

COVID-19 DEATHS AND VACCINATION: a comparative analysis

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ABSTRACT

Purpose: COVID-19 deaths before and in the vaccination era across countries of interest in Africa and other regions were compared to observe how vaccination impacted the trajectory of COVID-19 deaths in selected jurisdictions.

Method: COVID-19 cases, deaths and vaccination rates in *World Health Organization* database up to 07 June 2023 were extracted for countries in Africa, Asia, Europe, and North America that included China, Ghana, India, Nigeria, Norway, South Africa, Sweden, United States, and the United Kingdom, selected based on their COVID-19 trajectory. Case fatality rate (CFR) per 1,000 was computed for the period prior to vaccination (CFR1) and the period after vaccination commenced (CFR2). Tests of correlation between the vaccination rate per 100 persons and variables of interest were undertaken and examined.

Result: COVID-19 mortality increased in all countries ranging from 112.35% in South Africa to 2304.43% in China during vaccination era except in Nigeria where this decreased 38.3% relative to pre-vaccination figure. The percentage (%) change in COVID-19 deaths rose with increasing vaccination rates; correlation coefficients for primary vaccination being $r=0.564$ ($p=0.05$), booster 1 with positive correlation $r=0.612$ ($p=0.04$); booster2, $r=0.678$ ($p=0.03$) coverage respectively. In contrast, CFR per 1,000 in vaccinated areas declined as vaccination rates increased; with negative

correlation, $r=-0.740$ ($p=0.011$), $r=-0.746$ ($p=0.011$), $r=-0.814$ ($p=0.007$) for primary, first booster, second booster rates respectively.

Conclusion: COVID-19 deaths occurred more with vaccination and appears to increase as vaccination expands across the entire sample.

Key words: *COVID-19 deaths, vaccination, regions.*

BACKGROUND

World Health Organization (W.H.O) championed timely access to COVID-19 vaccines everywhere with global vaccination targets of 40% and 70% set for 2021 and 2022 respectively [1]. Despite such efforts and reports[2- 3] of relatively low COVID-19 deaths in Sub Saharan Africa SSA, some estimates [4] indicate, more people in the region as a share of the vulnerable populations died from COVID-19 by 2021 ending than everywhere else due to late/inadequate vaccination. With the global crisis of terrifying daily COVID-19 deaths formally declared over in May 5, 2023[5], COVID-19 deaths in the period before COVID-vaccination in countries of interest in Africa and other regions and those during vaccination era were compared to observe how vaccination impacted COVID-19 deaths.

METHOD

Data acquisition: COVID-19 cases, deaths and vaccination rates in *World Health Organization* database [6] up to 07 June 2023 and other variables of interest unavailable therein but in another open-source [7] for nine countries drawn from Africa, Asia, Europe, and North America were extracted and examined. The countries

selected were China, Ghana, India, Nigeria, Norway, South Africa, Sweden, the United Kingdom, and the United States based on their COVID-19 trajectory. Specifically, China was chosen because the pandemic was first reported from there, while the United States has had the highest reported deaths from the pandemic. Nigeria, Ghana and South Africa were chosen for their comparatively low vaccination rates, while United Kingdom, Norway and Sweden were selected because of their high vaccination rates and varied national responses [8]. India was chosen for its demographic similarity to many countries in Sub-Saharan African. As Case Fatality Rate (CFR) as a measure of lethality generally tends to fluctuate as an epidemic for which little or no population immunity exist progresses before stabilizing over time; thus, for the purpose of this analysis, the time frame from the start to the end of one period (pre-and post-vaccination) were used to calculate the CFR. Specifically, the case fatality rate (CFR) per 1,000 was computed for the period prior to vaccination (CFR1) and the period after vaccination commenced (CFR2) for the selected countries; in this case, China, Ghana, India, Nigeria, Norway, South Africa, Sweden, the UK, and US. Besides comparing recorded deaths in the two time periods (Table1), and because of differences when vaccination commenced in the different countries and when the first case was documented, COVID-19 deaths were further disaggregated into years 1, 2 and from year 2 to June 07, 2023 as summarized in Table 2. Tests of correlation of the variables of interest as captured in Table 3 were undertaken to examine any possible link between them.

