SKINFOLD MEASUREMENTS AS DETERMINANTS OF BLOOD PRESSURE LEVELS AMONG ADULT HYPERTENSIVES ATTENDING A SECONDARY HEALTHCARE CENTRE IN NIGERIA

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Date of Acceptance: 31st Dec., 2022

Background: **The prevalence of obesity is increasing globally, making it a growing pandemic affecting adults and children. Obesity is associated with multiple morbidities and mortalities increasing the burden on the health care system.**

Objective: **There is inadequacy of data in Nigeria on the prevalence of obesity among adult patients with hypertension and adequate data on these conditions would help in their comprehensive management.**

Methods: **This was a cross-sectional study of 354 patients with hypertension, and the systematic sampling technique was used to recruit patients. The data were analysed using SPSS software version 23. Logistic regressions and linear regressions were done to determine the predictors of obesity and blood pressure levels.**

Results: **The mean age of the respondents was 52.60(SD±8.26) years and the prevalence of obesity was 53.1%. After adjusting for other variables, the predictors of obesity were female sex. Females were about six times more likely to be obese than males (OR=6.23; 95%CI= 3.16 – 12.32). For every 1 unit increase in triceps skinfold, there was a statistically significant increase in diastolic blood pressure by about 2.77units (95% C.I equals 2.63 to 2.91, p-value= 0.0001). Also, for every 1 unit increase in biceps skinfold, there was a statistically significant increase in systolic blood pressure by about 5.78 units (95% C.I equals 5.46- 6.10, p-value= 0.0001).**

Conclusions: **The prevalence of obesity was high, and the predictors of obesity were female sex. Triceps skinfold measurements were predictors of diastolic blood pressure while biceps skinfold measurements were predictors of systolic blood pressure.**

Keywords: Blood pressure, Determinants, Hypertensives, Skinfold measurements

INTRODUCTION

Obesity is defined as excessive fat accumulation in the body resulting in impairment of health. The prevalence of obesity is increasing globally, making it a growing pandemic affecting adults and children. Even in the paediatric age group, the prevalence is growing which may predispose them to diabetes mellitus and cardiovascular diseases later in life. Physical inactivity and poor diet are the major risk factors for overweight and obesity. Based on the report of a Scottish Survey, 68.2% of males and 60.4% of females were overweight or obese.[1] In Scotland, the prevalence of overweight and obesity has increased over the years. By 2016, 65% of adults aged 16 and above were overweight, while 29% were obese.[2] In another study conducted among healthcare workers in a Scottish Survey, 69% of the nurses were overweight or obese. The prevalence of overweight and obesity was higher in the nurses compared with other healthcare professionals.[3] About 67% of adults and 25% of children were obese in Scotland. Obesity can decrease the average life span by about 10 years.[4] Lecube *et al.* reported low self-perception of obesity among the participants in a Spanish study. Family history, aging, eating of snacks, and alcohol intake were associated with being overweight and obese.[5]

In a study conducted in Nairobi, Kenya, to find out the predictors of overweight and obesity among women, high-calorie diets and sedentary lifestyles were the predisposing factors. This was a community study with a good methodology and hence it had good external validity.[6] Initially, there were epidemics of communicable diseases but in the last few years, there has been an increasing prevalence of non-communicable diseases of which obesity and overweight are included.[7] In another study on the prevalence and pattern of overweight and obesity in a rural community in Nigeria, Adebayo *et al.* reported that 8.4% were obese and 20.8% were overweight.[8] It was observed that the mode of nutrition in the rural communities was healthier and there were increased physical activities. Oladoyinbo *et al.* conducted a study in South-Western Nigeria among some traders at a market. The prevalence of obesity (26.7%) and abdominal obesity (52.0%s) were found to be high with female preponderance.[9] In a study conducted in Jos, Nigeria, among chief executives, the prevalence of obesity was 38%, and the knowledge of obesity on the risk factor and associated complications was fair among the respondents. There is a need to counsel the chief executives of organisations to do regular check-ups and counsel them on the health problems related to obesity and overweight.[10]

