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## Obesity and obstructive sleep apnea risk among Nigerians

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### Abstract

**Background**—The contribution of obesity to obstructive sleep apnea (OSA) is poorly described in Nigeria. We aimed to compare OSA risk between obese and nonobese adults in urban Nigeria.

**Materials and Methods**—An analytic cross-sectional study was conducted. Participants were interviewed using the World Health Organization Non-Communicable Disease questionnaire. OSA risk assessment was performed using the STOP-BANG questionnaire. A total score of  $\geq 3$  on the STOP-BANG questionnaire indicated OSA risk, whereas a score  $\geq 5$  indicated high OSA risk. Obesity was defined as body mass index (BMI)  $>30$  kg/m<sup>2</sup>. Relationship between obesity and OSA was tested using chi-square and logistic regression models used to control for confounding factors.

**Results**—There were 744 respondents, with a mean age of 44 (standard deviation 10) years. A total of 206 [27.7%, 95% confidence interval (CI) 24.46–30.9] respondents were obese (BMI  $\geq 30$  kg/m<sup>2</sup>). A total of 307 (41.3%, 95% CI 37.7–44.9) respondents scored  $\geq 3$  on the STOP-BANG questionnaire, whereas 37 (4.9%, 95% CI 3.6–6.7) scored  $\geq 5$ . More number of obese than nonobese [57.8% (119/206) versus 34.9% (188/538)] respondents met the criteria for OSA risk ( $P < 0.001$ ). Similarly, more obese persons [10.3% (21/206)] met the criteria for high-risk OSA compared to the nonobese [3% (16/538)];  $P < 0.001$ . In logistic regression models adjusted for cigarette smoking and alcohol consumption, the odds for OSA risk was 15.76 (95% CI 7.44–33.9) in persons with BMI  $>35$  kg/m<sup>2</sup> compared to those with a BMI range of 18.5–24.99.

**Conclusion**—Obesity and OSA may be more prevalent in Nigeria than previously predicted. Obesity independently increased OSA risk in this population.

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#### Conflicts of interest

There are no conflicts of interest.

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## Keywords

Africa; nigeria; obesity; obstructive sleep apnea hypopnea syndrome; sleep apnea; stop-bang

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## INTRODUCTION

Obesity is an emerging epidemic in Nigeria, Africa's most populous country, with prevalence rates ranging from 11.2 to 26%.<sup>[1-4]</sup> Recent surveys also suggest a high burden of obstructive sleep apnea (OSA).<sup>[5-7]</sup> Obesity is a recognized risk factor for OSA.<sup>[8,9]</sup> Other risk factors include increasing age, male sex, familial predisposition, cigarette smoking, alcohol consumption, and hormones.<sup>[10,11]</sup>

OSA has a negative impact on the quality of life and has been identified as a modifiable cardiovascular risk factor.<sup>[12-14]</sup> The adverse effects of OSA are aggravated by a low level of awareness and delayed diagnosis of the condition.<sup>[15-17]</sup> With rising prevalence of obesity in Nigeria, the prevalence of OSA is likely to increase. Although an increasing trend of obesity has been described in Nigeria, its contribution to OSA risk is yet to be elucidated. We hypothesize that a significant proportion of urban dwellers in Nigeria are at high risk for OSA, with obesity being a major contributor to OSA risk.

We assessed the risk for OSA in an urban population in Nigeria using the STOP-BANG questionnaire, and evaluated the association between obesity and OSA risk in the population. Our primary hypothesis was that 25% of the obese would meet the criteria for high-risk OSA compared to 15% among the nonobese.

## MATERIALS AND METHODS

### Study design and setting

This analytic cross-sectional study was a part of a broader survey of noncommunicable diseases in a tertiary institution in North-central Nigeria between January and June 2014. All members of the University workforce were eligible for the study. Invitation to participate in the survey was sent to all department heads for subsequent circulation to their staff. The information was also displayed on posters around the university campus.

The estimated sample size was 694. This was determined based on the assumption that 25% of the obese will be at risk for OSA compared to 15% among the nonobese,<sup>[5]</sup> with an estimated obesity prevalence of 30%,<sup>[18]</sup> power of 80%, and two-sided confidence level at 95%.

