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Original Research Article

Prevalence of Metabolic Syndrome among Igbos in Enugu Metropolis

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Abstract

Background: Metabolic syndrome refers to the co-occurrence of several known cardiovascular risk factors, including insulin resistance, obesity, atherogenic dyslipidemia and hypertension. It is usually associated with abdominal obesity and is implicated in the development of diabetes mellitus, cardiovascular diseases and various cancers. ***Objectives***: This study aimed at establishing the prevalence of metabolic syndrome in Enugu metropolis. ***Method***: This was a cross-sectional community-based descriptive survey carried out in Enugu Metropolis involving 469 apparently healthy adult volunteers age range 18-75 screened for metabolic syndrome using the joint interim statement (JIS) definition. Stratified random sampling technique was used in the selection of participants in this cross-sectional study. Ethical approval was obtained from the Ethical Committee of Enugu State University Teaching Hospital, in accordance with the declaration of Helsinki. The data obtained were coded and analyzed into frequencies, percentages and mean using the Statistical Package for Social Sciences (SPSS) version 23. Chi-square (x) test was used to compare categorical variables for associations while multi-nominal logistic regression was used to examine correlates. Statistical significance is set at $p<0.05$ and 95% confidence interval. ***Result***: The study shows 16.4% prevalence in the study population with higher female prevalence (Female=23%; Male=8%). Increase in prevalence with age was also noted (1.98%=18-30year; 22.73% = 31-50year; 57.14% =51-75year). ***Conclusion*:** Metabolic syndrome is already a health challenge in Enugu and life style modification should be encouraged in our clinics on or before the age of 30.

Keywords: Metabolic syndrome, Igbos, Enugu, Obesity, Insulin Resistance.

INTRODUCTION

Metabolic syndrome is a constellation of interrelated abnormalities including obesity (central and general), dyslipidaemia, hyperglycaemia, and hypertension that increase the risk for cardiovascular disease and progression to type 2 diabetes [1]. The prevalence of metabolic syndrome increases with increase in obesity especially with android obesity and with increase in age [2], as such more increase in prevalence is to be expected as longevity increases globally. Metabolic syndrome sometimes known by other names such as metabolic syndrome X, cardiometabolic syndrome, syndrome X, insulin resistance syndrome, Reaven's syndrome (named for Gerald Reaven), and CHAOS (in Australia) [3], is a clustering of at least three of the five following medical conditions: abdominal obesity, high blood pressure, high blood sugar, high serum triglycerides and low high-density lipoprotein (HDL) levels [4], and the prevalence of metabolic syndrome in a given population depends on the definition used as there are various definitions which use different criteria with some emphasizing obesity and others insulin resistance [5].

Pathophysiology of metabolic syndrome is multifactorial ranging from sedentary lifestyle and excessive eating which engenders obesity, dyslipidemia and hypertension but the common final pathway is insulin resistance which is why the metabolic syndrome

is also known as the insulin resistance syndrome. Insulin resistance has been defined as a defect in insulin action that results in hyperinsulinemia, necessary to maintain euglycemia [6]. The concept of insulin resistance provides a conceptual framework with which to place a substantial number of apparently unrelated biological events into a pathophysiological construct and help us to visualize in the detail the vital role of insulin in the energy homeostasis of the body while standing alone against host of other hormones such as glucagon, epinephrine and glucocorticoids [7].

The interconnection between obesity and the pathophysiology of metabolic syndrome can also be better appreciated by understanding the endocrine functions of adipose tissues which hitherto was considered a dormant energy store. Recent studies have shown that Adipose tissue secretes bioactive peptides, termed 'adipokines', which act locally and distally through autocrine, paracrine and endocrine effects [8]. In obesity, increased production of most adipokines impacts on multiple functions such as appetite and energy balance, immunity, insulin sensitivity, angiogenesis, blood pressure, lipid metabolism and haemostasis, all of which are linked with cardiovascular disease. The imbalance in these adipokines is involved in the development of obesity-related insulin resistance [9], nevertheless; the relationship of obesity and metabolic syndrome is well established in the literature and this is even worse with abdominal or central obesity as visceral fats are more metabolically active releasing adipokines and other adipose tissue hormones [10, 11], and this abdominal obesity is best measured by indices of central obesity viz: waist height ratio (WHtR), waist hip ratio (WHR) and waist circumference (WC) [12], the advantage of central obesity indices in detecting obesity is spectacularly demonstrated in those with normal weight by BMI but are centrally obese so-called 'normal weight central obesity' [13], that are most likely be have metabolic syndrome or at increased risk of it without intervention. Therefore, one would expect the prevalence of metabolic syndrome to mirror that of obesity and this should be a cause for concern as obesity prevalence in Enugu is already significant ranging from 19.7% to 47.7% [14].

