of Guyana. The primary aim was to assess whether the introduction of RDTs provided good value for money and whether it could be considered a cost-effective intervention for malaria diagnosis in remote, high-burden areas. A quantitative analysis approach was employed, utilizing secondary data collected from multiple authorized sources, including government agencies such as the Ministry of Health. The data included expenditure records, payment vouchers, project reports, and receipts, providing critical financial information to estimate costs associated with the RDT pilot and microscopy testing. The results revealed that the total cost of implementing the RDT pilot project was USD 67,161, with the majority of expenditures allocated towards human resources. The estimated cost for administering a single RDT was USD 13.23. The findings demonstrated that the community-based approach was more cost-effective because it avoided additional expenses related to the construction and operation of new health facilities and hiring of personnel. By comparison, the cost of microscopy testing was estimated at USD 31.44 per patient, with the principal cost drivers identified as human resource salaries and facility operational expenses. Based on the Incremental Cost-Effectiveness Ratio (ICER) analysis, the intervention was deemed highly cost-effective. When compared to Guyana's GDP per capita, which was USD 3,883 in 2017 according to the Guyana Bureau of Statistics, the piloting of RDTs was shown to be a financially sustainable and impactful approach to strengthening malaria diagnosis in underserved regions.

Keywords*: Cost-effectiveness, Economic Evaluation, Guyana, Malaria, Rapid Diagnostic Test,*

Introduction

In 2016, Malaria accounted for 455,000 deaths worldwide [1], with young children in sub-Saharan Africa accounting for most morbidities and mortalities [2]. However, this number showed a decline from the estimated 800,000 who died globally from the disease in the year 2010 [3]. Though Malaria-related deaths have been reducing, the number of new cases has remained relatively constant globally. Estimates stood at 216,000,000 new cases of Malaria in 91 countries in 2016 [1], a 2% increase from 2015. Malaria remains a priority on the global health agenda, as captured in Sustainable Development Goal Three, which aims to end the epidemic of Malaria by 2030 [4, 5].

Malaria is a significant public health issue in Guyana. Established in the early 1950s, the National Malaria Programme was created with an emphasis on reducing Malaria in the sugar plantations of Guyana's coastal regions, ultimately reducing cases to just 72 in the entire country [6]. Of the ten administrative regions, Regions 1, 7, 8 & 9 (Hinterland Regions) are the known endemic Malaria regions. According to the National Census (2012), the Hinterland Regions had a population of 81,333 people, or

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Corresponding Author: pooja_pbc@yahoo.com

11% of the country's total population, with a population density of 8.6 persons per km2. The incidence of the disease, however, increased in 2007, ultimately peaking in 2013, with a high prevalence in the malaria-endemic hinterland regions. It is thought that the rise in global gold prices served as a pull factor, attracting more people to the hinterland regions [7].

The pillars of Guyana's economy/Gross Domestic Product (G.D.P.), are agriculture and extractive industries such as mining and forestry. 31% of the G.D.P. is made up of the agricultural and mining sector industries, both of which occur in the same areas that are natural habitats of the Anopheles mosquitoes, the vector that transmits Malaria [8].

Method

This study will employ CEA to determine whether the introduction of RDTs in Guyana provides value for money to Guyanese taxpayers. CEA brings together data on demographics, the burden of disease, the impact of the intervention, and costs within a reference framework. These analyses contextualize whether a response is worthwhile relative to others, contributing to the decision about which interventions should be given priority across different budget thresholds.

The methodology was guided by the CEA design articulated in "Operationalization of the National Malaria Strategy in Guyana: A Pilot Project in Region 8 (Potaro-Siparuni) and its progressive scale-up to all malaria-endemic regions." Secondly, the report of the pilot of the RDTs as also used to estimate the number of RDTs and other resources. Data was also gathered from the Management Information System Unit (MISU)-VCS [19].

Study Setting

This research examined the cost-effective analysis of piloting of the RDT kits within Region 8 more specifically the 12 mining camps: B/K, Minne ha-ha, Tesouro, R/V, # 35 miles, Mouwsi, Takuba Lodge, White Water, Princeville, Pamela, Water Dog, Jumbie Creek and Eagle Mountain mining site. The study examined the costs of procurement and distribution of RDTS in Malaria Endemic Region #8 of Guyana. At the time of this study, the pilot had been completed (July to December 2016). The analysis covered a time horizon of two years, to allow capturing costs from procurement, implementation, and evaluation.

Study Design

This study was a cost-effectiveness analysis of a community-based approach in Guyana, using an economic evaluation. Also, a retrospective/observational component of the project focused on quantitative data and the estimation of cost-effectiveness as well as the outcome variables.

Study Perspective

The study perspective was from a provider or health system perspective, which accounted for travel costs, salaries, procurement of commodities, and health promotion, among others. All prices reflected in the study were converted to United States Dollars using the Bank of Guyana's average exchange rate.

Outcome Variable

The primary outcome measure was the number of diagnosed malaria cases within the study frame. The health outcome was not considered because of the pilot's short time frame. Secondly, the expectation is that malaria incidence will increase due to enhanced surveillance resulting from the piloting of RDTs in the 12 mining camps. The counterfactual will be a difference-in-differences analysis, which compares changes in outcomes over time between a population enrolled in a program (the treatment group) and a population not enrolled (the comparison group). To answer the impact question, which is the impact or causal effects of a programme (P) on the outcome of interest (Y), which had the intervention, the formula below will be used.

$$\Delta = (Y \mid P = 1) - (Y|P = 0)$$

Where: Δ is impacted

Y is the outcome

P is the programme

The indicator to measure effectiveness would be Resource Adjusted Malaria Incidence (RAMI). RAMI will be given by:

$$(Weekly\ or\ monthly\ number\ of\ malaria\ cases\ /population\ at\ risk)\ /Quantity\ of\ resources\ used\ to\ detect\ malaria\ cases$$

The denominator will allow adjusting malaria incidence by the number of resources used and, therefore, will enable controlling for the potential increase in the number of malaria cases due to better diagnosis rather than to higher transmission. The effectiveness indicator hence, will be related only to the improvement in diagnosis and not to improved treatment or improved health results for those diagnosed.

Comparator

The comparator that was used with regards to the outcome variable was that an Incremental Cost-Effectiveness Ratio (ICER) was calculated, i.e. the additional effect (diagnosis) for additional cost compared to no campaign which would be the use of microscopy as done at a health facility.

The period before will be years 2014, 2015 and 2016 (until the introduction of the intervention); the period after will be the year 2016 (after the introduction of the intervention) and years 2017 and 2018.

$$ICER = (C_1 - C_2) / (E_1 - E_2) = \Delta C / \Delta E$$

Ci and Ei are the costs and effectiveness measure of alternative I The purpose is to compare the incremental costs to the incremental benefits.

Measure Cost-Effectiveness

The criteria to measure cost-effectiveness are based on Willingness-To-Pay thresholds (WTP) related to Gross Domestic Product (GDP), in accordance with the WHO's Commission on Macroeconomics. ICER describe the threshold for (WTP) for an additional year of life which is the maximum amount of money that society is willing to pay for an additional year of life.

Data Gathering

The researcher used quantitative methods by collecting secondary data such as reports which captured expenditure (payment vouchers, reports and receipts) from authorized sources within the MOPH, Regional Democratic Council of Region 8, Health Sector Development Unit-MOPH which is the execution agency of the Global Fund - AIDS, Tuberculosis and Malaria (GFATM) and the local organs of the financial system.

If the cost was not documented, the activity was approximated by the researcher using the ingredients approach where the unit activities were first determined and then the unit cost assigned to each activity for the total cost calculations. Secondly, the step-down costing method was used for cost activities that shared other responsibility, not only the RDTs pilot. The steps were given by expert opinion in the form the Director of Vector Control Unit.

Sensitivity Analysis

A one-way sensitivity analysis was performed to examine the robustness of the critical assumptions within the model. The outcome measure, that is, the number of tests done were varied to reflect the upper and lower limits (95% CI 501 to 612) [20]. The parameters have been varied to the extreme of their potential range based on a survey of literature and expert opinion. The cost of procurement would be increased by 10 %.

Results

The results shown in table 1 summaries that a total of 28 boxes of RDTs, each containing 25 cassettes, were distributed to the volunteers during the pilot in Region 8 between July and December 2016 and 14 boxes to the health facilities. Five hundred fifty-seven malaria RDTs were used during the pilot project [19]. In a total of 6 separate training sessions, 68 volunteers and 13 Health Care Workers (HCWs) personnel were trained between July and December 2022 [19]. Only the cost for the trainers was accounted, the mining camp bore the cost for the trainees. The HCWs were from Region 8 and Vector Control Unit comprising of 11 microscopist, 5 Community Health Care Workers (CWHs) and 1 General Doctor.

Table 1. Costing Results of Implementation

Line Item	Detail	Quantity	Unit Cost	Total Cost	Remark
1.1	Procurement of RDTs	557	1.5	836	
1.2.	Freight cost to the Region 8			500	This cost is assumed to be the cost of shipping the RDTS into the mining sites
1.3.	Other consumables			100	This cost is assumed to be the cost of sterile gloves, sharps and sharp boxes and cleaning agents
2.1.	Training Cost	6	762	4,571	In a total of 6 separate training sessions, 68 volunteers and 13 health staff personnel were trained between July and December 2016. Only the cost of the trainers was accounted, the cost for the trainers was borne by the mining camp.
2.2.	Training Materials			100	The estimate of the cost for pens, pens and other stationery
3.1.	Fuel			1,105	The fuel was purchased for a pick-up truck belonging to the Regional Health Department. The pick-up assisted with transportation for training and supervisory visits. Assumption: 4 drums (40 gallons per drum) of diesel was used at a unit cost of $ 58,000 per drum.
4.1.	Printing and distribution of S.O.P for storage of RDTs at National, Regional and Local Level according to WHO Guidelines.	24	64	1,536	24 posters printed Size 18"x24". Assumption: Two posters was given to each of the 12 sites.
4.2.	Surveillance forms	312	0.5	156	Reporting was done weekly. Therefore, a total of 312 surveillance was needed at a unit cost of $0.5

Line Item	Detail	Quantity	Unit Cost	Total Cost	Remark
4.3.	Computer	1	1000	1,000	To assist in data input of the surveillance data. The computer was for the Data entry clerk at Madhia Hospital.
5.1.	Supervisory visits (Weekly)	36		26,743	Local HCWs and VCS do Per-diem and logistics
6.1.	Personnel cost			24,406	This is for the supervisory visit and implementation.
7.1.	Overheads			6108	The overheads were estimated at 10 % of the total cost. This will account for any unaccounted cost.
	Total Cost			67,161	

Figure 1 shows the major cost category of the implementation of the RDT pilot within 12 mining camps in Region #8. The major cost contributors towards the pilot of the RDTs, the bulk of the cost went into the cost of personnel and supervisory visits with 77 % leaving 23 % of the total cost to be divided into the procurement of the RDTs with the lowest cost to implementation.

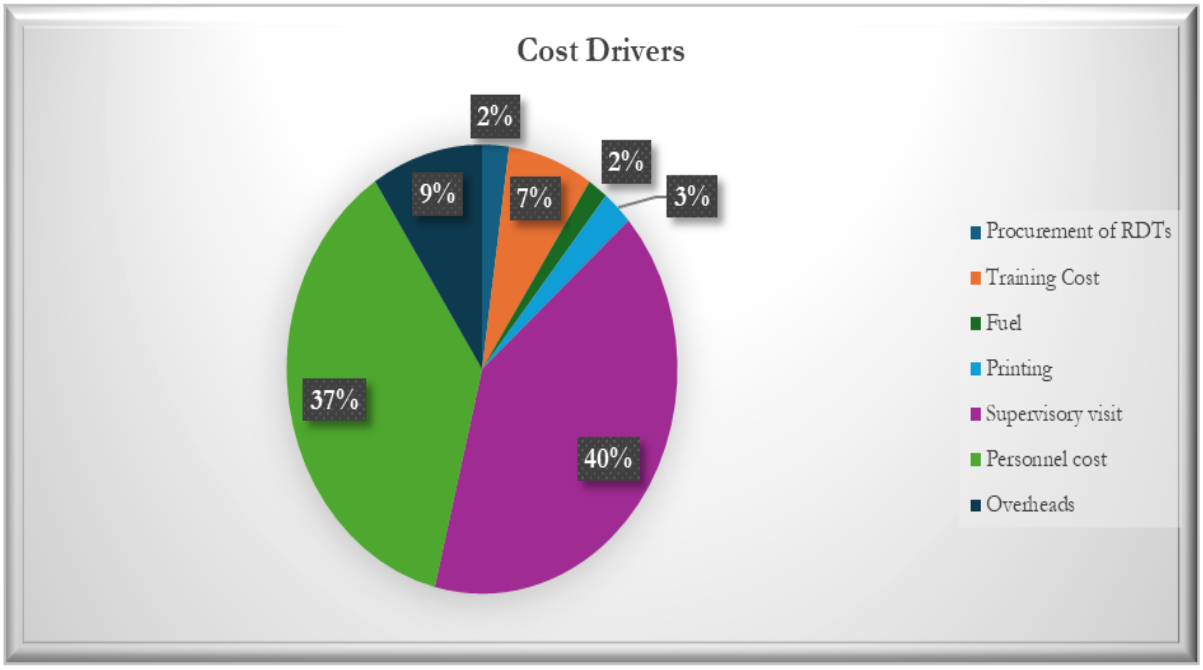


Figure 1. Cost Drivers

Training cost was 7 % while fuel and printing accounted for 5 % of the total cost. The average cost of using one RDT within the parameters of the pilot $ 121.00 however if the cost was only accounted for unitization and reporting it would have been $ 13.23.

Costing of Microscopy Testing

As mentioned before the comparator variable under this study is the cost to provide microcopy rather than RDTs at the mining sites. The average number of test done in 2022 was 615 as shown in table 2.

Table 2. Costing of Microscopy testing

Items	Pack size	Quantity	Unit Cost	Total cost	Remarks
Microscopist Salaries		2	362	9,412	Assumption: two Microscopist is employed per health facilities. One-year Salary is calculated.
Microscope, slides and stains		1	1,000	1,000	The cost of procurement of slides which will be disposed of after every test, one patient will use two slides per visit. The cost of procurement of a microscope is also accounted for.
Powder-Free Latex Exam Gloves	100	13	10	125	Consumables for testing.
Alcohol Prep Pad, Sterile, Medium	200	4	3	13	Consumables for testing.
Safety Boxes	1	4	1	4	Consumables for testing.
Reporting Forms		52	0.5	26	Surveillance from
Utilities			2,000	2,000	Cost took form the operating budget to run one health post in region 1
Maintenance cost			5,000	5,000	Cost took form the operating budget to run one health post in region 2
Overheads				1758	Unaccounted costs.
Total cost				19,338	

The calculation shows that on average; it will cost 19,338 to provide microscopy services per health facility. The average cost per patient will be the total cost divided by the total test done within 2016. Hence the researcher estimates that the average cost per patient would be USD 31.44.

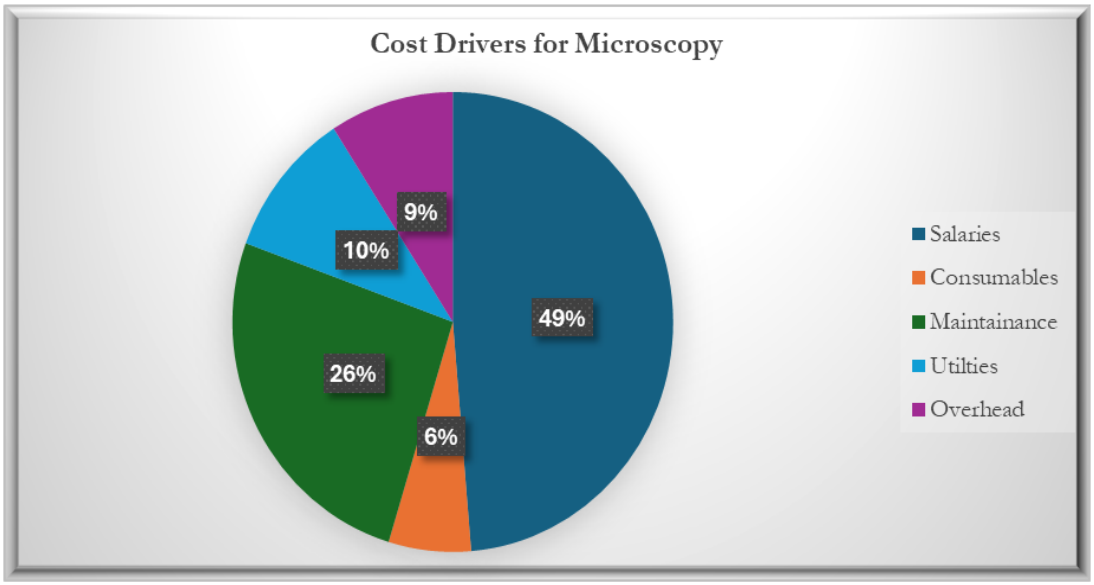


Figure 2. Cost Drivers of Microscopy

Figure 2 shows that the cost of human resource is almost half the cost of testing while the consumables cost is only 6%. The cost of maintenance and utilities of the health facilities is approximately 36 % of the total cost.

Sensitivity Analysis

Univariate sensitivity shown in table 3 was done on the following variables procurement cost of the outcome measure. The parameters have been varied to the extreme of their potential range based on a survey of literature and expert opinion. The outcome measure, that is, the number of tests done were varied to reflect the upper and lower limit (95% CI 501 to 612) [20].

Table 3. Sensitivity Analysis

Variable	Base Value	Value assumed	Cost per test
Procurement cost of RDTs	1.5	10 % increase in prices $1.13	13.38
Test was done using RDTS	557 test	501	12.17
Test was done using RDTS	557 test	612	14.54

Malaria Testing Data

The figure 3 shows the number of tests done by the endemic region. Region 1 had the most tests done but has a larger population than the other endemic Regions.

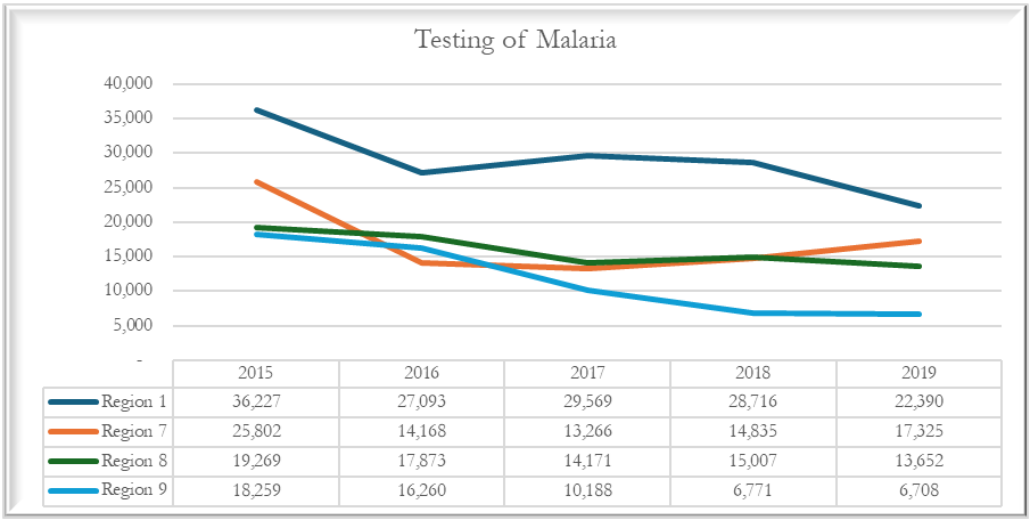


Figure 3. Malaria test is done from 2015 to 2019

Discussion

All of the regions have shown a decline in the total number of tests done except Region 7. The number of tests done in Region 9 reduces more than 60 % from 2015 to 2019. Region 8 saw a decrease in the number of tests done by 7.24 % in 2016 when compared to 2015, the number of tests declined further in 2017 by 21 % when compared to the previous year; however, a 6 % increase was noted in 2018.

Malaria imposes a significant economic impact on the individual, the family and the economy [21]. This study estimated the cost-effectiveness of the introduction of RDTs in Guyana by looking at the cost of the pilot versus the cost of microscopy.

The cost of the pilot was USD 67,161, of which the lion shares of the cost went towards human resources and the cost of weekly supervision. The human resource cost was that of the HCW who was doing the follow-up with

the miner; no cost was estimated for miner's time to test and treat a patient using RDTs. Although, the pilot was only for six months (July to December 2016) 557 persons from 12 mining camps were tested using RDTs. This represents 3 % of the total malaria test done in Region 8 for 2016. The estimated cost for the administering of one RDTs is USD 13.23. This figure is derived by minus the cost of supervision and human resource otherwise during the pilot, it cost USD 121.00 per person. What makes the community-based approach more cost-effective is that no health facilities need to be constructed, no cost of operation and no human resources cost. However, the scale-up cost would be 13.23 because the need to supervise and the human resource cost would be significantly reduced. Ghana has an average cost for RDTs testing at USD 2.6 compared to 1.9 for microscopy from a societal perspective [16] while the country of Uganda had average cost for RDT testing at USD 1.29 and microscopy of USD 1.53.

The cost to treat one person by using microscopy was estimated from the health budget of Region # 1. The cost was estimated by using a health system perspective and using the step-down costing approach. The average cost was estimated by using the total number of tests done in 2016, divided by the cost of testing using microscopy. The cost of microcopy testing was estimated to be USD 31.44 per patient tested. The major cost drivers were the cost of human resources and operational cost of the health facility.

Limitations must be considered with an economic evaluation, whether it be a cost-benefit analysis, cost-minimization analysis or CEA. One limitation of this study was that no long term health outcome or a utility measure such as Disability Adjusted Life Year (DALYs) was included. The outcome measure for this study was the diagnosis of Malaria using the RDTs. However, based on the assumption articulated within the study, the ICER for the use of RDTs can be estimated as USD 13.23 versus the ICER of using microscopy at 31.44. The result of the sensitivity analysis shows that the variables are robust to changes. Also, without the absence of randomization, it reduces the power of the results. The study protocol assumed that testing would increase in the short term, but the opposite took place; analysis should be conducted to ascertain why the reduction in testing. Another limitation is the size of the sample, which was 3 % of the total testing done within 2016; it will be difficult to convince policymakers to invest in the provision of RDTs with a small sample population. Finally, another limitation was that the study perspective was from a provider or health system perspective where travel costs, salaries, procurement of commodities, health promotion among others were not accounted for from a societal perspective.

Conclusion

The Incremental Cost-Effectiveness Ratio (ICER), when calculated, showed that the intervention was very cost-effective when examining WTP which is Guyana's GDP per capita which according to the Guyana Bureau of Statistics stood at US$3,883 in 2017. The results of the univariate sensitivity showed that the impact of uncertainty on variables demonstrated that the results were robust to moderate changes, the results showed that the changes would not have any significant effect of not begin a cost-effective intervention. However, on the basis of the cost-effectiveness ratio, the researcher concluded that the intervention was cost-effective.

Recommendation

It is recommended that cost-benefit study be done to estimate the increase on investment of using RDTs and CEA be done from a societal perspective using microscopy, RDTs, presumptive diagnoses as outcome variables or a utility measure such as DALYs. Also, a Markov model and perspective economic model should be created using expert opinion

and other studies done with the subject area before scaling up the intervention.

Conflict of Interest

The author declares that there is no conflict of interest in this manuscript.

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Exploring Community Knowledge and Awareness of Emergency Medical Services in the Kweneng West Subdistrict, Botswana

Kolobetso Malatsi[1*], Sonika Raj Goel[1], Dintle S. Molosiwa[2]
[1]*School of Public Health, Texila American University, Guyana*
[2]*University of Botswana, Faculty of Medicine, Department of Family Medicine and Public Health and Medicine, Gaborone, Botswana*

Abstract

In rural Botswana, accessing to Emergency Medical Services (EMS) remains challenging due to logistical, infrastructural, and awareness-related barriers. This study aimed to explore community knowledge and identify specific needs regarding Emergency Medical Services (EMS) in the Kweneng West Subdistrict utilizing a qualitative descriptive approach. This study was conducted at Letlhakeng village. In-depth interviews and focus group interviews were conducted and triangulated data from 34 community stakeholders, including healthcare providers, Village Development Committee (VDC) members, police officers, and community workers. Purpose sampling was used to select the participants for this study. The findings revealed significant gaps in awareness and understanding. A substantial proportion of the participants were unaware of the emergency contact numbers for EMS and often relied on informal communication channels. Additionally, most participants reported receiving information through health talks at the clinic, police stations and Kgotla gatherings. The lack of formal EMS education contributed to misconceptions about EMS services. These findings underscore the need for targeted interventions to enhance community knowledge and awareness of EMS.

Keywords: *Awareness, Botswana, Community Knowledge, Emergency Medical Service, Emergency Response, Healthcare Providers.*

Introduction

Emergency Medical Services (EMS) play a crucial role worldwide in delivering immediate medical assistance and facilitating patient transport to healthcare facilities for comprehensive care. The effectiveness of EMS depends significantly on community knowledge, awareness, and trust in these services [1]. In many rural African contexts, including Botswana, misconceptions and limited awareness about EMS capabilities often results in the underutilization of services or delayed contact in emergency situations [2]. Therefore, for EMS to achieve its intended impact, be effective, communities must recognize the value of these services, as well as understand the appropriate circumstances and means for accessing them [3].

Over recent decades, Botswana has expanded its EMS, improving accessibility across the country. However, a substantial gap remains, particularly between urban and rural populations, with rural areas facing significant barriers to accessing healthcare [4]. Evidence suggests that rural communities may lack adequate knowledge of the EMS resources available to them, thereby impeding timely use in critical situations [5]. Additionally, communities in these areas may experience unmet needs, such as insufficient ambulances, poorly equipped EMS teams, and long response

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****Corresponding Author: kolobetsomalatsi@gmail.com***

times. These barriers underscore the need to understand community-specific needs and perceptions to enhance EMS utilization [5]. In Kweneng West Subdistrict, Botswana, unique cultural and social factors such as traditional healing practices, and language challenges pose additional challenges to engaging rural communities with formal healthcare services, including EMS [3, 6].

Despite growing recognition of the need for EMS systems in African settings, little known about how rural communities perceive and utilize EMS. To date, existing literature has not thoroughly explored the specific cultural, logistical and educational factors that contribute to low EMS utilization rates in rural Botswana. A more comprehensive understanding of these factors is essential to design a targeted intervention that improve EMS awareness and accessibility in these underserved areas. This study aims to address this gap by exploring community knowledge and identify specific needs regarding Emergency Medical Services (EMS) in the Kweneng West Subdistrict, to inform targeted interventions to improve service awareness, accessibility, and utilization. The findings of this study will provide valuable insights for policy makers and healthcare providers, supporting initiatives to improve EMS service delivery, community education, and health outcomes within the subdistrict [1, 7]. Furthermore, the results may inform strategies to optimize EMS utilization in other rural areas facing similar challenges across Botswana and the wider Southern African region.

Methods

The qualitative study was conducted in Letlhakeng village, located within the Kweneng West Subdistrict of Botswana. This village was selected for its alignment with the study criteria, including their relevance to the research objectives, infrastructure, and available healthcare services, particularly the presence of a facility offering ambulance services to the local community and surrounding villages. In-depth, semi structured interviews and focus group discussions were conducted with 34 key community stakeholders, including healthcare providers, Village Development Committee (VDC) members, police officers, and community workers to capture a diverse range of perspectives. Each interview was recorded to ensure accuracy and facilitate detailed analysis. Purposive sampling was used to select participants who met specific inclusion criteria; adults 18 years and above, residents of the village chosen for at least one year, and individuals who provided informed consent to participate in the study.

Four focus group discussions (FGDs) were held with six participants per group in a private venue provided by the council. The sessions were facilitated by trained healthcare professionals fluent in Setswana and knowledgeable about Emergency Medical Services (EMS). Each discussion was guided by a moderator, with a note-taker present to capture detailed observations. Additionally, individual in-depth interviews were conducted with subject matter experts, including doctors and nurses. The FGDs lasted 45 to 60 minutes, while the personal interviews were approximately 45 minutes each. All sessions were audio-recorded with the verbal consent of participants to complement the detailed notes taken during the discussions. Data collection continued until saturation was achieved, indicating that no new themes or insights were emerging. Employing both FGDs and interviews enabled data triangulation, which enhanced the richness and credibility of the findings. Reliability of the study was achieved through theoretical saturation [8]. Table 1 provides demographic information about the participants.

Data Analysis

Thematic analysis was employed as the primary method of data analysis, which allowed for the identification of key themes emerging

from the qualitative data. The analysis was facilitated using ATLAS. ti software, which aided in the coding and organization of the data to uncover insights regarding community knowledge and awareness of EMS services. Triangulation was used to enhance the validity of findings, ensuring that data from different sources were cross-verified for consistency and reliability.

Ethical Considerations

The ethical permit for the study and informed verbal consent was obtained from all participants as approved by the relevant authorities, i.e. Ministry of health (MoH), Kweneng DHMT administrators, Letlhakeng district council and the Botswana police administration. All guidelines and regulations were carried out as per the MoH IRB.

Demographic Information

Table 1. Socio Demographic Information for Participants

Variables	Percentage (%)
Gender	
Male	40
Female	60
Age in years	
21-30	15
31-40	35
41-50	25
51-60	25
Level of Education	
Primary	20
Secondary	30
Tertiary	15
Occupation	
Farmer	20
Self-employed	10
Unemployed	35
Others	35
Home Village	
Letlhakeng	100
Length of Residency	
1-5 years	25
Over 5 years	75
Family Size	
1-2 members	45
3-4 members	30
5-6 members	15
More than 7	10

Transport to Healthcare	
Foot	60
Bicycle	5
Vehicle	25
Donkey	10

As indicated in Table 1, Males made up 60% of the respondents interviewed, with females making up only 40%. The respondents were between 21 to 60 years with majority of the respondents aged 31-4o% at 35%. The demographic results from the study showed varied levels of education and occupation among participants. A significant portion of participants (35%) were unemployed, with 30% having completed secondary education, 20% having primary education and 15% holding tertiary qualifications. In terms of occupation, 35% of respondents were unemployed, while 20% worked as farmers, 10% self-employed and the remaining 35% were engaged in other occupations. Most participants (75%) lived in their home village for more than five years, while 25% had resided there for 1-5 years. The family size of the participants also varied, with the majority (45%) having small families of 1-2 members, followed by 30% with 3-4 members, 15% with 5-6 members and 10% with more than 7 members. Regarding transportation to healthcare, majority of the participants (60%) relied on foot, and 5% used bicycles (Table 1).

Findings

The section below describes participants' knowledge and awareness of EMS service in the community. This section is organized into subheadings reflecting the subthemes that emerged from the two main themes: "Knowledge and awareness of EMS" and "Community EMS Needs." The first theme encompasses four subthemes: limited awareness of emergency numbers, over-reliance on informal communication, lack of EMS education in rural communities, and misconceptions about EMS. The second theme includes subthemes addressing the need for reliable and timely services, the shortage of trained personnel and ambulances, and a focus on the needs of vulnerable populations.

Community Knowledge and Awareness of EMS Services

Limited Awareness of Emergency Numbers

A significant proportion of participants reported being unaware of the emergency contact numbers for EMS, a trend observed across various stakeholder groups, including community members, healthcare providers, and law enforcement officers. This lack of awareness underscores a critical gap in the communication of essential information within the community, where individuals may delay seeking assistance or resort to less ineffective methods, potentially resulting in negative health outcomes. One participant expressed,

> *"I didn't know we had an emergency number to call for an ambulance, we usually just take people to the clinic ourselves because we don't know how to call the ambulance."-* ***Community worker.***

This gap highlights a critical area for improvement in public health communication strategies and community education initiatives, ensuring that all residents have the knowledge needed to access EMS efficiently. Without addressing these communication barriers, efforts to enhance EMS utilization and improve emergency health outcomes may remain limited.

Over-Reliance on Informal Communication

Many participants indicated that during emergencies they often turned to informal channels such as social media, friends, or

neighbors for assistance rather than contacting EMS directly. This dependence on informal networks can result in delays in receiving necessary medical care, as valuable time might be lost seeking help from individuals who are not equipped to handle medical crises. This lived experience reflects a significant barrier to accessing EMS, with the lack of readily available emergency contact numbers posing a considerable obstacle to timely emergency response. The statements below illustrate the various ways communication occurs during emergencies.

"Me being young, I get information from social media and friends about emergency services. I do not think the emergency service in the village is effective ... " Community worker.

"When something happens, the first person I call is usually a neighbor or a relative, not the ambulance." – VDC member.

These findings underscore the diverse reliance on both formal and informal communication channels and the difficulties participants encounter in consistently accessing EMS. Bridging these gaps through targeted education and awareness efforts could enhance EMS effectiveness by promoting more frequent use of emergency numbers and formal contact methods.

Figure 1 summarizes the suggested communication channels members of the community used.

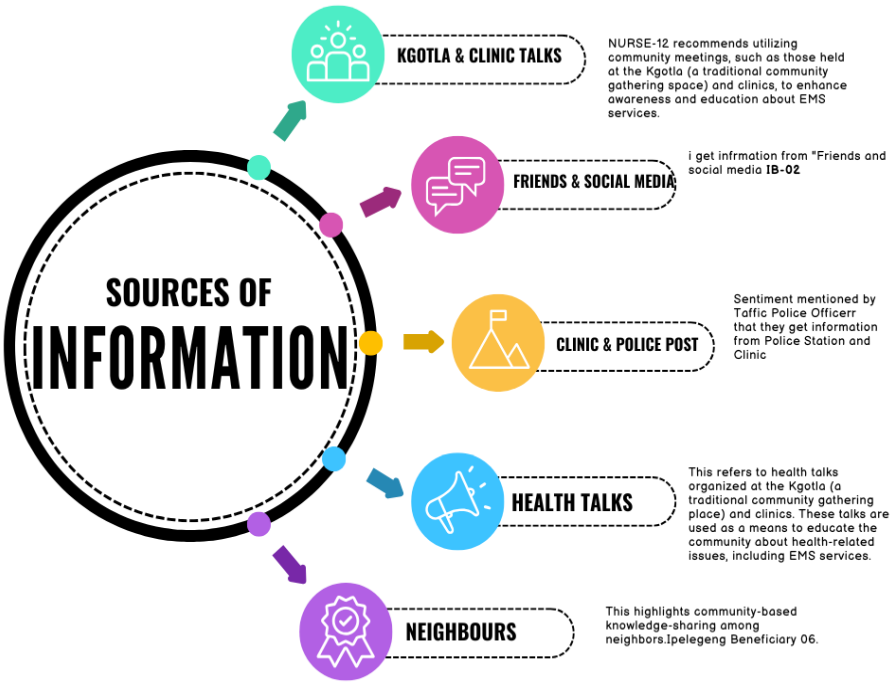


Figure 1. Sources of Information

Lack of EMS Education in Rural Communities

Rural communities generally lack structured education on EMS which contributes to widespread misconceptions about their role and scope, ultimately leading to underutilization of these services. The educational gap is likely due to limited access to healthcare information and resources in these areas, as well as the absence of targeted awareness campaigns tailored to rural populations' needs. The statements below demonstrate the lack of EMS education in rural areas.

"I do not think the community knows or has any information about EMS because most of them are illiterate" – Nurse -04

"No one has ever come to talk to us about what to do in an emergency." – Ipelegeng Beneficiary-05.

The quotes underscore the absence of EMC education in rural communities, revealing a significant gap in healthcare outreach and educational initiatives. This highlights the need for targeted programs to inform community members about the role of EMS, the process of assessing emergency services, and the importance of receiving timely medical care.

Misconceptions about EMS

Several participants expressed misconceptions about EMS, including the belief that it is sorely intended for severe injuries or accidents or that it should not be used for less critical situations. Such misunderstandings can deter individuals from utilizing EMS services when timely medical assistance could be beneficial. The statements below illustrate the community's misconceptions about EMS.

"Some misconceptions that the ambulance service is used to provide general patient care and transport patients and relatives everywhere they want to go... " – Nurse – 04

"I thought that if it wasn't a life-or-death situation, I shouldn't bother calling the ambulance." – Ipelegeng Beneficiary -07

The quotes reveal the community's limited understanding of EMS's scope, reflecting a tendency to underestimate the range of emergencies for which EMS can provide vital assistance. This lack of awareness may stem from an incomplete understanding of EMS capabilities, such as the ability to deliver pre-hospital care for conditions like heart attacks, strokes, and childbirth complications.

Cultural beliefs and past experiences also play a role in shaping misconceptions. For instance, negative encounters with the healthcare system may foster distrust or hesitation to seek formal medical help. Similarly, cultural norms emphasizing self-reliance or skepticism about external assistance for health issues may further contribute to misunderstanding about EMS services.

Community Knowledge Awareness

Figure 2 below depicts the frequency of key issues concerning community knowledge and awareness of emergency services. "Community awareness" emerges as the most prominent concern, with the highest frequency at 34, highlighting a critical need for enhanced public education. Other significant issues include "knowledge about EMS gap" (20) and "lack of awareness of emergency call lines" (10). These findings underscore the need to implement targeted educational initiatives to improve community understanding and the effective use of emergency services.

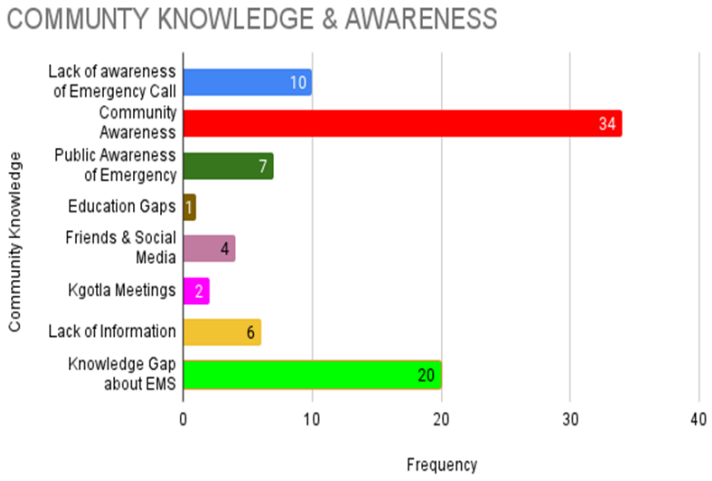


Figure 2. Key Issues Concerning Community Knowledge and Awareness of Emergency Services

Healthcare Needs of the Community

This theme examines the specific EMS needs identified by the community in Kweneng West subdistrict. The analysis highlighted an apparent demand for enhanced EMS services, especially for vulnerable groups as well as improvements in resources and response times.

Need for Reliable and Timely Services

Participants constantly stressed the importance of EMS being reliable and arriving swiftly during emergencies. This underscore the community expectation that EMS will respond quickly and efficiently when help is needed. This is especially critical in rural areas, where access to healthcare facilities is limited and delays can lead to sever consequences. The following quotes illustrate the community's concern about the reliability and timeliness of EMS responses.

" This difficult road delays the response of EMS providers which compromises patient care outcomes." - Nurse 05

"We need to be able to trust that the ambulance will come when we call." - VDC Member

This finding highlights the critical need for investment in infrastructure and resources that can facilitate quicker response times, including better road networks, strategically positioned EMS stations, and an adequate fleet of ambulances to effectively serve the population.

Lack of Trained Personnel and Ambulances

The community clearly highlighted the shortage of trained EMS personnel and lack of sufficient ambulances to meet their needs. The shortage of trained personnel and ambulances limits the EMS system's ability to respond effectively to emergencies, potentially compromising the quality of pre-hospital care and delaying transportation to appropriate medical facilities. The statements below illustrate the lack of trained personnel and ambulances to meet their needs.

"Most factors hinder timely delivery of EMS services; no EMS trained personnel, shortage of ambulances and equipment to use during an emergency". Nurse- 09

"We need more ambulances in our village, especially during the rainy season when the roads are bad." – VDC member -06

"The provision of adequate ambulances with appropriate equipment...for each village in the district." - Doctor-02

The above quotes clearly illustrate the resource constraints encountered by both the community and healthcare providers in Kweneng West subdistrict. They emphasize the need for additional ambulances, particularly in adverse weather conditions, and stressed the importance of well-equipped ambulances and properly trained personnel for delivering effective prehospital care.

Figure 3 shows the frequency of healthcare needs reported in the study. The categories are based on the themes identified, and the chart illustrates the distribution of needs mentioned by participants.

Emphasis on Vulnerable Populations

Participants emphasized the particular needs of vulnerable groups, including the elderly, pregnant women, and children. Vulnerable groups may have specific healthcare needs that demand specialized attention during emergencies and may encounter additional challenges in accessing timely care, such as limited mobility or difficulty in communicating their needs. The following statements emphasizes the particular needs of the vulnerable populations.

"The elderly often have difficulty getting to the clinic on their own, so having an ambulance that can come to them is very important." - Community Leader

*"Elderly people with NCDs complications, miscarriages, stab wounds, and other injuries including RTA victims. Farmers also sustain injuries and bites that require emergency care. "*Nurse- 06

"High risk pregnant women and women in labor - Many women deliver at home or on the way to the clinic so they should be prioritized" Nurse- 01

These quotes highlight the diverse needs of vulnerable groups in Kweneng West, including the elderly, pregnant women, children, individuals with disabilities, and those with chronic health conditions. Participants emphasized the importance of prioritizing these groups and ensuring that EMS services are equipped to meet their specific needs. For example, the elderly may require assistance with mobility, while pregnant women may need specialized care during transport. Children may have difficulty communicating their symptoms, requiring EMS personnel trained in pediatric assessment and care.

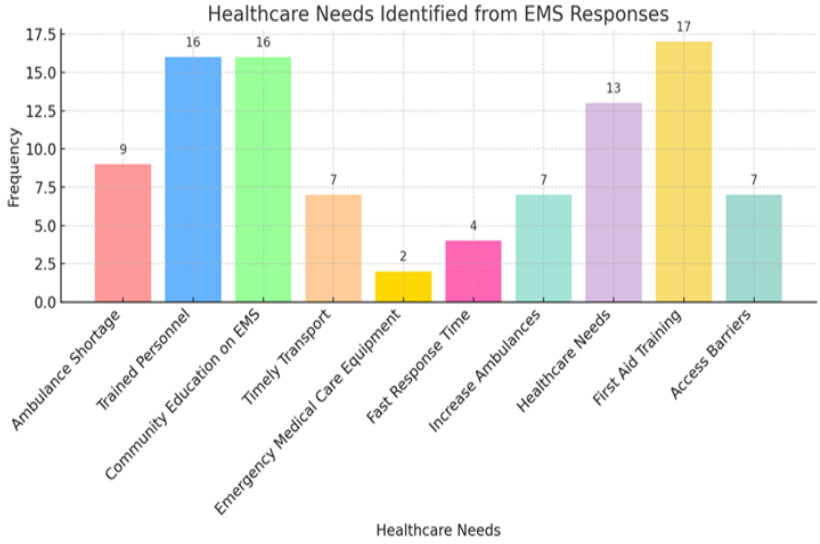


Figure 3. Frequency of Healthcare Needs

Table 2 reflects the range of vulnerable groups identified, emphasizing the importance of a responsive EMS system that addresses both routine and urgent medical needs across the community.

Table 2. Vulnerable Population Groups

Vulnerable Population Group	**Description**
Elderly Individuals with NCD Complications	Require EMS support for complications from hypertension, renal failure, and hyperglycemia
Children	High risk of injuries and illnesses, requiring timely EMS access
Pregnant Women (including Labor & Miscarriages)	Urgent EMS needs for labor and miscarriage complications
People with Disabilities	Require additional assistance during emergencies due to physical or cognitive limitations
Road Traffic Accident (RTA) Victims	Immediate EMS response needed for injuries sustained in road accidents
Stab Wound Victims	Require urgent EMS intervention for trauma and blood loss
Farmers	Higher risk of injuries from accidents, bites, and stings due to work environment

Individuals with Chronic Illnesses (NCDs)	EMS required for conditions like hypertension, diabetes (hyperglycemia), and renal failure
Low-Income Families	Depends heavily on public EMS due to limited access to private transport and healthcare resources
Remote Community Members	Experience delays in EMS response due to geographic isolation and poor infrastructure
Uninsured or Medically Unassisted	Rely on public EMS as they lack alternative healthcare resources
Women in Labor	Immediate EMS needed for safe transport and delivery support
Injured Adults and Children	Require EMS for a variety of injury types, including household and community-related injuries.

Discussions

Community Knowledge and Awareness of EMS

The study found that residents of the Kweneng West Subdistrict exhibit varying levels of awareness regarding EMS. While some are aware of EMS's lifesaving potential, others are unfamiliar with its functions, often turning to private vehicles or traditional healers in emergencies. This knowledge gap presents an opportunity for local authorities to launch community education programs to clarify the role of EMS and when to use it.

These findings align with those of [3], who suggested that a single toll-free emergency number is essential for increasing community use of EMS. When community members are aware of the emergency contact number, they are more likely to seek help during acute illness or injury, potentially improving patient outcomes. Similar issues related to a lack of public awareness have been observed in other developing countries, as noted by [9] and in EMSAT studies [10]. The lack of knowledge regarding emergency contact numbers, as found in [11], who identified a lack of public awareness about emergency care and social inequalities in Germany, which were influenced by education and migration status. In Kweneng West, the community's relatively low education level aligns with these findings. Several studies indicate that low health literacy is associated with frequent and inadequate use of healthcare services, including emergency services [12, 13].

According to the WHO EMS system framework, community members must be aware of and know how to request help by calling EMS, such as an ambulance, in response to injury or acute illness. However, the study found that the Letlhakeng community lacks knowledge of the emergency call number, which may hinder their access to EMS services. WHO recognizes emergency medical treatment as a vital component of integrated healthcare delivery and highlights strengthening EMS as a key step toward achieving universal health coverage [14].

Community Needs

The theme of "Healthcare Needs of the Community" highlights the significant demand for expanded Emergency Medical Services (EMS) in the Kweneng West Subdistrict, particularly due to the unique healthcare challenges faced by this rural region. Participants in the study emphasized the vulnerability of specific groups, such as children, the elderly, and individuals living in remote areas, who would greatly benefit from enhanced EMS availability. This need aligns with findings from other studies [15, 16] that recognize how timely EMS intervention can

notably improve health outcomes for at-risk populations.

However, concerns about the inadequate availability of EMS services were widespread among participants. Many called for more ambulances and better-equipped medical personnel to serve the community, particularly given the logistical challenges posed by the rural setting. Geographic isolation, limited transportation options, and the scarcity of healthcare facilities all contribute to these challenges, making it difficult for residents to access timely care when needed [17].

To ensure that the community fully benefits from EMS services, addressing these healthcare needs is paramount. This requires not only increasing the availability of EMS but also ensuring that the services are equipped to handle a variety of medical emergencies [18]. Another significant barrier identified in the study is the limited public understanding of when and how to utilize EMS. Many community members still hold misconceptions, believing that EMS should only be called for severe injuries or critical conditions. This lack of awareness often results in delays in seeking help during emergencies, potentially compromising patient outcomes [9, 19].

Research across contexts reinforces the importance of improving community knowledge of EMS's role and capabilities. Studies in countries such as Saudi Arabia have demonstrated that insufficient public knowledge of emergency services leads to underutilization, a challenge that similarly affects developing nations [3]. These findings highlight the need for targeted educational initiatives that clarify the full scope of EMS functions and encourage proper usage.

Ultimately, addressing the community's healthcare needs in Kweneng West requires a dual approach: improving the availability and capacity of EMS services while simultaneously enhancing public awareness. By fostering a better understanding of EMS's role through community outreach and education, the community can be better prepared to respond to emergencies, leading to improved health outcomes and overall resilience.

Misconceptions and Knowledge Gaps

Research has consistently shown that public awareness of Emergency Medical Services (EMS) is essential for improving the effectiveness of emergency responses. Studies conducted in Saudi Arabia and other developing countries [9, 10] have found that many individuals lack crucial knowledge about the roles, availability, and accessibility of EMS. This knowledge gap can hinder EMS from delivering timely and life-saving assistance. For instance, [9] discovered that individuals with higher education levels were sometimes less informed about EMS than those with lower levels of education.

In the Kweneng West subdistrict, particularly in Letlhakeng and surrounding remote areas, many residents with limited literacy were unaware of EMS services and relied on traditional healthcare methods instead. However, those familiar with EMS recognized its potential to save lives in emergencies. Despite this, misconceptions remain, including the belief that EMS should only be used for severe injuries. Addressing these misunderstandings through targeted education initiatives could increase EMS awareness among less educated community members, leading to greater EMS utilization, improved patient outcomes, and reduced fatalities and complications from acute illnesses and injuries.

The study also found that younger individuals were more likely to be aware of EMS, often through social media and visits to larger villages. This trend mirrors findings by [9] in Saudi Arabia. Additionally, community members who understood EMS recognized specific service needs, particularly for vulnerable groups, further underscoring the importance of education in promoting better EMS awareness and use.

This study had limitations. These include a small sample size of 34 participants, which may not fully capture the diversity of EMS awareness and needs across the entire Kweneng West Subdistrict. The geographic focus on a rural area may limit the applicability of the findings to urban regions with different infrastructure and socio-economic characteristics. Logistical challenges in accessing remote areas also meant that some isolated communities may have been underrepresented. Additionally, reliance on self-reported data may introduce biases or inaccuracies, highlighting the need for future studies to incorporate larger, more diverse samples and triangulation methods to enhance the reliability of findings.

Conclusions

In conclusion, this study highlights the critical need for a comprehensive understanding of community perspectives on Emergency Medical Services (EMS) in the Kweneng West Subdistrict. Enhancing community awareness and addressing existing misconceptions are fundamental to improving the effectiveness of emergency healthcare delivery, particularly in rural Botswana. As EMS systems continue to evolve, community education must keep pace to ensure that all populations, including vulnerable groups, can access and use these life-saving services. Targeted awareness campaigns, resource allocation, and training programs will be key to bridging the knowledge gap and fostering greater community engagement with EMS, ultimately leading to improved health outcomes and more timely, effective emergency responses.

Conflict of Interest

The author declares no conflict of interest.

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Factors Associated with Non-Adherence to Medication Among Geriatric Diabetic Patients in Mandeville, Jamaica

Ainsworth M. Reynolds[1*], Sean Moncrieffe[2], Justin Chanda[3]
[1]*School of Public Health, Texila American University, Zambia*
[2]*Department of Pharmacy, Faculty of Health and Applied Science, University of Technology, Jamaica*
[3]*Department of Public Health, Faculty of Allied Medical Sciences, Texila American University, Zambia*

Abstract

Diabetes mellitus is a common health problem in Jamaica, causing a massive burden for individuals, families, communities, and the health sector. Diabetes leads to chronic physical and socioeconomic challenges. Adherence to diabetes therapy is crucial for preventing complications and alleviating the socioeconomic burden on the healthcare system. This study aimed to determine the factors contributing to non-adherence to diabetic therapy among geriatric patients with diabetes in Mandeville, Jamaica. Using a convenient sampling method, a quantitative cross-sectional design was conducted across five health centers in Mandeville, Jamaica. A sample size of 150 participants was surveyed using a semi-structured, self-administered questionnaire. Using a convenient sampling method, a quantitative cross-sectional design was conducted across five health centers in Mandeville, Jamaica. A semi-structured, self-administered questionnaire was used to survey 150 participants. The prevalence of diabetes among geriatric diabetic patients was 62.5% for Type 2 diabetes and 37.5% for Type 1 Diabetes. The sample size used indicates an overall prevalence of 100. The study concluded that medication adherence was low and significantly associated with poor compliance. However, future management interventions for diabetic geriatrics should focus on improving medication adherence.

Keywords: *Adherence, Comparative, Diabetes, Factors, Geriatrics.*

Introduction

Medications are frequently used among the elderly to improve quality of life, extend life expectancy, and cure diseases. Evidence shows, however, that the elderly often fail to adhere to prescribed medications, leading to unwelcome clinical and economic consequences [1].

Diabetes mellitus (DM) is a metabolic disorder resulting from a defect in insulin secretion, insulin action, or both, and its prevalence is rapidly rising all over the globe at an alarming rate [1]. Data from the World Health Organization (2017) revealed that the number of people living with diabetes had risen from 108 million in 1980 to 422 million in 2014. They confirmed that the global prevalence of diabetes among adults over 18 years of age had increased from 4.7% to 8.5% within the same time [14]. In 2015, the American Diabetes Association reported that 30.3 million Americans (9.4%) of the population had diabetes, with the most prevalent being seniors aged 65 and older, remaining high, at 25.2%, or 12.0 million seniors (diagnosed and undiagnosed).

For Latin America and the Caribbean, there was a projected 148% increase in the number of

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****Corresponding Author: Areynolds184@gmail.com***

people with diabetes, resulting in 33 million people living with diabetes by 2030 [14]. This projected increase is attributable to rising prevalence of diabetes risk factors and an aging population. (Wild et al., 2018). In the Jamaica Health and Lifestyle Survey 2007-2008 (JHLS-2), the prevalence of diabetes ranged from 1.2% among persons 15-24 years to 29.6% among those 65-74 years (Wilks et al., 2008). In 2016, the WHO reported that the overall prevalence of diabetes in Jamaica was 11.9% [15].

(JHLS 3) 2016-17 revealed that 2,339 persons died from diabetes in Jamaica, accounting for 12.7% of all deaths. As a cause of death, diabetes is ranked third for men, with 966 deaths, and first for women, with 1,373 [3].

The prevalence of diabetes has increased by 41.1% from 2001 to 2017 among Jamaicans 15 to 74 years old. Approximately 11.9% (9% men, 14.6% women) or 236,200 Jamaicans 15 years and older have diabetes. The prevalence increases with age, and more women than men have diabetes. There are 92.5% (91.3% male, 93.0% females) of Jamaicans 15 years and older with diabetes who are on treatment. Of those on treatment, only 27.5% (29.0% males, 27.0% females) are controlled [5]. According to the Jamaica Health and Lifestyle Survey (2016), the prevalence of diabetes ranged from 1.2% among persons 15-24 years to 29.6% among those 65-74 years [8]. In 2016, the WHO reported that the overall prevalence rate of diabetes in Jamaica was 11.9%, which is high and of grave concern.

Effective management of diabetes is associated with lower morbidity, mortality, and healthcare utilization, thereby reducing the cost and burden of illness (BOI) to the government, individuals, and the community. However, findings from several studies have revealed that several factors contribute to the poor management of diabetes. A study done in the United States indicated that people with diabetes who did not adhere to treatment had significantly worse. Clinical outcomes compared to patients who adhered to treatment [3]. Despite the emphasis put on patients on the importance of appropriate medication use, many patients poorly adhere to drugs, especially for chronic diseases, and fall short of achievable health goals as a result [8].

Non-adherence is associated with factors that are patient-centered, therapy-related, or healthcare system-related [6]. The patient-centered factors include demographic and psychological issues. Demographic educational level and marital status are among the demographic issues. In contrast, patients' beliefs and motivation towards therapy, negative attitudes, patient-prescriber relationships, understanding of health issues, and patients' knowledge contribute to the psychological issues. The therapy-related factors include the route of medication administration, treatment duration, treatment complexity, type of medication, and drug side effects [4]. The factors linked to the healthcare system include the availability and accessibility of healthcare, as well as the interaction between health providers and patients [9]. Medication-related side effects are also associated with non-adherence [2].

Method

Research Design

A quantitative cross-sectional design was employed to identify factors contributing to nonadherence and to assess the level of nonadherence among participants from Mandeville, Jamaica. The survey was conducted among five Type 5 health centers serving geriatric patients aged 65 and older. The sample size was calculated as 150. After obtaining ethical approval from the Ministry of Health, a pre-tested questionnaire incorporating input from the Morisky Model was used to collect data. The Statistical Package for the Social Sciences (SPSS) version 21 and Microsoft Excel were used to analyze the data.

Study Population

The population comprised geriatric patients who have been diagnosed with diabetes and are receiving care from five types (5) health centres in Mandeville, Jamaica. Most participants in this study are from communities adjoining Mandeville, where many are retired and unemployed. Some are employed and are within the middle-income bracket (some live. within a reasonable distance from the health center and public hospital, others must travel a considerable distance to the health facilities. The percentage of geriatrics with diabetes aged 65.

The population aged 65 and older in Mandeville accounts for 3.2% of the Jamaican population [5].

Distribution of the Study Population

Health Centres	Frequency	Percentage
Health Centre I (Colleyville District)	30	20
Health Centre II (Langley District)	30	20
Health Centre III (Lincoln District)	30	20
Health Centre IV (Cedar Valley District)	30	20
Health Centre V (Hatfield District)	30	20

Sample Size

The sample size was determined by using the Yamane (1967) formula shown below:

$$n = \frac{N}{1 + Ne^2}$$

Where:

$n =$ Representable sample size

$N =$ Total population size

$e =$ Desired level of precision

After consulting with the clinics, it has been determined that with five clinics, the calculated diabetic geriatric population (*N*) would be more than or equal to 240. The desired level of precision (*e*) is ±5%. The representable sample size (*n*) is therefore given by:

$$n = \frac{240}{1 + 240(0.05)^2} = \frac{240}{1.6} = 150$$

Therefore, a sample size of 150 diabetic patients is required to be selected from a population of 240 patients.

Sampling Method

Convenient sampling was used to select the sample population. This method was chosen since attendance may vary among clinics; hence, it was implemented on a first-come, first-served basis.

This allowed faster and more efficient data collection.

Inclusion Criteria

1. Participants over 65 years of age and diagnosed with diabetes mellitus.
2. Participants who resided in Mandeville
3. Participants who consented to participate in the research study.

Exclusion Criteria

1. Participants younger than 65
2. Participants who were too ill to participate in the study.

Data Collection Methods

Self-administered structured questionnaires were used to gather information. This tool consisted of information about the sociodemographic characteristics of the respondents, the pattern of drug adherence, and factors contributing to non-adherence. The questionnaire also contained information on the drugs prescribed, their doses, and frequencies. The instrument consisted of approximately twenty (20) questions. All participants who required assistance were given it.

The selected clinics were visited during the scheduled clinic time (8:00 am to 12:00 noon),

and biweekly (Tuesday and Thursday), as it was convenient within six weeks. Nurses were asked to assist in identifying geriatric patients, and data were collected until the required numbers were met. One hundred and fifty (150) questionnaires were printed and divided equally among the five (5) clinics, so that each clinic would receive (30) questionnaires to achieve the sample size. Patients were allowed to complete the questionnaire independently, and the researcher gave them standard assistance with reading and writing if necessary.

Pilot Study

To test the data collection methods, one (1) government clinic was identified and informed of the research via letter. Visits were made to these sites to prepare an area where the work could be performed without distracting from the staff's typical workflow. Information on all the patients was collected, which helped in the selection process. Questionnaires were given to 5 patients (3.3%) to assess clarity and whether the instrument's questions needed tweaking to improve understanding. The pilot study was conducted to improve the questionnaire's reliability.

Reliability and Validity

Criterion validity (or criterion-related validity) evaluates how accurately a test measures the outcome that it was designed to measure. Internal validity is the degree of confidence that the causal relationship you are testing is not influenced by other factors or variables. External validity is how your results can be generalized to different contexts. The validity of your experiment depends on your experimental design. Criterion validity (or criterion-related validity) evaluates how accurately a test measures the outcome it was designed to measure. An outcome can be a disease, behavior, or performance. Concurrent validity measures tests and criterion variables in the present, while predictive validity measures those in the future.

Data Analysis Plan

Data collected at the end of the six (6) weeks of assessment were coded and entered into the Microsoft Excel and Statistical Package for Social Sciences (SPSS) software (version 21) for statistical analysis. The primary outcome variable was the level of adherence. Using chi-squared statistics will follow descriptive statistical analysis for the outcome variable, association with patient-centered, therapy-related and healthcare system factors. Inferential statistics will be used to draw conclusions about the target population from sample results.

Ethical Considerations

Ethical approval was obtained from the Southern Regional Health Authority and the Ministry of Health Ethics Committee before the study's conduct. Participants provided informed consent before the questionnaire was distributed, and respondents were informed that their participation in the survey was voluntary. All respondents were respected and reassured about privacy and anonymity, and the discussions and data analysis were conducted with the highest objectivity and accuracy required. The collected data was not made accessible to any third party and was used solely for research. The completed questionnaires were stored in a locked room to ensure data security, and we eventually shredded them.

Presentation of Findings

Demographic Characteristics of Participants

Table 1. Demographic Characteristics of participants n=150

Variable	Frequency	Percentage
Age		
65-69	33	22

70-78	24	16
75-79	24	16
80-84	23	15
85-89	26	17
90 and over	20	13
Gender		
Male	52	35
Female	98	65
Residence of Jamaica		
Residents	127	85
Non-residents	33	15
Level of Education		
Primary	32	21
Secondary	63	42
Tertiary	55	37

Table 1: Most participants, 42%, had attained secondary education, while 37% had tertiary-level education and 21% had primary education. As represented in the table the majority of the respondents 127(85%) were residents of Jamaica.

Diabetes Mellitus (DM) and Sociodemographic Characteristics

Table 2. Relationship between Diabetes Mellitus (DM) and sociodemographic characteristics (n =150).

Age	**Present**	**Absent**	**Total**
Less than 70	33(22%)	117(78%)	150(62.5%)
More than 70	45(50%)	45(50%)	90(37.5%)
Total	78(32.5%)	162(67.5%)	240(100%)
Gender	**Present**	**Absent**	**Total**
Male	98(68.5%)	45(31.5%)	143(59.5%)
Female	52(53.6%)	45(46.4%)	97(40.5%)
Total	150(62.5%)	90(37.5%)	240(100%)
Occupation	**Present**	**Absent**	**Total**
Employed(Housewife)	38(60.3%)	25(39.6%)	63(26.25%)
Unemployed	84(73.6%)	30(26.4%)	114(47.5%)
Retired	28(44.4%)	35(55.6%)	63(26.3%)
Students	0	0	0
Others	0	0	0
Total	150(62.5%)	90(37.5%)	240(100%)
Marital Status	**Present**	**Absent**	**Total**
Single	32(56.2%)	25(43.8%)	57(23.8%)
Married	37(68.5%)	17(31.5%)	54(22.5%)
Divorced	17(58.6%)	12(41.3%)	29(12.1%)
Widowed	13(44.8%)	16(20.6%)	29(12.1%)
Separate	51(71.8%)	20(29.8%)	71(29.6%)
Total	150(62.5%)	90(37.5%)	240(100%)

Table 2 shows that most participants were aged 70 or above (37.5%) and were male (59.5%). Furthermore, the majority (49.6%) were unemployed, single (23.8%), and separated from their spouse (29.6%).

Medical History of Participants

Table 3. Medical History of Participants

Duration of diagnosis with diabetes	**Frequency**	**Percentage**
Less than 1yr	6	4
3-5 yrs	25	17
6-10 yrs	34	23
11-15 yrs	35	23
16-20 yrs	20	13
>21 yrs	30	20
Total	**150**	**100**
Knowledge of the effects of disease on the body		
Yes	53	35
No	97	65
Total	**150**	**100**
Prescribed anti-diabetic medication		
Yes	103	71
No	43	29
Total	**150**	**100**
No. of anti-diabetic medication taken per/day		
1-2	49	32
3-4	64	43
>5	37	25
Total	**150**	**100**

Table 3: above shows that the majority (23%) have been living with DM for 6 – 15 years, and a few (4) were recently (less than a year) diagnosed with DM. Further, 35% are knowledgeable about the effects of DM, and the majority (71%) are on treatment. The majority (43%) of the participants take more than three medications.

Pharmacological History of Study Participants

Table 4. Percentage Adherence of Participants on a different class of Medications and some common combinations (Health Centres I-V) n=150

Age Range	**Class/Combination of Drugs**	**Dose/Per day**				**High Adherence**	**Moderate Adherence**	**Low Adherence**
		OD	**BD**	**TDS**	**QID**			
65-69	Sulfonylureas only	92	48	0	0	0.00%	32%	61%
70-78	Biguanides only	101	45	4	0	3%	30%	67%
75-79	Insulin only	85	53	0	0	0.00%	35%	57%
80-84	Biguanides and Sulfonylureas	115	35	0	0	0.00%	33%	67%

85-89	Biguanides with Insulin	84	42	22	0	16%	28%	56%
90 and over	Biguanides with Dipeptidyl Peptidase 4 inhibitors and Insulin	103	33	14	0	9%	22%	69%

Table 4 shows a general low adherence to ant-diabetic therapy. Those on a combination of Biguanides and Insulin exhibited higher adherence levels (16%) compared to those on Biguanides only. Those on Insulin only were the least in terms.

Table 5. Knowledge of treatment/complications for health centres I-V n=220

Knowledge of medication usage	**Frequency**	**Percentage**
Yes	95	63
No	55	37
Medication regimen change		
Yes	35	23
No	115	77
Compliance with the pharmacist's explanation		
Yes	79	53
No	71	47
Ability to read and understand medication labels		
Yes	83	55
No	67	45
Factors preventing the intake of prescribed medicines		
Side effects	19	13
Cost	70	47
religious beliefs	9	6
Herbal medicines	15	10
Limited access to health care	23	15
Lack of confidence in the doctor	14	9
Common complaints other than high blood sugar		
Heart problem	24	16
Kidney problem	46	31
Eye condition	30	20
Sight Challenge		
Yes	67	45
No	83	55
If yes, does it prevent you from taking medication?		
Yes	40	27
No	110	73

Table 5: shows that the cost of medication was the most common factor (47%) cited for non-adherence to medication while limited access to healthcare facilities accounted for 15%.

Table 6. Levels of Adherence from the Morisky 8 Medication Questionnaire n=150

Question	Answer	Number	%
Do you sometimes forget to take your hypertensive pills?	Yes	93	62
	No	57	38
People sometimes miss taking their medications for reasons other than forgetting. Thinking over the past two weeks, were there any days when you did not take your high blood pressure (hypertension) medicine?	Yes	89	60
	No	61	40
Have you ever cut back or stopped taking your medication without telling your doctor/ pharmacist because you felt worse when you took it?	Yes	111	74
	No	39	26
When you travel or leave home, do you sometimes forget to bring along your high blood pressure medication?	Yes	70	47
	No	80	53
Did you take your high blood pressure (hypertension) medicine yesterday?	No	63	42
	Yes	87	58
Do you sometimes stop taking your medicine when you feel your blood pressure is under control?	Yes	83	55
	No	67	45
Taking medication every day is a genuine inconvenience for some people. Do you ever feel pressured to stick to your blood pressure treatment plan?	Yes	115	77
	No	35	23
How often do you have difficulty remembering to take all your medications?	Never/Rarely	31	20.7
	Once in a while	32	21.3
	Sometimes	33	22
	Usually	28	18.7
	All the time	26	17.3

Table 6, in general, shows a moderate to low level of adherence and describes the total number of participant responses. Although 77% of patients had problems adhering to their treatment regimen and stopped taking their medications even when they felt worse, responses to the questions about forgetting medications, stopping medications when they felt better, and forgetting to take medications had more yes responses than no responses. According to the MMAS-8 score, 115(77%) of respondents exhibited moderate adherence, while 33(22%) and 32(21.3%) showed low adherence. The average adherence score was 52.2, with a standard deviation (SD) of 21.08.

Table 7. Socioeconomics for Health Centres I-V

Type of financial support	Frequency	Percentage
Self	34	23
Government	41	27
Health Insurance	49	33
Family	26	17
None	0	0

Description of the living conditions among geriatrics		
Stable	78	52
Unstable	59	39
Homeless	13	9

Table 7 reveals that the majority (33%) of the study participants are covered by a health insurance scheme. In comparison, 27% are dependent on government support, 23 % meet the health bills (self-financed), and only 17 % depend on their families. A significant percentage (39%) described their living conditions were unstable, while 9 % indicated being homeless.

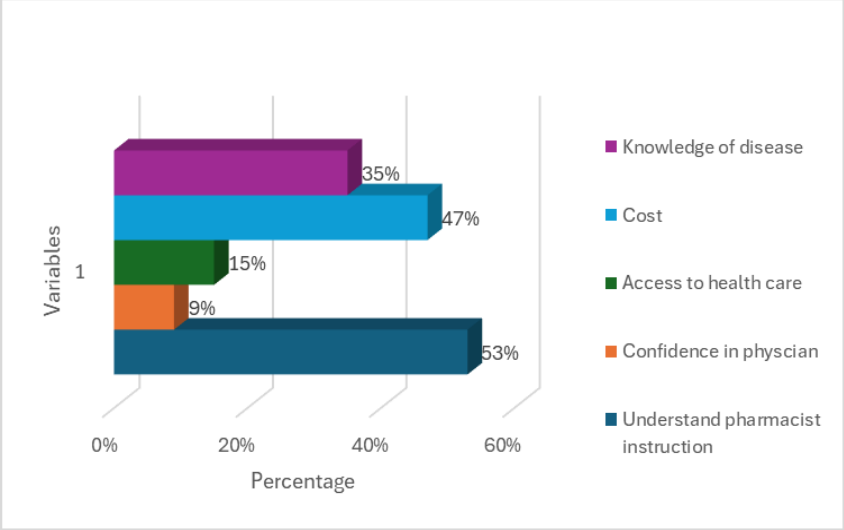


Figure 1. Factors influencing adherence

As shown in Figure 1, understanding the instructions of the pharmacist (53%) was the key factor influencing adherence, followed by the cost (47%) and knowledge of the disease (35%).

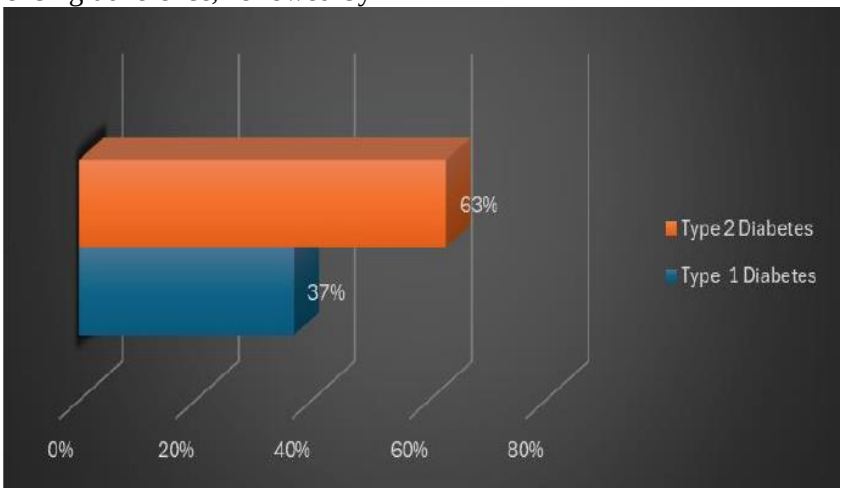


Figure 2. Prevalence of diabetes among the geriatrics in Mandeville, Jamaica

As shown in Figure 2, 63% of geriatric diabetics have Type 2 diabetes, and 37% have Type 1 diabetes indicates that there is a high prevalence of type 2 diabetes.

