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Prevalence of Obesity, Diabetes Type 2 and Hypertension among a Sampled Population from Sokoto Metropolis-Nigeria

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Authors' contributions

Authors may use the following wordings for this section. This work was carried out in collaboration between all authors. All the authors contributed substantially in the design of the study, planning the conduct of the study, supervision of data collection, data analysis, interpretation, literature searches, all the write ups, editing/critics as well as financial contribution.

Original Research Article

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ABSTRACT

Aims: To determine the prevalence of obesity and its relationship with hypertension and diabetes among dwellers of Sokoto metropolis.
Study Design: A descriptive cross sectional study.
Place and Duration of Study: We conducted the study in March 2012, within Sokoto metropolis to mark the world kidney day.
Methodology: We enrolled 300 participants using a convenience sampling technique. An interviewer administered questionnaire was used to obtain the biodata and past medical history. Blood pressure and anthropometric parameters were measured while blood and urine samples were taken for RBS estimation and urine analysis respectively.

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We analyzed the data obtained using the Statistical Package for Social Sciences (SPSS) version 17.
Results: Out of the 300 participants that came for screening, two opted out, thus leaving 298 participants. There were 50.3% males and 49.7% females. Their mean age was 42±31 years. The BMI ranged between 14-48 kg/m^2 with mean of 24.24 $kg/^2$ ±5. Mean SBP and RBS were 130mmhg (±25) and 7.34±4 $mmol^{-1}$ respectively. About 13.9% of the participants were found to be obese. Obesity was significantly associated with SBP ($p<0.001$) and RBS level ($p=0.002$).
Conclusion: Obesity is quite common in our environment and it contributes to the occurrence of hypertension and elevated blood sugar. Screening for obesity markers should be encouraged at every contact with healthcare provider. Physical activity for at least 30 minutes/day should be encouraged in order to reduce the risk of obesity, hypertension and diabetes mellitus.

Keywords: Obesity; hypertension; diabetes mellitus; sokoto.

1. INTRODUCTION

Obesity is a non-communicable medical disorder that has largely been accepted as reflection of healthy living and affluence among Nigerians. It is usually defined as body mass index (BMI) ≥ 30 kg/m^2 and is assuming an epidemic dimension globally [1]. Obesity is a modifiable cardiovascular risk factor which predisposes to and occurs in combination with other non-communicable disease such as diabetes mellitus, hypertension, dyslipidaemia and metabolic syndrome [2].

An imbalance between energy intake and its expenditure is thought to principally lead to obesity [3]. Physical inactivity, excess caloric intake and genetic factors play significant role in aethiopathogenesis of obesity [3]. Body mass index (BMI), is the most commonly used marker for body-weight assessment and is highly correlated with body fat [4].

The medical risk of obesity is closely associated with the distribution of body fat, with abdominal fat considered at least as important a medical risk as the total amount of body fat [5]. The BMI serve as a veritable platform for evaluation of obese subjects, with predisposition to its deleterious effect increasing with its severity.

Nigeria is currently witnessing both demographic and epidemiologic transitions which could be some of the possible reasons why the prevalence of non-communicable diseases is increasing. In a cross-sectional study by Ojofeitimi et al in southwestern Nigeria [6], it was found that 21.2% of their respondents were obese while Kadiri et al. Found obesity in 21% and 28% of males and females respectively in a study of 146 middle-aged Nigerians [7]. In Ghana and Republic of Benin, obesity was found among adults in 13.6% and 18% respectively [8,9].

World Health Organization and other national organizations have devised strategies for chronic non-communicable disease prevention and control [6,10]. The failure to diagnose obesity and obesity-related morbidities by clinicians leads to missed opportunities to counsel these patients on lifestyle modification and screen them for obesity-related morbidities. The rising burden of obesity and other related co-morbidities in developing countries including Nigeria, formed the basis for this study. An early recognition of these disorders through periodic screening programs would significantly reduce the morbidities and mortalities caused by NCDs.

The objectives of the study were to screen for obesity markers, hypertension and diabetes mellitus with a view to determine their relationship among inhabitants in Sokoto metropolis.

2. MATERIALS AND METHODS

2.1 Study Area

We carried out this study in March 2012, within Sokoto metropolis to mark the world kidney day. Sokoto metropolis comprised of three local government areas (LGAs); Sokoto North, Sokoto South and Wamakko LGAs.