Expectedly, the prevalence of metabolic syndrome is on the increase globally but varies from low-income countries to high-income countries being higher in the latter [15, 16], and worse in the overweight and obese subjects [16,17]. Prevalence is also noted to increase with age in most studies [16-19], and the prevalence also varies with the definition used in determining it. A study by Ford *et al.*, [20] showed prevalence of the metabolic syndrome was 23.1% in NHANES III and 26.7% in NHANES 1999–2000 (P = 0.043), with the age-adjusted prevalences at 24.1% and 27.0% (P = 0.088), respectively, and the age-adjusted prevalence was noted to be higher in women in that study. Ford and Giles., [21] in 2003 also found different prevalence rates of metabolic syndrome which was 23.9% using the ATP III definition and 25.1% using the WHO definition; they also noted that this difference in prevalence was more substantial in the subgroups for example in the African-American men where it was 24.9%, by the WHO definition was 24.9%, compared with 16.5%. By NCEP ATP III definition.

Ethnic differences are also observed in the metabolic syndrome prevalence in the same environment. In a study carried out by Aguilar *et al.*, [22], in the united states between 2003 and 2012, the overall prevalence of the metabolic syndrome in the United States was found to be 33% (95% CI, 32.5%-33.5%), but when stratified by race/ethnicity, the highest prevalence of the metabolic syndrome was seen in Hispanics (35.4%; 95% CI, 34.2%- 36.6%), followed by non-Hispanic whites (33.4%; 95% CI, 32.6%-34.2%) and blacks (32.7%; 95% CI, 31.5%-33.9%). They also found significantly higher prevalence in women compared with men (35.6% vs 30.3%, respectively, P < .001). Similarly, another study by Ervin [23], in the United States found an overall metabolic syndrome prevalence of 34% with statistically significant ethnic difference which was 37% prevalence in non-Hispanic white males compare to 25% prevalence in black males. They also noticed increased prevalence with age but no significant difference in prevalence between the sexes. Conflicting results were found in the gender variation of metabolic syndrome prevalence and these ranges from no difference in prevalence, difference only in the elderly group to greater male prevalence while majority reported greater female prevalence [23-29].

No global data on metabolic syndrome exists unlike obesity and type II diabetes however, since metabolic syndrome is thrice commoner than type II diabetes, the global prevalence can be estimated to be present in 25% of the global population [30]. This finding is in consonance with the finding in a systematic review and meta-analysis of metabolic syndrome involving 27 studies and 45811 study participants by Belete *et al.*, [31]. Prevalence varies across the countries but generally increased prevalence is recorded in every country in last decade. Metabolic syndrome prevalence of 14.39% was found in study of a Chinese population in 2018 by Lan *et al.*, [32], the study also found higher male prevalence (7.78%, 95% CI: 6.93–8.63%) compare to female (6.76%, 95% CI: 6.10–7.42%) and these findings are not static as previous studies have shown gradual rise in prevalence over the years such as 9.8% in 2005 [33], and 10.5% in 2009 [34]. A prevalence of 19.52% was found in India in 2011 by Sawant *et al.*, [28], while in Saudi Arabia prevalence was 39.8% in 2018 with greater male prevalence compare to female (34.4% in men and 29.2% in women) and 31.6% (45.0% in men and 35.4% in women) using NCEP ATP III and IDF criteria [35]. Similarly, in Brazil, prevalence was found to be 29.6%

with worst prevalence (65.3%) among the indigenous population and lowest prevalence of (14.9%) in the rural area [36], whereas prevalence was 30.7% among the Black population of Cape Town, South Africa [37]. In Nigeria prevalence ranges from 12.1% to 35.1% depending on the region surveyed and definition used [29-39]

This study aimed to determine the prevalence of metabolic syndrome among Igbos living in Enugu metropolis.