Teachers are predisposed to physical inactivity and poor diets, especially in urban schools. In a study conducted in South-Southern Nigeria among primary school teachers, it was reported that the prevalence of hypertension was 27.4%, the prevalence of obesity was 80.8% and abdominal obesity was 84.1%.[11] Teachers in this part of Nigeria need health education on obesity and its accompanied co-morbidities to prevent the problems associated with them. In another study conducted to assess the gender variation in factors associated with overweight, obesity, and hypertension, Ajani *et al.* reported the crude prevalence of overweight and obesity to be 70.7%. The prevalence of general obesity was higher in females while the prevalence of abdominal obesity was higher in males. The prevalence of hypertension was higher in females than males.[12] There is inadequate data in Nigeria on the prevalence of obesity, obesity in patients with hypertension, and adequate data on this condition would help in their comprehensive management.

MATERIALS AND METHODS

A cross-sectional study of hypertensives was conducted from March 2021 to August 2021 at the medical out-patients clinic of the State Hospital, Oyo, a secondary healthcare centre in Nigeria. The study involved 354 adults between 18 to 60 years with an established diagnosis of hypertension and already on treatment for six months and follow-up.

Inclusion criteria included patients with a blood pressure of systolic ≥140mmHg and diastolic ≥90 mm Hg diagnosed six months previously or patients on drugs for hypertension for at least six months. Exclusion criteria included Patients with severe hypertension, systolic blood pressure >180 mm Hg, diastolic blood pressure > 110 mm Hg who would need immediate evaluation, patients with emergencies, and pregnant and lactating women.

The sample size was estimated using the formula:[13]

$$n = \frac{Z^2 pq}{d^2}$$

Quoting n= minimum sample size

$Z_{\acute{a}}$=the standard normal deviate, usually set at 1.96, which corresponds to the 95% confidence level. P = the prevalence of hypertension to be 22.7% for Nigeria.[14]

q=1.0- p d=degree of accuracy desired usually set at 0.05.

Considering 20% non-response

q= 1/1-f q is the adjustment factor f = non response rate, if f =20%

q = 1/0.8 = 1.25

n = 1.25 x 270 = 338

For the purpose of this study, a minimum of 338 patients with hypertension were to be recruited. However, 354 patients were recruited to improve the power of the study.

Sampling techniques: The systematic sampling technique was used. About 80 patients with hypertension were seen per clinic which took place twice a week. Eight clinic days are run per month which means 640 patients would be seen per month. Three thousand and two hundred patients (3200) patients were expected to be seen in five months. The sampling interval was 9(3,200/354). The first patient was recruited by the Simple Random technique by the use of computer-generated random numbers. Random numbers within the range of the number of registered patients with hypertension were generated using the random number function of Microsoft Excel 2016. The numbers were sorted from smallest to largest and on each clinic day nine patients with serial numbers corresponding to the random numbers generated were selected for recruitment. The consenting patients were numbered serially, and every 9th patient was recruited until the sample size of 354(n) was completed.

Precautionary measures during Covid-19 pandemic

Respondents were educated about Covid-19 pandemic. They were asked to use masks when coming to the clinic, and wash their hands before and after consultations. Respondents were asked if they have had symptoms of Covid-19 positive patients or come in contact with Covid-19 positive patients. Suspected cases of Covid-19 were counselled to go for a test.

The principal investigator and the research assistants wore surgical masks or N95, surgical gloves and ward coats to recruit patients. The laboratory scientists wore laboratory coat, surgical gloves, face shields, and surgical masks. Any physical item used by the participants were disinfected before and after use by each participant. Hand sanitizers with at least 60% alcohol, tissue papers, trash baskets, cleaners and disinfectants were provided. The personal data of the respondents, blood specimen and anthropometric measurements were taken. The reasons for the assessments were explained to the respondents.