2.2 Study Design

It was a descriptive cross-sectional study.

2.3 Eligibility

Only those aged 15 years and above and who gave their free consent to participate in the study were included in the study. Participants were advised not to smoke, drink alcohol, coffee or tea and not to perform physical exercise at least 30 minutes before enrollment into the study. Pregnant women were excluded from the study.

2.4 Sample Size/Sampling Technique

No specific sample size was determined because the study was primarily a screening program; we therefore used a convenience sampling technique to select 300 participants that came for the screening. Two participants opted out before their measurements were taken, thus leaving 298 participants.

2.5 Data Collection

Data collection was done using a set of structured questionnaire, which sought information on socio-demographic characteristics of participants, history of hypertension, diabetes mellitus and obesity. The questionnaire was pretested on a small group of people in the central motor park of Sokoto and amendments made as appropriate. Resident doctors who were trained on the objectives of the screening and how to apply the study instrument were used as research assistants.

For the blood pressure (BP) measurements, appropriate size cuffs were used for each participant and the BP was measured every 2 minutes using standardized mercuric column sphygmomanometer, with the participant sitting. Average of three measurements was taken as the BP for each participant.

Height was measured to the nearest 0.5 cm using standardized protocols, with participant barefooted, back against a wall tape, looking straight ahead. Weight was measured using a lever balance to the nearest 100g, with participant wearing light undergarments and no shoes. Waist circumference (WC) was measured to the nearest 0.5 cm using a tape rule. All the measurements were recorded in the participants' respective questionnaires. Blood samples for random blood sugar estimation were taken and spot urine samples were taken for urinalysis.

2.6 Diagnostic Criteria

Body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters) squared (kg/m^2). According to the guidelines set by WHO, BMI was used to measure generalized overweight (BMI of ≥25<30 kg/m^2) and generalized obesity (BMI of ≥30 kg/m^2), WC was used to measure abdominal overweight (WC of ≥94<102 cm in men and ≥80 <88 cm in women) and abdominal obesity (WC ≥102 cm in men and WC≥88 cm in women). These are the criteria used by the International Diabetes Federation [11].

A random blood sugar (RBS) of ≥11.1 mmol/L (200 mg/dL) was considered diabetes mellitus whereas prehypertension was defined as a systolic BP (SBP) between 120 and 139 mmHg or a diastolic BD (DBP) between 80 and 89 mmHg, and hypertension was defined as average SBP≥140 mmHg or an average DBP≥90 mmHg [12].

2.7 Data Analysis

We sorted out the questionnaires for accuracy and completeness immediately after collection, before we entered the data into the computer for analysis. The data obtained were analysed with the Statistical Package for Social Sciences (SPSS) version 17, and Microsoft Excel 2007. We gave continuous variables as means±SD^s and categorical variables as frequency/percentage in each subgroup. We used *t* test to compare means (for height, weight, WC, SBP, DBP and BMI) between men and women. For associations between categorical variables we used X^2 test and for continuous variables, we used Pearson's correlation. All statistical analyses were 2-tailed and were set at 5% level of significance.

2.8 Ethical Consideration

All the participants present were informed about the screening exercise, its benefits and potential harm. They were also informed of the possibility of using the data obtained for academic purpose and thereafter, their free consents to participate were obtained and each given a copy of the informed consent form to sign. Each of them was given the opportunity to request for his/her result from the researchers and those that were observed to be having elevated blood pressure, albuminuria/proteinuria and/or raised random blood sugar were referred to the Medical Outpatient Department (MOPD) of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto for further evaluation. They were also informed about their right to withdraw their consent to be part of the study at any point, without any consequence to them. The study was approved by the ethical committee of the author's institution and the state Ethical Review Board.

3. RESULTS

The ages of the respondents ranged from 15-96 years. Those within the age group of 45-54yrs constituted the highest number of respondents (N=67), which made up about 23.8% of the whole respondents, whereas those above 65 years of age were the least represented (7.1%). The mean age of the respondents was 42 years SD±31.9. Sex distribution was fairly equal with males making up 50.35% and females 49.7% of those that were surveyed in the study. In terms of occupation, 15.1% (N=45) of the participants were students, 22.5% (N=67) were housewives, 24.8% were civil servants, 23.2% were business men and women. The remaining participants (14.4%) were engaged in vocational jobs like plumbing, carpentry etc. Forty nine of the participants (16.5%) had no form of formal education while 53 (17.8%) had up to tertiary level of education Table 1.