Discussion

Socioeconomic Factors Contributing to Non-Adherence to Diabetic Therapy

The current findings also showed that patients who traveled long distances to reach the health centers were more likely to be non-adherent to their medications (due to Limited access to healthcare) than those who traveled shorter distances (Table 5). This may be because patients who live far from health facilities may not visit them as frequently as those who live nearby, due to transport costs and other financial constraints. Findings from the study also revealed that patients' overall knowledge of the disease was high at 65%, and employment is low at 38% which could be major contributing factors to non-adherence. The current findings also showed that 15% of patients had limited access to healthcare, and 47% had low confidence in their physician, which contributes to the factors leading to non-adherence. It was also found that low income, which often contributes to chronic stress, is a major contributor to non-adherence.

The cost of health care and anti-diabetic medications was found to be high, which could lead to a high rate of non-adherence due to medication non-compliance. The study further revealed that financial support to cover medical bills and other social services was a significant challenge for the elderly [11, 12].

The study (Table 7) revealed that a significant portion of the population had no health insurance or government support, as 23% and 17% relied on self and family support, respectively, to meet medical bills. This, therefore, could be attributed to one of the social factors contributing to adherence to diabetic therapy among the elderly. Other socioeconomic factors identified in the study included the highly stable living conditions among the geriatric population (Table 7). An unstable living condition implies challenges with movement to and from accessing medical services as well as other needs, therefore affecting the general well-being of geriatric diabetic clients.

This study yielded similar findings to those reported by the American Medical Association (2015) regarding diabetes and age. The study findings indicated that those over 70 years and who were diabetic had challenges adhering to treatment. This finding is similar to what the American Medical Association (2015) reported, that the elderly living with diabetes and are on treatment recorded low adherence to treatment. This suggests that age plays a role in treatment adherence.

The study further revealed that the cost of medication, 47% (Table 5), was one of the common factors contributing to non-adherence. This could be attributed to the low (33%) participation in health insurance schemes and to 39% of those who described their living conditions as unstable (Table 7). The high cost of medication can also be attributed to the fact that most participants (84%) were unemployed, thereby facing economic challenges in purchasing medication [13].

Prevalence of Non-Adherence to Diabetic Therapy

In this study, the overall non-adherence of participants to diabetic drugs was found to be 77% (Table 6). The prevalence of Type 2 Diabetes among geriatrics was found to be 63% and Type 1 Diabetes 38% from a sample of 150 geriatric diabetics, which indicates an overall prevalence of 100% (Fig. 2), of which 65% were males and 35% were females (Table 2). This suggests that Type 2 DM is more prevalent than Type 1 DM among the geriatric population in Mandeville, Jamaica. The study further revealed that patients' overall knowledge of medication use was high (63%), which could be attributed to the fact that most participants had attained a secondary education level.

Compliance with pharmacist instructions was 53%, and the ability to read and understand medication labels was 55% (Table 5). Despite above-average compliance and educational

levels, medication adherence remained low. Other factors cited for non-adherence to diabetic therapy included the side effects of drugs and religious beliefs. A few patients expressed concerns about their medications, citing cost and side effects they experienced, and were unable to access all their medications at the pharmacy health center [16]. A lack of confidence in physicians at the health centers was also found to negatively impact medication adherence in this study, which results in an unwillingness to initiate new therapies [17].

This study's findings of nonadherence to medication therapy were sub-optimal among geriatric diabetics (77%). This was found to be similar to a survey done by [6], which stated that non-adherence to medication was common among geriatric diabetics. Other studies on medication non-adherence among diabetics include "Patient medication adherence measures in daily practice" by Beena Jimmy et al. (2008), received February 3, 2011, and Accepted April 9, 2011. The unmet challenge of medication adherence, purchased online, July 5, 2018. The Impact of Medication Adherence on Health Status and Medical Expenses among Patients with Diabetes Mellitus in Taiwan. (Lin Chin-Shien) Ph.D., Khan Haider Ph.D.

Another finding of this study revealed that complications such as kidney disease, eye conditions, and hypertension (Table 5) were identified by the study population living with diabetes and were common complications. This reveals similarities with [2], finding that poor adherence leads to chronic complications. Generally, adherence to medication among the study population was poor.

Interventions Contributing to the Effective Management of Non-Adherence to Diabetic Therapy

The researcher found that exploring patients' concerns about their medications and addressing potential barriers to taking them as prescribed should be considered in future patient-centered interventions aimed at improving medication adherence, thereby enhancing glycemic control and health outcomes among patients with diabetes. Moreover, team-based care that includes pharmacists is an effective strategy for giving patients opportunities to raise their concerns, thereby improving their adherence [10]. Due to the strong association between medication adherence and patients' beliefs about medications observed in this study, it is necessary to investigate the variables that are associated with medication beliefs.

The study also revealed that a lower education level was associated with a lower perception of medication necessity and increased concerns about the medications. Therefore, exploring the benefits of diabetes medications in controlling blood glucose and the serious complications that can develop due to medication non-adherence should be incorporated into disease management intervention programs for patients with low levels of education, particularly during their delivery. Healthcare needs to be more accessible for patients who live great distances from healthcare facilities, and stakeholders and economic groups should provide more financial support to help offset the costs of healthcare, such as medication costs, for these patients [18].

Health education programs need to be improved through health promotion to better educate patients about their disease condition, which will reduce mortality and further complications and co-morbidities, especially among diabetic clients. A reduction in co-morbidity and mortality related to diabetes will consequently lead to lower medical expenses at both the household and national levels.

Conclusion

It can be concluded that effective management of diabetes is associated with lower morbidity, mortality, and healthcare utilization, thereby reducing costs and burdens

on the government and the community. It is also argued that, because the magnitude of nonadherence and the scope of its effects are high, more health benefits within the community, adjoining areas, and worldwide would result from improving adherence to existing treatments than from developing new medical therapies [7]. It was also concluded from the study that the prevalence of diabetes mellitus among geriatric diabetics in Mandeville, Jamaica, was 62.5% for Type 2 Diabetes and 37.5% for Type 1 Diabetes, which indicates an overall prevalence of 100%, from a sample of 150 geriatric diabetics, which was taken from a population of 240. It can be concluded that Type 2 Diabetes (Fig. 2) is more prevalent than Type 1 among geriatric diabetics in Mandeville, Jamaica.

Practitioners should always be on the lookout for poor adherence and work to reduce it by emphasizing the value of the patient's regimen, making it as simple as possible, and tailoring it to the patient's lifestyle. The influence of eliminating drug costs for individuals discharged from the hospital on non-adherence to therapy cannot be prevented even if patient drug costs are eliminated [5].

According to [4], adequate, clear, and high-quality information regarding diabetes and antidiabetic medications should be provided to all diabetic patients to make them aware of the disease's future complications and the benefits of drug therapy. These factors fall into the category of health promotion and are considered key to modifying behaviors among people with diabetes. Quality information on antidiabetic therapy remains an essential recommendation for healthcare providers, as it helps improve knowledge about diabetes and its treatment.

The prevalence of non-adherence to diabetic drugs in this study was suboptimal at 77% (Table 6). Urgent interventions are needed to follow guidelines for improving care among people with diabetes.

Regular counseling and follow-up of patients are also needed to address this nonadherence.

The significant factors associated with patients' non-adherence to anti-diabetic medications were monthly income, the dose administered at each visit, the distance traveled from home to the health facility, the number of medicines prescribed per visit, the number of admissions due to diabetic complications, and the presence of drug side effects. Socioeconomic factors, including monthly income, living conditions, and employment status, were found to be major contributors to the level of non-adherence experienced at the health facilities [19].

From the study, it can be concluded that the level of non-adherence and medication compliance among geriatric diabetics is poor overall, and several patients have lost confidence in the services received at the health facilities.

Recommendation

Tackling the issue of non-adherence to medication is a priority for policymakers and researchers. In line with this, pharmacists and nurses are considered front-line professionals in addressing medication-related non-adherence. The high prevalence of medication non-adherence and the contributing factors identified in this study should serve as a baseline for policymakers, concerned governmental bodies, and various stakeholders who promote rational medicine use to assess the currently available policies regarding rational medicine use. Based on the findings of this study, the researcher recommends that diabetes mellitus (DM) clinics within health institutions enhance their chronic patient follow-up mechanisms. Additionally, healthcare providers should develop educational programs that promote patients' adherence to prescribed medications and reduce the number of drugs prescribed to diabetic patients. Furthermore, the researcher recommends that researchers and

academic institutions conduct additional, more comprehensive scientific studies in the region to understand patient adherence better and identify various issues related to adherence and non-adherence within the area [20]. Factors such as limited access to healthcare, patients' knowledge of the disease, and the clarity of pharmacist instructions and medication labels must be addressed during clinic visits. The pharmacist's initiation of counseling and follow-up must be consistent to achieve optimal adherence. Infrastructure within health centers must be improved to enable patients to access a broader range of medical services, such as various medications, thereby offsetting costs and enhancing compliance. Patients need to be monitored closely for side effects, especially if they are on several diabetic medications, to help reduce the level of non-adherence. Furthermore, the government needs to provide more financial support to improve adherence, as it currently contributes only 27% of total healthcare funding, including medication and other supplies. Patients need to be better educated about their condition through health promotion programs initiated by the government and private-sector groups.

Ethical Approval

Ethical approval was obtained from the Southern Regional Health Authority.

Conflict of Interest Statement

The authors declare that there are no commercial or financial relationships that could be construed as a potential conflict of interest in the research, authorship, or publication of this article.

Data Availability

The primary data collected and analyzed in this study are available from the corresponding author on reasonable request.

Author Contributions

Ainsworth M. Reynolds – Principal investigator. Conceptualization, methodology, data collection, writing original draft

Sean Moncrieffe - Applying statistical, mathematical, or computational techniques to interpret data.

Justin Chanda - Overseeing the project and guiding the research and final editing.

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Knowledge of Male Caregivers on Childhood Routine Immunization and Zero Dose Children in Borno State

Bashir Adebayo Elegbede[1*], Adegboyega Oyefabi[2], Shettima Abdul – Kadir[3]
[1]*Department of Public Health, Texila American University,Guyana*
[2]*Department of Community Medicine, Kaduna State University, Nigeria*
[3]*Pathfinder International, Maiduguri, Nigeria*

Abstract

Immunization remains a mainstay in safeguarding children's health worldwide, but achieving universal vaccination coverage has been a significant global challenge. Nigeria faces a particularly alarming situation among these countries, with over 2.2 million estimated zero-dose children in 2021. This study determined male caregivers' knowledge of childhood RI and zero-dose children in Borno. It is a settlement-based descriptive cross-sectional study, and a multi-stage sampling technique was employed to recruit 1,318 respondents. Data collection involved a structured questionnaire and data analysis was completed using IBM SPSS version 25 and STATA SE Version 17. The level of significance was set at 5%. Overall, 56% of respondents demonstrated poor knowledge of childhood RI and ZD, whereas 44% showed good knowledge. Using the Chi-Square Test, there was a statistically significant association between socio-demographic factors (educational status, occupation, and income) and poor understanding of childhood RI and zero-dose vaccination. Also, the multivariate logistics regression analysis results further buttress the outcome of the Chi Square tests; analysis showed that participants who attained secondary education (AOR=0.45, 95% CI=0.26-0.79) and those with tertiary education (AOR=0.46, 95% CI=0.24-0.88) had statistically significantly lower odds for poor knowledge compared to their counterparts with none, Qur'anic or primary education. Despite some positives regarding increased awareness of childhood RI, the understanding of male caregivers about childhood RI and zero-dose vaccination remains poor. Initiatives such as health education and community engagement targeting men should be incorporated into immunization activities.

Keywords: *Childhood Routine Immunization, Knowledge, Vaccination, Zero Dose.*

Introduction

Immunization is the process by which a person becomes resistant to a disease, typically by receiving a vaccine. The vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease [1, 2]. Infectious diseases known as vaccine-preventable diseases (VPDs), such as cervical cancer, poliomyelitis, measles, rubella, parotitis, diphtheria, tetanus, pertussis, hepatitis A and B, bacterial pneumonias, rotavirus diarrheal diseases and bacterial meningitis can be prevented through immunization [1, 2]. Vaccination is a very significant factor in the decline in the prevalence and related mortality from infectious diseases. Over 51.5 million deaths have been averted from 2021 to date, and 5.2 million deaths as immunization coverage increases across the globe [3].

Zero-dose children are those who have not received the first dose of routine vaccination, such as diphtheria, tetanus, and pertussis (DTP), and this remains a significant public

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****Corresponding Author: elegbedebashir@gmail.com***

health challenge [4]. Zero dose prevalence is influenced by several factors like geographic, economic and social determinants. Rural and conflict-affected areas experience disproportionately higher rates due to inaccessibility, weak health systems and cultural resistance. Nigeria accounts for the largest country with the highest number of zero-dose children globally, with an estimated number of 2.3 million unvaccinated children in 2024 [5–7].

Initiatives to increase the Expanded Program on Immunization globally have been made over the years, including the Global Alliance for Vaccines and Immunization (Gavi), universal childhood vaccination, the Global Immunization Vision and Strategy, and, most recently, the Global Vaccine Action Plan. These efforts with a specific strategy, like Reaching Every District, implemented in the African region have increased immunization coverage globally. The percentage of children who received three doses of DTP3 vaccination at 12 months of age increased from 5% in 1974 to 85% in 2010 globally [8].

Globally, strategies to address zero-dose children, a major problem in Nigeria, focus on strengthening healthcare systems, increasing and improving community engagement, and leveraging technology [9, 10]. Outreach campaigns, health worker training, and innovative service delivery models, such as mobile vaccination units, have proven effective in various settings. Also, integration of vaccination services with broader maternal and child health programs is also critical [11–13].

Immunization remains a major problem in Nigeria, and in Borno state, immunization coverage has been adversely affected since the advent of a violent insurgency that started in 2013. The insecurity has left a large number of the population displaced and isolated. The factors have made the state susceptible to wild polio virus transmission discovered in Borno in 2016, and also posed the risk of the spread of serotype two vaccine-derived polio virus. All these factors, coupled with insecurity, have led to insufficient healthcare services in both immunization and surveillance efforts [14, 15].

Studies consistently reveal low levels of caregiver knowledge about immunization in Northern Nigeria. Similar research found that only 3% of caregivers in rural Northwestern communities could accurately describe the immunization schedule, while over 50% displayed negative attitudes toward vaccines due to misinformation and mistrust. This knowledge deficit is worsened by limited access to education, with maternal literacy rates remarkably low in rural and semi-urban areas [16].

A study in 2019 found that only 15% of male caregivers could correctly list the names of childhood vaccines in the National Program of Immunization compared to higher percentage in female caregiver. It is crucial to note that male caregivers, especially, play a significant role in successful vaccination coverage and hold considerable authority over family health decisions, particularly in Northern Nigeria. It is crucial to note that without the consent of and support of male partners, the vaccination program may not succeed. [17, 18]. There are limited studies on male caregivers' knowledge of childhood routine immunization (RI). This research was conducted to determine male caregivers' understanding of childhood RI and zero dose in Borno state.

The findings of the study might contribute to local policy formulation on immunization and improve advocacy for immunization which will be an essential tool that can help in improving immunization coverage in Borno state and other parts of Nigeria.

Materials and Methods

Study Design

This research is a settlement-based descriptive cross-sectional study aimed at comprehensively assessing the levels of knowledge of male caregivers regarding childhood routine immunizations (RIs) and

zero-dose children within of Borno State. The rationale for the selection of this particular research design is predicated upon the fundamental characteristics of cross-sectional studies, which are inherently observational in nature and are employed to effectively analyze and interpret data gleaned from a specified population at a singular point in time; this methodological approach is frequently usually used within various fields, including but not limited to the social sciences, medical research, and health-related studies [19, 20].

Study Area, Participant, Sample Size and Sampling Technique

The research was conducted in Borno State, the state has an approximate population of 7.5 million people, comprises 27 local government areas, and is divided into three political zones north, central and south [21–23].

The study participants are fathers and other male caregivers of children under 5 who have given consent. Inclusion criteria included consenting fathers or male givers with children aged 0 to 59 months who provide financial or social support, inform family or social decisions, and are responsible for the health and well-being of the children in the family, while male caregivers who do not have a child or children within the age of 0 – 59 months were excluded from the study.

To calculate the sample size for this study, the formula below was used.

$$\boldsymbol{n = \frac{DEFF * Np(1-p)}{[(d^2/Z^2_{1-\alpha/2})) * (N-1) + p(1-p)]}}$$ [24]

n=sample size

N=Population size (2,090,893) [22]

p=hypothesized frequency/prevalence of study (47.5) [25]

DEFF=design effect for cluster survey (2)

d= margin of error (4%)

$Z_{1-\alpha/2}$=z-score for desired confidence (1.96 for 95%)

The total number of males above 18 years old in Borno state was calculated according to National Population Commission [22], a total of 2,090,893 individuals. The prevalence rate used for this study, based on previous research, was 47.5% for male caregivers' overall knowledge of childhood RI, which was used for the sample size calculation [25]. Based on the formula, a sample of 1,198 respondents was recruited for the study, with a 10% margin added to account for non-participation or refusal, yielding a final sample size of 1,318.

A multi-stage sampling technique was employed in this research study. The research consists of four-unit clusters. The state was divided into three zones: Borno South, North and Central. In each zone, three Local Government Areas (LGAs) were randomly selected, and the last unit was a settlement chosen by simple random sampling. Upon selecting the settlement, all eligible households with a male caregiver aged 18 or older and children aged 0–59 months were sampled, while others were excluded. Of the 1,318 male caregivers interviewed for this study, 10 declined to participate, resulting in a high response rate. This was achieved through community entry meetings conducted in each settlement, bringing the total number of respondents to 1,308.

Data Collection and Analysis

A structured questionnaire was used to evaluate the extent of respondents' knowledge. It was thoroughly scripted using the Kobo toolbox, which was used for data collection across the study locations. Quantitative data were analysed descriptively using International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) version 25 and STATA Special Edition Version 17. Descriptive statistics were used to analyse categorical variables, and frequency tables and bar charts were also used to present the data. In addition, inferential statistics were used for categorical data, with p-values below 0.05 for the chi-squared test. Multivariate regression analysis was also used to assess the relationships among the variables in this study.

Each respondent was comprehensively assessed and scored on questions on the knowledge of childhood RI and the zero dose. The cumulative aggregated total score based on respondents' responses was categorized into two distinct classifications, namely good and poor knowledge, to facilitate the interpretation of the data, for further analysis, and thereby allowing for a thorough understanding of their overall performance. Based on previous study, benchmark of 70% and above was employed to designate a score of good knowledge, while any score that fell below the 70% (69 and below) threshold was classified as poor knowledge in a similar research study [26]. The average administration time for the questionnaire was 15–20 minutes, which ensured completeness and data quality. Missing data were minimized by digitizing the questionnaire and making all critical fields mandatory. Multicollinearity among independent variables, including age, income, occupation, and education, was evaluated using bivariate correlation to assess the association between the variables with an r <0.7 as a significant level.

Results

In the study 1308 respondents were surveyed under this research. Table 1 shows that most of the respondents were Muslims (98.6%), and Christians were small in number (2.4%). Concerning age, the majority of respondents were adults (63.4% aged 30-49 years), and only a small percentage were younger than 20 years (0.4%), and older than 70 years (1%). The majority of the respondents were located in rural settings (83.3%), with only a minority located in urban settings (16.7%). On educational status, more than half have Quranic education (52.4%), while secondary education stands at (15.6%), primary education (13.8%) and tertiary education with the lowest proportion of (8.6%). It was also noteworthy that 9.6% did not have any education. Under the occupation of the respondents, the majority (68.7%) were farmers or traders, and the rest were employed (10.2%), unemployed (9.8%), entrepreneurs (9.3%), and a minor fraction of students (2.1%). The majority of the respondents indicated they were earning low and almost 6 out of 10 incomes were below $20. The highest reports were at 3.3%, with earnings above $100. As for marital status, most were married (97.1%), followed by singles (1.8%), divorced (0.5%), separated (0.3%), and widows (0.2%).

Table 1. Sociodemographic Characteristics of Respondents

Variables	Frequency	Percentage
Religion		
Christianity	32	2.4
Islam	1276	98.6
Age of respondent		
<20years	5	0.4
20-29years	233	17.8
30-39years	433	33.1
40-49years	396	30.3
50-59years	177	13.5
60-69years	51	3.9
70 and above	13	1
Geographic Location		
Rural	1089	83.3

Urban	219	16.7
Educational status of respondents		
None	125	9.6
Primary	181	13.8
Qur'anic	686	52.4
Secondary	204	15.6
Tertiary	112	8.6
Occupation of respondents		
Employed	134	10.2
Entrepreneur	121	9.3
Farmer/Trader	898	68.7
Student	27	2.1
Unemployed	128	9.8
Average monthly income (in USD)		
0 - <20	782	59.8
20 - <50	324	24.8
50 - 100	159	12.2
Greater than 100	43	3.3
Marital Status		
Divorced	7	0.5
Married	1270	97.1
Separated	4	0.3
Single	24	1.8
Widower	3	0.2

Knowledge of Male caregivers towards childhood routine immunization and zero dose children

The knowledge of the male caregivers was assessed, where 1214(92.8%) of respondents agreed with the need for immunization in keeping children safe, and the percentage that disagreed with this opinion is small (7.2%). Approximately, 60.7% of the people who responded had heard about diphtheria infection, yet a significant 39.3% responded they were unaware or had no knowledge of diphtheria infection. However, only 28.6% could name the vaccines that prevent diphtheria, and 71.4% could not state whether a vaccine exists to prevent diphtheria in children. An immense percentage (70.6%) had heard about hepatitis infection but nearly one in three people had not heard of the hepatitis infection. A great majority (67.7%) were able to state that first contact for immunization for children occurs at birth. Still, a smaller respondents (21.7%) gave "I don't know," with respondents choosing 6 weeks, 8 weeks, and 9 months for first contact for children's immunization respectively (0.4%, 0.4%, and 0.4%). A high percentage of respondents (45.9%) said 'I don't know' when asked about the last immunization for children under 5 years old, while only 25.7% had the correct answer of 15 months. Some of them provided the wrong answer because they replied at birth (7.8%), 6 weeks (1.0%), 8 weeks (0.8%) and duration of 9 months (7.0%).

Most of the respondents (92.1%), were in agreement that vaccines are also key to child health with only 7.9% indicating otherwise. The majority (86.1%) of the respondents had heard about childhood vaccination, but 13.9% reported being unaware of childhood RI. Almost three-quarters (72.9%) responded that vaccines are only given to children under 5 years of age, while a minority (27.1%) knew otherwise. A large proportion of respondents (38.8%) believed that vaccines could make children sick, whereas 61.2% said this was not true. A majority of the respondents (87.3%) knew the vaccination status of their children but 12.7% have no idea on the vaccination status of their children.

In Figure 1, cumulatively, 773(44%) of the respondents have good knowledge of childhood routine immunization and zero dose children, while 575(56%) have poor knowledge, which shows that knowledge of childhood RI is generally poor among male givers.



Figure 1. Knowledge of male caregivers towards childhood RI and zero dose children

Association Between Socio-Demographic Characteristics and Knowledge of Respondents

In Table 2, the chi-square test was carried out, showing that most of the socio-demographic characteristics of the respondents (religion, location, educational status, occupation, and income) were significantly associated with male caregivers' knowledge of childhood routine immunization and zero dose children (all p-values <0.05). Respondents who identified as Christians' faith demonstrated higher good knowledge (71.9%) compared to Muslim faith (43.8%) and those of other faiths (13.0%), and this difference was statistically significant ($\chi^2 = 19.1, p = 0.001$). The place of residence of the respondents also showed a strong association, with urban dwellers having substantially better knowledge (73.5%) than their rural counterparts (38.0%) and p-value = 0.001.

Educational qualifications of the respondents were also positively associated with knowledge status, with respondents with tertiary (66.1%) and secondary (63.2%) education reporting significantly higher knowledge than those with Qur'anic education only (34.1%) ($\chi^2 = 83.4, p = 0.001$). Moreover, occupation of the respondents was significantly linked with knowledge, those in formal employment (71.6%) were more knowledgeable than farmers/traders (39.0%) and entrepreneurs (37.2%) ($\chi^2 = 59.7, p = 0.001$). Interestingly, monthly income displayed a reverse pattern, with respondents earning above $100 reporting the lowest proportion of good knowledge (9.3%), while those in the lower income brackets ($0-$20 = 49.2%; $20-$50 = 47.8%; $50–$100 = 31.3%) had comparatively higher knowledge, and this association was statistically significant ($\chi^2 = 36.2, p = 0.001$) (Table 2).

Regression Analysis to Determine the Determinants Poor knowledge for Childhood RI and Zero dose vaccination

In Table 3, the result shows that the age group of the respondent was not statistically significant in determining knowledge of childhood RI and zero dose vaccination. All the age groups, however, had increased odds for poor understanding of childhood RI compared to age <20 years. The age group >70, however, had 32% reduced odds for poor knowledge of childhood RI and zero dose children ($\boldsymbol{AOR = 0.68, 95\% CI = 0.07 - 6.79}$). The result also shows that the Shuwa tribe had statistically significant lower odds for poor knowledge of childhood RI and zero-dose vaccination ($\boldsymbol{AOR = 0.5, 95\% CI = 0.25 - 0.98}$). The odds for poor knowledge of childhood RI were estimated 9 times higher for the traditional religions compared to Christianity ($\boldsymbol{AOR = 8.70, 95\% CI = 1.82 - 41.52}$).

The participants who attained secondary (AOR=0.45, 95% CI=0.26-0.79) and those with Tertiary education ($\boldsymbol{AOR = 0.46, 95\% CI = 0.24 - 0.88}$) had statistically significant lower odds for poor knowledge compared to their counterparts with none, qur'anic or primary education. The farmers ($\boldsymbol{AOR = 2.77, 95\% CI = 1.72 - 4.46}$) and the unemployed ($\boldsymbol{AOR = 2.98, 95\% CI = 1.58 - 5.62}$) also had increased odds for poor knowledge compared to the other occupational group. The middle income; $50-<$100 ($\boldsymbol{AOR = 2.03, 95\% CI = 1.32 - 3.12}$) and higher income group; >$100 ($\boldsymbol{AOR = 12.56, 95\% CI = 3.93 - 40.16}$) were noted to present with increase odds for poor knowledge of childhood RI compared to the low-income group; < $20 (Table 3). Multicollinearity among independent variables shows no strong association as the results found were $r \geq 0.7$.

Table 2. Association between socio-demographic characteristics and knowledge of respondents

Variables		Knowledge		Chi-Square Value	P-Value
		Good Knowledge Freq.(%)	Poor Knowledge Freq.(%)		
Age group	<20years	3(60.0)	2(40.0)	9.0	0.179
	20-29years	87(37.3)	146(62.7)		
	30-39years	204(47.1)	229(52.9)		
	40-49years	174(43.9)	222(56.1)		
	50-59years	74(41.8)	103(58.2)		
	60-69years	25(49.0)	26(51.0)		
	70 and above	8(61.5)	5(38.5)		
Tribe	Babur	45(49.5)	46(50.5)	7.2	0.125
	Fulfulde	37(37.4)	62(62.6)		
	Kanuri	313(42.6)	422(57.4)		
	Others	124(44.6)	154(55.4)		
	Shuwa	56(53.3)	49(46.7)		
Religion	Christianity	23(71.9)	9(28.1)	19.1	0.001
	Islam	549(43.8)	704(56.2)		
	Others	3(13.0)	20(87.0)		
Location	Rural	414(38.0)	675(62.0)	93.3	0.001
	Urban	161(73.5)	588(26.5)		
Educational status	None	64(51.2)	61(48.8)	83.4	0.001
	Primary	74(40.9)	107(59.1)		

	Qur'anic	234(34.1)	452(65.9)		
	Secondary	129(63.2)	75(36.8)		
	Tertiary	74(66.1)	38(33.9)		
Occupation	Employed	96(71.6)	38(28.4)	59.7	0.001
	Entrepreneur	45(37.2)	76(62.8)		
	Farmer/Trader	350(39.0)	548(61.0)		
	Student	14(51.9)	13(48.1)		
	Unemployed	70(54.7)	58(45.3)		
Income (USD)	0 - <20	362(46.3)	420(53.7)	36.2	0.001
	20 - <50	159(49.1)	165(50.9)		
	50 - 100	50(31.4)	109(68.6)		
	> 100	4(9.3)	39(90.7)		
Marital Status	Divorced	3(42.9)	4(57.1)	1.3	0.867
	Married	559(44.0)	711(56.0)		
	Separated	1(25.0)	3(75.0)		
	Single	10(41.7)	14(58.3)		
	Widower	2(66.7)	1(33.3)		

Table 3. Multivariate logistic regression for the sociodemographic determinants of poor knowledge of childhood RI and Zero-dose vaccination

Variable	**Adjusted Odds Ratio**	**P-value**	**95%CI**
Age group in years			
<20	1 [Reference]		
20-29	3.95	0.179	0.53-29.29
30-39	2.44	0.380	0.33-18.00
40-49	2.56	0.358	0.35-18.89
50-59	2.74	0.327	0.36-20.68
60-69	1.59	0.663	0.20-12.72
>=70	0.68	0.743	0.07-6.79
Tribe			
Babur	1 [Reference]		
Fulfulde	1.22	0.558	0.62-2.41
Kanuri	0.66	0.123	0.39-1.12
Shuwa	0.50	0.043*	0.25-.98
*Others	0.89	0.673	0.52-1.53
Religion			
Christianity	1 [Reference]		
Islam	2.21	0.081	0.91-5.41
Others	8.70	0.007*	1.82-41.52
Residence			
Rural	1 [Reference]		
Urban	0.18	0.001*	0.12-.26
Highest education level			
None	1 [Reference]		

Primary	1.23	0.455	0.71-2.12
Quranic	1.97	0.003*	1.26-3.08
Secondary	0.45	0.005*	0.26-.79
Tertiary	0.46	0.018*	0.24-.88
Employment status			
Self Employed	1 [Reference]		
Entrepreneur	3.59	0.001*	1.96-6.56
Farmer	2.77	0.001*	1.72-4.46
Student	2.44	0.198	0.63-9.50
Unemployed	2.98	0.001*	1.58-5.62
Average monthly income in USD			
<20	1 [Reference]		
20-<50	1.05	0.746	0.77-1.44
50-<100	2.03	0.001*	1.32-3.12
>100	12.56	0.001*	3.93-40.16
Marital status			
Divorced	1	-	-
Married	1.21	0.891	0.22-5.77
Separated	8.67	0.171	0.39-191.46
Single	1.65	0.641	0.20-13.36
Widower	0.50	0.641	0.03-9.33

Discussion

Significant relationships between the socio-demographic factors of education, occupation, religion and locality of male caregivers in Borno State and knowledge of childhood immunization were established. As reflected in national evidence, paternal education became an influential factor, fathers having at least secondary level education were more likely to express appropriate knowledge of immunization, matching the results of another national survey, the Demographic and Health survey of Nigeria [27]. However, advanced statistics such as linearity of the logit among the continuous predictors, Hosmer Lemeshow goodness of fit, pseudo-R2 estimates and interaction effects were not utilized in this model and require further analytical improvements in the future. This research evaluated the male caregivers knowledge on childhood routine immunization and zero-dose children in Borno State. Most of the male caregivers acknowledged that vaccination is effective in preventing child disease but there are still huge gaps in knowledge related to vaccine-preventable diseases, schedules and safety. These results are reflective of prior research in Northwestern Nigeria where similar studies discovered that the majority of caregivers had knowledge of routine immunization but lacked understanding of specific vaccines and schedules [28]. Although many respondents had heard of diphtheria, only a few could name vaccines that prevent it. This is a typical situation in the Nigerian context, where caregivers have general awareness of immunization but not of the disease in question [29]. Similarly, while awareness of hepatitis infection was relatively high, a considerable number of caregivers had never heard of it, showing that knowledge of certain vaccine-preventable diseases remains uneven. Similarly, it was documented that while awareness levels were high in Kaduna, recall of specific vaccines

and their schedules was poor [30]. Knowledge of immunization schedules also showed striking gaps. Many respondents correctly mentioned that the first vaccination contact occurs at birth. However, only a small subset identified the correct age of the last contact at 15 months, while many either gave incorrect answers or admitted they did not know.

This knowledge gap has also been highlighted in Lagos [31], where the study found that caregivers with generally positive attitudes still lacked an accurate understanding of the complete immunization schedule, limiting vaccine completion [31]. The other interesting result was a general misunderstanding that vaccination is solely for children under 5 years old. This misunderstanding suggests inadequate communication strategies and reliance on informal sources of information. A study in Zamfara State similarly reported that caregivers often relied on traditional and religious leaders for health information, which sometimes perpetuated vaccination myths [32]. The question of vaccine safety also featured prominently and many of the respondents believed that vaccines were likely to cause sickness in children. This view is consistent with past studies on the subject, as fear of side effects was among the significant vaccine correlates of hesitancy in Nigerian communities [33]. It is important to discuss these fears with the community and provide clear information about vaccine safety.

The overall knowledge was categorized; less than half of the respondents were found to have good knowledge, and more than half were found to have poor knowledge. This is in accordance with regional evidence. Recently, it was reported that a high level of inadequate immunization knowledge in Northwestern Nigeria, and poor vaccine knowledge and hesitancy, have been consistently associated with low literacy, cultural beliefs, and economic hardship across West Africa [28]. These findings show that while male caregivers in Borno value immunization, their knowledge about specific vaccines, schedules, and safety remains weak. Similar trends across Nigeria and West Africa emphasize the urgent need for targeted interventions. Male-focused, culturally sensitive health education delivered through trusted community leaders and supported by health systems would address knowledge gaps, dispel misconceptions, and ultimately reduce zero-dose prevalence in Northern Nigeria and the wider region [29, 30, 33].

The results of this research show a strong relationship between socio-demographic factors and male caregivers' awareness of child routine immunization. Religion also was a significant predictor, and Christians showed superior knowledge relative to Muslim and other religious caregivers. This is similar to previous research in Northern Nigeria that made similar conclusions that religious beliefs and the role of faith leaders can inform the perceptions and acceptance of immunization programs by caregivers [32]. In most rural North Nigerian communities with high Muslim populations, some misbeliefs on vaccines as alien intervention or unsafe practices exist that could be attributed as the source of the identified gap in knowledge. Another critical factor was residence, as urban dwellers had significantly better knowledge than their rural counterparts. This supports the results of previous studies that reported that rural caregivers tend to lack access to immunization information and health promotion activities more frequently than urban residents, where health facilities are more concentrated, and where health promotion campaigns are more active [29]. The difference between urban and rural care makers indicates a need to implement targeted awareness activities in less-served rural settings.

Knowledge was closely linked to respondents' educational qualifications, with caregivers with secondary or tertiary education having higher levels of knowledge than those with Quranic education only. This finding

supports the results of other investigations in Kaduna and Kano States, which emphasized that formal education enables caregivers to perceive immunization messages and counter misinformation [35]. It is also consistent with broader West African evidence that more educated caregivers tend to recognize vaccination's benefits and follow immunization schedules [35]. There was also a strong association with occupation, as caregivers who are in formal employment exhibited more knowledge than farmers, traders and entrepreneurs. This is elucidated by the reality that employees, who are formally engaged, have generally a superior chance of accessing formal health education through places of work, social systems, and urban residence. In contrast, subsistence farmers and merchants, particularly in rural settings, might depend on informal sources of information. Similar associations have been reported in studies from Zamfara and Sokoto States, where occupational class influenced exposure to immunization campaigns and health promotion messages [32].

Furthermore, household income did not show statistical significance differences. This finding may suggest that low-income caregivers, particularly those who depend on primary health care services, are more exposed to vaccination information at health facilities during child welfare visits. In contrast, wealthier households may underutilize public immunization services, relying instead on private facilities where structured health education may be less emphasized. A similar pattern was observed in a Lagos study, where caregivers from higher socio-economic classes had lower awareness of specific vaccine-preventable diseases despite accessing private hospitals [31].

Regression analysis offers further understanding of the factors underlying poor knowledge of childhood routine immunization (RI), and zero-dose vaccination among male caregivers. Although age was not a statistically significant determinant, the trend suggests that older caregivers were not always better informed. Surprisingly, older caregivers (aged over 70) were less likely to have poor knowledge than the youngest, which may be because of their lived experience with vaccine-preventable diseases (VPDs), e.g., measles, polio, and diphtheria, which can impact their perception of the benefits of immunization. Similar outcomes have been reported in Northern Nigeria, where older caregivers, particularly grandparents, were more supportive of vaccination due to witnessing disease outbreaks in the past than the younger ones [30, 32]. Another significant determinant was also ethnicity, the Shuwa Arab tribe were found to show much lower probability of poor knowledge than other ethnic groups, which implies that within this group, cultural orientation and community leadership arrangements could serve to enhance positive knowledge and awareness of immunization. This follows the results of Sokoto and Zamfara States that showed that ethnic and cultural settings had a substantial impact on care-givers attitude towards immunization uptake [32]. Another predictor of knowledge was religion, the association reflects broader evidence from West Africa that certain traditional beliefs contribute to mistrust in biomedical interventions and fuel vaccine hesitancy [36]. In Nigeria, Christian caregivers are often reached more effectively through faith-based health campaigns. In contrast, traditionalists and some Muslim caregivers remain more resistant due to entrenched socio-cultural narratives around vaccination safety and intent [35].

Knowledge of male caregivers towards immunization was also affected by occupational status. Unemployed caregivers and farmers were much more likely to be poorly informed than other occupational groups. Similar relations have been found in rural Northern Nigeria, where subsistence farmers and unemployed caregivers were less exposed

to vaccination awareness campaigns than the ones who worked in salaried jobs [29]. Probably the least anticipated was the correlation of income and knowledge. Caregivers with middle and high incomes had better odds of having poor knowledge than low-income caregivers. The income of those making over 100 a month was also under risk especially increasing odds by over a dozen times. This is in contrast with the expectation that better knowledge should be associated with higher income. One potential reason is that better-off caregivers tend to use privately owned health facilities, where health education on the importance of routine immunization is not as heavily promoted as in state-owned facilities. A study in Lagos similarly reported that caregivers of higher socio-economic status underutilized public immunization services and had poorer awareness of specific VPDs, despite having financial access to health services [31].

Conclusion

The article highlights the importance of socio-demographic variables such as education, occupation, religion and the place of residence as determining knowledge in male caregivers in Borno State, Nigeria about childhood RI and ZD vaccination. Although the general awareness about immunisation and its significance was quite impressive, as well as caregivers' understanding of RI for children is free.

In conclusion, the findings of this research have demonstrated convincingly that the level of understanding among male caregivers regarding childhood routine immunisation, as well as the concept of zero-dose children, remains alarmingly inadequate.

Recommendations

1. The active involvement of men in health education initiatives, alongside having a friendly and supportive environments that promote health awareness and proactive health behaviours towards immunisation, has the potential to improve knowledge of male givers significantly.
2. To effectively promote good social behaviour towards childhood RI, it is essential for government agency and other key immunization stake holder like UN agencies and civil societies, to initiate advocacy campaigns and social mobilization efforts that are specifically designed to resonate with male caregivers, thereby ensuring widespread acceptance among community members regarding the critical significance of vaccinations while simultaneously addressing key issues.
3. Strategic advocacy efforts led by the government and supported by immunisation stakeholders to sensitise and engage stakeholders, including traditional leaders, influential religious figures, men's groups, and other key stakeholders, in advocating for childhood RI and reducing zero-dose children in the community.

Conflict of Interest

I hereby declare that I have no conflict of interest regarding the publication of the article titled “Knowledge of Male Caregivers on Childhood Routine Immunization and Zero Dose Children in Borno State”. This research is independent and does not represent the views of any organization or body.

Ethics Approval

Ethics approval for the study was obtained from the TAU University Review Board (URB) and the State Ministry of Health in Borno state. All participants were informed, both in writing and orally, before the administration of the questionnaire about the nature and scope of the study, while they were also informed of their willingness to participate or withdraw at any time during data collection and were informed that their information would only be used for research purposes. No personal information or identifiers, such as names, phone numbers and house addresses, were collected to maintain

confidentiality. Data collected were stored on a password-protected computer accessible only to the research team.

Authors' Contribution

Bashir Adebayo Elegbede: The corresponding author and a PhD student with Texila American University, conceived and designed, analysed and interpreted the data and wrote the paper.

Adegboyega Oyefabi: The supervisor of my PhD research work, and served as the lead technical supervisor for the writing of this paper.

Shettima Abdul–Kadir: Served as technical supervisor for this research work.

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Data Availability

The data of this research are available upon request from the corresponding author.

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Effect of Covid-19 Pandemic on Maternal Health Indicators in Nigeria

Oyaole Daniel Rasheed
Department of Public Health, Texila American University, Guyana

Abstract

This study examines the impact of the COVID-19 pandemic on maternal healthcare indicators in Nigeria between 2018 and 2024. Before the pandemic, Nigeria's health system faced significant challenges, reflected in persistently high maternal mortality rates. COVID-19 exacerbated these issues, disrupting services and testing the healthcare system's resilience. Using a retrospective, cross-sectional comparative design, this research analyzed nationally representative secondary data from the Demographic and Health Survey (DHS) before and during the pandemic. Descriptive statistics, Chi-square tests, logistic regression, and multivariate analysis of variance (MANOVA) were employed to assess temporal and regional shifts in maternal health indicators. Nationally, declines were observed in skilled birth attendance (67% to 63%) and antenatal care participation (57% to 52%), although these changes were not statistically significant ($p > 0.05$). Regional analyses revealed substantial declines in skilled birth attendance in the North-East and North-West regions ($p < 0.001$) and a substantial improvement in antenatal care attendance in the South-West ($p = 0.032$). Modest improvements were also noted nationally, with institutional deliveries increasing from 39% to 43%, and modest gains in postnatal care utilization. These findings underscore the fragility of maternal healthcare services during global health crises and highlight urgent need to strengthen health system resilience at regional levels. Key recommendations include improving healthcare access in underserved areas, enhancing the healthcare workforce, expanding digital health initiatives, and promoting community-based maternal health education. This study provides critical insights into the pandemic's impact on maternal health outcomes and emphasizes the importance of equity-focused public health strategies for future emergencies.

Keywords: *COVID-19, Health Systems Resilience, Maternal Healthcare, Nigeria, Public Health, Regional Disparities.*

Introduction

Globally, maternal health has improved significantly over the past two decades. Between 2000 and 2019, the global maternal mortality ratio (MMR) dropped from 339 to 223 deaths per 100,000 live births, representing a 34% decline [1]. This downward trend is also evident in Africa, where maternal mortality declined over the same 20-year period at an average annual percent change of −3.0%, reflecting progress in maternal healthcare interventions [2, 3]. However, these global gains mask deep regional build, particularly in low- and middle-income countries like Nigeria, where, despite global gains, the country continues to face a severe maternal health crisis, with its MMR remaining among the highest in the world. In 2018, the MMR stood at approximately 512 deaths per 100,000 live births, rising to over 800 per 100,000 by 2019. This accounts for nearly 20% of global maternal deaths [4, 5].

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Corresponding Author: dannyrexo@gmail.com

The persistently high maternal mortality in Nigeria is primarily driven by postpartum haemorrhage, eclampsia, pre-eclampsia, infections, and complications from unsafe abortion and obstructed labour, most of which are preventable with timely and adequate medical care. Contributing factors include delays in accessing care, inadequate healthcare infrastructure, a shortage of skilled health professionals, and widespread poverty, highlighting critical gaps in maternal healthcare service delivery [6].

Public health interventions in maternal care are essential to addressing these challenges by ensuring that pregnant women receive adequate antenatal care (ANC), skilled birth attendance, emergency obstetric care, and maternal health education, including family planning services [7]. Regular ANC visits, for instance, enable early detection of complications such as preeclampsia and infections, allow for nutritional and preventive care, and ensure preparedness for delivery. Skilled attendance at birth is strongly associated with reduced maternal and neonatal mortality. Despite these interventions, however, access to care in Nigeria remains uneven, with stark contrasts between the northern and southern regions, and between rural and urban areas [8].

The COVID-19 pandemic severely disrupted global health systems, necessitating innovative public health interventions to mitigate adverse effects. Nigeria, like many developing nations, faced significant challenges in maintaining essential health services, particularly maternal care. Lockdowns, transport disruptions, fear of infection, and health facility closures all contributed to a decline in routine maternal health services. As the pandemic evolved, it became clear that its indirect effects on maternal health could be as devastating as the virus itself. Understanding the impact of these disruptions is critical for informing future public health strategies [3].

This study, therefore, seeks to examine the effect of the COVID-19 pandemic on key maternal health indicators in Nigeria from 2018 to 2024. It uses a comprehensive analytical approach to assess national trends, highlight regional disparities, and identify emerging opportunities to improve maternal healthcare delivery. By evaluating changes in skilled birth attendance, ANC participation, institutional deliveries, and postnatal care, this research provides a holistic view of how Nigeria's maternal health system responded to one of the most severe global health crises of our time.

Methods

Study Area

Nigeria, located in West Africa, is the most populous country on the continent and the seventh most populous in the world, with an estimated population of over 220 million as of 2024. The country is politically and administratively divided into 36 states and the Federal Capital Territory (FCT), Abuja. These are further grouped into six distinct geopolitical zones, namely; North-Central, North-East, North-West, South-East, South-South, and South-West. These zones were formed on the basis of shared ethnic, historical, and cultural identities and are often used for administrative, political, and research purposes.

Each zone encompasses diverse populations, languages, and levels of socio-economic development, which significantly influence health outcomes and service delivery.

The country's vast size, coupled with regional disparities in health system performance, infrastructure, and sociocultural practices, creates complex dynamics that significantly influence maternal health indicators. Thus, understanding Nigeria's geopolitical structure and its implications for health equity is essential for interpreting variations in healthcare access and outcomes across regions, especially in the context of pandemic-induced disruptions.

Study Design

This study conducted a retrospective, cross-sectional comparative analysis using secondary data from the Demographic and Health Survey (DHS) before and after the COVID-19 pandemic [9]. The DHS, a global initiative funded primarily by USAID, provides high-quality, nationally representative data on health, nutrition, fertility, and infectious diseases in low- and middle-income countries. Conducted every five years using stratified multistage sampling, the DHS provides critical health indicators, vaccination coverage, and trends in disease burden.

Data Analysis

Descriptive and inferential statistical methods were employed. Summary statistics (mean, standard deviation, proportions) were used to compare pre-and post-pandemic indicators. The relevant DHS data was filtered using Microsoft Excel spreadsheet for further analysis and comparisons. Chi-square tests of independence to determine the significance of differences in maternal health indicators between pre- and post-pandemic periods, logistic regression analysis to assess the influence of period (pre/post-COVID), region, and antenatal care participation on skilled birth attendance and Multivariate Analysis of Variance (MANOVA) to assess the combined effect of period and region on multiple maternal health outcomes were further conducted. All statistical tests were two-tailed, with significance levels set at $p < 0.05$. Analyses were performed using Python (SciPy, StatsModels libraries).

Ethical Considerations

This study utilized publicly available DHS data, ensuring compliance with ethical standards and confidentiality regulations. No direct human participants were involved, minimizing ethical concerns. Ethical approval was sought for the use of supplementary qualitative data obtained from healthcare professionals.

Results

Healthcare services during pregnancy, childbirth, and the postpartum period are essential for the survival and well-being of both mothers and infants. Providing continuous care throughout the antenatal, intrapartum, and postnatal stages is vital for maternal and newborn health and remains a key priority for the Federal Ministry of Health. Access to quality antenatal care (ANC) services during pregnancy plays a crucial role in preventing maternal deaths, as these visits enable healthcare providers to identify and manage infections and obstetric complications while also administering preventive injections, medications, and supplements. During ANC visits, women receive education on healthy behaviours during pregnancy, counselling on recognizing pregnancy danger signs, and information on family planning, ensuring they are well-informed and better prepared for childbirth and postpartum care.

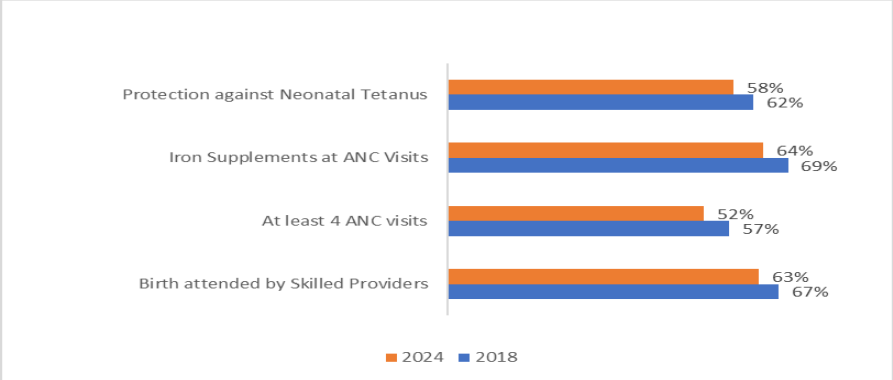


Figure 1. Summary of Indices for Antenatal Care

The data in Figure 1 indicates a decline in key ANC indicators in Nigeria between 2018 and 2024, with the proportion of births attended by skilled providers decreasing from 67% to 63%, suggesting reduced access to or utilization of professional delivery care, while the percentage of women attending at least four ANC visits dropped from 57% to 52%, potentially limiting early detection and management of pregnancy complications. Similarly, iron supplementation during ANC visits declined from 69% to 64%, increasing the risk of maternal anaemia and associated adverse pregnancy outcomes. In contrast, protection against neonatal tetanus fell from 62% to 58% heightening the risk of neonatal tetanus.

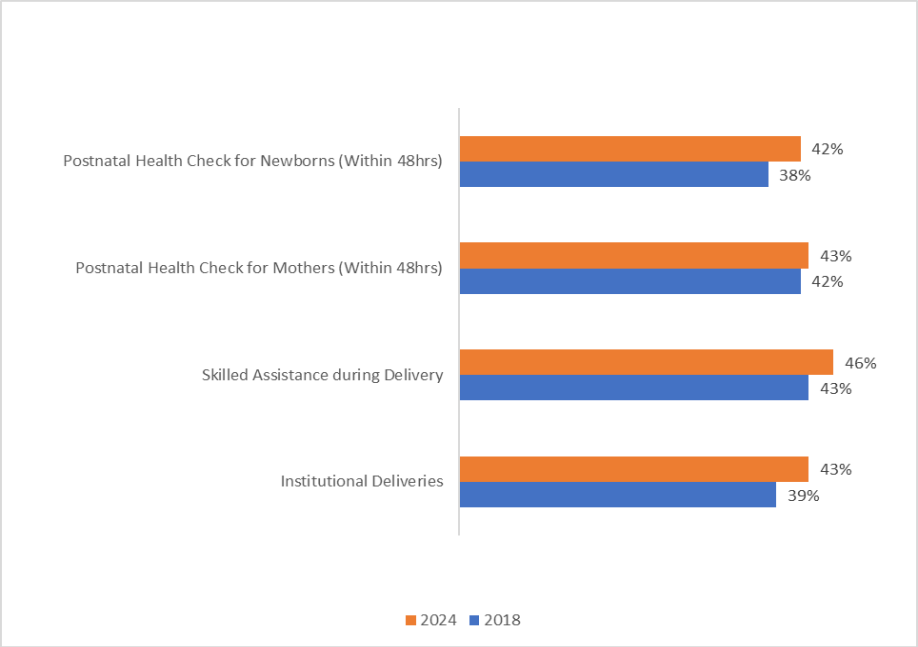


Figure 2. Summary of Delivery Services and Post-Natal Care

The data in Figure 2 indicates a modest improvement in key delivery and postnatal care indicators in Nigeria between 2018 and 2024, with institutional deliveries increasing from 39% to 43%, suggesting a gradual shift towards facility-based births, while skilled assistance during delivery rose from 43% to 46%, reflecting slight progress in access to professional obstetric care. Similarly, the proportion of mothers receiving a postnatal health check improved marginally from 42% to 43%. In contrast, postnatal health checks for newborns increased from 38% to 42%, indicating enhanced but still limited postnatal care coverage, collectively underscoring the need for further efforts to strengthen maternal and newborn healthcare services.

Table 1. Nationwide and Regional Differences in Antenatal Care Indices

Indices for Antenatal care	**Percent Coverage (%)**	
	2024	**2018**
Birth attended by Skilled Providers- Nationwide	63.0	67.0
North-Central	54.6	66.2
North-East	32.3	58.5
North-West	25.6	53.9
South-East	88.1	89.2

South-South	76.6	77.1
South-West	84.9	88.2
At least 4 ANC visits-nationwide	52.0	57.0
North-Central	50.3	51.3
North-East	50.6	46.6
North-West	40.6	38.3
South-East	73.6	84.1
South-South	67.1	67.8
South-West	80.8	66.4
Iron Supplements at ANC Visits-nationwide	64.0	69.0
North-Central	54.7	66.8
North-East	73.7	69.1
North-West	58.3	61.5
South-East	78.5	93.3
South-South	83.4	66.9
South-West	84.0	76.1
Protection against Neonatal Tetanus-nationwide	58.0	62.0
North-Central	52.0	57.9
North-East	64.7	54.0
North-West	42.1	45.7
South-East	86.3	92.0
South-South	81.2	75.7
South-West	82.7	83.2

Table 1 presents nationwide and regional differences in antenatal care indicators, showing significant declines in skilled birth attendance and ANC visits [9].

Between 2018 and 2024, there was a national decline in skilled birth attendance (67.0% to 63.0%), with the sharpest drops in the North-East (58.5% to 32.3%) and North-West (53.9% to 25.6%). The North-Central zone also saw a significant decline (66.2% to 54.6%), while the South maintained relatively high coverage despite slight reductions.

Visits for ANC also declined nationally (57.0% to 52.0%), with the South-East experiencing the largest drop (84.1% to 73.6%). However, the South-West improved significantly (from 66.4% to 80.8%), while the North-East and North-West saw slight gains. Iron supplementation during ANC fell nationally (69.0% to 64.0%), with declines in the North-Central and North-West but improvements in the North-East, South-South, and South-West. The South-East, despite a decline, remained the highest (93.3% to 78.5%).

Neonatal tetanus protection dropped nationally (62.0% to 58.0%), with declines in the North-Central and North-West but improvements in the North-East (54.0% to 64.7%) and South-South (75.7% to 81.2%). The South-East and South-West saw minor declines. Overall, regional disparities persist, with the North facing greater challenges compared to the South.

Table 2. Nationwide and Regional Differences in Postnatal Care Indices

Delivery and post-natal care indices	**Percent Coverage (%)**	
	2024	**2018**
Institutional Deliveries-Nationwide	43.0	39.0
North-Central	49.7	49.2
North-East	37.2	25.4
North-West	21.9	15.6
South-East	86.7	81.8
South-South	64.8	50.2
South-West	82.5	76.3
Skilled Assistance during Delivery-Nationwide	46.0	43.0
North-Central	49.7	49.2
North-East	37.2	25.4
North-West	21.9	15.6
South-East	86.7	81.8
South-South	64.8	50.2
South-West	82.5	76.3
Postnatal Health Check for Mothers 48 hours after delivery-nationwide	43.0	42.0
North-Central	53.4	44.5
North-East	36.3	33.7
North-West	24.9	21.1
South-East	63.1	71.6
South-South	66.5	52.6
South-West	78.5	77.3
Postnatal Health Check for Newborns 48 hours after delivery--Nationwide	42.0	38.0
North-Central	53.7	42.2
North-East	35.4	31.1
North-West	23.9	16.9
South-East	61.8	69.0
South-South	67.1	44.6
South-West	79.2	71.7

Table 2 highlights nationwide and regional variations in delivery and postnatal care, including improvements in institutional deliveries and postnatal checks in most southern regions [9].

Nationally, institutional deliveries rose from 39.0% to 43.0% (2018–2024), with notable gains in the North-East (25.4% to 37.2%) and North-West (15.6% to 21.9%). The South-South increased significantly (50.2% to 64.8%), while the South-East (81.8% to 86.7%) and South-West (76.3% to 82.5%) maintained high rates. The North-Central remained stable (49.2% to 49.7%). With similar regional trends, skilled delivery assistance also improved nationally (43.0% to 46.0%).

Postnatal checks for mothers rose slightly (42.0% to 43.0%), with significant gains in the North-Central (44.5% to 53.4%) and South-South (52.6% to 66.5%), but declines in the

South-East (71.6% to 63.1%). Newborn postnatal checks increased nationally (38.0% to 42.0%), with the North-Central (42.2% to 53.7%), South-South (44.6% to 67.1%), and South-West (71.7% to 79.2%) showing great improvements, while the South-East declined (69.0% to 61.8%). Regional disparities persist, particularly in the North-East and North-West.

Table 3. National-level Statistical Analysis

Analysis	Result	Interpretation
Chi-Square (Skilled Birth)	p = 0.657	No significant difference
Chi-Square (ANC 4+ Visits)	p = 0.570	No significant difference
Chi-Square (Institutional Delivery)	p = 0.666	No significant difference
Logistic Regression (Period effect)	p = 0.553	Period not a predictor
MANOVA (Overall Effect)	p = 0.696	No significant multivariate effect

While descriptive statistics revealed overall declines in skilled birth attendance and ANC visits and a modest increase in institutional deliveries between 2018 and 2024, further statistical analysis, as shown in Table 3, showed that these changes were not statistically significant at the national level.

The Chi-square tests indicated that observed shifts in skilled birth attendance, ANC participation, and institutional delivery could be due to random variation rather than true systemic change. Similarly, logistic regression showed that being in the post-COVID period did not significantly influence the likelihood of skilled birth attendance, although a slight decline was observed. The MANOVA results further confirmed that the COVID-19 pandemic did not have a statistically significant combined effect on maternal healthcare utilization indicators when analyzed simultaneously. These suggest that while the pandemic may have disrupted services and access, the aggregate national-level impact on maternal health service utilization was limited.

However, regional disparities, as seen in the descriptive breakdowns, remain critical. The lack of national statistical significance seem to mask regional inequalities, particularly affecting northern Nigeria as observed in the regional declining trend.

Table 4. Regional-level Statistical Analysis (P-Value)

Region	Skilled Birth Attendance	ANC 4+ Visits	Institutional Delivery
North-Central	0.125	1.000	1.000
North-East	0.000 (significant)	0.671	0.100
North-West	0.000 (significant)	0.851	0.337
South-East	0.982	0.100	0.449
South-South	1.000	1.000	0.052 (borderline)
South-West	0.634	0.032 (significant)	0.363

Table 4 shows that regional chi-square tests revealed significant declines in skilled birth attendance in the North-East (p = 0.0003) and North-West (p = 0.00008) regions, highlighting the disproportionate impact of COVID-19 on maternal health services in northern Nigeria. No significant change was detected in antenatal care (ANC 4+) visits or institutional deliveries

for these regions. Conversely, the South-West region demonstrated a statistically significant increase in ANC 4+ visit completion rates ($p = 0.032$), suggesting the effectiveness of post-pandemic recovery interventions. The South-South region showed a borderline significant improvement in institutional deliveries ($p = 0.052$), while no statistically significant changes were observed in the North-Central and South-East zones. These results underscore substantial regional disparities in the pandemic's effects on maternal health service utilization in Nigeria.

Discussion

Between 2018 and 2024, maternal healthcare utilization in Nigeria witnessed notable disruptions. The pandemic disrupted multiple building blocks of Nigeria's health system. Service delivery was impaired due to facility closures and reduced antenatal outreach. Health workforce availability declined amid fears of infection and burnout [9]. Applying the Health Belief Model, fear of infection, misinformation, and perceived barriers during the pandemic likely deterred many women from seeking ANC and facility-based deliveries. Using Andersen's Behavioral Model, we see that enabling factors such as health system closures, transportation difficulties, and regional poverty compounded the decline in service utilization. Meanwhile, Systems Theory elucidates how the pandemic, acting as a health system shock, led to systemic failures, especially in the North-East and North-West where health systems were already fragile. The observed improvements in institutional deliveries in certain southern regions align with Systems Theory's concept of system adaptation, where more resilient areas rapidly adjusted service delivery mechanisms (e.g., through outreach and mobile clinics). Thus, interpreting the findings through these models highlights not only the direct effects of the pandemic but also how underlying structural vulnerabilities magnified its impact. Table 1 shows that the North-East and North-West regions witnessed the largest declines in skilled birth attendance, to 32.3% and 25.6%, respectively, compared with 88.1% in the South-East [10]. These disparities illustrate geographical inequities in healthcare access, worsened by the pandemic. However, some areas, such as institutional deliveries and postnatal care, highlighted in Table 2 showed modest improvements, with the South-South and South-West regions seeing notable gains between 2018 and 2024, indicating targeted regional recovery efforts in maternal health programs. These trends underscore both challenges and opportunities in maternal healthcare during this period.

Skilled birth attendance fell from 67% to 63%, while the percentage of women attending at least four ANC visits dropped from 57% to 52%. These declines align with global reports of reduced healthcare access during the pandemic, driven by lockdowns, transportation barriers, and fears of infection [11]. Similar trends were observed in sub-Saharan Africa, worsening risks for maternal and neonatal health [12].

The decline in ANC visits and skilled birth attendance can be linked to pandemic-related restrictions, economic hardships, and fears of infection, which deterred pregnant women from seeking care [13]. Despite these challenges, institutional deliveries increased from 39% to 43%, and skilled birth assistance rose from 43% to 46%, likely due to targeted efforts to promote facility-based births through community outreach, transportation support, or financial incentives.

Postnatal care also saw slight improvements, with coverage for mothers rising from 42% to 43% and for newborns from 38% to 42%. While this reflects growing recognition of the importance of postnatal care, coverage remains below global recommendations [14], highlighting the need for further investment.

Regional disparities persisted, with northern regions experiencing sharper declines due to weaker healthcare infrastructure, economic

hardships, and sociocultural barriers. These challenges, including limited facilities, reduced incomes, and cultural norms restricting women's autonomy, underscore the need for targeted interventions to address systemic and sociocultural barriers [15-17]. Regional statistical analyses provided deeper insights beyond the national picture with statistically significant declines in skilled birth attendance in the North-East and North-West regions, confirming that pandemic-induced disruptions disproportionately impacted already vulnerable populations. In contrast, the South-West demonstrated resilience, with a statistically significant increase in antenatal care attendance. These divergent regional patterns reinforce the urgent need for tailored, region-specific strategies, recognizing that national averages may obscure critical local disparities. Strengthening maternal health systems in the northern zones must be a priority, focusing on rebuilding healthcare infrastructure, addressing sociocultural barriers, and restoring trust in health services disrupted during the pandemic [18].

Conclusion

This study, informed by public health theories such as the Health Belief Model, Andersen's Behavioral Model, and Systems Theory, demonstrates that both individual behavior and systemic resilience jointly influenced maternal health outcomes during the COVID-19 pandemic in Nigeria. Addressing future shocks requires strategies that consider individual perceptions, systemic enablers, and structural vulnerabilities across regions. Between 2018 and 2024, the pandemic disrupted access to essential maternal healthcare services, resulting in a noticeable decline in skilled birth attendance and antenatal care visits. These declines highlight not only the fragility of Nigeria's maternal health infrastructure in times of crisis but also the broader implications of underinvestment in health systems, particularly in low-resource and high-risk regions.

Regional disparities were a recurring theme throughout the study, with the northern zones, especially the North-East and North-West, experiencing the steepest declines in key maternal health metrics. These regions continue to grapple with entrenched challenges, including insecurity, cultural barriers, poverty, and inadequate health service delivery systems. In contrast, the southern zones, particularly the South-East and South-West, showed more resilience and in some cases modest improvements, reflecting stronger health infrastructure and more adaptive local responses.

However, the increase in institutional deliveries and postnatal care suggests that positive changes were possible even amid a global health emergency, when focused interventions and policy responses were implemented. These gains should serve as a foundation for scaling up successful programs and crafting responsive health policies.

Moving forward, Nigeria must prioritize investments in maternal health as part of a broader strategy to build resilient and equitable health systems. This includes decentralizing maternal health services, ensuring uninterrupted access during emergencies, enhancing the capacity of the healthcare workforce, and implementing inclusive, region-specific interventions. Ultimately, sustaining maternal health improvements post-pandemic will depend on the country's ability to learn from this crisis, address longstanding inequities, and commit to health system strengthening at all levels. Without urgent and strategic actions, the pandemic risks reversing decades of hard-won progress in maternal health outcomes.

Policy Recommendations

Strengthening Nigeria's maternal health resilience post-COVID requires region-specific, evidence-based strategies embedded

in systemic reform. Future health policies must prioritize not only national averages but also local disparities that affect maternal health outcomes at their root. Investments in health information systems, workforce development, and digital health innovations will be essential to achieving maternal health equity across Nigeria.

The South-West region, which recorded a statistically significant increase in ANC visits, serves as a successful model for digital health integration. Building on this momentum, the Federal Ministry of Health's Digital Health Division should scale up mobile health (mHealth) platforms that offer ANC booking, reminders, and remote consultations. These efforts should be institutionalized as ongoing programs, with coverage of four or more ANC visits tracked as a key performance indicator.

To address the significant decline in skilled birth attendance observed in the North-East and North-West, the government should consider deploying mobile clinics and scaling up community midwife programs. These interventions could be led by the National Primary Health Care Development Agency (NPHCDA), in collaboration with state Ministries of Health, and delivered by trained community-based health workers. Implementing these solutions within 6-12 months can directly increase the proportion of births attended by skilled personnel in underserved regions.

Given the persistent gaps in postnatal care coverage, there is an urgent need to integrate postnatal checkups with routine child vaccination visits. National Health Insurance Scheme (NHIS) and Primary Health Care Boards should introduce bundled service packages that make postnatal care both accessible and efficient. Implementation within the next 12 months should aim to improve maternal and newborn postnatal care uptake, as measured by postnatal visit completion rates.

Lastly, disparities in the distribution of the health workforce require urgent attention. The Federal Ministry of Health and the National Council on Health should consider establishing rural workforce incentive programs to attract and retain skilled professionals in underserved areas. These initiatives could include task-shifting strategies, continuous training, and deployment through regional training hubs, with an expected rollout over 12-24 months. The success of these programs should be monitored and documented.

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Conflict of Interest

There is no conflict of interest related to the research, authorship, or publication of this study.

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Impact of Cervical Cancer Screening Education on Knowledge, Attitude, and Willingness to Uptake HPV Self-Sampling in Delta State

Priscilla Uruemuesiri EBUNU[1*], Beatrice M. Ohaeri[2], Ezekiel Nwabuwanne EZEKIEL[3], Joel Ojo ALUKO[4]

[1]*Delta State College of Nursing Sciences, Warri, Delta State*
[2]*Faculty of Nursing Sciences, University of Ibadan*
[3]*Government Hospital Agbarho, Asaba, Delta State*
[4]*Department of Nursing Sciences, College of Health Sciences, University of Ilorin, Ilorin, Nigeria*

Abstract

Cervical cancer remains a significant public health challenge in Nigeria, particularly among women of childbearing age. Despite available screening methods, the uptake of Human Papillomavirus Self-Sampling (HPVSS) remains low due to limited awareness and knowledge. This study evaluated the outcomes of a cervical cancer screening educational intervention on knowledge, attitude, and willingness to uptake HPVSS among childbearing women in Delta State, Nigeria. A quasi-experimental study was conducted using pre- and post-intervention assessments. A total of 196 questionnaires (98 each at pre- and post-intervention) were analyzed using SPSS version 25.0. The intervention involved structured educational sessions on cervical cancer screening and HPVSS. Descriptive statistics and paired-sample t-tests were used for data analysis. Post-intervention, awareness of HPVSS increased from 35.7% to 66.3%. The proportion of women with adequate knowledge improved from 6.1% to 45.9%. Positive attitude towards HPVSS risen from 99% to 100%, while willingness to uptake HPVSS improved from 93.9% to 99%. Significant differences were observed between pre- and post-intervention scores across all measured parameters ($p < 0.000$). The educational intervention significantly improved knowledge, attitude, and willingness to uptake HPVSS among childbearing women. These findings suggest that structured educational programs can enhance cervical cancer screening awareness and acceptance of HPVSS, potentially increasing screening uptake and reducing cervical cancer burden in Nigeria.

Keywords*: Cervical Cancer Screening, Educational Intervention, HPV Self-Sampling, Impact, Women's Health.*

Introduction

Cervical cancer is the fourth most common cancer among women globally, with over 660,000 new cases and approximately 350,000 deaths in 2022 [1]. Over 94% of cervical cancer-related deaths occur in low- and middle-income countries (LMICs), including Nigeria, where the burden is particularly high [2]. The World Health Organization (WHO) has developed a 90–70–90 strategy to eliminate cervical cancer by 2030, which includes HPV vaccination, increased screening, and improved access to treatment [3].

Human Papillomavirus (HPV) infection is the leading cause of cervical cancer, with HPV types 16 and 18 accounting for 70% of cases [4]. HPV Self-Sampling (HPVSS) is a

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****Corresponding Author: prisig2000@gmail.com***

convenient and effective method for increasing screening uptake, particularly among underserved populations [5]. However, in Nigeria, uptake remains low due to limited awareness, cultural beliefs, and accessibility challenges [6]. Educational interventions can address these barriers by improving knowledge, attitudes, and willingness to participate in screening programs [7].

This study assessed the impact of a cervical cancer screening educational intervention on knowledge, attitude, and willingness to uptake HPVSS among childbearing women in Delta State, Nigeria.

Methods

A quasi-experimental design was employed, with pre- and post-intervention assessments conducted among 196 childbearing women in Delta State. Participants were recruited from primary healthcare centers using a multi-stage sampling technique. The intervention consisted of structured educational sessions covering cervical cancer risk factors, HPV infection, and self-sampling procedures.

Data collection was conducted using a structured questionnaire adapted from previously validated instruments [8]. Data analysis was performed using SPSS version 25.0. Paired-sample t-tests were conducted to determine significant differences between pre- and post-intervention scores, with a significance level set at $p < 0.05$.

Results

Socio-Demographic Characteristics

The study sample included 98 women in both the pre- and post-intervention phases. The majority (68.4%) were aged 20–35 years, 93.9% were married, and 57.1% had a tertiary education (Table 1).

Table 1. Respondents Socio-demographic Data (N=98)

Personal Socio-demographic	**Frequency**	**Percent**
Age range (years)		
18-19	2	2
20-35	67	68.4
36-49	23	23.5
50-58	6	6.1
Marital Status		
Single	6	6.1
Married	92	93.9
Highest Educational level		
Tertiary Education	56	57.1
Secondary Education	33	33.7
Primary Education	5	5.1
Informal Education	4	4.1
Religion		
Christianity	92	93.9
Islam	4	4.1
Traditional	2	2

Occupation		
Unemployed	7	7.1
Student	1	1
Trading	45	45.9
Artisan	20	20.4
Civil servant	25	25.5

Age: *minimum = 18, maximum = 58, mean ± SD = 32±8.91*

Changes in Awareness and Knowledge of HPVSS

Post-intervention, awareness of HPVSS increased from 35.7% to 66.3%, while knowledge of cervical cancer prevention improved significantly. The proportion of women with adequate knowledge rose from 6.1% to 45.9% (Table 2).

