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Effect of multiple measures of obesity on asthma control among Nigerians

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Abstract

Background: Asthma and obesity are disorders with a significant public health impact. There is evidence from literatures suggesting that obesity is a risk factor for developing asthma and possible poor asthma control. The systemic inflammatory responses in obesity leads to metabolic, cardiovascular and respiratory complications. There is paucity of data regarding the prevalence of obesity among asthma patients in Nigeria using different measures of adiposity. In addition, the relationship between obesity and asthma control has not been well elucidated. This is a potential area of intervention in the management of asthma to improve asthma control.

Aim: To determine the prevalence of obesity among patients with asthma and explore the relationship between different measures of adiposity and measures of asthma control.

Methods: This was a cross sectional study among asthma patients attending the Respiratory Clinic of the Lagos University Teaching Hospital. We measured Weight and height for body mass index (BMI) calculation, waist circumference (WC) and hip circumferences for waist-hip-ratio (WHR), and triceps skin fold thickness (TSFT). We assessed asthma control using the Asthma control test questionnaire (ACT) scores and spirometry measurement with pre-bronchodilator forced expiratory volume in first second (PRE-FEV1) values. We also explored the relationship between different measures of adiposity and asthma control using univariate and multivariate linear regression analysis.

Results: Two hundred asthma patients who performed adequate spirometry were included in the analysis (96 females and 104 males). Frequency of obesity using: BMI>30kg.m^2 was 18.0%, WC >88cm for females or >102 for males was 34.0%, WHR>0.85 for females or >0.9 for males was 56.5% and TSFT >23mm for females or >12mm for males was 28.5%. There was a significant inverse relationship between the FEV1 and measures of adiposity on univariate linear regression analysis (BMI: r^2= -0.175 p = 0.013, WC: r^2= -0.209 p= 0.003, WHR: r^2= -0.148 p=0.036). There was no significant relationship between measures of adiposity and ACT score. On multivariate regression analysis after controlling for age, sex, comorbidities (including smoking, GERD and rhinitis), measures of adiposity were not significant determinants of asthma control: ACT [BMI-OR=0.569 : 95%CI(0.245-1.328) P= 0.193,WHR-OR= 0.996: 95%CI(0.467-2.114) P=0.987 , TSFT-OR=0.699 : 95%CI(0.310-1.578) P=0.389] and FEV1[BMI-OR= 1.392: 95%CI(0.591-3.283) P= 0.449,WHR-OR= 1.191: 95%CI(0.551-2.575) P=0.657 , TSFT-OR= 1.647: 95%CI(0.707-3.833) P=0.247].

Conclusion: The prevalence of obesity among patients with asthma varies depending on the measure of adiposity used. Obesity negatively impacts on the lung function. None of the measures of obesity was an independent determinant of poor asthma control. This is a potential target area for improving asthma control among asthma patients.

Keywords: *Asthma, Obesity, adiposity, asthma control, Spirometry, Airway obstruction.*

Abstrait

Contexte : L'asthme et l'obésité sont des troubles qui ont un impact important sur la santé publique.Il existe des preuves de la littérature suggérant que l'obésité est un facteur de risque de développer de l'asthme et des risques complications cardiovasculaires et respiratoires. Il y a peu de données concernant la prévalence de l'obésité chez les patients asthmatiques au Nigeria en utilisant des

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mesures différentes de l'adiposité.De plus, le rel domaine d'intervention potentiel dans la prise en charge de l'asthme pour améliorer le contrôle de l'asthme.