Table 1. Some socio-demographic characteristics of participants

SN	Variable	Frequency (%)
1	Age group (years)	
	15-24	55(19.6)
	25.34	65(23.1)
	35-44	30(10.7)
	45-54	67(23.8)
	55-64	44(15.7)
	>65	20(7.1)
	Total	281(100)
	Mean= 42 SD±31.6	
2	Gender	
	Male	150(50.3)
	Female	148(49.7)
	Total	298(100)
3	Occupation	
	Student	45(15.1)
	House wife	67(22.5)
	Civil servant	74(24.5)
	Business	69(23.2)
	Others	43(14.4)
	Total	298(100)
4	Educational status	
	None	49(16.5)
	Primary	87(29.3)
	Secondary	108(36.4)
	Tertiary	53(17.8)
	Total	297(100)

In Table 2 below, the mean weights of both male and female participants were fairly comparable ($p>0.05$), with the males having slightly higher mean weight (66.25kg±12). The mean height for males was significantly higher than that of the females (M=1.7m, F=1.59m, $p<0.001$).The BMI ranged from 14-48 kg/m^2, where those that had normal BMI (18.5-24.9 kg/m^2) were the most represented, with 30.7% of them being males and 22.6% being females. Female participants constituted the highest number of those that had abnormal BMI, where 12.5% were found to be overweight, 10.5% were obese, whereas only 3.4% of male participants were obese. Only 9.2% of the respondents had positive family history of obesity. The overall mean BMI for both males and females was 24.24 kg/m^2 (±5), with the female participants having statistically significant higher BMI (M= 22.98±4 kg/m^2, F=25.5±6 kg/m^2, $p<0.001$). Overall prevalence of generalized obesity was 13.9% and the prevalence was significantly higher among women (P=.013). Mean waist circumference (WC) for both males and females was 86.2±14.2cm, with females having higher mean WC (91.14±12cm) compared to the males (80.96±13.8cm). This difference was statistically significant (P<.001). Up to 23.5% of the participants had abdominal overweight, out of which 17.5% were females. We also observed that, out of the 30.9% of the participants that had abdominal obesity, up to 27.5% of them were females (P<.001). The systolic blood pressure of the respondents ranged from 70-250 mm Hg, with mean of 130 SD±25.4 mm Hg. Up to 51.5% of the participants had normal blood pressure, 17.8% had prehypertension (males: 10.4%, females: 7.4%) and up to 30.1% had hypertension (males: 11.4%, females: 19.2%). The mean SBP was significantly higher for females than for males (females = 134±37 mm Hg, males =125±22 mm Hg, P=0.003). About 10% of them were found to be diabetic, as measured by the random blood sugar (RBS≥11.1 mmol/L) and no significant sex difference was observed (P=.778). The mean RBS was also comparable for both sexes (M=7.02±3.7 mmol/L, females =7.66±4 mmol/L, P>0.05).

Table 2. Sex-specific distribution of anthropometric parameters, SBP, RBS and family history of DM of the study participants

