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Body Mass Index and Its Implication on GOLD Staging in COPD Patients Accessing Healthcare in a Tertiary Hospital in Ilorin, Nigeria

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Abstract

Patients with Chronic Obstructive Pulmonary Disease (COPD) who have low Body Mass Index (BMI) are usually misdiagnosed and have a low survival rate. This research was to investigate the connection between BMI and COPD patients' Global Initiative for Chronic Obstructive Lung Disease (GOLD) stage. At the University of Ilorin Teaching Hospital's chest clinic and medical out-patient division, 184 COPD patients were enrolled in a cross-sectional observational study between January 1 and June 30, 2022. To categorize the level of blockage in COPD patients, pulmonary function and GOLD staging are employed. All participants' BMIs were calculated. The anticipated forced expiratory volume in the first second (FEV1%) post-bronchodilator in COPD patients was correlated with BMI and obstruction severity. There were 68 women and 116 men (63.04%) in total. The patients were 56.95 years old on average ($SD \pm 9.376$). Based on GOLD staging, the anticipated post bronchodilator FEV1% classified the COPD patients into four groups. Of the 184 individuals in the study, 74 (40.2%) were impacted by the first stage, followed by 62 (33.7%), 34 (18.5%), and 14 (7.6%) in the second stage. We found a negative association between BMI and post-FEV1% predicted using the Pearson correlation test ($R = -0.196$, $P 0.05$). When the GOLD stage and BMI were looked at tandem, a favorable relationship between both was found ($R = 0.298$, $p = 0.05$). The patients' BMI increased as the disease progressed, according to a one-way ANOVA, and this link was statistically significant ($F = 487.79$, $p = 5.632e-7$). BMI and the degree of airway blockage were discovered to be closely related in COPD patients.

Keywords: BMI, COPD, FEV1%, GOLD, Nigeria

Introduction

In terms of causes of death worldwide, Chronic Obstructive Pulmonary Disease (COPD) has been reported to claim

about 3.2 million lives in (World Health Organization (WHO) *et al*; 2021) and is predicted to come in third (Ale *et al*; 2022). Spirometry examination, which is typically internally consistent, showed that the

prevalence of COPD in Nigeria was 9.2% (interquartile range, IQR: 7.6-10.2) as opposed to 5.1% in studies employing British Medical Research Council (BMRC) guidelines or a physician's diagnosis. (Park *et al*; 2019) (IQR: 2.2-15.4). As the population ages and is exposed to COPD risk factors including smoking and air pollution more often, it is expected that the burden of COPD will rise in the next decades Yao, H. and Rahman, I., (2011). Increased metabolic demands brought on by increased baseline oxygen consumption and the production of cytokines that produce cachexia, such as tumor necrosis factor- α and interleukin 6, are the major causes of malnutrition in COPD (Di Stefano, *et al*; 2002) and (Mete *et al*;2018). At least 20% of COPD sufferers are underweight and consume insufficient calories and protein (Harik-Khan, *et al*; 2002). The severity of COPD, the evolution of a handicap, and the impairment of respiratory muscle dysfunction are all impacted by malnutrition (Benton *et al.*, 2010).

A poor prognosis for patients with COPD is commonly associated with low body mass index (BMI), which varies depending on the stage of the disease (Rabe, *et al*; 2013). Loss of appetite and nutritional deficiencies are symptoms of COPD. Severe COPD is more likely to occur in patients with low BMI. (Di Stefano,*et al* ;2002).Another element that reduces COPD patients' life expectancy is low BMI. (Mete, *et al* ;2018).However, little or no information is available on the relationship between BMI and level of blockage in COPD patients, pulmonary function and GOLD staging. In this study, the association between BMI and the degree of obstruction in COPD patients was examined.

Methods

The required sample size for this study was calculated using statistical formula for single population proportion by considering 95% confidence interval, 4% level of precision, design effect of 2, 16.2% prevalence of COPD and 10% non-response rate [21]. Accordingly, the final sample size was 184. This cross-sectional, observational study was conducted. From January 1st, 2021, to June 30th, 2022, 184 randomly selected COPD patients who visited our medical outpatient and chest clinic or were referred to our clinic for pulmonary function testing participated in the study at the University of Ilorin Teaching Hospital in Ilorin, Nigeria.

The trial's participants had to be at least 30 years old and diagnosed with COPD. On spirometry, there was no significant post bronchodilator FEV1 reversibility (less than 12% and 200 ml) and the ratio of forced expiratory volume in the first second to forced vital capacity (FEV1/FVC) was less than 0.7.