Objectif : Déterminer la prévalence de l'obésité chez les patients asthmatiques et explorer la relation entre les

Méthodes: Il s'agissait d'une étude transversale chez des patients asthmatiques fréquentant la clinique respiratoire de l'hôpital universitaire de Lagos.Nous avons mesuré le poids et la taille pour l'indice de masse corporelle (IMC) calc circonférences de la hanche pour le rapport taille-hanches (WHR) et épaisseur du pli cutané du triceps (TSFT).Nous avons évalué le contrôle de l'asthme à l'aide des scores du questionnaire de test de contrôle de l'asthme (ACT) et de la mesure de la spirométrie avec volume expiratoire en valeurs de première seconde (PRE-FEV1). Nous avons également exploré la relation entre différentes mesures de l'adiposité et le contrôle de l'asthme à l'aide d'une régression linéaire univariée et multivariée

Résultats : Deux cents patients asthmatiques ayant effectué une spirométrie adéquate ont été inclus dans l'analyse (96 femmes et 104 hommes).Fréquence de l'obésité en utilisant: IMC>30kg.m2 était de 18,0%, WC >88cm pour fou femelles ou >102 pour les hommes était de 34,0 %, WHR>0,85 pour les femelles ou >0,9 % pour les hommes était de 56,5 % et le TSFT >23 mm pour les femelles ou >12 mm pour les hommes était de 28,5 %. Il y avait une relation inverse significative le VEMS1 et les mesures de l'adiposité sur analyse de régression linéaire univariée (IMC: r^2= -0,175 p = 0,013, WC: r^2= -0,209 p= 0,003, WHR: r^2= -0,148 p = 0,036).Il n'y avait pas de relation significative entre mesures de l'adiposité et score ACT. Sur l'analyse de régression multivariée après avoir contrôlé l'âge, le sexe, les comorbidités (y compris le tabagisme, le RGO et la rhinite), les mesures de l'adiposité n'étaient pas significatives déterminants du contrôle de l'asthme : ACT [IMC-OR=0,569 : IC à 95 % (0,245-1,328) P= 0,193,WHR-OR= 0,996 : IC à 95 % (0,467-2,114) P = 0,987 , TSFT-OR = 0,699 : IC à 95 % (0,310-1,578) P = 0,389] et VEMS 1 [IMC-OR = 1,392 : IC à 95 % (0. 591-3,283) P= 0,449,WHR-OR= 1,191 : IC à 95 % (0,551-2,575) P = 0,657 , TSFT-OR = 1,647 : IC à 95 % (0,707-3,833) P = 0,247].

Conclusion: La prévalence de l'obésité chez les patients asthmatiques varie en fonction de la mesure d'adiposité utilisée. L'obésité a un impact négatif sur la fonction pulmonaire.Aucune des mesures de l'obésité n'était un déterminant indépendant d'un mauvais contrôle de l'asthme.Il s'agit d'un domaine cible potentiel pour l'amélioration.

Mots-clés : *Asthme, Obésité, adiposité, Contrôle de l'asthme, Spirométrie, Obstruction des voies respiratoires.*

Introduction

The prevalence of asthma is increasing worldwide and obesity is now a recognised risk factor for developing asthma and also influences asthma severity and control [1-3]. The worldwide prevalence of asthma is estimated to range from 1-18% [4]. In Nigeria, the prevalence of asthma in adults is increasing and it is estimated that about 10% of Nigerian adults may have asthma [5,6]. There is also a high rate of poorly controlled asthma in Nigeria implying a high physical, social and economic burden on the individuals and on the healthcare system [7]. The prevalence of obesity is also increasing in Nigeria and about 8.1%-22.2% of adult Nigerians are estimated to be obese [8,9]. The adverse impact of obesity on cardiovascular outcomes is well known and the increasing evidence shows a negative impact on respiratory outcomes including asthma risk and asthma control [10].

Genetic and environmental factors overlap in the etiology and pathogenesis of asthma and obesity. Human genome such as chromosomes 5q, 6, 11q, 13 and 12q have been identified which are related to the development of asthma and obesity [11,12]. Furthermore, increased oxidative stress and nitric oxide metabolism, high insulin and leptin levels which occur in obesity that upregulate inflammatory markers and vagal induced bronchoconstriction [13]. Obesity is defined as abnormal or excessive fat accumulation that presents risk to health [14]. This can be determined using different measures including BMI, WC, WHR, TSFT(14). BMI estimates general obesity, WC and WHR estimates visceral obesity while TSFT estimates the subcutaneous adiposity [14].