SN	Variable	Males	Females	P- value	TOTAL
1	Mean weight (kg)	66.25±12	65.96±17	p>0.05	66.11±14.5
2	Mean height (m)	1.7±0.07	1.59±0.09	P<0.001	1.65±0.08
3	BMI Category				
	Under-weight	19(6.4)	11(3.7)		30(10.1)
	Normal	91(30.7)	67(22.6)		158(53.3)
	Generalized over-weight	30(10.1)	37(12.5)		67(22.6)
	Generalized obesity	10(3.4)	31(10.5		41(14.9)
	TOTAL	150(50.6)	146(49.4)		296(100)
	Mean±SD	22.98±4	25.5±6	P<.001	24.24±5
4	WC category				
	Normal	96(38.1)	19(7.5)		115(45.6)
	Abdominal overweight	15(6.0)	44(17.5)	P<.001	59(23.5)
	Abdominal obesity	9(3.4)	69(27.5)		78(30.9)
	TOTAL	120(47.5)	132(52.5)		252(100)
	Mean±SD	80.96±13.8	91.14±12.8	P<.001	86.2±14.2
5	Family history of obesity				
	Yes	29(9.9)	34(11.6)	P=.756	63(21.5)
	No	118(40.4)	111(38.0)		229(78.4)
6	SBP				
	Normal	85(28.6)	68(22.9)		153(51.5)
	Prehypertension	31(10.4)	22(7.4)	P=.009	53(17.8)
	Hypertension	34(11.4)	57(19.2)		91(30.6)
	TOTAL	150(50.4)	147(49.6)		297(100)
	Mean±SD	125±22	134±27	P=.003	129.5±24.5
7	DBP				
	Normal	55(18.5)	39(13.1)		94(31.6)
	Prehypertension	65(21.9)	43(14.5)	P<.001	108(36.4)
	Hypertension	29(9.8)	66(22.2)		95(32)
	TOTAL	149(50.2)	148(49.8)		297(100)
	Mean±SD	78.6±11.9	85.0±15.7	P<.001	81.8±18.8
8	RBS				
	<11.1 mmol/l	128(45.9)	124(44.4)		252(90.3)
	≥11.1 mmol/l	12(4.3)	15(5.4)	P=.778	27(9.7)
	Total	140(50.2)	139(49.8)		279(100)
	Mean±SD	7.02±3.7	7.66±4.3	p>0.05	7.34±4

The highest prevalence of generalized overweight was seen among women aged 45-54 years and generalized obesity was also highest among women of same age group. The prevalence of abdominal overweight was also observed to be highest among women of the same group (45-54 yrs), who had prevalence of 16(34.8) and the same goes for generalized obesity [23(50.0)]. The age-sex group with the lowest prevalence of both overweight and obesity were men aged between 15-24 years Table 3.

Table 3. Age-sex prevalence of normal weight, overweight and obesity based on BMI and WC

SN	Age group (years)	Body mass index			Waist circumference		
		Normal	Overweight	Obesity	Normal	Overweight	Obesity
1	**Men**						
	15-24	26(96.3)	1(3.7)	0(0.0)	30(100)	0(0.0)	0(0.0)
	25-34	22(78.6)	5(17.9)	1(3.6)	33(91.7)	1(2.8)	2(5.6)
	35-44	7(58.3)	4(33.3)	1(8.3)	10(71.4)	4(28.6)	0(0.0)
	45-54	5(45.5)	6(54.5)	0(0.0)	8(44.4)	5(27.8)	5(27.8)
	55-64	7(58.3)	5(38.5)	1(7.7)	9(64.3)	4(28.6)	1(7.1)
	>=65	2(40.0)	1(20.0)	2(40.0)	5(71.4)	1(14.3)	1(14.3)
	Total	69(71.9)	22(22.9)	5(5.2)	95(79.8)	15(12.6)	9(7.6)
2	**Women**						
	15-24	4(80.0)	1(20.0)	0(0.0)	2(28.6)	3(42.9)	2(28.6)
	25-34	9(52.9)	4(23.5)	4(23.6)	3(17.6)	5(29.4)	9(52.9)
	35-44	7(58.3)	1(8.3)	4(33.3)	0(0.0)	6(40.0)	9(60.0)
	45-54	17(50.0)	8(23.5)	9(26.4)	7(15.2)	16(34.8)	23(50.0)
	55-64	11(50.0)	7(31.8)	4(18.2)	4(14.8)	7(25.9)	16(59.3)
	>=65	7(63.6)	3(27.3)	1(9.1)	2(18.2)	4(36.4)	5(45.5)
	Total	55(54.5)	24(23.8)	16(15.8)	18(14.6)	41(33.3)	64(52.1)

For the possible effect of gender and age on BMI, Table 4. Below shows that, out of the 13.9% of the participants that were found to be obese, up to 10.5% of them were females, whereas only 3.4% were males. This relationship was found to be statistically significant (P=.001). For the possible relationship between age and obesity, the Table shows that out of the 13.3% that were obese, 11.1% were those aged 35 years and above, whereas only 2.2% of those below the age of 35 years were obese. This relationship was also found to be statistically significant (P<.001). Regarding possible effect of family history on development of obesity, no statistically significant association was observed between the two (P=.778, Fischer's exact).