Table 2. Respondents Awareness of HPVSS (N=98)

Awareness of HPV Self-sampling (HPVSS)	**Pre-intervention**		**Post-intervention**	
	Freq	**%**	**Freq**	**%**
Awareness of cervical cancer disease				
Aware	68	69.4	89	90.8
Not aware	30	30.6	9	9.2
Preventability of cervical cancer				
Preventable	78	79.6	82	83.7
Not preventable	16	16.3	7	7.1
I don't know	4	4.1	9	9.2
Awareness of HPVSS method of preventing cervical cancer				
Aware	35	35.7	65	66.3
Not aware	63	64.3	33	33.7
Source of awareness of HPVSS				
Family members	2	2	4	4.1
Health workers	25	25.5	55	56.1
Mass media	7	7.1	4	4.1
Friends/co-workers	7	7.1	1	1
School	1	1	2	2
Never heard it before	56	57.1	32	32.7
Period of HPVSS awareness				
Less than one year	24	24.5	46	46.9
Above one year	11	11.2	19	19.4
Never heard of it before	63	64.3	33	33.7

Attitude towards HPVSS

Before the intervention, 99% of participants exhibited a positive attitude towards HPVSS, which increased to 100% post-intervention (Figure 1).

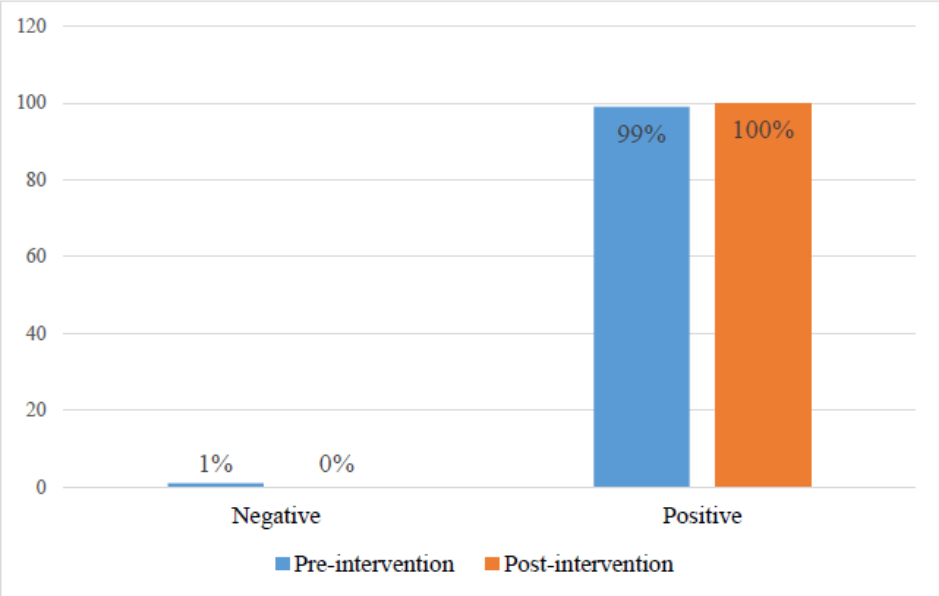


Figure 1. Respondents Attitude towards HPVSS (N=98)

Willingness to Uptake HPVSS

In Figure 2, willingness to undergo HPVSS increased from 93.9% to 99% post-intervention. The paired-sample t-test indicated statistically significant improvements across all measured parameters ($p < 0.000$).

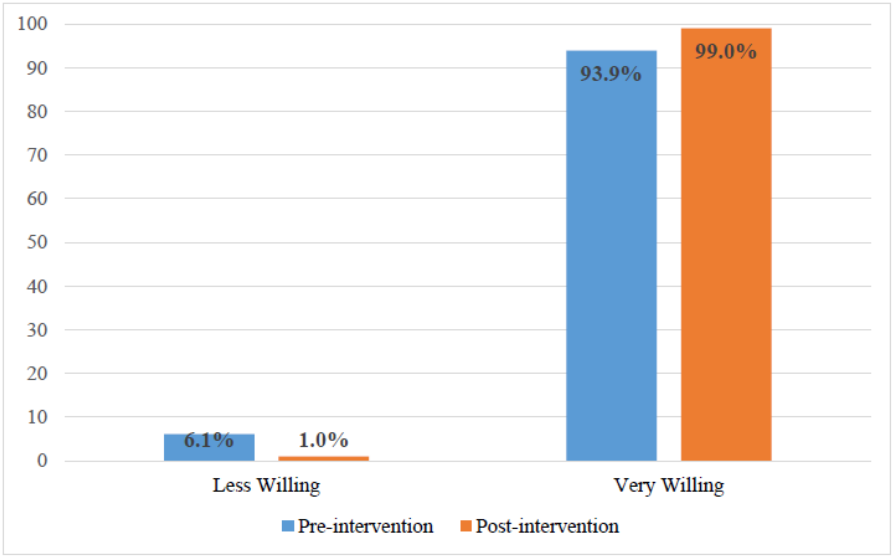


Figure 2. Respondents' Level of Willingness to Uptake HPVSS (N=98)

Discussion

The findings of this study align with global evidence indicating that educational interventions enhance cervical cancer screening uptake [9]. Similar studies in Nigeria and Sub-Saharan Africa have reported that knowledge gaps and cultural barriers hinder HPVSS adoption [6]. Our study demonstrated that targeted educational programs can significantly improve knowledge, attitudes, and willingness to undergo HPVSS.

Despite these promising findings, challenges such as limited healthcare access and the affordability of screening kits remain key barriers. Governmental and non-governmental organizations should prioritize subsidizing HPVSS kits and integrating educational interventions into existing reproductive health programs [10].

Conclusion and Recommendations

This study demonstrates that a structured cervical cancer screening educational intervention significantly improves knowledge, attitude, and willingness to uptake HPVSS among childbearing women in Delta State. To sustain these improvements, healthcare policymakers should integrate HPVSS awareness programs into routine maternal healthcare services. Further large-scale studies are recommended to assess the long-term impact of such interventions on cervical cancer prevention.

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Seasonality of COVID-19 Transmission in Tropical Countries: The Case of the Health Districts of Kati and Commune VI of Bamako in Mali

Moulaye Baby[1*], Nouhoum Telly[2], Boubacar Doumbia[3], Seydou Ouattara[3], Ismaël Simaga[4] Seydou Doumbia[2]

[1]*Texila American University (TAU)*
[2]*Faculty of Medicine and Odontostomatology University of Science, Technology and Technology of Bamako (FMOS/USTTB)*
[3]*National Institute of Public Health/Department of Public Health Emergency Operations (INSP/DOU SP)*
[4]*Reference Health Center of Kati/Koulikoro region*

Abstract

The existence of seasonality in COVID-19 transmission remains a major concern in the management of COVID-19 outbreaks. To answer this question, we conducted a retrospective cohort study using epidemiological surveillance data from the health districts of Kati and Commune VI of Bamako. The data was collected between January 1, 2021 and December 31, 2021. Two semi-structured questionnaires included 114 cases of COVID-19, including 43 symptomatic and 71 asymptomatic, for whom 1227 contacts were identified and followed daily for 14 days. Our results showed that 112 of the contacts followed developed the disease, i.e. an incidence rate of 9.1%. The sex ratio was 1.5 in favour of the female sex. The incidence rate was higher in the dry season with 13.2% 95% CI [10.3 - 16.7] compared to 6.7% 95% CI [4.6 - 9.4] in the cool season and 5.8% 95% CI [3.4 - 9.2] in the winter period. Also, the risk of contracting COVID-19 for exposed contacts was 2.25 times higher in the dry season compared to other seasons (RR=2.25 95% CI [1.55 - 3.28]). Incidence rates were higher for average temperatures between 28 and 34 degrees Celsius, the same is true for humidity between 19 and 37%. The dry season has been identified as favorable for the transmission of COVID-19 in our study area. As a result, response measures must be stepped up before and during the dry season.

Keywords: *COVID-19, Kati and Commune VI Health Districts, Seasonality, Transmission.*

Introduction

The COVID-19 virus, since its discovery in Wuhan in December 2019, has spread throughout the planet and was declared a pandemic by the World Health Organization (WHO) on March 11, 2020 [1]. Indeed, scientific evidence shows that COVID-19 is transmitted mainly through aerosol droplets and direct contact with soiled surfaces [2]. Despite this evidence, the level of knowledge about the COVID-19 epidemic remains low today.

According to the results of the studies carried out, the natural history of COVID-19 is not well known, the incubation time varies from 1 to 14 days with an average of 5 days as for Severe Acute Respiratory Syndrome (SARS). The reproduction number of the disease (R0 or R) lacks precision in the different estimates. At the beginning of the epidemic, the WHO announced the reproduction number of 1.4 to 2.5; A study done in China finds 2.38 [3] while the analysis of data from 11 European countries finds a value of 3.87 [3.0 to 4.7] [4].

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****Corresponding Author: moulaye.baby@yahoo.fr***

The literature accepts that patients with asymptomatic COVID-19 (healthy carriers) can transmit the disease [18]. However, the transmission of infectious diseases remains dependent on several determinants, including environmental, biological, genetic and socio-behavioural factors. Regarding the ecological aspects of COVID-19, studies have shown that transmission is lower during the summer month in temperate countries [5]. This corroborates with the seasonality of endemic respiratory viruses, including influenza and other endemic coronaviruses (CoVs) in temperate countries [5]. Also, seasonal waves have been clearly observed in the majority of temperate regions, in tropical and subtropical countries, where peaks occur sporadically throughout the year, with the discovery of new variants. The rainy season is consistently correlated with peaks, as shown in studies by Shek and Col de Viboud [6,7]. Yang [8] reported an increase in viral transmission during the rainy and wet seasons. This seasonality of COVID-19 would explain the low rates of positive cases and deaths recorded in Africa. Indeed, as of September 7, 2021, 7,926,999 confirmed cases have been recorded with 200,045 deaths in 55 African Union Member States against 220,626,513 confirmed cases with 4,566,532 deaths worldwide [9].

Indeed, Sajjad et al. concluded that epidemic areas at the global level are located within the average temperature corridors of 5 to 11 ◦C, with low humidity levels of 4 to 7 g/m3 [10]. This trend has been observed by Bukhari et al. between the northern and southern states of the United States, with many cases recorded in regions with low temperatures (4 to 10° C) and low humidity (3 to 9 g/m3) [11]. Also, James H et al. find in their study a considerable difference between the cases and deaths recorded between North Africa (a slowdown during the summer season) and South Africa (an increase in the winter period) from May [5]. Biologically, heat and humidity are known to reduce the transmission of respiratory viruses.

In Mali, the first 2 cases of COVID-19 were reported on 25/03/2020, and as of 18 June 2023, 33,151 confirmed cases, including 743 deaths, were recorded [12]. To our knowledge, there is no data in Mali on the number of secondary cases an infectious person can generate or contaminate. In addition, the climatic effects on COVID-19 transmission in the epidemic district have not been documented in this country. It has also been noted that at the global level, the impact of environmental factors on the transmission of respiratory viruses is understudied [5].

This study is situated in this context to contribute to understanding the epidemiology of COVID-19 through analysis of seasonal variation in incidence rates.

Materials and Methods

Scope of the Study

The study took place in two health districts, namely commune VI of the District of Bamako, which has a Reference Health Center (CSREF) (Figure 1, *Source: CPS-SS-DS-PF, MSDS, 2020, Health card of Mali*) for 12 health areas covering a population of 741,811 inhabitants, and the Kati health district in the Koulikoro region (Figure 2, *Source: CPS-SS-DS-PF, MSDS, 2020, Health card of Mali*), which has a CS Ref and 46 Community Health Centers (CSCom) with a population of 792,307 inhabitants in 2024 [13].



Figure 1. Health map of commune VI of the District of Bamako

Source: CPS-SS-DS-PF, MSDS, 2020, Health card of Mali



Figure 2. Health map of Kati district

Source: CPS-SS-DS-PF, MSDS, 2020, Health card of Mali

Type and Period of the Study

We conducted a retrospective cohort study with data from the epidemiological surveillance of COVID-19 cases and their contacts followed from January 01, 2021 to December 31, 2021.

Study Population

Our study population consisted of 114 cases confirmed by reference laboratories and listed in the labline of the national response coordination committee. There were 43

symptomatic cases and 71 asymptomatic cases, among whom 1227 contacts were identified and followed daily for 14 days after identification. Also, meteorological data from Bamako's monthly bulletins for 2021 were used to cross-reference with the climatic seasons.

The sample of index cases was constituted through a systematic random selection of confirmed cases on the linear list of the laboratory (labile COVID-19 of the Ministry of Health and Social Development). Index cases and contacts were included based on the criteria below:

Inclusion Criteria

1. Have a file with health facilities and be registered on the linear list or in the DHIS2 COVID Tracker instance for confirmed cases.
2. Be identified by one of the health structures and have a contact tracing sheet or be entered into the DHIS2 COVID Tracker instance for contact cases.

Exclusion Criteria

Any cases that do not have a usable/complete file, including the various forms of the DHIS2 COVID Tracker instance.

Data Collection

Two semi-structured questionnaires were used to collect data from health facilities (CS Ref Commune VI and CS Ref of Kati).

Data Processing and Analysis

Data processing and analysis were performed using SPSS version 21 and Excel. Chi2 was used for the comparison of proportions and risk ratio was used to assess the association between seasonality and COVID-19. The results were significant for a $p < 5\%$ (Figure 3 Source: *Current study)*.

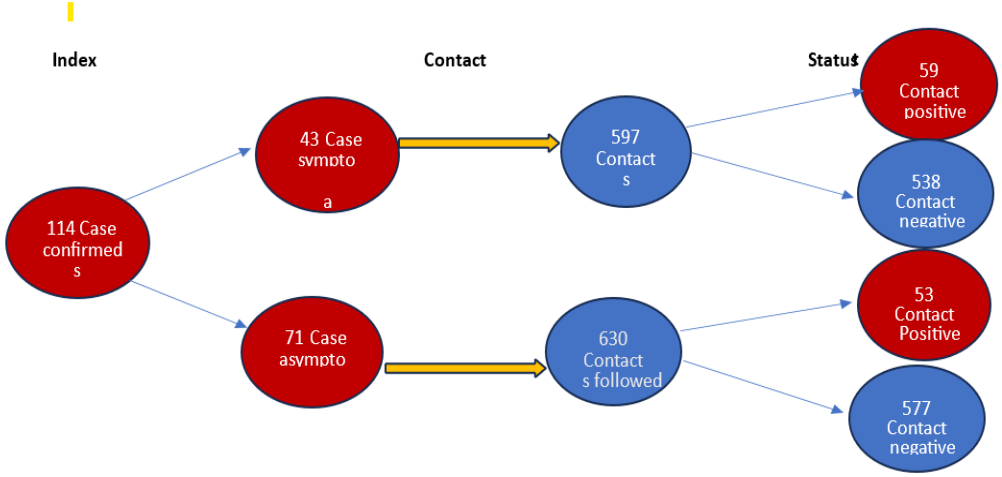


Figure 3. Design of the Study

Source: Current study

Ethical Consideration

This study used secondary data from epidemiological surveillance in the health districts of Commune VI of Bamako and Kati in the Koulikoro region. The study protocol was approved by the ethics committee of the National Institute of Public Health (INSP) of Mali (Decision No. 10/2023/CE-INSP).

Results

Socio-Demographic Characteristics

Distribution of Participants by Gender

The sex ratio was 1.2 in favor of males for index cases and 1 for followed contacts, i.e., 50% for each sex (Figures 4 and 5, Source: *Current study*).

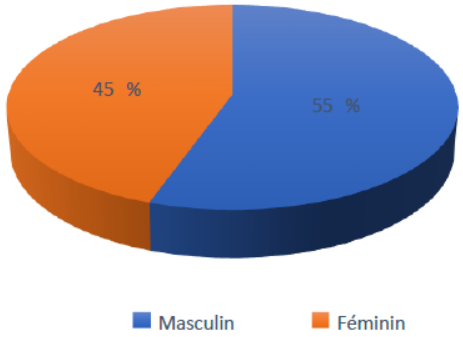


Figure 4. Distribution by sex of the 114 index cases from January 1 to December 31, 2021 in the health districts of Commune VI and Kati.

Source: Current study

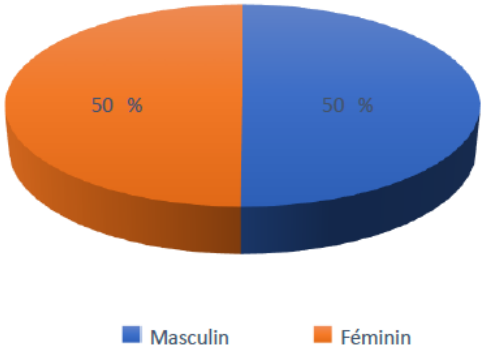


Figure 5. Distribution by sex of the 1227 contacts followed from January 1 to December 31, 2021, in the health districts of Commune VI and Kati.

Source: Current study

Distribution of Participants by Age Group

The average age was 35.9 years ± 15.6 years for index cases and 25.1 years ± 15.9 years for followed contacts. We found that 69.3% of index cases and 56.8% of contacts followed were in the 18-50 age group. Those under 18 years of age accounted for 9.7% of index cases, and the age group 51 years and over was the least represented among the contacts monitored, i.e., 8.2% (Table 1, Source: *Current study*).

Table 1. Distribution of the 114 index cases and 1227 contacts followed from January 1 to December 31, 2021, in the health districts of Commune VI and Kati by age group

Age range (years)		**Index cases**	**Contacts followed**
Less than 10	Number	2	188
	%	1,8	15,3
	95% CI	0,5 ; 6,2	13,4 ; 17,4
11 to 17	Number	9	242
	%	7,9	19,7
	95% CI	4,2 ; 14,3	17,6 ; 22,0
18 to 50	Number	79	696
	%	69,3	56,8
	95% CI	60,3 ; 77,0	53,9 ; 59,5
51 and over	Number	24	101

	%	21,1	8,2
	95% CI	14,6 ; 29,4	6,8 ; 9,9

Source: Current study

Analysis of Secondary Contamination Rates

The secondary contamination rate was 9.9% for contacts exposed to symptomatic cases compared to 8.4% for those exposed to asymptomatic cases. Contacts of symptomatic cases were at higher risk of secondary infection than those of asymptomatic cases (Table 2; Source: *Current study)*.

Table 2. Distribution of positive contacts by the presence of symptoms or not in the index case

Status Contact Tracking		**Index cases**		**Total**
		Asymptomatic	**Symptomatic**	
Negative	Number	577	538	1115
	%	91,6	90,1	90,9
Positive	Number	53	59	112
	%	8,4	9,9	9,1
Total	Number	630	597	1227

Chi-Square = 0.79, p=0.37; RR=1.19 95% CI (0.81, 1.76), Source: Current study

The table below shows that 112 contacts have become positive out of 1227 contacts followed, i.e. a positivity rate of 9.1%. The rate of secondary infection was higher in females with 11.1% (95% CI [8.7 - 13.9]) compared to 7.2% (95% CI [5.3 - 9.6]) for males, i.e. a ratio of 1.5 in favour of females (Table 3, Source: *Current study)*.

Table 3. Positivity rate of the 1227 contacts followed in the study area by sex

Status	**Sex n (%)**		**Total**
	Feminine	**Masculine**	
Negative	547 (88,9)	568 (92,8)	1115 (90,9)
Positive	68 (11,1)	44 (7,2)	112 (9,1)
95% CI	8,7 ; 13,9	5,3 ; 9,6	7,6 ; 10,9
Total	615	612	1227

Chi2= 5,5 et p=0,019, Source: Current study

Analysis of the Incidence Rate According to Seasonal Variation

The table below shows a link between seasonal variation and the level of COVID-19 contamination. The contamination rate was 13.2% (*95% CI [*10.3 - 16.7]) in the dry season compared to 6.7% (*95% CI [*4.6 - 9.4]) in the cool season and 5.8% (*95% CI [*3.4 - 9.2]) in the winter period (Table4, Source: *Current study)*.

Table 4. Determination of the secondary contamination rate by season

Status	**Season n (%)**			**Total**
	Cold	**Rainy season**	**Dry**	
Negative	421 (93,3)	260 (94,2)	434 (86,8)	1115 (90,9)
Positive	30 (6,7)	16 (5,8)	66 (13,2)	112 (9,1)
95% CI	4,6 ; 9,4	3,4 ; 9,2	10,3 ; 16,7	7,6 ; 10,9
Total	451	276	500	1227

Chi-Square =17,02; p < 0,001, Source: Current study

Regarding the relative risk, the figure below shows that the dry season was more favourable for COVID-19 transmission than other seasons, with a risk incidence of 2.25 and a 95% CI of [1.55 - 3.28]. Indeed, contacts exposed to COVID-19 cases during the dry season were 2.25 times more likely to be contaminated by COVID619 than those exposed during the winter or cold season (Figure 6, Source: *Current study)*.

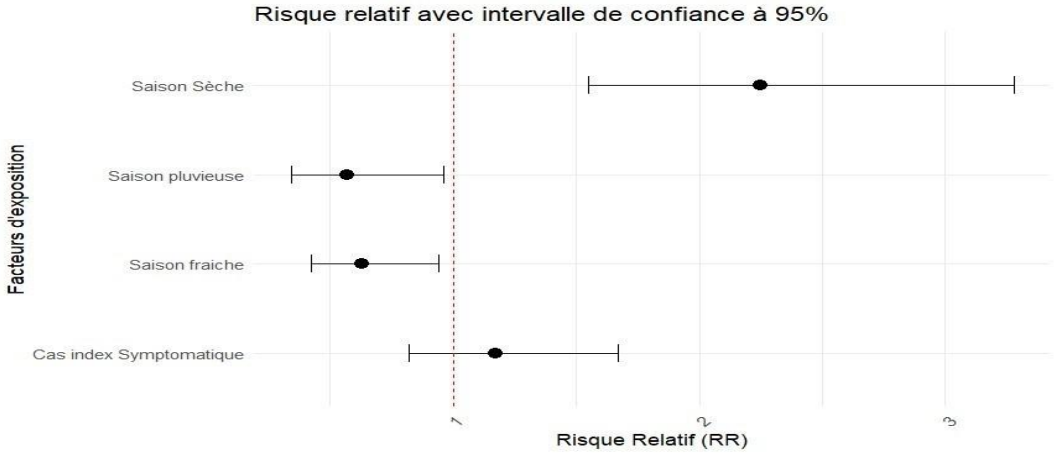


Figure 6. Relative risk of COVID-19 in the 1227 contacts followed from January 1, 2021 to December 31, 2021 by exposure factors.

Source: Current study

Analysis of the Incidence Rate According to the Monthly Change in Average Temperature

Contamination was higher in March followed by April with a monthly incidence of 16.8% and 12.9% respectively, followed by November (12.8%) and December (11.9%) and no contact identified and followed up in June became positive (0.0%) ($p < 0.001$).

In terms of the change in monthly impacts as a function of average temperature, the rate of contamination/transmission was higher for temperatures between 28 and 34 degrees Celsius. (Figure 7, Source: Current study).

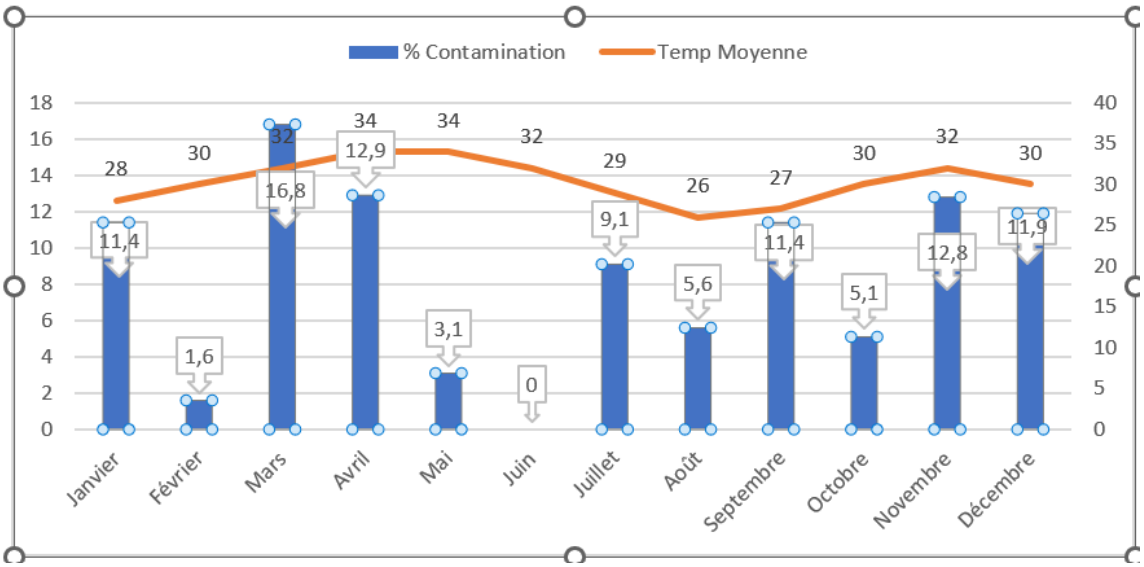


Figure 7. Monthly evolution of the Positivity rate among the 1227 contacts followed from January to December 2021 according to the average temperature in degrees Celsius

Chi-Square =44,84; p < 0,001, Source: Current study

The analysis as a function of humidity shows that transmission would be favoured by a humidity between 19 and 37%, the higher the humidity, the more confirmed cases decreased (Figure 8, Source: *Current study)*.

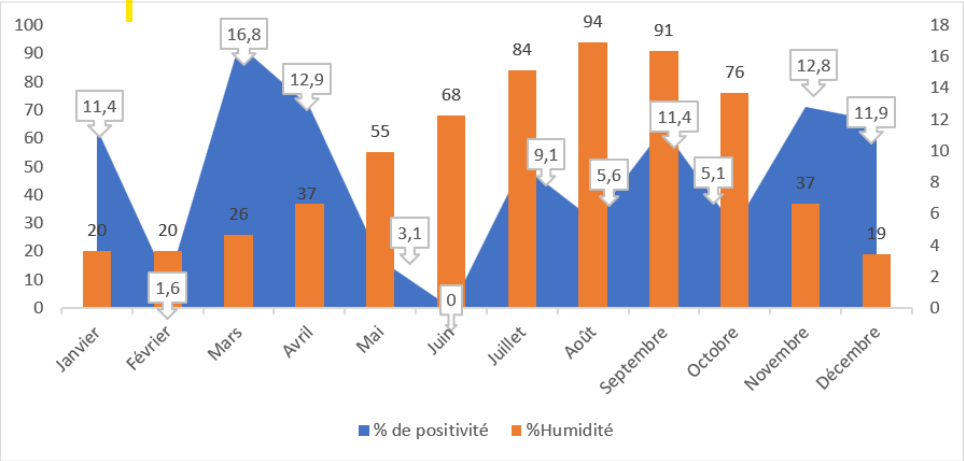


Figure 8. variation in the positivity rate as a function of humidity in the study area from January 1, 2021 to December 31, 2021

Source: Current study

Discussion

This cohort study carried out with 114 index cases and 1227 contacts followed daily for 14 days in the health districts of Kati and Commune VI of Bamako aimed to analyze the seasonality of COVID-19 transmission from January 1 to December 31, 2021. Our results confirm a link between seasonality and the risk of COVID-19 contamination. They also show that the dry season was more favourable for disease transmission in our study areas. Of the 1227 contacts followed, 112 developed COVID-19, with an incidence rate of 9.1%, 95% CI [7.6 - 10.9] (Table4). This rate was higher in females with 11.1% 95% CI [7.6 - 10.9] compared to 7.2% 95% CI [5.3 - 9.6] for males, i.e. a ratio of 1.5 in favour of females (p=0.019) (Table 3). The factors that may explain this predominance were not explored in our study. Our result is different from that of De Lusignan S et al, who in a British cohort study in primary care, found a predominance in men (OR = 1.55 95% CI [1.27 - 1.89]) [14].

For the analysis of COVID-19 incidence by season, the risk of COVID-19 for contacts was 2.25 times higher in the dry season compared to other seasons (RR=2.25, 95% CI [1.55 - 3.28]). We found an incidence rate of 13.2% 95% CI (10.3; 16.7) in the dry season versus 6.7% 95% CI (4.6; 9.4) in the cool season and 5.8% 95% CI (3.4; 9.2) in the winter period (Figure 6). This result is comparable to that of Sajadi et al, who found that the risk of being contaminated by COVID-19 is higher in a range of average temperatures of 5 to 11◦C with a low humidity level of 4 to 7 g/m3 [11]. Our results are inconsistent with those of Lagacé-Wiens P et al, who find that endemic coronaviruses and other common respiratory viruses cause annual seasonal outbreaks during the Canadian winter months [15].

In Mali, the dry season runs from March to May, the incidence rate found in our study was higher in March with 16.8% followed by April (12.9%) (Figure 7). This low rate in May and June coincides with the beginning of the wintering season. This result is consistent with the SitRep N°178 of the Ministry of Health of Mali where the peak of positivity occurred in the 14th and 15th epidemiological weeks with 14.7% and 11.7% respectively. These periods correspond to April 2021 [16]. This result is comparable to that of Peter J et al, who find low levels in periods of relative humidity (per 10%)

and absolute humidity (per 5g/m) with RTIs of 0.91 (0.85–0.96) and 0.92 (0.85–0.99) respectively [17].

For the analysis of monthly impacts based on average temperature, the rate of contamination/transmission is higher for temperatures between 28 and 34 degrees Celsius. In addition, transmission would be favored by a humidity between 19 and 37%. From a biological perspective, heat and humidity are known to affect the transmission of respiratory viruses negatively [18].

Conclusion

This cohort study, conducted in the health districts of Kati and Commune VI of Bamako, aimed to analyze COVID-19 transmission seasonality from January 1 to December 31, 2021.

Our results showed differences in incidence rates across seasons in Mali. The dry season from March to May has been identified as more favorable for COVID-19 transmission in our study areas than in others. This outcome needs to be taken into account in the mobilization of resources for the COVID-19 response, especially in this context of limited resources. There is a need to strengthen control measures before and during the dry season in response models for human-to-human diseases, including COVID-19.

Acknowledgement & Conflict of Interest

We want to thank in particular:

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The Chief Medical Officers and Surveillance Officers of the health districts of Kati and Commune VI of the District of Bamako shared their field experiences on the theme.

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Trends and Predictors of Pre-Eclampsia between 1990 and 2020 in Ghana: A Systematic Review

Priscilla N. A. Odei-Quansah[1*], Francis Z. Taabia[2], Martin Nyaaba. Adokiya[3]
[1]*Department of Public Health, Texila American University, Academic Delivery Facilitator of the University of Central Nicaragua, Managua, Nicaragua*
[2]*Department of Nutrition and Food Science, University of Ghana, Accra, Ghana*
[3]*Department of Global and International Health, University for Development Studies, Tamale, Ghana*

Abstract

Pre-eclampsia is a specific form of hypertension in pregnancy that raises significant public health concerns globally. Mothers may sometimes appear healthy, yet later develop pre-eclampsia, leading to adverse consequences, including death. This situation has underscored the necessity for ongoing research to improve maternal birth outcomes and prevent disabilities and fatalities. This systematic review assessed trends and predictors of pre-eclampsia in Ghana over the last three decades. This review covered publications from January 1990 to December 2020, using three bibliographic databases. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was used to screen and select the papers included in the review. The tool for Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) was used to enhance the quality of the evaluated papers. The majority (13 out of 21) of studies on the prevalence and predictors of pre-eclampsia were conducted between 2011 and 2020. The review found an average incidence rate of 9.1% for pre-eclampsia and identified approximately twenty-six predictors among pregnant women. These predictors included demographic and maternal factors, dietary and environmental influences, as well as maternal and perinatal care services. There is an increasing trend of pre-eclampsia among women in Ghana. Although the predictors of pre-eclampsia are relatively similar to those in other parts of the world, healthcare providers should ensure timely screening, treatment, and management to reduce adverse outcomes, including maternal mortality during pregnancy.

Keywords: *Ghana, Maternal, Predictors, Pre-eclampsia, Pregnancy.*

Introduction

Pre-eclampsia is a specific form of hypertension that occurs during pregnancy, presenting a significant global public health concern. It has been a major contributor to maternal deaths and adverse birth outcomes in both high- and low-resource settings [1]. Typically, pre-eclampsia develops after the first trimester, around 20 weeks of gestation, during labour, or within two days post-delivery, and is often accompanied by proteinuria [2, 3]. The condition is characterized by the persistent and progressive elevation of blood pressure, and if left untreated, can lead to eclampsia, a significant cause of adverse maternal and neonatal outcomes [2].

Despite extensive research, the precise biological mechanisms behind pre-eclampsia remain unclear [1]. Clinical evidence suggests that it results from a series of physiological reactions triggered by poor perfusion of the

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****Corresponding Author: naaserwah2@gmail.com***

uterus and placenta [2]. This leads to oxidative stress, causing the release of anti-angiogenic proteins and inflammatory mediators into the maternal bloodstream, ultimately raising blood pressure [4, 5]. Pre-eclampsia is a leading cause of maternal and perinatal complications, including death [1]. Globally, hypertensive disorders during pregnancy affect 5-8% of women [6], contributing to 10-15% of maternal deaths and 25% of infant and neonatal mortality [7-9]. In Africa and Asia, hypertension-related disorders account for an estimated 10-16% of maternal deaths [2, 10].

In low-resource settings, the morbidities associated with pre-eclampsia are often underreported, as maternal outcomes are typically recorded only in terms of mortality [11]. This underreporting poses significant challenges for public health efforts and health system strengthening. In Ghana, the maternal mortality rate is estimated at 343 per 100,000 live births, with pregnancy-related deaths accounting for 14% of all-cause mortality among women [12]. Pre-eclampsia alone contributes to 19.4% of maternal deaths, ranking among the top three causes of maternal mortality in the country [13, 14].

Antenatal care (ANC) services have evolved over the years, aiming to provide focused care to pregnant women. Currently, women are advised to attend at least eight ANC visits before delivery [15]. These frequent visits enable healthcare providers to detect and manage pregnancy-related conditions, including hypertension, promptly to prevent complications and deaths [15]. However, various health-sector challenges, such as limited institutional capacity, inadequate in-service training, and insufficient resources, have hindered the effective implementation of ANC interventions, especially at peripheral health facilities [16]. Additionally, poor health-seeking behaviours, including delayed attendance at ANC clinics, have exacerbated the problem in Ghana [16].

Moreover, known predictors of pre-eclampsia do not always align with its causes in maternal mortality and morbidity. Some women who are otherwise healthy develop hypertension during pregnancy and experience adverse outcomes, including death. This underscores the need for ongoing research to understand better and address the predictors of pre-eclampsia to improve maternal outcomes and reduce mortality. Given its continued impact on maternal health, this systematic review aims to assess the rates and predictors of pre-eclampsia in Ghana from 1990 to 2020.

Research Questions

1) What has been the trend of pre-eclampsia in Ghana from 1990 to 2020? and 2) What have been the predictors of pre-eclampsia over the same period?

Materials and Methods

Search Strategy

This systematic review covered publications from January 1990 to December 2020 and used the following bibliographic databases: https://www.scholar.google.com, http://www.scopus.com, and https://pubmed.ncbi.nlm.nih.gov/.

Search Terms

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was utilised in this review [17]. Search terms used to identify relevant literature included: “pre-eclampsia”, “eclampsia”, “pregnancy-induced hypertension”, “predictors of pre-eclampsia”, and “pregnant women in Ghana” (Table 1). Publications included in this systematic review comprised journal articles and institutional reports published in English.

Table 1. Search Terms used for Relevant Articles

Subjects	**Exposure**	**Outcomes**
("women"; "adolescents"; "mothers")	("pregnancy")	("pre-eclampsia"; "eclampsia"; "predictors of pre-eclampsia"; "determinants of pre-eclampsia"; "determinants of eclampsia")
AND		
("Ghana"; "Africa"; "West Africa")		

Screening of Articles

The researchers conducted an independent evaluation of the titles and/or abstracts of all articles retrieved from the search. A third researcher resolved all discrepancies that arose during the initial screening and the final evaluation of the articles. The researchers only included articles and reports that met the eligibility criteria, namely those that reported on pre-eclampsia or eclampsia and/or the factors associated with pre-eclampsia in Ghana, conducted and/or published within the last three decades.

Selection Criteria for the Review

The twenty-one publications included in this systematic review had to meet the following criteria: 1) they reported on pre-eclampsia, eclampsia, or pregnancy-induced hypertension among pregnant women in Ghana; 2) they examined the associated predictors or determinants among this population; 3) they included official reports from state institutions and their associated partners in the health sector; and 4) they were published in English. Both quantitative and qualitative studies were included in the review.

Study Quality Assessment

The first measure taken to ensure data quality involved utilising the built-in filtering features of the databases. To facilitate the publication process, the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) tool was used [18]. Two independent reviewers screened and evaluated all 1,040 publications extracted from the three databases based on the eligibility criteria.

Data Synthesis

The findings of the articles were evaluated in accordance with the established criteria of the study, which included the author's name, year of publication, country, study population, research design, and sample size. The proportion of the sample group identified as having pre-eclampsia, along with the associated predictors, was documented for the primary outcome variable of the study. The results of the reviewed papers, along with synthesised information, are presented in tabular format.

Results

Search Results

A total of one thousand and forty (1,040) papers were identified in the initial search conducted through Google Scholar (567), PubMed (94), and Scorpius (379). One hundred and two (102) duplicates in the combined dataset were removed before screening papers based on their titles and abstracts. The methodology for screening and final selection of papers is depicted in Figure 1. Although three (3) papers were published post-2020, the data for these studies were collected before 2020 and were therefore included in the current review. The remaining two papers did not specify the timeframe for data collection; however, they provided the most recent data regarding the relationship between dietary intake and pre-eclampsia, warranting their inclusion in the review. These papers did not address the prevalence of pre-eclampsia and

therefore did not affect the average estimate in the review. The reviewed papers were categorised into three main groups: the first, second, and third decades of the review. The majority of the papers (13/21) concerning pre-eclampsia were published between 2011 and 2020.

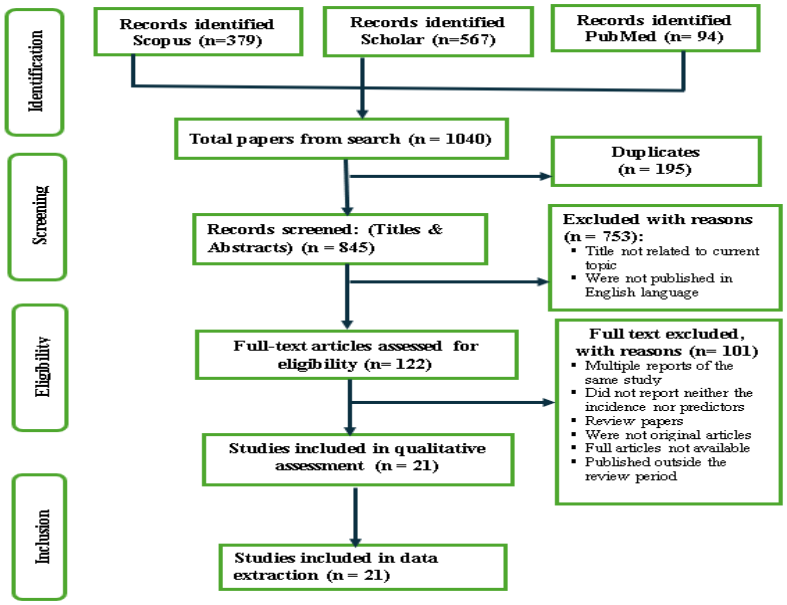


Figure 1. PRISMA Flow Diagram for Screening Articles; Adopted and Modified from Page et al, (2021)

Study Design

The reviewed papers encompassed a variety of observational study designs, including cross-sectional (n=8), case-control (n=6), and cohort (n=6) studies. A total of twelve (12) papers were conducted in the Southern Belt of Ghana, eight (8) in the Middle Belt, and one (1) in the Northern Belt during the specified review period. The sample sizes reported in these studies ranged from 100 to 10,307 pregnant women within clinical settings. Notably, the majority of the studies (n=13) were carried out at Korle-Bu Teaching Hospital (n=7) and Komfo Anokye Teaching Hospital (n=6).

Prevalence of Pre-eclampsia

Eleven (11) of the twenty-one (21) papers reported the incidence of pre-eclampsia over the past three decades. Among these 21 papers, one (1) study was conducted between 1990 and 2000, two (2) studies between 2001 and 2010, and eighteen (18) studies were reported in the most recent decade (Table 2). Geographically, the majority of the studies were conducted in the Southern Belt (12), followed by the Middle Belt (8). Korle-Bu and Komfo Anokye Teaching Hospitals were the predominant healthcare facilities for pre-eclampsia research in Ghana. The majority (8) of the papers included in this review were cross-sectional studies, followed by case-control studies (6) and cohort studies (5). On average, the reported prevalences of pre-eclampsia were 1.3%, 5.6%, and 11% for the periods 1990 to 2000, 2001 to 2010, and 2011 to 2020, respectively. The Southern Belt exhibited an average incidence of pre-eclampsia of 6.2%, the Middle Belt had 14%, and the Northern Belt reported 7% during this period. The overall average percentage of pre-eclampsia across the 22 papers over the three decades was 9.1%. The trend in pre-eclampsia prevalence is illustrated in Figure 2. Collectively, the studies encompassed a total of 24,037 participants, with 1,215 individuals diagnosed with pre-eclampsia, resulting in an estimated overall incidence of 5.1% during the studied period.

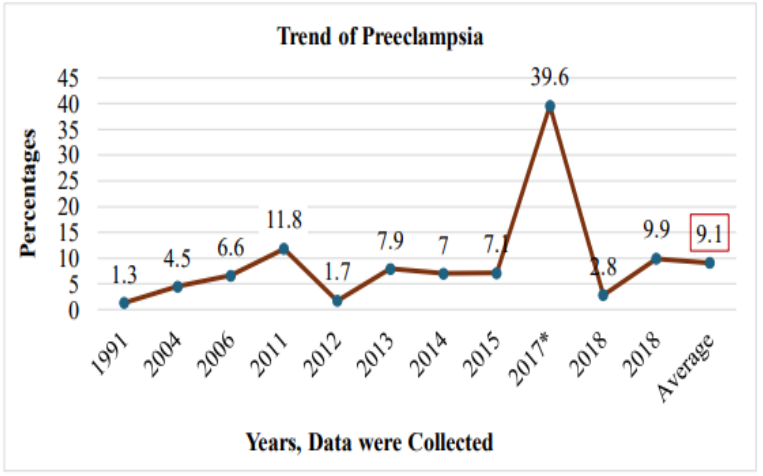


Figure 2. Trend of Pre-eclampsia

*(*was extremely high because the sample population was a special group (pregnant women with medical emergencies).*

Predictors of Pre-eclampsia

The review identified only one paper published between 1990 and 2000 that addressed the predictors of pre-eclampsia in Ghana. Between 2000 and 2001, three papers were published; between 2010 and 2020, nine. The studies identified maternal and environmental factors, nutrition, and access to health services as significant predictors of pre-eclampsia. Maternal age consistently emerged as a predictor of pre-eclampsia among pregnant women across the three decades [19-21]. Mothers younger than 20 years of age were reported to be at a higher risk of developing pre-eclampsia during pregnancy [19, 21, 22]. Similarly, mothers older than 35 years of age were also observed to be at an increased risk of pre-eclampsia [20-22]. The season of pregnancy was found to significantly predict the risk of pre-eclampsia [19, 21, 23]. This association was noted between the 1990–2000 and 2001–2010 decades, with mothers who were pregnant during the rainy season being at a higher risk of developing pre-eclampsia compared to those who were pregnant in the dry season [24].

Mothers with multiple pregnancies were consistently found to be at significant risk of developing pre-eclampsia across the three decades reviewed. In the 2011–2020 decade, multiple deliveries (parity) were reported by Adu-Bonsaffoh et al. [20] as a predictor of pre-eclampsia, while twin pregnancies were noted in the most recent decade to predict pre-eclampsia [22]. Other maternal factors that predicted pre-eclampsia included nulliparity [25], family history [24], depression or tension [26], and anxiety. Two out of twenty-one papers indicated that a change in sexual partner prior to pregnancy predicted pre-eclampsia in the two most recent decades [24, 27]. Several nutrition-related factors were also reported to predict pre-eclampsia, including obesity or higher Body Mass Index (BMI) scores [22, 24, 28-30], low serum concentrations of calcium and magnesium [30], high intakes of protein, high dietary intakes of folic acid and manganese, low intakes of vitamin B12, folate, and calcium, and excessive intakes of vitamin C [31]. Higher serum triglyceride levels were also associated with an increased risk of pre-eclampsia in recent decades [29]. Access to healthcare-related services was likewise reported as a predictor of pre-eclampsia; for instance, a lack of access to prenatal care was identified as a predictor between 1990 and 2000, although it was not examined in the last two decades [19]. Additionally, the use of contraceptives was reported to predict pre-eclampsia [23, 32].

Table 2. Prevalence and Predictors of Pre-eclampsia within the Three Decades

Authors	**Year of publication**	**Year of data collection**	**Study design**	**Study location**	**Geographic Belt**	**Sampling protocol**	**Sample size**	**Prevalence of PE**	**Predictors of PE**
Obed et al. [19]	1994	1991	Survey	KBTH- Greater Accra	Southern	Survey	10307	134 (1.3%)	Young maternal age, nulliparity, delivery in the rainy season, multiple pregnancy
Owiredu et al. [21]	2010	2006-2007	Cross sectional	KATH – Ashanti	Middle	Survey	8091	530 (6.6%)	Rainy season, younger and advanced maternal age
Obed & Aniteye, [27]	2007	2004	Longitudinal study	KBTH – Greater Accra	Southern	-	381	17 (4.5%)	Change of sexual partner
Owiredu *et al.,* [24]	2012	2006-2007	Case-control	KATH – Ashanti	Middle	-	100	-	Advanced maternal age, obesity, family history of hypertension
Oppong *et al., [33]*	2019	2006-2007	Case-control	KATH	Middle	-	150	-	Advanced maternal age, obesity, family history of hypertension
Owusu *et al.,* [34]	2013	2011	Cross sectional	KBTH- Greater Accra	Southern	Systematic review	220	26 (11.8%)	Snoring during pregnancy
Yeboah *et al.,* [30]	2017	-	Case-control	KATH- Ashanti	Middle	-	200	-	Low serum calcium and magnesium levels, high BMI
Abebrese *et al., [25]*	2017	2015	Cross sectional	Regional hospital – Brong Ahafo	Middle	Systematic random sampling	450	32 (7.1%)	-
Adu-Bonsaffoh *et al., [20]*	2017	2013	Cross sectional	KBTH – Greater Accra	Southern	Survey	1856	140 (7.9%)	Parity ≥2, gravidity ≥3, high maternal age >35yrs, high gestation age at ANC booking, low gestation at delivery
Anot *et al., [35]*	2019	2017-2018	Cohort study	KATH – Ashanti	Middle	-	493	197 (39.6%)	High suboptimal health status score

Awuah *et al., [36]*	2020	2018	Case-control	KATH- Ashanti	Middle	-	214	6 (2.8%)	-
Brown *et al.,* [37]	2015	2012-2014	Cohort study	Ridge hospital – Greater Accra	Southern	-	789	13 (1.7%)	-
Dalaba *et al.,* [38]	2015	2014	Cross sectional	District hospital KND -UER	Northern	Survey	60	4 (7%)	-
Beyuo *et al.,* [22]	2022	2018-2020	-	KBTH – Greater Accra	Southern	-	1176	116 (9.9%)	Maternal age <20yrs, twin gestation, underweight
Amegah *et al., [39]*	2021	2020	Cross sectional	CCTH/UH-Central	Southern	Simple random	799	-	Decreasing intake of vitamin D, exposure to household air pollution
Amoakoh-Coleman *et al., [28]*	2017	2011	Cohort study	KBTH – Greater Accra	Southern	Survey	600	-	Overweight Obesity at first trimester
Asare et al., [32]	2021	2019	Case-control	Comboni Mission H.- Volta	Middle	-	60	-	Contraceptive use (DMPA)
Avoka *et al., [31]*	2022a	-	Cohort study	Hospitals (7)-Eastern region	Southern	Simple random	475	-	Inadequate intake of vitamin B12, C, Calcium, & folate high intake of protein in pregnancy high intake of Manganese & folic acid
Avoka *et al.,* [26]	2022	-	Cohort study	Hospitals (7)-Eastern region	Southern	Simple random	475	-	Poor psychological and emotional health (tension, anxiety, & depression)
Ephraim *et al., [29]*	2014	2013	Case-control	Central regional & University hospitals – Central	Southern	Consecutive sampling	110	-	High BMI scores High triglyceride level
Obiri *et al., [40]*	2020	2015	Cross sectional	KBTH- Greater Accra	Southern	-	134	-	Placental pathology, placental malaria, primigravida

Discussion

Prevalence of Pre-eclampsia

We observed a consistent increase in the prevalence of pre-eclampsia over the past three decades. Specifically, the prevalence of pre-eclampsia in the last decade (2011-2020) was approximately 10%, representing an increase of 5 percentage points compared to the prevalence recorded between 1990 and 2000, as well as between 2001 and 2010. The notably high prevalence in 2017 can be attributed to the inclusion of a special study group consisting of pregnant women with medical complications. Overall, the elevated prevalence of pre-eclampsia in the recent decade (2011-2020) may be ascribed to broader healthcare coverage, and enhanced health-seeking behaviour among pregnant women compared to earlier decades [41-43]. Currently, a greater number of pregnant women have improved access to primary healthcare services, including antenatal care (ANC) at the community level, relative to those who lived between 1990 and 2000. The implementation of community-based health planning and services (CHPS), along with enhancements in health infrastructure, may have resulted in more women being screened and diagnosed with pre-eclampsia than in the preceding two decades. Additionally, the increased prevalence may be attributable to advancements in the diagnosis of pre-eclampsia, facilitated by the availability of more clinical equipment and skilled personnel in recent years [44]. The lower prevalence observed in 2011-2020 could also be linked to a relatively smaller number of studies on pre-eclampsia rates compared to more recent times. While data on pre-eclampsia have been somewhat accessible, they have generally been limited to the causes of maternal mortality and morbidity [45, 46], rather than the prevalence of the condition among pregnant women. The average prevalence of pre-eclampsia in the current study aligns with the 8.2% reported in all developing countries by Zhang et al. [44]. The findings of this study are comparatively higher than rates reported in Madagascar, Ethiopia, Nigeria, and other regions of Africa [47-49], as well as in Europe [50] and the USA [51]. The prevalence rate reported in this study falls within the range observed for Ghana (4.4% to 11.8%) and Ecuador (3.5% to 9.6%) and is closely related to the ranges reported for Iran (3.3% to 7.8%), Finland (3.6% to 8.1%), and Brazil (1.5% to 8.2%) [44]. The prevalence rate of pre-eclampsia identified in this study is double the global rate [52] and positions Ghana among the countries with the highest rates of pre-eclampsia, consistent with the findings of Zhang et al. [44].

Predictors of Pre-eclampsia

One of the most significant public health concerns is the insufficiency of effective treatment for pre-eclampsia. Consequently, both clinicians and public health practitioners prioritise the primary and secondary prevention of pre-eclampsia by implementing appropriate screening measures for pregnant women to enhance health and nutritional outcomes for both mother and infant [44]. This screening process involves the identification of potential risk factors and the provision of support to mothers in order to mitigate their impact on pregnancy outcomes.

Demographic and maternal factors

Lower maternal age consistently increases the risk of mothers developing pre-eclampsia across the three decades. Mothers younger than 20 years have been reported to be at a higher risk of developing pre-eclampsia [19, 21, 22]. This finding is not limited to pregnant women in Ghana but extends across different ethnicities [51]. One possible explanation for this phenomenon is that younger mothers often face challenges related to limited opportunities, economic resources, and maternal experience, as most women within this age group are nulliparous [25]. The new experience of pregnancy for these mothers may overwhelm

them, compounded by the anticipated economic burden of childcare and other responsibilities, potentially rendering the duration of the pregnancy a strenuous undertaking. This could lead to elevated blood pressures, as reported by Avoka et al. [26]. Additionally, advanced maternal age has been found to predict pre-eclampsia in recent decades, consistent with findings from Europe [53], America [54], China [55], Saudi Arabia [56], and France [57]. Multiple pregnancy emerged as a consistent risk factor for pre-eclampsia in the review spanning several decades. Mothers with more than three pregnancies, as well as those with twin pregnancies, exhibited a heightened risk of pre-eclampsia in Ghana [19, 20, 22]. This finding was corroborated among pregnant women in developed countries, including the USA [58], Sweden [59], and China [60]. Furthermore, a parity greater than two was identified in the review as a factor that increases the risk of pre-eclampsia for mothers [20]. However, this relationship between higher parity and pre-eclampsia is contradicted by several well-documented studies [61, 62]. Maternal history also emerged as a predictor of pre-eclampsia in the review, aligning with findings from another research [44, 63]. According to Zhang et al. [44], the risk associated with maternal history escalates with the number of pregnancies: 15% in the second pregnancy and approximately double that in subsequent pregnancies for pre-eclampsia. Additional studies have found a similar correlation between familial history and the prevalence of pre-eclampsia among pregnant women [50, 63].

Dietary and Environmental Factors

Overweight and/or obesity was the most frequently identified nutritional factor in the review that increased the risk of pre-eclampsia among pregnant women [22, 28-30]. The increased prevalence of overweight and obesity among Ghanaian women may, therefore, account for the rising rate of pre-eclampsia observed over the past three decades, with more than half of pregnant women with a parity of two or more in Ghana being classified as overweight or obese [64]. The relationship between obesity and pre-eclampsia is consistent with findings from other studies [50, 63]. Insufficient intake of specific dietary nutrients (including protein, vitamin C, B12, calcium, and folate) as well as low serum concentrations of dietary minerals (specifically calcium and magnesium) have been reported to increase the risk of pre-eclampsia in women [31, 39]. The low serum levels of calcium and magnesium in pre-eclamptic women corroborate findings among Pakistani women and have been reported to negatively affect arterial pressure, thus predisposing women to pre-eclampsia [65]. Nevertheless, a randomised trial found no significant effect size associated with calcium supplementation on the onset of pre-eclampsia [66]. Similarly, Zhang et al., [44] support the notion that inadequate nutrient intake could present a considerable risk for developing pre-eclampsia. Conversely, heightened intake of manganese and folic acid, along with elevated serum concentrations of triglycerides, are associated with an increased risk of pre-eclampsia among women [29, 31]. Elevated serum lipids, such as triglycerides and cholesterol (lipoproteins), lead to vasoconstriction, thereby predisposing pregnant women to pre-eclampsia. This finding is consistent with a study conducted in Pakistan that compared lipid profiles of normative and pre-eclamptic women [67]. The prevalence of pre-eclampsia varied by season, peaking during the rainy season [19, 21]. The fluctuation in the prevalence of pre-eclampsia correlated with changing climate and weather temperature is widely reported; however, the findings are often confounded by racial factors [44]. Two studies included in the review indicated that pre-eclampsia among Ghanaian women peaked during the rainy season, lasting from June to September. This phenomenon may relate to the impact of cold weather, as housing conditions

in many developing contexts, including Ghana, inadequately provide warmth and comfort. Such conditions may exacerbate maternal stress, anxiety, and discomfort during pregnancy, consequently leading to elevated blood pressure. Colder temperatures in Europe and South Africa have been reported to increase the risk of pre-eclampsia by over 13% [44, 68], which aligns with the current findings. Interestingly, while the risk of pre-eclampsia for Black women increases during summer months, White women experience a decreased risk [21, 44]. A high prevalence of pre-eclampsia has also been documented within the same timeframe in Nigeria, which is consistent with the current review [49]. However, the season in Nigeria is characterised by the dry season, whereas the corresponding period in Ghana encompasses both the major and minor rainy seasons (June to December). Nonetheless, the mean prevalence of pre-eclampsia per month in Ghana was consistent with findings in Nigeria [49] and China [69]. While summer months in China and the USA are characterised by warm or hot weather, the same period in Africa is marked by rain and cooler temperatures; nevertheless, this has been reported to contribute to a high prevalence of pre-eclampsia globally. Another environmental factor identified in the review was air pollution, which aligns with findings from Zhang et al., [44]. Exposure to air contaminants, including particulate matter, nitrogen dioxide, and noise during pregnancy, is reported to induce oxidative stress and inflammation, which affect vascular function and cytotrophoblasts, ultimately resulting in pre-eclampsia [70-73]. Amegah et al., [39] reported that the detrimental effects of air pollutants could potentially be mitigated through adequate intake of vitamin D.

Maternal and Perinatal Care

Inadequate prenatal care has been identified as a predictor of pre-eclampsia in both the 1990s and the 2010s. As noted, adequate and early screening of pregnant women facilitates appropriate interventions that can enhance maternal and perinatal outcomes [44]. Delayed antenatal care (ANC) registration adversely affects the quality of maternal and perinatal care provided to pregnant women, potentially increasing their risk of pre-eclampsia. Early antenatal care allows for timely screening and management of other associated conditions, such as poor psychological and emotional health, placental pathology, and malaria, all of which have been reported to predict pre-eclampsia [29, 31] independently. This may also elucidate the heightened risk of pre-eclampsia among pregnant women with suboptimal health status [35]. Additionally, sexual behaviour, changes in partner, and contraceptive use have been identified as risk factors for pre-eclampsia; however, the evidence in the literature outside of Ghana remains inconclusive [74, 75]. Nonetheless, it is recommended that women avoid contraceptives containing oestrogen, as they may contribute to elevated blood pressure [76].

Conclusion

There is a noticeable upward trend in the prevalence of pre-eclampsia among women in Ghana. The findings indicate that the average prevalence of pre-eclampsia from 2011 to 2020 is among the highest globally. Although the predictors of pre-eclampsia are relatively consistent across different regions, clinicians must implement timely screening and intervention strategies to mitigate or potentially eliminate adverse pregnancy outcomes.

Acknowledgment

Not applicable.

Conflict of interest

Authors declare that there is no conflict of interest with the production and publication of this finding.

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Barriers to Optimal Index Testing for Improved HIV Positivity Yield in Lusaka Urban District of Zambia

Cibangu Katamba
HIV/TB Mentorship Program, Lusaka Provincial Health Office, Lusaka, Zambia

Abstract

As the proportions of people living with HIV who do not know their HIV infection status decrease, reaching the first 90 will require effective and efficient HIV testing approaches. This project used an explanatory sequential mixed-methods study design to: 1) to understand the perceived facilitators and barriers to HIV partner testing from the perspective of the health-care provider; and 2) to propose interventions necessary for improved HIV case finding. At baseline, 452 index contacts (53.5%) tested HIV negative, 113 index contacts (13.4%) tested HIV positive. Following the intervention, 384 index clients were enrolled in the study. Total number of 668 contacts: 333 males and 335 females. The mean age of contacts was 34.5, ranging from 18 to 68 (SD = 8.638). HIV status: 320 tested positive, 240 tested negative, 29 not tested, 79 known positive. Positivity yield = 57% (320/560). Provider and client related challenges were addressed with the following key interventions: implemented were: Peer pairing approach using experienced counselors and hand holding mentorship; Training facility based volunteers and healthcare workers in Index Testing; Setting up network of counselors to reach contacts not in the same catchment as the index clients; Improving appointment system: After hours, week-ends and men's clinics; Ensuring correct, complete and consistent documentation in all registers. As in several other literatures, our study findings show that following appropriate interventions addressing barriers to index testing, the testing positivity rate improved from 20% to 57%.

Key words: *Contact Testing, HIV, Index Testing, Positivity Rate.*

Introduction

According to the 2018 UNAIDS Global AIDS Update [1], there are an estimated 36.9 million people living with HIV. Recently, marked progress on HIV test and treat strategy has been achieved by countries' commitment to achieve the 90-90-90 targets by 2020 [1]. As of December 2017, three out of every four people living with HIV knew their HIV status globally; 90% of HIV-infected individuals are expected to know their HIV status by the year 2020 [1].

According to ZAMPHIA 2016 fact sheet [2], only 67.3% of people living with HIV (ages 15 – 49) knew their HIV status. In 2017, Zambia had 1.1 million people living with HIV and 48,000 new HIV infections [3]. Without HIV testing services interventions targeted to key populations, including sexual partners of index clients infected with HIV, it will be hard to end HIV epidemic by 2030 [4].

Many studies have shown that index partner testing has the potential to increase HIV testing services (HTS) uptake; identify and diagnose HIV infected partners (yield ranging from 35% to 62% without reported intimate partner violence (IPV) [5].

However, they are barriers to effective HIV index testing. Some reviewed challenges pertaining to both male and female index

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Corresponding Author: patrickkatamba@gmail.com

clients noted are difficulties notifying past or casual partners [6]. Disease symptoms are a motivating factor for HIV testing for men as well as women. Studies have shown that gender determinants such as tolerant attitudes about intimate partner violence and unequal power dynamics within relationships, had noticeable effects for men and women, on deciding to get tested for HIV [7].

Gender-specific barriers for female index clients to successful referral include the following: women face gender roles and inequalities in relationships such as lack of education, lack of resources or ability to access services; fear of abandonment, violence or other abuse associated with partner notification [6, 8, 9]. They may need additional support to overcome challenges in the partner notification process. Antenatal care exposure makes women more likely to get tested for HIV.

For men, especially those in Sub-Saharan Africa, the following challenges to HIV testing and disclosure were noted: stigma, gender and social roles prescribing that men should be healthy, strong, and dominant [10, 11]. Studies have shown that men, compared to women, underestimate their level of risk of HIV infection [12]. However, once men have tested, they may be more likely to disclose their HIV status [12]. Some men believe that their role of breadwinner for the family protect them from rejection when disclosing their HIV positive status [13].

Rational: Effective approaches to HIV testing are needed to reach undiagnosed people and link them to HIV care and treatment as part of the UNAIDS 90-90-90 goals. Understanding barriers to index testing is crucial for planning appropriate interventions to improve HIV testing yield and to provide appropriate care for both index clients and their partners.

Generating such evidence requires a combination of quantitative and qualitative research methods.

In this context, we aimed at assessing the barriers to optimal index testing for improved HIV testing yield in Lusaka urban district of Zambia.

Significance: The cornerstone for achieving the UNAIDS 90-90-90 targets by the year 2020 begins with people living with HIV (PLHIV) knowing their status. As the proportions of those living with HIV who do not know their HIV infection status decrease, reaching the last mile of those who are asymptomatic and not in contact with the health care system becomes a critical challenge. Therefore, reaching the first 90 requires effective and efficient HIV testing approaches. The number of people living with HIV who know their HIV status and that of those who receive antiretroviral therapy could increase by the expansion of index testing services. This will result in the reduction of the number of people who can transmit the virus, and subsequently in reduced new HIV infections.

The goal of index testing is to break the chain of HIV transmission by offering HTS to persons who have been exposed to HIV.

The specific objectives were:

1. To understand the perceived facilitators and barriers to HIV partner testing from the perspective of the health-care provider.
2. To propose interventions necessary for improved HIV case finding.
3. To reach high risk but hard to reach populations in HIV programs such as middle aged men, and adolescent girls and young women (AGYW).

The permission to conduct this study was obtained from the Lusaka provincial health office before its commencement. Ethical clearance was sought and obtained from the ERES Converge research ethical committee. Authority to conduct research was also sought from the National Health Research Authority.

Review of Literature

Research Question

Can addressing barriers to optimal index testing results in improved HIV case finding among middle aged men and young women in Matero' Lusaka sub-district?

Construction of searchable question using PICO:

Problem: Barriers to optimal index testing in Lusaka sub-district

Intervention: Partner notification services

Comparative intervention: Routine HIV testing services

Outcomes: Improved HIV case finding among hard to reach populations in Lusaka sub-district:

1. Increased HIV case finding among middle aged men
2. Increased HIV case finding among young women
3. Increased HIV testing positivity yield

Search Strategy

To review the current knowledge of the above question, qualitative and quantitative studies were reviewed in the already published literature. The search was conducted in PubMed and other scientific data bases (including TRIP, Plos One, and science direct) to identify suitable and accessible peer reviewed articles published between January 2000 and September 2019. The reference list and citations of identified articles were also consulted to increase the reviewed results [14, 16-35].

The selected articles for further review contained at least one of the following search terms: Barriers AND HIV OR HIV AND Index testing; and HIV OR HIV AND contact tracing OR contact AND tracing OR contact tracing OR partner AND notification OR partner notification AND services. A total number of 34 articles were selected after screening for duplication and relevance. Most of the reviewed studies selected were from developing countries (Table 1).

Literature Research Flow Chart

The following literature review flow chart was constructed following the PRISMA 2020 flow diagram model [15] (Figure 1).

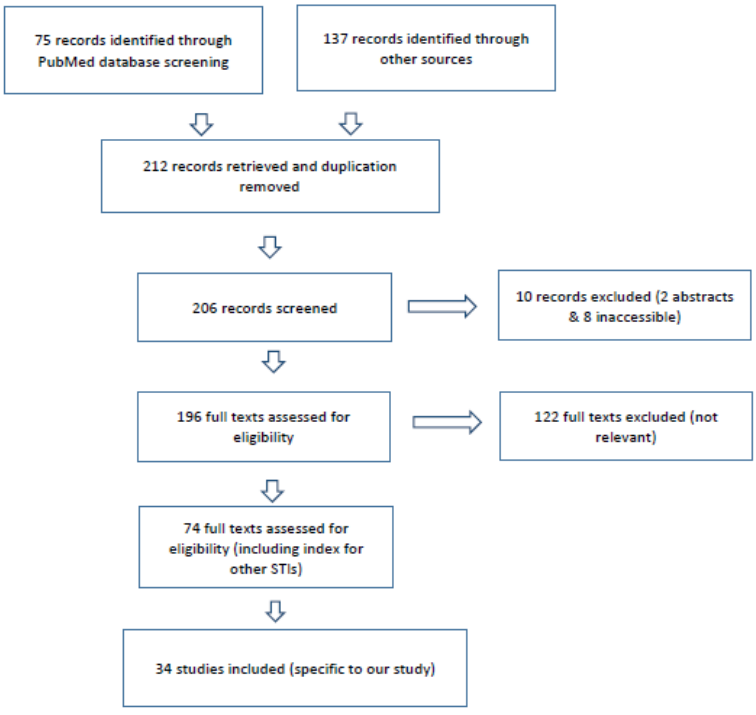


Figure 1. Prisma flow chart [15].

Summary of Reviewed Records by Type

Table 1. List of reviewed records

NO	Type of Record	Records Reviewed
1	Randomized controlled trials and RCT protocols	4
2	Systematic reviews and Meta-analysis	3
3	Non-controlled interventional studies	3
4	Program implementation studies	7
5	Observational and Cohort studies	2
6	Case-control studies	0
7	Mixed methods studies (qualitative & quantitative)	3
8	Cross-sectional & population based surveys	8
9	Secondary data analysis	3
10	Literature review	1
	TOTAL	34

Importance of Index Testing

HIV index testing has shown higher uptake and good yield than routine HIV testing methods. The World Health Organization has called for increased operational research to evaluate HIV care processes, and particularly linkage to care.

Barriers to Index Testing

Non-disclosure of HIV status (due to fear of marital discord), non-disclosure and under-disclosure of the number of sexual partners by the index clients, fear of negative consequences, difficulties notifying past or casual partners, geography/remote partners, and risk perception were major barriers for using the testing services. Key populations and people with casual partners were less able or willing to identify partners. Barriers to partner notification services included concerns around privacy/confidentiality and intimate partner violence. Lack of awareness of risk for HIV infection/misconceptions; structural, psychological, financial, were barriers to being tested. Other factors, such as demographic characteristics, marital dynamics, partner relationship, and relationship with the health care services such as fear of being labeled by health workers as promiscuous, also greatly affects the participants' decision making. The lapse between the enrollment of the index cases and HIV testing of partners often exceeded three months in some studies. Other common barriers included insufficient staff, inability of PNS providers to identify and contact partners, and limited resources.

Barriers to pediatric HIV testing included emotional, interpersonal, structural, financial and logistical challenges.

Being male index case, illiterate, above 25 years old, belonging to key populations, substance abuse and advanced HIV clinical stage, were factors more likely associated with partner non-testing. Male clients feared exposure of infidelity and were often not available for testing due to economic reasons.

Barriers specific to women were: fear of being abandoned; being undervalued for not having a child; sex work for livelihood; fear of violence or harm; perceived community level HIV stigma; individual level factors such as anticipated stigma, depression, and older age.

There is therefore a need for health workers to be given appropriate training that will empower them with the right counseling skills in order to be able to encourage index clients to voluntarily disclose information about their sexual contacts (UNAIDS/WHO, 2000).

Facilitetors to Index Testing

In the reviewed literature, the proportion of HIV positive partners were 1.5 times higher with assisted partner notification than with passive referral; successful partner referral was 2.5 times more likely among married compared to unmarried index; spouses and steady partners were more likely to be notified than other partners. Higher education was a common facilitator of HIV testing. Provider-based notification strategies are potentially cost-effective for identifying new cases of HIV. These strategies offer a simple, effective and easily implementable opportunity to control HIV transmission. Ensuring that health workers were trained on methods for sexual partner notification to improve counseling of index clients was a facilitator to disclosure.

Gaps in Existing Literature

High level evidence, Meta-analysis of three individually randomized trials showed that assisted partner notification services resulted in a 1.5-fold increase in HTS uptake among partners compared with passive referral. However, it was difficult to trace identified partners which may have resulted in the low ratio of partners notified per index patient.

Challenges experienced that have future implications for index partner testing included non-disclosure and under-disclosure of the number of sexual partners by the index clients. A study has also demonstrated sub-optimal HIV testing of unique partners of PLWH enrolled in the HIV program at this particular public hospital was suboptimal, both in frequency and timing; but, excluding multiple partners. In some studies, program data was used, which had some gaps in its completion and not specifically designed for research. This also limited ascertainment of client facilitators to linkage to care.

There is limited literature on HIV index testing in developing settings. There are variable concepts definition for index testing in various settings, sometimes not clear to participants, limiting the generalizability of study findings to others settings with different characteristics. HIV testing services need to adapt to the social context of Zambia where HIV-related stigma and discrimination is still persistent and overwhelming. The practices of HIV-testing have been always evolving.

Some studies have tackled the issues of barriers to successfully referring partners for testing, but were not specific to sex or age. Alternative strategies to target and provide acceptable and accessible HIV testing services to gender and age-specific populations are critically needed.

As Zambia makes significant progress towards achieving HIV epidemic control, more efforts are needed to reach specific high risk but hard to reach populations in HIV programs such as men and adolescent girls and young women (AGYW).

Materials and Methods

Study Design

An explanatory sequential mixed-methods study design was used. The quantitative phase, a retrospective study looking at index registers of clients who tested HIV positive and were elicited for index testing between October and December 2019. This was conducted in three high volume health facilities in Matero sub-district 3 of Lusaka district in Zambia. The overview results of the study, which looked at the effectiveness of HIV index testing, was described. The analysis examined index clients' identification, elicitations of index contacts, and testing of index contacts. The main quantitative outcome of interest for this analysis was the success of index testing to improve yield for HTS among female versus male and between ages among index clients; and secondly ART initiation for positive index contacts. This was followed by a qualitative phase, one to one interviews to explore index testing providers' views on barriers and other experiences arising during the process of HIV index testing. An interview guide was used for

consistency of information to be collected. The study was concluded by a five months optimized index testing through partner notification services, following on the job mentorship (addressing identified barriers) of index testing providers.