MATERIALS AND METHOD

This was a cross-sectional community-based descriptive survey carried out in Enugu Metropolis. Enugu is the former capital of the defunct Eastern region which presently comprises of the five states of the southeast Nigeria and the current capital of Enugu state. People from all Igbo-speaking states are adequately represented. Its population according to 2006 population census is 722,664 [40].

The sample size was determined using Fisher's formula; $n=Z^2Pq/d^2$ where $q=(1-P)$ [41, 42].

The calculated sample size was 384, however, 469 participants were recruited to make up for cases of attrition. A stratified random sampling technique was used in the selection of this cross-sectional study. In this study, 469 apparently healthy subjects with no physical deformity were selected in this study. The cohort consisted of 205 males and 264 females with age range 18-75 years from different parts of Enugu Metropolis using stratified random sampling technique. Ethical approval was obtained from the Ethical Committee of Enugu state university teaching hospital, in accordance with the declaration of Helsinki. The nature of the study was explained to the participants before obtaining a verbal informed consent and only those who volunteered took part in the study and data collected during the study was kept confidential.

Participants were of Igbo ethnic nationality and resident of Enugu Metropolis for at least one year. Authentication of ethnicity was by patient admittance and name. The age range under study was between 18 - 75 years. Physically challenged persons, pregnant women, those with clinical evidence of ascites; or abdominal mass, malignancy, acute cerebrovascular accident and those outside the age range were excluded from the study. The data for the study was collected from all parts of Enugu metropolis. Enugu is a cosmopolitan city with good representation of Igbos from all Igbo-speaking states. A brief medical assessment was carried out on each participant followed by anthropometric measurements, venous blood collection from the antecubital vein and blood pressure checked. The main findings were filled into the study questionnaire. Clinical data collection (by interviewer administered questionnaire) and measurements was carried out as provided in the WHO STEPS instrument on surveillance of behavioral risk factors (version 2). All the measurements were conducted in strict privacy where the participants were neither heard nor seen by other people.

Oral Informed consent was also obtained from the participants before their inclusion into the study using consent form. In this case, the nature of the study was explained to the participants in the language they understood. Anthropometric measurements were collected directly and with the help of trained research nurses and students.

Anthropometric Measurements

Waist Circumference

The subject was lightly dressed while standing erect. He/she was asked to roll up the shirt/sweater, to undo the belt and/or open and lower the trouser/skirt waistband, so that the hip area is identified as the measurement reference points. The measure was taken at the midpoint between the lowest rib and the iliac crest. The measuring tape was placed perpendicular to the long axis of the body and horizontal to the floor, with sufficient tension to avoid slipping off but without compressing the skin. The measurement is made at the end of a normal expiration to the nearest 0.1cm [43].

HIP CIRCUMFERENCE

Hip circumference was measured at the widest point of the buttocks. Standard tailor measuring tape, maximum length 150 cm was used for hip measurement. The subject stands erect, the weight evenly distributed on both feet. The tape was placed at the maximum extension of the buttocks (usually at the level of the greater trochanter) horizontal to the floor, with sufficient tension to avoid slipping off. The tape was held a bit tighter but without compressing the buttocks. The zero end of the tape was held under the measurement value recorded to the nearest 0.1cm [43].

Height

Participant height was measured with a rigid tape stadiometer ((SECA: Model Seca culta 786 Mechanical Column Scale with Large Round Dial. Hamburg Germany), in accordance to the World Health Organization (WHO) multinational monitoring of trends and determinants in cardiovascular disease criteria. To measure height the participants were asked to take off their shoes (and with heels together, toes apart, ensuring that weight is evenly distributed on both feet) hat or head ties, stand with back to the tape measure, and hold their head in a position where he/she can look straight at a spot head high on the opposite wall. A flat rule was placed on the participant's head, so that their hair (if present) was pressed flat. Height was measured to the nearest centimeter, at the level where the flat rule touches the rigid rule [43].

