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# Indices of Metabolic Syndrome in 534 Apparently Healthy Nigerian Traders

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**Abstract: Background:** Metabolic Syndrome (MS) increases the risk of developing type-2 diabetes (DM2) and cardiovascular diseases (CVD) and it is thought to be prevalent in Nigeria. This study aims at determining the prevalence of MS and its component risk factors among apparently healthy traders in a local market in Ibadan, Nigeria. **Methods:** 534 apparently healthy traders from a local market in Bodija, Ibadan, Nigeria aged (18–105) years with neither DM2 nor CVD were participants of a cohort study on risk assessment of type 2 diabetes and dementia in Nigerians with metabolic syndrome. The International Diabetes Federation (2005) and the World Health Organisation (1998) criteria were used for MS and BMI respectively. Anthropometric indices (weight, height, body mass index (BMI), percentage body fat (PBF), waist and hip circumferences (WC & HC) and their ratio (WHR), waist circumference to height ratio (WHT)) and blood pressure (BP) were obtained by standard methods. Blood samples (6 ml) were obtained for the determination of glucose (FPG), total cholesterol (TC), triglycerides (TG), high density lipoprotein cholesterol (HDL-C) by enzymatic methods while low density lipoprotein cholesterol (LDL-C) was calculated. Descriptive statistics, Chi-square test and ANOVA were among the analyses conducted. **Results:** 301 (56.4%) of traders studied were overweight (176, 33.0%) or obese (125, 23.4%) while 17 (3.4%) and 125 (40.4%) were underweight and normal weight respectively. The prevalence of MS and obesity were 87 (16.3%) and 125 (23.4%) respectively. There was significant association between obesity and MS ($p < 0.05$). Both MS and obesity were significantly associated with gender ($p < 0.05$). The prevalence of MS and obesity was higher in female (20.9%; 31.0%) than male traders (6.5%; 7.1%) respectively. The prevalence of MS increased from normal weight (8.3%) to overweight (18.8%) to obesity (28.8%). There were significantly higher differences in age, BP(systolic and diastolic), weight, BMI, WC, HC, WHT, WHR, and PBF but lower difference in height when overweight/obese groups were compared with normal weight group ($p < 0.05$). TC and LDL-C were significantly higher in only obese than normal weight traders. However, FPG, TG and HDL-C were similar in all groups ($p > 0.05$). **Conclusion:** There is high prevalence of MS and obesity among Nigerian traders. Female gender, hypercholesterolemia, hypertension, increasing age, general and abdominal obesity appear to be important metabolic risk factors of CVD and not DM2 among Nigerian traders. Health care strategies for effective modulation of diet and lifestyle are needed urgently. In addition, screening programs for indices of MS in all Nigerians irrespective of BMI could be considered.

**Key words:** Metabolic syndrome, cardiovascular diseases, type 2 diabetes mellitus, dyslipidaemia, abdominal adiposity, body mass Index.

## 1. Introduction

Obesity is epidemic worldwide as a result of physical inactivity and adoption of poor nutritional habits [1, 2]. Obesity particularly its abdominal (visceral) component and insulin resistance are important twin components of metabolic syndrome (MS). Visceral adiposity has been reported as the most common cause of insulin resistance and a powerful aetiopathogenic factor for the development of type 2 diabetes mellitus (DM2) and accelerated atherogenesis [3]. MS is the concurrence of disturbed glucose and insulin metabolism, overweight and abdominal fat distribution, mild dyslipidaemia, and hypertension associated with subsequent development of DM2 and cardiovascular disease (CVD) [2, 4, 5]. The prevalence of metabolic syndrome has been reported globally and is thought to affect Nigerians [2, 6–9]. International Diabetes Federation (IDF) defined MS as waist circumference (WC) (> 90 cm for men; > 80 cm, women), triglycerides (TG) (> 150 mg/dL), high density lipoprotein cholesterol (HDL-C) (<40 mg/dL (men), < 45 mg/dL (women), blood pressure (BP) (> 135/80 mmHg), and fasting glucose (FG) (> 100 mg/dL) [7]. However, waist circumference does not adjust for body stature, and different waist circumference thresholds may be needed for different ethnic groups [10]. Zeno et al. [5] showed that current guidelines for MS including the IDF criteria were appropriate in excluding healthy individuals if diagnosis of metabolic syndrome was intended for early recognition of CVD risk and slowing CVD development. Ethnic differences in these guidelines were eliminated in their study when percentage body fat (PBF) was included as a criterion.