### Participant selection and measurements

Consecutive adults presenting for a noncommunicable disease survey were enrolled into the study. All participants were interviewed using the World Health Organization (WHO) STEP 1 questionnaire (available at: <http://www.who.int/chp/steps/instrument/en/>). The WHO STEP 1 questionnaire has questions on demographics, behavioral risk factors (including tobacco use), and history of non-communicable disease (NCDs) such as raised blood pressure, and it was collected as a self-report. It also includes the anthropometric

measurements of height and weight to measure the body mass index (BMI, defined as weight in kilograms divided by the square of height in meters), waist circumference, and blood pressure. In addition to these, all participants had their neck circumferences measured.

Risk for OSA was assessed using the STOP-BANG questionnaire. This is a validated questionnaire having eight questions and has demonstrated a high correlation with OSA in various populations.<sup>[19,20]</sup> The questions are the following: (1) Do you snore loudly (louder than talking or loud enough to be heard through closed doors)? (yes/no); (2) Do you often feel tired, fatigued, or sleepy during daytime? (yes/no); (3) Has anyone observed you stop breathing during your sleep? (yes/no); (4) Do you have or are you being treated for high blood pressure? (yes/no); (5) Body mass index  $>35 \text{ kg/m}^2$  (yes/no); (6) Age over 50 years (yes/no); (7) Neck circumference  $>40 \text{ cm}$  and male gender (yes/no).

All study participants gave written informed consent prior to enrolment, and the study was approved by the ethical review board of the institution.

## Variables

The outcome variable was “risk for OSA.” Persons with a total score of  $\geq 3$  on the STOP-BANG questionnaire were rated as being at risk for OSA.<sup>[21]</sup> In addition, a STOP-BANG score of 3–4 was categorized as intermediate risk, whereas a score of 5–8 was categorized as high risk for OSA. These were validated cut-off points obtained from previous studies comparing the STOP-BANG questionnaire to polysomnography (PSG, the gold standard for OSA diagnosis).<sup>[22]</sup> The main exposure was obesity defined as a BMI  $\geq 30 \text{ kg/m}^2$ .<sup>[23]</sup> BMI was further categorized as normal (18.5–24.9  $\text{kg/m}^2$ ), preobesity (25–29.9  $\text{kg/m}^2$ ), obesity class I (30–34.9  $\text{kg/m}^2$ ), obesity class II (35–39.9  $\text{kg/m}^2$ ), and obesity class III ( $\geq 40$ ).<sup>[23]</sup>

## Data analysis

The characteristics of the participants were summarized as means [standard deviation (SD)] if normally distributed or median (interquartile range) if skewed. OSA risk was analyzed as a categorical variable: risk or no risk, or else as low, intermediate, or high risk. The prevalence of obesity and OSA risk categories was presented as percentages [95% confidence interval (CI)]. The association between obesity and OSA risk categories was evaluated using the chi-square test; logistic regression models were subsequently used to adjust for confounding factors. Risk factors for OSA, which are included in the STOP-BANG questionnaire (sex, age, and neck circumference), were excluded in the regression models. Confounders were identified a priori from previous studies. Factors with a  $P < 0.2$  in the bivariate model were all included in the multivariate model, with the final model obtained using backward regression. Statistical analysis was performed using STATA version 14 software (StataCorp LLC, College Station, Texas, USA). In all analyses, a two-tailed  $P < 0.05$  was considered significant.

## RESULTS

Of the 884 participants in the NCD survey, 744 (84.2%) completed the STOP-BANG questionnaire and were included in this analysis. The study population comprised 432 (58.1%) males and 312 (41.9%) females, with a mean age of 44 (SD 10) years. A total of 39

(5.2%) persons (all males) reported that they never smoked a cigarette, 361 (51.3%) reported never having taken an alcoholic drink, and 169 (22.7%) reported taking an alcoholic drink within 30 days of the study. Other characteristics of the participants are shown in Table 1.