WAIST-HIP RATIO

Waist–hip ratio or waist-to-hip ratio (WHR) is the ratio of the circumference of the waist to that of the hip. This was calculated as waist measurement divided by hip measurement (W ÷ H).

WAIST-HEIGHT RATIO

Waist-to-height ratio (WHtR) is the ratio of the circumference of the waist to that of the height

Blood Pressure Measurement

Blood pressure was measured using beurer [BM 28] automatic blood pressure monitoring kit. Prior to the measurement, the participant was seated and rested for 5 minutes in sitting position on a chair that supported the back comfortably. The left arm muscles were relaxed and the forearm supported with the cubital fossa at the heart level. A cuff of suitable size was applied evenly to the exposed arm with care taken not make it too tight by sliding a finger freely between the cuff and the skin.

Blood Sample Collection

The participants were fasted for at least 12h before blood collection. They were rested for at least 10min in a quiet room before taking a sample. A 5ml sample was collected from each participant from an antecubital vein from 8:00a.m.-10:00a.m. in the morning, stored in fluoride and plain bottles and sent to the laboratory for analysis.

The presence of metabolic syndrome was determined using abdominal obesity, hyperglycemia and dyslipidemia according to the joint IDF/NHLBI/AHA criteria and a participant is considered to have metabolic syndrome if he/she has three out of the following five criteria: Central adiposity (Population- and country-specific definitions) plus two or more of the following four factors: 1) raised concentration of triglycerides: ≥150 mg/dl (1.7 mmol/l) or specific treatment for this lipid abnormality; 2) reduced concentration of HDL cholesterol: <40 mg/dl (1.03 mmol/l) in men and <50 mg/dl (1.29 mmol/l) in women or specific treatment for this lipid abnormality; 3) raised blood pressure: systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg or treatment of previously diagnosed hypertension; and 4) raised fasting plasma glucose concentration ≥100 mg/dl (5.6 mmol/l) or previously diagnosed type 2 diabetes [44].

Cut-off points of the anthropometric indices were as defined by the World Health Organization (WHO): central adiposity as WC ≥ 94 cm for men and ≥80 cm for women, WHR of ≥0.90 in men and ≥0.85 in women and WHtR as >0.5 in both genders [45-48].

Data Analysis

The data obtained was coded and analysed into frequencies, percentages and mean using the Statistical Package for Social Sciences (SPSS), version 23. Chi-square (x) test was used to compare categorical variables for associations while multi-nominal logistic regression was used to examine correlates. Statistical significance was set at $p< 0.05$ and 95% confidence interval.

RESULT

This is the data presentation, analysis, and interpretation of various parameters measured and has been summarized in the tables and figures below.

Table 1: Distribution of participants by gender

Male	Female	Total
205(43.7%)	264(56.3%)	469 (100%)

This shows the distribution of participants by gender. Fewer males (205) participated in the study compare to 264 females that took part in the study

Table 2: Distribution of participants by age range and sex

	Male No (%)	Female No (%)	Total No (%)
18-30 years	163 (53.4)	142 (46.6)	305 (100)
31- 50 years	19 (28.8)	47 (71.2)	66 (100)
51 – 72 years	24(24.5)	74 (75.5)	98 (100)

Most of the participants (305 or 65%) in the study population were from 18-30years age group while the most productive age group (31-50year) recorded the least participation with only 66 or 14% of the participants. Note also that more female participants were recorded in all the age groups except in the young age group.