Each patient had a full clinical examination as well as a thorough history-taking process. Each patient's BMI (weight in kg/height in m^2) was determined. All patients had pre- and post- bronchodilator spirometry testing. Patients with considerable reversibility (improvement of 12% and 200 ml of FEV1) and post-bronchodilator FEV1/FVC less than 0.7 were excluded. Patients with a low chance of reversibility are the ones we choose. Using the GOLD (Global Initiative for Chronic Obstructive Lung Disease) staging approach, they were classified as being in stages 1 and 2 (post-bronchodilator FEV1 P 80% and 50%, respectively).

Statistical methods

The statistical tool R, version 4.1, was used to code and input the data. The mean, standard deviation, median, amount, and percentage for qualitative and quantitative variables, were used to summarize the data using descriptive statistics. For both qualitative and quantitative normally distributed variables, the chi square test and ANOVA were employed to evaluate statistical differences between groups. To determine whether the variables had any linear relationships between BMI and FEV1, and BMI and Gold stages correlations were run. Statistical level of significance was defined as a p-value of less than 0.05.

Ethical consideration

Ethical approval was sorted and obtained from the Ethics and Research Committee of the University of Ilorin Teaching Hospital. Strict confidentiality was maintained about the information of the patients during and after the study.

Results

Participants in the research varied in age from 30 to 85. The mean age of the population was 56.95 years (SD $\pm$ 9.376). The age range with the highest prevalence in each group was 50 -59 years (60 patients), followed by 60 – 69 years (53 patients) and then 30 – 49 years (47 patients)(Table 1).

Table 1: Age range and Number of patients within each GOLD with their respective percentages

Variable	Counts	%
Age range		
30 – 49	47	25.54348
50 -59	60	32.6087
60 – 69	53	28.80435
>70	24	13.04348
Current GOLD Stage		
Stage 1	74	40.21739
Stage 2	62	33.69565
Stage 3	34	18.47826
Stage 4	14	7.608696
Sex		
Male	101	54.891304
Female	83	45.108696

68 women and 116 men, or 63.04 percent each, were present. The BMI ranged from 17.36 to 45.92 kg/m², with a mean of 26.36. (SD $\pm$ 4.439). The estimated FEV1% ranged from 22.6% to 81.7%, with a mean of 56.13%. (SD $\pm$ 14.81).

The COPD patients were divided into four groups using the post-bronchodilator

FEV1% predicted values, in accordance with GOLD. Of the 184 individuals in the research, 74 were in stage 1 (or 40.2%), 62 were in stage 2, 34 were in stage 3, and 14 were in stage 4 (or 7.6%). (Table 1). The predicted FEV1%, age, and body mass index (BMI) of COPD patients at various GOLD stages are shown in Table 2.

Table 2: Age, BMI and FEV1% predicted of the COPD patients in their different GOLD stage

Current GOLD Stage	Age Mean ($\pm$ SD)	BMI Mean ($\pm$ SD)	FEV1% Mean ($\pm$ SD)
Stage 1	60.029 (9.9069)	25.29 (3.7138)	60.138 (12.8)
Stage 2	56.323 (9.2732)	27.399 (4.6623)	53.305 (16.463)
Stage 3	54.269 (8.3261)	28.162 (4.3437)	52.018 (12.874)
Stage 4	47.167 (2.137)	29.815 (3.8499)	47.067 (14.366)

Using the Pearson correlation test, we discovered a weak link between BMI and FEV1% ($R = -0.196$, $P = 0.05$). The same test was performed on the GOLD stage and BMI in Table3, and it was discovered that they correlated positively ($R = 0.298$, $P < 0.05$). As illustrated in Table 4, a one-way

ANOVA revealed a statistically significant relationship between the patients' BMI and the development of their disease ($p = 5.632e-7$). The same techniques were used to discover a statistically significant correlation between patient age and illness severity (GOLD) ($p = 0.0000015$).