Diet quality

The assessment of diets of the patients questionnaire (modified Rapid Eating Assessment for Participants - Shortened Version) was used to assess diet quality. This is a validated 13-item questionnaire for a brief dietary assessment and it was interviewer administered. The Cronbach alpha is 0.86. It is used to assess the nutrient intake and assist in brief lifestyle counselling by a healthcare provider.[15]

Physical activity

The Global Physical Activity Questionnaire (GPAQ) was used to assess physical activity. It was developed by WHO to assess the type, frequency, duration and intensity of physical activity at work, transport and leisure time in a typical week. It has 16 items, interviewer- administered and is a validated instrument used in a previous study.[16]

Blood pressure assessment

A standard sphygmomanometer (Accosson, London) and Littman Stethoscope were used. Systolic blood pressure and diastolic blood pressure were measured as Korotkoff sound phases I and V separately. The readings of the sphygmomanometer were directed away from the patients to assure blinding to the readings. The readings were recorded with the patient in a seated position with their arms supported at heart level, after five minutes of break, after abstinence from food, nutritional complements, caffeinated drinks and smoking for at least two hours before the assessment at around similar period and day of the week. The mean of the two blood pressures recorded was used for analysis.

Anthropometric measurements

Height

The heights of the subjects were assessed using a calibrated wooden stadiometer. The heights were measured to the nearest 0.01meter(m). The stadiometer was positioned on a flat surface. The respondents were asked to remove their shoes, and their heels were positioned against the wall. The respondents were also asked to remove their headwear, and the hair was flattened temporarily with a hard-flat surface making it vertical to the wall. Zero error was adjusted for after each subject for accuracy.

Weight

The patient was asked to have a 12-hour fast and an emptied bladder. The weight was measured to the nearest 0.1kg using a weighing scale (Elgil Medical, England) with the subjects wearing only very light body clothing and bare footed. The participants were asked to stand on the platform looking straight but still. After the first measurement, the process was repeated and the mean recorded.

Waist circumference

This was assessed by an inelastic measuring tape to the 0.1 cm. The subject was asked to stand erect with arms to the sides. The right lowest rib margin was located and marked with a pen. The iliac crest was felt in the mid-axillary line and marked. The inelastic tape was then applied midway between the iliac crest and the lowest rib firmly round the umbilicus.

Hip circumference

This was assessed by an inelastic measuring tape to the 0.1 cm. The subject was asked to stand erect with arms to the sides and the legs together. The measurement was taken at the point with the highest circumference at the buttocks with the tape held horizontally touching the skin.

Subscapular

The instrument used to measure the skin folds was the Slim Guide which is the Canadian version for measuring skin folds. The subscapular skinfold was assessed at the lower angle of the right scapula. The skinfold was acquired at 45^0 about 2cm below the lowest tip of the shoulder blade, almost parallel to the inside angle of the shoulder blade itself.

Triceps

The triceps skinfold was assessed at the upper arm mid-point mark on the posterior surface of the right upper arm. It is the perpendicular skinfold that is acquired mid-way between the top portion of the shoulder and the elbow.

Biceps

This comprises of a vertical skin fold parallel to the arm located over the biceps midway between the shoulder and the elbow.

Supra-iliac

The skinfold was situated between the upper portion of the hip bone and the bony portion of the same hipbone along the lower right of the body above the iliac crest in the mid-axillary line.

Definition of obesity

Different weight classes are defined according to the World Health Organisation (WHO) based on a person's Body Mass Index (BMI) as follows: Healthy weight (18.5–24.9 kg/m^2), Overweight (25–29.9 kg/m^2), Obesity class I (30–34.9 kg/m^2), Obesity class II (35–39.9 kg/m^2), and Obesity class III (40 kg/m^2 or more). Abdominal obesity was defined as a waist circumference ≥94 cm in men and ≥80 cm in women.[17]

Ethical Approval

The approval of Ethical Review Committee of the Ministry of Health, Oyo State, Ibadan, Nigeria was obtained. Then, the Medical Director, State Hospital, Oyo was informed about the study. Written informed consent was obtained from eligible patients before the administration of the questionnaires, and examinations. Privacy and confidentiality of the respondents were guaranteed by the anonymity of respondents. The committee's reference number for ethical approval is AD 13/479/4023B.

RESULTS

Socio-demographic characteristics of respondents

Socio-demographic characteristics of respondents was shown in table 1. Three hundred and fifty-four patients who met the criteria for recruitment were interviewed. The mean age of the respondents was 52.60 (SD±8.26) years. Fifty-three were less than 45 years. Almost one third of the patients were between 45-54 years of age and about half of the respondents were from 55years and above.