Study Setting

Lusaka is Zambia's highest HIV prevalence province with 16.1% of the people living with HIV (ZAMPHIA 2016). The study facilities included Matero first level hospital, Matero Main clinic, George health Centre (in Matero Sub-district 3 of Lusaka Urban district, Zambia).

Study Population

Quantitative:

The study population was comprised of all index clients (men and women at the study facilities who had been diagnosed with HIV and elicited for HIV index contact testing during the study period. This retrospective phase used a total sample enumeration technique.

Qualitative:

HIV index testing providers involved in patient care and management (Index testing champions, nurses, medical officers, counsellors and community liaison officers) were interviewed. Key informants included medical officers, health systems strengthening nurses, index community liaison officers, and index testing counselors). A saturation of findings was used to guide the sample size.

Eligibility Criteria

Participants in the final phase of the study were 384 index cases (men and women at the study facilities who are newly diagnosed with HIV or newly enrolled in care, through either VCT or PICT) and their sexual contacts (sexual partners of index clients who have been elicited and offered HIV index testing services). The study participants included:

1. Newly diagnosed HIV positive or newly enrolled in HIV care/ART (for less than 6 months);
2. Aged 18 years and above;
3. Had a sexual partner currently or in the past 12 months.
4. Eligibility criteria for enrollment as a sexual partner was that the partner was 18 years of age or older.

Exclusion criteria:

1. Known HIV clients on ART for 6 months or more.
2. ART LTFU (Lost to follow up) and those with high viral load of more than 1000 copies/ml.
3. Age below 18 years.
4. Sexual contact more than 12 months ago.

Sampling

The sample size for the study was calculated to answer the main study objective, which is the improved index testing yield among participants. The sample size calculation for the original research question was based on an assumption that index clients would list an average of one sexual contact, and that 51% of sexual partners would accept HIV index testing, as seen in a study conducted in the hospital setting in Malawi[14] and replicated in Tanzania[15]. The determination of the sample size was done through the approach based on precision rate and confidence level.

Using the Zambia Ministry of Health (MOH) HIV program target indicators, it is projected that optimized HIV testing services will yield a positivity rate of 26% in 2020.

Based on these assumptions, an effective sample size of 296 index contacts was needed to detect a similar rate of testing among sexual contacts with 80% power ($\alpha = 0{\cdot}05$, two-sided test).

The sample size formula was: $n = 1.96^2 \times p \times (1 - p) / e^2 = 1.96^2 \times 0.26 \times (1 - 0.26) / (0.05)^2 = 296$

Anticipating a non-response or drop out percentage of 20%, the final sample size was calculated as follows: 296 / 1 – 0.2 = 370.

Study Procedures

Review of data: retrospective review of index registers of clients who tested HIV positive and were elicited for index testing between October and December 2019.

Qualitative study: Participants in the qualitative component of the study were selected on a convenience basis from the index testing services providers. The index providers were selected in equal number from male and female index testing services providers who have been providing index testing for more than twelve months. Index providers were selected by the principal investigator who is trained in qualitative and quantitative studies for participation in a face to face interview on a convenience basis. A rough quota was given to each facility, balancing out male and female participants, and those providers who were invited to participate and agreed and consented were interviewed. This procedure intended to have a large enough sample size to uncover a variety of opinions, but to limit the sample size at the point of saturation (occurring when adding more participants to the study did not result in obtaining additional perspective or information).

Intervention study: Potentially eligible men and women (diagnosed with HIV through VCT or PICT at the study facilities) were offered HIV index testing services as per national guidelines. HIV trained index testing counselors (study staff) screened potential candidates for study eligibility using eligibility criteria for enrollment as index clients.

Written informed consent was obtained from interested and eligible clients before enrolling them as index cases.

Index cases elicited names and contact information (phone number and physical address) for sexual partners to study staff, who then entered the elicited contacts in index registers. Index clients also decided how the partner was to be contacted for HIV index testing services.

Index clients were encouraged to elicit as many partners as they can, indicating the type (married, unmarried, casual partner), duration, and status (past or current) of the relationship for each partner.

During partner elicitation, the index client was asked questions designed to identify sexual contacts to whom disclosure or the referral to HIV index testing might cause a risk of intimate partner violence (IPV). Any sexual partners the index client felt might react with violence were excluded from index testing services.

Index cases would choose to contact their partner themselves (passive referral), have the health provider contact the partner (provider referral), Sits with his/her partner (s) together with trained providers to provide support as they disclose their HIV status while the provider also offers voluntary HTS to the partner (dual referral), or attempt to contact the partner themselves, with the understanding that the health provider would contact the partner should the index client fail to do so (contract referral).

Index clients were given a choice as to whether or not they wanted a written referral letter (love letter) to take to their partner.

If the index client was agreeable, each listed partner was: (1) contacted, (2) informed that they have been exposed to HIV, and (3) offered voluntary HIV testing services (HTS).

All index testing needed to meet the 5Cs and be consensual, confidential, counselling, correct test results and connection to treatment or prevention services.

Data Sources, Variables and Collection

Quantitative:

Data on the index clients (cases) characteristics (age, sex, contacts, ART status), and the contacts' HIV test outcome (yield, initiation status) were extracted from

the HIV index testing registers into a structured pro forma.

Qualitative:

HIV index testing providers were interviewed by the HIV/TB district medical mentor (trained both qualitative and quantitative research). It was an onsite face to face interview, conducted in English, and audio-recorded using an 'audio-recorder' application after obtaining consent. An interview guide was used to explore the challenges and make suggestions for improving Index contact testing outcome for HIV.

Data Management and Analysis

Quantitative:

Data entry and analysis were performed using Statistics package for social science software (SPSS version 16.0). Descriptive statistics were performed to describe the background characteristics of index clients and successful testing of index contacts. Analysis entailed simple frequencies of the main study outcomes and cross-tabulations. The association of index contact testing with the Gender of the index cases was examined using the Chi Square test, and unadjusted relative risks (RR) with 95% confidence intervals (CI) was calculated.

Qualitative:

A descriptive content analysis by manual coding was performed to generate categories or themes. Audio-recorded interviews were transcribed verbatim on the same day by the HI/TB district medical mentor. The traditional method of qualitative analysis was used in the following steps: (a) manual coding; (b) identifying themes, patterns and relationships; (c) summarizing the data. After gathering the data, the source material was transcribed with a word processor, multiple photocopies of the text were made, painstakingly read through and assigned codes to the material, cut the pages up into coded passages and then, manually sorted the coded text in order to analyze the patterns found. The primary data was scanned to look for words and phrases commonly used by respondents (word and phrase repetitions). Using the framework for descriptive analysis, responses were ranged in categories. Recurrent themes were identified while looking for similarities and differences. The findings of the qualitative analysis were then linked to the research aim and objectives.

Ethical Considerations

Informed written consent was obtained from all key informants before conducting the interviews. Participants were free to skip questions that they deemed personal or otherwise.

Informed written consent was also obtained from interested and eligible clients before enrolling them as index cases. Since index testing service that was offered is part of the recommended national HIV testing services, universal testing principles were observed for all participants. Study participation was voluntary. The information collected during the course of this study was kept confidential. Client's privacy and confidentiality were observed by assigning a serial number to each participant that was known only to the health care providers. Only the client's initials and serial number appeared on the data collection forms. Research subjects were also given an option to opt out of the project at any time during the implementation period; and this did not affect their access to clinical care they are otherwise entitled to receive. Ethical clearance was sought and obtained from the ERES Converge Zambian Institutional Review Board (IRB), and authority to conduct research from the National Health Research Authority before the commencement of the study.

Results and Discussion

Quantitative Results

The total number of index clients included in the study was 604. Matero First Level Hospital leads the participation per facility

with 292 participants, followed by George Health Centre and Matero Main Clinic with 164 and 148 participants, respectively. The total number of female participants was 314. (representing 52%) and male participants was 290 (representing 48%) (Table 2).

Table 2. Number of participants (index cases) by sex, month, and facility

Month/Sex	Matero Main		Matero level 1		George		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
October 2019	20	26	57	56	26	28	103	110
November 2019	26	28	37	25	26	28	89	81
December 2019	23	25	49	68	26	30	98	123
Total	69	79	143	149	78	86	290	314
Grand Total	148		292		164		604	

The age of participating index clients ranged from 16 to 78 years, with mean age calculated at 34 years (SD = 9.1). Out of the total number of 604 participants, 514 clients (85.1%) were married, 85 clients (14.1%) were unmarried, 3 clients were widowed, and 2 clients were divorced.

Concerning the time spent from HIV test to the initiation of ART for index cases: 595 index clients started ART within 7 days (98.5%), 1 index client started ART within a month (0.2%), 1 index client started ART after 1 month (0.2%), and there was no evidence of starting ART for 7 clients (1.2%).

The number of contacts elicited per index client were as follows: 413 clients (68.4%) elicited 1 sexual contact each, 146 clients (24.2%) elicited 2 sexual contacts each, 40 clients (6.6%) elicited 3 sexual contacts each, and 5 clients (0.8%) elicited 4 sexual contacts each (Table 3).

Table 3. Number of elicited contacts by sex, month, and facility

Month/Sex	Matero Main		Matero level 1		George		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
October 2019	30	25	113	110	35	34	178	169
November 2019	35	39	45	65	35	27	115	131
December 2019	36	35	52	55	42	32	130	122
Total	101	99	210	230	112	93	423	422
Grand Total	200		440		205		845	

The mean age of elicited contacts was calculated at 33 years (range, 17–80 years SD = 9.4). From the total number of 845 elicited contacts, 604 contacts were main partners of index cases, 238 contacts were additional partners of index cases, and 3 contacts were casual.

The time spent from elicitation to HIV testing of index contacts varied across participants: 294 index contacts were tested within 7 days (34.8%), 76 index contacts were tested within 14 days (9%), 77 index contacts were tested within a month (9.1%), 133 index contacts were tested after 1 month (15.7%), and 265 index contacts were not yet tested (31.4%).

The HIV test outcomes for index contacts were as follows: 452 index contacts (53.5%) tested HIV negative, 113 index contacts (13.4%) tested HIV positive, 108 index contacts (12.8%) were known HIV positive, and 172 index contacts (20.4%) were not yet tested for HIV. Of the 113 contacts who tested HIV positive, 90 index contacts started ART within 7 days (79.6%).

There was no documented evidence of starting ART for 23 HIV positive contacts (20.4%).

The total number of 565 index contacts were tested for HIV and 172 index contacts had not yet been tested for HIV (Table 4).

Table 4. Contact Gender * Contact HIV status Cross tabulation

			Contact HIV status		Total
			Tested	Not tested	
Contact Gender	Male	Count	275	89	364
		Expected Count	279.1	84.9	364.0
	Female	Count	290	83	373
		Expected Count	285.9	87.1	373.0
Total		Count	565	172	737
		Expected Count	565.0	172.0	737.0

The Pearson Chi-Square test value was calculated at 0.498 and the p value was 0.481.

Qualitative Results

A total of 18 participants (index providers) were interviewed; 13 women and 5 men. Table 5 presents demographic characteristics of participants.

Major activities of an index testing provider in the past one year included ensuring that all newly tested HIV clients were listed, counseling was provided to them on partner notification service, elicitation of sexual contacts, contact tracing, testing of contacts and linkage of positive contacts to care.

Table 5. Demographics of the 18 index providers interviewed.

#	Facility	Age	Sex	Provider' Job Title	Interview Duration (minutes)
1	MFLH	42	Female	Community liaison officer	15
2	MFLH	38	Female	Counselor	15
3	MMAIN	51	Female	Health Systems Strengthening Nurse	16
4	MMAIN	39	Female	HTS Head of department	18
5	MFLH	28	Female	Counselor	18
6	MFLH	32	Female	Counselor	22
7	GEORGE	43	Female	Community liaison officer	20
8	GEORGE	26	Female	Community liaison officer	18
9	GEORGE	24	Male	Community liaison officer	15
10	MMAIN	35	Female	Counselor	21
11	MMAIN	36	Male	Community liaison officer	16
12	MFLH	42	Male	Counselor	14
13	MFLH	45	Male	HTS Head of department	24
14	MFLH	49	Female	Health Systems Strengthening Nurse	14
15	MMAIN	35	Female	Counselor	19
16	George	33	Female	Health Systems Strengthening Nurse	32
17	MFLH	39	Male	Medical Officer	18
18	George	28	Male	Medical Officer	17

"My major activities concerning index is if we find a positive, making sure that the client is indexed and elicitation is supposed to be done also. If the client says that I have got sexual contacts, I am supposed to book those sexual contacts and follow them either at home

or at the facility if the client agrees to bring them". (Participant 1)

Index testing workers worked together with other providers and implementing partners to provide index testing. Specifically, index testing providers from respective facilities worked hand in hand with program implementation partners to ensure activities were coordinated.

"For index testing to work, we need a multidisciplinary team. In working with other, being a nurse by profession, I need to work with counselors as I also provide testing. We need to identify people who are very skillful, who can spend more time with the client to get information on their contacts". (Participant 16)

There were many successes or experiences reported by respondents arising from index testing. Providers were open to share their experiences and lessons learned while providing services.

"My experience or successful story it was one time when we had a session with a certain index client. That client was able to open up and give us 6 contacts of whom 5 tested positive and 1 negative. That person was polygamous". (Participant 1)

"Through index testing, there was a certain man who had tested 7 years ago. When he came he was not feeling well. After we tested he said in the eyes of the public he only has one sexual partner (his wife). According to him he is a God fearing man. After eliciting we discovered that he had 3 extra girlfriends. Little by little after interacting with him those names were given to me. After that he said he may not be able to disclose to them because they will suspect that he may have infected them…." (Participant 12)

Barriers and facilitators to effective index testing were also identified by respondents.

"The index client may give you the correct contact information. But the contact might have lied to the index client. hard to reach clients that are out of town (Lusaka) or out of the country. the contact, when followed, two of them have really brought up their religious believes strongly: "you are not going to test me, I cannot do an HIV test, I don't believe in HIV". (Participant 7)

"Like earlier mentioned, index testing is a concept that is new. It is a concept that was not long ego embedded in our understanding as healthcare providers. One of the barriers in delivering this service has been its acceptance among healthcare workers or among facility based workers as well as community based workers. Because we have had to ask on sexual contacts from clients that come out positive. And looking at our culture, it is one thing that we don't easily talk about to bring out sexual relations to clients. Many staff tend to bring out they traditions, they cultural believes, they religious believes when it comes to them getting sexual partners. It has limited the number of sexual partners that we are getting from the client…" (Participant 16)

Specific challenges related to index clients' identification and elicitation of index contacts. Some clients did not open up easily (as this was the first time to meet a counselor) or immediately and others were not providing full contact information. This was usually resolved within two weeks of follow-up, as clients become more comfortable interacting with ART providers.

"One of the challenges of finding positives when doing index is most clients do not open up easily. Being the first time of meeting you as a counselor they can't open up just there and then. And then the other thing when it comes to elicitation, we elicit the client, you will find that when calling the sexual contacts, you are asked questions like where did you get my contact from? It is not everyone who will agree right there and then. It is not a one-day thing if I may say".

"… elicitation on the other hand is a skill. So one big challenge is they are very few staff who are skillful when it comes to elicitation. So you will find out that if you have a client in front of you, but if you don't have the skill and

if you do not perfect this skill, the client will be in front of you but you will not be able to get out this information from them". (Participant 16)

Specific challenges related to testing of index contacts. Various logistic challenges were noted with regards to tracing and testing of contacts.

"Number 1, transport must be readily available at all times. Number 2, … in short I can say logistics must be available at all times. If one says right now I have left my wife at home. If at all you are ready let's go together so that you can test her. You will find that we don't have transport at the facility at that particular time. The time you will be calling the client maybe he will say this time she is not around, maybe she is busy with something else. We know these clients; they've got a lot of things to do beside accessing services from the hospital". (Participant 1)

Perceived factors causing/contributing to sub-optimal index testing were reported as gender, age, stigma, social status, health system, facility structure, staff, and skill level.

"…when it comes to age, this is another challenge because elicitation is also age sensitive. By this I mean you cannot get a youth to elicit from a senior citizen for example who is maybe above 65. They will perceive the youth as a young boy or a young girl who has no concept of living, and they would close up on giving information…." (Participant 16) (Table 6).

Table 6. Field notes

#	**Theme**	**Description**
1	Major activities of an index testing provider in the past one year.	• Ensure all new positives clients are listed • counseling on partner notification service (PNS) • elicitation of sexual contacts • contact tracing • use of HIV screening tool to determine eligibility of index contact to take an HIV test • testing of contacts either at home/community or at the facility • assignment of tasks • linkage of positive contacts to treatment • prevention services to negative contacts • recording/documentation in various registers • reporting using available reporting tools • handholding mentorship with peers • conduct quality improvement projects
2	Working together with other providers and implementing partners to provide index testing.	• Work Hand in hand with all partners • Pairing of less experienced community health workers with those who are experienced • morning or afternoon meetings to verify data • when there was no coordination, different partners could follow the same contacts, there was dispute over numbers between community & facility implementing partners • good communication to settle differences • working together in conducting elicitation and at each stage of index testing • sharing work, distributing tasks • community initiation

		• technical advice/support provision • zoning of population, training of testers, support of weekend index testing • A multidisciplinary team of partners: counselors, nurses, community volunteers, etc. work together: follow up of index contacts for testing and linkage of contacts to care; provision of transportation, other resources/ finances, test kits, etc.
3	Successes or experience arising from index testing.	• Index client (polygamous) opening up and giving 6 sexual contacts (5 tested positive and 1 negative) • scale up program (community testing, hot spots) increased yield • openness on contact's behavior (narrating how he targets small ones/school going girls) • difficult contact was finally tested after several attempts by various providers • one partner elicited the girl friends for testing & wife (to protect the wife) • successfully contacted an arrogant contact who insisted to know where the provider got the phone number • reassured index contact on shared confidentiality (different provider from the one who elicited) and tested successfully • hesitant female client opened up over time and at the end a total number of 12 contacts were elicited • both partners did not disclose to each other (the male contact was followed, tested and disclosed that he is known positive, then disclosed to the female and started treatment) • a client elicited 8 contacts who were also tested in the same community • a self-believed God fearing client known positive for 7 years (pretending to have only 1 partner in the eyes of the public) disclosed 3 extra partners (he was initially fearing to disclose to them for fear of being victimized to have infected them), he was counseled and partners were finally tested • MCH client failing to disclose to partner (plan was made and provider assisted) the husband was later tested and provided 3 more contacts • index yield above 30% last year facilitated by weekend testing, finding men on weekends/mini bus drivers and testing they contacts as well
4	Barriers to effective index testing.	• Mobile clients such as track drivers with contacts out of town • transportation challenge • space for elicitation and confidentiality when disclosing (clients not disclosing more partners) • short time for elicitation because of patient queues, long waiting time • wrong contact details, wrong addresses and phone numbers, • patients refusing completely to give contacts • contacts out of town, denying to have more than one partners • clients not returning (defaulters) • contacts lying/giving wrong information to index • other contacts not believing in HIV testing • fear of GBV (giving up wrong details)

		• elicited adolescent girls below 18 were difficult to test without consent • lack of disclosure (fear to be labelled womanizers) • fear that the provider will disclose client status to the contact • it is difficult to elicit from people who test as a couple (separate them or elicit on subsequent visits) • transport challenges for contacts who live far from the facility • fear that they are known in the community • new counselors without needed skills lowered the yield • index testing is a new concept, its acceptance among health care providers is still a challenge • culture limits providers to discuss sexual matters with clients/traditional beliefs • facility set up do not promote privacy • knowledge gap • over-testing of children
5	Specific challenges related to index clients' identification and elicitation of index contacts.	• Clients not opening up easily (being the first time to meet you as a counselor) or immediately • difficult contacts asking difficult questions such as who gave you my number & details • very ill patients failing to give more partners, new clients not providing full information (resolving at 2 weeks) • wrong contact details • refusal to disclose sexual contacts, closing up of clients because of closed ended questions, buddies' collection of drugs, no elicitation room/lack of confidentiality/ cases not opening up, cases are gotten from both facility and community • elicitation of contacts is a process and is done over time, casual contacts are difficult to be identified • lack of probing skills for more contacts elicitation • new positives are often not ready to elicit partners (? still thinking, fear that the provider will disclose the result to the contact) • poor documentation, denying/declining identity by contacts • for others it takes time to believe and consent • more providers calling the same contact on the same day (contact may become emotional and close up) • poor counseling, consent from the clients to test contacts, age difference • dating married partners have it difficult to provide contacts' phone numbers • most staff not optimizing the use of the HIV screening tool • lack of skills for elicitation
6	Specific challenges related to testing of index contacts.	• Transport, logistics, preparedness to immediately follow the contacts who are ready • busy contacts with work • clients not opening up to give more contacts • stigma to test at home because of family members, also not coming to the facility when appointment is given (only after several attempts)

		• wrong address/locator information • contacts not keeping appointment sometimes, some who tested positive decline treatment/not ready • clients not opening up on first contact • clients lost their previous partners' contact details • contacts give excuses/ busy with work during the week/church on Sunday, fear of knowing their results/status • poor elicitation (1:1 main partner or biological children) • contacts may be other people's husband/wife (why did you call and what do you want to talk to my wife?) • age difference and communication barrier (e.g. adolescent clients with older counselors) • poor counseling • limited man power to meet the demand of follow up •
7	Perceived factors to be causing/ contributing to sub-optimal index testing (gender, age, stigma, social status, health system, facility structure, staff, skills, etc).	• Most CHWs not fully trained • lack of counseling skills • being a referrals hospital some clients come from far places, high social status barrier/ high profile • stigma, self-stigma (people may think that I have been sleeping around, lack of disclosure to partners, social status/pastors • lack of space for privacy and confidentiality • age difference (elderly not opening up to adolescent), ashamed to talk about sex, condoms, etc. married clients attended by younger ones (were not calling for assistance) • some staff being too judgmental to clients who give more than two partners • men are hard to find/always at work/ want to test on weekend • lack of skills on elicitation and contacts finding • community not sensitized on the benefits of index testing • across ages, male Vs female (provider/client), women have it difficult to disclose to their husbands compared to men • social status (celebrity, nurses, doctors, counselors, bishops, elders in churches) • fear of breaking relationships or losing marriage, skills to convince the client and contacts • female adolescents are more difficult to open up • high status people often hold back information on contacts • lack of proper planning at facility level •
8	Raisons for perceived challenges affecting optimal index testing.	• Some are temporal and can be sorted out • lack of confidentiality leads to no disclosure • similar challenges to most clients • space is a real challenge (we do ask for rooms when we have clients for elicitation), room for elicitation used for other activities (e.g. enrollment room), busy rooms/occupied by other providers, other people enter the

		room while elicitation is taking place/disturbing (making it difficult for clients to open up) • because it is what we are experiencing • poor documentation forms, elicitation forms not well documented/poor sketch map • long waiting time when contacts come • space is a real limitation • the results are not encouraging •
9	Specific actions or recommendations to address challenges.	• Have all logistics (transport, air time) in place when starting a program • have trained providers to initiate ART in the community, only link to the facility those clients that cannot be initiated in the community • call on other colleagues of same age to help with elicitation • need more attention and time when doing elicitation • educate clients (some are ignorant), IEC • engage the media/drama to address knowledge gap about index and its benefits in the community • resolve issue of shared space, create rooms/tents • invitation letter to partners • sensitization of the community • counseling of clients and contact • skilled individuals should lead index services • training, orientation, hand holding mentorship for skill transfer • frequent refresher courses for the counselors, psychosocial training for those who lack it • fast track contacts • stake holders' participation • effective supervision in all the department • sharing of challenges and experiences • involve elder counselors for old clients • continuous mentorship • improve on staffing •
10	Other interventions to improve index testing.	• Transport & lunch allowance to CHWs • work after hours • motivation (orientation/ same people always go for orientations and keep information to themselves/ alternate) • allocate specific individuals on weekly basis to attend to index testing • weekly report on targets and challenges • good rapport with the clients, reassuring the clients on the shared confidentiality • good elicitation skills, identify those who are good at elicitation • offer PNS testing modalities • engage churches/other stake holders for index sensitization • dispel myths and believes • proper documentation

		• continuous peer mentorship, proper documentation • elicitation skills improvement • sensitization of the public (advertise, drama, radio, TV) • foot soldiers to target hot spots in the community (e.g. churches, markets, bust stations, door to door) • Community initiation, same person doing elicitation should follow up and test contacts • translate most community tools/HIV screening tools in local languages because index testing is mostly applied by community workers •
11	Proposed change to improve HIV index testing yield.	• Delays in implementing programs • administrative procedures/late signing of checks • involve everyone/every index provider • improve on documentation on registers, address space challenge • same people always attend programs/learn new things/keep it to themselves (we need rotation), motivation • drama/role plays • refresher courses/orientations are needed, prioritize index testing • involve clinicians • preferably the one eliciting should contact the partners (other facility staff should not call the index to confirm the contacts/it makes them feel un-comfortable and distrust the provider) • age appropriate pairing of client/provider to improve communication and break the culture barrier • dressing code for providers • motivation of providers handsomely (notches, performance based reward) • avoid double counting of clients'/data duplication/ clients entered twice in the registers • improve yield by the use of the screening tool • follow the client instead of waiting for them to come • improve skills, IPV and disclosure • involvement of professional staff in index because they are most trusted by patients and not lay counselors or community volunteers • improve quality of care by improving the conditions of services for healthcare providers •
12	Other additions to improved HIV testing.	• Engage owners of bars, lodges to meet the key pop • Motivation of providers • introduce community testing/ hotspots • being passionate and real about the job, carrying it at heart • ensure that screening tool is used correctly, only test those who are eligible • improve on documentation • flat out index testing, sensitization in the field/community on index testing

		• motivation and support from management • refresher courses/orientations, reach-out to those who are hard to reach/ adolescents & men • engage work supervisors'/company supervisors/incorporate index with other services • introduce deliberate policies that support index testing • inform the community on index testing/sensitization

Results Following the Interventions

Total number of 384 index clients were enrolled in the study (140 from Matero Level 1 Hospital, 124 from Matero Main Clinic, and 120 from George Health Centre). Total number of 384 index clients were enrolled in the study (140 from Matero Level 1 Hospital, 120 from George Health Centre, and 120 from Matero Main Clinic) (Table 7).

Table 7. Number of participants (index cases) by sex, month, and facility

Month/Sex	Matero level 1		Matero Main		George		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
March 2020	16	15	11	19	4	5	31	39
April 2020	18	13	9	18	9	8	36	39
May 2020	11	12	14	15	14	7	39	34
June 2020	7	18	6	10	28	18	41	46
July 2020	15	15	11	11	15	12	41	38
Total	67	73	51	73	70	50	188	196
Grand Total	140		124		120		384	

Of all the cases, 70 were enrolled in March, 75 in April, 73 in May, 87 in June, and 79 in July 2020. The mean age for the 384 enrolled clients was 35.5 ranging from 18 to 64 (SD = 8.930).

Marital status: 327 were married and 57 not married. Participants by entry point were as follows: 293 from PICT (76.3%) and 91 from CICT/VCT (23.7%).

The number of contacts elicited were 668 (elicitation ratio = 1:2). 187 clients elicited 1 contact each, 123 clients elicited 2 contacts each, 64 clients elicited 3 contacts each, 9 clients elicited 4 contacts each, and only 1 client elicited 5 contacts.

From the total number of 668 contacts, 333 were males and 335 were females. The mean age of contacts was 34.5, ranging from 18 to 68 (SD = 8.638). Out of 668 elicited contacts, 384 were main partners to index contacts (57.5%), 277 were secondary partners (41.5%), and only 7 were casual relationships (1%). 518 contacts were married, 147 were not married, 2 widows, and 1 divorced.

The results for referral of index contacts are presented in the following table. (Table 8).

Table 8. Index testing notification type

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		384	100.0	100.0	
	Passive referral	32	8.3	8.3	8.3
	Provider referral	352	91.7	91.7	100.0
	Total	384	100.0	100.0	

Referral type: 352 provider referrals (91.7%) and 32 passive referrals (8.3%). Of the 668 elicited contacts, 639 were reached with HIV index testing services and 29 were not reached. Out of the 639 contacts reached, 79 were known HIV positive and 560 were eligible for HIV test.

Table 9. Index Contact HIV testing status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Positive	320	47.9	47.9	47.9
	Negative	240	35.9	35.9	83.8
	Not tested	29	4.3	4.3	88.2
	Known Positive	79	11.8	11.8	100.0
	Total	668	100.0	100.0	

Following the HIV index testing, 320 tested positive and 240 tested negative, representing a positivity yield of 57% (320/560) (Table 9).

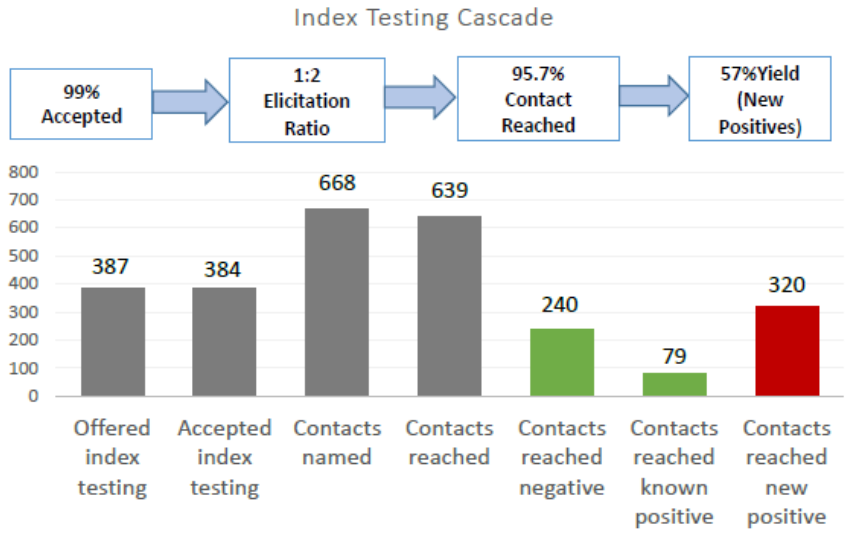


Figure 2. Index Testing Cascade

Figure 2 shows the index testing cascade from contacts offered HIV test to those who tested positive.

Of the 320 positive clients, 154 were males (48.1%) and 166 females (51.9%). The mean age for newly diagnosed HIV positive clients was 34 years (from 18 to 62 years, SD = 8.711). Out of the 154 new HIV positive men, 136 were between 25 and 49 years representing 88% (including 93 middle aged men aged 25 to 40 years). Only 4.5% (7/154) new positives were adolescent boys and young men (15 to 24 years old). The proportions of new HIV positive adolescent girls and young women between the age of 15 and 24 years were 24.7% (41/166).

The time elapsed from elicitation to testing of the 560 eligible index contacts was as follows: 473 within seven days (84.5%), 66 within two weeks (11.8%), 19 within four weeks (3.4%), 2 beyond a month (o.3%). Time from testing to ART initiation of the 320 new positives = 302 within seven days (94%), 15 within two weeks (4.7%), 1 within four weeks (0.3%), 2 not linked (0.6%).

Of the 320 positive clients, 154 were males (48.1%) and 166 females (51.9%). The mean age for newly diagnosed HIV positive clients was 34 years (from 18 to 62 years, SD =

8.711). Out of the 154 new HIV positive men, 136 were between 25 and 49 years representing 88% (including 93 middle aged men aged 25 to 40 years). Only 4.5% (7/154) new positives were adolescent boys and young men (15 to 24 years old). The proportions of new HIV positive adolescent girls and young women between the age of 15 and 24 years were 24.7% (41/166).

The above data was analyzed and the results indicate that there was no significant association between gender and HIV positive result (Chi square value = 1.050, p = 0.306). This study also shows that contact testing positive for HIV was independent of gender (alpha significance level > 0.05).

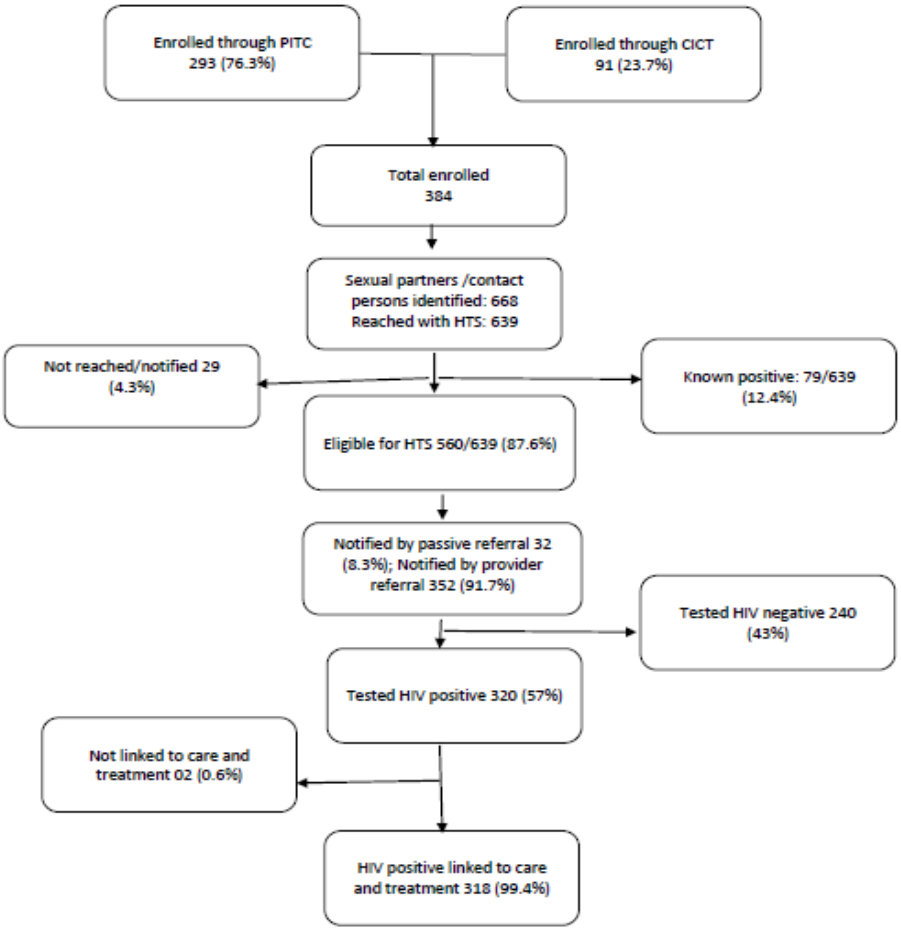


Figure 3. Index flow chart

Figure 3 discusses the steps of index testing from enrollment or entry point to enrollment to care and treatment for new HIV positive patients.

Discussion

At baseline, most index clients (98.5%) had documented evidence of starting ART within 7 days of HIV diagnosis. This demonstrates strongly that the test and start strategy is being implemented to scale in Matero urban sub-district of Lusaka. There was an elicitation of 845 contacts out of 604 cases, giving us a low elicitation ratio of 1:1.4. There was not much difference between gender for elicited contacts (423 males and 422 females).

A total number of 565 index contacts were eligible for HIV test. 113 of them tested HIV positive, representing a positivity yield of 20%. This index testing positivity yield was below the expected yield of above 25% as reported by several other studies [5-13]. The linkage rate for positive contacts was 79.6% at

the time. The calculated Chi-Square test value was 0.498 and the p value was 0.481. This result is not significant since p value (0.481) is greater than the designated alpha level (0.05), so we'd accept the null hypothesis that asserts the two variables are independent of each other. Therefore, there was no association between the gender of the contact and their HIV testing status.

In the qualitative phase of this research, barriers to accessing HTS were divided into provider- and client-related challenges.

Provider-related challenges: Inadequate elicitation skills among the newly trained community healthcare workers, treatment supporters and counsellors; trained providers such as healthcare workers were not fully involved; low number of volunteers trained in index testing; inadequate index testing knowledge among staff; limiting elicitation of index partners to only wife and husband (not eliciting all sexual partners); and limited transport for contact tracing (long distances to reach contacts).

Client-related challenges: Mobile communities due to seasonal activities such as cross boarder trades (e.g. truck drivers), sex work and farming; some index clients do not live in the same district/town as the index clients; key populations and adolescents index clients do not have contact details for some of their contacts; missing details on client locator forms or wrong details provided; and limited space dedicated to conduct elicitation of index clients (lack of privacy).

These findings are in keeping with evidence from other studies [2-5], that showed that non-disclosure of HIV status (due to fear of marital discord), non-disclosure and under-disclosure of the number of sexual partners by the index clients, fear of negative consequences, difficulties notifying past or casual partners, geography/remote partners, and risk perception were major barriers for using testing services. Key populations and people with casual partners were less able or willing to identify partners. Barriers to partner notification services also included concerns around privacy/confidentiality and intimate partner violence. Lack of awareness of risk for HIV infection/ misconceptions; structural, psychological, financial, were barriers to being tested.

Following the interviews with key informants, the following were implemented solutions to address identified challenges:

1. Peer pairing approach using experienced counselors and hand holding mentorship; Pairing treatment supporters to newly tested HIV positives clients for index testing and treatment support;
2. Training facility-based volunteers and healthcare workers (Nurses, Clinical officers, Medical officers etc.) in index testing.
3. Setting up network of counselors to reach contacts not in the same catchment as the index clients.
4. Providing transport to follow up clients (index contacts): additional vehicles needed or support transport refunds.
5. Identifying and allocating dedicated space for elicitation using experience counsellors.
6. Improving appointment system: after hours, weekends and men's clinics.
7. Ensuring correct, complete and consistent documentation in all registers.

The index testing elicitation ration improved from 1:1.4 at baseline to 1:2 at the end of the project.

As in several other literatures, our study findings show that following appropriate interventions addressing barriers to index testing, the testing positivity rate improved from 20% to 57%. Many studies have shown that index partner testing has the potential to increase HIV testing services (HTS) uptake; identify and diagnose HIV infected partners (yield ranging from 35% to 62% without reported intimate partner violence (IPV).

The data was analyzed and the results indicate that there was no significant association between gender and HIV positive result (Chi square value = 1.050, p = 0.306). This study also shows that contact testing positive for HIV was independent of gender (alpha significance level > 0.05).

Strengths and Limitations of the Research

Some studies have tackled the issues of barriers to successfully referring partners for testing [5, 9], but were not specific to gender or age. Alternative strategies to target and provide acceptable and accessible HIV testing services to gender and age-specific populations are addressed in this study. This study also addresses the gap of limited literature on HIV index testing in developing settings.

We used convenience sampling to explore barriers and facilitators of index testing. One other limitation was that the key informants in this research were only healthcare providers.

The perspective of HIV positive clients themselves was not explored in this study to balance the information bias.

Our findings may differ in settings with lower HIV prevalence. This may result in more stigma for HIV infected individuals and more reluctance to HIV status disclosure to sexual partners.

These findings have limitations. One limitation of the study was that we excluded index clients or partners for IPV reporting; if not, these participants might have been reluctant to notify their sexual partners, leading to accrued fewer HIV testing outcomes, and therefore biasing the results away from the null hypothesis. Not all partners were tested, and those who participated differed from those who did not by gender and age. Additionally, our data do not include all HIV tests received by partners as a result of notification in the HIV program, but rather only those who were offered and accepted to take part in the study. We may have therefore underestimated the number of partners tested for HIV.

Summary

Introduction: As the proportions of people living with HIV who do not know their HIV infection status decrease, reaching the last mile of those who are asymptomatic and not in contact with the health care system becomes a critical challenge. Therefore, reaching the first 90 will require effective and efficient HIV testing approaches. The number of people living with HIV who know their HIV status and that of those who receive antiretroviral therapy could increase by the expansion of index testing services.

Methods: This project used an explanatory sequential mixed-methods study design. The specific objectives were:

1. to understand the perceived facilitators and barriers to HIV partner testing from the perspective of the health-care provider;
2. to propose interventions necessary for improved HIV case finding;
3. to reach high risk but hard to reach populations in HIV programs such as middle aged men, and adolescent girls and young women (AGYW).

The permission to conduct this study was obtained from the Lusaka provincial health office before its commencement. Ethical clearance was sought and obtained from the ERES Converge research ethical committee. Authority to conduct research was sought from the National Health Research Authority.

Results: The HIV test outcomes for index contacts were as follows:

Baseline

452 index contacts (53.5%) tested HIV negative, 113 index contacts (13.4%) tested HIV positive, 108 index contacts (12.8%) were known HIV positive, and 172 index contacts (20.4%) were not yet tested for HIV. Of the 113 contacts who tested HIV positive,

90 index contacts started ART within 7 days (79.6%).

End line

Total number of 384 index clients were enrolled in the study (140 from Matero Level 1 Hospital, 124 from Matero Main Clinic, and 120 from George Health Centre). Number of contacts elicited: 668 (elicitation ratio = 1:2). 187 clients elicited 1 contact each, 123 clients elicited 2 contacts each, 64 clients elicited 3 contacts each, 9 clients elicited 4 contacts each, and only 1 client elicited 5 contacts. Total number of 668 contacts: 333 males and 335 females. The mean age of contacts was 34.5, ranging from 18 to 68 (SD = 8.638). HIV status: 320 tested positive, 240 tested negative, 29 not tested, 79 known positive. Positivity yield = 57% (320/560).

Of the 320 positive clients, 154 were males (48.1%) and 166 females (51.9%). The mean age for newly diagnosed HIV positive clients was 34 years (from 18 to 62 years, SD = 8.711). Out of the 154 new HIV positive men, 136 were between 25 and 49 years representing 88% (including 93 middle aged men aged 25 to 40 years). Only 4.5% (7/154) new positives were adolescent boys and young men (15 to 24 years old). The proportions of new HIV positive adolescent girls and young women between the age of 15 and 24 years were 24.7% (41/166).

The above data was analyzed and the results indicate that there was no significant association between gender and HIV positive result (Chi square value = 1.050, p = 0.306). This study also shows that contact testing positive for HIV was independent of gender (alpha significance level > 0.05).

Discussion

Barriers Identified include the following:

1. **Provider related challenges:** Inadequate elicitation skills among the newly trained Community healthcare workers, treatment supporters and Counsellors; trained providers such as healthcare workers not fully involved; Low number of volunteers trained in index testing; inadequate Index testing Knowledge of among staff; Limiting elicitation of Index partners to only wife and husband (not eliciting all sexual partners); and limited transport for contact tracing (long distances to reach contacts).
2. **Clients related challenges:** Mobile communities due to seasonal activities such as cross boarder trades (e.g. truck drivers), sex work and farming; some index clients do not live in the same district/town as the index clients; key populations and adolescents index clients do not have contact details for some of their contacts; missing details on client locator forms or wrong details provided; and limited space dedicated to conduct elicitation of index clients (lack of privacy).

Interventions implemented were:

1. Peer pairing approach using experienced counsellors and hand holding mentorship.
2. Pairing treatment supporters to newly tested HIV positives clients for index testing and treatment support.
3. Training facility based volunteers and healthcare workers (Nurses, Clinical officers, Medical officers etc.) in Index Testing.
4. Setting up network of counsellors to reach contacts not in the same catchment as the index clients.
5. Providing transport to follow up clients (index contacts): Additional vehicles needed or support transport refunds.
6. Identifying and allocating dedicated space for elicitation using experience counsellors.
7. Improving appointment system: After hours, week-ends and men's clinics.
8. Ensuring correct, complete and consistent documentation in all registers.

As in several other literatures, our study findings show that following appropriate

interventions addressing barriers to index testing, the testing positivity rate improved from 20% to 57%.

Conclusion

HIV index testing services are an effective way for improved HIV case identification. The challenges identified have future implications for index partner testing. These barriers were also gender and age specific. HIV testing services need to adapt to the social context of Zambia where HIV-related stigma and discrimination is still persistent and overwhelming. HIV programs need to explore and address barriers to HIV partner testing services to maximize HIV case identification. As Zambia makes significant progress towards achieving HIV epidemic control, more effort is needed to reach specific high risk, but hard to reach populations in HIV programs, such as men, adolescent girls and young women.

We believe that our findings, in combination with previously published and presented data, show that assisted partner services is an efficacious and acceptable public health intervention that needs to be brought to scale in low-income and middle-income countries.

Disclosure/Conflict of Interest

The author reports no conflicts of interest in this work.

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Evaluation of the Preparedness and Responses for Medical Emergencies in Edo State

Charles Omheaka Okpere[1]*, Christopher Ehis Okaka[2], Innocent Osi Alenoghena[3], Daniel Aromeh Odekina[4]

[1]*School of Public Health, Texila America University, Georgetown, Guyana*
[2]*Department of Animal and Environmental Biology, and former Dean of the Faculty of Sciences, University of Benin, Benin City, Nigeria*
[3]*Department of Community Medicine, Ambrose Alli University, Ekpoma, Nigeria*
[4]*Primary Health Care Development Agency, Edo State, Nigeria*

Abstract

This article helps evaluate the preparedness and response to medical emergencies within the Edo State healthcare system. Having a functional emergency medical response could reduce deaths in low and middle-income countries by about 25%. This entails efficient pre-hospital care, functional ambulance services, a prompt and designated emergency call centre and number, trained first responders, efficient transportation to a ready healthcare facility, and more. This study was conducted in the three senatorial regions of Edo State. The study design was cross-sectional, with data collected via a semi-structured questionnaire. Five hundred and twenty-four people were sampled in the research, and the analysis was conducted using SPSS software. The research revealed that three-quarters of the participants have no available call centre and/or call number in their location. More than four-fifths of the respondents reported having no ambulance services and no available Automated External Defibrillators (AEDs) in their localities. Two-thirds of the participants are unable to carry out CPR, and only about one–fourth had training in CPR in the last two years. To have an effective preparedness and prompt response to medical emergencies, the following are recommended: 1. The government needs to set up a functional emergency response centre in every Local Government Area. 2. The government should provide functional ambulance vehicles and position them in strategic locations across the state. 3. The training of the first responders should be prioritized to shorten response time.

Keywords: *Edo-State, Medical-Emergency, Preparedness-Response.*

Introduction

There is a high burden of deaths and disabilities from non-communicable diseases in several regions of the world. Despite the perennial exposure of populations to diseases, medical emergencies, and environmental disasters, many countries lack the institutional capacity to manage health emergencies. Notably, countries with well-developed emergency medical response systems have consistently recorded low morbidity and mortality rates from health emergencies, while nations lacking functional EMS infrastructure have worrisome mortality and morbidity rates [1, 2].

Medical Emergencies are indeed major contributing factors to premature deaths in Low and Middle-Income Countries (LMICs), including Nigeria. It is estimated that a

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****Corresponding Author: okpere@hotmail.com***

functional Emergency Medical Services/ Response (EMS/R) could reduce these death rates by as much as 25% [3] Studies equally show that in up to 75% of Road Traffic Accidents (RTA), patients die before they get to a hospital or within six hours of admission, mainly due to poor pre-hospital Medicare, poor infrastructure, inadequate/ inefficient transportation system to the hospital, and lack of training [4]. The International Medical Corps emphasizes that a disaster can occur at any time and in any place, and therefore a timely and effective emergency response is essential to saving lives [5].

EMS entails providing an efficient medical response service for urgent pre-hospital treatment and stabilization of patients with severe or life-threatening medical emergencies. This encompasses a functional, coordinated emergency call centre and number, a robust ambulance system with a Mobile Intensive Care Unit (MICU), trained first responders, prompt transportation to the hospital, a ready health facility with an efficient triage system, and an adequate workforce for immediate treatment.

A critical component of EMS is emergency preparedness (EP). Emergency preparedness encompasses plans implemented before an emergency occurs, while Emergency Response, or ER, entails actions taken to save lives. Thus, EMS boils down to putting preparedness into action. Both EP and ER form part of the four phases of emergency management, encompassing mitigation, preparedness, response, and recovery [6].

It is estimated that over half of deaths in LMICs can be averted by an effective and efficient emergency healthcare system [7], and that could translate to over 3000 lives saved daily [8, 9]. Several developed nations with a robust Emergency Medical Response include the USA, the UK, Australia, the Netherlands, and Canada, among others. The USA is generally regarded as the country with the highest EMR service, with a Global Health Security Index (GHSI) score of 83.5 compared to the global average of 40.2 and 51.9 for high-income countries [10]. The 2019 GHSI also showed that Nigeria ranked very low, scoring only 12.5% in emergency preparedness and response planning [10, 11]. Despite Nigeria having a national framework for disaster management, implementation is defective, and medical emergencies are not given the desired attention, especially at the Primary Health Care level.

In most advanced nations, once a medical emergency occurs and Emergency Medical Response is activated, you will see a prompt and coordinated multipronged action as the police, firefighters, and ambulance service all will come for rescue within seven minutes of activation in an urban area, and fourteen minutes in a rural setting [12, 13]. On the contrary, in Nigeria, this level of preparedness and response is tragically hindered by numerous challenges, including a lack of emergency call centres and numbers, inefficient ambulance services, a shortage of personnel, and a lack of postgraduate training in emergency medicine. Other factors include non-motorable road networks, non-functioning traffic systems, ambulances not given the right of way, and lots more [14, 15]. This is in line with the T.C. Health Survey, which revealed that three out of every four Nigerians have experienced at least one medical emergency in the last five years, while numerous problems plague the Emergency Medical Response system [16].

Nigeria has several agencies empowered by law to manage emergencies, including the National Emergency Management Agency, State Emergency Management Agencies, the Ministry of Health, Local Government Emergency Management Committees, the Fire Service, and the Nigeria Police Force. The preparedness and response of these agencies are questionable as they often struggle to foster strong collaboration and frequently fail to respond promptly and effectively [17]. Inadequate resources, weak institutional

capacity, poor communication and information sharing, increased urbanization, inadequate budgetary planning, insecurity, and numerous other factors primarily contribute to this issue.

The non-prioritization of emergency medical care in Nigeria often results in delayed responses of over one hour, leading to adverse socio-economic and financial effects. Addressing these challenges, therefore, will not only enhance prompt EMR services but could also reduce the economic burden by about 54% [18].

There is no gainsaying that the rapid medical response system is becoming a global public health phenomenon, mainly due to the increasing mortality from accident trauma and medical emergencies. It has become imperative to address issues relating to inappropriate responses and unnecessary delays in emergency medical services, which entail emergency calls for help, first-aid Medicare, training of first responders, transportation to a ready medical facility, delays in rendering prompt Medical Care, and overall system preparedness.

To this end, the Lagos state government has taken the lead in emergency preparedness and response in Nigeria since March 2021 when it launched the Lagos State Emergency Medical Services (LASEMS) and Lagos State Ambulance Services (LASAMBUS) initiative, which has a MICU operated by trained personnel; and this has a significant positive impact on the morbidity and mortality indexes [19]. These services operate 24 hours a day and are involved in awareness campaigns, personnel training, improving the communication network, linking LASEMS and LASAMBUS to a dedicated line -123, establishing 15 ambulance points, a marine rescue unit, and a pre-hospital Medicare service.

The above is laudable compared to other parts of Nigeria, where EMR is still in its primordial stage, lacking integration, rapid response teams, ambulances, and trained paramedics [20]. Moreover, the few ambulance vehicles available lack necessary resuscitation equipment, and they are not given priority on our roads.

Recently, the Edo State Government, in collaboration with Emergency Response Africa (ERA), launched a technologically driven Emergency Medical Services (EMS) program in three Local Government Areas (LGAs) – Oredo, Egor, and Ikpoba-Okhae, with plans to extend the services to other LGAs [21]. The goals of the EDO-EMS / ERA program are as follows:

1. Save lives by providing emergency ambulance services for quick response.
2. Raising public awareness regarding the use of emergency call numbers - 112 and 739.
3. Train a Community-Based First Responders (CBFR) network to provide first aid at emergency scenes.
4. Help promote the linkage of emergency care to the Edo–Health Insurance Scheme (Edo-HIS), which could lead to increased enrollment in HIS.

Edo State EMS also recently graduated the second batch of Community-Based First Responders (CBFR). The CBFR play a vital role in strengthening emergency response within their local community as the first line of defence during health crises, thereby serving as a critical link between life and death [22].

Time, however, will tell how effective these set goals and collaboration will be in fostering an improved and efficient emergency medical response in Edo State, given the current reality of the emergency response system.

The justification/ purpose of the study includes the following**:**

1. To ascertain the level of readiness of the Edo State emergency medical response services during emergencies for both the individual victim and the larger population.
2. Secondly, Edo State appears to lack a functional and centrally coordinated emergency response system.
3. Furthermore, the study also aims to identify the salient challenges that hinder the

effectiveness of emergency medical responses.

This study aims to understand the status of Edo EMS, identify significant gaps in emergency medical response and equally examine the preparedness and response of the Edo State healthcare system to medical emergencies.

Methodology

Study Area/ Population

The study was conducted in Edo State. Edo State has an estimated population of approximately 5 million people, a land area of 19,187 km², and a population density of 168 persons per km². It has 18 Local Government Areas (LGAs), with the major ethnic groups being Binis, Esan, Afemai, Etsako, and Owan. There are three senatorial districts: Edo South, Edo Central, and Edo North.

Research Design

A descriptive cross-sectional study was conducted using a semi-structured questionnaire to assess information from the participants. The questionnaire was pilot-tested, and those who assisted in administering it received training before the pilot study. The data obtained, however, were not included in the final survey. Regarding the validation process, the questionnaire tool underwent a substantial degree of pilot testing and expert review.

Exclusion-Inclusion Criteria

To select respondents from households, all houses in the community were assigned numbers. Respondents' households were drawn from the pool of numbered houses, and eligible persons were administered the questionnaire. The participants included the general public, families, and public institutions. However, hospital patients and those under -15 years were excluded from the study.

Sample Size

600 questionnaires were distributed using the formula outlined below:

N = Z2Pq/d2, since the estimated sample size is more than 10,000 [23]

N = desired sample size

Z = standard normal deviate (1.96) at 95% confidence level

P = proportion of target population

q = 1 - P

d = degree of accuracy, assume it is 0.05

N = 1.962x50%x0.5/0.052

N = 400

N = 440. Four hundred and forty questionnaires were, therefore, the minimum that should be distributed, assuming 10% is voided.

Sampling Techniques

The multistage sampling method was employed. First, the stratified method was applied for the three ecological zones- Edo North, Edo Central, and Edo South. After that, simple random sampling was used to select the local government area of study, wards, communities, and, eventually, households, using a home-numbering sampling frame. The same approach was applied to institutions and other sampled locations. For robust information, 200 questionnaires were distributed in each senatorial zone, making a total of 600 questionnaires.

Data Collection and Analysis

Data collection was conducted using a semi-structured questionnaire. The answered questionnaires were assembled, and the information therein was extracted, noting the target variables. Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 26 software and the Excel package. The statistical protocols employed in the analysis included descriptive measures, such as percentages, as well as Chi-square tests and p-values to assess associations.

Expected Output

The following expectations are expected to be achieved at the end of the research:

1. It will help identify significant gaps in Emergency Medical Response and preparedness within the Edo state health care system.
2. It is expected to provide the needed data and information to advocate to the various stakeholders on EMR reforms. Some stakeholders include the Edo State Emergency Management Service (EDO-EMS), the Edo State Primary Health Care Development Agency, the Edo State House of Assembly's Health Committee, the Edo State Government, and international health partners such as the WHO, UNICEF, and UNFPA.
3. It is expected to accelerate the prompt establishment of an efficient and well-coordinated EMR system in Edo State.
4. It will help initiate regular training and certification of health personnel in emergency medical response, with an initial focus on first aid training, BLS, CPR, the use of Personal Protective Equipment, and infection control measures.
5. To ensure triage stations are correctly set up in emergency centres to avert unnecessary third-stage delays.

Ethical Considerations

Consent was obtained from the ethical board of the Edo State Ministry of Health and the local government authority. The participants were also assured of absolute confidentiality before the commencement.

Results

Table 1 indicates that 524 respondents participated in this study. The largest proportion of respondents, 194 (37.0%), came from the Edo South Senatorial zone. The highest proportion of respondents live in rural areas, 206 (39.3%). The highest proportion of respondents came from Esan North East LGA, with 137 (26.2%), followed by Akoko-Edo with 92 (17.6%), Ikpoba-Okha with 77 (14.7%), and Orhionmwon with 73 (13.9%). The mean age of respondents was 39.27 ± (11.45) years. The highest proportions of respondents who participated in the research were female (59.5%), married (70.6%), and tertiary educated (71.2%). The highest proportion of respondents was Esan, at 151 (28.9%), followed by Bini, at 127 (24.2%). The highest proportion of respondents was 155 (29.6%) civil servants.

Table 1. Sociodemographic characteristics of respondents (N=524)

Variable	Frequency	Percentage
Senatorial zone		
Edo South	194	37.0
Edo Central	179	34.2
Edo north	151	28.8
Type of Community		
Urban	104	19.8
Semi-urban	214	40.8
Rural	206	39.3
Local Government Area		
Ikpoba-Okha	77	14.7
Esan North East	137	26.2
Oredo	19	3.6
Orhionmwon	73	13.9

Egor	14	2.7
Akoko edo	92	17.6
Esan central	64	12.2
Etsako west	14	2.7
*Others	34	6.4
Age		
15 – 30	125	23.9
31 – 45	253	48.3
46 – 60	137	26.1
61 – 75	8	1.5
> 76	1	0.2
Mean age = 39.27 ± (11.45)		
Sex		
Male	212	40.5
Female	312	59.5
Marital Status		
Single	143	27.3
Married	370	70.6
Separated/Divorced	8	1.5
Widow/Widower	3	0.6
Level of Education		
No formal education	6	1.1
Primary	25	4.8
Secondary	120	22.9
Tertiary	373	71.2
Tribe		
Bini	127	24.2
Esan	151	28.9
Etsako	26	4.9
Urhobo	17	3.2
Igbanke	11	2.1
Akoko edo	17	3.2
Igarua	8	1.5
Ekpe	3	0.5
Edo	19	3.6
Ishan	49	9.4
Owan	11	2.1
Afemai	18	3.4
Igbo	7	1.3
Others	60	11.5
Occupation		
Civil servant	155	29.6
Health worker	85	16.2
Doctor/nurse	31	5.9

Self-employed	124	23.7
Student	82	15.6
Teacher	23	4.4
Unemployed	5	1.0
Engineer	5	1.0
Accountant	1	0.2
Electrician	1	0.2
Others	12	2.3

Table 2 shows respondents' previous experiences with emergency services. Less than half of the respondents, 250 (47.7%), had observed or experienced sickness requiring urgent attention. The highest proportion of respondents went to the hospital when sick 207 (39.5%), followed by health centre 188 (35.9%), then Patent Medicine Store 64 (12.2%). Of the 250 respondents who needed urgent medical attention, 207 (82.8%) met health worker(s) and received quick attention; the highest proportion of self-reported time to a health facility response to the emergency was 81 (39.1%) as immediately and between 5-10 minutes. Most respondents, 452 (89.5%), had not learned of an emergency response team in the locality. 414 (79.0%) did not know any phone number to call in an emergency, and only 0.6% called an emergency no. Of the 73 respondents aware of an ambulance service in their locality, 44 (60.3%) were privately owned, with the majority of the ambulance type, 49 (67.1%) being a bus. The highest proportion of respondents, 25 (34.3%), reported the EMR team's response time as 10 to 15 minutes, and 5.5% of respondents took less than 10 minutes to respond. Only 18 (3.4%) respondents had ever been taken to the hospital with an ambulance. Among the respondents, 64.3% indicated they cannot do CPR. 86.5% of the respondents stated there were no ambulances in their locality. The principal means of transportation during an emergency were motorbikes (32.8%) and private vehicles (32.4%). Regarding the availability of EMR, only 13.9% of the respondents had available ambulances, of which 60.3% were privately owned. The ambulance lacked essential resuscitation equipment as only 6.8% of the respondents indicated AEDs were available, and another 4.1% stated radio-communication systems were available in the ambulances.

Table 2. Previous experiences of Emergency services

Variable	**Frequency**	**Percentage**
Observed or experienced severe unexpected sickness requiring urgent attention		
Yes	250	47.7
No	274	52.3
During sickness, where do you/your relation go for care?		
Health centre	188	35.9
Hospital	207	39.5
Medicine store	64	12.2
Call emergency number	3	0.6
Nil	62	11.8
Who called the emergency number (n = 3)		

A friend/relative	3	100.0
Encounter when you observed or experienced a serious unexpected sickness requiring urgent attention (n = 250)		
Met health worker, received quick attention	207	82.8
Met health worker did not receive quick attention	26	4.9
Met health worker, patient sent away	2	0.4
Health centre/hospital locked	6	1.2
No response	9	54.0
How quickly the health facility responded to an emergency (n = 207)		
Immediately	81	39.1
Between 5 to 10 minutes	81	39.1
10 to 30 minutes	24	11.6
More than 30 minutes	14	6.8
Can't recall	7	3.4
Knowledge of any Emergency Medical Response team in the locality?		
Yes	55	10.5
No	452	89.5
State the time to get to you from their location (n = 55)		
1 – 10 minutes	3	5.5
11 – 20 minutes	12	21.8
21 – 30 minutes	10	18.2
Above 30 minutes	30	54.5
Knowledge of any phone number you can call in case of any life-threatening emergency		
Yes	110	21.0
No	414	79.0
Emergency numbers called		
Stated various private GSM nos	77	47.5
Nurse/Doctor/Health worker	78	48.2
Family member/relation	7	4.3
Can you give a cardiopulmonary resuscitation?		
Yes	187	35.7
No	337	64.3
Had any formal training in cardiopulmonary resuscitation (n = 187)		
Yes	143	76.5
No	44	23.5
Can anyone in your house perform CPR (n = 337)		
Yes	26	7.7
No	311	92.3

*** Response in times of sudden collapse**		
Carry out CPR	124	23.7
Rush to the hospital/health centre	205	39.1
Call for help/medical personnel	52	9.9
Increase ventilation	47	9.0
BLS	1	0.2
Prayer	1	0.2
Pour water on the body	26	5.0
Availability of medical ambulance in case of medical emergency		
Yes	71	13.5
No	453	86.5
Contact/phone no. (n = 71)		
Stated various private GSM nos	60	84.5
Do not have the number	11	15.5
Means of transportation to the health facility in case of emergency		
Walking	17	3.2
Bicycle	2	0.4
Motorcycle	172	32.8
Private vehicle	170	32.4
Commercial vehicle	125	23.9
Government ambulance	4	0.8
No response	34	6.8
Availability of Emergency medical response ambulance service in the locality		
Yes	73	13.9
No	451	86.1
Ownership of ambulance (n = 73)		
Government-owned	29	39.7
Private owned	44	60.3
Type of ambulance (n = 73)		
Bus	49	67.1
Keke	14	19.2
Others	10	13.7
How early does the EMR team respond to your emergency call (n = 73)		
Immediately (less than 10 minutes)	6	8.2
10 to 15 minutes	25	34.3
15 to 30 minutes	21	28.8
More than 30 minutes	15	20.5
Can’t recall	6	8.2
***Equipment contained in the ambulance (n = 73)**		

Oxygen supply	31	42.5
PPE	53	72.6
Trained driver	31	42.5
At least one trained medical personnel	19	26.0
AED	5	6.8
EMS guide book	6	8.2
Portable stretcher	33	45.2
Splints	7	9.6
Radio communication system	3	4.1
Automotive safety belt	10	13.7
Have you ever been taken to the hospital in an Ambulance?		
Yes	18	3.4
No	506	96.6
How clean was the ambulance? (n = 18)		
Very clean	2	11.1
Fairly clean	12	66.7
Not very clean	3	16.7
Don't know/can't remember	1	5.6
Did the ambulance come in a crew? (n = 18)		
Yes	14	77.8
No	4	22.2
***Members of the crew (n = 14)**		
Doctor	1	7.1
Nurse	7	50.0
Paramedics	14	100.0
Driver	1	7.1
Treated with respect and dignity by the crew? (n = 14)		
Yes, definitely	3	21.4
Yes, to some extent	7	50.0
Don't know/can't recall	4	28.6
Rate the care you received from the ambulance (n = 18)		
Very good	5	27.8
Good	7	38.9
Fair	6	33.3

**Multiple response type*

Figure 1 shows the availability of EMR ambulance services in the study area. It indicated that 59 (11.3%) of the participants reported EMR ambulance services, while 465 (88.7%) reported that no ambulance services were available in the study communities.

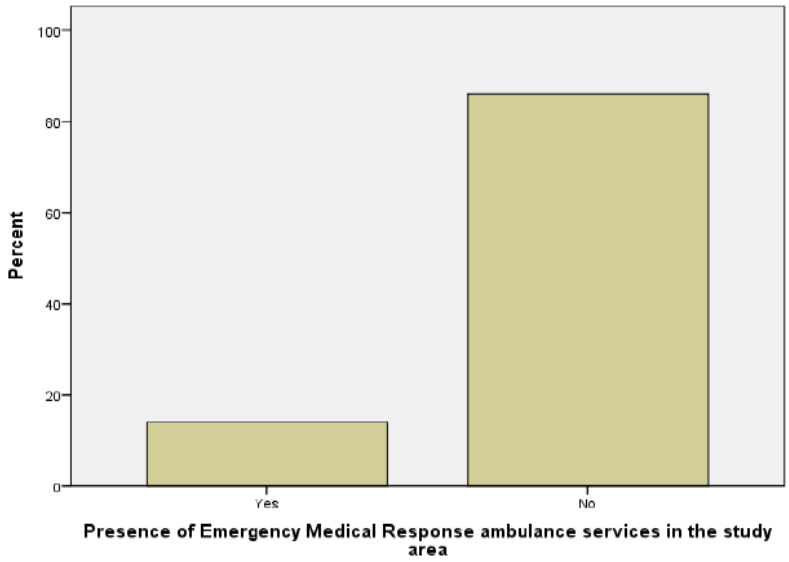


Figure 1. Availability of EMR ambulance services in the study area

Table 3 presents respondents' knowledge/previous training in Emergency Care. The highest proportion, 277 (52.9%), had previously participated in First Aid training, while 112 (21.4%) had participated in cardiopulmonary resuscitation training. Of the 112 respondents who self-reported CPR training, 73 (65.2%) had received it more than five years prior. Only 59 (11.3%) respondents had ever heard of an external defibrillator; among these, 83.1% had no AED available at their location.

Table 3. Knowledge/Previous Training on Emergency Care

Variable	Frequency	Percentage
***Training you have participated in:**		
First aid	277	52.9
CPR	112	21.4
Basic Life Support	59	11.3
Had training on Cardiopulmonary resuscitation?		
Yes	112	21.4
No	412	78.6
Date of last CPR training (n = 112)		
1 – 2 years	22	19.6
3 – 4 years	17	16.1
> 5 years	73	65.2
Have you heard of an Automated external defibrillator?		
Yes	59	11.3
No	465	88.7
State the nearest location to you: (n = 59)		
3 – 5 minutes away	10	16.9
None available around the location	49	83.1

**Multiple response*

Table 4 presents a contingency table illustrating the association between sociodemographic characteristics and CPR training among respondents. One-fifth of respondents (112, 21.4%) had received CPR training. The highest proportion of respondents who had received CPR training was from the Edo Central senatorial district, 34.6% (p<0.001). The highest proportion of respondents who had received CPR training lived in semi-urban communities (32.7%; p<0.001). The highest proportion of respondents who had received CPR training were male (30.2%; p < 0.001) and aged 46-60 years (41.0%; p < 0.001). The highest proportion of respondents who had received training in CPR had a tertiary level of education, at 28.4% (p < 0.001). Doctors and nurses were the occupational groups with the highest proportion of respondents who had received CPR training, at 48.4% (p < 0.001). These variables were significantly associated with respondents' previous training in CPR.

Table 4. Association between sociodemographic characteristics and training in CPR

Variable	Training in CPR		□2	Df	p-value
	Yes	No			
Senatorial zone					
Edo south	33 (17.0)	161 (83.0)	27.311	2	<0.001
Edo central	62 (34.6)	117 (65.4)			
Edo north	17 (12.2)	122 (87.8)			
Type of community					
Urban	26 (25.0)	78 (75.0)	34.235	2	<0.001
Semi-urban	68 (32.7)	140 (67.3)			
Rural	18 (9.0)	182 (91.0)			
Age group					
15 – 30	21 (17.1)	102 (82.9)	40.540	4	<0.001
31 – 45	36 (14.6)	210 (85.4)			
46 – 60	55 (41.0)	79 (59.0)			
61 – 75	0 (0.0)	8 (100.0)			
76 and above	0 (0.0)	1 (100.0)			
Sex					
Male	62 (30.2)	143 (69.8)	14.011	1	<0.001
Female	50 (16.3)	257 (83.7)			
Marital status					
Single	25 (18.0)	114 (82.0)	5.538	3	0.136
Married	84 (23.2)	278 (76.8)			
Separated/divorced	1 (12.5)	7 (87.5)			
Widow/widower	2 (66.7)	1 (33.3)			
Educational level					
No formal education	0 (0.0)	6 (100.0)	32.352	3	<0.001
Primary	2 (8.3)	22 (91.7)			
Secondary	6 (5.2)	110 (94.8)			
Tertiary	104 (28.4)	262 (71.6)			
Occupation					
Unemployed	1 (20.0)	4 (80.0)	71.387	10	<0.001

Civil servant	60 (39.2)	93 (60.8)			
Health worker	16 (18.8)	69 (81.2)			
Doctor/nurse	15 (48.4)	16 (51.6)			
Self-employed	3 (2.5)	115 (97.5)			
Student	13 (16.3)	67 (83.8)			
Teacher	3 (14.3)	18 (85.7)			
Engineer	0 (0.0)	5 (100.0)			
Accountant	0 (0.0)	1 (100.0)			
Electrician	0 (0.0)	1 (100.0)			
Others	1 (8.3)	11 (91.7)			

Table 5 is a contingency table illustrating the relationship between social-statistical characteristics and the ability of respondents to perform CPR. One hundred and eighty-seven respondents (35.7%) self-reported their ability to perform CPR. Proportionally more of the respondents (53.1%; p<0.001) from Edo Central could perform CPR, proportionally more of the respondents in a semi-urban community (50.5%; p<0.001) could perform CPR, proportionally more of the respondents (45.6%; p<0.001) with tertiary level of education can perform CPR, and as expected, more of the doctors/ nurses (74.2%; p<0.001) can perform CPR. These variables were significantly associated with respondents' ability to perform CPR.