Adipose tissue (fat) is an endocrine organ made up of adipocytes, various stromal cells including many immune cells, and an endothelial network. It develops in several distinct anatomical depots within the body [11]. Both lean and obese adults have a wide range of body fat distribution and various fat depots have unique characteristics. Regional fat gain and loss appear influenced by strong genetic factors. Selective dysregulation of these depots probably plays an important role in the metabolic complications of obesity [12, 13]. Visceral fat distribution in obesity most strongly correlates with insulin resistance and cardiovascular disease in humans and animals [11, 12]. Conversely, subcutaneous fat distribution does not appear to have similar negative systemic consequences on metabolism. Dramatic loss of adipose tissue (lipodystrophy) on the other hand, triggers a high degree of insulin resistance as well as signs of other metabolic dysregulation that are similar to visceral fat [11].

Several approaches have been used to measure obesity [10]. Body mass index (BMI) is a measure of general adiposity while WC, waist-hip ratio (WHR) and waist-to-height ratio (WHT) are reliable proxy measures of abdominal fat [13, 14]. WHR and WHT provide a measure of abdominal obesity that adjusts for an individual's body shape [10]. These measures could be influenced by age, sex, ethnicity or the disease being studied [13, 14]. Variation in WC for a given BMI has been found to be a strong predictor of all cause mortality [10]. However, some studies indicate that measures of adiposity- BMI, WC, WHR, WHT are independently associated with cardiovascular and metabolic risk including DM2 [13, 14]. A combination therefore, of general adiposity and central adiposity has been recommended as both are independently related to the risk of death [10, 14].

This study was aimed at determining the prevalence of MS and its components among apparently healthy traders in a local market in Ibadan. This will provide novel approaches to preventing and managing non-communicable diseases.

## 2. Subjects and Methods

### *2.1 Study Design and Duration*

The study was a cross-sectional survey conducted over a period of 6 months after ethical approval was

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obtained from the Joint Ethical Committee of University of Ibadan/University College Hospital, Ibadan, Nigeria (UI/UCH).

*2.2 Subjects*

A total of 534 (170 males and 364 females) apparently healthy traders from a local market in Bodija, Ibadan aged 18–105 participated in this study after informed consent. This was in collaboration with leaders of their market association who were adequately informed about the study in their local language, Yoruba. They were among the 790 apparently healthy participants that enrolled in a cohort study on Risk Assessment of Type 2 diabetes mellitus and Dementia in Nigerians with Metabolic Syndrome. They were non-diabetic participants without cardiovascular events as assessed by physicians in the study and were not on any type of medication.

*2.3 Metabolic Syndrome*

International Diabetic Federation (IDF) criteria was used to classify participants (IDF criteria: abdominal obesity: waist circumference (WC) > 94 cm and at least two of the following: hypertriglyceridemia (plasma triglycerides (TG) > 150 mg/dl), low HDL-C (plasma HDL-C < 40 mg/dl), high blood pressure (blood pressure > 130/85 mmHg) and high fasting plasma glucose(FPG) (plasma glucose > 100 mg/dl) [15, 16 ].

*2.4 Classes of Obesity*

The recommendation of World Health Organisation for BMI classification [17] was used to group participants. Participants were grouped as underweight (< 18.5 kg/m$^2$; normal (18.5–24.9 kg/m$^2$), Overweight (25.0–29.9 kg/m$^2$); Obese (≥ 30.0 kg/m$^2$).

*2.5 Sample Collection*

6 ml of venous blood sample was aseptically obtained by venopuncture from the participants after an overnight fast (10–14 h). 4ml was dispensed into potassium ethylene diamine tetra acid ($K_3$EDTA) tube for the determination of lipid profile (total cholesterol (TC), TG, and HDL-C)). 2 ml was dispensed into fluoride oxalate tube for FPG estimation. All samples were centrifuged at 500 g for 5min after which plasma and serum were aspirated in small aliquots into clean vials and stored at -20$^o$C until analysis was done.

*2.6 Anthropometric Indices and Blood Pressure Measurements*

Weight, height, BMI, WC and hip circumference (HC), WHR and BP (systolic and diastolic) were obtained from the participants by standard methods as described elsewhere [18]. PBF was measured using Omron BF400 (Omron Healthcare. Co. Ltd, Ukyo-ku Kyoto, Japan). WHT was obtained by dividing waist circumference (cm) by height (m).

*2.7 Biochemical Indices in Blood*

Plasma TG, TC, HDL and FPG were estimated by enzymatic methods using commercial kits (Dialab Produktion, Austria) while LDL-C was calculated using Friedwald's formula [19].