Table 5 below shows the relationship between BMI, WC, gender, age, occupation and the presence/absence of diabetes mellitus (DM), where higher BMI was observed to be significantly associated with DM, in that out of the 11.2% of the participants who were diabetic 7.1% of them were either having overweight or obesity (P=.036). Significant association was observed between WC in men and DM (P<.001) but no association was observed among women (P=.324). Majority of those who were diabetic were those having 35 years and above, thus there was significant association (P<.001). Gender was not significantly associated with DM (P=.778) and likewise occupation of participants (P=.066).

Table 4. Relationship between obesity and age, gender and family history of obesity

Relationship between age and obesity			
Age	**Obesity**		
	No obesity	**Obesity**	**Test statistic**
<35 yrs	114(40.9%)	6(2.2%)	X^2=12
≥35 yrs	128(45.9%)	31(11.1%)	df=1
Total	242(86.7%)	37(13.3%)	p<0.001
Relationship between gender and obesity			
Gender	**Obesity**		
	No Obesity	**Obesity**	**Test statistic**
Male	140(47.3%)	10(3.4%)	X^2=13
Female	115(38.9%)	31(10.5%)	df=1
Total	255(86.1%)	41(13.9%)	P=0.001
Relationship between family history of obesity and obesity			
Family history of obesity	**Obesity**		
	No obesity	**Obesity**	**Test statistic**
Yes	23(7.8)	4(1.4)	P=0.778 (Fischer's exact)
No	229(78.2)	37(12.6)	
Total	252(86.0)	41(14.0)	

Table 5. Relationship between diabetes mellitus and BMI, WC, gender, age and occupation

Variable	**Diabetes mellitus**		**P-value**
	Absent	**Present**	
BMI			
Normal	113(57.4)	8(4.1)	P=.036
Generalized overweight	38(19.3)	9(4.6)	
Generalized obesity	24(12.2)	5(2.5)	
Total	175(88.8)	22(11.2)	
WC (men)			
Normal	91(76.5)	4(3.4)	P<.001
Abdominal overweight	9(7.6)	6(5.0)	
Abdominal obesity	7(5.9)	2(1.7)	
Total	107(89.9)	12(10.1)	
WC (women)			
Normal	18(14.2)	1(0.8)	P=.324
Abdominal overweight	38(29.9)	3(2.4)	
Abdominal obesity	57(44.9)	10(7.9)	
Total	113(89.0)	14(11.0)	
Age			
<35 years	108(40.8)	2(0.8)	P<.001
≥35 years	130(49.1)	25(9.4)	
Total	238(89.8)	27(10.2)	
Gender			
Male	128(45.7)	12(4.3)	P=.778
Female	125(44.7)	15(5.4)	
Total	253(90.4)	27(9.6)	
Occupation			
Student	47(17.0)	0(0.0)	P=.066
House wife	58(20.9)	7(2.5)	
Civil servant	62(22.4)	10(3.6)	
Business	57(20.6)	9(3.2)	
Others	26(9.4)	1(0.4)	
Total	250(90.3)	27(9.7)	

In table 6 below, both BMI and WC in men were significantly associated with hypertension (P=.001 and P=.022 respectively). WC in women had no significant association with hypertension (P=.499). Older age was also associated with hypertension in that out of the 30.7% participant who were hypertensive, 26.8% of them were aged 35 years and above (P<.001). There was a significant association between gender and hypertension (P=.01). Family history of hypertension had no significant association with hypertension (P=.420).

Table 6. Relationship between hypertension and BMI, WC, gender, family history of hypertension and age

Variable	SBP		P-value
	No hypertension	**Hypertension**	
BMI			
Normal	100(48.5)	29(14.1)	P=.001
Overweight	24(11.4)	23(11.2)	
Generalized obesity	17(8.3)	13(6.3)	
Total	141(68.4)	65(31.6)	
WC (men)			
Normal	77(64.2)	19(15.8)	P=.022
Overweight	9(7.5)	6(5.0)	
Generalized obesity	4(3.3)	5(4.2)	
Total	90(75.0)	30(25.0)	
WC (women)			
Normal	10(7.6)	8(6.1)	P=.499
Generalized overweight	29(22.1)	15(11.5)	
Generalized obesity	38(29.0)	31(23.7)	
Total	77(58.8)	54(41.2)	
AGE			
>35 years	109(38.9)	11(3.9)	P<.001
≥35 years	85(30.4)	75(26.8)	
Total	194(69.3)	86(30.7)	
GENDER			
Male	115(38.7)	34(11.4)	P=.01
Female	91(31)	57(19.2)	
Total	206(69.4)	91(30.6)	
Family history of hypertension			
Yes	90(30.8)	44(15.1)	P=.420
No	113(38.7)	45(15.4)	
Total	203(69.5)	89(30.5)	