The aim of asthma treatment is to achieve and maintain control and to prevent future risks of exacerbation [4]. Uncontrolled asthma increases the risk of exacerbation, lung function decline, poor quality of life and mortality [15]. Assessment of asthma control could therefore be based on symptoms control, quality of life as well as lung function [16]. Obesity has been described as one of the factors that impact on asthma control, quality of life and lung function [17]. The association between obesity and asthma control has been reported from studies conducted in high resource countries using both the body mass index (BMI) and the waist circumference (WC) [17]. Kim et al reported that higher BMI is a potential factor related to worse asthma control and quality of life [17]. Nan et al also reported correlation between abdominal obesity and poorer asthma control [18].

In the Nigerian context, prevalence of obesity among asthma patients and the effect of obesity on asthma control have not been extensively explored. An earlier study reported that a significant portion (53.8%) of asthma patients were obese but there was no association between the BMI and asthma control [19]. With the epidemiological transition occurring in low resource countries such as Nigeria and the increase in prevalence in obesity, there is need to explore the relationship between asthma control and measures of adiposity to clearly elucidate the impact it may have on the increasing prevalence and burden of asthma. It is also pertinent to determine which measure of obesity is most closely related to asthma control. We therefore aimed to determine the frequency of obesity using multiple measures of adiposity among asthma patients in Nigeria and the relationship between obesity and level of asthma control.

Method

This was a cross-sectional study conducted among asthma patients attending the out-patient respiratory clinic of the Lagos University Teaching Hospital (LUTH), Lagos Nigeria. Eligible patients were those ≥18yrs who had attended the clinic for at least one month prior to recruitment and had received a prescription and commenced controller medications for asthma. We excluded asthma patients not on treatment and patients with chronic obstructive pulmonary diseases, those on current treatment for tuberculosis, decompensated heart failure, pregnancy and chest deformity. Recruitment for patients with recent respiratory illness or who had an asthma exacerbation was delayed until they were fit to perform spirometry. The calculated sample size for the study was 156 participants based on frequency of poor asthma control of 35% from a previous study at the same clinic with a 5% margin of error [20].

Data collection

We recruited consecutively, consenting eligible patients who attended the clinic over a one-year period (December 2015 to November 2016). A proforma was used by trained interviewers to obtain information from participants by direct questioning during a face to face encounter and also by review of the case notes. The information obtained included socio-demographic parameters such as age, gender, level of education, occupation, ethnicity, asthma history, history of exacerbations, medication use and tobacco smoking history (current smoker, ex-smoker and never smoker). A current smoker was a person who had smoked greater than 100 cigarettes (including hand rolled cigarettes, cigars, cigarillos etc) in their lifetime and had smoked in the last 28 days. Ex-smoker was someone who had smoked greater than 100 cigarettes in their lifetime but had not smoked in the last 28 days. Never smoker is someone who has not smoked greater than 100 cigarettes in their lifetime and was not currently smoking [21-23].

Asthma control was assessed using the Asthma Control Test (ACT) questionnaire [24]. The adult version of the ACT is a validated simple five-item questionnaire that assesses interference of asthma with activities, symptoms of shortness of breath, nocturnal symptoms, use of rescue medication, and patient's self-assessment of symptoms in the preceding 4 weeks. Each item is scored 1-5, and total ACT scores ranges from 5-20. A score of $\geq$20 defines" controlled" asthma, and a score of < 20 defines uncontrolled asthma [24-25].

Asthma specific quality of life was assessed using the mini Asthma Quality of Life Questionnaire (AQLQ) with permission [26]. The Mini AQLQ is a validated 15-item questionnaire, which assesses the quality of life specifically in relation to asthma. The questionnaire assesses 3 domains of asthma interference with daily life (symptoms, environmental limitations, and emotions) and covering a 2 week period. Score ranges from 0-6 (lower is worse). The mini- AQLQ is calculated as the average of domain items. Higher scores greater than 4 is indicative of better quality of life (26, 27).