Table 5. Association between sociodemographic characteristics and ability to perform CPR

Variable	**Ability to perform CPR**		**□2**	**df**	**p-value**
	Yes	**No**			
Senatorial zone					
Edo south	64 (33.0)	130 (67.0)	43.526	2	<0.001
Edo central	95 (53.1)	84 (46.9)			
Edo north	28 (18.5)	123 (81.5)			
Type of community					
Urban	41 (39.4)	63 (60.6)	47.680	2	<0.001
Semi-urban	108 (50.5)	106 (49.5)			
Rural	38 (18.4)	168 (81.6)			
Age					
15 – 30	43 (34.4)	82 (65.6)	12.901	4	0.012
31 – 45	81 (32.0)	172 (68.0)			
46 – 60	63 (46.0)	74 (54.0)			
61 – 75	0 (0.0)	8 (100.0)			
76 and above	0 (0.0)	1 (100.0)			
Sex					
Male	69 (32.5)	143 (67.5)	1.529	1	0.216
Female	118 (37.8)	194 (62.2)			
Marital status					

Single	47 (32.9)	96 (67.1)	6.607	3	0.086
Married	138 (37.3)	232 (62.7)			
Separated/divorced	0 (0.0)	8 (100.0)			
Widow/widower	2 (66.7)	1 (33.3)			
Educational level					
No formal education	0 (0.0)	6 (100.0)	55.684	3	<0.001
Primary	2 (8.0)	23 (92.0)			
Secondary	15 (12.5)	105 (87.5)			
Tertiary	170 (45.6)	203 (54.4)			
Occupation					
Unemployed	1 (20.0)	4 (80.0)	113.349	10	<0.001
Civil servant	71 (45.8)	84 (54.2)			
Health worker	51 (60.0)	34 (40.0)			
Doctor/nurse	23 (74.2)	8 (25.8)			
Self-employed	7 (5.6)	117 (94.4)			
Student	31 (37.8)	51 (62.2)			
Teacher	2 (8.7)	21 (91.3)			
Engineer	0 (0.0)	5 (100.0)			
Accountant	0 (0.0)	1 (100.0)			
Electrician	0 (0.0)	1 (100.0)			
Others	1 (8.3)	11 (91.7)			

Discussion

Like other developing nations worldwide, EMS in Nigeria are at various stages of development, with multiple institutions continually making efforts to improve their quality of service, a position affirmed by Blackwell and Kaufman [24].

For efficient and effective emergency preparedness and response, there must be a multifaceted and concerted effort in addressing the identified issues, which, among others, include delayed Response, poor funding, poor communication/ information sharing, insecurity, bad roads, inadequate infrastructure like ambulances, dilapidated primary health care centres, and lack of training.

EMR team/call number: Over three-quarters of the participants stated that they were neither aware of any emergency medical response team in their locality nor knew a number to call in the event of a medical emergency. The research shows that fewer than 1% of respondents call the emergency number. It was also noted that less than ten per cent of the respondents call for help during medical emergencies, which is fundamental to saving lives. Raising public awareness about the emergency call numbers 112 and 739 is crucial for having a functional emergency preparedness and response system.

EMS response time: Over three-quarters of the time, the response time was over 10 minutes. It was only 5.5% of the time that EMS responses were less than 10 minutes. This was far below the average response time in advanced nations, which was about 7 minutes in urban settings and 14 minutes in rural settings in previous studies [11, 12].

Ambulance services: Over eighty per cent of the respondents reported the non-availability of ambulance services in their community. Among those that reported available ambulances, private GSM numbers were utilized to call for help. It was also noted that over half of the respondents used motorbikes or private vehicles to reach a health facility during a medical emergency. It is also noteworthy that the ambulances lack a mobile intensive care unit, a communication system, and other essential equipment. Most of the 'keke napep' ambulances supplied by the Government are currently moribund and non-functional, and are often dumped in the various council secretariats. These are issues that require urgent attention for a smooth and efficient emergency response.

Training: Slightly over half of the respondents had prior first-aid training, and about one-fifth had received CPR training in the last 2 years. Most of these recertification training sessions on emergency Medicare should be routinely carried out every two or three years to ensure an effective and efficient emergency medical response system.

Associations: It was observed that among the respondents, the most significant proportion of those with CPR training resided in the Edo Central Senatorial District, were from semi-urban communities, and had tertiary education, with the majority being doctors or nurses. The location of Irrua Specialist Teaching Hospital (ISTH) in the Edo Central senatorial region could have influenced the outcome, though no previous data substantiated it. Most communities around ISTH are mainly semi-urban. This underscores the importance of regular training for health workers on BLS, CPR, and ACLS, as it will significantly enhance prompt, efficient, and effective EMS services and preparedness within the Edo state health system.

Sustainability: There needs to be a strong advocacy for the government to provide regular training and retraining of EMS first responders. There should also be routine facility assessment and upgrades, along with improved budgetary allocation.

Conclusion/ Recommendation

1. Over three-quarters of the respondents stated there was no Emergency Medical Response team or an emergency number to call. To this end, the Government should set up an urgent Emergency Medical Response centre in every local Government of the state and carry out mass awareness campaigns regarding their functionality.
2. Over four-fifths of the respondents stated that neither medical ambulance services nor AEDs were available in their communities. Therefore, the Government should provide adequate ambulances and AEDs across the state and equally ensure they are decentralized and strategically positioned to respond promptly to medical emergencies.
3. The factors stipulated by the respondents/participants that caused delays in EMR included women waiting for approval from their spouses before seeking medical attention, poor road conditions, the non-availability of medical ambulances, the dilapidated state of most PHC centres, inadequate budgetary allocation to health, and insufficient funding. Others include poor resource management, untrained medical personnel, and a negative attitude among staff toward clients. Therefore, the Government should ensure that there are motorable roads, that PHC centres are rehabilitated and equipped with state-of-the-art facilities, and that adequate funding is available for medical emergencies.
4. More than three-quarters of the participants stated the EMS response time was over 10 minutes. There is an urgent need for government and healthcare institutions to reduce EMS response times and waiting times in emergency rooms. This can be achieved through continuous training of first responders and by establishing triage stations in large healthcare institutions.

5. Slightly more than one-third of the respondents could perform CPR. Among these numbers, about three-quarters had prior CPR training. Therefore, the Government needs to empower the Primary Health Care Development Agency to conduct routine training and retraining of all healthcare workers in first aid, CPR, BLS, and ACLS.

6. There was a strong association between the ability to give CPR and previous training among the respondents. About nine out of every ten with previous CPR training could render CPR during an emergency.

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Conflicts of Interest

I, Dr Charles Okpere, hereby state that there were no conflicts of interest while conducting this research.

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Decade of Progress: Trends in Key Maternal Health Performance Indicators in The Gambia

Joy Michael[1*], Abiodun Olaiya Paul[2**] and Armanda Nangmo[3]
[1]*United Nations Population Fund, Banjul, The Gambia*
[2]*Texila America University, Guyana, South America*
[3]*Gender Information Management Systems_GMIS, Banjul, The Gambia*

Abstract

Maternal health remains a pressing public health challenge in The Gambia, where maternal mortality rates have historically exceeded 300 deaths per 100,000 live births. Despite national efforts and global partnerships aligned with Sustainable Development Goal (SDG) 3.1, which aims to reduce maternal mortality to below 70 per 100,000 live births by 2030, significant disparities persist. This study, Decade of Progress: Trends in Key Maternal Health Performance Indicators in The Gambia, evaluates the effectiveness of community-based maternal health interventions implemented between 2010 and 2020. Employing a retrospective quasi-experimental design and secondary data analysis, the study focuses on eight key regions—Banjul, Kanifing, Brikama, Mansakonko, Kerewan, Kuntaur, Janjanbureh, and Basse—selected for their diverse socioeconomic profiles and disparities in healthcare access. Quantitative data were supplemented with qualitative insights from structured questionnaires and hospital interviews. Findings reveal substantial improvements in maternal health indicators. Health facility births increased across all ethnic groups. Skilled birth attendance rose from 57% to 84%, traditional birth attendant involvement declined sharply from 26.96% to 6.73%, reflecting a shift toward professionalized care but postnatal care coverage improved. These trends suggest that the deployment of community health workers and traditional birth attendant training, have contributed to improved maternal health outcomes, although disparities still persist. This study provides actionable insights for policymakers, healthcare providers, and researchers, emphasizing the need for inclusive strategies and data-driven planning to reduce maternal mortality further and enhance maternal care in The Gambia.

Keywords: *Antenatal Care, Maternal Health, Maternal Mortality, Postnatal Care, The Gambia.*

Introduction

Maternal and child health remains a fundamental cornerstone of sustainable development and public health in any nation, especially in developing countries, where morbidity and mortality rates remain unacceptably high [1]. Despite substantial national efforts, global partnerships, and the existence of strategic frameworks, the health outcomes for mothers and children in most developing countries have been largely unsatisfactory [2]. These disparities reflect deep-rooted systemic challenges, including inequitable access to health services, socio-cultural barriers, poor funding, and inadequate infrastructure [3]. The Sustainable Development Goals (SDGs), established in 2015 by the United Nations, represent a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity [4]. Specifically, SDG 3.1

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Corresponding Author: Michael.ukwojoy@yahoo.com; drabiodunop@gmail.com

aims to reduce the global maternal mortality ratio (MMR) to less than 70 per 100,000 live births, while SDG 3.2 focuses on ending preventable deaths of newborns and children under five by 2030 [5]. The Gambia, as a signatory to the SDGs and a member of the United Nations, is expected to align its national development policies and health programming with these global targets [6].

With the highest maternal death rate of 597/100,000 as of 2017, The Gambia is rated 13th [7]. The World Health Organisation (WHO) estimates that in 2017, there were around 430 maternal deaths for per 100,000 live births, which is a high rate historically [8]. This number underscores the urgency of effective measures. A hospital-based retrospective analysis also found that there were about 700 maternal deaths over the course of eight years, with a significant burden of new-born hospitalisation and an annual death rate ranging from over 1400 to 2100 deaths per 100,000 live births [9, 10]. According to the NDP of 2018 – 2021, the Gambia government set a goal in 2017 to lower maternal and neonatal mortality from 433 to 315 per 100,000 people nationwide by 2021 [11]. Over the past ten years, The Gambia has seen significant advancements and programs aimed at enhancing maternal health through community-based interventions, as published in its Demographic Health Surveys. Data for a variety of monitoring and effect evaluation indicators in the fields of population, health, and nutrition are provided by the nationally representative Demographic and Health Surveys (DHS), which are household surveys. Using Key Performance Indicators (KPIs) as recorded in the DHS, shows the impact and efficacy of these important initiatives from 2010 to 2020 will be the main focus of this endeavour [12].

The study aims to evaluate community-based maternal health interventions in The Gambia between 2010 and 2020 using the trends in key maternal health performance indicators in The Gambia. This study examines the trends in maternal mortality across various data sources. It evaluates the impact of maternal healthcare utilization, focusing on the effectiveness of interventions based on available data. This study can provide valuable insights and benefits across various stakeholders such as researchers, practitioners, patients and policy-makers. Researchers, practitioners, and policymakers can utilize the findings of the study to improve maternal and child health care by enhancing their ante-natal care (ANC) and post-natal care (PNC) services. This is so because improved service delivery ensures the realization of the best care for pregnant women, thereby reducing the risks of morbidity and mortality.

Methodology

Research Design and Site

This study assessed community-based maternal health interventions in The Gambia using a retrospective quasi-experimental design and secondary data analysis. The Demographic and Health Surveys (DHS) from 2013 and 2019–2020 provided data, and structured questionnaires and hospital interviews provided qualitative insights. There are about 2,779,799 million people living in the Gambia, [13] and 101,262 births each year from [14]. The following locations as documented in the DHS were considered in the present study: Banjul, Kanifing, Brikama, Mansakonko, Kerewan, Kuntaur, Janjanbureh and Basse. According to [6], there are more than 120 healthcare facilities in these locations. The Ministry of Health oversees the management of these medical institutions and ensures they offer crucial maternal health services. With a reported maternal mortality ratio of over 300 deaths per 100,000 live births as of 2020, maternal health is still a major public health concern in The Gambia [15]. This statistic emphasises how urgently effective initiatives are needed to lower maternal fatalities.

Increasing access to competent care during childbirth has been made possible by the

training and deployment of Community Health Workers (CHWs) and traditional birth attendants (TBAs), two of the most popular community-based maternal healthcare interventions [17]. The study will focus on community-based medical facilities in a few selected urban and rural areas of The Gambia. Because of their varied socioeconomic environments and disparities in access to medical care, these regions have been recognized as crucial locations for maternal health interventions. This study attempts to present a comprehensive picture of how well community-based interventions work to improve maternal health outcomes in The Gambia by combining quantitative data from DHS with qualitative insights from community interactions.

Sampling Technique and Sample Size

Sampling Technique

To analyze trends in key maternal health indicators in The Gambia between 2010 and 2020, data from the Demographic and Health Surveys (DHS) conducted in 2013 and 2019-2020 were used to assess the performance of health facilities in The Gambia.

Data Collection

Available data on trends in KPIs for Maternal Health in The Gambia were collected from published DHS 2013 and 2019/2020 reports. They are on the following aspects: 1) Trends in antenatal care coverage, 2) Trends in place of birth, 3) Trends in Health facility births by Local Government Area (LGA), 4) Trends in Assistance during delivery, 5) Delivery by Caesarean Section and 6) Postnatal Coverage. To avoid using direct images from the document, data extraction were entered into Microsoft Excel and graphs plotted.

Data Analysis

Data collected in this study were already calculated percentages, hence they were just plotted directly into charts for both years:

1. Antenatal Care Coverage.
2. Number of antenatal care visits and timing of first visit.
3. Component of Antenatal Care.
4. Number of Tetanus Toxoid Injections.
5. Assistance During Delivery.
6. Type of Provider of Postnatal check for the mother.
7. Problems in Accessing Health care in both 2013 and 2019 DHS.

Inclusion

Demographic Health Survey (DHS) in The Gambia within the timeframe of this study (2010 - 2020) were used and it is worthy to note that they were collected in 2013 and 2019/2020.

Exclusion

DHS data was collected outside the selected timeframe of the study.

Expected Outcomes

This study is expected to identify the key factors contributing to the reduction in maternal mortality in India, highlighting the impact of public health interventions, and identifying areas where further improvements are necessary to meet national and global targets for maternal health.

Results

Figure 1 shows the trends in antenatal care coverage in The Gambia, comparing data from 2013 and 2019/2020. As shown in the figure, slight improvement was observed in first-trimester ANC attendance, increasing from 37.65% to 42.74%, suggesting that more women sought early pregnancy care. The percentage of women attending four or more ANC visits showed minimal improvement, rising slightly from 77.64% to 78.48%, indicating consistent utilization of multiple ANC services over time. More so, significant progress was recorded in women receiving ANC from skilled providers, which increased substantially from 86.44% to 97.8%, representing an 11.36% improvement

indicating that more pregnant women received care from qualified healthcare professionals. The percentage of births protected against neonatal tetanus decreased from 41.54% to 35.36%, a decline of 6.18%.

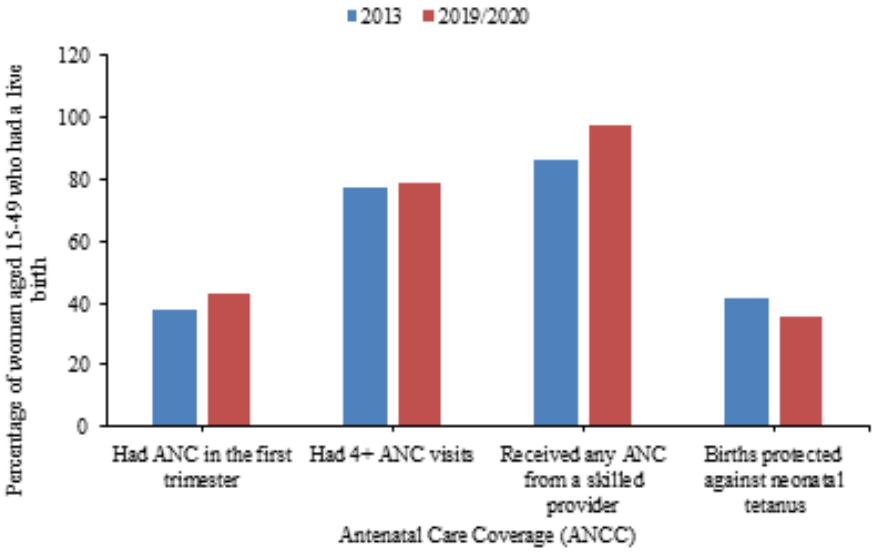


Figure 1. Trends in Antenatal Care Coverage (The ANC) [14, 30]

A total of live births across various Local Government Areas (LGAs) were analyzed for the percentage delivered in health facilities for 2013 and 2019/2020. There was a significant increase in health facility births in all LGAs from 2013 to 2019/2020. The Mandinka/Jahanka region increased from 60.89% to 85.76%, Wollof from 64.47% to 85.45%, and Jola/Karoninka from 73.67% to 86.36%. The Fula/Tukular/Lorobo region increased from 55.04% to 77.44%, while Serere improved from 75.78% to 92.50%. Serahuleh also showed a higher increase from 46.68% to 85.00%. The Creole/AkuMarabout group had the lowest value of 19.90% in 2013, but rose to 90.82% in 2019/2020. Manjago reached 100% of health facility births in 2019/2020, up from 58.53% in 2013. Bambara increased from 69.92% to 89.71%, and the "Others" category rose from 75.22% to 95.96%. Non-Gambian births also increased from 71.42% to 79.33%. These results indicate significant improvements in health facility delivery rates across all LGAs over the period studied.

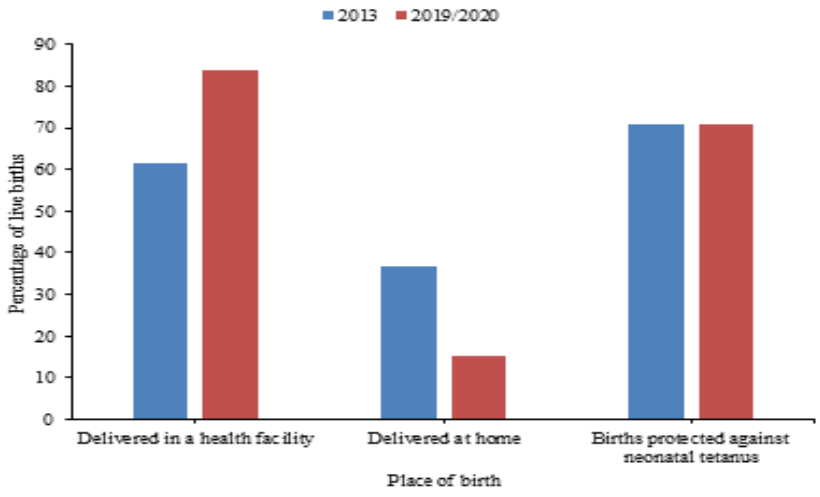


Figure 2. Trends in Place of Birth (Facility-Based Delivery) [14, 30]

Between 2013 and 2019/2020, health facility births increased substantially across all Local Government Areas (LGAs) in The Gambia. The Mandinka/Jahanka region saw an increase from 60.89% to 85.76%, Wollof from 64.47% to 85.45%, and Jola/Karoninka from 73.67% to 86.36%. Fula/Tukular/Lorobo rose from 55.04% to 77.44%, Serere from 75.78% to 92.50%, and Serahuleh from 46.68% to 85.00%. The Creole/AkuMarabout group showed a dramatic increase from 19.90% to 90.82%, while Manjago increased from 58.53% to 100%. Bambara increased from 69.92% to 89.71%, and the "Others" category rose from 75.22% to 95.96%. Non-Gambian births increased from 71.42% to 79.33%.

Improvement in first-trimester ANC attendance from 37.65% to 42.74% shows a critical advancement in early pregnancy care initiation, though it remains below the WHO recommendation that all pregnant women should receive their first ANC visit within the first trimester. This finding is consistent with systematic reviews by Moller et al. (2017) and Benova et al. (2018), which demonstrated that while ANC coverage has improved across sub-Saharan Africa, early initiation remains challenging due to cultural beliefs, geographical barriers, and limited awareness of pregnancy danger signs. The Gambian experience mirrors trends observed in neighboring West African countries, where Countdown to 2030 reports indicate that first-trimester ANC attendance averages 45% across the region (Victora et al., 2021).

Table 1. Health Facility Births by Local Government Area (LGA) – Number of Deliveries per Region

Regions	**Percentage of live births in the 5 years before the survey that were delivered in a health facility**	
	2013	**2019/2020**
Mandinka/Jahanka	60.89%	85.76%
Wollof	64.47%	85.45%
Jola/Karoninka	73.67%	86.36%
Fula/Tukular/Lorobo	55.04%	77.44%
Serere	75.78%	92.50%
Serahuleh	46.68%	85.00%
Creole/AkuMarabout	19,90%	90.82%
Manjago	58.53%	100%
Bambara	69.92%	89.71%
Others	75.22%	95.96%
Non-Gambian	71.42%	79.33%

Source: [14, 30]

Between 2013 and 2019/2020, the percentage of births assisted by doctors in The Gambia increased slightly from 7.03% to 10.90%. Births attended by nurses or midwives rose substantially from 50.15% to 72.95%, reflecting the majority of skilled birth assistance. Assistance by auxiliary nurses or community nurse attendants decreased markedly from 6.87% to 0.87%. Traditional birth attendants' involvement declined significantly from 26.96% to 6.73%. Births assisted by relatives or others decreased from 6.79% to 5.54%. The proportion of births with no assistance increased slightly from 1.72% to 3.02%. Cases reported as "don't know" or missing dropped from 0.48% to 0.00%. Skilled birth attendance increased from 57% in 2013 to 84% in 2019/2020, with nurses and midwives being the primary providers of delivery care.

Table 2. Assistance during Delivery – Skilled Birth Attendance (SBA)

Regions	**Percentage of live births in the 5 years before the survey Those were delivered in a health facility**	
	2013	**2019/2020**
Doctor	7.03%	10.90%
Nurse/ Midwife	50.15%	72.95%
Auxiliary nurse/ Community nurse attendant	6.87%	0.87%
Traditional birth attendant	26.96%	6.73%
Relative/ other	6.79%	5.54%
No one	1.72%	3.02%
Don't know/Missing	0.48%	0.00%

Source: [14, 30]

Figure 3 presents the trends in caesarean section deliveries and postnatal coverage in The Gambia, comparing data from 2013 and 2019/2020. The findings showed an increase in caesarean section rates, rising from 2.0% to 3.69%, representing an 84.5% relative increase. Furthermore, postnatal coverage improved substantially, rising from 76.0% to 88.0%, indicating a 12% increase in women receiving critical postpartum care.

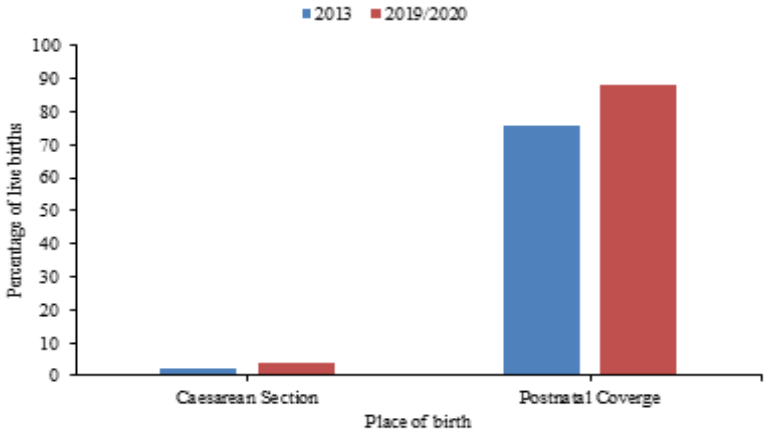


Figure 3. Trends in Delivery by Caesarean Section and Postnatal Coverage [14, 30]

Discussion

The increase in ANC provision by skilled providers from 86.44% to 97.8% represents an exceptional achievement, surpassing WHO benchmarks and exceeding performance in many comparable low- and middle-income countries. This 11.36% improvement suggests successful implementation of health system strengthening initiatives, particularly in rural areas where traditional birth attendants previously dominated maternal health service provision. Similar improvements have been documented in Ghana and Rwanda, where systematic investments in midwifery training and deployment resulted in comparable skilled provider coverage rates [17, 18]. However, the concerning decline in neonatal tetanus protection from 41.54% to 35.36% warrants immediate attention. This reduction contradicts global efforts to eliminate maternal and neonatal tetanus and suggests gaps in immunization program implementation or supply chain management. The decline is particularly troubling given the emphasis placed on tetanus toxoid vaccination by the WHO, as a cost-effective maternal health

intervention with significant neonatal mortality reduction potential [19].

The COVID-19 pandemic has substantially impacted and disrupted the delivery of essential Reproductive, Maternal, Newborn, Child, and Adolescent Health and Nutrition (RMNCAH + N) services [20]. The recommendation to curb the pandemic restricts travel and urges people to stay home. Disruptions have occurred across various levels of healthcare delivery, affecting service utilization and accessibility. Thus, enforcement of these measures has posed unprecedented difficulties for many vulnerable women accessing health services. In the present study, improvements in health facility delivery rates across all ethnic groups and Local Government Areas represent perhaps the most significant achievement documented. The universal increase from ranges of 19.90% to 100% (Creole/AkuMarabout and Manjago groups, respectively) shows successful implementation of facility-based delivery promotion strategies. These improvements exceed those documented in most sub-Saharan African countries and align with success stories from Ethiopia and Rwanda, where focused government policies and community mobilization achieved similar transformations [21, 18]. The particularly impressive improvement in the Creole/AkuMarabout group from 19.90% to 90.82% suggests that targeted interventions can overcome initial barriers to facility-based delivery, even among populations with historically low utilization rates. This finding supports the theoretical frameworks proposed by [22] regarding the modifiability of healthcare utilization patterns through appropriate interventions that address predisposing, enabling, and need factors.

An increase in skilled birth attendance from 57% to 84% represents substantial progress toward universal skilled birth attendance, though it remains below the 90% target established in the Global Strategy for Women, Children, and Adolescents' Health [23]. The shift from traditional birth attendants (26.96% to 6.73%) to nurses and midwives (50.15% to 72.95%) reflects the successful implementation of evidence-based maternal health policies emphasizing skilled birth attendance as a critical intervention for reducing maternal and neonatal mortality. This transformation aligns with findings from systematic reviews demonstrating that countries achieving significant reductions in maternal mortality consistently prioritized improvements in skilled birth attendance [24, 25]. However, the slight increase in births with no assistance (1.72% to 3.02%) suggests persistent access barriers for the most marginalized populations, consistent with equity concerns documented across sub-Saharan Africa [26].

The increase in caesarean section rates from 2.0% to 3.69%, while representing an 84.5% relative increase, maintains The Gambia within the WHO's recommended range of 5-15% for population-based caesarean section rates. This increase suggests appropriate clinical decision-making rather than the concerning trend toward unnecessary caesarean sections documented in middle-income countries [27]. The rate remains consistent with other low-income countries in sub-Saharan Africa, where caesarean section rates typically range from 2-8% [28]. Similarly, improvement in postnatal coverage from 76.0% to 88.0% represents significant progress toward comprehensive maternal health service provision. This improvement exceeds achievements documented in many comparable countries and approaches WHO recommendations for universal postnatal care coverage [29]. The finding agrees with evidence demonstrating that postnatal care represents a critical window for preventing maternal and neonatal complications, yet remains the most neglected component of the maternal health continuum.

Findings from this study showed significant improvements in key maternal health indicators in The Gambia The Gambia between 2013 and 2019/2020, demonstrating substantial progress toward achieving Sustainable between 2013

and 2019/2020, demonstrating significant progress toward achieving Sustainable Development Goal 3.1, which aims to reduce global maternal mortality ratio to less than 70 per 100,000 live births by 2030. The observed trends align with broader regional improvements documented across sub-Saharan Africa, though the trajectory from The Gambia shows both convergence with and divergence from continental patterns. All the progress toward decreasing the MMR has to be revised and revamped. The need to ensure convergence among stakeholders when structuring maternal health policies to enable effective health reforms at all levels of health care.

Conclusion

This research evaluated maternal and child health trends in The Gambia between 2010 and 2020, focusing on progress toward Sustainable Development Goals (SDGs) 3.1 and 3.2. By comparing data from The Gambia Demographic and Health Surveys (DHS) 2013 and 2019/2020, augmented with qualitative analysis, the study provides empirical and thematic perspectives on maternal and child health outcomes. Two key objectives guided the research: evaluating trends in antenatal care (ANC) and skilled birth attendance (SBA), which serve as vital markers of health system effectiveness, equity, and accessibility. Quantitatively, findings show modest but positive progress across multiple indicators. Increasing community awareness, improved child health interventions, and scaled-up immunization efforts contributed to these gains. The proportion of women attending four or more ANC visits increased, while skilled birth attendance improved, indicating greater advances in institutional delivery in rural areas. Qualitative analysis revealed deeper systemic challenges through four major themes: geographic and infrastructural access, socioeconomic constraints, community trust and service engagement, and program implementation gaps. Long travel distances, poor road networks, and dysfunctional referral systems created barriers, particularly in rural areas. Socioeconomic challenges, including poverty, out-of-pocket costs, and food insecurity, prevented timely care access. Hidden costs such as transportation and facility fees served as deterrents despite theoretically "free" services. The study highlighted that technical fixes alone are insufficient. Maternal and child health outcomes are deeply influenced by social determinants including education, gender equity, and household income. Addressing these requires cross-sectional collaboration with education, agriculture, and social protection programs. While The Gambia demonstrates progress, it remains off-track in meeting the SDGs. In conclusion, this study presents a mixed picture. Meaningful progress is evident through improvements in child mortality, ANC coverage, and service utilization. However, insufficient pace and persistent regional, socio-economic, and systemic disparities undermine progress. Success requires strengthening health system functions while building trust and accountability.

Ethical Considerations

This study does not require direct interaction with human participants; instead, it focuses on secondary data analysis. However, written consent from the WHO Country Office, the Ministry of Health in The Gambia, the Bureau of Statistics, and pertinent NGOs will be required before any data may be used. The relevant Ethics Committee in The Gambia will provide ethical approval for the qualitative component, which includes group discussions and hospital interviews. Strict confidentiality will be guaranteed. Hard copies will be kept under lock and key, and all digital material will be stored on a password-protected computer.

To maintain anonymity, codes will be used in place of identifying information throughout analysis. The results will be disseminated to pertinent parties while protecting the privacy of

the data sources. Participants in the trial face little danger. The results will be disseminated to relevant parties while preserving the privacy of the data sources. Any possible conflicts of interest will be disclosed and handled correctly.

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Conflict of Interest

The authors declare no conflict of interest.

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Exploring Sociocultural and Familial Dimensions of Postnatal Depression in Southwestern Nigeria: A Mixed-Methods Perspective

Adeola Oluwatobi Aminu[1*], Wakili Adelani Tijani[2], Olalekan Amos Oladejo[3], Michael Oloyede Oladeji[4], Fatimah Omobolanle Azeez[5], Doubra Aanuoluwapo Onoviron[6]

[1]*Department of Public Health, Texila American University, Georgetown, Guyana, United Kingdom*
[2]*Department of Nursing, Federal University of Technology Oye-Ekiti, Nigeria.*
[3]*Department of Nursing, Liverpool John Moore's University, United Kingdom*
[4]*Department of Nursing, Ajayi Crowther University, Oyo State, Nigeria*
[5]*School of Nursing, University College Hospital Ibadan, Nigeria*
[6]*Department of Public Health, Liverpool John Moore's University, United Kingdom*

Abstract

Postnatal depression (PND) has emerged as a significant public health issue, affecting individual health, family cohesion, and child development. This study investigated the societal and familial dimensions of postpartum depression among parents in Southwestern Nigeria through a mixed-methods approach. Quantitative data were collected from 200 respondents (113 women and 87 men) using stratified random sampling, while qualitative insights were derived from 8 focus group discussions, 4 for men and 4 for women. The Edinburgh Postnatal Depression Scale (EPDS) was utilised for screening, and thematic analysis guided the qualitative interpretation. Quantitative findings revealed that 29.6% of participants met the criteria for probable depression with a higher frequency in females (34.5%) than in males (24.1%). The qualitative findings revealed four primary themes: cultural stigma and emotional silence, maternal guilt and unrealistic expectations, family-role conflict, and inadequate social support. The integration of data indicated that patriarchal norms, gendered expectations, and insufficient mental health literacy intensify vulnerability to depression. The study shows that gender-sensitivity and family-centred interventions are essential for the prompt recognition and treatment of postpartum depression within Nigeria's postnatal care system.

Keywords: *Family Dynamics, Gender, Mixed Methods, Nigeria, Postnatal Depression, Sociocultural Factors.*

Introduction

Global and African Context

Postnatal depression (PND) is a prevalent, although frequently neglected, mood illness that manifests within the initial year following childbirth. It affects about one in five moms around the world, but new research shows that fathers are equally at risk [1]. The World Health Organisation (WHO) now identifies mother and paternal depression as key determinants impacting family and child health, leading to repercussions such as disturbed bonding and worse cognitive outcomes for children [2, 3]. In high-income nations, improvements in screening and psychosocial support have led to earlier detection. However, in low- and middle-income countries (LMICs), the burden remains disproportionately high, with prevalence rates of 25%-40% [4, 5]. Poverty, poor access to healthcare, gender inequity, and cultural stigma

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****Corresponding Author: adeolaaminu95@gmail.com***

together exacerbate risk and impede the pursuit of care—gender and Sociocultural Aspects.

Gender and Sociocultural Dimensions

Gender norms significantly influence the manifestation and management of postpartum depression (PND). In the context of parenthood, women's depressive symptoms are frequently normalised, but men's emotional challenges are generally suppressed due to cultural norms that emphasise strength and stoicism [6, 7]. Research conducted in Asia and Africa indicates that men's postnatal depression, although frequently overlooked, can profoundly affect familial relationships and child development [4]. Sociocultural conceptions and familial roles significantly shape African contexts, where delivery is a collective event linked to social status and religious obligations. Emotional difficulties are often ascribed to spiritual factor, hence reducing psychological interpretations [8]. Stigma hinders transparent communication and obstructs the pursuit of assistance.

The Nigerian Perspective

In Nigeria, PND is still not being identified or reported enough, even though there is a lot of evidence that it happens more often than it should. Public health services primarily focus on physical and obstetric outcomes, significantly neglecting psychological dimensions. Prior studies have established a connection between maternal anxiety and factors such as low income, marital discord, and inadequate social support [10, 17]. Nevertheless, there is a lack of comprehensive information elucidating how cultural and familial factors exacerbate these experiences for both mothers and fathers.

Theoretical Framework

This research is based on Family Systems Theory, which asserts that individuals function as interdependent entities within a family; distress in one person influences the entire system [11]. Social Relations Theory elucidates how power dynamics and role expectations shape coping techniques. They view PND as a relational phenomenon situated within gendered societal frameworks rather than as an individual disorder.

Objectives of the Study

The study sought to investigate the sociocultural and familial determinants affecting postpartum depression (PND) in Southwestern Nigeria through a mixed-methods framework to:

1. Quantitatively assess the gender-specific prevalence of PND.
2. Qualitatively discern sociocultural and familial influences on depressive experiences.
3. Synthesise both aspects to recommend culturally appropriate strategies for prevention and care.

Materials and Methods

Study Design

A sequential explanatory mixed-methods design was utilised. Quantitative data collection occurred before qualitative analysis to enhance the contextualisation and comprehension of statistical results.

Research Setting

The research took place in Adeoyo maternity teaching hospital in Ibadan, Oyo State, Nigeria, which is a city with a wide range of socioeconomic status. This teaching hospital provides postnatal care, family planning services, and vaccination services.

Sampling and Respondent Selection

The quantitative phase utilised a stratified random sampling method to guarantee fair gender representation. We identified the parents of babies aged 0-6 months from the clinic records and sorted them by gender. Balloting was used to choose participants from each stratum until 113 mothers and 87 fathers had signed up.

Inclusion criteria: people must be biological parents of babies aged 0-6 months, living in Ibadan, and fluent in either English or Yoruba.

Exclusion criteria: Parents with diagnosed psychiatric illnesses or recent child loss were excluded.

During the qualitative phase, purposive sampling facilitated the selection of participants for eight focus group discussions (FGDs); 4 with males and 4 with females. Sampling persisted until topic saturation was attained.

Data Collection Instruments

The Edinburgh Postnatal Depression Scale (EPDS) was employed to assess depressive symptoms. The EPDS has been validated in Nigeria and internationally with cut-off scores above 13 signifying probable depression [12]. The instrument underwent translation and subsequent back-translation into Yoruba to guarantee linguistic precision. We used semi-structured guides to acquire qualitative data on views of depression, cultural beliefs, family ties, and ways of coping. Interviews were audio-recorded with consent and conducted in secluded settings to maintain confidentiality.

Data Collection Procedures

Three days of instruction on ethical conduct, relationship-building, and neutrality in interviews were provided to research assistants who spoke both English and Yoruba. To clarify, the interviewers and participants were the same gender. The data collection phase lasted eight weeks. Transcripts were made word-for-word, checked for accuracy, and, as needed, translated into English.

Data Analysis

We used SPSS v25 to analyze quantitative data using descriptive and inferential statistics (χ^2 and t-tests). Qualitative data were processed manually with Braun and Clarke's six-phase theme analysis framework [13].

Coding utilised both inductive and deductive reasoning. A composite display matrix was used to combine quantitative and qualitative results. It showed where data threads converged and diverged.

Reliability and Precision

Data source triangulation, longer interaction, and member validation all helped to make the information more credible. Maintaining an audit trail of field notes and coding decisions ensured the work was reliable. Peer debriefing with a qualitative research mentor facilitated confirmability.

Ethical Approval

The study was conducted in accordance with the most stringent ethical standards to guarantee the respect, dignity, and protection of all participants. In accordance with the Universal Declaration of Human Rights, the International Code of Medical Ethics, and the WHO Ethical Guidelines for Health Research, ethical sanction was obtained from the Oyo State Ministry of Health Ethical Review Committee (Ref No: MOH/OY/2024/071). The purpose, procedures, potential hazards, and benefits of the study were fully disclosed to all participants. Prior to participation, written informed assent was obtained, and information sheets were distributed in both English and Yoruba to guarantee comprehension. Respondents were guaranteed the right to withdraw at any point without incurring any penalties, and participation was entirely voluntary. Anonymity and confidentiality were rigorously upheld. All identifiable data was eliminated from the records and substituted with codes. Hard copies were securely stored, and all electronic data was password-protected. To prevent identification, transcripts and quotations were anonymised. Participants were treated with empathy, and those who demonstrated distress were informed about available counselling and referral services, as postnatal depression is an emotionally sensitive condition. The investigation refrained from employing any form of coercion, deception, or

undue influence. Data security and integrity were prioritised throughout the research process. After completion, all materials will be securely stored and kept confidential. The study was in accordance with the National Health Research Ethics Code of Nigeria (NHREC, 2011) and the Research Ethics Policy of Texila American University.

Results

Quantitative Overview

Of the 200 responses, 56.5% were from women and 43.5% were from men. The average age was 31.6 years, with a range of 6.4 years. A majority of the participants were married (93%), self-employed (57%), and resided in urban regions (67%). About one-third (29.6%) showed positive screening results for possible postpartum depression (EPDS > 13). There were more women (34.5%) than men (24.1%) who had it. There were essential links between depression and education (p = 0.041), work (p = 0.034), and social support (p = 0.009).

Table 1. Sociodemographic Characteristics of Respondents (n=200)

Variables		**Gender**		**Total n(%)**	**p**
		Male n(%)	**Female n(%)**		
Age	18–25	13(14.9)	36(31.9)	49 (24.5)	0.002
	26–35	40(46.0)	59(52.2)	99 (49.5)	
	36–45	29(33.3)	13(11.5)	42 (21.0)	
	46–55	3(3.4)	3(2.7)	6 (3.0)	
	56+	2(2.3)	2(1.8)	4 (2.0)	
Marital Status	Single	4(4.6)	3(2.7)	7 (3.5)	0.488
	Married	82(94.3)	105(92.9)	187 (93.5)	
	Separated	1(1.1)	4(3.5)	5 (2.5)	
	Widowed	0(0)	1(0.9)	1 (0.5)	
Educational Level	No formal education	0(0)	4(3.5)	4 (2.0)	0.217
	Primary	6(6.9)	3(2.7)	9 (4.5)	
	Secondary	34(39.1)	49(43.4)	83 (41.5)	
	Tertiary	43(49.4)	50(44.2)	93 (46.5)	
	Others	4(4.6)	7(6.2)	11 (5.5)	
Employment Status	Full time	32(36.8)	19(16.8)	51 (25.5)	0.012
	Part time	7(8.0)	9(8.0)	16 (8.0)	
	Self-employed	44(50.6)	71(62.8)	115 (57.5)	
	Unemployed	3(3.4)	7(6.2)	10 (5.0)	
	Student	1(1.1)	7(6.2)	8 (4.0)	
Household Income	< 50,000	3(3.4)	37(32.7)	40 (20.0)	0.000
	50,000 – 100,000	30(34.5)	42(37.2)	72 (36.0)	
	100,000 – 200,000	25(28.7)	22(19.5)	47 (23.5)	
	200,000 – 500,000	25(28.7)	11(9.7)	36 (18.0)	
	> 500,000	4(4.6)	1(0.9)	5 (2.5)	
Residential Area	Urban	68(78.2)	65(57.5)	133(66.5)	0.007
	Semi-urban	13(14.9)	37(32.7)	50(25.0)	
	Rural	6(6.9)	11(9.7)	17(8.5)	

Ethnicity	Yoruba	77(88.5)	106(93.8)	183(91.5)	0.237
	Hausa	2(2.3)	4(3.5)	6(3.0)	
	Igbo	5(5.7)	2(1.8)	7(3.5)	
	Others	3(3.4)	1(0.9)	4(2.0)	

Source: (Field Survey, 2025)

Table 1 presents the sociodemographic characteristics of the respondents; with respect to the age of the participant, more than half 113 (56.5%) were female. The age distribution showed that the largest group of respondents was aged 26–35 years, representing about half 99 (49.5%). In terms of marital status, the majority of respondents were married 187, 93.5%). Regarding educational attainment, approximately half of the respondents had attained tertiary education 93 (46.5%). Employment status revealed that self-employment was the most common, accounting for more than half 115 (57.5%) of the respondents. Household income distribution indicated that over one-third, 72 (36.0%), earned between ₦50,000–₦100,000. With respect to residential location, the majority resided in urban areas 133 (66.5%). The ethnic distribution showed that the Yoruba ethnic group predominated, accounting for 183 (91.5%) respondents.

The majority of respondents in both genders were aged 26–35 years, though females had a slightly higher proportion in the 18–25 age group compared to males (31.9% vs. 14.9%, p = 0.002). Most participants were married, with no significant gender difference in marital status (p = 0.488). Educational attainment was generally high, with tertiary education being most common; however, differences by gender were not statistically significant (p = 0.217). Employment status showed a significant association with gender (p = 0.012), with males more likely to be in full-time work and females more likely to be in self-employment or student categories. Household income also differed significantly by gender (p < 0.001), with males more frequently in higher income brackets (≥ 200,000) and females more concentrated in the lowest category (< 50,000). Residential area was significantly related to gender (p = 0.007), with males more often living in urban settings and females more often in semi-urban areas. Ethnicity distribution showed no significant gender difference (p = 0.237), with Yoruba being the predominant ethnic group among both males and females.

Table 2. Edinburgh Postnatal Depression Scale (EPDS)

Variables		**Gender**		**Total n(%)**	**P**
		Male n(%)	**Female n(%)**		
Able to laugh and see the funny side of things	As much as always	67(77.0%)	85(75.2%)	152 (76.0%)	0.868
	Not quite so much	10(11.5%)	17(15.0%)	27 (13.5%)	
	Definitely less	7(8.0%)	7(6.2%)	14 (7.0%)	
	Not at all	3(3.4%)	4(3.5%)	7 (3.5%)	
Looked forward with enjoyment to things	As much as always	72(82.8%)	88(77.9%)	160 (80.0%)	0.510
	Less than usual	8(9.2%)	14(12.4%)	22 (11.0%)	
	Definitely less	3(3.4%)	8(7.1%)	11 (5.5%)	
	Hardly at all	4(4.6%)	3(2.7%)	7 (3.5%)	
Blamed self unnecessarily when things went wrong	Yes, most of the time	4(4.6%)	21(18.6%)	25 (12.5%)	0.000
	Sometimes	12(13.8%)	36(31.9%)	48 (24.0%)	
	Not often	26(29.9%)	39(34.5%)	65 (32.5%)	
	No, never	45(51.7%)	17(15.0%)	62 (31.0%)	

Felt anxious or worried for no good reason	No	47(54.0%)	37(32.7%)	84 (42.0%)	0.001
	Hardly ever	11(2.6%)	8(7.1%)	19 (9.5%)	
	Yes, sometimes	26(9.9%)	54(47.8%)	80 (40.0%)	
	Yes, very often	3(3.4%)	14(12.4%)	17 (8.5%)	
Felt scared or panicky for no very good reason	Yes, quite a lot	8(9.2%)	18(15.9%)	26 (13.0%)	0.001
	Yes, sometimes	12(13.8%)	35(31.0%)	47 (23.5%)	
	No, not much	17(19.5%)	26(23.0%)	43 (21.5%)	
	No, not at all	50(57.5%)	34(30.1%)	84 (42.0%)	
Things have been getting on top of me	Yes, most of the time	11(12.6%)	21(18.6%)	32 (16.0%)	0.004
	Yes, sometimes	15(17.2%)	36(31.9%)	51 (25.5%)	
	No, I have coped well	22(25.3%)	31(27.4%)	53 (26.5%)	
	No, as well as ever	39(44.8%)	25(22.1%)	64 (32.0%)	
Been so unhappy that I have had difficulty sleeping	Yes, most of the time	16(18.4%)	21(18.6%)	37 (18.5%)	0.117
	Sometimes	8(9.2%)	21(18.6%)	29 (14.5%)	
	Not often	18(20.7%)	29(25.7%)	47 (23.5%)	
	No, not at all	45(51.7%)	42(37.2%)	87 (43.5%)	
Felt sad or miserable	Yes, most of the time	2(2.3%)	18(15.9%)	20 (10.0%)	0.002
	Quite often	7(8.0%)	15(13.3%)	22 (11.0%)	
	Not often	25(28.7%)	35(31.0%)	60 (30.0%)	
	No, not at all	53(60.9%)	45(39.8%)	98 (49.0%)	
Been so unhappy that I have been crying	Yes, most of the time	6(6.9%)	20(17.7%)	26 (13.0%)	0.001
	Quite often	3(3.4%)	13(11.5%)	16 (8.0%)	
	Occasionally	6(6.9%)	16(14.2%)	22 (11.0%)	
	No, never	72(82.8%)	64(56.6%)	136 (68.0%)	
The thought of harming myself has occurred to me	Yes, quite often	2(2.3%)	15(13.3%)	17 (8.5%)	0.009
	Sometimes	7(8.0%)	16(4.2%)	23 (11.5%)	
	Hardly ever	2(2.3%)	5(4.4%)	7 (3.5%)	
	Never	76(87.4%)	77(68.1%)	153 (76.5%)	

Table 2 presents the Edinburgh Postnatal Depression scale of the respondents; majority 152(76.0%) were able to laugh and see the funny side of things as much as always. Similarly, majority160(80.0%) looked forward to things as much as always. Regarding self-blame when things went wrong, below one-quarter 25(12.5%) reported blaming themselves most of the time. Feelings of anxiety or worry without a clear reason were reported by approximately two out of five 80(40.0%), sometimes. In terms of feeling scared or panicky for no good reason, about half 84(42.0%) were not experiencing it at all. Sleep disturbances due to unhappiness were reported most of the time by less than one-quarter 37(18.5%), and not at all by about half 87(43.5%). Feelings of sadness or misery were experienced most of the time by below one-quarter20(10.0%), and not at all by about half 98(49.0%).

Episodes of crying due to unhappiness occurred most of the time in less than one-quarter 26(13.0%), while more than two-third 136(68.0%) never experienced it. Concerning thoughts of self-harm, few 17(8.5%) reported this quite often, while the majority, 153(76.5%), had never experienced such thoughts. Cross-tabulation of Edinburgh Postnatal Depression Scale (EPDS) items by gender showed several significant differences. Female respondents were

significantly more likely than males to report blaming themselves unnecessarily ($p < .001$), feeling anxious or worried without reason ($p = .001$), feeling scared or panicky ($p = .001$), and feeling overwhelmed by problems ($p = .004$). Females were also more likely to report feeling sad or miserable ($p = .002$), crying more often ($p = .001$), and having thoughts of self-harm ($p = .009$).

No significant gender differences were found in the ability to laugh, enjoyment of activities, difficulty sleeping, or most other emotional symptoms. However, females tended to report higher frequencies of distress in these areas.

About two-thirds (80.0%) were not depressed,53(26.6%) were probably depressed, while 23(11.5%) were possibly depressed.

Participants' overall postnatal depression was determined based on their responses to 10 Edinburgh Postnatal Depression questions with questions 1, 2, and 4 scored 0 – 3 and 3, 5-10 scored 3 - 0; participants with total scores between (0 - 9), (10 - 12) and (13 - 30) were adjudged to have no depression, possible and probable depression respectively.

Table 3. Sociocultural Factors Affecting Postnatal Depression

Variables	**Categories**	**Gender**		**n(%)**	**p**
		Male	**Female**		
In your community, do people believe men can experience postnatal depression?	Yes	41(47.1)	49(43.4)	90(45.0)	0.356
	No	15(17.2)	29(25.7)	44(22.0)	
	Unsure	31(35.6)	35(31.0)	66(33.0)	
Feels there is stigma around mental health issues in your community?	Yes, a lot	23(26.4)	41(36.3)	64(32.0)	0.328
	Yes, but only for severe cases	30(34.5)	35(31.0)	65(32.5)	
	No	34(39.1)	37(32.7)	71(35.5)	
Ever sought help for emotional distress or mental health issues	Yes	15(17.2)	37(32.7)	52(26.0)	0.015
	No	72(82.8)	76(67.3)	148(74)	
Factors preventing people from seeking help for depression in community *	Stigma	x	x	28(11.6)	
	Lack of awareness	x	x	100(41.3)	
	High cost	x	x	48(19.8)	
	Lack of trust	x	x	58(24.0)	
	Other	x	x	8(3.3)	
Typically discuss emotional challenges with *	No one	x	x	18(8.7)	
	Partner	x	x	103(49.8)	
	Family	x	x	40(19.3)	
	Friends	x	x	15(7.2)	
	Religious leader	x	x	13(6.3)	
	Therapist	x	x	17(8.2)	
	Elderly people	x	x	1(0.5)	
Believe men and women experience depression differently?	Yes	72(82.8)	89(8.8)	161(80.5)	0.053
	No	1(.1)	10(8.8)	11(5.5)	
	Unsure	14(16.1)	14(12.4)	28(14.0)	

** Multiple responses allowed*

Table 3 presents sociocultural factors affecting postnatal Depression; when respondents were asked whether people in their community believe men can experience postnatal depression, about half 90, 45.0%) indicated yes. Regarding the presence of stigma around mental health issues in their community, about one-third 64, 32.0%) believed there is a lot of stigma. When asked about help-seeking behavior, more than one-quarter , 52(26.0%), had ever sought help for emotional distress or mental health issues, while the majority , 148(74.0%), reported never seeking help. In terms of barriers preventing people from seeking help for depression, lack of awareness was the most reported factor 100(41.3%). Concerning who respondents typically discuss emotional challenges with, partners were the most common option, 103(49.8%). Finally, a large majority 161(80.5%) believed that men and women experience depression differently.

Analysis of sociocultural factors showed that beliefs about men experiencing postnatal depression and perceptions of mental health stigma did not differ significantly by gender ($p > .05$). However, females were significantly more likely than males to have sought help for emotional distress or mental health issues ($p = .015$). A higher proportion of both genders believed men and women experience depression differently, though this difference approached but did not reach statistical significance ($p = .053$).

Table 4. Coping Mechanisms & Support Systems

Variables	Categories	n(%)
Coping mechanism with stress or sadness*	Talking to friends/family	97(46.9)
	Religious activities	31(15.0)
	Exercise	30(14.5)
	Alcohol/substances	11(5.3)
	Professional help	13(6.3)
	Others	25(12.1)
Support received post-childbirth*	Family support	148(62.2)
	Healthcare support	43(18.1)
	Religious support	28(11.8)
	No support	19(8.0)
Most helpful interventions for parents struggling with postnatal depression*	Awareness programs	105(43.4)
	Mental health services	54(22.3)
	Family involvement	46(19.0)
	Support groups	30(12.4)
	Others	7(2.9)
	No	11 (5.5)
	Unsure	28 (14.0)

** Multiple responses allowed*

Table 4 presents respondents' coping mechanisms and support systems; nearly half 97 (46.9%) relied on talking to friends or family when coping with stress or sadness. In terms of support received after childbirth, the majority, 148 (62.2%), reported receiving support from family members. When asked about the most helpful interventions for parents struggling with postnatal depression, awareness programs were identified by about half 105 (43.4%) as being most beneficial.

Qualitative Findings

Four main themes came up:

1. Cultural Stigma and Emotional Suppression in Men; A lot of fathers said they felt like

they could not show their sadness or worry. One person said, "In our culture, a man who says he's unhappy is seen as weak." One must act as if everything is well. This quietness made it even harder to identify the internal struggle that was already there. This theme demonstrates the gendered stigma associated with men's emotions, reflecting previous research that masculine ideals inhibit vulnerability and postpone the acknowledgement of paternal postpartum depression (6,8,10).

2. . Maternal Regret and Unrealistic Expectations; Mothers expressed the difficulty of maintaining a cheery demeanour and nurturing behaviour despite their fatigue. A mother said, "One should thank God; so, when one cries, others may think they are ungrateful." This shows how stigma and unrealistic expectations from mothers make emotional pain seem normal. This guilt-induced silence reflects findings from African studies that indicate postpartum sadness is spiritualised and inadequately reported (4,5,9).
3. Family Role Conflict and Ineffective Communication Among Spouses; Both men and women said that their relationships were strained because of money problems and unequal childcare duties. Husbands expressed emotional detachment, whereas wives conveyed dissatisfaction with insufficient assistance. This theme corroborates that financial difficulties and inequitable caregiving exacerbate emotional stress within families, aligning with Family Systems Theory (12).
4. Little awareness and community support; from the community Participants observed that sorrow was infrequently recognised in familial or religious contexts. Many people went to pastors or traditional healers for help before seeing a doctor. These accounts demonstrate that the spiritualization of mental illness persists, hindering access to formal treatment and perpetuating stigma (7,9,11).

The qualitative findings suggest that postnatal depression is a socially ingrained phenomenon influenced by gender, culture, and familial relationships. Men's emotional repression and women's guilt exemplify gendered societal roles. Financial stress and poor communication exacerbate family tension, highlighting the interconnectedness of emotional well-being. The results support Family Systems and Social Relations Theories, showing that PND is both relational and sociocultural.

Integration of Quantitative and Qualitative Results

Quantitative studies indicated a considerable predominance of females and notable associations with social support, corroborated by qualitative narratives highlighting relational tension and cultural silence. The integration matrix showed that stigma made men less likely to talk about their problems whereas unrealistic social expectations made women feel more pain.

Discussion

Interpretation of Findings

This study demonstrates that postpartum depression affects both genders in Nigeria, with women experiencing a greater burden. The results corroborate studies from Ethiopia [14] and Ghana [15], which exhibited similar gender disparities. Patriarchal standards, financial stress, and insufficient spousal communication were identified as persistent factors. Comparable community-based research in Ethiopia indicates heightened depression symptoms in both mothers and fathers, influenced by economic hardship and limited access to mental health services [19, 20]. The combination of EPDS scores and qualitative narratives gave a full picture of how cultural scripts affect emotional experiences. Mothers internalised shame or guilt whereas males externalised sadness through withdrawal adhering to gendered emotional standards.

Theoretical Implications

The findings corroborate Family Systems Theory, illustrating that distress in one parent influences the entire home, affecting marital peace and caregiving practices. Social Relations Theory elucidates how gender roles and societal systems generate varying emotional loads. These concepts indicate that interventions ought to focus on relational dynamics rather than solely on individuals.

Policy Implications

As Nigeria does not have enough mental health infrastructure, it is important to include regular depression screenings to the current postnatal care plans. Teaching nurses and other community health workers to use the EPDS can facilitate early detection. Counselling programs that focus on couples can assist in easing stress in marriages, and public awareness campaigns can help break the taboo around men revealing their feelings.

At the policy level, including perinatal mental health in Nigeria's National Primary Health-Care Development Policy is in line with Sustainable Development Goal 3, which is about promoting mental health. Working together with the ministries of health, women's affairs, and social welfare can make family-support programs more effective.

Comparison with Global Literature

The reported frequency of 29.6% aligns with pooled estimates from African LMICs (25–35%) [4, 5] and exceeds rates observed in Europe (10–15%) [16, 18]. This difference shows that there are bigger problems with how easy it is to get healthcare and how people accept mental illness in different cultures. Shorey et al. [4] and Paulson & Bazemore [9] documented similar global prevalence rates of father postnatal depression, underscoring that postnatal mental illness is a universal occurrence, albeit influenced by cultural factors.

Research Limitations

The mixed-methods approach enhanced validity; however, several drawbacks remain. The final sample size (n = 200) fell short of the expected 236 due to difficulties in recruiting fathers which may diminish the statistical power for subgroup analysis. Self-reported EPDS data could be affected by social desirability bias. Qualitative findings were confined to urban Ibadan; rural viewpoints may vary. The cross-sectional design ultimately inhibits causal inference. Future longitudinal studies are advised to evaluate temporal variations.

Conclusion

In Southwestern Nigeria, sociocultural norms, gender expectations, and a lack of familial support have a significant effect on how people suffer postnatal depression. Both mothers and fathers experience emotional vulnerability; yet cultural stigma and shame impede transparency and support. Enhancing postnatal care through gender-inclusive mental health assessments, spouse counselling, and community awareness initiatives can promote family welfare and facilitate equitable mental health outcomes.

Conflict of Interest

There is no conflict of interest in this study.

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Data Availability Statement

The datasets produced and examined in this investigation are available and can be obtained

from the corresponding author upon a reasonable request.

Author's Contribution

Adeola Oluwatobi Aminu conceived and designed the project, coordinated fieldwork, supervised data collecting, and wrote the initial manuscript draft. Wakili Adelani Tijani provided overall supervision, technical mentorship, and guidance on study design and analysis. Fatimah Omobolanle Azeez facilitated training for research assistants and oversaw field data collection. Olalekan Amos Oladejo, Michael Oloyede Oladeji and Doubra Aanuoluwapo Onoviron collaboratively engaged in the review, editing, and proofreading of the final text draft to ensure intellectual clarity and consistency. All authors reviewed and sanctioned the final version of the text.

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Applying the Health Belief Model to COVID-19 Vaccine Hesitancy Among Health Care Workers in Nigeria: A Comparative Study

Sotimehin Oladipo[1*], Esomonu Sabastine[2], Onajole Adebayo[3]
[1]*Department of Public Health, Texila American University, Georgetown, Guyana*
[2]*Department of Planning and Research, Federal Capital Territory (FCT) Primary Health Care Board, Abuja, Nigeria*
[3]*Department of Community Health & Primary Care, College of Medicine, University of Lagos, Nigeria*

Abstract

Though health care workers (HCW) are central to the COVID-19 pandemic response, they face a higher risk of infection in the course of their duties, and vaccine hesitancy exists among them. This study aimed to compare the barriers and drivers of hesitancy among medical doctors with other HCWs to COVID-19 vaccination in two health facilities in Abuja, Nigeria (April-May 2022), with a view to designing interventions to mitigate the problem. A cross-sectional study was undertaken using a self-administered questionnaire for data collection. 316 HCPs completed the questionnaire, comprising 49.7% doctors and 50.3% other HCWs. Descriptive and inferential statistics were applied in the analysis. Among the hesitant HCWs, more doctors were unwilling to receive the COVID-19 vaccine though the finding was not statistically significant nor was the proportion of the two groups who received COVID-19 vaccination. However, other HCWs (22%) believed that their chances of serious complications and hospitalization if they contracted COVID-19 were higher than those of doctors (8.3%), and the difference was statistically significant (χ^2=11.609, p=0.003). Some of the perceived barriers in both groups included uncertainty of the safety and efficacy of the vaccines, perceived absence of scientific assurances, religious belief and lack of trust in the government. HCWs' confidence plays a critical role in patient vaccination behaviour. Therefore, it is highly recommended to implement effective awareness campaigns, educational initiatives, and continuous medical training for healthcare workers, supported by strong leadership endorsement. Additionally, policymakers should avoid adopting a one-size-fits-all communication approach to better address the specific needs and barriers among frontline providers.

Keywords: *Barriers, COVID-19, Health Care Workers, Health Belief Model, Vaccine Hesitancy.*

Introduction

COVID-19 was first reported in December 2019 by Chinese Health Authorities and rapidly spread globally within 3 months. On January 30, 2020, the WHO declared the novel coronavirus a Public Health Emergency of International Concern (PHEIC) and thereafter declared COVID-19 a pandemic. Kwok et al. [1] stated that health care workers in hospitals are a high-risk group during epidemics, and their risk is amplified due to various factors that include continuous exposure to patients, shortages of personal protective equipment, and inadequate infection control training. According to WHO [2], people who are vaccinated are very likely to be protected against the targeted disease.

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****Corresponding Author: ladimehin@gmail.com***

Vaccination is one of the most potent preventive strategies against diseases. 75% vaccination rate is needed to achieve herd immunity among the population [3]. However, the proportion of the population that must be vaccinated against COVID-19 to begin inducing herd immunity is unknown but will likely vary by variant, community, vaccine, populations prioritized for vaccination, and other factors [4]. High and equitable coverage reduces severe disease and transmission potential.

The COVID-19 vaccines can prevent most people from getting infected, but not everyone. Despite taking all recommended doses and waiting a few weeks for immunity to build, there is still a chance of infection [5].

Though vaccination of a large proportion of the population is considered essential to establish herd immunity, multiple potential COVID-19 vaccines have been developed at unprecedented speed [6-8], raising concerns about vaccine safety [9-11]. As noted by Alsubaie et al. [12], the WHO Strategic Advisory Group of Experts on Immunization (SAGE) describes vaccine hesitancy as a delay in accepting or refusing vaccines despite the availability of vaccination services. Vaccine hesitancy leads to disease outbreaks and deaths from vaccine-preventable diseases. This situation poses a threat to COVID-19 and control of all vaccine-preventable diseases and has been considered one of WHO's top 10 global health threats in 2019 [13-14]. Vaccine hesitancy includes outright refusals to vaccinate, delays in vaccination, accepting vaccines but remaining uncertain about their use, or using certain vaccines and refusing others.

Addressing low vaccination rates among specific groups requires an adequate understanding of the problem's determinants, tailored, evidence-based strategies to improve uptake, and monitoring and evaluation to assess the impact and sustainability of the interventions. Glanz et al. [15] posit that the health belief model (HBM) is by far the most commonly used theory in health education and promotion. This model was developed in the 1950s by a group of psychologists (Hochbaum, Kegeles, Leventhal, and Rosenstock) to explain why the medical screening programmes done by the US Public Health Service, especially for Tuberculosis, were not very successful. The HBM has been extensively used in vaccination research to study vaccination behaviours and identify participants perception towards disease and vaccination [16-17]. The HBM posits that health behaviours can be optimized as long as constructs such as perceived barriers, benefits, self-efficacy and threats are addressed [18-19].

Perceived severity is about the belief of an individual in the seriousness of a disease on their own health, while perceived susceptibility is about an individual's assessment of their chances of getting the disease. The perceived benefits speak to an individual's conclusion whether the new behaviour is better than what he is already doing, and the perceived barriers are an individual's opinion on what will stop him from adopting the new behaviour. It is an individual evaluation of the obstacles in the way of adopting new behaviour [16, 20-23]. It is therefore necessary for a new behaviour to be adopted, a person needs to believe that the benefits of the new behaviour outweigh the consequences of continuing the old behaviour. Furthermore, Wong et al. [24] stated that trust in the healthcare system and vaccine manufacturer was positively associated with COVID-19 vaccine acceptance. Other constructs have been included to the HBM and these are Cues to Action, Motivating factors and Self-efficacy. Cues to action are factors that prompt a person to change behaviour. Modifying factors are personal and affect whether a new behaviour is adopted. The Self-efficacy construct is the personal belief in one's ability to perform a task. These other constructs affect our perception of

susceptibility, severity, benefits, and barriers, and consequently our behaviour.

Hence, identifying factors associated with acceptance of the COVID-19 vaccine is required to formulate context-specific education and policy implementation. Eze et al. [3] quoting the Johns Hopkins University - Nigeria vaccine tracker highlighted a growing body of anecdotes about many Nigerians not believing in the existence of the pandemic which is due in part to low levels of trust in government and burgeoning conspiracy theories concerning the virus and vaccines.

There are substantial implications on public health interventions during epidemics with respect to health care workers' vaccine hesitancy. Nosocomial infections among healthcare workers during epidemics would reduce the available healthcare workforce. They are usually at the frontline fighting with epidemics, and some of them are required to routinely perform procedures with high risks of contracting the pathogens. Therefore, the key role of health care workers cannot be overemphasized. Protecting healthcare workers from infection is pivotal in controlling nosocomial transmission [1, 25]. Also healthcare workers can convey the message of vaccination benefits and address the worries and concerns of the patients on a newly developed vaccine. These frontline workers are major influencers in vaccination, therefore their acceptance or hesitancy to the COVID-19 vaccine would either aid its acceptance or refusal among the populace [26-27]. However, prior research indicated that vaccine uptake among nurses was low, with the influenza vaccination rate slightly above 30% in Hong Kong [1]. A low vaccination acceptance rate among nurses could negatively affect individuals' vaccination compliance, given their engagement with this healthcare cadre. In the study by Eze et al. [3], more than 60% of Nigerians were willing to take the COVID-19 vaccines if recommended by health care workers. Another Nigerian study among HCWs showed that 45.7% of respondents had no confidence in the vaccine and 39.7% rejected it [26]. The main reasons for hesitancy were concerns about effectiveness, side effects, safety and fear of the unknown. In a study by Ekwebene et al. [28] among HCWs in Nigeria, 92% had a good knowledge of COVID-19 vaccination although only 53.5% were willing to get vaccinated against the disease. Even if the vaccine is proven safe, 48.1% of respondents remain unwilling to accept it. A multicentre study [29] on perceptions to COVID-19 vaccines and willingness to receive was also conducted among HCWs in Ondo state Nigeria which reported only 53.5% of HCWs with positive perception of the vaccine and 55.5% being willing to receive the vaccine. Another multicentre study conducted among HCWs in Democratic Republic of Congo by Kabamba et al. [30] to estimate the acceptability of COVID-19 vaccine revealed significant association with willingness to be vaccinated among doctors primarily and also having positive attitude towards the vaccine. Using the health belief model construct, an Ethiopian study [22] among employees had 62.3%, 53.7%, 49.7%, 79.1%, 48.2% and 52.4% of the respondents with high perceived susceptibility, severity, benefit, barrier, cues to action, and self-efficacy to COVID-19 prevention practices, respectively.

As at the time of this study, very few comparative studies between doctors and other health care workers had been done. This study was undertaken to comparatively determine the barriers and hesitancy among the doctors and other HCWs, associated with accepting the COVID-19 vaccination in the Federal Capital Territory, Nigeria and make appropriate recommendations for interventions.

Materials and Methods

Description of Study Area

Abuja is Nigeria's capital city and is located within the Federal Capital Territory. As of 2016, the metropolitan area of Abuja is estimated at six million people. The Federal Capital Territory is administered by the Federal Capital Territory Administration, under which is the Health and Human Services Secretariat (HHSS). The FCT Hospitals Management Board is an agency under the HHSS and is responsible for delivering secondary health services to the FCT populace. There are four public secondary health facilities in the city of Abuja, of which two facilities were randomly selected for the study. The two health facilities were Asokoro District Hospital and Maitama District Hospital. Asokoro District Hospital also serves as the undergraduate medical training facility for the Nile University College of Health Sciences, Abuja.

Study Design

This is a comparative (quantitative), cross-sectional study to assess the hypothesis that barriers to COVID-19 vaccination differ among the doctors and other health care workers at public secondary health facilities in Abuja in Nigeria's Federal Capital Territory.

Study Population

The study population comprised of doctors and other health care workers who are involved in the management of patients/clients in the selected health facilities. All these populations manage COVID cases, as the hospitals are a high-risk environment even before diagnosis is made.

Sample Size

The sample size for the study was determined by the formula for estimation of two independent proportions, as shown below;

$$N = 2\frac{\left(Z_{\alpha} + Z_{1-\beta}\right)^2 x\,[P_1(1-P_1) + P_2(1-P_2)]}{(P_1 - P_2)^2}$$

where,

N= Minimum sample size

$Z\alpha$ = Percentage point of standard normal deviate (2 sided) set at 95% confidence level =1.96 (from Z table)

$Z_{1-\beta}$ = Power of the test set at 80% (20% B error) = 0.84 (from Z table)

P_1 = Proportion of the first group

P_2 = Proportion of the second group

assuming a 5% margin of error, a 95% confidence interval and power of study at 80% and a 15% non-response rate. From a Nigerian study by Agha et al. [31], the proportion of doctors who accepted the vaccine was 50.6% (P1), and using the proportion of nurses who received the vaccine to represent others, 34.1% (P_2). The minimum sample size required for this study was therefore 275.

Inclusion Criteria

Doctors and other HCWs who are involved in the management of patients/clients in the selected health facilities and agreed to participate in the study. All participants were aged 18 years and above.

Exclusion Criteria

Doctors and other HCWs who are involved in the management of patients in the selected health facilities who declined consent or were absent at the time of data collection were excluded from the study.

Sampling Technique

According to records from the FCT Hospitals Management Board, four public secondary healthcare facilities are managed in Abuja. The following sampling stages were applied.

In stage I: Simple random sampling was used to select two general hospitals by balloting. Asokoro and Maitama District Hospitals were randomly chosen from the four health facilities.

In stage II, based on the calculated sample size, 50% of the sample (138) was allocated to each hospital.

In stage III: In each hospital, half of the sample size was allocated to the doctors (69), and the remaining half (69) was proportionately allocated to the remaining categories of health workers.

In stage IV: The staff strength of the two hospitals were obtained from their medical records units. Asokoro District Hospital had 412 health care workers, while Maitama District Hospital had 340 health care workers. Consecutive sampling was subsequently used to recruit respondents at the hospitals where the questionnaires were handed over to them.

Data Collection Tool

The tool was adapted from two studies carried out by Angelo et al. [32] and Costa [19]. An orientation training on the questionnaire was conducted for six research assistants to ensure good understanding of the variables and the expectations. A pre-test of the tool was conducted at a general health facility outside the study sites. Based on the pre-test findings and observations, the data collection tool was adjusted accordingly. The questionnaire achieved a reliability score of 75% for the HBM constructs. All research assistants adhered strictly to COVID-19 safety prevention protocols during the survey

Data Collection

A semi-structured, self-administered questionnaire was used to collect data. The survey questionnaire consisted of 8 sections and 57 variables. The first section consisted of the participants' socio-demographic variables, such as age, sex, marital status, professional cadre, etc. The second section assessed knowledge of COVID-19 infection, while the third section assessed medical history and perceived COVID-19 susceptibility. The fourth and the fifth sections assessed participants' perceived benefits of COVID-19 prevention practices and perceived severity respectively. The sixth section consisted of perceived barriers to COVID-19 vaccination and the seventh section evaluated vaccine hesitancy. The seventh section provided the cues to action that may lead to change of behaviour towards vaccination for those who were not vaccinated. The level of statistical significance was pre-determined at a p-value of <0.05, two-sided.