Table 1: Socio-demographic characteristics of respondents n=354

Variable	Frequency (n)	Percentage (%)
Age group(years)		
<45	53	15
45-54	119	33.6
55 and above	182	51.4
Sex		
Male	71	20.1
Female	283	79.9
Religion		
Christianity	150	42.4
Islam	198	55.9
Traditional	6	1.7
Ethnic group		
Yoruba	328	92.7
Hausa	8	2.3
Ibo	18	5.0
Highest education level		
No formal education	109	30.8
Primary	46	13
Secondary	60	16.9
Tertiary	139	39.3

Distribution of BMI, waist circumferences and waist hip ratios of the patients

Figure 1 shows the distribution of BMI of the patients. Respondents who were obese were a little bit above half of the patients interviewed (53.1%). Respondents who were overweight were about a third of the patients recruited. The prevalence of obesity was 53.1% in this study. Only 2 respondents were in the underweight category and were merged with normal weight group. Figure 2 shows that about four fifths of the Respondents had high waist circumferences and waist hip ratios.

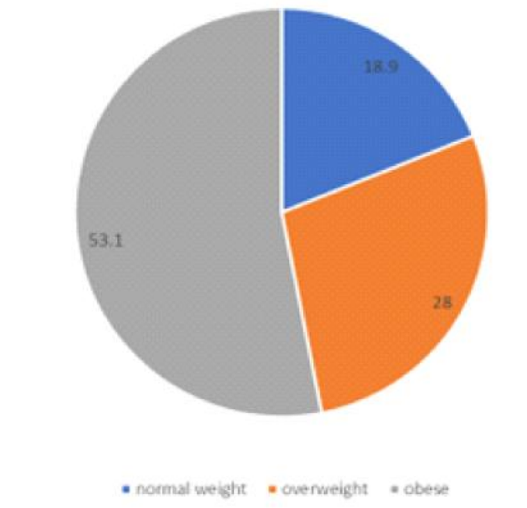

Figure 1: Distribution of body mass indices of the respondents

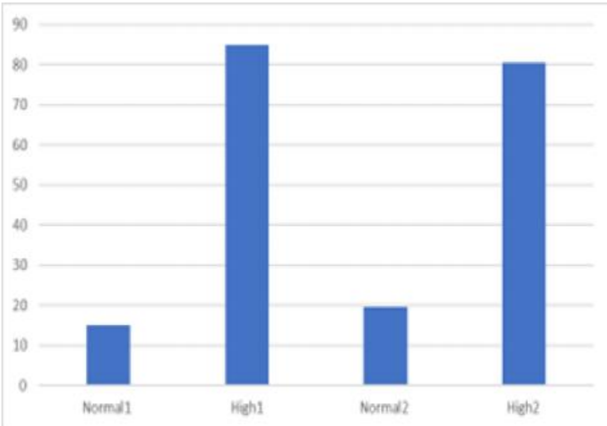

Figure 2: Distribution of waist circumferences and waist hip ratios

1= waist circumferences

2= waist hip ratios

Table 2: Association of BMI with sex, diet, waist hip ratio and physical activity

Variable	Normal weight	Overweight	Obese	χ2	p-value
Sex					
Male	28(41.8%)	22(22.2%)	21(11.2%)	29.3	0.0001*
Female	39(58.2%)	77(77.8%)	167(88.8%)		
Physical activity					
Low	24(35.8%)	30(30.3%)	83(44.1%)	6.77	0.15
Moderate	21(31.4%)	31(31.3%)	56(29.8%)		
High	22(32.8%)	38(38.4%)	49(26.1%)		
Waist hip ratio					
Normal	28(38.8%))	18(18.2%))	25(13.3%))	20.63	0.0001*
High	41(61.2%))	81(81.8%))	163(86.7%))		
Diet score					
Good	28(41.8%)	47(47.5%)	80(42.6%)	0.77	0.68
Poor	39(58.2%)	52(52.5%)	108(57.4%)		

**Significant at 5% level of significance*

Association of BMI with sex, diet, waist hip ratio and physical activity

As shown in table 2, a higher percentage (88.8%) of the females were obese while a minority (11.8%) of the males were obese, the association was statistically significant (χ^2 = 29.3, p-value = 0.0001). There were no associations between diet quality, physical exercise and obesity.

the association was positive, weak in strength and statistically significant(p-value=0.012).