The mean BMI was 27.5 (5.3) kg/m<sup>2</sup>. A total of 206 responders (27.7%, 95% CI 24.46–30.9) were obese (BMI ≥ 30 kg/m<sup>2</sup>). Obesity was present in 20.6% (89/432) of males compared to 37.5% (117/312) of females,  $P < 0.001$ . The prevalence of obesity also increased with the number of years of formal education [11.5% (16/202) in persons with six or less years of formal education, 15% (32/214) in persons with 7–12 years of formal education, and 42.7% (100/234) in persons with more than 12 years of formal education,  $P < 0.001$ ]. Obesity prevalence also increased with increasing age [11.5% (29/253) in persons <40 years, 30% (77/257) in persons between the ages of 40 and 49 years, and 42.7% (100/234) in persons aged ≥ 50 years,  $P < 0.001$ ].

Responses to the STOP-BANG questionnaire are shown in Table 2. A total of 307 (41.3%, 95% CI 37.7–44.9) participants scored ≥ 3 on the STOP-BANG questionnaire meeting criteria for OSA risk. Thirty-seven (4.9%, 95% CI 3.6–6.7) participants scored ≥ 5 implying a high risk for OSA. More obese participants met the criteria for OSA risk compared to the nonobese [57.8% (119/206) versus 34.9% (188/538);  $P < 0.001$ ]. Similarly, more number of obese persons met the criteria for high-risk OSA compared to the nonobese [10.3% (21/206) versus 3% (16/538);  $P < 0.001$ ]. Table 3 compares age, sex, blood pressure, and anthropometric measures of the participants based on OSA risk. Participants with STOP-BANG scores of ≥ 3 were mostly males and had higher anthropometric and blood pressure measurements.

The relationship between BMI category and OSA risk stratification using the STOP-BANG questionnaire is shown in Table 4. In logistic regression models adjusted for cigarette smoking and alcohol consumption, the odds for OSA risk increased along BMI categories. Odds for OSA risk was 15.76 (95% CI 7.44–33.9) in persons with BMI >35 kg/m<sup>2</sup> compared to those with BMI range of 18.5–24.99 [Table 5].

## DISCUSSION

Utilizing the STOP-BANG questionnaire, we assessed risk for OSA in a university community in North-central Nigeria and evaluated the contribution of obesity to OSA risk. We found that 41.3% of the study population met the criteria for OSA risk, and 4.9% met the criteria for high risk of OSA. Scores on the STOP-BANG questionnaire increased with BMI, and persons with obesity class II or higher were 15.8 times more likely to have a score of ≥ 3 on the STOP-BANG questionnaire compared to persons with normal BMI.

Majority of the study population (62%) were either preobese or obese, with 28% being obese. The high prevalence of preobesity and obesity found in our study supports the findings from earlier studies that an obesity epidemic is occurring in Nigeria.<sup>[4,24]</sup> In one of the earliest studies on overweight and obesity in Nigerians, Johnson<sup>[25]</sup> in 1970 reported obesity prevalence rates of 4.3 and 18.8% in males and females, respectively. In a recent survey conducted in 2010, about 60% of Nigerians were overweight or obese.<sup>[4]</sup>

Our finding of an increase in OSA risk with BMI supports earlier studies.<sup>[8,9]</sup> Compared to persons with normal BMI, the odds of OSA risk was significantly greater in higher BMI categories, with the most remarkable difference being in persons with BMI  $\geq 35$  kg/m<sup>2</sup>. This finding bears clinical significance because obesity is a modifiable risk factor for OSA. In one study, a 10% weight gain predicted a 32% increase in apnea-hypopnea index (AHI).<sup>[26]</sup> Weight loss could improve symptoms in persons with OSA, particularly in morbidly obese persons.<sup>[27]</sup> Conversely, weight gain has been reported shortly after the diagnosis of OSA suggesting a reciprocal relationship.<sup>[27,28]</sup>