Data Analysis

Data was entered into SPSS (Statistical Package for Social Sciences) statistical software version 22.0 after a manual check for completeness. Descriptive and inferential statistics was applied in the analysis. Frequency tables and cross tabulations were generated for the variables: Qualitative data was summarized using percentages, while quantitative data was summarized using means and standard deviations. The pairwise deletion method was used to handle missing data.

Results

Out of the 389 questionnaires given out to the health care workers in the two hospitals, 316 participants completed the questionnaires given a response rate of 81.2%. Doctors made up 49.7% of the participants, while 50.3% were other HCWs, who comprised nurses, pharmacists, laboratory scientists, community health workers, and other allied staff. The nurses made up the highest proportion (31%) among the other HCWs.

Table 1 below shows the other socio-demographic characteristics of health workers. There was a statistically significant difference in the age groups of respondents, as a higher proportion of doctors (41.4%) was in the age group of 30-39 years, while a higher proportion of other HCWs (44.7%) was in the age group of less than 30 years (χ^2=8.007, p=0.044). Similarly, higher proportions of doctors had Bachelor's and Master's degrees (66.2% & 21%) than other HCWs (62.3% &

15.1%), and the difference was statistically significant (χ^2=11.532, p=0.021).

Table 1. Socio-demographic Characteristics of Health Workers

Variables	**Categories of health workers**		**χ^2 p-value**
	Doctors (n=157) N (%)	**Other workers (n=159) N (%)**	
Mean Age ± SD (years)	34.2±8.4	33.6±9.4	0.578* 0.564
Age groups (years)			
< 30	51 (32.5)	71 (44.7)	
30 – 39	65 (41.4)	43 (27.0)	8.007 0.044
40-49	29 (18.5)	33 (20.8)	
50 And Above	12 (7.6)	12 (7.5)	
Marital Status			
Married	68 (43.3)	75 (47.2)	0.475 0.491
Single**	89 (56.7)	84 (52.8)	
Religion			
Islam	52 (33.1)	40 (25.2)	2.428 0.119
Christianity	105 (66.9)	119 (74.8)	
Educational Qualification			
Diploma	5 (3.2)	20 (12.6)	
Bachelor's degree	104 (66.2)	99 (62.3)	11.532 0.021
Master's degree	33 (21.0)	24 (15.1)	
PhD	0 (0.0)	1 (0.6)	
Others***	15 (9.6)	15 (9.4)	

**t-value ; ** Never married, separated, or divorced.; ***Other educational qualifications (Fellowship, SSCE, Pharm.D, etc.)*

Table 2. Medical History and Perceived COVID-19 Susceptibility

Variables	**Doctors (n=157) N (%)**	**Other workers (n=159) N (%)**	**χ^2 p value**
Do you have a known medical condition?			
Yes	17 (10.8)	14 (8.8)	0.365 0.546
No	140 (89.2)	145 (91.2)	
If yes, specify	**n=17**	**n=14**	
Asthma	4 (23.5)	4 (28.6)	
Hypertension	13 (76.5)	5 (35.7)	8.343 0.080
Cancer	0 (0.0)	1 (7.10)	
Diabetes	0 (0.0)	2 (14.3)	
Hepatic disease	0 (0.0)	2 (14.3)	
Perceive risk to COVID-19 infection	**n=157**	**n=159**	
High	62 (39.5)	37 (23.4)	
Medium	47 (29.9)	54 (34.2)	9.934 0.007
Low	48 (30.6)	67 (42.4)	

Has personal history of COVID-19 infection	**n=157**	**n=159**	
Yes	48 (30.6)	19 (11.9)	16.400 < 0.001
No	109 (69.4)	140 (88.1)	
Knows anyone sick (now or before) with COVID-19 in your immediate network	**n=157**	**n=159**	
Yes	84 (53.5)	74 (46.5)	
No	66 (42.0)	69 (43.4)	4.209 0.122
Not Sure	7 (4.5)	16 (10.1)	

Table 2 shows a higher proportion of doctors (39.5%) perceived that they were at high risk of COVID-19 infection than the other category of HCWs (23.4%) and the difference was statistically significant, (χ^2=9.934, p=0.007). In addition, a higher proportion of doctors (30.6%) had a personal history of COVID-19 infection than the other category of health care workers (11.9%), and the difference was also statistically significant (χ^2=16.400, p<0.001).

Table 3. Perceived Benefits of COVID-19 Prevention Practices

Variables	**Doctors (n=157) N (%)**	**Other workers (n=159) N (%)**	**χ^2 p value**
Do you wash your hands or sanitize your hands regularly?			
Yes	149 (94.9)	156 (98.1)	2.421 0.120
No	8 (5.1)	3 (1.9)	
If No is your response to 401, why?	**n=8**	**n=3**	
Laziness	0 (0.0)	1 (33.3)	
Tiredness	0 (0.0)	1 (33.3)	6.519 0.038
No reason	8 (100)	1 (33.3)	
Do you regularly use facemask at point of care (when rendering service to sick patients)			
Yes	144 (91.7)	142 (89.3)	0.535 0.465
No	13 (8.3)	17 (10.7)	
Do you use a facemask when you have flu-like symptoms?			
Yes	137 (87.3)	147 (92.5)	2.340 0.126
No	20 (12.7)	12 (7.5)	
In recent times, have you worn a face mask when leaving your home?			
Yes	119 (75.8)	117 (73.6)	0.204 0.651
No	38 (24.2)	42 (26.4)	
If No is your response to 405, why?	**n=17**	**n=19**	
No need/Govt. asked us to stop	8 (47.1)	8 (42.1)	
COVID-19 has reduced	3 (17.6)	2 (10.5)	
Makes me uncomfortable/Don't like it	0 (0.0)	2 (10.5)	2.430 0.787
I am vaccinated	1 (5.9)	2 (10.5)	

I usually forget/carelessness	2 (11.8)	2 (10.5)	
I wear it when I get to my destination/hospital	3 (17.6)	3 (15.8)	
Missing values (non-responses) = 43			
Do you believe that the COVID-19 vaccine can prevent infection?	**n=157**	**n=159**	
Yes	125 (79.6)	117 (73.6)	1.603 0.205
No	32 (20.4)	42 (26.4)	
Are you ready to participate in sensitization on COVID 19 vaccination?	**n=157**	**n=159**	
Yes	124 (79.0)	125 (78.6)	0.006 0.937
No	33 (21.0)	34 (21.4)	

Table 3 shows perceived benefits of COVID-19 prevention practices among healthcare providers. A slightly higher proportion of other HCWs wash and sanitize their hands regularly than the doctors, but the difference was not statistically significant. However, there was a statistically significant difference in the reasons given by the HCWs for not washing/sanitizing their hands regularly (χ^2=6.519, p=0.038). It is pertinent to note that 79% of health care providers (doctors and other HCWs) expressed willingness to participate in COVID-19 sensitization.

Table 4. Perceived Severity of COVID-19 Infection

Variables	**Doctors (n=157) N (%)**	**Other workers (n=159) N (%)**	**χ^2 p value**
If I got infected with COVID-19, the intensity of my symptoms will be			
High	16 (10.2)	28 (17.6)	
Medium	65 (41.4)	71 (44.7)	5.407 0.067
Low	76 (48.4)	60 (37.7)	
If I got infected with COVID-19, I believe the chances of having serious complications and being hospitalized is			
High	13 (8.3)	35 (22.0)	
Medium	47 (29.9)	42 (26.4)	11.609 0.003
Low	97 (61.8)	82 (51.6)	
If I got infected with COVID-19, the chances of getting too compromised to do my daily activities is			
High	22 (14.0)	27 (17.0)	
Medium	64 (40.8)	69 (43.4)	1.163 0.559
Low	71 (45.2)	63 (39.6)	
I believe that most people with COVID-19 will have severe symptoms			
Yes	17 (10.8)	44 (27.7)	
No	132 (84.1)	97 (61.0)	21.135 <0.001
Don’t Know	8 (5.1)	18 (11.3)	

As shown in Table 4, higher proportion of other HCWs (22%) believed that their chances of having serious complications and being hospitalized if they caught COVID-19 infection was high than the doctors (8.3%) and the difference in proportions was statistically significant, (χ^2=11.609, p=0.003). Also, a higher proportion of other HCWs (27.7%) believed that most people with COVID-19 infection will have severe symptoms than the doctors (10.8%), and the difference in proportions was also statistically significant (χ^2=21.135, p<0.001).

Table 5. Perceived Barriers to COVID-19 Vaccination

Variables	**Doctors (n=157) N (%)**	**Other workers (n=159) N (%)**	**χ^2 p value**
COVID-19 vaccines are not readily available			
Yes	44 (28.0)	38 (24.1)	0.646 0.421
No	113 (72.0)	120 (75.9)	
Going to the vaccination point will take up too much of my time			
Yes	64 (40.8)	61 (38.4)	0.190 0.663
No	93 (59.2)	98 (61.6)	
My job is more important than going to receive the vaccine			
Yes	32 (20.5)	30 (19.0)	0.115 0.734
No	124 (79.5)	128 (81.0)	
The side effects of COVID-19 vaccination is too much to bear, so will not take the vaccine			
Yes	73 (46.5)	67 (42.1)	0.608 0.435
No	84 (53.5)	92 (57.9)	
Other perceived barriers	**n=17**	**n=24**	
Uncertainty of vaccine safety/efficacy	9 (52.9)	13 (54.2)	
Perceived absence of scientific assurances	0 (0.0)	2 (8.3)	4.963 0.175
Religion/Ignorance/Lack of trust in the Govt.	8 (47.1)	6 (25.0)	
Believe COVID-19 is a mild disease	0 (0.0)	3 (12.5)	

The perceived barriers to COVID-19 vaccination among the health workers are shown in Table 5. A higher proportion of doctors (28%) perceived that COVID-19 vaccines were not readily available than the other category of HCWs (24.5%), but the difference in proportions was not statistically significant. Furthermore, there was no statistically significant difference in the proportion of those in the two groups who believed that going to the vaccination point would take up too much of their time, as well as among those who believed that the side effects of COVID-19 vaccination were too much to bear. Lastly, the uncertainty of the vaccine safety, religion, ignorance and lack of trust in government are other mutually perceived barriers.

Table 6. Vaccine Hesitancy among Health Care Workers

Variables	**Doctors (n=157) N (%)**	**Other workers (n=159) N (%)**	**χ^2 p-value**
i Have you ever refused a vaccine for yourself or a child because you considered it useless or dangerous?			
Yes	7 (4.5)	14 (8.8)	2.406 0.121
No	150 (95.5)	145 (91.2)	
ii If yes to question i, why?	n=7	n=11	
Need to confirm efficacy/safety	0 (0.0)	2 (14.3)	
Previous side-effects	1 (14.3)	5 (35.7)	4.1366 0.388
Fear or trust on vaccines	3 (42.9)	4 (28.6)	
Peer-pressure	1 (14.3)	0 (0.0)	
Perceived uncertainties of vaccines	2 (28.6)	3 (21.4)	
iii Have you ever had a vaccine for a child or yourself despite doubts about its efficacy?			
Yes	104 (66.2)	103 (64.8)	0.075 0.785
No	53 (33.8)	56 (35.2)	
iv Have you received COVID-19 vaccine?			
Yes	116 (73.9)	118 (74.2)	0.004 0.947
No	41 (26.1)	41 (25.8)	
v If yes to question iv, which vaccine were you given?	**N=116**	**N=118**	
Astra Zeneca	86 (74.1)	83 (70.3)	
Pfizer/Bio Tech	10 (8.6)	14 (11.9)	11.401 0.010
Moderna	10 (8.6)	20 (16.9)	
Johnson and Johnson	10 (8.6)	1 (0.8)	
vi If yes to question iv, how many doses have you taken?	**N=116**	**N=118**	
1	10 (8.6)	7 (5.9)	
2	75 (64.7)	92 (78.0)	5.123 0.077
3	31 (26.7)	19 (16.1)	
vii If no to iv, are you willing to receive the vaccine?	**N=41**	**N=41**	
Yes	12 (29.3)	20 (48.8)	3.280 0.070
No	29 (70.7)	21 (51.2)	

As shown in Table 6, higher proportion of other category of HCWs (8.8%) refused vaccination in the past than doctors (4.5%), but the difference was not statistically significant. Similarly, there was no statistically significant difference in the proportion of the two groups who received COVID-19 vaccination, as well as in the number of the vaccine doses they received.

On the other hand, there was a statistically significant difference in the vaccine types received by the two groups: a higher proportion of doctors (74.1% & 8.6%) received the AstraZeneca and Johnson &

Johnson vaccines, respectively, than the other HCW category (70.3% & 0.8%).

While a higher proportion of other HCWs received the Pfizer/BioNTech and Moderna vaccines (11.9% and 16.9%) than the doctors (8.6% and 8.6%), (χ^2=11.401, p=0.010).

Table 7. Predictors of Willingness to Receive COVID-19 Vaccination among Doctors who were not vaccinated

Variables	**Willingness to receive the COVID-19 vaccination**		**p[a]**	**AOR[b] (95% CI)[c]**	**p[d]**
	Yes (n=12) N (%)	**No (n=29) N (%)**			
Perceived susceptibility					
High	4 (30.8)	9 (69.2)		0.25 (0.01-4.71)	0.354
Medium	4 (36.4)	7 (63.6)	0.759	0.88 (0.60-13.59)	0.927
Low	4 (23.5)	13 (76.5)		1	
Perceived benefits					
Yes	8 (32.0)	17 (68.0)	0.631	0.24 (0.02-2.30)	0.214
No	4 (25.0)	12 (75.0)		1	
Perceived severity					
High	2 (40)	3 (60.0)	0.851	1.38 (0.63-30.06)	0.838
Medium	4 (28.6)	10 (71.4)		3.534 (0.25-50.53)	0.927
Low	6 (27.3)	16 (72.7)		1	
Perceived barriers					
Yes	7 (38.9)	11 (61.1)	0.231	0.13 (0.01-1.89)	0.140
No	5 (21.7)	18 (78.3)		1	
Age groups (years)					
< 30	7 (53.8)	6 (46.2)		0.0 (0.0-0.0)	0.999
30 – 39	4 (20.0)	16 (80.0)	0.108	0.0 (0.0-0.0)	0.999
40 – 49	1 (20.0)	4 (80.0)		0.0 (0.0-0.0)	0.999
≥ 50	0 (0.0)	3 (100)		1	
Sex					
Male	3 (23.1)	10 (76.9)	0.553	1.61 (0.11-22.82)	0.725
Female	9 (32.1)	19 (67.9)		1	
Educational Status					
Diploma	0 (0.0)	0 (0.0)		0.80 (0.02-43.11)	0.913
Bachelors	11 (36.7)	19 (63.3)	0.175	0.0 (0.0-0.0)	0.999
Masters	0 (0.0)	6 (100)		1	
PhD	0 (0.0)	0 (0.0)			
Others[e]	1 (20.0)	4 (80.0)			
Personal history of COVID-19 infection					
Yes	3 (37.5)	5 (62.5)	0.568	0.81 (0.08-8.18)	0.857
No	9 (27.3)	24 (72.7)		1	

Has a known medical condition?					
Yes	2 (28.6)	5 (71.4)	0.965	0.44 (0.02-8.17)	0.581
No	10 (29.4)	24 (70.6)		1	
Health Facility					
Asokoro	10 (41.7)	14 (58.3)	0.038	0.34 (0.00-0.81)	0.040
Maitama	2 (11.8)	15 (88.2)		1	

[a]P-value in bivariate analysis; bAOR=Adjusted Odds Ratio; c95% CI=95% Confidence Interval:

[d]P-value on logistic analysis; eOther educational qualifications (Fellowship, SSCE, Pharm. D, etc.).

Table 7 shows the predictors of willingness to receive the COVID-19 vaccine among doctors who had not been vaccinated. Doctors working at Asokoro Hospital were three times less willing to receive the COVID-19 vaccine compared to those at Maitama Hospital (AOR = 0.34, 95% CI = 0.00–0.81, p = 0.040). No statistically significant association was observed between the HBM constructs and doctors' willingness to receive the COVID-19 vaccine.

Table 8. Predictors of Willingness to Receive COVID-19 Vaccination among other categories of Health workers who were not vaccinated

Variables	**Willingness to receive Covid-19 vaccination**		**p[a]**	**AOR[b] (95% CI)[c]**	**p[d]**
	Yes (n=20) N (%)	**No (n=21) N (%)**			
Perceived susceptibility					
High	3 (50.0)	3 (50.0)		3.39 (0.07-169.42)	0.541
Medium	6 (37.5)	10 (62.5)	0.484	49.88 (1.25-1993)	0.038
Low	11 (57.9)	8 (42.1)		1	
Perceived benefits					
Yes	13 (59.1)	9 (40.9)	0.155	0.09 (0.01-1.30)	0.076
No	7 (36.8)	12 (63.2)		1	
Perceived severity					
High	3 (100)	0 (0.0)	0.164	0.00 (0.00-0.00)	0.999
Medium	11 (47.8)	12 (52.2)		0.11 (0.00-3.02)	0.188
Low	1 (8.3)	4 (13.8)		1	
Perceived barriers					
Yes	10 (66.7)	5 (33.3)	0.082	0.40 (0.05-3.38	0.403
No	10 (38.5)	16 (61.5)		1	
Age groups (years)					
< 30	11 (55.0)	9 (45.0)		11.95 (0.19-0.773)	0.244
30 – 39	5 (50.0)	5 (50.0)	0.791	6.94 (0.08-589)	0.393
40 – 49	2 (33.3)	4 (66.7)		38.78 (0.21-7160)	0.169
≥ 50	2 (40.0)	3 (60.3)		1	
Sex					
Male	4 (36.4)	7 (63.6)	0.336	2.154 (0.14-34.09)	0.586
Female	16 (53.3)	14 (46.7)		1	

Educational Status					
Diploma	2 (50.0)	2 (50.0)		0.83 (0.00-6.15)	0.257
Bachelors	14 (60.9)	9 (39.1)	0.257	0.129 (0.00-4.13)	0.247
Masters	2 (22.2)	7 (77.8)		1.475 (0.03-63.77)	0.840
PhD	0 (0.0)	0 (0.0)		0.179 (0.00-9.34)	0.394
Others[e]	2 (40.0)	3 (60.0)		1	
Personal history of COVID-19 infection					
Yes	2 (66.7)	1 (33.3)	0.520	0.18 (0.00-9.34)	0.394
No	18 (47.4)	20 (52.6)		1	
Has a known medical condition?					
Yes	2 (66.7)	1 (33.3)	0.520	0.02 (0.00-20.76)	0.258
No	18 (47.4)	20 (52.6)		1	
Health Facility					
Asokoro	12 (54.5)	10 (45.5)	0.427	0.65 (0.09-4.67)	0.665
Maitama	8 (42.1)	11 (57.9)		1	

[a]P-value in bivariate analysis; bAOR=Adjusted Odds Ratio; c95% CI=95% Confidence Interval;

[d]P-value on logistic analysis; eOther educational qualifications (Fellowship, SSCE, Pharm. D, etc.)

Table 8 presents the predictors of willingness to receive the COVID-19 vaccine among other category of health workers who were not vaccinated. The other health workers with a medium level of perceived susceptibility were found to be 50 times more likely to accept vaccination compared to those with a low level of perceived susceptibility. (AOR; 49.88, 95% CI=1.25-1993, p=0.038). There was no statistically significant association between the remaining HBM constructs and the willingness to receive the COVID-19 vaccine among the other categories of health workers.

Discussion

Vaccination is one of the most potent preventive strategies against COVID-19 infection. It is therefore pertinent to state that a successful COVID-19 response depends on the availability of a fully vaccinated health workforce capable of responding to the pandemic and the availability of the vaccines. In this study, the Health Behaviour Model (HBM) was adopted as a theoretical framework to comparatively determine the barriers and hesitancy to COVID-19 vaccination among doctors and the other health care workers (HCWs) with a view to further elucidate the interventions to overcome barriers and hesitancy to getting COVID-19 vaccination. It is pertinent to further state that at the time of this study, only about 20% of the national population target had been vaccinated with the second dose.

In this study, the mean age of the doctors and the other HCWs were not statistically significant. However, higher proportion of doctors were aged above 30 years, compared to other HCWs within the same age range. Conversely, there were more other HCWs below 30 years of age compared to the doctors. Furthermore, more doctors had Bachelor's or Master's degrees when compared with other HCWs. These observations are not unexpected in view of the fact that you can only qualify to be a doctor with a university degree while among the other HCWs, there are cadres with much lesser qualifications.

The study by Robinson et al. [26] did not dis-aggregate the health workers, however, majority of respondents were within the age group of 30-39 years with most having a Bachelor's degree. This is also similar to the

finding in a study by Aemro et al. [33] in Ethiopia where the average age of the health workers (not disaggregated) was 30 years. Oriji et al. [34] in their study of other health care workers (excluding doctors) had almost 50% less than 35 years of age which is close to finding of this study.

The results in this study observed that though the knowledge level in both groups was very high, only 73.9% and 74.2% of doctors and other HCWs, respectively, had received the COVID-19 vaccine, with around a quarter of respondents showing hesitancy in both groups. The study by Aemro et al. [33] in Ethiopia reported a hesitancy rate of 45.9%, which may have been partly attributed to the limited availability of vaccines in the country at that time. This was not the case in the Nigerian study, as the hospitals where data were collected in Abuja also served as vaccination sites.

Among the respondents that refused to receive the COVID-19 vaccine, the other health care workers (HCWs) indicated more willingness to receive the vaccine as compared to the doctors (48.8% vs 29.3%) even though the doctors signified a higher perceived risk to COVID-19 infection. This finding warrants further investigation, given that the present study revealed a significantly higher proportion of doctors with a personal history of COVID-19 infection and a heightened perception of risk of contracting the virus. Some of the perceived barriers in both groups included uncertainty of the safety and efficacy of the vaccines, perceived absence of scientific assurances, religion, fear or lack of trust in the government on vaccines and ignorance.

Just like the current study, Adedeji-Adenola et al. [35] also elucidated trust issues as to whether the COVID-19 vaccines produced were safe and effective and also fear of the side effects of the vaccines. Luma et al. [36], in their study of health care workers in Iraq, cited fear of side effects and a lack of confidence in using the vaccine as the most common perceived barriers among the 27.9% of respondents who were vaccine-hesitant. Here the midwives were more hesitant than the physicians and their study affirmed that higher educational level increased vaccine acceptance.

Even though this study elaborated a significantly perceived susceptibility to the virus among the doctors compared to other HCWs (Table 2), it is important to note that among the health care providers expressing hesitancy, a higher proportion of the doctors were unwilling to receive the COVID-19 vaccine though the finding was not statistically significant. The explanation here could be due to the fact that the doctors complied more with prevention practices and had low severity perception of COVID-19 symptoms if they contract the virus than other HCWs. This probably could be due to the doctors being more educated than the other HCWs which gives them a higher level of confidence in taking care of themselves. Costa [19] alluded to this in his study where respondents with lower schooling levels showed more concern about possible symptoms because of their perceived severity being much higher than those with higher educational levels. Conversely, in a Malaysian study [11], people with higher level of education (tertiary education) were more willing to consider receiving the vaccine than those with lower education level. A systematic review and meta-analysis conducted by Rahbeni et al. [37], revealed global vaccine hesitancy necessitating credible information dissemination and culturally sensitive interventions to foster vaccine acceptance

As stated earlier, more than 70% of the doctors and other HCWs had received the vaccine as at the time of collecting this data. This is an indication of perceived benefit outweighing perceived barrier. More encouraging is the fact that 79% of respondents in both groups indicated willingness to participate in sensitization on COVID-19 vaccination. Ensuring that all

healthcare providers are vaccinated against COVID-19 will significantly boost their confidence in engaging with clients and offering informed guidance on immunization. This is particularly crucial given the emergence of new COVID-19 variants circulating in the country, underscoring the importance of everyone receiving the recommended vaccine doses.

Conclusion

This study reveals similar perceived benefits and barriers to COVID-19 vaccination in the two groups with significant differences to perceived severity and susceptibility. It also indicates how these four central HBM constructs are modified by educational level, past experiences, and motivation.

COVID-19 infection is no longer classified as a public health emergency of international concern (PHEIC). However, it remains a global health threat in view of the lives that are being lost due to the disease. Therefore, health care providers should not let their guard down but should continue to manage the disease with utmost precautions.

Policymakers are also encouraged to consider the following specific recommendations:

1. Provide tailored, cadre-specific messaging to health care workers to ensure that information is relevant and addresses their unique roles and concerns.
2. Allocate dedicated and protected vaccination times at health facilities specifically for health care workers to encourage uptake without disrupting service delivery.
3. Ensure strong leadership endorsement of vaccinations to build trust and set a positive example for all staff in the health facility.
4. Develop and disseminate a set of frequently asked questions on adverse events following immunization (AEFI) to support health care workers with accurate, evidence-based responses.
5. Integrate contemporary issues, such as vaccine hesitancy, into continuing medical education (CME) modules to strengthen health workers' knowledge and communication skills.
6. Establish monitoring dashboards to track progress, identify gaps, and provide real-time feedback on vaccination coverage among health care workers.

This study is among the limited number of comparative analyses in the literature that examine COVID-19 vaccine uptake among health care workers. The application of the Health Belief Model (HBM) framework is particularly appropriate, as it provides valuable insights into vaccination behaviors, elucidates participants' perceptions of disease and immunization, and helps inform relevant interventions.

However few limitations should be acknowledged. These include the use of non-probability sampling so cannot be used to infer causality, the inability to assess health care workers' exposure to various media content, data collection based on self-reports with potential influence of social desirability bias, as well as instances of missing data in some responses.

Ethical Consideration

Ethical approval was obtained from the FCT Health Research Ethics Committee of the Department of Health and Human Services Secretariat, Federal Capital Territory Administration, Abuja.

Asokoro District Hospital further requested the submission of the research proposal to their own facility ethics committee, which was done and an approval was thereafter received to go ahead with the survey. A written informed consent was included in the questionnaire for the participants with assurance of confidentiality of their information. The return of a completed

questionnaire indicated voluntary participation in the study. Participants also had the right to withdraw from the study at any time, this was clearly stated to the participants.

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Conflict of Interest

The author confidently declares that there was no conflict of interest before, during and after the research study was carried out. The study's costs were borne entirely by the principal investigator.

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Predictors of Hesitancy in Childhood Vaccination Uptake Post-Covid-19 in Bayelsa State, Nigeria

Adelekun, Omobolanle Esther*, Abiodun Olaiya Paul, Moyosola Abiodun Bamide
School of Public Health, Texila American University, Guyana

Abstract

The COVID-19 pandemic disrupted routine immunization services worldwide, including in Bayelsa State, Nigeria. This study aims to identify the predictors of childhood vaccination uptake post-COVID-19 and understand the factors associated with vaccine hesitancy in this region. A cross-sectional study was conducted involving 810 parents and caregivers of children eligible for vaccination in Bayelsa State. Data on demographic characteristics, attitudes towards vaccination, and vaccination uptake were collected using structured questionnaires. Logistic regression analysis was performed to identify significant predictors of vaccine hesitancy. The study found that female participation in child healthcare was significantly higher (78%), with most participants being married (60.2%) and having secondary education (55.1%). Positive attitudes towards childhood immunization were associated with higher vaccination uptake (88.9%). Significant predictors of vaccine hesitancy included self-employment (aOR 1.3), rural residence (aOR 1.8), not believing in mandatory immunization (aOR 5.1), not advising other parents to immunize (aOR 4.1), never taking children for scheduled immunizations (aOR 8.4), and not participating in community programs (aOR 3.1). The study highlights the importance of parental education, occupation, area of residence, and attitudes towards immunization in determining childhood vaccination uptake. Targeted interventions addressing these factors, promoting positive attitudes, and enhancing community engagement are essential to improve vaccination rates and reduce vaccine hesitancy in Bayelsa State.

Keywords: *Bayelsa State, Childhood Vaccination, COVID-19, Nigeria, Predictors, Vaccine Hesitancy.*

Introduction

The global rollout of COVID-19 vaccines marked a turning point in the fight against the pandemic. However, the success of vaccination campaigns varies significantly across regions, influenced by factors such as vaccine availability, socioeconomic status, healthcare infrastructure, and individual behaviors [1, 2]. The COVID-19 pandemic has significantly impacted healthcare systems worldwide, including vaccination programs essential for preventing childhood diseases [3, 4]. In Nigeria, the pandemic disrupted routine immunization services, leading to concerns about decreased vaccination coverage and increased susceptibility to vaccine-preventable diseases among children [5, 6]. Bayelsa State, like many regions, faced challenges such as restricted movement, reduced access to healthcare, and heightened fear of virus transmission, which may have influenced parents' and caregivers' decisions about childhood vaccinations [7, 8].

Child vaccinations are the administration of vaccines to protect children from infectious diseases. These vaccines stimulate the immune system to recognize and fight specific pathogens, thereby preventing illnesses such as measles, polio, diphtheria, and tuberculosis. Vaccination is one of the most effective public

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****Corresponding Author: sp_pubs@outlook.com***

health interventions, significantly reducing morbidity and mortality from infectious diseases [9, 10].

The public health importance of childhood vaccinations cannot be overstated. They not only protect individual children from potentially severe illnesses but also contribute to herd immunity, which helps prevent the spread of diseases within communities [11]. High vaccination coverage is crucial for maintaining disease eradication and controlling outbreaks, particularly in regions with limited healthcare resources [12].

Vaccination behavior is a complex phenomenon influenced by a myriad of factors. Sociodemographic characteristics, such as age, gender, education level, and income, often play a crucial role [13, 14]. Behavioral and psychological factors, including perceived susceptibility to disease, trust in healthcare systems, and vaccine confidence, also significantly impact decision-making [15, 16]. Furthermore, structural barriers, such as limited access to healthcare facilities and challenges in vaccine distribution, can hinder vaccine uptake, particularly in rural and underserved areas like Bayelsa State [8, 17].

In the post-COVID-19 era, understanding the predictors of vaccination uptake has become more urgent. The pandemic exposed vulnerabilities in healthcare systems and revealed widespread misinformation and vaccine hesitancy [13, 18]. In Bayelsa State, these issues are compounded by a history of distrust in government-led health initiatives and the influence of religious and cultural beliefs. Identifying the specific predictors of vaccination uptake in this context is critical for developing targeted interventions that address the unique challenges faced by the population. This study aims to provide an evidence-based understanding of the factors influencing vaccination uptake post-COVID-19 in Bayelsa State. By identifying key predictors, the research seeks to guide policymakers, healthcare providers, and public health practitioners in designing tailored strategies to improve vaccine acceptance and coverage, ultimately contributing to better health outcomes in the region.

Methods

Study Population

The study included 810 parents or primary caregivers of children aged 0 to 5 years residing in Bayelsa State, Nigeria. This age group was selected because it aligns with the period when children typically receive early childhood immunizations as outlined in the national immunization schedule.

Study Procedure

Quantitative data were collected using a structured questionnaire (Appendix I) administered to parents and caregivers. The questionnaire captured demographic details, perceptions of childhood immunization, fears and attitudes toward vaccines, and knowledge of immunization schedules. Attitudes toward vaccination were categorized using Bloom's Taxonomy into two groups: Poor (Likert scale average < 2.5) and Good (Likert scale average $\geqslant 2.5$) [14]. Data collection was conducted at community centers and healthcare facilities to maximize accessibility and participation

Data Analysis

The quantitative data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were employed to summarize respondents' socio-demographic characteristics and their perceptions of immunization. Inferential statistical methods, such as chi-square tests and logistic regression, were used to explore the relationships between independent variables (parental characteristics, perceptions, fears, and attitudes) and the dependent variable (immunization uptake).

Results

Table 1 summarizes the demographic information of the study participants. The majority of participants were aged 30-39 years (34.3%), followed by 19-29 years (29.9%), 40-49 years (23%), and 50+ years (12.8%). A higher proportion of participants were female (78%) compared to male (22%). Most participants were married (60.2%), with singles (27.2%), divorced/separated (9.4%), and widowed (3.2%) making up the rest. The largest group had secondary education (55.1%), followed by tertiary education (28.9%), no formal education (8.4%), and primary education (7.7%). Self-employed participants formed the largest group (40.2%), followed by those unemployed (18.5%), employed in the private sector (23.2%), employed in the government sector (17.3%), and students (0.7%). A significant majority (84.4%) resided in rural areas, while a smaller proportion (15.6%) lived in urban areas. Most participants identified with Christianity (93.3%), with smaller percentages identifying with Islam (3.2%) and traditional beliefs (3.5%).

Table 1. Demographic distribution of Study Participants

Demographic Variable	Frequency (n=810)	Percent (%)
Age groups		
19 - 29	242	29.9
30 - 39	278	34.3
40 - 49	186	23
50 and above	104	12.8
Gender		
Female	632	78
Male	178	22
Marital Status		
Single	220	27.2
Married	488	60.2
Divorced/Separated	76	9.4
Widowed	26	3.2
Highest level of education		
No formal education	68	8.4
Primary education	62	7.7
Secondary education	446	55.1
Tertiary education	234	28.9
Occupation		
Unemployed	150	18.5
Self-employed	326	40.2
Employed (private sector)	188	23.2
Employed (government sector)	140	17.3
Student	6	0.7
Area of Residence		

Urban	126	15.6
Rural	684	84.4
Religious affiliation		
Christianity	756	93.3
Islam	26	3.2
Traditional beliefs	28	3.5

Figure 1 shows that 518 respondents (63.95%) reported their children had received all vaccinations as scheduled, while 292 (36.05%) said they had not.

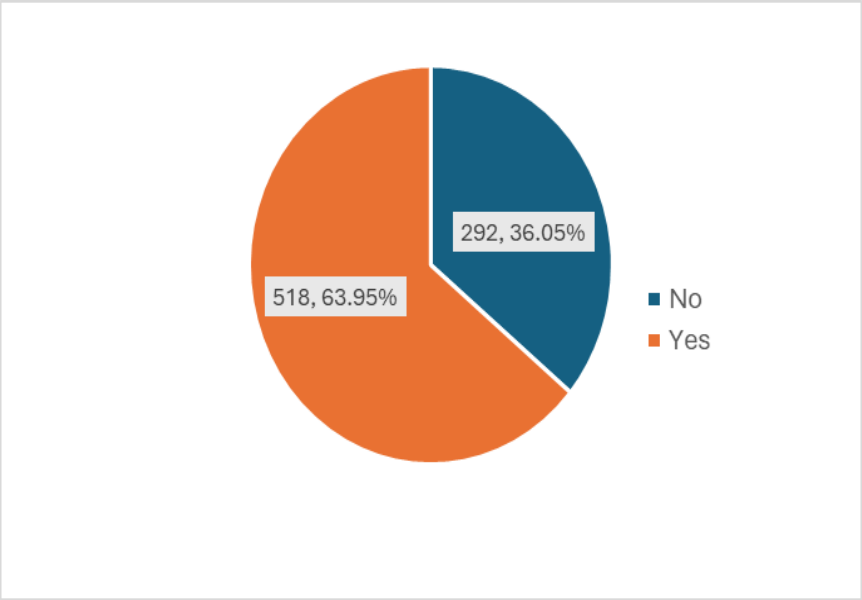


Figure 1. Distribution of Children that have Received all Vaccinations as Scheduled

The results from Table 2 show a strong association between parents' attitudes towards vaccination and child vaccination uptake. Parents with a strongly positive attitude towards childhood immunization had the highest vaccination rate (88.9%). In contrast, those with a strongly negative attitude had none of their children fully vaccinated. Similarly, parents who believed that immunization should be mandatory or would advise other parents to immunize their children had higher vaccination rates for their children (78.2% and 76.0%, respectively). In terms of adherence to scheduled immunizations, children whose parents always took them on time had the highest full vaccination rate (94.6%). Public health centers were the most common vaccination sites, with 65.0% of children receiving all required vaccinations there. Participation in community programs aimed at increasing immunization awareness also correlated with higher vaccination rates: 76.5% of children whose parents participated in such programs were fully vaccinated. The chi-square test results for these associations were statistically significant, indicating a strong relationship between parents' positive attitudes and higher vaccination uptake.

Table 2. Association of Parent's Attitudes towards Vaccination and Child Vaccination Uptake

Attitudes	**Child Received all Vaccination Required**			**Chi-square (p-value)**
	No n, (%)	**Yes n, (%)**	**Total n, (%)**	
How would you describe your attitude toward childhood immunization?				
Strongly positive	14(11.1)	112(88.9)	**126(100.0)**	*129.36 (0.001)**
Positive	128(28.6)	320(71.4)	**448(100.0)**	
Neutral	106(60.2)	70(39.8)	**176(100.0)**	
Negative	34(68.0)	16(32.0)	**50(100.0)**	
Strongly negative	10(100.0)	0(0.0)	**10(100.0)**	
Do you believe that immunization should be mandatory for all children?				
No	188(56.3)	146(43.7)	**334(100.0)**	*100.9 (0.0001)**
Yes	104(21.8)	372(78.2)	**476(100.0)**	
Would you advise other parents to immunize their children?				
No	164(59.4)	112(40.6)	**276(100.0)**	*99.18 (0.0001)**
Yes	128(24.0)	406(76.0)	**534(100.0)**	
How often do you take your child for scheduled immunizations?				
Always on time	12(5.4)	212(94.6)	**224(100.0)**	*200.70 (0.0001)**
Sometimes on time	122(34.7)	230(65.3)	**352(100.0)**	
Rarely on time	120(63.2)	70(36.8)	**190(100.0)**	
Never	38(86.4)	6(13.6)	**44(100.0)**	
Where do you typically take your child for vaccinations?				
public health centre	254(35.0)	472(65.0)	**726(100.0)**	*Fischer's Exact= 0.0001**
Private clinic	22(32.4)	46(67.6)	**68(100.0)**	
Don't believe in immunization	4(100.0)	0(0.0)	**4(100.0)**	
Don't go to clinic	2(100.0)	0(0.0)	**2(100.0)**	
No go to Hospital	2(100.0)	0(0.0)	**2(100.0)**	
No visit	2(100.0)	0(0.0)	**2(100.0)**	
None	6(100.0)	0(0.0)	**6(100.0)**	
Would you participate in community programs aimed at increasing awareness about immunization?				
No	198(48.3)	212(51.7)	**410(100.0)**	*53.98 (0.0001)**
Yes	94(23.5)	306(76.5)	**400(100.0)**	

**Statistically significant (p<0.05)*

The results from Table 3 indicate associations between parent's demographic characteristics and child vaccination uptake. Age groups showed varied vaccination uptake, with parents aged 50 and above having the highest percentage of fully vaccinated children (69.2%). Gender did not show a significant difference in vaccination uptake, with similar percentages for female (63.6%) and male (65.2%) parents. Marital status also showed no significant difference, though married parents had slightly lower vaccination uptake (61.9%) than single (67.3%) and divorced/separated (68.4%) parents. Education level was significantly associated, with parents with tertiary education showing the highest vaccination uptake (70.9%) and those with no formal education showing the lowest (44.1%). Occupation also showed a significant association: parents employed in the

government sector had the highest vaccination uptake (75.7%), while those unemployed had a lower uptake (61.3%). Residence showed a significant difference, with urban residents having a higher vaccination uptake (76.2%) compared to rural residents (61.7%). Religious affiliation did not show a significant difference, though parents affiliated with traditional beliefs had slightly higher vaccination uptake (64.3%) than those affiliated with Christianity (64.6%) or Islam (46.2%). Statistically significant associations ($p<0.05$) were found for education level, occupation, and area of residence, highlighting their importance in predicting child vaccination uptake.

Table 3. Association of Parent's Demographic Characteristics and Child Vaccination Uptake

Demographic Variable	**Child Received all Vaccination Required**			**Chi-square (p-value)**
	No n,(%)	**Yes n,(%)**	**Total n,(%)**	
Age groups				
19 - 29	82(33.9)	160(66.1)	**242(100.0)**	3.94 (0.268)
30 - 39	112(40.3)	166(59.7)	**278(100.0)**	
40 - 49	66(35.5)	120(64.5)	**186(100.0)**	
50 and above	32(30.8)	72(69.2)	**104(100.0)**	
Gender				
Female	230(36.4)	402(63.6)	**632(100.0)**	0.14 (0.702)
Male	62(34.8)	116(65.2)	**178(100.0)**	
Marital Status				
Single	72(32.7)	148(67.3)	**220(100.0)**	2.68 (0.444)
Married	186(38.1)	302(61.9)	**488(100.0)**	
Divorced/Separated	24(31.6)	52(68.4)	**76(100.0)**	
Widowed	10(38.5)	16(61.5)	**26(100.0)**	
Highest level of education				
No formal education	38(55.9)	30(44.1)	**68(100.0)**	17.49 (0.001)*
Primary education	26(41.9)	36(58.1)	**62(100.0)**	
Secondary education	160(35.9)	286(64.1)	**446(100.0)**	
Tertiary education	68(29.1)	166(70.9)	**234(100.0)**	
Occupation				
Unemployed	58(38.7)	92(61.3)	**150(100.0)**	10.94 (0.027)*
Self-employed	130(39.9)	196(60.1)	**326(100.0)**	
Employed (private sector)	68(36.2)	120(63.8)	**188(100.0)**	
Employed (government sector)	34(24.3)	106(75.7)	**140(100.0)**	
Student	2(33.3)	4(66.7)	**6(100.0)**	
Area of Residence				
Urban	30(23.8)	96(76.2)	**126(100.0)**	9.69 (0.002)*
Rural	262(38.3)	422(61.7)	**684(100.0)**	
Religious affiliation				

Christianity	268(35.4)	488(64.6)	**756(100.0)**	3.69 (0.158)
Islam	14(53.8)	12(46.2)	**26(100.0)**	
Traditional beliefs	10(35.7)	18(64.3)	**28(100.0)**	

**Statistically significant (p<0.05)*

The logistic regression analysis from Table 4 reveals various factors associated with vaccine hesitancy. Education level shows no significant association, as parents with no formal education have an OR of 1.3 (p-value of 0.241) compared to those with at least primary education. The occupation analysis shows that being unemployed is not significantly associated with vaccine hesitancy (OR of 1.3, p-value of 0.104), whereas being self-employed is (OR of 1.4, p-value of 0.018), indicating that self-employed parents are more likely to exhibit vaccine hesitancy. Living in rural areas significantly increases vaccine hesitancy (OR of 1.9, p-value of 0.001). Attitudes towards immunization show no significant association for negative attitudes (OR of 0.2, p-value of 0.133). However, parents who do not believe immunization should be mandatory have a significantly higher likelihood of hesitancy (OR of 4.6, p-value of 0.0001), as do those who would not advise others to immunize their children (OR of 4.6, p-value of 0.0001). Parents who never take their children for scheduled immunizations are significantly more likely to be hesitant (OR of 12.7, p-value of 0.0001). Those who do not believe in vaccination or do not visit hospitals have the highest odds of hesitancy (OR of 29.7, p-value of 0.0001). Lastly, non-participation in community programs aimed at increasing awareness is significantly associated with vaccine hesitancy (OR of 3.0, p-value of 0.001).

Table 4. Logistic Regression of Factors Associated with Vaccine Hesitancy

Variable	**Child Received all Vaccination Required**			**Chi-square (p-value)**	**OR (95% CI)**
	No n,(%)	**Yes n,(%)**	**Total n,(%)**		
Highest level of education					
No formal education	38(55.9)	30(44.1)	**68(100.0)**	1.37 (0.241)	1.3 (0.8 – 2.2)
At least Primary Education	254(49.2)	262(50.8)	**516(100.0)**		
Occupation					
Unemployed	58(38.7)	92(61.3)	**150(100.0)**	2.63 (0.104)	1.3 (0.9 – 2.0)
Self-employed	130(39.9)	196(60.1)	**326(100.0)**	5.50 (0.018)*	1.4 (1.0 – 2.0)
Student's/Employed (Private/Government)^{R}	104(31.1)	230(68.9)	**334(100.0)**		
Area of Residence					
Rural	262(38.3)	422(61.7)	**684(100.0)**	9.69 (0.001)*	1.9 (1.2 – 3.1)
Urban	30(23.8)	96(76.2)	**126(100.0)**		
How would you describe your attitude toward childhood immunization?					
Negative	35(68.6)	16(31.4)	**51(100.0)**	2.25 (0.133)	0.2 (0.02 – 1.8)
Neutral/Positive^{R}	10(100.0)	0(0.0)	**10(100.0)**		
Do you believe that immunization should be mandatory for all children?					
No	188(56.3)	146(43.7)	**334(100.0)**	101.0 (0.0001)*	4.6 (3.3 – 6.2)
Yes^{R}	104(21.8)	372(78.2)	**476(100.0)**		
Would you advise other parents to immunize their children?					

No	164(59.4)	112(40.6)	**276(100.0)**	99.1 (0.0001)*	4.6 (3.4 – 6.3)
Yes[R]	128(24.0)	406(76.0)	**534(100.0)**		
How often do you take your child for scheduled immunizations?					
Never	38(86.4)	6(13.6)	**44(100.0)**	51.1 (0.0001)*	12.7 (5.3 – 30.6)
Always/Rarely/Sometimes[R]	254(33.2)	512(66.8)	**766(100.0)**		
Where do you typically take your child for vaccinations?					
Don't believe in immunization/No hospital visit	16(100.0)	0(0.0)	**16(100.0)**	25.11 (0.0001)*	29.7 (3.9 – 225.6)
public health centre/private clinic[R]	254(35.0)	472(65.0)	**726(100.0)**		
Would you participate in community programs aimed at increasing awareness about immunization?					
No	198(48.3)	212(51.7)	**410(100.0)**	53.98 (0.001)*	3.0 (2.2 – 4.1)
Yes[R]	94(23.5)	306(76.5)	**400(100.0)**		

**Statistically significant ($p<0.05$) R Reference Variable OR: Odds Ratio*

Table 5 identifies key predictors of vaccine hesitancy, highlighting significant factors and their adjusted odds ratios (aOR). Self-employment is a significant predictor, with an aOR of 1.3 (p-value = 0.018), indicating that self-employed parents are more likely to exhibit vaccine hesitancy than employed parents in other sectors. Rural residence is another significant predictor, with an aOR of 1.8 (p-value = 0.001), suggesting that parents in rural areas are more hesitant about vaccines than those in urban areas. Not believing in mandatory immunization is strongly associated with vaccine hesitancy, with an aOR of 5.1 (p-value of 0.0001). Parents who oppose mandatory vaccination are more likely to be hesitant. Similarly, not advising other parents to immunize their children is a significant predictor, with an aOR of 4.1 (p-value of 0.0001), indicating that these parents are more likely to be hesitant. Never taking children for scheduled immunizations is a significant predictor, with an aOR of 8.4 (p-value of 0.0001). Parents who do not adhere to immunization schedules are more likely to exhibit hesitancy. Not believing in immunization or not visiting hospitals is also strongly associated with vaccine hesitancy, with an aOR of 10.1 (p-value = 0.0001). Finally, not participating in community programs aimed at increasing immunization awareness is a significant predictor, with an aOR of 3.1 (p-value = 0.001). Parents who do not engage in these programs are more likely to be hesitant. These findings underscore the importance of addressing these factors to reduce vaccine hesitancy among parents.

Table 5. Predictors of Vaccine Hesitancy

Variable	**OR (95% CI)**	**aOR (95% CI)**	**p-value**
Occupation			
a. Unemployed	1.3 (0.9 – 2.0)	1.1 (0.6 – 1.9)	0.104
b. Self-employed	1.4 (1.0 – 2.0)	1.3 (1.0 – 2.1)	0.018*
Student's/Employed (Private/Government)[R]			
Area of Residence			

b. Rural	1.9 (1.2 – 3.1)	1.8 (1.2 – 3.6)	0.001*
a. Urban			
Do you believe that immunization should be mandatory for all children?			
No	4.6 (3.3 – 6.2)	5.1 (2.6 – 7.1)	0.0001*
Yes[R]			
Would you advise other parents to immunize their children?			
No	4.6 (3.4 – 6.3)	4.1 (3.1 – 7.1)	0.0001*
Yes[R]			
How often do you take your child for scheduled immunizations?			
d. Never	12.7 (5.3 – 30.6)	8.4 (4.1 – 16.1)	0.0001*
Always/Rarely/Sometimes[R]			
Where do you typically take your child for vaccinations?			
Don't believe in immunization/No hospital visit	29.7 (3.9 – 225.6)	10.1 (5.1 – 16.8)	0.0001*
a. public health centre/private clinic[R]			
Would you participate in community programs aimed at increasing awareness about immunization?			
No	3.0 (2.2 – 4.1)	3.1 (2.2 – 6.1)	0.001*
Yes[R]			

**Statistically significant (p<0.05) R Reference Variable; OR: Odds Ratio aOR: Adjusted Odds Ratio*

Discussion

The demographic distribution of study participants showed a higher proportion of females (78%) compared to males (22%). This is consistent with other studies that have found women to be more involved in child healthcare decisions [19, 20]. The majority of participants were married (60.2%), which is often associated with greater stability and support systems for child healthcare. The largest group had secondary education (55.1%), followed by tertiary education (28.9%), indicating a relatively educated population. This is significant as higher educational levels are generally associated with better healthcare practices, including vaccination uptake. The results of this study align with several other studies that have explored factors influencing vaccination uptake and hesitancy. For example, the significant impact of parental education and urban residency on vaccination rates is well-documented in literature [21, 22].

Self-employment (40.2%) and rural residence (84.4%) were prominent among participants. The high rural population reflects the state's geographical characteristics. Rural residence has been associated with lower vaccination rates due to limited healthcare access, as corroborated by studies such as [23] and [24], which found that rural dwellers in Nigeria are less likely to fully vaccinate their children.

The study revealed a significant association between parents' attitudes towards vaccination and child vaccination uptake. Strongly positive attitudes towards childhood immunization were associated with a high percentage of children receiving all required vaccinations (88.9%). In contrast, strongly negative attitudes resulted in none of the children being fully vaccinated. This aligns with findings by [25], who reported that positive parental attitudes significantly

improve vaccination rates. Belief in mandatory immunization showed that parents who opposed it were more likely to exhibit vaccine hesitancy (OR = 4.6). This is consistent with previous research [15, 26, 27] that highlighted the impact of mandatory vaccination policies on improving immunization rates. The association between positive parental attitudes and higher vaccination uptake has been emphasized in multiple studies, including [28] and [24]. These studies highlight the importance of educational interventions to improve parental attitudes towards vaccination.

Education level was a significant predictor of child vaccination uptake, with parents having tertiary education showing the highest vaccination uptake (70.9%). This finding is consistent with earlier studies, such as [29] which identified parental education as a critical factor in improving vaccination coverage. Occupation also played a role, with government sector employees having the highest vaccination uptake (75.7%), likely due to better access to healthcare services and information. Area of residence was another significant factor, with urban residents having higher vaccination uptake (76.2%) than rural residents (61.7%). This finding is in line with studies [29-31] that reported that urban dwellers have better access to vaccination services, leading to higher vaccination coverage.

The logistic regression analysis identified self-employment, rural residence, not believing in mandatory immunization, not advising other parents to immunize, never taking children for scheduled immunizations, and not participating in community programs as significant predictors of vaccine hesitancy. Self-employed parents were more likely to exhibit vaccine hesitancy (aOR of 1.3), possibly due to irregular income and a lack of employer-provided healthcare benefits, as suggested by studies such as [31]. Living in rural areas significantly increased vaccine hesitancy (aOR of 1.8), aligning with research by [30] that found rural residents face more barriers to accessing vaccination services. The belief that immunization should not be mandatory was a strong predictor of hesitancy (aOR of 5.1), consistent with findings by [21] which emphasized the role of perceived autonomy in vaccination decisions.

Parents who never took their children for scheduled immunizations were significantly more likely to be hesitant (aOR of 8.4). This is supported by findings from [23], which highlighted the importance of routine healthcare practices in ensuring complete vaccination. Not participating in community programs aimed at increasing immunization awareness was also a significant predictor of vaccine hesitancy (aOR of 3.1), underscoring the importance of community engagement in improving vaccination rates, as noted in previous studies [22, 23].

Conclusion

The study highlights significant predictors of childhood vaccination uptake and vaccine hesitancy in Bayelsa State, Nigeria. Factors such as parental education, occupation, area of residence, and attitudes towards immunization play crucial roles in determining vaccination coverage. The findings emphasize the importance of positive parental attitudes, support for mandatory vaccination, timely adherence to immunization schedules, and participation in community awareness programs. These elements are essential for improving vaccination rates and reducing vaccine hesitancy. Based on these findings, it is recommended that targeted interventions be designed to address the specific barriers faced by self-employed and rural-dwelling parents. Efforts should be made to enhance educational programs that promote the benefits of immunization and address misconceptions about vaccines. Community engagement initiatives should be strengthened to increase participation in awareness programs. Additionally, policies that support mandatory immunization and improve access to

vaccination services in rural areas are essential. By implementing these recommendations, it is possible to enhance childhood vaccination uptake and protect children from preventable diseases, ultimately contributing to better public health outcomes in the region.

Ethical Considerations

Ethical approval for the study was obtained from the Research and Ethics Committee of the Bayelsa State Primary Healthcare Board. Participants were fully informed about the study's objectives and procedures before participation. A comprehensive explanation of their rights, including the voluntary nature of participation and their ability to withdraw at any time without penalty, was provided. Informed consent, either written or verbal, was obtained from all participants before data collection. Confidentiality was maintained by assigning unique study IDs to anonymize participants' personal information, preventing data from being traced back to individuals.

Conflict of Interest

The authors declare that there is no conflict of interest for this study.

Acknowledgement

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Reagent Costs as Primary Drivers of Biochemical and AST Expenses: Challenging Assumptions of Time-Based Laboratory Efficiency: An Example from Zambia

Lutinala Nachilembo Nalomba[1*], Mox Kalumbi[2], Baron Yankonde[3], Pascalina Chanda-Kapata[4]

[1]*Family Health and Infectious Diseases/MPH, East, Central and Southern Africa Health Community, Tanzania*

[2]*Microbiology Department/MSc Micro, Levy Mwanawasa Medical University, Zambia*

[3]*Laboratory Department/BSc, Churches Health Association of Zambia, Zambia*

[4]*Independent Consultant, Zambia*

Abstract

Microbiological testing underpins effective antimicrobial resistance (AMR) surveillance; however, its financial implications remain poorly characterized in resource-limited settings. This study evaluated the time, labor, and cost components of biochemical and antimicrobial susceptibility testing (AST) in Zambia. Between December 2024 and March 2025, data were collected from 13 laboratories across nine provinces using structured questionnaires. Inputs related to labor and time, reagents, and equipment were analysed using the WHO Laboratory Testing Costing Tool (LTCT) and Julius AI, with pricing guided by the Zambia Public Procurement Act. Ethical approval was obtained from the University of Zambia Biomedical Research Ethics Committee (UNZABREC) and the National Health Research Authority (NHRA). A mixed-methods approach was employed to complement quantitative costing with contextual insights. Biochemical tests clustered into two categories based on time requirements: high-intensity tests averaging 78 minutes and rapid tests averaging 13 minutes. Despite this variation, costs ranged from USD 4.25 to 7.99 per test, with rapid tests such as Coagulase being the most expensive due to specialized reagent needs. AST using Mueller Hinton media averaged USD 11.86 per test, with reagents accounting for over 88% of total expenditure. Across all test types, reagent costs dominated, while labor and equipment contributed minimally. Findings reveal a disconnect between test duration and cost, underscoring that efficiency gains are limited primarily by reagent pricing rather than workflow optimization. Strategic procurement, local reagent production, and targeted cost-control measures are essential to sustain affordable microbiological diagnostics in Zambia and similar low-resource settings.

Keywords: *Costs and Cost Analysis, Drug Resistance, Laboratories, World Health Organization, Zambia.*

Introduction

Antimicrobial resistance (AMR) is an urgent global health crisis of the 21st century, endangering the globe to a possible pandemic despite significant medical progress with relation to infectious disease management [1, 2]. With AMR potential to render common infections untreatable, The World Health Organization (WHO) identifies AMR as a paramount global public health concern, that could lead to increased mortality, morbidity,

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****Corresponding Author: lnmulenga@gmail.com***

and healthcare expenditures globally [2]. A large portion of this AMR burden can be pointed to bacteria featured on the WHO Bacterial Priority Pathogen List (BPPL) [17]. While it is a worldwide challenge, the repercussions of AMR are disproportionately felt in low- and middle-income countries (LMICs) such as Zambia, where constraints in diagnostic capacity, underdeveloped surveillance systems, and inconsistent access to appropriate antimicrobial therapies worsen the problem [4, 5]. In 2019, AMR was linked to an estimated 255,000 deaths in Africa, largely due to factors including imprudent antimicrobial use, suboptimal vaccination coverage, environmental contamination, limited availability of quality diagnostics and medicines, and insufficient public and healthcare worker awareness [5].

Although Zambia's public health system is functional, bacteriology testing capacity remains notably limited. Only a minute 1% of public health laboratories in Zambia are equipped to perform bacteriology testing, severely restricting diagnostic access [6, 7]. Just as in many LMICs, healthcare investments have often prioritized vertical disease programs, such as Human Immunodeficiency Virus (HIV), Tuberculosis (TB), and Malaria, at the expense of strengthening broader diagnostic infrastructure [7]. Consequently, essential microbiological methods, including culture and antimicrobial susceptibility testing (AST), which are cornerstone tools for effective antimicrobial stewardship (AMS), are significantly underutilized. AST services which are crucial for guiding appropriate antibiotic therapy and thereby curbing the emergence of resistance, are only accessible in 55% of second-level hospitals and a mere 23% of third-level hospitals, with virtually no presence at the primary care level [6]. These diagnostic gaps compel empirical antibiotic prescribing, which further accelerates AMR. Furthermore, only 19% of Zambian facilities possess the necessary infrastructure for AMR surveillance, a figure that marginally increases to 34% even in the comparatively better-equipped faith-based hospital facilities [8, 9].

The World Bank estimates that if AMR is not addressed, it could lead to an annual global GDP loss of 3.8% by 2050, accumulating to nearly $100 trillion [10]. Cost analysis within the health sector offers a pivotal tool for quantifying this financial burden and showing the value of investing in diagnostics [30-33]. Such costing data are also instrumental in advocating for the inclusion of AMR diagnostics within essential health service packages [32, 34]. While initial diagnostic expenses may be higher, diagnostic-driven treatment strategies have been shown to improve patient outcomes and minimize unnecessary drug exposure [11]. Despite the undisputed utility of laboratory diagnosis, encompassing microscopy, culture, and AST, in guiding appropriate antimicrobial therapy, particularly in resource-limited settings, there is a scarcity of cost studies specifically exploring these microbiology-specific diagnostics**.** Most existing economic data are inclined to clinical chemistry or newer, often more expensive, diagnostic technologies [12]. This gap is particularly concerning given the proven efficacy of AST in guiding targeted antibiotic use, thereby reducing the reliance on multiple or stepwise broad-spectrum antibiotic regimens that inevitably contribute to the development of AMR [35].

Therefore, this study was designed to assess the time, labor, and cost implications associated with various microbiological biochemical and AST tests in Zambia. By generating a detailed cost analysis, this research aims to provide critical evidence that can influence policy decisions regarding financing for AMR initiatives, ultimately championing the indispensable practice of pre-prescription diagnostic testing to guide antibiotic use.

Materials And Methods

Data were collected between December 2024 and March 2025 from 13 laboratories performing culture and antimicrobial susceptibility testing (AST) across nine provinces in Zambia: Muchinga (2), Lusaka (4), Northwestern (1), Southern (1), Northern (1), Eastern (1), Central (1), Western (1), and Luapula (1). Five provinces were classified as rural and three as urban. A structured questionnaire was administered to capture standardized information on human and material resource inputs required for microbiological testing. The questionnaire collected detailed quantitative and qualitative data [14] on time spent during key steps of bacteriological testing, including media preparation, culture and AST inoculation, and result interpretation. Additional information on Gram stain procedures included average smear reading time and volume of staining reagents used per test. Staff wage data were based on the Ministry of Health full-time salary for a Biomedical Technologist and were consistent across laboratories. Once data saturation was reached, defined as the point at which no new significant information emerged [13], the responses were averaged and summarized. These consolidated values were then entered into the WHO Laboratory Testing Costing Tool (LTCT) [3] to compute unit costs per microbiological test, allowing standardized estimation of direct and indirect costs. Information on testing requirements for microscopy, culture, and AST was obtained from the local laboratory standard operating procedures (SOPs), the American Society for Microbiology [36], and manufacturer protocols from Himedia [16], chosen to align with local supplier quotations. Three Zambian vendors provided detailed cost estimates in Zambian Kwacha, which were converted to U.S. dollars using OANDA [16] exchange rates. All reported costs excluded taxes for consistency. Laboratory reagent and equipment quotations were obtained following the Zambia Public Procurement Act of 2020 [37], which permits simplified bidding (minimum three bidders), limited selection, or single sourcing when only a few suppliers are available. Requests for quotations were sent to eight pre-identified suppliers; three responded for reagents and consumables, and one for equipment. Reliance on a single equipment quotation was legally compliant and reflected the limited supplier landscape [37]. Market prices were used to calculate per-test costs.

Data Analysis

Cost per test for microscopy, culture, biochemical tests, and AST, including tests for WHO Bacterial Priority Pathogen List organisms, was estimated using the WHO LTCT [3]. Key cost components included reagents and consumables, equipment (depreciation and usage), and staff time (converted from minutes to wage costs). Descriptive analyses were conducted using Julius AI [23], an artificial intelligence assistant that selects appropriate large language models to perform statistical analyses and generate code for data processing.

Figure 1 outlines the flow of events during data collection and analysis, highlighting the sequential steps followed in the study.

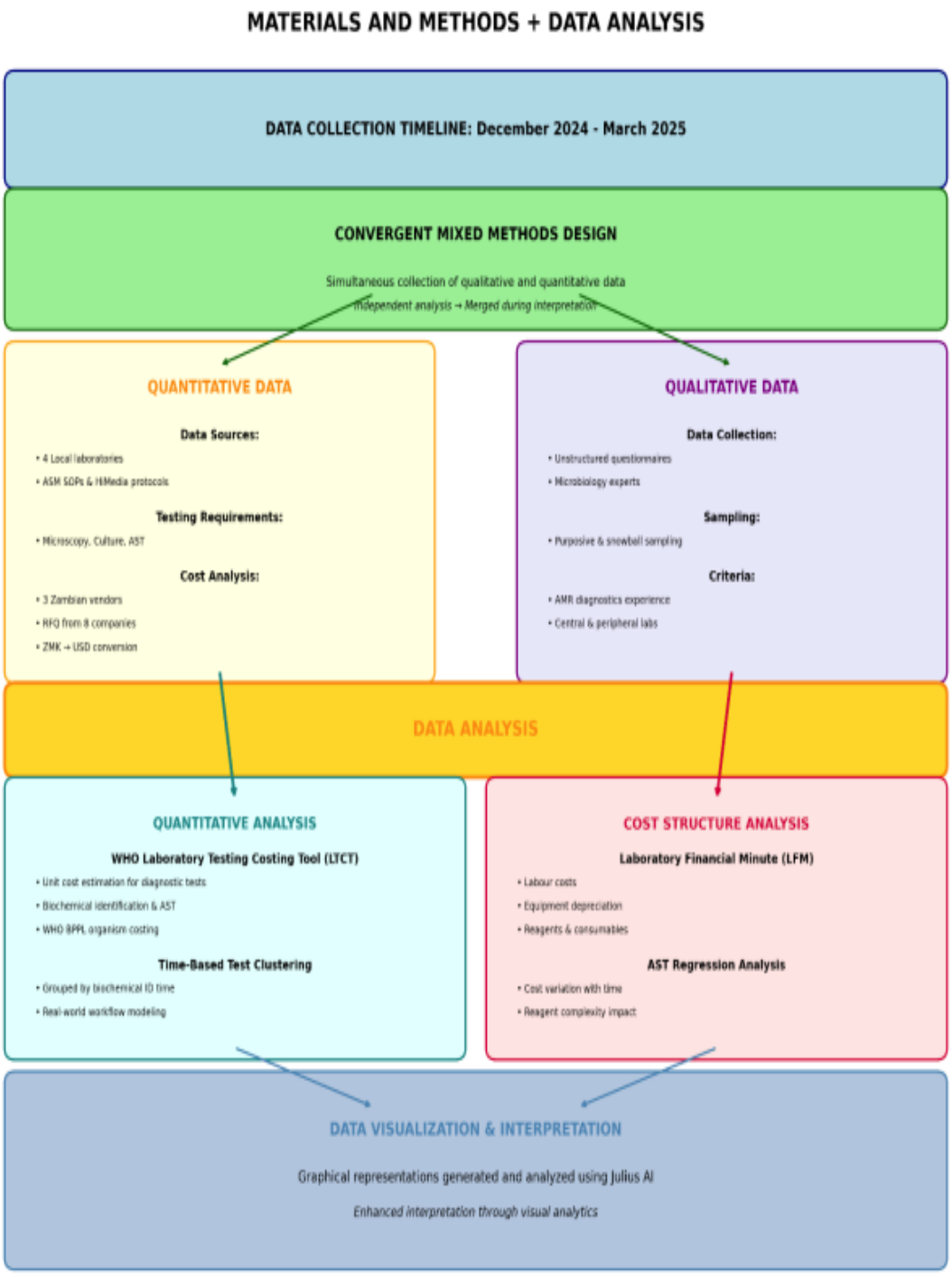


Figure 1. Methods and Materials Illustration

Results

Time Based Clustering of Biochemical Tests

The tests assessed in this study, grouped naturally into two categories based on LFM. High time-intensive tests, including Triple Sugar Iron (TSI), Kligler Iron Agar, SIM Medium, Simmon's Citrate, and Urease, each required approximately 78 minutes. These procedures involve the preparation of solid media, incubation periods, and multi-step interpretation, which significantly increase their time demands. In contrast, a second group of tests, Catalase, Coagulase, and Kovac's Oxidase, demonstrated substantially lower time requirements, averaging just 13 minutes per

test. These "quick tests" are rapid enzymatic or biochemical assays performed using slide or spot methods, with minimal preparation and no incubation, making them far less labor-intensive and more suitable for high-throughput diagnostic settings.

Cost Structure Breakdown of Biochemical Tests Based on LFM

High time-intensive tests, including Triple Sugar Iron (TSI), Kligler Iron Agar (KIA), SIM Medium, Simmon's Citrate, and Urease, had consistent total costs per test ranging from $4.25 to $4.49. Their cost composition was relatively uniform, with reagents and consumables accounting for $3.48–$3.72, fixed equipment costs of $0.35, and staff costs of $0.42, proportional to the longer processing time.

In contrast, the quick tests, Catalase, Coagulase, and Kovac's Oxidase, exhibited greater cost variability, with total costs ranging from $4.30 to $7.99. This variation was primarily due to reagent expenses ($4.23–$7.92), while equipment costs were negligible and staff costs remained minimal ($0.07). Notably, the Coagulase test emerged as the most expensive at $7.99, driven almost entirely by its high reagent cost, despite requiring only 13 minutes and no equipment—highlighting that reagent pricing can outweigh time or equipment in determining cost. Conversely, Simmon's Citrate Medium was the most economical test at $4.25, illustrating the cost efficiency of traditional in-house biochemical media.

The time-cost scatter plot reveals two distinct clusters of diagnostic tests, reinforcing that test duration does not directly predict total cost. While high-time tube tests (e.g., TSI, SIM) exhibit consistent, mid-range pricing due to balanced reagent, staff, and equipment inputs, rapid tests like Coagulase defy expectations by being among the most expensive, driven largely by high reagent costs. This decoupling of time and cost highlights the need for multidimensional analysis when evaluating test efficiency and financial sustainability. In summary, optimizing diagnostic protocols requires considering both workflow efficiency and cost composition, not just turnaround time. Figure 2 illustrates the cost distribution of biochemical tests and outline of laboratory financial minutes versus total cost per test.

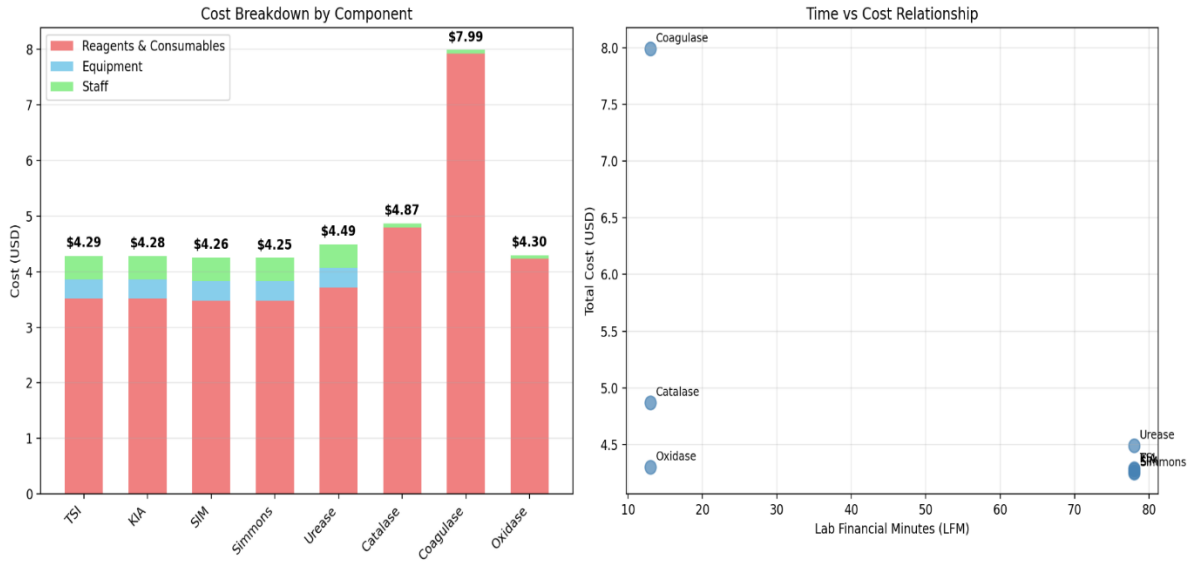


Figure 2. Cost Distribution of Biochemical Tests (left) and Outline of Laboratory Financial Minutes Versus Total cost per test

Regression Analysis: AST total cost as function of time and reagent complexity

The model comparison highlights that reagent costs are the strongest predictor of total antimicrobial susceptibility testing (AST) costs, with a perfect fit ($R^2 = 1.000$, RMSE ≈ $0). Time-based models also predict well ($R^2 = 0.991$), while complexity contributes moderately ($R^2 = 0.658$). A high F-statistic (627.78) confirms statistical significance. The inverse time-cost trend reflects that rapid AST methods are more expensive, despite shorter durations. In practice, laboratories should prioritize reagent cost control for budgeting and procurement. Financial models like Total Cost ≈ $1.14 + 0.90 × Reagent Cost offer accurate, simplified forecasting tools for cost-efficient decision-making and planning. Figure 3 outlines the regression analysis reveals a fascinating cost structure in antimicrobial susceptibility testing that follows predictable mathematical relationships.