Table 5: Linear regression for diastolic blood pressure on significant variables

As shown in table 5, for every 1 unit increase in triceps skinfold, there was a statistically significant increase in diastolic blood pressure by about 2.77units (95% C.I equals 2.63 to 2.91, p-value= 0.0001).

Table 3: Logistic regression analysis of risk of developing obesity and overweight on selected variables

Body Mass Index	Odd Ratio	Wald	95% CI	p-value
Overweight				
Physical Activity	1.12	0.339	0.767-1.630	0.56
Sex	2.466	6.747	1.248- 4.875	0.009*
Obese				
Physical activity	.737	2.86	0.518- 1.049	0.091
Sex	6.04	27.41	3.08-11.84	0.0001*

**Significant at 5% level of significance*
The reference category is normal weight
***Dependent variable**: Body Mass Index*
***Predictors:** Sex*

Logistic regression analysis of risk of developing obesity on selected variables

Table 3 shows the Logistic regression analysis of predisposing factors to obesity on selected variables. After adjusting for other variables, the predictors of obesity were sex. Females were about 6 times more likely to be obese compared with males (OR=6.23; 95%CI= 3.16 – 12.32).

Table 4: Correlations of diastolic and systolic blood pressures with selected variables

There was no association between diastolic blood pressure and subscapular skinfold. For biceps skinfold,

As shown in table 5, for every 1 unit increase in biceps skinfold, there was a statistically significant increase in diastolic blood pressure by about 0.948 units (95% C.I equals0.243-1.652, p-value= 0.0001).

Table 6: Linear regression for systolic blood pressure on significant variables

As shown in table 6, for every 1 unit increase in biceps skinfold, there was a statistically significant increase in systolic blood pressure by about 5.78 units (95% C.I equals 5.46- 6.10, p-value= 0.0001).

Table 4: Correlations of diastolic and systolic blood pressures with selected variables.

	Diastolic blood pressure	Systolic blood pressure
Supra-iliac skinfold		
Pearson correlation	0.012	0.039
p-value	0.818	0.464
Subscapular skinfold		
Pearson correlation	0.012	0.031
p-value	0.826	0.532
Biceps skinfold		
Pearson correlation	0.134	0.084
p-value	0.012*	0.114
Triceps skinfold		
Pearson correlation	0.097	0.045
p-value	0.069	0.395
BMI		
Pearson correlation	0.039	0.004
p-value	0.470	0.941
Waist circumference		
Pearson correlation	0.035	0.023
p-value	0.514	0.669
Hip circumference		
Pearson correlation	0.003	0.012
p-value	0.962	0.817
WHR		
Pearson correlation	0.023	0.074
p-value	0.671	0.166

Table 5: Linear regression for diastolic blood pressure on significant variables

ANOVA TABLE					
Model	Sum of squares	Degree of freedom	Mean square	F	Significant
1 Regression	26.58	1	26.580	4.54	0.034*
Residual	2061.095	352	5.855		
Total	2087.67	353			
2 Regression	51.262	1	25.63	4.42	0.013*
Residual	2036.41	351	5.802		
Total	2087.67	353			
Linear regression for Diastolic blood pressure on significant variables					
Variable	**Regression coefficient(B)**	**Standard Error for B**	**95% CI for B**	**p-value**	**T**
1 Triceps skinfold	2.77	0.072	2.63-2.91	0.0001*	38.55
			-		
2 Triceps skinfold	2.050	0.282	1.494-2.605	0.0001*	7.26
Biceps skinfold	0.948	0.358	0.243-1.652	0.0001*	2.65