*2.8 Statistical Analysis*

Data were analyzed using the Statistical Package for Social Sciences (SPSS) software 15.0 version. Analysis of Variance (ANOVA) and Post hoc tests were used for comparison of quantitative variables. Two-tailed independent t-test of significance at 95% confidence limit with $p < 0.05$ was considered significant for the variables. Chi-Square test ($X^2$) was used to find relationship between two qualitative variables.

## 3. Results

*3.1 Comparison of Age and Indices of Metabolic Syndrome in Groups Classified According to Body Mass Index*

Comparisons of age and indices of metabolic syndrome in underweight, normal weight, overweight and obese groups are shown in Tables 1–2. There were

consistent increases in all indices from underweight to obese groups except in height and HDL-C. There was reduction in height from normal weight to overweight and obesity while in HDLC, reduction was observed from overweight to obesity. These differences were significant except in FPG, TG and HDL-C ($p < 0.05$). There were significantly higher differences in age, BP(systolic and diastolic), weight, BMI, WC, HC, WHT, WHR, and PBF but lower difference in height when overweight/obese groups were compared with normal weight group ($p < 0.05$, Table 2). Only TC and LDL-C were significantly higher in obese group only compared with normal weight group. However, significantly higher differences were observed in weight, BMI, WC, HC, WHT, WHR, and PBF in obese group compared with overweight group as well as in normal weight compared with underweight ($p < 0.05$).

*3.2 Comparison of the Age and Indices of Metabolic Syndrome between Male and Female Traders*

Table 3 shows comparisons of age and indices of metabolic syndrome between male and female traders. There were significant differences in all indices except weight, FPG, TG and HDL when males were compared with females ($p < 0.05$). Age, BP (systolic and diastolic), BMI, WC, HC WHT, WHT, PBF, TC and LDL-C were significantly higher in females compared with males ($p < 0.05$). Only height was significantly higher in males than females ($p < 0.05$).

*3.3 Association of Metabolic Syndrome with Body Mass Index in Traders*

In traders, the prevalence of MS was 87 (16.3%) while that of obesity was 125 (23.4%) respectively. Only 216 (40.4%) of traders had normal weight (Table 4). Among the traders with MS, none was underweight 18 (8.3%) had normal weight, 33 (18.8%) were overweight while 36 (28.8%) were obese. There was significant association between MS and BMI in the traders ($p < 0.05$).

**Table1 Comparison of age and indices of metabolic syndrome in groups classified according to body mass index (ANOVA).**

| Group | Underweight | Normal weight | Overweight | Obese | Total | F | p |
|---|---|---|---|---|---|---|---|
| n | 17 | 216 | 176 | 125 | 534 | | |
| Age (years) | 39.71±15.64 | 41.67±13.89 | 44.80±12.19 | 47.12±09.83 | 43.91±12.72 | 5.949 | 0.001* |
| Systolic BP (mmHg) | 115.88±14.60 | 123.46±19.31 | 132.49±27.51 | 135.16±22.32 | 128.93±23.50 | 10.456 | 0.000* |
| Diastolic BP (mmHg) | 75.29±09.43 | 77.36±10.91 | 82.01±13.89 | 84.61±12.74 | 80.52±12.70 | 11.138 | 0.000* |
| Height (m) | 1.65±0.071 | 1.65±0.089 | 1.61±0.11 | 1.62±0.06 | 1.63±0.09 | 6.891 | 0.000* |
| Weight (kg) | 47.22±4.87 | 60.35±7.56 | 72.12±7.53 | 87.59±10.46 | 70.19±14.01 | 334.199 | 0.000* |
| BMI ($kg/m^2$) | 17.38±01.06 | 22.00±01.69 | 27.36±01.42 | 33.88±03.81 | 26.40±5.39 | 807.673 | 0.000* |
| Waist Circumference (cm) | 72.12±03.12 | 83.55±07.28 | 97.09±06.35 | 111.11±09.29 | 94.10±13.65 | 421.882 | 0.000* |
| Hip circumference (cm) | 84.76±03.73 | 93.35±05.97 | 104.13±05.74 | 115.05±07.46 | 101.71±10.94 | 371.697 | 0.000* |
| Waist: Height ratio | 43.82±01.67 | 50.72±04.99 | 60.77±11.07 | 68.80±05.85 | 58.05±10.77 | 175.141 | 0.000* |
| Waist:Hip ratio | 0.852±0.0489 | 0.895±0.0584 | 0.934±0.0594 | 0.967±0.0759 | 0.923±0.070 | 43.425 | 0.000* |
| Percentage body fat | 14.58±04.26 | 23.92±08.48 | 36.08±07.63 | 45.04±06.41 | 32.80±11.72 | 234.362 | 0.000* |
| Fasting plasma glucose (mg/dl) | 78.06±10.49 | 83.41±19.56 | 85.82±26.95 | 87.90±28.92 | 85.09±24.41 | 1.413 | 0.238 |
| Total cholesterol (mg/dl) | 127.47±39.19 | 141.06±41.88 | 146.00±40.56 | 151.13±38.06 | 144.60±40.69 | 2.709 | 0.045* |
| Triglyceride (mg/dl) | 58.29±18.13 | 64.44±32.21 | 66.49±42.81 | 70.68±28.58 | 66.37±31.31 | 1.438 | 0.231 |
| High density Lipoprotein Cholesterol (mg/dl) | 36.47±10.97 | 43.31±15.42 | 44.88±13.69 | 42.70±17.11 | 42.38±15.23 | 2.021 | 0.110 |
| Low density Lipoprotein Cholesterol (mg/dl) | 76.88±41.09 | 85.22±37.23 | 90.28±36.69 | 93.69±35.28 | 88.60±36.85 | 2.104 | 0.099 |