The likelihood of gastroesophageal reflux disease (GERD) among the participants was assessed using the Gastroesophageal Reflux Disease Symptoms Assessment Scale (GSAS) questionnaire [27,28]. The GSAS is a 15 item validated questionnaire that measures the frequency and distress of GERD associated symptoms in the preceding one week [28]. Each item is scored as 1 or 0 based on if the symptom was present or absent. The total score ranges from 0-15 with higher scores above 3 suggesting a likelihood of GERD [29].

The probable clinical diagnosis of allergic rhinosinusitis was considered in patients with history of recurrent and chronic nasal congestion, nasal itch, rhinorrhea and sneezing associated with environmental triggers with each episode lasting more than 2 weeks [30,31].

Assessment of obesity

We measured weight to the nearest 0.1kg and height to the nearest 0.1 cm [32]. The BMI was calculated using the formula weight/height^2 and categorized as follows; underweight (<18.5kg /m^2), normal (18.5 – 24.9) overweight (25 – 29.9kg/m^2), and obesity (30kg/m^2 and above)[14,33] World Health Organization (WHO) protocol was used for measuring waist and hip circumference [32,33]. Waist circumference was measured to the nearest centimeter with flexible tape measure at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch resistant tape that provides a constant 100 g tension. Abdominal obesity was defined as WC greater than 102 cm in men, and 88 cm in women [34].

Hip circumference was measured around the widest portion of the buttocks, with the tape parallel to the floor. For both measurements, the subjects stood with feet close together, arms at the side and body weight evenly distributed, with light clothing. Each measurement was taken twice, with the measurements within 1cm of one another, the average was calculated. The measurements with the difference exceeding 1cm, were repeated [14,35]. Waist-hip ratio was then calculated for each subject.

Triceps skin fold thickness was measured to the nearest millimeter with skin fold caliper (Holtain, Crymch; UK) on the right arm. Normal Triceps skin fold thickness in males is 12 mm while normal skin fold thickness in females is 23 mm. Skin fold thickness >12 mm in males and >23 mm in females were categorized as obesity [36].

Spirometry

Spirometry was performed according to the American Thoracic Society/European Respiratory Society (ATS/ERS) standards for measurement of spirometry using a Vitalogragh alpha model 6000. NHANES normative value for blacks was used to assess spirometry pattern and determine severity of impairment. Spirometry measures of interest were Forced Expiratory Volume in the first second (FEV1), Forced Vital Capacity (FVC) and the ratio of the FEV1/FVC.

Impairment in the spirometry pattern was characterized as follows: an obstructive impairment (ratio of FEVI/FVC<0.7 with FVC% predicted e"80%), a restrictive impairment (FVC% predicted <80% with FEV1/FVC e"0.7) or a mixed impairment (FEV1/FVC ratio <70% with FVC% predicted <80%). The level of asthma control on spirometry was based on the pre-bronchodilator FEV1% predicted following the ERS/ATS 2005 guidelines. An FEV1, of 80% predicted was categorized as "normal," 60–79% as "mild airway obstruction," and <60% as "moderate to severe airway obstruction". The post bronchodilator parameters were documented and the reversibility was assessed. Significant reversibility is an increase in postbronchodilator FEV1 that is more than 15% of the pre-trial value and more than 200ml [37,38].

Ethical considerations

Ethical approval was obtained from the Health Research Ethics Committee of LUTH. Only patients who met the inclusion criteria and provided written informed consent were recruited.

Statistical analysis

Data was analyzed using the Statistical Software for Social Sciences (SPSS, IBM Corporation, Somers, New York, USA)® statistical software version 20.0. The numerical demographic and clinical data (e.g., age, WC, and BMI) were summarized as means and standard deviations. Categorical variables (e.g., gender, BMI category, abdominal adiposity, and degree of asthma control) were summarized as frequencies (%) and compared using the chi square tests. The relationship between the measures of obesity and scores on the ACT, the FEV1 and mini AQLQ respectively were assessed using linear regression. Independent determinants of measures of asthma control (ACT scores, and PRE-FEVI) were evaluated using multivariate linear regression analysis. Odds ratios was determined and a p value of <0.05 was considered significant.