The diagnosis of OSA is based on PSG, which is capital intensive and not readily available. In Nigeria for example, there are no facilities for PSG. In several settings, sleep questionnaires have been used to assess OSA risk. Although most were developed for screening presurgical patients or patients in sleep clinics, their ease of administration has facilitated their use in population surveys.<sup>[5,29]</sup> The STOP-BANG questionnaire has been validated in various populations and has compared favorably with other sleep questionnaires with the added advantage of ease of use.<sup>[21,30]</sup> In one study, the sensitivity of the STOP-BANG questionnaire score of  $\geq 3$  with AHI of  $\geq 5$ /h,  $\geq 15$ /h, and  $\geq 30$ /h were 94.9, 96.5, and 97.7%, respectively, with specificities of 50.0, 28.6, and 17.9%, respectively, thus making it a good screening tool.<sup>[31]</sup> A systematic review and meta-analysis of 17 studies validating the STOP-BANG questionnaire also yielded similar results.<sup>[32]</sup> These favorable characteristics influenced our choice for the STOP-BANG questionnaire.

Our study had some limitations. First, the study was performed using a convenient sample, so persons with health concerns may have incentive to turn up for a health screening exercise resulting in selection bias. Second, our study was conducted in a population of university workers and may not necessarily represent the general population. Despite these limitations, the prevalence of obesity in our study mirrors that previously described in urban populations in Nigeria, suggesting we had a representative sample. This is further strengthened by the spread of employees in the university community ranging from unskilled workers to highly skilled professionals typical of an urban community.

We have demonstrated a twin burden of obesity and OSA among Nigerians. Although tools for the definitive diagnosis of OSA are not currently available, awareness of the disease is also very low among healthcare providers.<sup>[17]</sup> OSA is treatable, and untreated disease increases morbidity and mortality.

In conclusion, our study highlights the high prevalence of persons at high risk of OSA in a Nigerian population and the contribution of obesity to OSA risk. Obesity in our population needs to be addressed, and diagnostic tools for OSA are urgently needed.

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**Table 1**

Characteristics of adults screened for obstructive sleep apnea using STOP-BANG questionnaire in Jos, Nigeria

Characteristic	Total 744	Male 432 (58.1)	Female 312 (41.9)	P value
Age (years), mean (SD)	44.3 (9.8)	43.3 (10.2)	45.3 (9.1)	0.02
Age group (years), <i>n</i> (%)				<0.01
<40	253 (34)	169 (39)	84 (27)	
40–<50	257 (35)	137 (38)	120 (39)	
50	234 (31)	126 (29)	108 (34)	
Income, <i>n</i> (%)				<0.01
Lower quartile	202 (27)	144 (31)	58 (21)	
Middle quartile	363 (49)	241 (52)	122 (44)	
Upper quartile	179 (24)	82 (17)	97 (35)	
Years of formal education, <i>n</i> (%)				<0.01
6 years	57 (8)	42 (10)	15 (5)	
>6–12 years	124 (29)	147 (31)	67 (24)	
>12 years	473 (63)	278 (59)	195 (70)	
Weight (kg), mean (SD)	75.7 (14.0)	75.5 (5.4)	76.2 (13.9)	0.52
BMI (kg/m <sup>2</sup> ), mean (SD)	27.5 (5.3)	27.3 (5.4)	27.7 (2.2)	0.22
BMI* category (kg/m <sup>2</sup> ), <i>n</i> (%)				<0.01
<25	273 (37)	273 (63)	0 (0)	
25–<30	265 (36)	159 (37)	106 (34)	
30–35	140 (19)	0 (0)	140 (45)	
>35	66 (9)	0 (0)	66 (21)	
WC (cm), mean (SD)	91.9 (12.3)	84.2 (8.4)	102.1 (9.3)	<0.01
HC (cm), mean (SD)	103.4 (11.8)	96.7 (7.2)	112.78 (10.7)	<0.01
Waist–hip ratio	0.89 (0.07)	0.88 (0.06)	0.91 (0.08)	<0.01
NC (cm), mean (SD)	36.74 (3.36)	36.74 (2.84)	36.74 (3.96)	0.99

SD =standard deviation, BMI =body mass index, WC =waist circumference, HC =hip circumference, NC =neck circumference.

\* Fisher's exact test was used when observations were &lt;5 in number.