For the relationship between BMI of participants and their SBP, DBP and RBS, a positive linear correlation was observed between BMI and SBP which was statistically significant (r=0.25, p<0.001), between BMI and DBP (r=0.35, p<0.001) and also between BMI and RBS (r=0.127, p=0.002) Table 7. With respect to abdominal obesity as measured by the WC, positive linear correlation was observed between WC and SBP (r=.301, P<.001), WC vs. DBP (r=.396, P<.001)

Table 7. Correlation coefficients of BMI and WC with SBP, DBP and RBS among the study participants

Variable	SBP	DBP	RBS
BMI			
Pearson correlation	.251	.352	.127
p-value	P<0.001	P<0.001	P=0.002
Waist Circumference			
Pearson correlation	.301	.396	.199
p-value	P<.001	P<.001	P=.002

4. DISCUSSION

It is well established that NCDs are the leading cause of death in the world, responsible for 63% of the 57 million deaths that occurred in 2008 [13].There were 366 million people living with diabetes as of 2011 and this is expected to rise by 522 million by 2030 [14]. Over 600 million people are currently hypertensive and this figure is predicted to increase to 1.56 billion people by the year 2025 [15,16]. As oobesity, hypertension and diabetes mellitus are all growing public health problems in Nigeria [17], this study screened for obesity markers and determined their association with hypertension and diabetes mellitus.

The result of our findings showed that the prevalence rate of generalized obesity was 13.9%, of which 1.7% had BMI>40 kg/m^2. This prevalence rate is higher than the national prevalence rate in Nigeria reported in the WHO country profile reports for NCDs in 2011, where a prevalence rate of 6.5% was reported [17]. Other studies however, reported relatively higher prevalence rates in some regions both within and outside Nigeria. In Rivers state, Nigeria, a study reported a prevalence rate of 16.3% [4], whereas in Cameroun, a prevalence rate of 17.1% was observed [18]. In China, a study reported a prevalence of generalized obesity measured by BMI as high as 34.2% [19], and in South Korea, prevalence rate of 28.3% was reported for overweight/obesity [20]. With respect to abdominal obesity measured by WC, this study revealed an overall prevalence rate of abdominal obesity to be 30.9%, which was a close figure to the 31.1% reported in China [19] and lower than the 38.5% reported in a study in South Korea [20]. In the United States, the prevalence rates of abdominal obesity in 3 ethnic groups (White, Black and Hispanic) were 27.1%, 20.2% and 21.4% respectively in men and 43.2%, 56.0% and 55.4% respectively in women [21]. These relatively high prevalence rates of obesity across different regions shows that obesity has become a public health problem both in Nigeria and across the globe. Studies in some rural areas in Nigeria however, reported lower prevalence rates [22,23]. Disparities in the prevalence rates of obesity between urban and rural communities have been reported in a number of studies, with the urban centers having higher prevalence rates [6,19,21,24]. The interplay between socio-cultural lifestyle, high physical inactivity, high caloric energy intake and environmental factors may have contributed to the higher prevalence of obesity observed among the urban dwellers as against the rural areas that tend to have more of agrarian lifestyle. Autoimmune diseases though not sought for in this study, also contribute to higher prevalence of obesity as suggested in a study which reported that individuals with autoimmune disease were 2.11 times more likely to report being overweight than individuals without autoimmune disease [25].

Of the 13.9% of the respondents that were obese, 10.5% were females while only 3.4% were males, thus indicating a much higher prevalence rate of obesity among females than in males ($p<0.001$). The study therefore showed gender to be an important determinant of obesity, as reported in previous studies as well [7,23,26,27], which may all be attributed to low physical activity among females and some genetic differences between males and females [28]. This finding is of public health importance because it can serve as a guide to where interventions should mainly be directed to, more so that women, especially those within the reproductive age group constitute a high risk group for other morbidities and mortalities [29]. It is interesting to note that in this study, only 9.2% of the respondents admitted to positive family history of obesity, even though the prevalence rate was as high as 13.9%. No significant association was observed between the two variables ($p>0.05$). This could mean that the high prevalence rate observed in this community is probably due to environmental and lifestyle effect, rather than due to genetic predisposition.