Results

The questionnaires were administered to 212 asthma patients. Two hundred patients were able to perform adequate pre-bronchodilator spirometry. Eleven of those who performed spirometry were unable to perform adequate post-tests, most complained of fatigue and were uncooperative. Therefore, we included 200 participants in the analysis but analyzed 189 posttests.

The general characteristics of the patients are presented in Table 1. They were 104 (52.0%) males, mean age was 40.57$\pm$15.86, and mean BMI was 25.27 $\pm$5.9 kg/m^2. Obesity diagnosed based on the BMI >29.9kg/m^2 was 36 (18.0%), WC >102cm in males and >88cm in females was 68 (34.0%), WHR >0.5 in males and > 0.6 in females was 113 (56.5%) and TSFT > 18mm in males and > 23mm in

Table 1: Characteristics of participants

Variable	Frequency (n=200)	Percentage
Age group (Years)		
18-30	63	31.5
31-40	43	21.5
41-50	34	17.0
51-60	32	16.0
61-70	28	14.0
Mean±SD	40.57±15.86	
Gender		
Male	104	52.0
Female	96	48.0
Educational level		
Primary	10	5.0
Secondary	49	24.5
Post-secondary	150	70.5
Ethnic group		
Yoruba	100	50.0
Igbo	9	46.5
Hausa	37	3.5
Income (in Naira)		
<100,000	118	59.0
100-200,000	51	25.5
>200,000	31	15.0
BMI		
Underweight	10	5.0
Normal	106	53.0
Overweight	48	24.0
Obese	36	18.0
Mean±SD	25.27±5.88	
Waist circumference		
Obese	68	34.0
Normal	132	66.0
Mean±SD	83.35±12.5	
Waist hip ratio		
Obese	113	56.5
Normal	73	43.5
Mean±SD	0.85±0.1	
TSFT		
Obese	55	28.50
Normal	155	72.50
Mean±SD		
ACT		
Mean±SD	18.64±4.63	
< 14	50	25
14-19	50	25
>20	100	50
Mini AQoL		
Mean±SD	5.6±1.4	
Pre-bronchodilator FEV1% predicted		
Mean FEV1±SD	3.27±16.0	
<80%	125	62.50
>80%		

	75	37.50
Post-bronchodilator FEV1% predicted Mean FEV1±SD	2.25±0.91	
<80%	100	50.0
>80%	89	44
Excluded	11	5.5
Reversibility		
Yes	142	71.0
No	47	23.5
Unspecified	11	5.5

Footnote= BMI- Body mass index, WC- Waist circumference, WHR- Waist hip ration, TSFT- Thick skin fold thickness, FEV1- Force expiratory volume in one second, ACT- Asthma control test, QoL- Quality of life.

females was 55 (28.5%) respectively. Asthma was controlled in 100 (50%) patients using ACT score of >20. About 75 (37.5%) had optimal asthma control using PRE-FEV1 >80% predicted.

Asthma comorbidities

The associated asthma comorbidities of participants are represented in Table 2 below. There were 99 (49.5%) and 63 (31.5%) with history of suspected allergic rhinitis and GERD respectively. There were twelve males and one female with previous smoking history.

Association between FEV1, ACT, and MINIAQLQ and markers of obesity

Univariate Linear regression analysis was used to explore the association between measures of obesity and measures of asthma control (Table 3). There was significant association between FEV1% and BMI, WC as well as WHR. However, there was no significant relationship between measures of adiposity and ACT as well as Mini AQLQ.

Table 2: Asthma comorbidities

Variable	Male (%)	Female (%)	Overall	p-value
Family history of Asthma				
Yes	44(42.3)	46(47.9)	90 (45.0)	0.426
No	60(57.7)	50(52.1)	110(55.0)	
Allergic rhinosinusitis				
Yes	48(46.2)	51(53.1)	99(49.5)	0.325
No	56(53.8)	45(46.9)	101(50.5)	
Symptoms of allergic rhinosinusitis*				
Runny nose	37(77.1)	40(78.4)	77(77.8)	0.872
Block nose	24(50.0)	22(43.1)	46(46.5)	0.979
Post nasal drip	5(10.4)	8(15.7)	13(13.1)	0.438
Smoking status				
Current smoker	1(1.0)	0(0.0)	1(0.5)	0.006*
Former smoker	12(11.5)	1(1.0)	13(6.5)	
Never	91(87.5)	95(99.0)	186(93.0)	
GERD				
Present	27(74.0)	36(37.5)	63(31.5)	0.079
Absent	77(74.0)	60(62.5)	137(68.5)	