Table 6: Linear regression for systolic blood pressure on significant variables

ANOVA table					
Model	**Sum of squares**	**Degree of freedom**	**Mean square**	**F**	**p-value**
1 Regression	5610315.07	1	5610315.07	1270.8	0.0001*
Residual	1558395.93	353	4414.72		
Total	7168711.00	354			
Linear regression for systolic blood pressure on significant variables					
Variable	**Regression coefficient(B)**	**Standard Error for B**	**95% CI for B**	**p-value**	**T**
Biceps skinfold	5.78	0.162	5.46- 6.10	0.0001*	35.65

Dependent variable: Systolic blood pressure
Predictors: Biceps skinfold

DISCUSSION

This study was conducted at the State Hospital, Oyo State, a secondary health care centre in Nigeria, from March 2021 to August 2021. Majority of the respondents were females and mostly were from the Yoruba ethnic group which is the dominant ethnic group in Oyo town, South-Western Nigeria.

The prevalence of obesity in this cohort of patients with hypertension was 53.1%. This was higher than what, was reported (34.5%) by Olabisi *et al.* in a study conducted in Ibadan on patients with hypertension.[18] However, Chidima *et al.* also reported the prevalence of obesity to be 80.8% and abdominal obesity to be 84.1% in a study conducted in Portharcourt, Nigeria.[12] The prevalence of overweight found in this study was 28% which was higher than 7.8% reported by Adediran and colleagues in a study conducted in a rural community in Nigeria.[19] In another rural community, the prevalence of overweight and obesity were recorded as 20.8% and 18.4% respectively.[20] This could be due to differences in lifestyles of rural and urban communities. The proportions of waist circumferences and waist hip ratios were very high in this study showing high prevalence of abdominal obesity. In a study conducted among traders in Ijebu-ode market, Nigeria, the prevalence of abdominal obesity recorded was 52%.[8] This was in contrast to 85% prevalence found in this study of hypertensives. It was also found that the majority of the obese patients were females with low physical activity and poor diet. These were similar to the findings of Olawuyi *et al.* and Okafor *et al.* who reported that female sex was associated with overweight, abdominal obesity and obesity.[21, 22] In this study, the predictors of obesity were female sex. These were similar to what were reported by Bello *et al.,* Wahab *et al.* and Oladimeji *et al.* in studies conducted in Lagos, Katsina and Kaduna in Nigeria who found that obese patients were more likely to be females.[23,24,25] Topan and colleagues reported that the BMI reduces with better diet quality in a study conducted in Turkey. Mindful eating was affected by the age of the respondents, family history of obesity and improved with physical activity.[26]

In this study, the predictors of systolic blood pressure levels were biceps skinfold measurements and the predictors of diastolic blood pressure levels were biceps and triceps skinfold measurements. Triceps skinfold was a predictor of high blood pressure in a study conducted in Brazil by Giglio and colleagues. Body mass index and waist circumference were also associated with high blood pressure.[27]

Implication of the study to research and clinical practice

The study had given insights into the high prevalence and the risk factors of obesity in patients with hypertension. Female respondents with low physical activities and majority of the people who took poor diet were more likely to be obese. Healthcare providers would have to counsel patients especially women on the need to be more active and take good quality diets to curb the increasing prevalence of overweight and obesity. Most of the previous studies on prevalence of obesity and overweight among hypertensives in Nigeria used secondary data or small sample sizes. There is paucity of data on the association of skinfold measurements with blood pressure levels and the results of this study has added additional knowledge to science.

CONCLUSION

The prevalence of overweight and obesity was high in this population of hypertensives. A higher percentage of females were overweight and obese compared with males. After adjusting for other variables, the predictors of obesity were female sex. Additionally, biceps and triceps skinfold measurements were predictors of blood pressure levels in this study.

Limitations of the study and future research

The study was a hospital-based cross-sectional and the results obtained might not be a true reflection of what obtains in the community. However, the hospital serves a big population covering a very wide geographical area. Besides, causal relationships could not be established and hence there are needs for case control, prospective cohort and interventional studies to establish causal relationships.

Acknowledgements

I would like to express my sincere gratitude to the Internal Medicine MSc programme team of the University of Edinburgh, United Kingdom for their critical appraisal of my project. The team includes Professor Simon Maxwell, Dr Frances Parry, Dr Ian Handel, Dr Marshall Dozier and Dr Ahmad Mostafa. I was redirected to change my project to a more novel study.

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