With respect to hypertension, this study revealed a prevalence rate of 30.6% (11.4% in men and 19.2% in women), which is lower than the national prevalence rate observed in 2008 [17]. A study conducted in 5 Indian cities reported a prevalence rate of 28.9% [30] and in China a study reported a prevalence rate of 28.7% [19], which were all close to what was observed in this study. Studies conducted in some developed countries of Asia reported that the prevalence of hypertension among Koreans aged 25 years and above was 22.9% [31] and 24.5% [32] among Japanese aged 20-65 years, which are all lower than the value observed in this study.

A positive linear correlation was observed between body mass index (BMI) of the study participants and systolic blood pressure (SBP) ($r= 0.25$, $p<0.001$), as was reported in some studies [33,34]. This positive linear correlation suggest that the higher the BMI, the higher the SBP. This study showed that WC was more strongly related to hypertension than was the BMI. Studies have shown that the relationship between anthropometric measurements (BMI and WC) and hypertension varies globally. In the US for example, SBP and DBP were more strongly related to WC than to BMI [35], similar results were also reported among Australian adults [36]. In contrast to these findings, a study in Japan however, reported that BMI had a stronger association with hypertension than did WC [37] and so were the findings of a study in Turkey [38]. These discrepancies in the degree of association between BMI, WC and hypertension may be attributable to socio-demographic differences between the study populations. Some studies demonstrated that combining both BMI and WC was more superior to using only one the measures [39,40].

This study also showed that both BMI and WC were significantly associated with hypertension in men, but in women, WC had no significant association with hypertension. Older age was also associated with hypertension. Several studies reported that age and sex could modify the association between body fat, abdominal fat and hypertension. In a cohort study conducted by Benetou et al. WC circumference seemed to be a more useful predictor of hypertension in men, whereas in women BMI was more useful. The study also showed that WC was the dominant predictor of hypertension among men aged 55 years and above [41]. Another study also reported that, at age of 45 years and below, WC is more important in predicting hypertension than BMI in both sexes, whereas beyond that age WC becomes more important for men and BMI for female [19]. Abdominal obesity tends to increase with age in both sexes, whereas generalized obesity shows different patterns of association with age between males and females [19]. There is evidence that women have slightly more subcutaneous fat and less visceral fat than men. Studies have shown that metabolic abnormalities have stronger associations with visceral fat than with subcutaneous fat and also, visceral fat measured by computed tomography has also been positively associated with higher prevalence of hypertension [42,43].

There was weak direct correlation between BMI and random blood sugar of the study participants ($r = 0.13$, $p= 0.039$). BMI has been shown to be a strong risk factor for the development of non-insulin dependent diabetes mellitus [44]. It has been suggested that free fatty acid (FFA) may be an important link between obesity, insulin resistance and type 2 DM [45]. The prevalence of diabetes is significantly lower among people who engage in vigorous physical activities for least 30 min per day. Defay et al. Reported in their study that, physically active subjects had substantially reduced the risk of diabetes and the risk remained significantly reduced after adjustment for age, BMI, WHR, cardiovascular disease and educational level [46]. Prospective epidemiological studies have shown that elevated FFA level is a risk factor for long term development of glucose intolerance and progression to type 2 DM [47].

5. STUDY LIMITATIONS

- We included a small-non-probability sample, which might have undermined the overall generalizability of the results.
- The design, a cross-sectional with built in problem in determining the causation.
- Using unknown with questionable reliability and validity data collection protocol.
- We carried out correlation based on a random blood sugar blood test; which contaminates the results even after adjustment.

6. CONCLUSION

This study has been able to demonstrate the close association between obesity and some NCDs, notably hypertension and diabetes mellitus. Mean BP levels increased significantly with increasing BMI categories. The risk of hypertension was higher among population groups with overweight and obesity. Gender had a significant influence on the development of obesity, elevated blood pressure and elevated blood sugar. Until such time that regular screening for common NCDs become feasible in developing countries, screening for obesity markers should be encouraged at every contact with healthcare provider.

There is the need to reverse the notion that obesity, hypertension and diabetes are the problems of the rich.

CONSENT

We declare that written informed consent was obtained from the participants for publication of this study.

ETHICAL APPROVAL

We hereby declare that the study protocol have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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