*Footnote: *multiple responses apply, p value compared the frequency between males and females.*

Table 3: Linear regression between asthma control measures and obesity markers

Obesity measures	FEV1%		ACT		Mini asthma QoL	
	Regression coefficient	p-value	Regression coefficient	p-value	Regression coefficient	p-value
BMI	-0.175	0.013*	-0.007	0.954	-0.034	0.351
WC	-0.209	0.003*	0.045	0.465	0.021	0.279
WHR	-0.148	0.036*	4.196	0.482	0.657	0.720
TSFT	-0.199	0.093	-0.109	0.055	-0.020	0.258

Footnote= BMI- Body mass index, WC- Waist circumference, WHR- Waist hip ration, TSFT- Thick skin fold thickness, FEV1- Force expiratory volume in one second, ACT- Asthma control test, QoL- Quality of life, Bold text p value <0.05

Independent determinants of measures of asthma control

The independent determinants of measures of asthma control using the ACT score and pre-bronchodilator FEV1% predicted respectively were explored using multivariate linear regression adjusted for age, sex, smoking status and comorbidities i.e. GERD and allergic rhinitis (Table 4). To prevent collinearity only the WHR, BMI and TSFT were included in the model. None of the measures of obesity was an independent determinant of poor asthma control.

However, increasing age was an independent determinant of poor FEV1% predicted (below 80%) and presence of GERD and allergic rhinitis were independent determinants of poorly controlled asthma (ACT below 20).

Table 4: Multivariate linear regression showing independent determinants of ACT, and FEV1%

Variables	ACT			Pre-FEV1%		
	OR	95% CI	p-value	OR	95% CI	p-value
Age	0.981	0.964-1.008	0.201	1.032	1.010-1.060	0.005*
Female Sex	1.092	0.483-2.497	0.824	2.006	0.877-4.594	0.099
Smoking	1.011	0.289-3.544	0.985	1.011	0.286-3.571	0.987
GERD	3.412	1.498-6.155	0.002*	0.754	0.377-1.510	0.426
Allergic rhinitis	2.020	1.101-3.710	0.024*	1.445	0.770-2.712	0.251
Obese (BMI)	0.569	0.245-1.328	0.193	1.392	0.591-3.283	0.449
Obese (WHR)	0.996	0.467-2.114	0.987	1.191	0.551-2.575	0.657
Obese (TSFT)	0.699	0.310-1.578	0.389	1.647	0.707-3.833	0.247

Footnote: GERD-Gastro-esophageal reflux disease, BMI- Body mass index, WC- Waist circumference, WHR- Waist hip ration, TSFT- Thick skin fold thickness. P value<0.05

Discussion

There is evidence of a relationship between asthma and obesity with suggestions that obese patients have more symptoms, poor control and poor response to therapies [1-3]. Previous studies have focused on the association between general obesity (measured by BMI) and asthma control but there is emerging evidence that BMI may not be the most appropriate predictor of adverse outcomes [1,3]. This study explored the association between multiple measures of adiposity with asthma control.

We found that the frequency of obesity among these asthma patients attending a tertiary care hospital was 18%, 34%, 56.5%, and 28.5 based on BMI, WC, WHR and TSFT respectively. About half of the participants had poor asthma control using the ACT and two third had suboptimal lung function using pre FEV1%. BMI, WC and WHR were negatively associated with PRE FEV1% predicted on univariate analysis. There was no significant association between measures of obesity and ACT as well as Mini AQLQ. Furthermore, none of the measures of obesity was an independent determinant of poor asthma control. However, comorbidities including allergic rhinosinusitis and GERD were independent determinants of poor asthma control.