RESULT

COVID-19 deaths increased across the countries studied during the vaccination era regardless of when vaccination commenced or coverage achieved as at 07 June 2023 (Table 1). The percentage (%) increase relative to the pre-vaccines mortality figures varied from 61.71% in Nigeria to 2504.04% in China (Table 1), the changes (%) remained the same whether absolute mortality numbers or after correction for differences in population sizes of the different countries (*deaths/10⁶*) were used in the computation (Table 1). Strikingly, the percentage increase in COVID-19 mortality was higher in countries in Europe, North America and Asia with high primary vaccination rates compared to countries like Ghana, South Africa and Nigeria in Africa with low vaccination rates (Table 1). When the COVID-19 deaths were disaggregated into years 1, 2 and from year 2 to June 07, 2023 as summarized in Table 2 for reasons indicated in the methods section, the increased COVID-19 deaths were mostly in the first year post-vaccination, and by the 3rd year only up to June 07, 2023 such deaths had virtually fizzled out. The results of correlation tests summarized in Table 3 further showed this percentage (%) change in COVID-19 deaths increased in the same direction as the primary vaccination rates and booster doses coverage; the values being; primary vaccination, with positive correlation $r=0.564$ ($p=0.05$), booster 1 $r=0.612$ ($p=0.04$), booster2, $r=0.678$ ($p=0.03$) coverage rose. In contrast, the calculated CFR1 values for China, Ghana, India, Nigeria, Norway, South Africa, Sweden, the UK, and US were 53.99, 7.38, 14.43, 12.37, 9.23, 32.34, 22.60, 40.81, and 18.99 respectively; and corresponding CFR2 values were 1.18, 9.64, 11.02, 11.05, 3.55, 21.05, 6.66, 6.22, and 9.39. Specifically, CFR per 100 in the vaccination era declined

with increasing vaccination rates; with negative correlation $r=-0.740$ ($p=0.011$), $r=-0.746$ ($p=0.011$), $r=-0.814$ ($p=0.007$) for primary vaccination coverage, first booster, second booster doses coverage respectively across the entire sample (Table 3).

COMMENT

Previous reports [4, 9-13] on the impact of vaccination on COVID-19 trajectory derived mainly from *mathematical modeling* based on the *worst case scenario* and clinical *trials* results [14]. This analysis involving actual cases and deaths reported to W.H.O by the countries studied as the pandemic unfolded, suggest COVID-19 mortality increased with vaccination regardless of when vaccination commenced or rates achieved (Table 1). The percentage (%) increase in COVID-19 mortality as vaccination progressed seem more in the countries with high vaccination relative to those with low vaccination (Tables 1 & 2); at the one-month point after the pandemic emergency ended. The findings were completely unexpected, and raise the intriguing possibility that mass vaccination at the time it commenced might have achieved the opposite of what was intended particularly in the first year post vaccination and in jurisdictions with high vaccination rates (Tables 1 & 2). To these extent, the results echo similar observations [15] across many countries in Europe and Asia of escalating COVID-19 deaths especially in groups under 60 when vaccination commenced, and extends recently published data [16] across 47 Western countries suggesting increasing excess deaths - of which COVID-19 deaths was a major contributor- during the worst years (2020-2022) of the pandemic- as vaccination expanded consistent with correlation results summarized in Table 3. Further, the findings draw attention to the level of

protection against COVID-19 severity in the countries with relatively minimal deaths despite low vaccination at the time COVID-19 emergency was declared over [Table 1]. This raises the question whether COVID-19 vaccine could still be regarded a *game-changer* at the time of deployment especially in the countries (Table 1) with low vaccination rates significantly below 70% coverage for 2022 recommended to save lives and end the pandemic emergency everywhere as declared in May 2023. This is even more so in the countries in Sub-Saharan Africa [17] where a sustained pattern of low COVID-19 hospitalizations /mortalities emerged early in the pandemic before vaccines became available, and against a background of projections [18- 23] available at the time the pandemic started as also confirmed by recent global data [24] showing COVID-19 did not significantly alter life expectancies in the region.

Even so , the present observations of increasing COVID-19 deaths with vaccination across the entire sample are concerning and calls for further investigation.

DATA AVAILABILITY

The datasets for this analysis are open-sources as defined in the method section; but the combined dataset for the appraisal is also available on request

AUTHORS CONTRIBUTION

EOO and NAI are joint first authors. Specifically, concept was by EOO, design, data acquisition and analysis was by NAI and EOO, while results interpretation involved all authors. The initial draft was by EOO, with all authors subsequently making inputs

consolidated by BEO and EOO into the final manuscript approved by each and every author. Sadly, this fifth draft involving a minor adjustment to further reduce *word count* was not seen by AO Giwa, PhD who suddenly passed away on Sunday May 26, 2024.