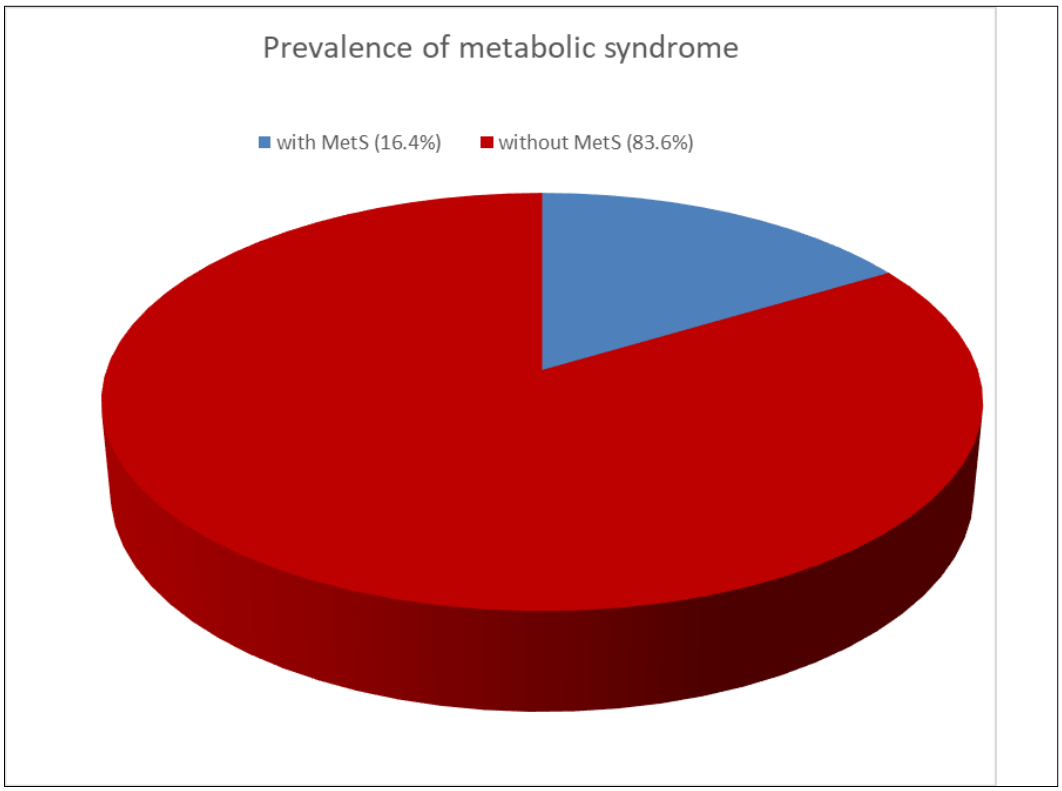

Fig. 1: Pie chart showing the prevalence of metabolic syndrome in the study population.

It shows that 16.4% of the study population met the criteria for metabolic syndrome while 83.6% are free of the condition.