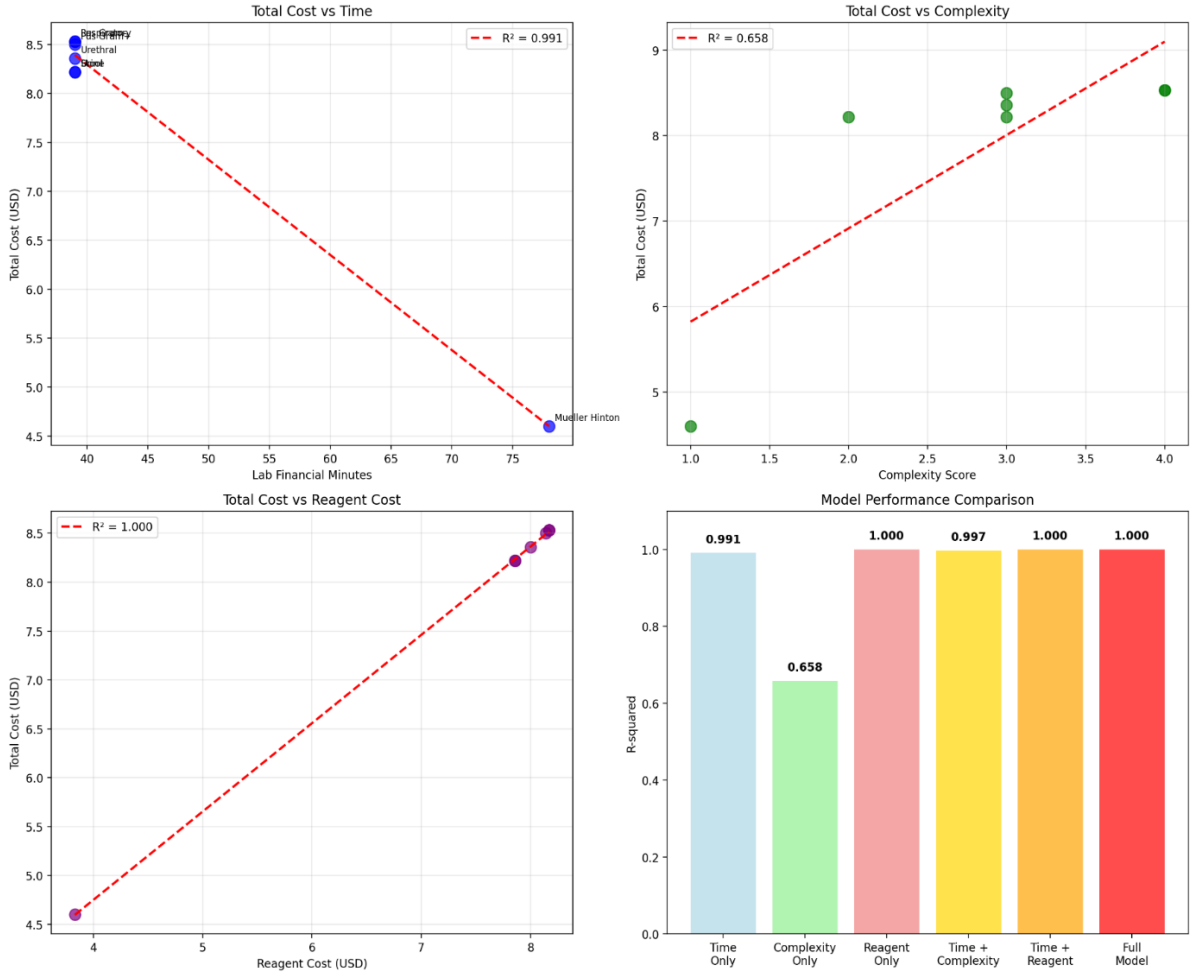


Figure 3. The Regression Analysis Reveals a Fascinating Cost Structure in Antimicrobial Susceptibility Testing that follows Predictable Mathematical Relationships

Discussion

Efficiency Metrics and Workflow Implications

This study's analysis of LFM reveals two distinct temporal clusters of biochemical tests, reflecting underlying methodological and operational differences. High time-intensive tests (e.g., TSI, Kligler Iron Agar, SIM Medium, Simmon's Citrate, and Urease) averaged 78 minutes and aligns with traditional culture-based diagnostic workflows. These procedures involve multiple steps, media preparation, inoculation, incubation, and interpretation, each contributing to extended

turnaround times. Such temporal patterns are consistent with established microbiology workflows that categorize tests by complexity and time investment [24].

Conversely, rapid tests (Catalase, Coagulase, and Kovac's Oxidase) averaging 13 minutes showcase the efficiency of enzymatic spot methods. These rely on immediate biochemical reactions, enabling real-time interpretation and eliminating the need for incubation. The resulting six-fold throughput improvement has meaningful implications for operational efficiency and clinical responsiveness.

Despite the clear differences in LFM, cost analyses revealed a paradoxical decoupling between test duration and total cost. High-intensity tests demonstrated tightly clustered costs ($4.25–$4.49), driven by standardized reagents, consistent equipment usage ($0.35), and proportional labor allocation ($0.42). These findings reflect mature, optimized workflows that benefit from economies of scale in traditional microbiological testing and resonates with the call for Africa to enhance local manufacturing unlike the current situation where 70% and 100% of finished pharmaceutical products, 99% of vaccines, and nearly all medical devices and active pharmaceutical ingredients are imported [28].High cost of reagents can increase inequalities amongst vulnerable communities, driving local manufacturing could potentially reduce the gap in access [20, 29].

In contrast, rapid tests exhibited a wider cost range ($4.30–$7.99), with reagent costs emerging as the dominant variable. This variability underscores the influence of proprietary or commercially prepared reagents in rapid testing protocols. For example, the Coagulase test, despite minimal time and equipment needs, had the highest overall cost ($7.99), largely due to the use of specialized non-in-house reagents. This reinforces the critical role of reagent pricing in determining diagnostic cost structures, independent of complexity or time investment.

These observations have important operational and financial implications. The consistent cost structure of high-LFM tests supports predictable budgeting and centralized procurement strategies. In contrast, the volatile cost profile of rapid tests demands flexible financial planning and emphasizes the importance of strategic reagent sourcing. Furthermore, the weak linear relationship between LFM and total cost, evident in scatterplot analyses, highlights the inadequacy of time alone as a predictor of financial burden. This non-linearity confirms that cost-effectiveness cannot be inferred solely from test duration, a finding consistent with other studies showing that time-efficient tests may be more economical in multitasking environments or settings with part-time staffing [18, 19, 22].

Strategically, laboratories can use these insights to optimize workflow and resource allocation. High-intensity tests may benefit from batch processing [26] and scheduling efficiencies, while rapid tests may require focused cost control strategies such as reagent substitution, supplier negotiation, or selective menu optimization [27]. The identification of Coagulase testing as a cost outlier within the rapid cluster further illustrates the need for test-specific economic evaluations.

Cost Structure and Predictive Modeling

The exceptional predictive power of reagent costs in this analysis underscores the fundamental economics of antimicrobial susceptibility testing (AST), where consumables consistently represent the largest variable cost component. This finding corroborates existing literature in clinical laboratory economics, which consistently identifies reagent expenditure as the primary financial concern for laboratory operations [25]. The near-perfect correlation between reagent costs and total testing expenses suggests that other cost elements, such as

labour, equipment depreciation, and overheads, remain relatively constant across AST methodologies. As such, reagent costs serve as a practical proxy for estimating overall AST costs, simplifying budget forecasting and resource allocation.

One of the most notable findings in the cost breakdown is the remarkably narrow cost range across different AST test types, with only a $0.31 variation. This tight distribution highlights a significant degree of standardization in test materials and procedural workflows, particularly due to the universal use of Mueller Hinton media. The implication for laboratories is substantial, such consistency allows for streamlined procurement, improved budgeting accuracy, and more predictable cost modelling, key factors for national health programs seeking to scale up or decentralize AST services [31].

The analysis further reveals that nearly 90% of AST costs are attributable to reagents and consumables. Equipment and labour contribute minimally to total costs, offering laboratories an opportunity to exert financial control by focusing on reagent-related strategies. Approaches such as bulk purchasing, vendor negotiations, and the use of locally manufactured media can significantly enhance cost efficiency [29]. These strategies align with findings from other studies advocating for localized procurement and inventory management systems as mechanisms for ensuring financial sustainability in laboratory services [12, 21].

However, it is critical to recognize that cost should not be the sole determinant in the decision to introduce or scale up AST. Several studies have demonstrated that despite higher testing costs, the use of faster and more sophisticated diagnostics can result in substantial downstream clinical benefits, including reduced turnaround times, shorter hospital stays, and more targeted antimicrobial use [21, 22]. These outcomes ultimately contribute to broader health system savings and better patient care.

The strong performance of time based cost prediction models ($R^2 = 0.991$) presents an alternative lens for laboratory cost modelling, especially for operational planning. The high correlation likely reflects the integrated demands of AST systems, where longer tests require more reagents and labour. Yet, the slightly lower predictive value compared to reagent cost models suggests that time alone cannot account for variations in reagent quality or procurement dynamics.

In contrast, test complexity demonstrated only moderate predictive power ($R^2 = 0.658$), challenging the assumption that more intricate protocols directly equate to higher costs. This may reflect the efficiency gains from automated systems or inadequacies in the way complexity is currently measured. It also implies that economies of scale may neutralize the expected cost burden of complex tests.

Conclusion

This study demonstrates the natural clustering of biochemical tests into distinct temporal and cost categories, highlighting critical differences in diagnostic methodologies and their operational implications. High-intensity tests exhibited consistent costs and balanced resource utilization, whereas rapid tests showed substantial cost variability, largely driven by reagent prices. The observed decoupling between test duration and total cost challenges conventional assumptions about time-based efficiency and emphasizes the dominant influence of reagents on overall expenses. These findings provide a framework for optimizing test selection, resource allocation, and workflow planning in clinical laboratories.

The study has several limitations. The cost analysis focused primarily on direct expenses and did not fully capture indirect or hidden costs such as maintenance, infrastructure, training, or regulatory compliance.

Additionally, cost models did not account for bulk purchasing agreements, supplier-specific pricing, or regional market fluctuations. Time data were based on standard laboratory minutes and may not reflect real-world variations in technician performance or workload distribution.

Future research should integrate clinical outcomes, including patient recovery, antimicrobial stewardship metrics, and hospital length of stay, to develop comprehensive assessments of diagnostic value. Multi-centre and cross-regional studies are recommended to validate findings across diverse laboratory contexts. Exploration of emerging technologies, such as molecular diagnostics and AI-enhanced systems, will be important for forecasting future cost structures and guiding investment in laboratory infrastructure and innovation.

Based on these findings, several strategic recommendations emerge. Laboratories should prioritize reagent cost management through bulk purchasing, local sourcing, and supplier negotiation. Monitoring cost-per-test, particularly for rapid diagnostics with high variability, will enhance financial control. Workflow optimization should consider separate processing tracks for high-intensity and rapid tests, and in-house media preparation can reduce dependence on commercial products. Test selection should align with clinical urgency, using rapid tests for time-sensitive cases and high-intensity tests for routine procedures. Staff training should emphasize time-cost dynamics to improve task efficiency. At the policy level, the results can inform the design and scale-up of antimicrobial susceptibility testing programs, supporting evidence-based investment and procurement decisions. Replicating similar cost-time analyses in multiple laboratory settings will strengthen generalizability and promote more efficient, sustainable, and data-driven diagnostic services.

Ethical Consideration

Ethical approval was obtained from the University of Zambia Biomedical Research Ethics Committee (UNZABREC), 6016-2024 and the National Health Research Authority (NHRA), approval number NHRA-1802/18/12/2024. Informed consent was secured from all participants.

Data Availability

The datasets generated and analysed during this study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare no conflict of interest.

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Author Contribution

All authors contributed to the study in specific ways as outlined below:

1. **Lutinala Nachilembo Nalomba:** Lutinala led the conceptualization and design of the study and was primarily responsible for developing the research proposal. She took the lead in reviewing the data analysis and drafting the report and also spearheaded the writing and critical revision of the manuscript.
2. **Mox Kalumbi:** Mox played a key role in developing the data collection tool and provided practical insights into on-site

microbiology practices. He participated in data collection and contributed to reviewing both the proposal and the manuscript.

3. **Baron Yankonde:** Baron contributed to the development of the data collection tool and offered practical input on microbiology practices during fieldwork. He participated in data collection, reviewed the proposal and manuscript, and supported the compilation of technical requirements and distribution of vendor quotation requests.
4. **Pascalina Chanda-Kapata:** Pascalina contributed to the study's conceptualization and design and supported the development of the proposal. She also participated in reviewing the data analysis, report, and manuscript.

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Adherence to Anti-hypertensive Medication among Geriatric Hypertensive Patients in Mandeville, Jamaica

Ainsworth M. Reynolds[1*], Antor Odu Ndep[2], Moyosola A. Bamidele[3]
[1]*School of Public Health, Texila American University*
[2]*Department of Public Health, Faculty of Allied Medical Sciences, University of Calabar, Calabar, Nigeria*
[3]*School of Global Health & Bioethics, EUCLID University, The Gambia*

Abstract

This study assesses adherence to hypertensive therapy among geriatric hypertensive patients in Mandeville, Jamaica, in two different clinical settings. A clinic-based cross-sectional survey will be conducted in five comparable Level 5 health centers and at the Mandeville Regional Hospital in Jamaica among geriatric patients aged 65 years and older. Individuals will be selected purposively for both study sites. A Quantitative sample size of 220 participants will be surveyed using a semi-structured self-administered questionnaire. The Hill-Bone Compliance Scale and the Morisky Medication Adherence 8-item Self-Report Scale will be incorporated into the data collection instrument. The Qualitative part of the study will involve 23 participants and employ an interpretivist approach, using in-depth interviews. An interview guide will be used to collect data from participants diagnosed with hypertension for at least five years at the time of the interview and who attend the hypertension clinic at Mandeville Regional Hospital, Jamaica. Data collected from the quantitative analysis will be coded and entered into Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) software, version 21. Thematic analysis, employing an inductive approach, will be applied to the qualitative data analysis. Before the study is conducted, ethical approval will be sought from the Southern Regional Health Authority and the Ministry of Health Ethics Committee for both study sites. The data are expected to reveal the level of adherence to hypertensive therapy among geriatric patients in Mandeville, Jamaica. Based on the findings, recommendations will be made.

Keywords: *Adherence, Diastolic Blood Pressure, Geriatrics, Hypertension, Systolic Blood Pressure.*

Introduction

The Centers for Disease Control and Prevention defines hypertension (HTN) as blood pressure at 130/80 mmHg or higher. HTN affects populations worldwide. Ref. [1] state that HTN is "the single most important contributor to mortality and morbidity". More than 7.5 million deaths each year are attributed to uncontrolled high blood pressure (BP). Uncontrolled high BP can lead to comorbid conditions such as renal diseases, cardiovascular disease, and irregular heartbeat that may result in sudden death (World Health Organization [WHO], 2019). According to the Centers for Disease Control and Prevention (CDC), more than 859,000 Americans die of heart disease, stroke, and other cardiovascular diseases every year, which is approximately one-third of all casualties in the United States (U.S.) [1].

These diseases can harm the economy, costing our healthcare system around $213 billion annually [1]. Heart disease and stroke

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****Corresponding Author: Areynolds184@gmail.com***

are the first and fifth leading causes of death each year [1]. National risk factors for heart disease and stroke include the following: (a) high blood pressure, (b) high low-density lipoprotein cholesterol, (c) diabetes, (d) smoking, including second-hand smoke, (e) obesity, (f) unhealthy diet, and (g) physical inactivity [1]. Hypertension is one of the most common diseases affecting humans worldwide (U.S. Department of Health and Human Services Administration [5].

Studies suggest that many. older hypertensive patients are unable to achieve optimal blood pressure control because of poor. adherence to antihypertensive medications [2]. Poor adherence is related to illness. perception, discomfort caused by side effects, poor provider relationships, and low self-efficacy. [2]. In addition, it can lead to worsening of disease, increased comorbid disease, increased healthcare costs, and death [3].

A Healthcare Informatics report explained that countries are spending a significant amount of money to increase patient medication compliance. If patients start taking medication as prescribed, the healthcare industry can save on expenditures, such as the utilization of healthcare services and the cost of patient care in urgent hospitalization visits [1, 6, 7] determined that the cost of medication adherence related to disease management is less than that of hospitalization due to non-adherence. Medication adherence helps manage controllable diseases and can automatically reduce the burden on hospitals and urgent care clinics during emergency cases. In addition, medication adherence not only reduces the cost of diagnostic evaluations during emergency visits but also decreases the number of patients in the emergency room, thereby improving the quality of patient care [3]. Non-adherence or poor medication adherence can severely compromise the effectiveness of treatments, making this a critical issue in population health from both quality-of-life and health-economic perspectives [4]. Various factors can influence treatment adherence. Healthcare providers are responsible for identifying barriers to antihypertensive medication adherence, which is crucial for managing hypertension (HTN) and preventing complications. Improved adherence could prevent mortality, improve quality of life, and increase patient lifespan. Future developments for medication adherence in hypertension are likely to focus on integrating advanced technology like smart pill bottles, digital sensors, and wearable devices to monitor medication intake in real-time, alongside personalized patient education, streamlined medication regimens, and improved healthcare provider communication to address barriers to adherence and empower patients to manage their hypertension actively.

Poor blood pressure control will lead to significant public health challenges for the Caribbean in the twenty-first century. Non-adherence, poverty, lack of knowledge, and inadequate follow-up are the primary factors contributing to poor blood pressure control [3]. According to the Jamaica Health and Lifestyle Survey 2015, there were 6,457 deaths from CVD in 2019; for age-standardized mortality from CVD, it ranks in the bottom 40% of countries when ordering from the highest to the lowest. According to the WHO, more than 7.5 million deaths each year are attributed to uncontrolled high blood pressure (BP). Nonadherence to therapeutic strategies amongst geriatrics is a serious concern that poses a significant challenge to successful healthcare delivery. This phenomenon is widespread and has been reported worldwide [2]. Hypertension is poorly controlled due to a lack of adherence to the treatment regimen. The prevalence of poor treatment ranges from 67% to 74%, as reported in [3]. Moreover, poor blood pressure control has consistently been linked to long-term complications [1]. The 2016-2017 Jamaica Health and Lifestyle Survey reported that 35.8% of women and 31.7% of men in Jamaica have hypertension. The point prevalence of hypertension in the 15-

and-over age group is 30.8%. According to the Ministry of Public Health, in 2014, 19.4% of women and 23.4% of men in Cuba were hypertensive. A 2021 report from the WHO stated that Haiti had a 48% prevalence of hypertension, making it one of the countries in the Caribbean with the highest prevalence of the condition. The prevalence of hypertension in Jamaica is high, especially among the elderly. According to the 2012 Jamaica Health and Lifestyle Survey II, the prevalence of hypertension was 46.2% among people aged 45–64 and 54.1% among those aged 65–74.

This research aims to assess treatment adherence among clients educated by nurses, doctors, or nutritionists in the management of hypertension and recommend ways to improve adherence and achieve adequate blood pressure control, ultimately leading to a better quality of life for hypertensive patients. Thus, applying the recommended approach may facilitate significant improvements in the effective management of hypertension. Administrators will be guided on what should be emphasized in intervention planning and implementation. The results will be shared with patients attending hypertensive clinics, healthcare workers, and interested parties at scheduled seminars or workshops.

A study on medication adherence conducted across two settings may face limitations due to differences in patient populations, healthcare access, cultural norms, socioeconomic factors, and the methods used to measure medication adherence in each setting. This could make it difficult to compare results and potentially lead to misleading conclusions [4]. To reduce bias in a medication adherence study comparing two different patient populations, researchers can implement strategies like carefully matching patient groups on key demographic and clinical variables, using standardized data collection methods across populations, blinding researchers to patient group assignments, employing objective measures of adherence, and considering potential cultural or socioeconomic factors that could influence adherence when interpreting results.

Methods

Study Area

The research study will be conducted at five types of health centers, which are government facilities located approximately 15-20 kilometers outside Mandeville, Jamaica. The borders are Meru County to the northeast and north, Embu County to the southwest and south, and Kitui County boundaries to the southeast and east. The division lies between latitudes 0° 15’ 0” and longitudes 37° 1’ 45”. The study will be carried out in the medical outpatient clinics. These sites were selected because most patients with hypertension detected from level 2, level 3, and level 4 health systems were referred to Mandeville Regional Hospital, level 1 for specialized management and the obtainability of hypertensive medication. The facility offers additional clinics, including eye, surgical, medical, paediatric, and a comprehensive care clinic for HIV patients.

Study Design

For both studies, a clinic-based cross-sectional survey will be conducted in five (5) comparable-level 5 health centers and at the Mandeville Regional Hospital in Jamaica among geriatrics aged 65 years and older over six months. Individuals will be selected using convenience sampling at both study sites. A Quantitative sample size of 220 participants will be surveyed using a semi-structured self-administered questionnaire. The Hill-Bone Compliance Scale will assess patients in three important behavioral domains related to high blood pressure treatment: reduced sodium intake, medication adherence, and appointment attendance. The Morisky Medication Adherence 8-item Self-Report Scale will also help elucidate the degree of nonadherence to prescribed medication.

A deductive approach will also be employed in the thematic content analysis.

The Qualitative research study design will entail a sample size of 23 participants and employ an interpretivist approach, utilizing in-depth interviews. An interview guide will be used to collect data from participants diagnosed with hypertension for at least 5 years at the time of the interview and attending the hypertension clinic at Mandeville Regional Hospital, Jamaica.

Data collected from the quantitative analysis will be coded and entered into Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) software (version 21) for statistical analysis.

Thematic analysis with an inductive approach will be applied. Before the study is conducted, ethical approval will be sought from the Southern Regional Health Authority and the Ministry of Health Ethics Committee for both study sites. Informed consent will be obtained from participants before the questionnaire is distributed, and respondents will be informed that their participation in the survey is voluntary.

Target Population

The study population consisted of 562 hypertensive patients receiving antihypertensive treatment and attending Type 5 health facilities and the Mandeville Regional Hospital hypertension clinic. This mixed-methods study, combining quantitative and qualitative methods, will involve 489 participants from five Type 5 health facilities across Mandeville and 73 participants from the Mandeville Regional Hospital in Jamaica. Most participants in this study reside in communities adjoining to Mandeville, and the majority are retired or unemployed. Those employed are in the middle-income bracket; some live within a reasonable distance of health centers and public hospitals, while others must travel considerable distances to reach health facilities. The percentage of geriatrics with hypertension aged 65 and older in Mandeville remains high at 4.2% of the Jamaican population (National Health Fund Survey, 2020).

Distribution of Study Population

Health Centres	Frequency	Percentage
Health Centre I (Colleyville District)	44	20
Health Centre II (Langley District)	44	20
Health Centre III (Lincoln District)	44	20
Health Centre IV (Cedar Valley District)	44	20
Health Centre V (Hatfield District)	44	20

Sampling Frame

The sampling frame will encompass known hypertensive geriatric patients attending five government clinics in Mandeville, Jamaica, who receive antihypertensive medications during the study period. These clinics are similar in capacity, provide usual geriatric care services, and include a pharmacy.

Sample Size Determination

The sample size will be determined by using the Yamane (1967) formula shown below:

$$n = \frac{N}{1 + Ne^2}$$

Where:

$n =$ Representative sample size

$N =$ Total population size

$e =$ Desired level of precision

After consultation with clinics, I have determined that with five (5) clinics, the calculated hypertensive geriatric population (N) would be more than or equal to 489. The desired level of precision (e) is ±5%. The representative sample size (n) is therefore given by:

$$n = \frac{489}{1 + 489(0.05)^2} = \frac{489}{2.2225} = 220$$

So, a sample of 220 hypertensive patients from a total of 489 is needed.

Sampling Procedure

Convenient sampling will be used to select the sample population. This method was chosen since attendance may vary among clinics. It will be on a first-come, first-served basis and should allow faster, more efficient data collection.

Inclusion Criteria

1. Participants over 65 years of age were diagnosed with hypertension.
2. Participants who reside in Mandeville, Jamaica.
3. Participants who will consent to participate in the research study.

Exclusion Criteria

1. Participants younger than 65 years old.
2. Participants who are too ill to participate in the study.

A purposive sampling method will be used to select clinic attendees at the Mandeville Regional Hospital who the researcher believed could provide adequate information. The recruitment process will involve the researcher being permitted to be present in the waiting area, where they will introduce themselves to prospective participants, share pertinent information about the research, and request their participation. If you are interested, we will exchange contact information and provide additional details about the interview process. The researcher will attend the first and second fortnightly clinics and recruit participants on each occasion. Recruitment will begin when individuals arrive at the clinic and wait to be processed. Each interview will take at least 45 minutes; participants will be selected based on the number who need to be seen by clinicians.

Conclusion

The data are expected to reveal the level of adherence to hypertensive therapy among geriatric patients in Mandeville, Jamaica. Based on the findings, recommendations will be made.

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Community-Led Initiatives in Building Resilience to Flooding and Resulting Waterborne Diseases in Africa: A Scoping Review

NKERIFAC Christine Akasing[1*], BANGWEN Eugene Ndim[2], Brama KONE[3]
[1]*Public Health Administration, Texila American University, Guyana*
[2]*Institute of Tropical Medicine, Antwerp, Belgium*
[3]*Research Guide, Texila American University*

Abstract

Flooding ranks among the most frequent natural disasters in Africa often leading to outbreaks of waterborne diseases. This places considerable strain on already vulnerable communities. While top-down disaster management approaches are crucial, African communities have developed innovative strategies to enhance resilience to flooding and its related consequences. This scoping review explores the nature, scope, and effectiveness of community-led initiatives addressing flood resilience and associated waterborne diseases across African settings. Articles, reports, and case studies published between 2010 and 2025 that provided empirical evidence on community-based interventions targeting flooding and waterborne diseases across Africa were reviewed. Findings revealed a wide range of community-led strategies across Africa aimed at building resilience to flooding and mitigating waterborne diseases. Key interventions included community-based early warning systems, flood-resistant infrastructure, participatory water and sanitation management, hygiene education, and localized disease prevention efforts. Communities also leveraged social networks, indigenous knowledge, and decentralized resource management to strengthen preparedness and recovery. These approaches were linked to reduced disease incidence, such as cholera and dysentery, and improved infrastructure resilience. However, implementation was often hindered by limited financial and technical resources, poor coordination with government structures, rapid urban growth, and the escalating impacts of climate change. Community-led initiatives are vital in enhancing resilience to flooding and mitigating the impacts of flooding and waterborne diseases in Africa. Future efforts should focus on scaling and integration of broader resilience strategies for sustainable impact.

Keywords: *Africa, Community-led Initiatives, Flood Resilience, Waterborne Diseases.*

Introduction

Flooding ranks among the most frequent and devastating natural disasters globally. With the rising challenges associated with climate change and the increasing occurrence of extreme weather events, this is likely to increase over the coming years. While the immediate impacts of flooding are mainly those associated with immediate physical damage, floods could also result in significant medium to long term effects such as investment, labour, productivity, migration and overall economic growth, which could be very substantial [1]. These risks are of particular concern to Sub-saharan Africa where the already fragile economic and health systems increase vulnerability to the effects of flooding.

In Sub-Saharan Africa, a substantial number of flood events have been registered over the last twenty years. The most renowned include a major flood in Nigeria in 2022 and the

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****Corresponding Author: cnkeri16@gmail.com***

devastating flood in Libya in 2023. While no direct causation has been established, flooding has repeatedly triggered large cholera outbreaks with thousands of cases and deaths. A 20 analysis conducted in 40 Sub-Saharan countries found that flooding was associated with a 144-fold increase in cholera outbreaks compared to periods without floods [2]. Conflict zones such as Sudan face compounded risks of physical damage, displacement, increased outbreak potential and overwhelming health systems. Besides diseases with a more direct link, such as cholera, others, such as malaria, typhoid, as well as some respiratory infections due to poor sanitation post-floods and an increased breeding sites for vectors [2], have been associated with flooding and major diseases. There is a strong association also demonstrated by the recent surge in the incidence of cholera, typhoid and other diarrhoea diseases over the last decade, which could be associated with limited WASH services after floods.

While technical interventions are essential, there is growing evidence that suggests community-led initiatives may offer more sustainable context-specific solutions. Top-down disaster management approaches have been implemented.

To date, no comprehensive synthesis has examined the scope, characteristics, and effectiveness of community-led strategies to mitigate the health impacts of flooding in Africa. These Community-led initiatives involve the local populations in the entire process of planning, implementing, and maintaining interventions crafted to suit their unique environments. This scoping review aims to map and summarize the existing evidence on such initiatives, with particular attention to their role in preventing waterborne diseases.

Flooding and the resulting contamination of water sources put a considerable strain on already vulnerable communities. It leads to direct physical damage, displacement, and the radical multiplication of waterborne diseases, such as cholera, typhoid, and dysentery. While government-led responses have been vital, local communities have increasingly developed their resilience strategies to cope with recurring floods and mitigate health impacts. Thus, harmonizing government efforts with community-led initiatives offers a vital strategy to address this problem.

General Question

How do community-led initiatives contribute to building resilience against flooding and associated waterborne diseases in Africa?

Specific Questions

1. What are the community-led initiatives used to enhance resilience to flooding and reduce the occurrence of waterborne diseases?
2. What are the outcomes of these initiatives in terms of reducing flood risk and reducing community vulnerability to waterborne diseases?

General Objective

The overall objective of this scoping review is to assess and understand the extent and type of evidence regarding community-led initiatives aimed at building resilience against flooding and related waterborne diseases in Africa.

Specific Objectives

1. To examine existing literature on community-led flood resilience initiatives in Africa.
2. Identify key interventions used by communities to prevent and manage waterborne diseases post-flooding.
3. Highlight factors enabling the success of community-led initiatives and key challenges faced in the African regions.

Methods

This review followed the JBI methodology for scoping reviews [3] and systematically examined peer-reviewed literature, reports, and

case studies on community-led resilience to flooding and waterborne diseases in African countries. The study was equally guided by the Arksey and O'Malley review framework, which provides a structured approach to mapping key concepts and identifying gaps in existing literature [4].

Inclusion Criteria

The inclusion criteria emphasized studies of interventions explicitly described as community-based, with clear outcomes related to flood resilience and waterborne diseases.

1. Studies published between 2010 and 2025
2. Empirical research on community-led flood resilience in Africa
3. Papers discussing waterborne disease prevention within flood-affected communities.

Exclusion Criteria

The exclusion criteria used to eliminate duplicate literature involved deleting references with the same title and author, and those published in the same year. Studies without empirical data or unrelated to African contexts were also excluded.

Studies were selected based on relevance, geographical focus, and thematic alignment with the research objectives. Inclusion criteria encompassed:

This review considered qualitative and analytical observational studies that focus on qualitative data, including, but not limited to, designs such as phenomenology, grounded theory, ethnography, qualitative description, and action research. Text and opinion papers were also considered for inclusion in this scoping review.

Context

African communities traditionally rely on collective resilience through indigenous knowledge systems, social cohesion, and aid networks. Cultural practices such as communal water purification techniques and flood warning rituals play significant roles in grassroots disaster response. There are disparities between rural and urban communities: Urban populations face additional infrastructural challenges and lower access to traditional resilience frameworks. Also, religious and ethnic dynamics also influence resilience-building, as faith-based organizations and tribal groups often lead disaster recovery efforts.

Gender roles in African societies are known to influence water and sanitation management, with women often leading hygienic practices and disease prevention efforts at the household level. Socioeconomic inequalities also shape resilience, as poorer communities experience higher exposure to flood risks due to substandard housing and inadequate healthcare access.

Search Strategy

Academic databases (Google Scholar, PubMed, ResearchGate, and the African Journals Online (AJOL)) were searched, and relevant literature from studies within the last fifteen years (2010-2025) was reviewed. The basic research strategy was based on the research question, including all identified keywords, and adapted for each database. Searched key terms included the following:

1. "Community resilience and flooding in Africa."
2. "Waterborne diseases and community response."
3. "Flood mitigation strategies in African communities".
4. "Grassroots health interventions in disaster settings."

Source of Evidence Selection

Following the search, all identified citations were assembled and uploaded into Zotero, and duplicates were removed. Following a pilot test, titles and abstracts were screened by two independent reviewers to assess compliance with the review's inclusion criteria.

The full text of selected publications was assessed in detail against the inclusion criteria by two independent reviewers. Reasons for excluding sources of evidence at full text that did not meet the inclusion criteria were recorded, and disagreements that arose between the reviewers at each stage of the selection process were resolved through discussion. The results of the search and the study inclusion process are reported in this scoping review and presented in the PRISMA flow diagram below (Figure 1).

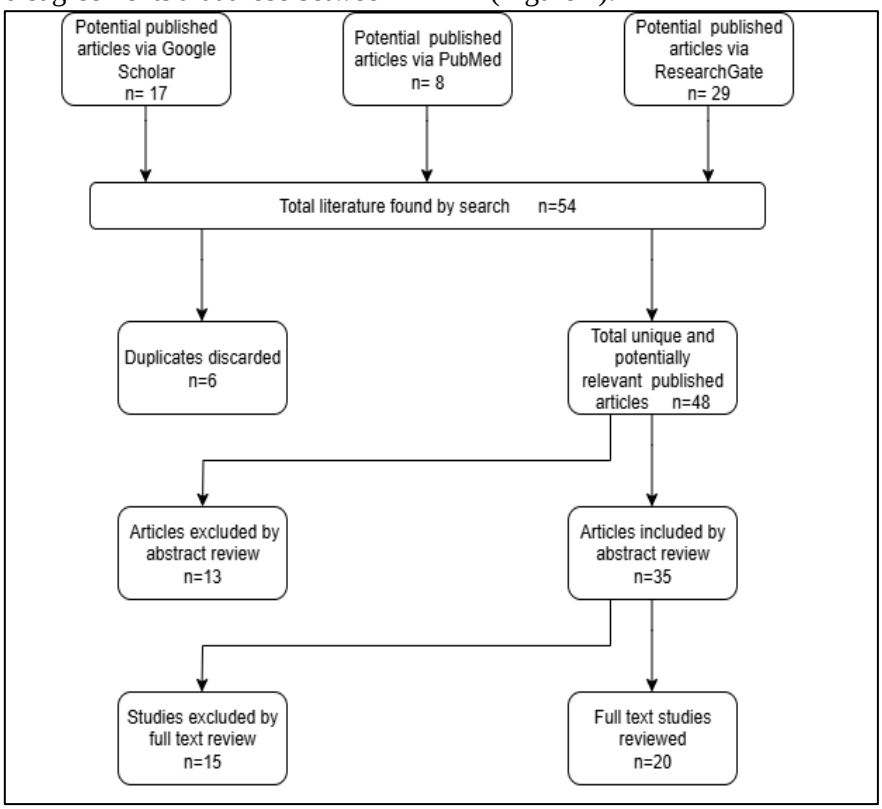


Figure 1. PRISMA flow Diagram for the Identification of Studies for this Review

Data Extraction

Two independent reviewers developed a data extraction tool used to extract data from the included papers. The data extraction tool, a self-developed structured data extraction matrix, is shown in Table 1 below. The data extracted includes specific details about the location, study methods, specific resilience outcomes, waterborne diseases outcomes, challenges and facilitators.

Table 1. Data Extraction Matrix Used

Review Data Extraction Matrix					
Study location (country, urban/rural setting)	Citation details (author, year, journal/source)	Methodology (qualitative, quantitative, mixed methods)	Community-led interventions (specific resilience strategies)	Waterborne disease outcomes (types, prevalence, interventions)	Challenges and facilitators (barriers to implementation, enabling factors)

A draft extraction form was prepared and was later modified and revised as necessary by reviewers to produce the data extraction tool. This tool facilitated the process of extracting data from each included evidence source. Disagreements that arose between the reviewers were resolved through discussion.

Results

Diverse community-led initiatives were identified, ranging from constructing flood barriers and improving drainage systems to hygiene education programs and water purification activities; active community participation facilitated these initiatives. Findings are outlined below; meanwhile, the product of the data extraction process is presented in Table 2.

Community-Led Flood Resilience Initiatives

The review highlighted the following approaches communities used to enhance flood resilience:

1. **Community-Based Early Warning Systems:** Local residents utilized indigenous knowledge, mobile alerts, and radio broadcasts to predict and prepare for floods [5-7]. Other communities set up community-based disaster readiness and response [8].
2. **Flood-Resistant Infrastructure:** Communities innovated affordable drainage systems, elevated homes, and communal flood shelters [9, 7]. Improved houses usually involved raising yard levels, building new homes in safer areas, and adhering to resettlement plans [10]. Other studies showed that traditional practices, such as elevated building techniques and the use of natural barriers [11] were very effective.
3. **Participatory Water Management:** In flood-prone areas, collective efforts focused on maintaining clean water sources through filtration systems and community-led sanitation drives [12, 13].
4. **Social Networks and Mutual Aid Groups:** Enhanced community cohesion and local networks proved critical in timely response and recovery efforts [14, 15]. Informal organizations facilitated disaster preparedness and relief efforts, ensuring equitable distribution of resources among vulnerable populations [10].
5. **Decentralized resources management:** Local management of resources such as communal funds, exhibited significant efficiency [15].
6. **Local restructuring:** Restructuring of housing units was a strategy to minimize water damage and involved the construction of communal drainage systems by residents themselves. Some communities went further to create local evacuation teams and safe havens [16].
7. **Knowledge sharing:** Some communities locally pursued the enhancement of public awareness of flood risks and promoted the adaptive capacity of communities [17].

Community Interventions to Prevent and Manage Waterborne Diseases

Post-flooding communities engaged in:

1. **Localized Hygiene Education:** Public health awareness campaigns were used to teach proper water storage, purification techniques, and sanitation practices [18].
2. **Strengthening communication channels:** Various information channels were used to improve knowledge, attitude and practice towards the management of diseases [19].
3. **Distribution of water purification tablets:** Some communities embarked on the distribution of water purification tablets for drinking water treatment at the household level [18].
4. **Health sector involvement:** Collaboration between local communities and the health sector was an approach to address routes and sources of fecal transmission and contamination in some areas [20].

Challenges in Implementing Community Resilience Strategies

Several barriers obstructed the effectiveness of community-led resilience initiatives:

1. **Insufficient government intervention and poorly coordinated flood management:** There was a lack of connection between national and local strategies [16, 15].
2. **Rapid population growth and increased housing density:** Rapid population increase led to poorly calculated/organized land occupation thereby rendering flood management more difficult [16, 10].
3. **Climate variability:** Increased climate change seriously limited the effectiveness of some community resilience initiatives [14].
4. **Limited resources:** Financial constraints and lack of specialized technical knowledge were the most common hindrances to the implementation of community resilience initiatives [9].

Table 2. Summary of the Themes and their Corresponding Studies

Review Data Extraction Matrix					
Study location (country, urban/rural setting)	**Citation details** (author, year, journal/source)	**Methodology** (qualitative, quantitative, mixed methods)	**Community-led interventions** (specific resilience strategies)	**Waterborne disease outcomes** (types, prevalence, interventions)	**Challenges and facilitators** (barriers to implementation, enabling factors)
Accra, Ghana (Urban)	Clifford Amoako (2018) Geo Journal	Qualitative	Restructuring of housing units to minimize water damage; Construction of communal drainage systems by residents themselves; Creation of local evacuation teams and informal safe havens; Maintenance of a sense of place and community solidarity as motivational anchors [16].	Not addressed but mentions public health threats, including waterborne diseases arising from poor environmental conditions post-flooding [16].	Challenges: Inadequate state intervention and lack of coordinated flood management; Rapid population growth and increased housing density; Limited formal infrastructure in informal settlements Facilitators: Residents' embodied understanding of flood risks from lived experience; Community ownership and autonomy in local decision-making; Flexibility and adaptability in modifying physical structures and

					response mechanisms [16].
Bagri, Northern Ghana (Rural)	Frederick Dapilah, Jonas Østergaard Nielsen & Cecilie Friis (2019) Climate and Development	Mixed methods	Formal and informal social networks and group formation (organized by NGOs or organically in the community) [14].	Not addressed	Challenges: Climate variability, Overdependence on limited resources Facilitators: Social networking and Group activities [14].
Brazzaville, Congo, Urban setting	Attipo Reisch Vanell, Aholou Cyprien Coffi (2024) International Journal of Design & Nature and Ecodynamics	Quantitative	Enhancement of public awareness/ perception of flood risks and adaptive capacity [17].	Highlights serious public health concerns, but no community effort [17].	Challenges - Most people living in flood-prone areas were unaware of the risks of flooding in their areas [17].
Global perspective	Abiodun Benedict Adeyemi, Tochi Chimaobi Ohakawa, Azubuike Chukwudi Okwandu, Obinna Iwuanyanwu, & Gil-Ozoudeh Ifechukwu (2024) International Journal of Applied Research in Social Sciences	Qualitative	Community engagement; Disaster preparedness (floodwalls, stilts, resilient material use, and building to code) into architecture and housing design [9].	Not addressed	Challenges: Financial constraints, regulatory hurdles, and lack of specialized knowledge. Facilitators: public-private partnerships, multistakeholder collaboration (community, government, and policymakers) [9].

Global Perspective, Analysis of Existing Literature	Cvetković, V.M. (2024) Preprints.org	Review	Active community involvement, Capacity building, Inclusive strategies [15].	Not addressed	Challenges: Shortage of financial resources, Lack of training to manage risks, disconnect between national and local strategies Facilitators: Institutional support, Regular training, Consistent access to resources for preventative measures [15].
Global Perspective	Norris, F.H., Stevens, S.P., Pfefferbaum, B., Wyche, K.F., & Pfefferbaum, R.L. (2008) American Journal of Community Psychology.	Qualitative	Community involvement; Promotion and protection of social supports; Promotion of trusted sources of information [19].	Not addressed	Facilitators: Economic Development, Social Capital, Information and Communication, Community Competence [19].
Global Perspective	Zaman, M.O., & Raihan, M.M.H. (2023) KeAi Natural Hazards Research	Systematic Review	Active community involvement; Institutional backing; Capacity development; Inclusive strategies [8].	Not addressed	Challenges: Implementation challenges with Community-Based Disaster Risk Reduction [8].
Kenya (Rural and Urban)	Amref Health Africa (2024) News	Not specified	Prioritizing distribution of essential supplies (mosquito nets, water treatment items) to affected populations [18].	Waterborne diseases like cholera and typhoid; Distribution of water purification tablets [18].	Facilitators: government support to affected communities. Challenges: "limited capacity, and resources" to do "a comprehensive approach beyond immediate relief efforts" [18].

Matola, Mozambique (Urban)	Neves, J.L., & Espling, M. (2025) International Journal of Disaster Risk Reduction	Mixed methods	Reinforcing house structures and installing water barriers, Improving/reconstructing houses (raising yard levels, building new homes in safer areas, adhering to resettlement plans) [10].	Not directly addressed, but the study implicitly links flood resilience to improved overall living conditions [10].	Challenges: Lack of financial resources, Deficient technical capacity, Difficulties involving politicians, planners and local communities, Lack of resources, Difficulties due to rapid population increase and horizontal land occupation [10].
Multicountry, with focus on Low and Middle Income Countries	World Health Organization (WHO) (2018) Guidelines on sanitation and health. Geneva: World Health Organization	Qualitative	Tailored sanitation systems based on local conditions, risk management, community participation, Health sector involvement [20].	Diarrheal, vector-borne, and neglected tropical diseases; Emphasis on addressing routes of fecal pathogen transmission [20].	Challenges: Poverty, climate change, urbanization Facilitators: Community participation, health sector involvement [20].
Multiple African cities (Urban)	UN-Habitat (2019) Website article	Not specified	Reinforcement of drainage systems; Ecosystem restoration, Better waste management, Early warning systems and safe havens [5].	Displaced communities with limited or no access to clean water, leading to infectious conditions [5].	Challenges: Extreme weather events, high vulnerability among Africa's urban poor [5]. Facilitators: Increased technical capacities and regional coordination [5].
Northern Nigeria (Rural and Urban)	Dube Philemon Abrak, Adelakun Rasheed Adeyinka, Ishaku Aisha Yusuf, Ubon Udoh Humapwa, Mukhtar Bello Muhammad, Chukwuedo N. Henry, and Ogbuke	Qualitative	Improving land use planning and enforcement; Establishing reliable early warning systems [6].	Waterborne diseases like cholera and malaria were identified [6].	Challenges: Poor urban planning, climate change, deforestation, and land degradation, inadequate flood control measures [6]. Facilitators: government-led multi-sectoral collaboration, focus on long-term

	Kingsley Nnamdi (2024) Wukari International Studies Journal				solutions and community engagement in flood risks management [6].
Southern Africa	Tseole, N.P., Mindu, T., Kalinda, C., & Chimbari, M.J. (2022) PLOS ONE	Scoping review	CLTS (Community-Led Total Sanitation) [13].	Prevalence of schistosomiasis, cholera, diarrhea, polio, and typhoid [13].	Challenges include geographical inequalities, climate change, low investment in WaSH infrastructure, inadequate knowledge of waterborne illnesses, and ineffective local community engagement [13]. Facilitators - increased latrine/toilet ownership by individual households, and development of social capital within small community units [13].
Swaziland (Rural)	Daniel. H. Mlenga (2016) American Journal of Rural Development	Quantitative	Recovery and development programming to build infrastructure and human capacity [12].	Effective promotion of WASH during relief [12].	Challenges: Limited access to water and sanitation, poor financial state [12].
Uganda (Rural)	Bosco Bwambale, Moses Muhumuza, Martine Nyeko (2018) Jàmbá: Journal of Disaster Risk Studies	Qualitative	Assessment and prediction of rainfall and flood by the traditional hydro-meteorologist (diviner); Mountain cleansing ritual as a flood-risk awareness platform; Immunization of	Not directly addressed, but the study mentions flood disasters increasing community vulnerability to diseases [11].	Facilitators: the demise and lack of replacement for indigenous experts, or if cultural institutions no longer exist [11].

			riverine communities through planting certain indigenous plants to improve hydrological systems [11].		
Wide Geographic Scope	Ma, Chenwei; Qirui, Chen; Lv, Yang (2023) BMC Public Health	Systematic Review	Social capital and networks; Local knowledge and learning; Preparedness and response capacity Adaptive infrastructure and resources [7].	Public health challenges	Challenges - interventions are more of theoritical; translating to practice was identified as a major gap. Facilitator - Effective governance and leadership [7].

Discussion

Community-led initiatives enhance resilience by leveraging local knowledge, fostering ownership, and ensuring interventions are culturally appropriate.

However, persistent challenges hinder widespread implementation, scalability and sustainability. Addressing policy/governance, integrating scientific knowledge and technical support, and ensuring sustained funding are crucial to amplify these initiatives' impact.

The general literary analysis considered for this review revealed a lack of robust evidence on the superior effectiveness of any single approach. The most effective solution will depend on various factors, including the specific geographic location, the community's socio-economic context, the nature of the flooding, and the prevalence of waterborne diseases. Hence, a multi-faceted approach will yield the best results.

This review noted common challenges including limited resources, governance issues, and lack of technical expertise. Other challenges were; a lack of consistent funding, insufficient training and capacity building for community members as well as socio-political factors that hindered successful implementation.

The synthesis of this evidence, while leading to a better understanding of how community participation can enhance flood resilience, also reveals significant gaps in the literature. Hence, there is a need for more research work to be done on community-based flood resilience in Africa including studying the cases of other African countries affected by flooding but whose resilience strategy is yet to be studied/published.

However, it is worth noting that integrating local practices with national policy is crucial for achieving a greater impact.

Conclusion and Recommendation

Community-led initiatives are vital in enhancing resilience to flooding and mitigating the impacts of flooding and waterborne diseases in Africa. While the efforts demonstrate resilience, systemic support is

needed for sustainability. Fostering enabling environments through better policy frameworks, strengthened partnerships and resource allocation is essential to empower communities to build adaptive and long-lasting resilience strategies.

As a recommendation, future efforts should focus on scalability and integration with broader resilience strategies for sustainable impact. Resilience frameworks should integrate traditional environmental knowledge in flood mitigation plans, and access to healthcare should be improved to manage waterborne diseases better. In addition, future research could also focus on community-based flood resilience in other flood-affected African countries where such initiatives are yet to be studied/reported.

Limitation

Previous studies address flooding and other studies waterborne diseases, but very few studies address both flooding and waterborne diseases. Also, the search strategy may have omitted pertinent information sources due to linguistic constraints, procedural issues or publication bias.

Conflict of Interest

There is no conflict of interest for this review.

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Quality at the Core: Strengthening Healthcare Delivery in Sub-Saharan Africa through Laboratory Quality Management Systems

Adebola Adekoya[1*], Kavitha Menon[2] and Mercy A. Okezue[3]
[1]*School of Public Health, Texila American University, Georgetown Lot 2442, Guyana*
[2]*Symbiosis School of Culinary Arts and Nutritional Sciences (SSCANS), Symbiosis International (Deemed University), Lavale, Pune 412115, Maharashtra, India*
[3]*School of Packaging, Michigan State University, East Lansing, MI 48824, USA*

Abstract

Laboratory Quality Management Systems (LQMS) are pivotal in ensuring accurate, reliable, and timely diagnostic services, which are foundational to effective healthcare delivery. In Sub-Saharan Africa, the role of LQMS has become increasingly critical due to the region's diverse healthcare challenges and resource constraints. This review systematically examines the multifaceted impact of LQMS on healthcare systems within the region, drawing from a broad spectrum of scholarly literature and case studies. Key areas explored include enhancing diagnostic accuracy, improving operational efficiency, and facilitating timely clinical interventions. The review further investigates how LQMS fosters compliance with international quality standards such as ISO 15189 and ISO/IEC 17025, supports laboratory accreditation, and promotes trust among healthcare providers and patients. Additionally, the paper assesses the impact of LQMS on public health outcomes by examining its role in disease surveillance, outbreak response, and health system resilience. Challenges related to LQMS implementation, including infrastructural limitations, workforce capacity, and regulatory inconsistencies, are critically assessed. Moreover, the benefits and limitations of standardization in laboratory practices under LQMS frameworks are discussed, highlighting the importance of metrological traceability and global coordination. Through a structured thematic analysis, this review highlights the importance of strategic investment in quality management infrastructure, stakeholder training, and policy development to fully realize the potential of LQMS in enhancing healthcare delivery across Sub-Saharan Africa.

Keywords: *Healthcare Delivery, Laboratory Accreditation, Laboratory Quality Management System, Public Health Laboratories.*

Introduction

The integrity and effectiveness of modern healthcare systems are heavily reliant on the accuracy, reliability, and timeliness of laboratory test results. Laboratory Quality Management Systems (LQMS) serve as a strategic foundation for achieving these objectives by embedding systematic processes that govern the technical and managerial activities within laboratories. These systems are critical for ensuring diagnostic precision, guiding appropriate clinical interventions, and improving overall patient outcomes [1, 2].

A Quality Management System (QMS) provides a structured framework for planning, controlling, and continuously improving all laboratory operations that influence test outcomes and user satisfaction. Within this context, LQMS constitutes a specialized

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****Corresponding Author: adekoyaadebola55@gmail.com***

application of QMS tailored to the complex demands of clinical, research, regulatory, and public health laboratories. Through the enforcement of standardized protocols and quality assurance procedures, LQMS mitigates errors, reduces variability, and enhances reproducibility in laboratory outputs [1, 2].

Beyond accuracy and standardization, LQMS significantly contributes to operational efficiency. It enables laboratories to optimize resource utilization—including human resources, instrumentation, and consumables—thereby expediting turnaround times without compromising quality. Efficient laboratory workflows are crucial for time-sensitive clinical decision-making, especially in high-demand healthcare environments [2].

Furthermore, the implementation of LQMS is integral to achieving and maintaining compliance with internationally recognized standards such as ISO 9001:2015, ISO/IEC 17025:2017, ISO 15189:2022, and WHO prequalification. Accreditation under these frameworks serves as a formal acknowledgment of a laboratory's technical competence and quality assurance capabilities. This not only boosts institutional credibility but also fosters confidence among patients, clinicians, regulatory agencies, and funding bodies [2].

The broader implications of LQMS extend into the realms of health economics and public health. By reducing diagnostic errors and eliminating redundant testing, LQMS contributes to cost-effectiveness in healthcare service delivery. Reliable and consistent laboratory services strengthen clinical decision-making, improve health outcomes, and elevate public trust in healthcare systems. Moreover, LQMS supports national and global public health objectives by ensuring the integrity of laboratory data used for disease surveillance, outbreak management, regulatory decisions, and health policy formulation [2].

Considering these multifaceted benefits, the adoption of robust LQMS frameworks is indispensable for healthcare systems aiming to deliver high-quality, evidence-based, and patient-centered care. LQMS not only enhances individual laboratory performance but also serves as a critical pillar in the architecture of modern, resilient, and responsive healthcare delivery.

Research Objective

This systematic narrative review aimed to comprehensively evaluate the impact of Laboratory Quality Management Systems (LQMS) on laboratory performance and healthcare delivery in resource-limited settings of Africa. Specifically, it investigates how LQMS influences diagnostic accuracy, operational efficiency, cost-effectiveness, standardization of practices, compliance with international accreditation standards, customer satisfaction, and overall public health outcomes. The objective is to identify the key benefits, challenges, and enablers of LQMS implementation, thereby providing strategies for sustainable quality improvement in laboratory services.

Materials and Methods

This comprehensive review employed a systematic search with a narrative analysis to evaluate the roles and impact of LQMS in healthcare delivery, particularly within the context of Sub-Saharan Africa. The review was strategically guided by well-defined research questions, which enabled focused inquiry across multiple thematic domains.

Study Selection Criteria and Screening Process

To identify relevant literature, a systematic search was conducted across three major electronic databases, including PubMed, Scopus, and Web of Science. The study employed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which were used to screen the articles [15].

Studies were selected based on predefined inclusion and exclusion criteria, which considered factors such as publication timeframe, language (English), study designs, and geographical relevance to Sub-Saharan Africa. The inclusion criteria encompassed peer-reviewed journal articles, publicly accessible reports, theses, conference proceedings, and academic projects published between January 2001 and May 2025.

Search Strategy

The search strategy utilized specific keywords and controlled vocabulary terms related to "laboratory quality management systems," "healthcare delivery," "laboratory accreditation," and "public health laboratories" together with Boolean operators (AND, OR, NOT) to enhance retrieval precision. The articles obtained from screening were imported into EndNote. Initially, duplicates were removed. Later, the search results underwent a two-tiered screening process: firstly, titles and abstracts were reviewed to eliminate articles not related to the study; secondly, full-text of the included articles was retrieved and assessed based on the eligibility criteria/research scope. The articles that met the eligibility criteria were included in the present review.

Data Extraction and Analysis

A narrative approach was used to synthesize the findings in addition to thematic analysis. Emerging patterns were categorized under six major thematic areas aligned with the research questions, facilitating a structured and coherent presentation of results. The present study used a rigorous methodological framework that ensured a transparent, reproducible, and in-depth exploration of existing literature on LQMS, enabling a well-grounded discussion of its significance in strengthening healthcare systems across diverse laboratory settings.

Results

An initial search retrieved approximately 5,000 Pub1000 records. After the removal of duplicates and non-relevant entries through title, abstract, and full-text screening, a total of 40 studies were included in the final synthesis. The PRISMA-ScR flow diagram details the identification, screening, and selection process from the initial search to the final inclusion of studies (Figure 1).

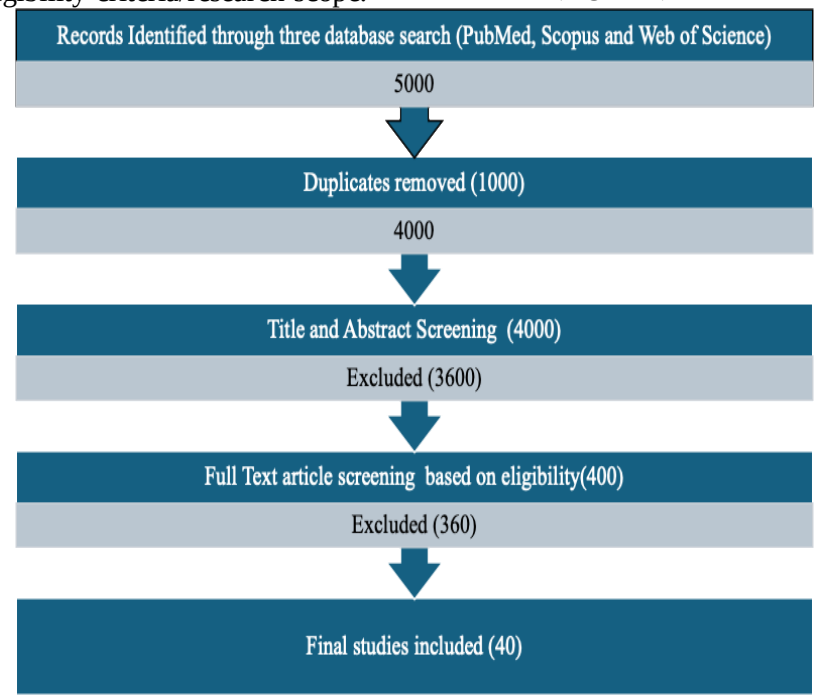


Figure 1. Systematic Review Study Selection Flowchart (PRISMA-ScR)

The Role of Laboratory Science, Global Health and LQMS in Medical and Public Health Laboratories

Babyar (2020) highlights the role of medical laboratory science in advancing global health, recognizing its contributions to healthcare delivery, disease surveillance, and scientific advancement. Despite increasing recognition of both clinical and biomedical laboratories, their effectiveness is hindered due to operational inefficiencies, workforce shortages, and fragmented regulatory environments [15]. The researcher advocated strategic reforms, including standardized credentialing, explicit regulatory frameworks, and improved public-private coordination to strengthen laboratory systems [15]. A globally integrated laboratory ecosystem characterized by a well-prepared workforce, harmonized standards, and collaborative research agendas—are essential for improving population health outcomes [15]. Central to this is the role of laboratory accreditation and compliance with quality standards. International accreditation systems and regional initiatives such as the WHO AFRO aim to build resilient and high-performing laboratory networks. While progress has been made, sustained investment, policy reforms, and international collaboration remain critical to overcome implementation challenges [9, 6, 11-15].

Medical and public health laboratories are cornerstones of healthcare delivery, particularly in disease diagnosis, monitoring, treatment, and response to outbreaks. A paucity of efficient laboratory services may result in misdiagnosis, irrational medication use, avoidable hospitalizations, and poorer patient outcomes[5]. Recognizing these critical challenges, especially in resource-constrained settings in African countries, the importance of LQMS has been emphasized since 2010. A quality laboratory system is defined by adherence to internationally accepted standards, ensuring test accuracy, reliability, and timeliness. [5]. Additionally, the ISO 15189 and ISO 17025 standards, as well as the World Health Organization (WHO) prequalification, serve as the benchmark for the competence of medical, general, and pharmaceutical laboratories, certifying labs capable of delivering high-quality test results. Accreditation and/or prequalification to this standard/guideline affirms a lab's technical proficiency and strengthens its role in clinical and regulatory decision-making and public health policy. [6].

Significance of Enhancing Accuracy and Reliability

For research, clinical diagnostics, testing, and manufacturing laboratories to operate effectively and efficiently, an LQMS is essential. The significance of having a strong and flexible LQMS is becoming increasingly clear considering changing technological environments and growing operational demands. These systems support a variety of activities, from clinical testing and research to regulatory compliance, by guaranteeing the timeliness, accuracy, reproducibility, and dependability of laboratory outputs [3, 4]. An effective LQMS helps avoid crucial mistakes that can jeopardize data integrity and institutional credibility by offering a systematic framework for identifying and reducing risks. Choosing an LQMS model that is appropriate for the functions of the laboratory is crucial, considering the variety of models that are available, ranging from regulatory frameworks to consensus standards. Sustainable development and scientific progress are fostered by efficient implementation that is based on fundamental quality principles [3, 4]. Overall, a thorough LQMS aligns laboratory performance with more public health objectives while improving operational efficiency and result accuracy as well as institutional reputation [3].

Implementation of LQMS in African Countries

Implementing an LQMS and achieving ISO 15189 accreditation in Africa has been hindered by inadequate infrastructure, limited technical capacity, and human resource shortages. However, these barriers were addressed through the introduction of phased initiatives by the World Health Organization (WHO) and National Ministries of Health, outlined below:

1. Strengthening Laboratory Management Towards Accreditation (SLMTA): Launched in 2009, this program trained laboratory managers and staff through workshops, mentorship, and practical improvement projects that gained global traction for its measurable impact on laboratory quality [6].
2. Stepwise Laboratory Quality Improvement Process Towards Accreditation (SLIPTA): A checklist-based assessment tool by WHO-AFRO that rates laboratory progress from zero to five stars, guiding labs towards ISO 15189 accreditation. While not certifying technical competence, SLIPTA indicated a lab's dedication to quality improvement [6].
3. Additionally, to support these efforts, tools like the LQMS training toolkit and the Laboratory Quality Stepwise Implementation (LQSI) tool were developed. to support laboratories to independently implement QMS aligned with international best practices [6].
4. Further in 2012, the African Society for Laboratory Medicine (ASLM) was tasked with enrolling 2,500 laboratories in SLIPTA to support 250 public laboratories attaining international accreditation by 2020—targets aimed at bolstering the impact of public health programs, including HIV and tuberculosis [6].

Accreditation and Quality Indicators

Accreditation ensures that laboratories implement quality systems effectively, enhancing technical operations, service delivery, and market competitiveness. This process hinges on comprehensive LQMS implementation, guided by both management and technical requirements [4, 7]. Quality indicators play a key role in benchmarking laboratory performance and guiding continuous improvement. Adherence to these indicators supports accreditation efforts and prevents service degradation due to quality system lapses [7-9]. Mulleta et al. (2021), an Ethiopian study, revealed that only 20.2% of health center laboratories had significantly improved services, achieving over 55% of quality targets. Factors linked to better performance included the presence of standard operating procedures (SOPs), proper documentation, preventive maintenance, regular staff meetings, customer feedback reviews, quality plans, result verification procedures, specimen guidelines, and established quality indicators [4, 10]. The study highlighted the importance of a structured QMS in ensuring the accuracy, reliability, and timeliness of laboratory results.

Impact of Implementation of LQMS on Patient Outcomes and Public Health

The implementation of LQMS is instrumental in improving the quality, accuracy and timeliness of diagnostic services, thereby influencing the patient outcomes and public health disease management. A cross-sectional study conducted in 2017 across selected Ethiopian government hospitals assessed awareness of LQMS implementation among 184 laboratory professionals [9]. While awareness of LQMS was universal among respondents, only 79% were actively involved in its implementation. Among 18 LQMS components evaluated, five exhibited weak implementations: internal quality control for all tests, development and dissemination of quality manuals, adequacy of storage space, action planning based on internal audits, and monitoring of environmental conditions.

Internal quality control practices across all test types emerged as a significant challenge [9].

Beyond individual facility assessments, systemic barriers continue to hinder access challenges to diagnostic services across Africa. The African Society for Laboratory Medicine (ASLM) and the Africa Centres for Disease Control and Prevention (Africa CDC) persistent constraints on human resources, funding, and technical capacity severely limit laboratory performance. Furthermore, the lack of standardized systems for evaluating and registering new diagnostic tools delays the adoption of improved technologies, compounding the diagnostic gap [6].

The public health consequences of these systemic gaps are far-reaching. For example, despite well-established HIV programs, approximately 40% of HIV-positive individuals on antiretroviral therapy do not receive the recommended annual viral load monitoring. In 2016, 21% of infants born to HIV-positive mothers in West and Central Africa did not get access to early diagnostic testing within eight weeks of life—a critical window for effective intervention. Similarly, the tuberculosis (TB) burden remains high, with the WHO's 2016 Global TB report revealing that nearly 70% of TB cases were unreported in Africa. In half of African countries, fewer than 10% of patients had access to rifampicin resistance testing, and only 60% of countries offered second-line drug resistance testing [6].

Efforts to address shortcomings have included strategic declarations aimed at strengthening laboratory systems. The Freetown Declaration of 2015, built on the earlier Maputo Declaration, advocated the delivery of diagnostic services through integrated national laboratory networks. These networks were designed to provide comprehensive, equitable, and cost-effective diagnostic services. Despite disease-specific investments—particularly in HIV and TB—national laboratory systems remained under-resourced and fragmented. This dysfunction limits Africa's capacity to effectively implement the "prevent, detect, respond" framework that underpins public health security. The consequences were substantial: in 2015 alone, Africa experienced and estimated $2.4 trillion in productivity losses and 630 million years of healthy life lost due to disease burden [6].

Additionally, diagnostic access remains critically low for diseases without dedicated international programs. For instance, nearly 90% of individuals infected with hepatitis B or C remain undiagnosed, despite these viruses causing 60% of liver cancer cases. In Senegal (2015–2016) it was found that <30% of pregnant women at the primary care level received essential diagnostic tests for conditions critical to maternal and child health. Also, inadequate cervical cancer screening had led to delayed diagnosis, with nearly half of related deaths attributed to late detection. Notably, only 2 out of 55 African countries had the capacity to detect the SARS-CoV-2 virus when the first COVID-19 case emerged in Egypt in February 2020 [6].

Such diagnostic gaps significantly compromise timely disease detection, appropriate treatment, and broader healthcare quality, impeding progress toward Universal Health Coverage (UHC). To mitigate these gaps, the ASLM and Africa CDC report recommended adopting robust, affordable, context-appropriate diagnostic solutions for low-resource settings. Tools such as rapid diagnostic tests (RDTs), community-level or self-testing kits, and point-of-care molecular technologies (e.g., GeneXpert® and m-Pima®) have shown promises in enhancing diagnostic speed and accuracy. However, the full potential of these technologies is often underutilized due to fragmented implementation, weak systems integration, and critical infrastructure gaps, particularly in supply chain management, sustainable financing, and trained workforce availability [6].

Evolution of Accreditation and International Standards Compliance

The evolution of laboratory accreditation has shifted from a narrow focus on procedural compliance to a more comprehensive and globally integrated system of quality assurance. While early accreditation frameworks primarily ensured adherence to established protocols, the contemporary models emphasize sustained quality improvement, risk-based thinking, and cross-border credibility in an increasingly globalized and technologically advanced landscape [11].

Central to this evolution has been the widespread adoption of international standards such as ISO/IEC 17025, which defined broader requirements for the competence of testing and calibration laboratories. These standards have provided a formalized structure for implementing robust quality systems, promoting global trust in laboratory results. National and international accreditation bodies, supported by mutual recognition agreements, have further enhanced the credibility of laboratory results worldwide, streamlining trade and cross-border cooperation [11]. The role of international bodies—such as the International Laboratory Accreditation Cooperation (ILAC), the International Accreditation Forum (IAF)- has been critical in this transformation. Through mutual recognition arrangements, these organizations have facilitated greater alignment among national accreditation, bodies, streamlining international trade, cross-border collaboration and research initiatives [11].

Technological innovations have further strengthened accreditation processes. Innovations in data management, traceability, and quality control have significantly improved efficiency and accuracy and transparency of laboratory operations. Consequently, accreditation is now firmly recognized as a cornerstone of quality assurance—bolstering confidence in laboratory testing across healthcare systems, regulatory agencies, and commercial sectors worldwide.

The WHO AFRO Model: Stepwise Accreditation in Resource-Limited Settings

In many low-and-middle-income countries, resource constraints, systemic complexity, and infrastructure limitations hinder full compliance with international laboratory standards. To address these challenges, the World Health Organization Regional Office for Africa (WHO AFRO) developed and implemented the Stepwise Laboratory Quality Improvement Process Towards Accreditation (SLIPTA) tailored to facilitate gradual progress toward ISO 15189 compliance in resource-constrained settings [12]. SLIPTA employs a 0- to 5-star rating system to evaluate laboratory performance against a standardized checklist. Laboratories scoring below 55% receive no stars, while those who meet or exceed 95% are awarded the highest five-star rating. This scalable model allows laboratories to benchmark progress, receive targeted feedback, and implement continuous improvement strategies [12]. However, it is important to note that SLIPTA is not a substitute for ISO 15189accreditation but rather a transitional mechanism. It encourages high-performing laboratories to build capacity incrementally while pursuing full international compliance. The framework effectively addresses affordability, sustainability, and accessibility challenges, making it a practical solution for elevating laboratory quality and promoting harmonization with global standards [12].

Strengthening Laboratory Systems through Quality Control and Management

Effective quality management and control mechanisms are essential for ensuring the safety and reliability of medical products and healthcare services. In West Africa, national and regional quality control laboratories serve a central role in verifying the reliability of testing services and strengthening public health

infrastructure. However, sustained improvements in laboratory Quality Management Systems (QMS) require long-term, collaborative investments from all stakeholders, along with a focus on continuous learning and system-wide integration [13]. A qualitative study in Rwanda assessed LQMS implementation and sustainability across selected laboratories using semi-structured interviews and performance metrics [14]. The findings revealed significant improvements in key service indicators such as turnaround time, patient wait time, and result accuracy following LQMS adoption. Crucial success factors included supportive hospital management, consistent staff training, efficient procurement processes, and recognition of professional qualifications of laboratory professionals. However, persistent challenges—such as limited training opportunities, inadequate infrastructure, delays in reagent procurement, and difficulties in maintenance service contracting—posed threats to long-term sustainability [14]. To maximize impact, the authors recommended strengthening procurement systems, improving supply chain efficiency, and reviewing inventory management protocols. Strengthening these components is vital for sustaining LQMS implementation across the health sector [14].

Persistent Gaps in LQMS Implementation

Despite measurable progress in accreditation and quality system strengthening, several core LQMS components continue to exhibit limited implementation. A study evaluating 18 core LQMS components found that five were especially weak: performance of internal quality control for all tests, development and dissemination of comprehensive quality manuals, adequacy of storage space, formulation of action plans following internal audits, and monitoring of environmental conditions. Internal quality control was a widespread challenge [10]. Similarly, a review of 12 key quality indicators in another lab in sub-Saharan Africa revealed poor or very poor performance in areas critical to overall system reliability: document control (77.7%), record control (70.3%), development of manuals and policies (69.7%), process and procedure development (68.6%), and internal communication (65.1%). These findings highlight internal quality control, documentation practices, and storage infrastructure as priority areas requiring intervention [9].

From Framework to Function: Country Experiences in Enhancing Laboratory Efficiency and Resource Use

Execution of LQMS in Nigeria

The use of Quality Management Systems (QMS) in Nigerian medical laboratories is still nascent, with a restricted number of institutions attaining accreditation. The implementation of Quality Management Systems (QMS) has predominantly focused on Government National Regulatory Agencies and few other private facilities. These agencies oversee private regulated laboratories and public health laboratories addressing infectious diseases such as HIV/AIDS and tuberculosis, driven by initiatives from the World Health Organization's African Region (WHO AFRO), particularly the Strengthening Laboratory Management Toward Accreditation (SLMTA) and Stepwise Laboratory Quality Improvement Process Towards Accreditation (SLIPTA) programs. These approaches have markedly improved and maintained quality management in designated institutions.