**Table 2**

Responses to the STOP-BANG questionnaire of 744 adults in Jos, Nigeria

Questions	Yes/total 744	Male 432 (58.06)	Female 312 (41.94)	P-value
Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?	187 (25)	90 (21)	97 (31)	<0.01
Do you often feel tired, fatigued, or sleepy during daytime?	433 (59)	262 (61)	171 (55)	0.11
Do you often feel tired, fatigued, or sleepy during daytime?	7 (1)	3 (1)	4 (1)	0.41
Do you have or are you being treated for high blood pressure?	315 (42)	143 (33)	172 (55)	<0.01
BMI >35 kg/m <sup>2</sup> ?	66 (9)	0 (0)	66 (21)	<0.01
Age >50 years?	225 (30)	108 (25)	117 (38)	<0.01
Neck circumference >40 cm?	74 (10)	18 (4)	56 (18)	<0.01
Male gender?	432 (58)	432 (100)	0 (0)	–

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**Table 3**

Characteristics of 744 adults in Jos, Nigeria stratified by obstructive sleep apnea risk assessment using STOP-BANG questionnaire

Characteristics	OSA risk		P-value
	Intermediate or high risk	Low risk	
Overall	307 (41.3)	437 (58.7)	
Age group, years, <i>n</i> (%)			
<40	170 (55)	83 (19)	<0.01
40–49	94 (31)	163 (37)	
50	43 (14)	191 (44)	
Sex, <i>n</i> (%)			<0.01
Female	94 (30.6)	218 (49.9)	
Male	213 (69.4)	219 (50.1)	
Weight, kg, mean (SD)	80.21 (15.9)	72.6 (11.4)	<0.01
Height, m, mean (SD)	1.66 (0.1)	1.67 (0.1)	0.13
BMI category, kg/m <sup>2</sup> , <i>n</i> (%)			<0.01
<25	77 (25)	196 (45)	
25–<30	111 (36)	154 (35)	
30–35	62 (20)	78 (18)	
>35	57 (19)	9 (2)	
Waist circumference, cm, mean (SD)	97.1 (12.6)	88.3 (10.7)	<0.01
Hip circumference, cm, mean (SD)	107.0 (12.2)	100.9 (10.9)	<0.01
Abnormal * waist–hip ratio, <i>n</i> (%)	215 (70)	183 (41.9)	<0.01
Neck circumference, cm, mean (SD)	37.3 (3.9)	36.35 (2.8)	<0.01
Systolic blood pressure, mmHg, mean (SD)	135.8 (19.3)	129.9 (17.1)	<0.01
Diastolic blood pressure, mmHg, mean (SD)	83.5 (11.2)	79.8 (10.9)	<0.01

OSA =obstructive sleep apnea, SD =standard deviation, BMI =body mass index.

\* Waist–hip ratio above 0.9 for males or 0.85 for females.

**Table 4**

Body mass index and obstructive sleep apnea risk among 744 adults in Jos, Nigeria

	Body mass index (kg/m)			
	<25	25–29.99	30–34.99	35
	<i>n</i> = 273	<i>n</i> = 265	<i>n</i> = 140	<i>n</i> = 66
STOP-BANG score, No. (%)				
<3	196 (71.9)	154 (58.1)	78 (55.7)	9 (13.6)
3–5	74 (27.1)	98 (37.0)	56 (40.0)	42 (63.3)
>5	3 (1.1)	13 (4.9)	6 (4.3)	15 (22.7)

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**Table 5**

Logistic regression models showing factors associated with risk for obstructive sleep apnea among 744 adults in Jos, Nigeria

	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
BMI (kg/m <sup>2</sup> )				
18.5–24.99	Reference		Reference	
25–29.99	1.83 (1.28–2.62)	<0.01	1.86 (1.30–2.67)	<0.01
30–34.99	2.02 (1.32–3.95)	<0.01	2.07 (1.35–3.18)	<0.01
35	16.01 (7.60–34.15)	<0.01	15.78 (7.44–33.85)	<0.01
Ever smoked cigarette	0.47 (0.24–0.90)	0.02	0.51 (0.24–1.02)	0.06
Alcohol consumption	1.06 (0.80–1.45)	0.44	–	

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