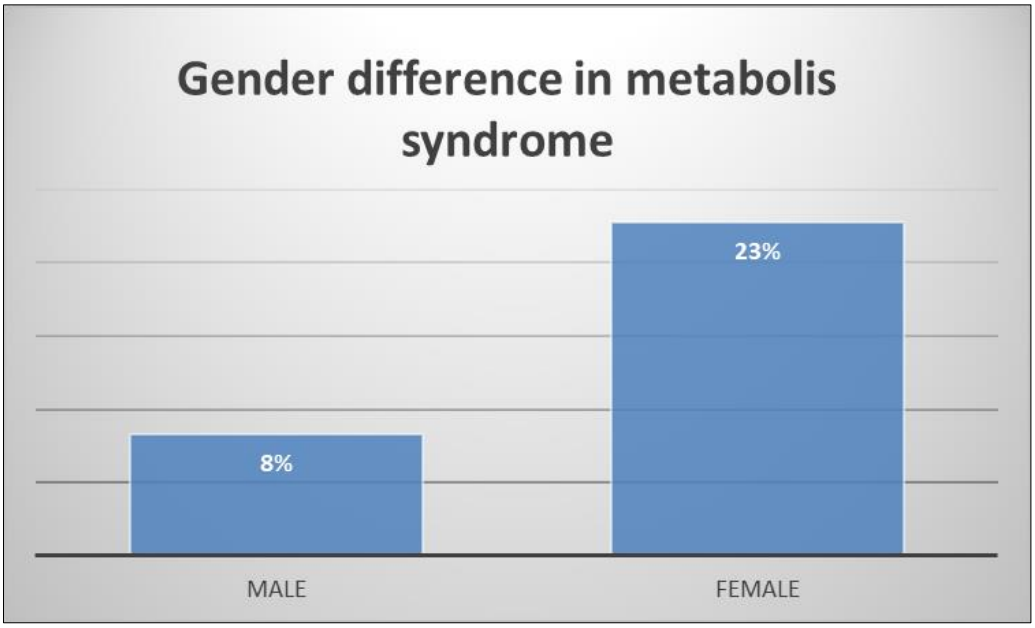

Fig. 2: Bar chart showing metabolic syndrome among the genders

This shows that there is significantly (X^2=17.521, p<0.001) higher prevalence of metabolic syndrome among the female gender (23%) compare to the male gender (8%) in the study population.

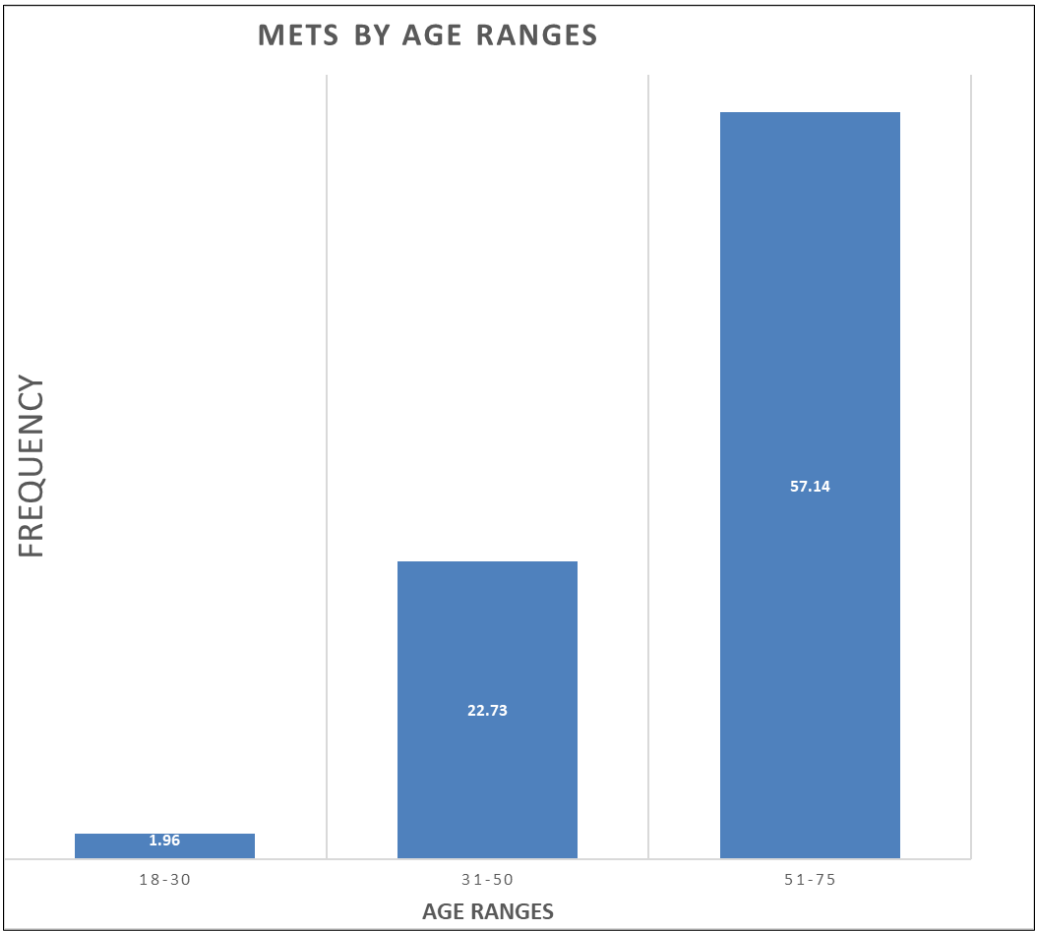

Fig. 3: Pie chart showing metabolic prevalence among the age groups

It shows that just 1.98% of those in the 18–30-year age group while 22.73% in the middle age group have the condition compare to 57.14% in the elderly that met the condition for metabolic syndrome. This proves that metabolic syndrome increases with age and is significantly (X^2=168.1027, p<0.001) higher in the elderly group compare to the young and middle age groups.