values in mean± n = no. of subjects, BP = blood pressure, * = significant, BMI = body mass index, p = probability, * = significant, F = F statistics

**Table 2 Comparison of age and indices of metabolic syndrome in pairs of groups classified according to body mass index (post hoc test).**

| Indices | Body Mass Index Group Pairs | p |
|---|---|---|
| Age (years) | normal weight vs overweight | 0.015* |
| | normal weight vs obese | 0.000* |
| Systolic blood pressure (mmHg) | normal weight vs overweight | 0.000* |
| | normal weight vs obese | 0.000* |
| Diastolic blood pressure (mmHg) | normal weight vs overweight | 0.000* |
| | normal weight vs obese | 0.000* |
| Height (m) | normal weight vs overweight | 0.000* |
| | normal weight vs obese | 0.001* |
| Weight (kg) | normal weight vs underweight | 0.000* |
| | normal weight vs overweight | 0.000* |
| | normal weight vs obese | 0.000* |
| | overweight vs obese | 0.000* |
| Body mass index (kg/m$^2$) | normal weight vs underweight | 0.000* |
| | normal weight vs overweight | 0.000* |
| | normal weight vs obese | 0.000* |
| | overweight vs obese | 0.000* |
| Waist circumference (cm) | normal weight vs underweight | 0.000* |
| | normal weight vs overweight | 0.000* |
| | normal weight vs obese | 0.000* |
| | overweight vs obese | 0.000* |
| Hip circumference (cm) | normal weight vs underweight | 0.000* |
| | normal weight vs overweight | 0.000* |
| | normal weight vs obese | 0.000* |
| | overweight vs obese | 0.000* |
| Waist:height ratio | normal weight vs underweight | 0.000* |
| | normal weight vs over weight | 0.000* |
| | normal weight vs obese | 0.000* |
| | overweight vs obese | 0.000* |
| Waist:hip ratio | normal weight vs underweight | 0.007* |
| | normal weight vs over weight | 0.000* |
| | normal weight vs obese | 0.000* |
| | overweight vs obese | 0.000* |
| Percentage body fat | normal weight vs underweight | 0.000* |
| | normal weight vs over weight | 0.000* |
| | normal weight vs obese | 0.000* |
| | overweight vs obese | 0.000* |
| Total cholesterol | normal weight vs obese | 0.028* |
| Low density lipoprotein cholesterol | normal weight vs obese | 0.041* |