Table 3: Correlation between BMI, Age, FEV1% and Current Gold stage

Variable 1	Variable 2	Bravais-Pearson Correlation
BMI (kg/m²)	Age	-0.29616
FEV1%	Age	0.25012
FEV1%	BMI (kg/m ²)	-0.19569
Current Gold stage	BMI (kg/m ²)	0.298

Table 4: one-way analysis of variance and Pos-Hoc test based on Current Gold stages

	Stage 1 (n = 82)	Stage 2 (n = 71)	Stage 3 (n = 21)	Stage 4 (n = 10)
Age	66.8 $\pm$ 0.696 ^a	52.7 $\pm$ 0.699 ^b	46.3 $\pm$ 0.269 ^c	41.5 $\pm$ 1.49 ^c
BMI	23.4 $\pm$ 0.403 ^b	25 $\pm$ 0.658 ^{ab}	26.4 $\pm$ 0.767 ^a	23.3 $\pm$ 1.18 ^{ab}

Values are means $\pm$ SEM. Means in a row without a common superscript letter differ ($P < 0.05$) as analyzed by one-way ANOVA and the TUKEY test.

Discussion

Since COPD is a frequent and exacerbating chronic inflammatory condition, it has a significant impact on morbidity and death globally. COPD is linked to significant systemic inflammation in addition to airway

inflammation. (Sorino, *et al*; 2019). Elevated levels of cytokines, chemokines, and acute-phase proteins as well as abnormalities in circulating cells are indicators of systemic inflammation. (Agusti, A. and Soriano, J.B., 2008).

Unintentional weight loss, skeletal muscle

atrophy, and an elevated risk of cardiovascular disease, osteoporosis, and gastroesophageal reflux disease are only a few of the detrimental effects of systemic inflammation. (Godoy, *et al.*, 2000.) Weight loss and nutritional deficiencies are typical COPD symptoms. Even if the precise mechanisms are uncertain, the two most significant processes are reduced food intake and increased energy expenditure through breathing. (Wouters, E.F., 2000. and Celli, *et al.*; (2004) Numerous investigations have revealed that individuals with COPD who had high BMIs outlived those with low BMIs.

According to research by Annemie *et al.*, (Vestbo, *et al.*; 2006), low BMI was a strong, independent predictor of higher mortality in 400 COPD patients. When 1898 COPD patients were prospectively tracked for 7 years, it was discovered that free fat mass index and BMI were significant predictors of mortality. (Chailleux *et al.*; 2003). Numerous studies have been conducted by the Association Nationale pour le Traitement a Domicile de l'Insuffisance Respiratoire Chronique (ANTADIR) network on the predictive significance of obesity in COPD patients. Obese COPD patients had the best survival and lowest hospitalization rates throughout the course of the 7.5 years of follow-up. (Mitra, *et al.*; 2013).

In this study, we found a negative correlation ($R = -0.196$) between BMI and both post-bronchodilators predicted FEV1%. Additionally, there was a strong association ($R = 0.298$) between the BMI and GOLD stage. According to Mitra *et al.*'s findings, there was a statistically significant relationship between patients' BMI and the severity of their illnesses (GOLD) ($P < 0.05$). We examined the relationship between BMI and obstruction severity in 101 male COPD

patients.

Age and obstruction severity were strongly correlated in our research group, and this finding revealed a statistically significant relationship between patient age and disease severity (GOLD) ($F = 349.29$, $p = 0.0000015$).

According to 2009 research by (Qiu *et al.*; Sahebajami, *et al.*; 1993), the anticipated FEV1% and BMI are related. (Sahebajami *et al.* findings's). (de Oca, *et al.*; 2008) that there was a connection between BMI and pulmonary function tests and advised using BMI as a benchmark for evaluating nutritional status in COPD patients further supported this recommendation.

In 397 male patients, Platino research. (Woldeamanuel, *et al.*; 2019), a population-based epidemiologic inquiry, discovered a correlation between lower BMI and (GOLD) stages 3 and 4. In 2008, the survey was carried out in five Latin American cities.

Limitation of the study

Mitra *et al.*, found that the GOLD staging deteriorated as the median age of the patient group increased. (Qiu, *et al.*; 2009) Therefore, more investigation will be required to establish the reasons for the differences between our findings and those of Mitra *et al.*, (Qiu, *et al.*; 2009) in this area. In COPD patients, our research discovered a link between obstruction severity and BMI. As the obstruction/disease severity increases, the patient's BMI increases in line with GOLD staging; this relationship was statistically significant.

Author's contribution

OAA, IMW, AEF and AKS had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of data analysis. Study conception and design was provided by OAA. Data analysis and interpretation was provided by OAA and IMW. Statistical

analysis was supervised by OAA. All authors revised the manuscript for important intellectual content

Data Availability

The authors confirm that data used to support the findings of this study are

available from the corresponding author upon request

Conflicts of Interest

The authors declare that there is no conflict of interest

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