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Table 1: COVID-19 vaccination and cumulative deaths statistics of selected countries up to June 7, 2023

Country	Date first case was reported (dd/mm/yy yy)	Vaccination start date (dd/mm/yy yy)	Cumulative cases at vaccination start	Cumulative cases as at June 7, 2023	Cumulative deaths at vaccination start	*Cumulative deaths/10 ⁶ at vaccination start	Cumulative deaths as at June 7, 2023 since the pandemic started	*Cumulative deaths/10 ⁶ at June 7, 2023 since the pandemic started	% change in deaths since vaccination started	Persons with incomplete vaccination on per 100	Persons vaccinated with a complete primary series per 100	Persons vaccinated with at least one booster or additional dose per 100
China	04/01/2020	22/07/2020	86226	99273266	4655	3.265	121236	85.025	2504.43	89.58	87.30	56.67
Ghana	12/03/2020	02/03/2021	85239	171653	629	18.79	1462	43.673	132.43	42.55	32.73	13.08
India	30/01/2020	16/10/2021	10542841	44991880	152093	107.321	531884	375.313	249.71	74.34	69.00	16.58
Nigeria	19/03/2020	05/03/2021	157671	266675	1951	8.927	3155	14.437	61.71	39.94	33.86	5.97
Norway	20/02/2020	23/12/2020	45606	1485102	421	77.471	5528	1022.942	1213.06	80.99	75.68	56.27
South Africa	06/03/2020	17/02/2021	1494119	4072533	48313	806.643	102595	1712.946	112.35	40.82	35.47	7.38
Sweden	31/01/2020	23/12/2020	395958	2710429	8948	848.204	24371	2318.626	172.36	72.33	71.00	53.65
UK	01/02/2020	21/12/2020	2126957	24618868	86796	1285.696	226645	3375.894	161.12	79.07	74.59	NA
US	02/02/2020	14/12/2020	16229549	1.03E+08	308161	910.938	1127152	3331.912	265.77	80.76	68.87	35.24

Source: World Health Organization (Reference 6) except the items in asterisk which were from www.ourworldindata.org (Reference 7)

Table 2: Disaggregated cumulative deaths and corresponding percentage change from the start of COVID-19 vaccination era up to June 7, 2023

Country	Vaccination start date (dd/mm/yy)	Duration of period before vaccination (Months)	Duration of Vaccination era up to June 7, 2023 (Months)	Cumulative deaths at vaccination start	Cumulative deaths 1 year after vaccination began	Cumulative deaths 2 years after vaccination began	Cumulative deaths as at June 7, 2023	% Change Year 1	% Change Year 2	% Change from Year 2 up to June 7, 2023	Overall % change from vaccination to June 7, 2023
China	22/07/2020	6	35	4655	5626	23072	121236	20.86	374.78	2108.79	2504.43
Ghana	02/03/2021	12	27	629	1313	1462	1462	108.74	23.69	0.00	132.43
India	16/01/2021	20	19	152093	528874	N/A	531884	247.73	N/A	1.98	249.71
Nigeria	05/03/2021	12	27	1951	3142	3155	3155	61.05	0.67	0.00	61.71
Norway	23/12/2020	10	29	421	1335	4745	5528	217.10	809.98	185.99	1213.06
South Africa	17/02/2021	11	27	48313	97431	102595	102595	101.67	10.69	0.00	112.35
Sweden	23/12/2020	11	29	8948	15274	21825	24371	70.70	73.21	28.45	172.36
UK	21/12/2020	10	29	86796	175411	214589	226645	102.10	45.14	13.89	161.12
US	14/12/2020	10	30	308161	793011	1074291	1127152	157.34	91.28	17.15	265.77

Table 3: Correlation matrix of percentage change in COVID-19 deaths, vaccination rates and case fatality rate per 1,000 persons in vaccination era with p-values (in brackets)

	% Change in Deaths	Persons vaccinated 1 Plus Dose per 100	Persons vaccinated Last Dose per 100	Persons with Booster Additional Dose per 100	Case Fatality Rate per 1,000 in vaccination era
% Change in Deaths	1	0.584 (0.05)	0.612 (0.04)	0.678 (0.03)	-0.653 (0.03)
Persons vaccinated 1 Plus Dose per 100	0.584 (0.05)	1	0.988 (<0.001)	0.844 (0.04)	-0.740 (0.011)
Persons vaccinated Last Dose per 100	0.612 (0.04)	0.988 (<0.001)	1	0.871 (0.002)	-0.746 (0.011)
Persons with Booster Additional Dose per 100	0.678 (0.03)	0.844 (0.04)	0.871 (0.002)	1	-0.814 (0.007)
Case Fatality Rate per 1,000 in vaccination era	-0.653 (0.03)	-0.740 (0.011)	-0.746 (0.011)	-0.814 (0.007)	1