p = probability, * = significant

**Table 3 Comparison of age and indices of metabolic syndrome between male and female traders (t-test).**

| Group | Males | Females | t | p |
|---|---|---|---|---|
| n | 170 | 364 | | |
| Age (yrs) | 40.24±13.46 | 45.63±11.10 | -4.647 | 0.000* |
| Systolic BP | 121.91±17.64 | 132.21±25.14 | -4.816 | 0.000* |
| Diastolic BP | 78.18±10.94 | 81.62±13.32 | -2.940 | 0.003* |
| Height (m) | 1.71±0.069 | 1.59±0.079 | 15.872 | 0.000* |
| Weight (kg) | 69.14±12.44 | 70.68±14.67 | -1.180 | 0.239 |
| BMI(kg/m$^2$) | 23.94±04.76 | 27.55±05.30 | -7.564 | 0.000* |
| Waist Circumference(cm) | 87.35±11.77 | 97.24±13.34 | -8.282 | 0.000* |
| Hip circumference(cm) | 95.46±08.30 | 104.62±10.82 | -9.778 | 0.000* |
| Waist: Height Ratio | 51.20±06.79 | 61.25±10.81 | -11.137 | 0.000* |
| Waist: Hip Ratio | 0.913±0.0656 | 0.928±0.0717 | -2.382 | 0.018* |
| Percentage body fat | 19.70±06.14 | 38.94±08.12 | -27.271 | 0.000* |
| Fasting plasma glucose (mg/dl) | 83.11±15.33 | 86.01±27.61 | -1.275 | 0.203 |
| Total cholesterol(mg/dl) | 138.03±38.91 | 147.68±41.19 | -2.565 | 0.011* |
| Triglyceride(mg/dl) | 68.09±32.05 | 65.57±30.97 | .865 | 0.387 |
| High density lipoprotein(mg/dl) | 40.54±13.72 | 43.25±15.83 | -1.920 | 0.055 |
| Low density lipoprotein Cholesterol(mg/dl) | 83.48±34.36 | 90.99±37.76 | -2.202 | 0.028* |

values in mean ± s.d, BP = blood pressure, n = number of participants, * = significant, t = t- test, p = probablity

### *3.4 Association of Metabolic Syndrome and Body Mass Index with Gender in Traders*

11(6.5%) of male traders and 76 (20.9%) of female traders had metabolic syndrome. 107 (62.9%) and 109 (29.9%) of males and females respectively had normal weight. Gender was significantly associated with BMI and MS ($p < 0.05$) (Table 4).

## 4. Discussion

MS predisposes individuals to increased risk for developing DM2 and CVD [2]. The prevalence of MS in traders in our study was 16.3%. MS was higher in female (20.9%) than male traders (6.5%). Our findings confirm other reports from different parts of Nigeria with 12.1–30.8% of Nigerians with MS [9, 18, 20, 21].

**Table 4 Association of gender with body mass index and metabolic syndrome in traders (Chi-Squared test).**

| | **Male** | **Female** | **Total** | **$X^2$** | **p** |
|---|---|---|---|---|---|
| | n = 170 | n = 364 | n = 534 | | |
| **Metabolic Syndrome** | | | | | |
| Without Metabolic Syndrome | 159 (93.5%) | 288 (79.1%) | 447 (83.7%) | 17.640 | 0.000** |
| With Metabolic Syndrome | 11 (6.5%) | 76 (20.9%) | 87 (16.3%) | | |
| **Body Mass Index** | | | | | |
| Underweight | 5 (2.9%) | 12 (3.3%) | 17 (3.2%) | 62.350 | 0.000* |
| Normal weight | 107 (62.9%) | 109 (29.9%) | 216 (40.4%) | | |
| Overweight | 46 (27.1%) | 130 (35.7%) | 176 (33.0%) | | |
| Obese | 12 (7.1%) | 113 (31.0%) | 125 (23.4%) | | |

values are in no of traders with percentages in parenthesis, $X^2$ = chi-squared test, p = probability, * = significant, n = total number of traders.

**Table 5 Association of metabolic syndrome with body mass index in traders (Chi-Squared test).**

| Body Mass Index Groups | Non- Metabolic Syndrome | Metabolic Syndrome | n | $X^2$ | p |
|---|---|---|---|---|---|
| Underweight | 17 (100.0%) | 0 (0%) | 17 | 28.460 | 0.000* |
| Normal Weight | 198 (91.7%) | 18 (8.3%) | 216 | | |
| Over Weight | 143 (81.3%) | 33 (18.8%) | 176 | | |
| Obese | 89 (71.2%) | 36 (28.8%) | 125 | | |

values are in no of traders with percentages in parenthesis, $X^2$ = chi-squared test, p = probability, * = significant, n = total number of traders

Obesity was observed in 23.4% of traders with higher prevalence in females (31.0%) than males (7.1%) in our study. All adiposity measures- PBF, BMI for general adiposity, WC, WHT and WHR for central adiposity and HC for subcutaneous adiposity were higher in traders with obesity than normal weight. These adiposity measures were also higher in females than males ($p < 0.05$) (Table 4). Our findings were similar to earlier studies conducted in Katsina, Northern Nigeria with prevalence of 21%, which was associated independently with female sex and hypercholesterolemia [20]. Higher levels of cholesterol -TC and LDL-C were observed in obese compared with normal weight traders as well as in females compared with males in our study. Increases observed in all measures of adiposity in overweight traders also (with prevalence of 33.0%) compared with normal weight traders in our study suggest that most of the traders (56.4%) are at risk of CVD. There is therefore an urgent need for early diagnosis of MS as well as modulation diet and lifestyles to prevent the burden of non-communicable diseases [20] especially in Nigerians who are blacks with known higher prevalence of metabolic diseases than Caucasians [5].