Notwithstanding these advancements, certain obstacles endure. Laboratories persist in facing insufficient infrastructure, ongoing funding limitations, equipment deficiencies, climate-related obstacles, and restricted training chances. Moreover, a deficiency of driven individuals further hinders advancement. Despite major strengths, especially in laboratory safety and the application of ISO/IEC 17025 and ISO 15189

core quality standards, substantial deficiencies persist in document control, internal audits, and occurrence management [16]. The successful implementation of a Quality Management System (QMS) in Nigeria necessitates a systematic approach, reinforced by robust managerial support, compliance with national health standards, active engagement in External Quality Assurance (EQA) programs, and a transformative culture shift among laboratory personnel. Despite the growing awareness of QMS advantages, considerable efforts remain necessary to enhance comprehension, tackle implementation obstacles, and broaden QMS integration throughout public and private laboratories countrywide [16].

Regional Capacity Development via SRL Training for LQMS in Uganda

The Supranational Tuberculosis Reference Laboratory (SRL) in Uganda exemplifies regional capacity enhancement by delivering specialized Laboratory Quality Management System (LQMS) training to National Tuberculosis Reference Laboratories (NTRLs) across 21 countries since 2015. The training, carried out from 2017 to 2021, was assessed utilizing the Kirkpatrick model, which evaluates reactivity, learning, behavior, and outcomes [17]. The evaluation findings indicated significant success. Most participants achieved scores exceeding 80% on post-training evaluations, with 14 of the 18 laboratories exhibiting quantifiable enhancements in quality practices. Moreover, other laboratories obtained elevated SLIPTA ratings, and five NTRLs successfully secured ISO 15189:2012 accreditation by 2021, with one maintaining its position. Participant response robustly affirmed the program's pertinence and influence, highlighting its efficacy in improving laboratory quality systems and reinforcing best practices [17].

Regulatory Reformation and Operational Superiority in Tanzania

Tanzania's pharmaceutical regulatory framework exemplifies how operational efficiency can be markedly enhanced via a systematic and comprehensive quality management strategy. Essential facilitators of this change comprised a comprehensive legal and policy framework that defined roles and norms, inclusive stakeholder involvement promoting multi-sector collaboration, and continuous capacity-building programs to enhance institutional competency [18]. Moreover, proficient organizational leadership was crucial in directing reforms, promoting adaptation, and guaranteeing the continuity of implementation. The amalgamation of these factors revolutionized Tanzania's regulatory framework from early ineffectiveness to a position of prominence in the East African area. The success of this change underscores the significance of strategic leadership, partnerships, and resilience in the establishment of adaptive and sustainable regulatory frameworks [18].

Hybrid Mentorship for Laboratory Accreditation in Malawi

The COVID-19 epidemic significantly disrupted laboratory certification initiatives, especially for programs reliant on in-person support and supervision. In Malawi, the pursuit of ISO 15189 accreditation for HIV molecular laboratories necessitated a swift strategic adjustment. The answer entailed the implementation of a hybrid mentorship model that integrated virtual and in-person training and evaluation [19]. The initiative commenced with a cohort of five laboratories chosen based on performance criteria, implementing weekly virtual mentorship meetings alongside in-person audits as travel limitations were progressively eased. A further cohort of four laboratories was then incorporated into the identical hybrid architecture. The mentorship comprised the electronic submission of

progress reports, virtual capacity-building workshops, and ongoing remote interaction with technical specialists [19]. The results were notable: within three years, 90% of the collaborating laboratories attained ISO 15189 accreditation. The hybrid method was both cost-effective and displayed adaptability and resilience in addressing issues related to limited resources and public health emergencies. The efficacy of this methodology highlights the significance of continuous, adaptable mentorship approaches in improving laboratory standards and attaining certification under intricate circumstances [19].

Thus, operational efficiency and resource management are crucial for attaining sustainable laboratory quality. The early-stage QMS adoption in Nigeria, Uganda's cross-national LQMS training activities, Tanzania's legislative reforms, and Malawi's mentorship innovations during the pandemic illustrate the imperative for flexible, well-supported, and contextually relevant quality initiatives. Advancing infrastructure, enhancing staff capacity, and fortifying institutional leadership—while utilizing technology and fostering regional collaboration—will be essential for establishing robust and high-performing laboratory systems throughout Africa [19].

Customer Satisfaction

Customer satisfaction is a cornerstone of quality assurance in medical laboratory services and is embedded within internationally recognized Quality Management System (QMS) frameworks such as ISO 9001, ISO 15189, and ISO 17025. These standards recognize patients and their families, healthcare professionals, and institutional stakeholders as primary customers whose feedback is critical to service improvement. Monitoring customer satisfaction is not only a regulatory requirement but also a strategic tool for enhancing service delivery and fostering trust in healthcare systems [20].

Integrating Patient Feedback into QMS

To systematically incorporate customer insights, laboratories are encouraged to implement structured service satisfaction surveys. These surveys are typically designed and administered by quality officers or laboratory directors following ISO standards, ensuring consistency and reliability in feedback collection [19]. By targeting all client groups that interact with laboratory services, including patients, clinicians, and support staff, these surveys offer a holistic view of service performance. Administered at regular intervals, these surveys support real-time monitoring of performance and timely identification of service gaps, procedural errors, or inefficiencies that may compromise quality. The results are analyzed to inform corrective and preventive actions, forming a feedback loop that drives continuous quality improvement. [20].

Benefits of QMS-Aligned Satisfaction Monitoring

The integration of patient satisfaction monitoring within a QMS framework yields several tangible benefits. Improvements in service delivery have been linked to enhanced patient experiences, faster recovery times, and a greater likelihood of patients returning for future services. Furthermore, by demonstrating responsiveness to client concerns, laboratories build confidence among healthcare users, contributing to a more reliable and patient-centered health system [20].This proactive engagement with customer feedback also reinforces the principles of Total Quality Management (TQM), promoting a culture of accountability, transparency, and continuous service enhancement. This alignment ensures laboratories remain patient-centered, transparent, and quality driven in their operations [20].

Customer Satisfaction in the Broader Public Health and Research Context

Beyond individual laboratory operations, customer satisfaction and quality assurance are increasingly relevant within the broader context of regional health cooperation in Africa. While African regional organizations have long supported national health systems, their role in enhancing health research systems, critical for addressing complex health challenges, has gained prominence in recent years, particularly considering recent public health emergencies [21]. A review of 15 regional organizations involved in health research mapped their activities across four core pillars: governance, resource creation, research production and utilization, and financing. Interviews with 18 representatives revealed that organizations with mandates in health or higher education are actively engaged in agenda-setting, policy harmonization, and knowledge dissemination. Most notably, these entities play key roles in shaping governance and promoting the use of research findings in policy and practice [21]. However, significant gaps persist in infrastructure, research capacity, and financing. While some organizations focus on strengthening human resources, few support the creation of physical infrastructure or regional research networks. Moreover, limited coordination among regional actors and insufficient advocacy capacity have constrained the potential of these bodies to fully support national health research systems [21].

These findings underscore the need for strategic engagement with regional organizations to maximize their comparative advantages in supporting national health objectives. Strengthening their role in customer-focused research, fostering infrastructure development, and building capacity for advocacy and financing can create a more cohesive and responsive regional health ecosystem. By reinforcing both service quality at the laboratory level and systemic health research at the regional level, African nations can more effectively meet current and future health challenges. Ultimately, an integrated approach—linking QMS-based customer satisfaction strategies with regional collaboration in health research—can elevate the standard of care and reinforce the resilience of healthcare systems across the continent [20, 21].

The Role of QMS in Enhancing Customer Satisfaction in Public Health Laboratories

The implementation of an LQMS in public health laboratories enhances customer satisfaction by improving the quality, efficiency, consistency, and responsiveness of services. These laboratories play a pivotal role in surveillance, outbreak response, and health system resilience. QMS-driven practices—such as continuous quality improvement, standardized procedures, feedback mechanisms, and regular performance evaluations—enable public health laboratories to provide accurate, timely, and client-centered results [22, 23]. Public health settings where timely and reliable laboratory information can influence disease control strategies and health outcomes at a population level [22]. Through structured processes such as continuous quality improvement, standardized operating procedures, customer feedback mechanisms, and regular performance monitoring, a QMS helps public health laboratories deliver high-quality, client-centered services. Satisfied customers, ranging from clinicians to public health agencies, are more likely to trust and rely on laboratory results, which are essential for effective diagnosis, treatment, and public health interventions [23].

Standardization: Benefits, Barriers and Strategic Directions

Importance of Standardization in Laboratory Testing

Standardization in the laboratory ensures consistency, accuracy, and comparability of results across healthcare systems. This

consistency is particularly critical when test results are used in conjunction with clinical guidelines or fixed reference intervals to inform medical decisions. ISO 17511:2020 serves as the international roadmap for standardization for achieving the metrological traceability, linking calibrators, control materials, and patient samples to recognized reference measurement systems [24].

Despite a clear framework, the global implementation of standardized laboratory practices face several challenges, especially in low resource settings. These include the limited availability of commutable, matrix-based certified reference materials (CRMs) and competent National Metrology Institutes (NMIs), which are fundamental to reliable calibration hierarchies. CRMs ensure that laboratory results accurately reflect patient conditions across different devices and methods. However, only a fraction of the thousands of clinically significant measurands currently have appropriate CRMs available. Similarly, only a few countries in Sub-Saharan Africa have NMI with the capacity and capability for required metrological traceability. [24]. The main barriers hindering LQMS implementation against the key enabling factors that facilitate adoption and sustainability in resource-limited settings (Table 1).

Table 1. Challenges and Enablers of LQMS Adoption in Sub-Saharan Africa

Challenges	Enablers
Infrastructure limitations	International standards (ISO)
Workforce capacity gaps	Training and mentorship programs
Regulatory heterogeneity	Stepwise accreditation models
Limited funding	Stakeholder collaboration
Lack of standardization	Regional and global coordination

Prioritization and Resource Constraints

A major outcome of an international workshop held in December 2021 was the recommendation to prioritize standardization efforts for measurands with the highest clinical impact. Tests such as creatinine, HbA1c, and prothrombin time—frequently used in chronic disease management and anticoagulation monitoring—were highlighted for immediate action. These analytes often guide high-stakes clinical decisions, making their standardization particularly urgent [24]. Developing a commutable CRM is a complex and resource-intensive process. Commutability studies are required to confirm that CRMs behave similarly to patient samples across various analytical systems, an essential characteristic for reliable calibration. Effective collaboration among NMIs, CRM producers, and in vitro diagnostic medical device (IVD-MD) manufacturers is crucial. Early involvement of IVD-MD manufacturers in the CRM development process can mitigate the technical difficulties of retrofitting calibration systems after product release, streamlining the adoption of standardized reference materials [24].

Regulatory Heterogeneity and Global Disparities

Regulatory variability among countries represents another significant barrier to global harmonization. In-vitro Diagnostics and Medical Devices (IVD-MDs) often require separate regulatory approval processes in multiple jurisdictions, each with distinct evidentiary requirements, timelines, and review mechanisms. This fragmentation increases costs and delays for manufacturers aiming to recalibrate devices annually in line with ISO standards using traceable reference standards. Notably, many recalibrations involve

mathematical adjustment factors that do not change the functional performance of devices, suggesting that a risk-based, simplified regulatory approach could be more efficient [24]. International regulatory alignment, with shared expectations and harmonized submission pathways, would significantly reduce redundancy and promote the broader adoption of standardized calibration practices. Such cooperation among regulators, standardization bodies, and manufacturers is critical to accelerating global standardization and ultimately improving patient care [24].

Advancing Standardization Through Education

An equally important aspect of standardization is building internal capacity within laboratories through education and training. A study conducted in Malta explored this dimension by assessing the training needs of laboratory professionals across various sectors, including pharmaceutical quality control, diagnostics, research, and forensic science. The aim was to improve adherence to ISO 17025:2017, a globally recognized standard for testing and calibration laboratory competence [25]. Using a validated questionnaire, the study identified a high demand for education on ISO 17025:2017, quality control procedures, measurement uncertainty, ISO 9001:2015, and Good Laboratory and Manufacturing Practices. Based on these findings, a tailored two-day course was developed and delivered to 22 personnel from forensic laboratories. The curriculum, spanning 14 hours, focused on both the theoretical foundations and practical applications of quality management systems, particularly within the forensic context [25]. Participant feedback from the course was overwhelmingly positive, with attendees citing high satisfaction with the course content, instructional quality, and organization. These results confirm the effectiveness of specialized, standard-focused training in enhancing laboratory personnel's understanding and implementation of quality standards [25]. Summarily, achieving comprehensive global standardization in laboratory medicine requires a multifaceted approach. This includes the clinical prioritization of analytes, increased production and dissemination of commutable CRMs, and streamlined, harmonized regulatory frameworks. Equally vital is the empowerment of laboratory professionals through targeted education that addresses specific gaps in knowledge of quality management systems. International collaboration across scientific institutions, regulatory bodies, industry, and educational platforms is essential to overcome technical, logistical, and policy-related barriers. By doing so, the healthcare sector can realize the full benefits of standardized laboratory testing, improved diagnostic accuracy, enhanced patient safety, and more efficient and trustworthy clinical decision-making worldwide [24, 25].

Discussion

The manuscript compiles essential findings regarding the implementation and effects of LQMS in healthcare delivery, with a focus on African countries. Using international standards such as ISO 15189 and evidence from regional programs like SLMTA and SLIPTA, the section highlights how LQMS enhances diagnostic accuracy, strengthens public health systems, improves operational efficiency, and fosters stakeholder trust. Also, it critically examines challenges related to accreditation, standardization, and sustainability, offering insights into the strategic value of LQMS in global health contexts.

Enhancing Accuracy and Reliability

The implementation of a robust LQMS, particularly aligned with international standards such as ISO/IEC 17025 and ISO 15189, significantly enhances the accuracy and reliability of diagnostic services across all laboratory phases. The pre-analytical phase is

often the most error-prone, especially in LMICs contributing to most laboratory errors [26, 27]. LQMS adoption introduces standardized procedures, an integrated framework for risk assessment, internal quality control (IQC), and external quality assessment (EQA), competent personnel, effective internal audits, and continual quality improvement, ensuring laboratories produce valid, timely, and reproducible results [26, 28, 31].

Programmes such as the SLMTA and SLIPTA—developed by WHO AFRO and partners—have been instrumental in guiding laboratories in resource-limited settings towards progressive quality improvements and accreditation. Evidence from 47 countries reported that these programmes improved document control, equipment management, turnaround times, and staff competencies—factors essential for diagnostic accuracy and institutional trust [29, 30]. Adopting LQMS strengthens institutional reputation and accountability.

Impact on Patient Care and Public Health

Reliable and well-structured laboratory systems are fundamental to delivering accurate, timely, and actionable diagnoses, which in turn directly impact patient outcomes and the effectiveness of public health systems. An effective and fully implemented LQMS reduces diagnostic errors, mitigates risk management, and improves patient outcomes (i.e., morbidity and mortality) [31]. In many LMICs, including Africa, the limited access to quality-assured diagnostics led the healthcare providers to rely on syndromic or presumptive diagnosis, particularly in rural or resource-constrained settings with implications—misdiagnosis, delayed treatment, and antimicrobial resistance [31, 32].

Functional LQMS frameworks enhance outbreak preparedness, integrate with health information systems, and support disease surveillance [32, 33]. The COVID-19 pandemic illustrated how established quality systems enabled timely molecular testing and sustained diagnostic capacity [33]. To reduce existing diagnostic gaps, especially in sub-Saharan Africa, LQMS must be included in national initiatives and backed by leadership, training, and long-term funding [31, 32].

Accreditation and International Standards Compliance

Laboratory accreditation, particularly under ISO 15189, serves as a standard for quality and proficiency [12, 34]. Although financial limitations frequently impede advancement, programs such as SLMTA and SLIPTA provide incremental, contextually relevant routes to accreditation [29, 30]. Success narratives, exemplified by Rwanda's nationwide implementation of LQMS, illustrate how policy endorsement and institutional commitment can facilitate quantifiable enhancements [30, 35].

Accreditation enhances local credibility and promotes involvement in international collaborations and clinical studies [12, 35]. Ongoing evaluation guarantees persistent adherence and fosters professional responsibility and pride, strengthening the laboratory's position within the health system.

Operational Efficiency and Resource Management

LQMS improves operational efficiency by implementing standardized workflows, defining roles clearly, and organizing documentation systematically [35]. In resource-constrained environments, this results in improved inventory management, diminished reagent waste, and enhanced utilization of workers and equipment. Insights from Nigeria and Malawi demonstrate that mentorship centered on quality and hybrid training models can maintain performance enhancements even during emergencies like the COVID-19 pandemic [36, 37].

Regional initiatives and reference laboratories have facilitated resource sharing

and capacity enhancement across borders, minimizing redundancy and expediting advancements toward certification.

Enhancing Customer Satisfaction

Customer satisfaction serves as both a quality metric and a catalyst for service enhancement in medical laboratories. Feedback systems connected with QMS enable laboratories to get insights from patients and healthcare providers, facilitating service enhancements and bolstering confidence. Research indicates that laboratories employing ISO-based Quality Management System frameworks experience improved communication, decreased turnaround times, and increased trust in test outcomes [37].

In low-resource environments, feedback loops have mitigated service bottlenecks and cultivated a culture of responsiveness and openness, essential for continued stakeholder engagement.

Standardization: Opportunities and Challenges

Standardization guarantees the comparability and precision of test outcomes across laboratories. ISO 17511:2020 establishes the metrological traceability framework essential for worldwide harmonization [39]. Nonetheless, the restricted accessibility to commutable certified reference materials (CRMs) and the disjointed regulatory frameworks continue to pose substantial obstacles.

It is essential to enhance the efficiency of regulatory approval processes, especially with recalibration [3]. Moreover, quality management must extend beyond just accreditation checklists. Pillai et al. observe that no singular Quality Management System (QMS) encompasses all World Health Organization (WHO) Quality System Essentials (QSEs), underscoring the necessity for integrated, multi-standard methodologies that prioritize continuous enhancement.

Conclusion

An effectively executed LQMS improves diagnostic precision, operational efficacy, patient confidence, and public health results. Initiatives like SLMTA and SLIPTA have demonstrated efficacy in resource-limited settings. To maintain and expand these advancements, laboratories must incorporate QMS concepts with national health policies, prioritize worker training, and promote regional and international collaboration. LQMS is not merely a technological instrument; it is a strategic investment in robust, patient-centered healthcare systems.

Conflict of interest

No conflict of interest.

Ethical Approval

Not Applicable.

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A Roadway to a Mixed Fungal Infection- A Rare Case Series

Naganandhini, M. Preethi*, S. Mary Lilly
Department of Pathology, Sree Balaji Medical College and Hospital, Chrompet, Chennai-44, Tamil Nadu, India

Abstract

Fungal infections of the nose and paranasal sinuses can be categorized into invasive and non-invasive forms. The clinical presentation and course of the disease is primarily determined by the immune status of the host and can range from harmless or subtle presentations to life threatening complications. Immunocompromised patients with poorly controlled diabetes mellitus, HIV and patients receiving chemotherapy or chronic oral corticosteroids are mostly affected In our first case A 54 years male came with complaint of nasal blockage for 3 months , UTI , headache and heaviness of head for 4 months. microscopically necrotic tissue with fungal colonies along with mixed inflammatory cell composed of neutrophilis and lymphocytes seen and silver stain both mucormycosis and aspergillosis fungal organism. A 58 years female came with complaint of nasal pain for 3 months, nasal block , headache, sneezing and heaviness of head for 4 months,right ear pain for 10years associated with tinnitus. microscopically section shows necrotic tissue with fungal colonies along with mixed inflammatory cell infiltrate composed of eosinophilis and lymphocytes and silver stain conforms the presence of both mucormycosis and aspergillosis fungal organism. Case 3 A 48 years male came with complaint of nasal blockage for 3 months. history of upper respiratory tract infection, headache and heaviness of head for 2 months. microscopically section shows necrotic tissue with fungal colonies along with mixed inflammatory cell infiltrate composed of eosinophilis and lymphocytes and silver stain conforms the presence of both mucormycosis and aspergillosis fungal organism in the slide.

Keywords: *Aspergillosis, Examination, Fungal Infection, Histopathology, Mucormycosis.*

Introduction

Fungi are ubiquitous in nature, and human exposure to fungi is unavoidable. The extent of fungal infections of the nose and paranasal sinuses is, therefore, primarily determined by the immune status of the host rather than the presence or absence of fungal organisms and can range from saprophytic colonization to orbital and cerebral involvement with often fatal outcomes. Due to a growing number of chemotherapy, human immunodeficiency virus (HIV) infections, and diabetes mellitus, the number of susceptible immunocompromised hosts is increasing. Sinonasal fungal infections can be broadly divided into invasive and non invasive forms. Invasive fungal sinusitis is defined by the presence of fungal hyphae within the mucosa, submucosa, bone, or blood vessels of the paranasal sinuses, differentiating it from noninvasive forms [1, 2] Depending on the immunologic response of the host and the course of the disease, invasive fungal sinusitis can be categorized into acute, chronic, or chronic granulomatous entities. Molds such as Aspergillus and Mucor are the most common opportunistic filamentous fungi, which can cause very serious infections that develop

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****Corresponding Author: drpreethi1290@gmail.com***

rapidly and that can sometimes be fatal. Generally these infections occur in immunocom-promised patients, patients with unregulated diabetes, and patients treated with immunosuppressive drugs. Rare cases of these types of fungal infections in previously healthy immunocompetent patients are documented. The infection is caused by spores from the environment, which get into the body through the lungs, gastrointestinal system, or the skin. Primary infection of the skin may occur only when the skin is damaged [1, 2]. Here we present the case of a young farmer with a hand injury sustained on a farm, where a mixed infection caused by bacteria and fungi developed and was successfully cured. Pulmonary aspergillosis refers to the clinical spectrum of lung diseases caused by several species of the genus Aspergillus. These fungal infections have recently shown increased incidence and are associated with significant morbidity and mortality.1 In spite of the known clinical impact and improvement in diagnostics, aspergillosis remains a diagnostic challenge in clinical practice.

Materials and Methods

Case report no 1

A 54 years male came to sree Balaji medical college and hospital to ENT department with complaint of nasal blockage for 3 months, it is relieved on medication and aggravated on cold. history of upper respiratory tract infection, headache and heaviness of head for 4 months. History of right ear pain for 10years associated with tinnitus. On examination mild pallor, koilonychia was present. Direct nasal endoscopy shows deviated nasal septum to left with right mild septal deviation with choana filled with mucoid discharge, bilateral middle meatus shows mucoid crowding. His blood investigation report show Hb-10gm/dl, MCV 80ft, MCH-28pg, MCHC-30%, RDW- 14.2. computerised topography shows diffuse mucosal thickening with hyperdense foci seen with left maxillary sinus causing complete deviation of maxillary sinus and extending into left nasal cavity through the wided maxillary ostium, could be fungal sinusistis. Following the investigation reports SMR with left MMA surgery was done under general anaesthesia and specimens were sent to histopathology investigations macroscopically it was single soft tissue measuring 1x0.5x0.5cm and microscopically section shows necrotic tissue with fungal colonies along with mixed inflammatory cell infiltrate composed of eosinophilis and lymphocytes (Figure 1). No vascular invasion seen and impression was fungal sinusitis. The fungal stain shows fungal organism morphologically resembling scattered mucormycosis colonies and few spore aspergillus and silver stain conforms the presence of both mucormycosis (Figure 2) and aspergillosis fungal organism in the material. Following the reports patient was started with antifungal medicines in intravenous route and monitored every 3 months once.

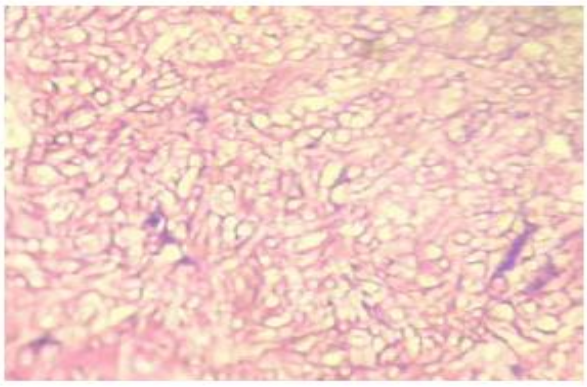


Figure 1. in H&E stain Aspergillus species comprising septate, branching hyphae (at acute angles) are seen

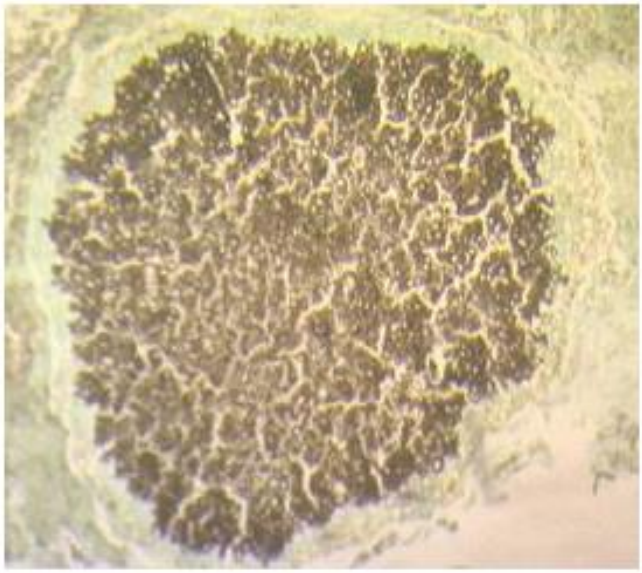


Figure 2. Silver stain highlights branching actinomycosis fungal organisms in 100x

Case report no 2

A 58 years female came to sree Balaji medical college and hospital to ENT department with complaint of nasal pain for 3 months, nasal block, it is relieved on medication and aggravated on cold . history of recurrent upper respiratory tract infection associated with fowel smelling discharge, headache and heaviness of head for 4 months. History of right ear pain for 10years associated with tinnitus. On examination mild pallor, koilonychia was present. Direct nasal endoscopy shows deviated nasal septum to left with right mild septal deviation with choana filled with mucoid discharge, bilateral middle meatus shows mucoid crowding. His blood investigation report show Hb-10gm/dl, mcv 80ft, mch-28pg, mchc-30%, rdw- 14.2. computerised topography shows diffuse mucosal thickening with hyperdense foci seen with left maxillary sinus causing complete deviation of maxillary sinus and extending into left nasal cavity through the wided maxillary ostium, could be fungal sinusistis. Following the investigation reports SMR with left MMA surgery was done under general anaesthesia and specimens were sent to histopathology investigations macroscopically it was single soft tissue measuring 0.5x0.5x0.cm and microscopically section shows necrotic tissue with fungal colonies along with mixed inflammatory cell infiltrate composed of eosinophilis and lymphocytes. No vascular invasion seen and impression was fungal sinusitis. The fungal stain shows fungal organism morphologically resembling scattered mucormycosis colonies and few spore aspergillus and silver stain conforms the presence of both mucormycosis and aspergillosis fungal organism in the material. (Figure 3 and 4) GMS stain highlights both mucormycosis and aspergillus organism in 100X. Following the reports patient was started with antifungal medicines and monitored every 2 months.

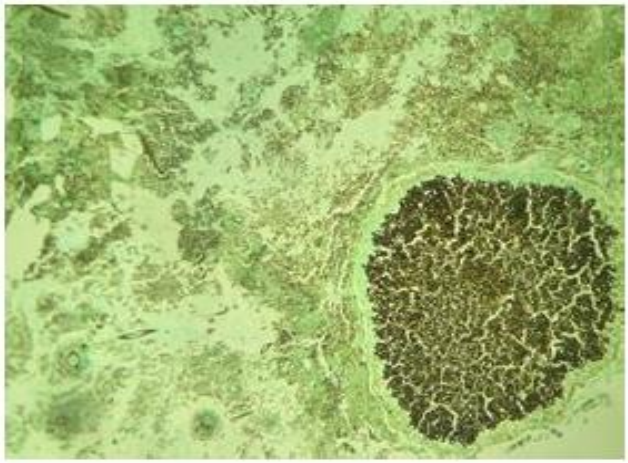


Figure 3. GMS stain highlights both mucormycosis and aspergillus organism in 100X

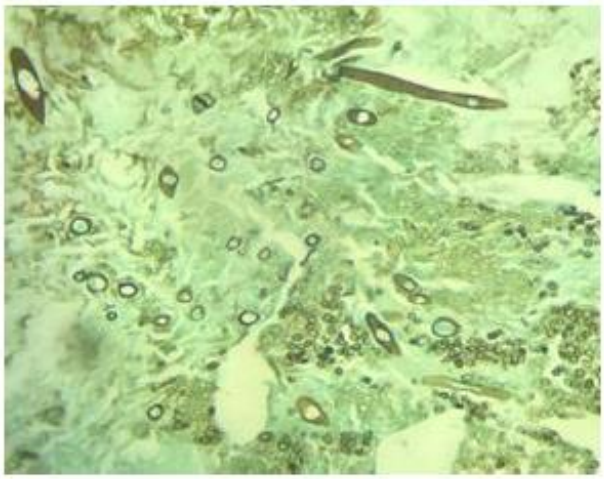


Figure 4. GMS stain highlights a broad aseptate fungi mucormycosis organism in 100X

Case report 3

A 48 years male came to Sree Balaji medical college and hospital to ENT department with complaint of nasal blockage for 3 months. history of upper respiratory tract infection, headache and heaviness of head for 2 months. History of right ear pain for 3 months associated with tinnitus and ear discharge. On examination mild pallor, koilonychia was present. Direct nasal endoscopy shows deviated nasal septum to left with right mild septal deviation with choana filled with mucoid discharge, bilateral middle meatus shows mucoid crowding. His blood investigation report show Hb-10gm/dl, MCV 78ft, MCH-26pg, MCHC-30%, RDW- 14.2 . computerised topography shows diffuse mucosal thickening with hyperdense foci seen with left maxillary sinus causing complete deviation of maxillary sinus and extending into left nasal cavity through the wided maxillary ostium, could be fungal sinusistis. Following the investigation reports SMR with left MMA surgery was done under general anaesthesia and specimens were sent to histopathology investigations macroscopically it was single soft tissue measuring 1x0.5x0.5cm and microscopically section shows necrotic tissue with fungal colonies along with inflammatory cell infiltrate composed of plasma cells, histocytes, eosinophilis and lymphocytes. No vascular invasion seen and impression was fungal sinusitis. The fungal stain shows fungal organism morphologically resembling scattered mucormycosis colonies (Figure 5)

and few spore aspergillus and silver stain conforms the presence of both mucormycosis and aspergillosis fungal organism in the material. Following the reports patient was started with antifungal medicines.

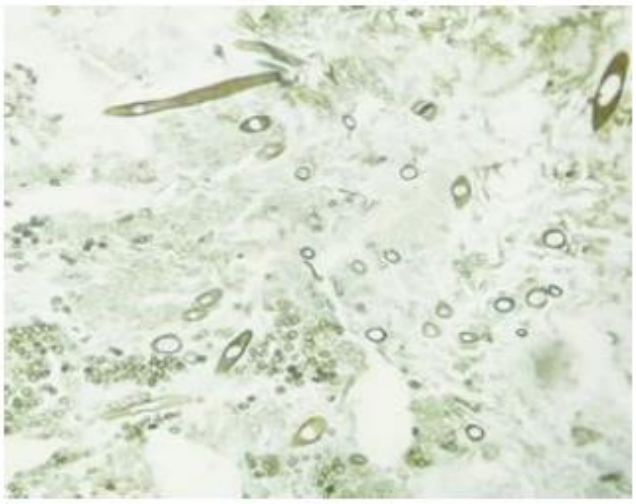


Figure 5. Sliver stain highlights a broad aseptate fungi mucormycosis organism in 100X

Discussion

Mucormycosis encompasses a range of infections caused by Zygomycetes, a class of fungi that produce branching ribbon-like hyphae and reproduce sexually by forming zygospores [12, 13]. Pathogen can be found ubiquitously in fruits, soil, and feces and can also be cultured from the oral cavity, nasal passages, and throat of healthy disease-free individuals [14,15]. Mucorales is a subgroup of Zygomycetes that causes a distinct clinical pattern of infection. Fungi are usually avirulent; they become pathogenic only when host resistance is exceptionally low [16, 17]. Ulceration of the mucosa or an extraction wound in the mouth can serve as a portal of entry for mucormycosis in the maxillofacial region, particularly when the host is immunocompromised.

Frequent clinical presentations include rhinocerebral, pulmonary, and cutaneous forms (superficial) and, less frequently, gastrointestinal, disseminated, and miscellaneous forms [18]. The rhinocerebral (rhinomaxillary) form is the most common infection seen in patients with uncontrolled diabetes mellitus [19]. Patients with rhinocerebral mucormycosis clinically present with malaise, headache, facial pain, swelling, and low-grade fever. The disease usually begins in the nasal mucosa or palate and extends to the paranasal sinuses, spreading through surrounding vessels, such as the angular, lacrimal, and ethmoidal vessels. In addition, mucormycosis can also involve the retro-orbital region by direct extension [20]. Once fungal hyphae enter the bloodstream, they can spread to other organs such as the cerebrum or lungs, which can be fatal for the patient [21].

Histopathologically, the lesion demonstrates broad, aseptate fungal hyphae that branch at right angles [22]. In the present case, the same histopathology was revealed. The histopathological differential diagnosis includes aspergillosis where the hyphae of Aspergillus species are septate, smaller in width and branch at more acute angles [23].

When diagnosed early, mucormycosis may be cured with a combination of surgical debridement of the infected area and systemic amphotericin B for 3 months. Proper management of the underlying condition is also an essential aspect affecting the outcome of the treatment.

Clinical differential diagnosis of lesion should include squamous cell carcinoma, chronic granulomatous infection such as tuberculosis, tertiary syphilis, midline lethal granuloma, and other deep fungal infections.

Conclusion

Mucormycosis is an aggressive invasive fungal infection with severe complications. It can occur more commonly in patients with many precipitating factors, such as uncontrolled diabetes, renal failure, organ transplant, long-term corticosteroid and immunosuppressive therapy. The earlier the investigation and identification of the organism, the more directly proportional they are to the recurrence rate of infectious diseases. Further efforts should be made to improve early diagnosis of this disease and to ensure prompt patient management.

Conflict of Interest

There are no conflicts of interest.

Declaration of Patient Consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given her consent for//their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Angiolymphoid Hyperplasia with Eosinophilia in a Male Patient: A Case Report

Ram Kumar. B, Alexander Mecheri Antony, Duvvuru Pooja Reddy*
Department of General Surgery, Sree Balaji Medical College and Hospital, India

Abstract

Angiolymphoid hyperplasia with eosinophilia (ALHE) is a rare, vascular tumor that often creates diagnostic challenges because of its multiple possible presentations. This case report details a 34-year-old male who has had multiple itchy nodular lesions on his chin for three years while also dealing with diabetes. Histopathological analysis showed ALHE, with vascular proliferation and eosinophilic and lymphocytic infiltration. A surgical procedure was successful when followed by split-skin grafting. Diagnosis accuracy and surgical treatment effectiveness for ALHE become vital for Asian male patients because of their higher risk of developing this condition. Additional research is needed to create optimal treatment approaches.

Keywords: *Angiolymphoid Hyperplasia with Eosinophilia, General Surgery, Head and Neck Lesions, Histopathology, Surgical Excision, Vascular Tumor.*

Introduction

ALHE is a rare benign vascular tumor with distinctive histopathological features. The architectural pattern of this condition involves well-differentiated endothelial cells that proliferate to form abnormal vascular structures which tightly connect to dense areas of lymphocytes and eosinophils within stromal tissue [1, 2].

The clinical presentation of ALHE is typically characterized by the appearance of smooth-surfaced, erythematous to violaceous papules or nodules. These lesions demonstrate a marked tendency to localise to head and neck, particularly in auricular and preauricular regions [1]. A subtle female preponderance is typically noted in the occurrence of ALHE; however, it is noteworthy that several Asian studies, particularly those originating from this subcontinent, have documented a higher incidence in male patients. The most frequent age of presentation is observed within the third to fifth decades of life, with mean age of onset ranging from 30 to 33 years. [3].

The differential diagnosis for ALHE is broad, with Kimura disease most frequently considered. However, a comprehensive clinical evaluation should also encompass other conditions that may mimic its presentation. These include cutaneous lymphomas, granulomatous processes of the face, hypersensitivity reactions to arthropod bites, and systemic granulomatous diseases such as sarcoidosis. [4] A 34-year-old male presented with multiple itchy, nodular skin lesions on his chin that persisted for three years alongside his diabetes mellitus.

Case Report

The patient is a 34-year-old man who has had Diabetes Mellitus for six years and reports multiple pink, itchy nodular lesions on his chin for three years (Fig.1). A single lesion started the condition when the patient first treated it without medical assistance by using traditional

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****Corresponding Author: pooja_pbc@yahoo.com***

remedies. The condition worsened when multiple lesions developed, thus leading the patient to seek professional medical care.

Fig.1. Pre-operative Picture showing multiple pink, nodular lesions.



Examination revealed multiple erythematous, smooth papules and nodules measuring between 0.5cm and 1.5cm on his lower lip and chin. These lesions were soft to firm, bled easily on touch, and were associated with swollen cervical lymph nodes. The patient also reported discomfort and mild pain in the affected area.

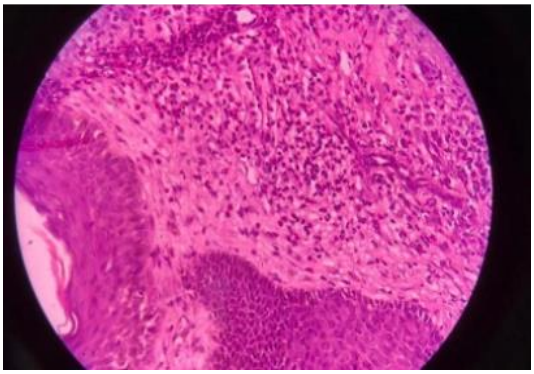
His lab results showed mild anaemia (haemoglobin of 10.6 g/dL) and elevated blood sugar (178 mg/dL), consistent with his diabetes. His HbA1c was 6.2%, suggesting fair glycemic control, while his ESR was markedly elevated at 132 mm/h, indicating significant inflammation. HIV, Hepatitis C, Hepatitis B surface antigen, and VDRL tests were all negative, though his eosinophil count was elevated at 14.8%, suggesting an ongoing allergic or inflammatory process (Table 1).

Table 1. Blood parameters

Test	Patient Value	Normal Range
Haemoglobin	10.60g/dL	13.5-17.5 g/dL
Eosinophils	14.80%	1-4%
Blood Sugar	178 mg/dL	70-99 mg/dL
HbA1c	6.2%	<5.7%
ESR	132	0-15
HIV	Non-Reactive	Non-Reactive
Anti-HCV	Negative	Negative
VDRL	Negative	Negative
HBsAg	Negative	Negative

A biopsy of one of the nodules revealed keratinised stratified squamous epithelium with underlying dermal changes (Fig. 2), including increased blood vessels and a dense infiltration of lymphocytes and eosinophils. The dermal stroma showed a mixed inflammatory infiltrate, consistent with chronic inflammation, with a Hobnail appearance. An FNAC of a nearby lymph node confirmed reactive lymphadenopathy, suggesting the body's immune response to the lesions.

Fig.2. Microscopic Picture showing Dense Inflammatory infiltrate, especially Lymphocytes & Eosinophils with proliferation of vascular channels in stroma with Hobnail appearance of endothelium & Keratinized Stratified Squamous Epithelium



Given the persistent nature of the condition and the patient's discomfort, he was admitted for further evaluation and treatment. After a thorough discussion of the options, the decision was made to proceed with complete surgical excision of lesions. The surgery was performed successfully; a post-excision Split Skin Graft was placed over the raw area on POD#14, and the patient's follow-up was unremarkable (Fig. 3).

Fig.3. Post-operative Picture showing Split Skin Grafting over the excised site



Discussion

ALHE, also known as epithelioid hemangioma (EH), is a vascular tumor with inflammatory features; the precise etiopathogenesis remains elusive. The defining histological feature is the proliferation of modified endothelial cells with histiocytoid morphology within a densely infiltrated stroma of lymphocytes and eosinophils. It is essential to acknowledge that this entity has been previously described under various alternative terminologies, such as 'histiocytoid hemangioma', 'angiomatous nodule,' and ‘pseudo pyogenic granuloma' [5]. Precise etiopathogenesis of ALHE/EH remains incompletely elucidated. While proposed mechanisms encompass reactive, neoplastic, and infectious etiologies, a definitive consensus has yet to be established. The ongoing debate persists over its classification as a true neoplasm versus an aberrant hypersensitivity response, with contemporary evidence favouring the latter.

Furthermore, anecdotal reports suggest a potential contributory role for antecedent trauma or infectious insults. The characteristic inflammatory infiltrate, a consistent histological feature, is posited to contribute to the disease's pathology, although its precise functional significance remains fully defined. A prevailing hypothesis suggests vascular proliferation emerges from endothelial cell responses to proliferative signals mediated by

inflammatory cells or allergic phenomena. Extra potential contributing factors include localised arteriovenous shunting, prior traumatic events, and elevated serum estrogen levels. [5, 6]. Identifying a TEK gene mutation that explicitly targets the Tie-2 receptor on endothelial cells in a reported dermal ALHE/EH case suggests a potential molecular basis for the disease's development. While this finding indicates a possible link between genetic alterations and ALHE/EH, further comprehensive investigations are necessary to establish a definitive causal relationship [6].

While a subtle female preponderance is noted in many studies, it is essential to acknowledge that Asian demographic studies, including those relevant to our local population, often reveal a greater incidence of ALHE in males. The condition primarily affects individuals within the 3rd to 5th decades of life, with an average age of onset of 30-33 years. Reports of ALHE in geriatric patients or pediatric cases outside of Asian ethnicities are exceedingly rare. [6]. Clinically, angiolymphoid hyperplasia with eosinophilia (ALHE) commonly manifests as solitary or multiple papulonodular lesions, displaying a colour spectrum from skin-toned to violaceous and exhibiting a size range from several millimetres to centimetres. [5, 9]. The interval between the initial manifestation of the lesion and patient presentation can vary significantly, ranging from several months to years. Although frequently asymptomatic, the vascular nature of these lesions can lead to symptoms such as tenderness, pulsatility, pruritus, or haemorrhage, particularly following minor trauma. In some instances, regional lymphadenopathy and peripheral eosinophilia have been documented. [5]. While ALHE typically presents as papulonodular lesions in the dermis and subcutis, rare extracutaneous cases have been reported. Numerous anatomical locations, including the lacrimal gland, colon, bone, radial artery, and oral mucosa, have shown these unusual appearances.[1]. ALHE lesions present as solitary lesions in about 53.4% of cases, with the remaining instances characterised by multiple lesions that frequently coalesce or form clustered configurations [1, 2].

Accurate diagnosis of ALHE can be particularly arduous, given its location within a dynamic and poorly delineated group of vascular tumors. A proper diagnosis of ALHE requires differentiation from Juvenile temporal arteritis (JTA), eosinophilic granulomatosis with polyangiitis and angiosarcoma, epithelioid hemangioendothelioma, and Kimura disease because these conditions share similar clinical features. Moreover, in the context of subcutaneous head lesions, differential diagnosis should include Kaposi's sarcoma, lymphoma, pyogenic granuloma, and metastatic malignancies [7].

Varied clinical presentations of ALHE frequently lead to diverse pre-biopsy diagnostic impressions. In an extensive series of 116 patients, Olsen and Helwig reported epidermal cysts and angiomas as the most common initial diagnoses. However, lesions' texture, color, morphology, dimensions, growth pattern, and other clinical features can suggest alternative diagnoses, including lymphadenopathy, pyogenic granuloma, scalp nodules, and lipomas, before histological confirmation [8].

Although peripheral eosinophilia is present in approximately 21% of ALHE cases, it is not a prerequisite for diagnosis. Radiographic imaging, including magnetic resonance imaging (MRI) or angiography, can be indicated to delineate the extent of the lesion. [9].

Histopathologically, ALHE is characterized by the proliferation of vascular structures within a stroma with a mixed inflammatory cell infiltrate [1]. Microscopically, ALHE demonstrates a characteristic pattern of endothelial cell proliferation, forming nests and cords within a stroma infiltrated by various inflammatory cell populations, including plasma cells, eosinophils, and lymphocytes.

This is often accompanied by areas of hemorrhage and a concurrent proliferation of both thin- and thick-walled blood vessels. Endothelial cells exhibit a distinctive 'hobnail' appearance, characterized by large, vesicular nuclei and acidophilic, occasionally vacuolated, cytoplasm. While mitotic figures may be observed, cellular atypia or anaplasia are consistently absent [10].

Given the typically benign clinical course of ALHE, conservative management with observation is a reasonable approach for asymptomatic patients. However, therapeutic intervention continues to be difficult due to the paucity of robust evidence encouraging the effectiveness of various modalities, including electrodessication, Mohs surgery, cryotherapy, surgical excision, systemic or topical corticosteroids, imiquimod, laser therapy, topical tacrolimus, or oral propranolol. [1, 11, 12].

Due to the limited incidence of ALHE, treatment strategies are primarily informed by individual case reports and retrospective analyses. Surgical excision is generally considered a preferred therapeutic option, despite a reported failure rate of 40.8percent, as determined by recurrence or incomplete resolution.

While ALHE typically follows a benign clinical course, rare instances have documented an association with lymphoproliferative disorders, including monoclonal T-cell proliferations and, exceptionally, peripheral T-cell lymphoma. [5]. Risk of recurrence in ALHE is significantly elevated in patients presenting with bilateral involvement, multiple lesions, prolonged disease course, earlier age of onset, and symptomatic manifestations. [2].

Conclusion

Drawing on our experience, we present this case and highlight the value of wide local surgical excision in managing ALHE, a rare entity often misdiagnosed. Therapeutic problems arising from insufficient evidence for alternative treatments require meticulous histopathological assessment and surgical intervention. Patients' positive outcomes validate this treatment approach. The success of patient treatment supports these medical methods, yet additional research on our regional population is needed to create improved treatment approaches and novel ALHE therapies.

Acknowledgement

The completion of this undertaking could not have been possible without the participation and assistance of so many people whose names may not be all enumerated. Their contributions are sincerely appreciated and gratefully acknowledged.

Conflict of Interest

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript, and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

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Roadway to A Rare Hemolytic Anemia - A Case Series of Cooley's Anemia

B. S. Chinna Devi, M. Preethi*
Department of Pathology, Sree Balaji Medical College and Hospital, Chennai, Tamil Nadu, India

Abstract

Thalassemia is a hemolytic anemia resulting from an inherited autosomal recessive genetic disorder. It is characterized by reduced hemoglobin synthesis due to defective production of either the alpha or beta globin chains. In our case report, we have discussed 3 case reports with exact similarity. All 3 cases were 5-year-old sex presented to the outpatient pediatric department at Sree Balaji Medical College and Hospital with complaints of cough, cold, dyspnea, irritability, and fatigue. On examination, the patient exhibited scleral pallor and a whitish tinge over the fingernails and extremities. There was evidence of a decayed upper tooth, though it was not associated with pain or swelling. Head and neck examination revealed maxillary prominence, a retracted upper lip, and a saddle nose, collectively giving the classical appearance of "chipmunk facies." The patient's hemoglobin level was critically low at 3.5 g/dL. Hematological investigations showed microcytic hypochromic anemia with anisopoikilocytosis and nucleated red blood cells (RBCs). Peripheral smear findings were consistent with hemolytic anemia, strongly suggesting thalassemia with concurrent hemolytic crisis.

Keywords: *Hemolytic Anemia, Hemoglobin Electrophoresis, Thalassemia, Target Cells.*

Introduction

Thalassemia is a group of inherited hemolytic anemias caused by mutations affecting the synthesis of alpha or beta globin chains of hemoglobin [1, 2]. Among them, beta-thalassemia is more prevalent and clinically significant, especially in populations with high rates of consanguineous marriages [3, 4]. It follows an autosomal recessive inheritance pattern, meaning that both parents must be carriers for a child to inherit the disease [5]. Early identification within families is crucial for genetic counseling, carrier screening, and prenatal diagnosis to prevent disease [6]. Recognizing the familial nature of beta-thalassemia is essential for breaking the transmission cycle and reducing the disease burden in future generations [7]. Treatment and regular follow up is required for the bata thalassemia patient. Early, the diagnosis and treatment increases the life expectancy of the people.

Case Report 1

A 5-year-old female child was brought to the Pediatric Outpatient Department at Sree Balaji Medical College and Hospital with complaints of cough, cold, dyspnea, irritability, and fatigue. There was no history of fever. Her family history with beta thalassemia trait for grandmother, explained in pedigree chart (figure 3).

On general examination, the child appeared ill-looking but had stable vital signs. Clinical evaluation revealed signs of anemia, including brittle hair and nails, severe koilonychia, and pallor of the sclera. The skin was ashen-grey, with yellowish discoloration of the fingernails. The patient was underweight (10.11 kg),

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****Corresponding Author: drpreethi1290@gmail.com***

underbuilt, and undernourished and exhibited short stature. Mild icterus and dehydration were noted. Craniofacial features included maxillary expansion, a retracted upper lip, and a saddle nose, giving a classical "chipmunk facies" appearance. Intraoral examination revealed periodontitis and broken lower anterior teeth, along with a decayed upper tooth, not associated with pain or swelling.

Ultrasonography, ophthalmologic, and audiologic examinations were within normal limits. Initial hematological evaluation revealed a critically low hemoglobin level of 3.5 g/dL. Peripheral smear examination demonstrated microcytic hypochromic anemia with marked anisopoikilocytosis and the presence of nucleated red blood cells (Figure 2), suggestive of hemolytic anemia and raising a strong suspicion of thalassemia with an ongoing hemolytic crisis. Subsequent hemoglobin electrophoresis confirmed the diagnosis of beta-thalassemia major, showing HbA at 94.6%, HbA2 at 5.1%, and HbF or variant at 0.3% (Figure 1). Additional investigations revealed a post-transfusion hemoglobin level of 7.5 g/dL and a markedly elevated serum ferritin level of 3452.69 ng/mL, while screening for HIV, Hepatitis B, and Hepatitis C was negative. Liver and renal function tests were within normal limits. The patient was immediately initiated on supportive care with transfusion therapy, receiving 3 units of packed red blood cells at a rate of 220 mL/hr. Her vital signs remained stable during the transfusion, and no adverse reactions were noted. On follow-up, her hemoglobin levels remained persistently low (5.5 g/dL), necessitating transfusions every 18 to 20 days. Given the iron overload, iron chelation therapy was initiated with Deferoxamine 2 g, administered four times weekly, along with oral Deferasirox 400 mg once daily. She is currently under regular follow-up with monitoring of liver and thyroid function tests every 20 days, and her growth and developmental milestones are assessed during each outpatient visit. The patient and her family have been counseled, and she has been advised to undergo bone marrow transplantation, which remains the definitive curative treatment for beta-thalassemia major.

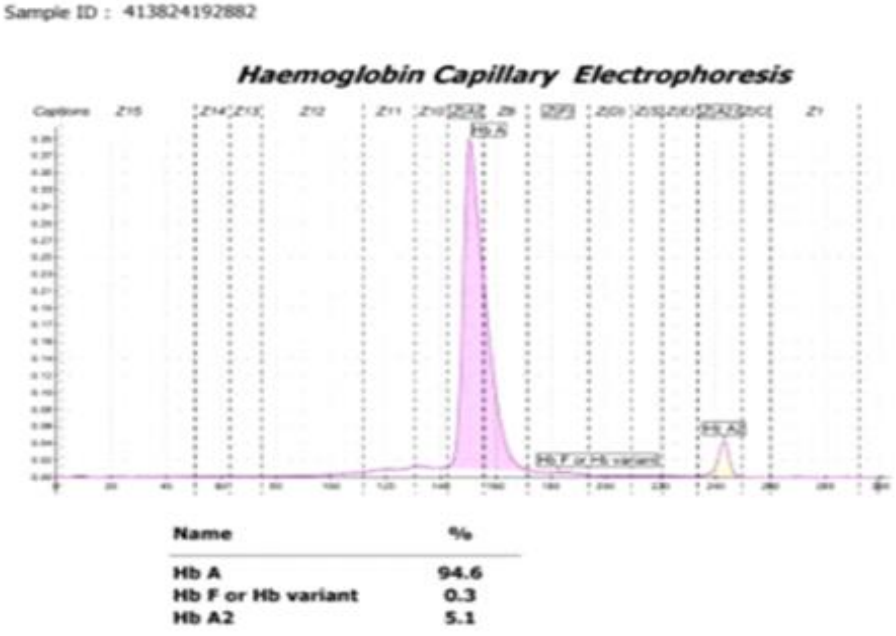


Figure 1. Hemoglobin Electrophoresis Graph with Values HbA 94.6%, HbF -0.3% and HbA2-5.1%

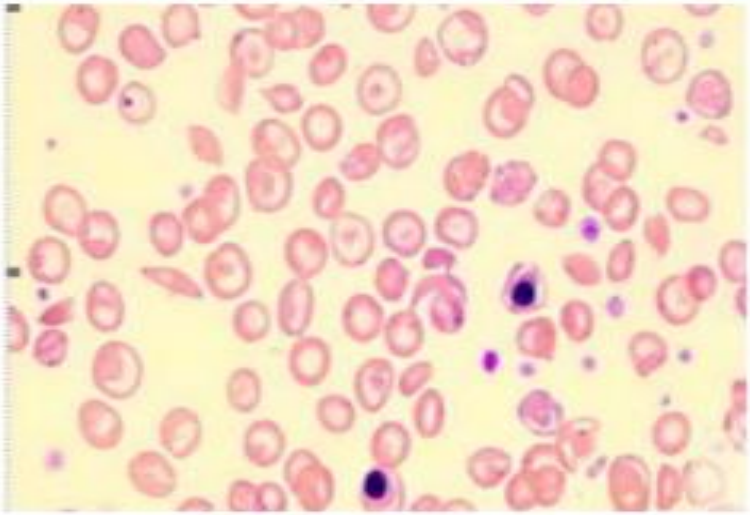


Figure 2. Smear (Case Report 1) Shows Microcytic Hypochromic Anemia with Severe Anisopoikilocytosis, Nucleated Red Blood Cells (RBC), Tear drop Cells, Target Cells (Codocytes), Acanthocytes and Macroovulocytic RBC)

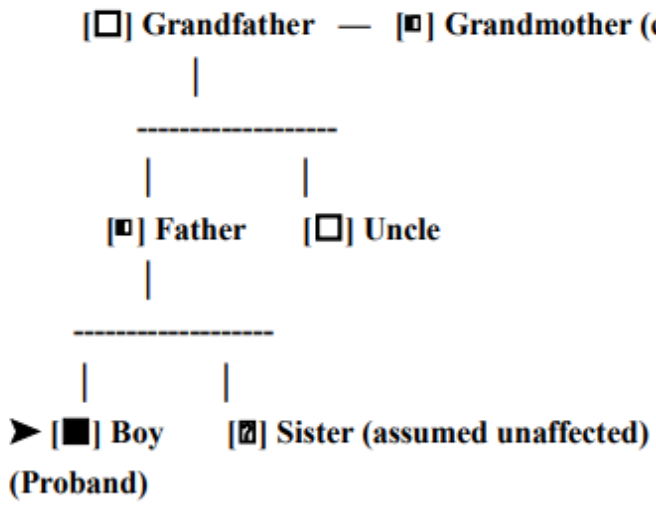


Figure 3. Pedigree Chart of the Case Report 1 with Explanation

■ = Affected male (thalassemia major), ◧ = Female carrier (thalassemia trait) ⍰ / □ = Unaffected male/female and ➤ = Proband (person of interest)

Case Report 2

A 4-year-old child was brought to the Pediatric Outpatient Department of Sree Balaji Medical College and Hospital with complaints of cough, cold, dyspnea, irritability, and fatigue. There was no associated fever. The family history was not significant for any hematological or genetic disorders (Figure 5), as explained in the pedigree chart.

On general physical examination, the child appeared ill-looking but was hemodynamically stable. She exhibited signs of anemia, including brittle hair, brittle nails, severe koilonychia, and pallor of the sclera. The fingernails and distal extremities showed a whitish tinge, and the skin was ashen grey. She was dehydrated and weighed 10.11 kg, indicating that she was underbuilt, undernourished, and had short stature. Mild icterus was noted, along with yellow-tinged fingernails. Dental evaluation

revealed a decayed upper tooth without pain or swelling. Craniofacial examination showed classical “chipmunk facies,” with maxillary expansion, a retracted upper lip, and a saddle nose. Intraoral examination revealed periodontitis and broken teeth in the lower anterior region. Ultrasound imaging and ophthalmologic and audiologic evaluations were within normal limits.

Initial hematological investigations revealed a hemoglobin (Hb) level of 3.5 g/dL. Peripheral blood smear (Figure 4) showed microcytic hypochromic anemia with anisopoikilocytosis and nucleated red blood cells (RBCs), suggestive of hemolytic anemia, raising suspicion for thalassemia in hemolytic crisis. Further evaluation with hemoglobin electrophoresis confirmed the diagnosis of beta-thalassemia major, with the following findings: HbA – 94.6%, HbA2 – 5.1%, and HbF/variant – 0.3% (Figure 2). Post-transfusion Hb was measured at 7.5 g/dL. Viral screening for HIV, Hepatitis B, and Hepatitis C was negative. Liver function test (LFT) and renal function test (RFT) were within normal limits. The child was managed with supportive transfusion therapy and was transfused with three units of packed red blood cells at a rate of 220 mL/hr. No transfusion-related complications were observed, and her vitals remained stable throughout the procedure. She was discharged and advised to follow up after 13 days. On follow-up, her serum ferritin level was found to be significantly elevated at 3452.69 ng/mL, prompting the initiation of iron chelation therapy with Deferoxamine (DFO) 2 grams per dose, administered four times a week, and oral Deferasirox 400 mg once daily. At that time, her Hb was 5.5 g/dL, and she received another unit of packed red blood cells before discharge.

Since then, she has required hospitalization every 20 days for packed RBC transfusions. Her liver and thyroid function tests are monitored every 20 days, and her growth and developmental milestones are evaluated during each outpatient follow-up. The patient has been counseled for bone marrow transplantation, which remains the only curative option.

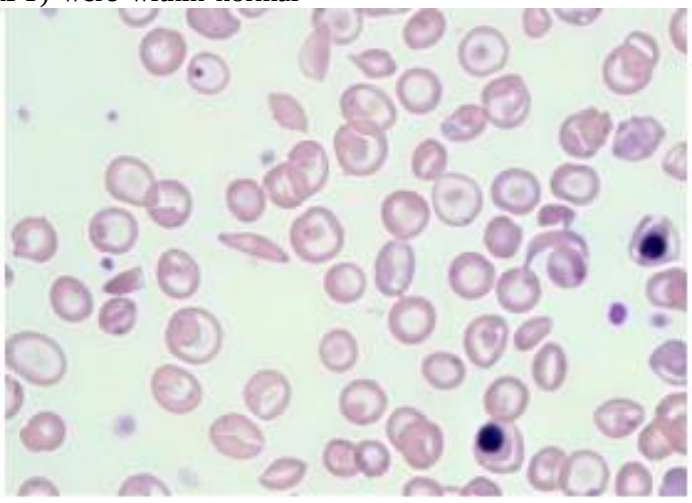


Figure 4. Smear (Case Report 2) Shows Microcytic Hypochromic Anemia with Severe Anisopoikilocytosis, Nucleated Red Blood Cells (RBC), Target Cells (Codocytes), Acanthocytes, Macroovulocytic RBC and Giant Platelet

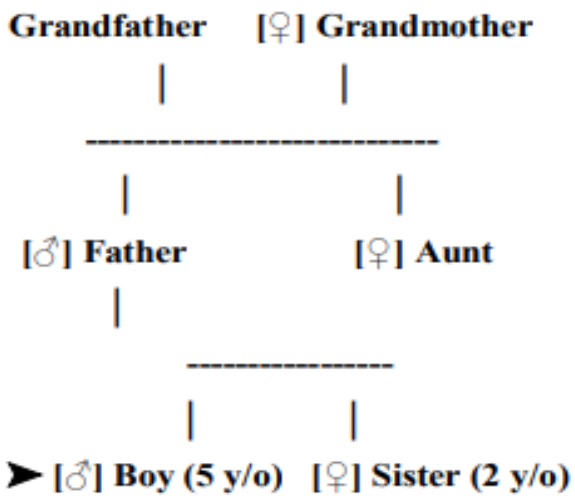


Figure 5. Pedigree Chart of the Case Report 1 with Explanation for Case Report 2

■ = Affected male (thalassemia major), ◧ = Female carrier (thalassemia trait), ⍰ / ☐ = Unaffected male/female, ➤ = Proband (person of interest)

Case Report 3

A 5-year-old boy presented to the outpatient pediatric department at Sree Balaji Medical College and Hospital with a history of cough, cold, Dyspnea, Irritability, and fatigue. She had no fever. Family history reveals beta thalassemia trait for her younger sister, and her mother is also a beta thalassemia trait positive, so it signifies that the blood-related disorder or genetic disease already exists in the family (Figure 7: Pedigree Chart). On physical examination patient was ill looking. Her vitals were stable. She was clinically anemic with brittle hair and nail, severe koilonychia. Patient's finger nails and skin extremities exhibited a whitish tinge, and the sclera showed pallor. Her skin was ashen grey in color, dehydration was present and her body weight of 10.11 kg. She was underbuilt, under-nourished, with a short stature, with mild icterus, and yellow-tinged finger nails. Decayed upper tooth, not associated with pain or swelling. Head and Neck examination showed maxillary expansion, retracted upper lip and saddle nose and resembling classical "Chipmunk facies". Intraoral examination showed periodontitis and broken teeth in the lower anterior aspect. Ultrasound findings were within normal limits, and ophthalmologic and audiologic examinations were within normal limits.

Haematological examination was performed. Her haemoglobin was 3.5 gm/dl. Hematologic investigation revealed microcytic hypochromic anaemia with anisopoikilocytosis and nucleated Red Blood Cells (RBCs) on the peripheral smear (Figure 6). The impression drawn from the peripheral smear study was that of haemolytic anaemia favouring Thalassemia with haemolytic crisis. Later Haemoglobin (Hb) electrophoresis was done which too was in favor of Beta Thalassemia major. Her Human immunodeficiency Virus (HIV), Hepatitis B, and Hepatitis C was negative. Liver function test and Renal function test were within standard limit. She was planned for blood transfusion and 3 points of packed cell transfused at the rate of 220 ml /hr. Her vitals were within normal limits during the transfusion, and no transfusion-related complications were encountered. Then she was investigated for Haemoglobin electrophoresis, which showed elevated HbA 94.6%, HbF or Hb variant 0.3%, HbA2 5.1% fig no. 2), and hemoglobin (Hb) was found to be 7.5 gm/dl. Then she was discharged and advised to follow up in 13 days. On follow-up, her ferritin was measured and found to be 3452.69 ng/mL. Then

she was started on iron chelating agent (Deferoxamine B(DFO) 2 gm per dose at the rate of 4 times in a week and oral Deferasirox 400 mg once in a day dose). Her Hb was 5.5 mg/dl, she was transfused with a point of packed cells and discharged home with a follow-up in 18 days for transfusion. She was hospitalized every 20 days for transfusion of packed RBC. She is investigated for Liver function test and thyroid function test every 20 days. Her growth and development are assessed in every OPD visit for follow-up, and the patient was advised of bone marrow transplantation.

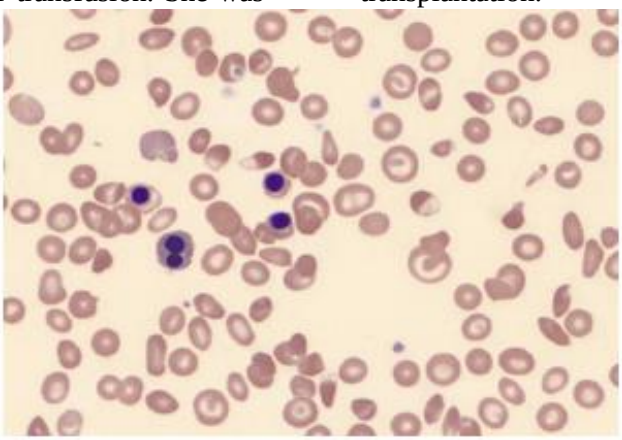


Figure 6. Smear Shows (Case Report 3) Microcytic Hypochromic Anemia with Severe Anisopoikilocytosis, Nucleated Red Blood Cells (RBC), Tear Drop Cells, Elongated Cells, Target cells (Codocytes), Acanthocytes, Macroovulocytic RBC and Neutrophils with Toxic Granules

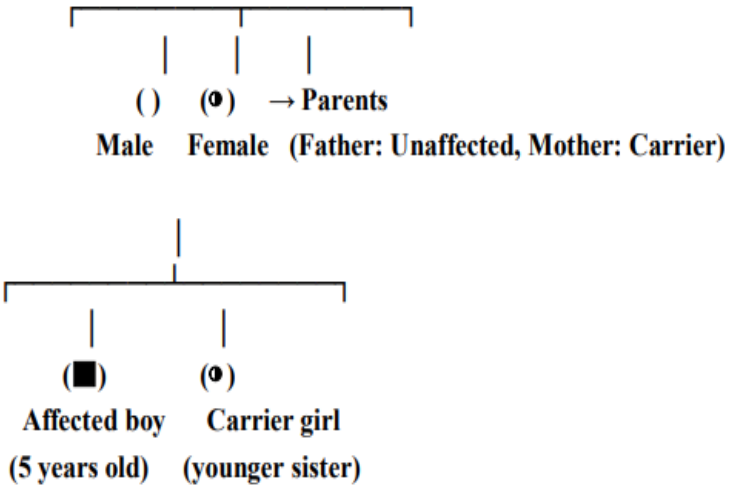


Figure 7. Pedigree Chart for Case Report 3

( ) = Father – unaffected, (◑) = Mother – beta thalassemia trait (carrier), (■) = Son – affected with beta thalassemia, (◑) = Daughter – beta thalassemia trait (carrier)

Discussion

In this case, the development has been hampered due to a loss of blood [8]. Beta-thalassemia major typically presents in infancy or early childhood with symptoms of profound anemia, growth retardation, hepatosplenomegaly, and skeletal deformities. This case highlights the classic clinical stigmata, including "chipmunk facies" and severe anemia, which prompted prompt diagnosis [9, 10].

The cornerstone of treatment remains regular blood transfusions, which help maintain hemoglobin levels and suppress ineffective erythropoiesis. However, chronic transfusions

lead to iron overload, necessitating early initiation of iron chelation therapy. Serum ferritin levels are helpful in monitoring iron burden. Bone marrow transplantation remains the only curative option and offers the best outcomes when performed early with an HLA-matched sibling donor [11, 12]. Genetic counseling for the family is critical for future reproductive planning.

This case reports highlights the typical presentation of beta-thalassemia major in early childhood, including progressive anemia, growth retardation, and characteristic craniofacial abnormalities [13]. Early detection based on clinical and hematologic features followed by confirmatory hemoglobin electrophoresis is critical for initiating prompt therapy. Chronic transfusion therapy improves survival and quality of life but leads to secondary iron overload, necessitating chelation therapy [14, 15]. Serum ferritin levels are a valuable marker of iron burden. Bone marrow transplantation, if performed early, offers the potential for a cure, especially in patients with an HLA-matched donor [16].

This case illustrates the typical presentation of beta-thalassemia major, with severe anemia, classical craniofacial deformities, and failure to thrive. Peripheral smear and hemoglobin electrophoresis remain key diagnostic tools [17, 18]. The mainstay of treatment is lifelong blood transfusion combined with iron chelation therapy to prevent secondary hemosiderosis. Regular monitoring is crucial to detect complications such as endocrine dysfunction, growth failure, and organ damage. Bone marrow transplantation offers the potential for a cure and is best performed at an early age with an HLA-matched sibling donor. Genetic counseling plays a vital role in preventing disease transmission and informing future family planning [19, 20].

Early diagnosis of beta-thalassemia major is essential for optimal disease management and improved patient outcomes. Delayed diagnosis often results in severe anemia, growth failure, skeletal deformities, and end-organ complications due to chronic hypoxia and iron overload [21, 22]. Neonatal screening and early clinical suspicion—based on signs such as pallor, poor weight gain, hepatosplenomegaly, and characteristic facial changes—allow for the timely initiation of transfusion therapy and iron chelation before complications develop. Hemoglobin electrophoresis or high-performance liquid chromatography (HPLC) is a definitive diagnostic tool that helps distinguish thalassemia from other causes of microcytic anemia [23, 24]. Once diagnosed, early genetic counseling and family screening are pivotal for identifying carriers and preventing recurrence through informed reproductive choices. Additionally, early initiation of therapy improves growth and developmental outcomes and enhances long-term quality of life. For patients with a matched sibling donor, early evaluation for bone marrow transplantation offers a curative opportunity, especially before transfusion-associated complications occur [25, 26].

The cornerstone of treatment in beta-thalassemia major is regular red blood cell transfusions to maintain adequate hemoglobin levels, suppress ineffective erythropoiesis, and promote normal growth and development [27, 28]. Transfusion therapy typically begins during infancy or early childhood and continues throughout life unless curative therapy is achieved. While transfusions improve quality of life and survival, they are associated with the risk of iron overload. Thus, iron chelation therapy is initiated once serum ferritin levels rise above 1000 ng/mL or after approximately 10–20 transfusions. Common chelating agents include Deferoxamine, which is administered subcutaneously or intravenously, and oral agents such as Deferasirox and Deferiprone, which offer improved compliance. Regular monitoring of serum ferritin, liver, and cardiac iron load (via MRI), and organ function is critical in patients receiving long-term chelation. Supportive care also includes folic

acid supplementation, vaccination against hepatitis viruses, endocrine evaluation, and management of complications such as growth retardation, hypothyroidism, and delayed puberty. In eligible patients, hematopoietic stem cell transplantation (HSCT) from an HLA-matched sibling donor is considered the only curative therapy and has shown the best outcomes when performed at a younger age before the onset of iron-related organ damage.

Although a common disease among the South Asian Population, case reports are very few and have been reported under different circumstances. We have tried to report cases that have failed to follow up despite the diagnosis. Complications can occur in any patient who refuses to follow up, so proper counselling should be provided to ensure the patient attends regular follow-ups and is saved, which can be prevented with timely intervention. Along with this, the community should take an active role in helping the patients with regular follow-up and proper supply of blood needed for the patient.

Conclusion

The Cooley's anemia or Beta-thalassemia major is a chronic hematologic condition that presents with severe clinical manifestations in early childhood. Timely diagnosis, comprehensive transfusion care, iron chelation, and growth monitoring are essential for optimal patient outcomes. Bone marrow transplantation remains the definitive cure and should be considered early in eligible patients. This case underscores the importance of a multidisciplinary approach and regular follow-up in the management of children with thalassemia.

Conflict of Interest

The Consent Form was signed by the patient for publishing the details.

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