The frequency of participants with obesity using different measures varies with BMI being the lowest. However, with the use of TSFT and other measures of central obesity the frequencies of obese patients with asthma were much higher. Adegoke *et al* recently reported a prevalence of 13% of obese individuals in Lagos, Nigeria using BMI. This is lower than the prevalence of obese patients with asthma (18%) in this study, suggesting that there may be an association between obesity and risk of asthma [9]. Furthermore, other Nigerian studies have reported central obesity prevalence of 24% using WC and 34% using WHR which are lower than the 34% and 56% respectively among asthma patients in this present study [39,40]. Noteworthy is the higher prevalence of obesity when assessed by other measures of adiposity other than the BMI, which may have implications. Farah et al reported a stronger association between measures of central adiposity and hypertension which is underscored by the increased level of inflammation and cytokine production from centrally distributed adipose tissue [41].

We found that about half of the participants had poor asthma control using the ACT and about two third also had suboptimal lung function using pre FEV1%. Ozoh *et al* reported similarly findings of about 43.4% patients with poor asthma control in 2012 in the same clinic [20]. However, only one third of the patients had suboptimal lung function at that time. The implication is that asthma control has not changed over the years in our clinic which is rather concerning and warrants interventions. Regarding the relationships between measures of adiposity and asthma control, we determined the effects using linear regression analysis. The results suggest significant inverse relationship between markers of adiposity and pre FEV1. Similar reports of low pre bronchodilator FEV1 among asthma patients have been reported in Nigeria [42]. The attributable reason may be related to the up-regulation of the inflammatory state of the airways caused by obesity and thicker airway smooth muscles causing induced vagal bronchoconstriction thereby reducing FEV1 [41]. Low FEV1 has been reported among patients with metabolic syndrome laying credence to the impact of adiposity on lung function [41,43]. The results of this study are particularly noteworthy in that markers of adiposity are important determinant of impaired pulmonary function. We therefore suggest that weight loss should be considered as a strategy to improve asthma control in these patients. Also, investigators should consider the inclusion of markers of adiposity as a potential confounding factor when investigating the determinants of pulmonary function.

The lack of association between measures of adiposity and ACT as well as MINI AQLQ may be ascribed to the possibly low accuracy of these measures in assessing asthma control due to recall bias [44,45]. It has been argued that the GINA questionnaire may be a better way to access asthma control as it gives a better assessment of the patient's symptoms and risk of exacerbation [46]. Other studies in Nigeria and elsewhere support this assertion with a reported lack of association between measures of adiposity and ACT but a significant association between asthma control measured using the GINA questionnaire and ACT score [43-46]. The implication of this in clinical practice is such that as much as these questionnaires may be useful in assessing the level of control and possible exacerbation risk, there may be a need for an additional tool in assessing the level of control objectively using lung function parameters. None of the measures of obesity was an independent determinant of poor asthma control. However, comorbidities including allergic rhinosinusitis and GERD were independent determinants of poor asthma control. The finding of allergic rhinosinusitis and GERD as independent determinants of poor asthma control in this study provides some direction for intervention. Rhinosinusitis particularly when not well treated has been consistently linked with persistent and severe asthma [47]. Similarly, there is a confirmed relationship between GERD and asthma as well as GERD with upper airway symptoms [48,49]. GERD could lead to pulmonary manifestations including chronic cough, bronchial asthma, bronchitis, pneumonia and interstitial fibrosis [49].

The study has limitations related to the cross-sectional design which makes the associations described exploratory. Another potential limitation of this study involves the nature of the population we studied. We sampled asthma patients being followed up at a tertiary care hospital whose asthma may be somewhat more severe than patients attending primary care hospitals. Therefore, the results may not be generalizable to the entire spectrum of asthma patients. Despite these limitations, the results added to the knowledge about relationship between obesity and asthma control because of the broader range of measures of adiposity used in this study to explore the relationship.

Conclusions

The prevalence of obesity among patients with asthma varies depending on the measure of adiposity used. Obesity negatively impacts on the lung function. None of the measures of obesity was an independent determinant of poor asthma control. Obesity prevention and management is a potential target area for improving asthma control among asthma patients.

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