In the midst of overweight and obesity, there were a few underweight traders showing a combination of plenty and lack in same environment. Our study showed the prevalence of underweight was 3.2%. Again, the prevalence was higher in females (3.3%) than males (2.9%). Contrary to our findings in overweight and obese traders, measures of adiposity were significantly reduced in underweight compared with normal weight. Loss of adipose tissue was associated with metabolic dysregulation similar to visceral fat [11].

HC measures subcutaneous adipose tissue [22]. Large HC after adjusting for WC and BMI is protective for metabolic risk factors in Caucasians [11, 23]. Contrarily, we observed reduced HC in underweight compared with normal weight traders and higher HC in overweight and obese traders than traders with normal weight ($p < 0.05$). Again HC of females was higher than that of males. It appears that increased HC is a risk factor rather than protective factor in Nigerians. Studies have shown that adiposity and metabolic risk factors vary across ethnicities [13, 23].

We observed an association between obesity and MS. Both MS and obesity were associated with gender ($p < 0.05$) (Tables 4–5). The prevalence of MS increased from normal weight (8.3%) to overweight (18.8%) to obesity (28.8%) in our study suggesting that these traders were at increased risk of developing CVD. This observation is similar to study among Emirati overweight and obese adults with 40% prevalence of metabolic syndrome [2]. Studies have reported the absence of metabolic abnormalities in some obese individuals with excess body fat [24, 25]. On the other hand, some moderately overweight individuals are characterized by a whole cluster of atherogenic and diabetogenic metabolic abnormalities [24]. It is thought that metabolic complications of overweight and obesity are more related to the location of body fat rather than to the amount of total body fat. Individuals with excess intra-abdominal or visceral adipose tissue have metabolic abnormalities and are at increased risk of DM2 or CVD. Moreover, WC has been reported as a

crude measure of visceral adipose tissue and does not discriminate intra-abdominal from subcutaneous abdominal adiposity [25].

However, increases in all measures of adiposity with increasing BMI in this study indicate that all measures of adiposity might be important risk factors for metabolic diseases in Nigerians. This is in agreement with recommendations from four cohort studies in the United Kingdom and study of adults of the Kiel Obesity Prevention Study– Family Study [26, 27]. Similarly, Knowles et al. [28] showed correlations of measures of adiposity with cardiovascular risk with no single adiposity measure best predicting MS.

FPG, TG and HDL-C were significantly indifferent between all groups tested as well as between males and females ($p > 0.05$). This suggests that obesity in the traders may not relate to DM2. The development of type 2 diabetes in subjects with excess adipose tissue mass is currently believed to be related to many factors including genetic predisposition and ethnicity [29]. Previous studies in the same geographical sub-region as ours showed that DM2 and hyperlipidaemia were relatively uncommon in the population. However, they observed 23–30% of their population with hypertension [30, 31]. We observed significantly higher BP in overweight and obese groups compared with normal weight group as well as in females compared with males. Significantly higher difference was observed in age of overweight and obese traders compared with normal weight traders ($p < 0.05$). This might be due to reduced physical inactivity with increasing age which is a cultural norm. Sodjinou et al. [31] (in Benin, West Africa) reported that out of the single lifestyle factors in their study, physical activity was the most strongly associated with several CVD risk factors.

In conclusion, we observed high prevalence of MS and obesity in Nigerian traders with significant association. The prevalence of both MS and obesity was higher in females than males. The association of MS and obesity with gender was significant. However, MS was prevalent in Nigerians with normal weight, overweight and obesity. The prevalence increased with increase in BMI. All measures of adiposity were significantly higher in overweight and obese groups but lower in underweight group compared with normal weight group. The presence of under-nutrition in combination with high prevalence of obesity is an indication to urgently develop specific programmes that will enlighten various segments of society for effective modulation of diet and lifestyle. In addition, screening programs for indices of MS in all Nigerians irrespective of BMI could be considered. This will assist in preventing the development of metabolic diseases.

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