DISCUSSION

This study was undertaken to determine the prevalence of metabolic syndrome in Enugu Metropolis which was hitherto not available in the literature. Joint interim statement definition was used to determine metabolic syndrome. We recruited 469 apparently healthy subjects ((205 –Male 43.7%; 264-Female 56.3%)) drawn from the age range 18-75years which was further divided into three age groups. The greater participation of females in the study could be explained by the anthropological characteristics of the traditional Igbo society like most other societies around the world where illness behavior is considered effeminate until an illness becomes so severe that it cannot be further ignored [14].

When the distribution of the participants by age range and gender was considered, it was discovered that young age group 18-30years recorded the greatest participation (305 or 65.0%) followed by the elderly age group 51-75years (98 or 21.0%) while the middle age group 31-50years (66 or 14.0%) had the least number of participants and this could be to this group being the most economically engaged group and are bound to be in their various places of work. The greater involvement of the first and last group is most likely due to availability of participants from these groups; most of the participants in the first groups (18-30years) were mostly students or unemployed young adults while the last age group (51-75years) were retirees or managers of businesses that provide them with time for healthcare attention. It was also noted predictably that more female participation was seen the middle age and elderly age groups whilst more male participation was noted in the young age group and this may be due to the propensity of young adults to want to gauge their manliness by assessing their anthropologic parameters such those used in this study.

The overall metabolic syndrome prevalence in this study was 16.4% using the joint interim statement definition which encompasses components from other definitions; this however, could differ if other definitions of Metabolic Syndrome were used as the prevalence of Metabolic syndrome vary with definition used, as shown in a study by Cameron *et al*., [48], in which IDF

definition gave the highest prevalence of 30.7% with EGIR scoring the lowest 13.4%; while prevalence of the Metabolic Syndrome using the ATPIII and WHO definitions were 22.1% and 21.7% respectively in the same study. Furthermore, Ford and Giles., (2003) [21], reported prevalence rates of 16.5% and 24.9% respectively using ATP III and WHO definitions in a study carried out among African- American men which are somewhat greater than the 16.4% obtained in this study.

Metabolic syndrome prevalence rate of 27.2% obtained in southern Spain by Gavrila *et al*., (2011) [49], which is a mediterranean nation with mediterranean-diet culture is higher than that obtained in this study and could be due to higher obesity prevalence in Spain which is also a high-income country. In the US, a prevalence rate of 34.7% was obtained by Hirode and Wong (2020) [50], in a literature update of 2011- 2016, here again greater obesity in a more affluent, high-income US could be responsible for the higher prevalence of metabolic syndrome compare to one obtained in this study. Prevalence of 33%, 20.0-22.5%, 30.7% seen in Brazil, Germany and south Africa [37-52], was higher than obtained in our study, comparable to the prevalence of 14.6%-21.1% and 16.5% obtained in France and China [53, 54], but higher than the prevalence of 11.2% and 13.6% obtained in southern India and Mexico 11.2% [55, 56].

Gender distribution of metabolic syndrome prevalence showed a significantly ($X2=17.521$, $p<0.001$) higher female prevalence at 23.0% compare to 8% in the male. This finding is in consonance with the findings in previous studies by different researchers. This trend was noticed in the study by Adedoyin *et al*., in 2013 [29], which gave male prevalence of 9.3% and a much higher female prevalence of 43.7%. Though the prevalence obtained in this study showed greater female prevalence, this is still somewhat lower than what was obtained by Beigh and Jain in 2012[24], which is at 29% and 23% for the female and male prevalences respectively. Similar trend was also seen in Saudi Arabia in a study by Al-Nozha *et al*., (2005) [56], with male and female prevalence of 37.2% and 42% respectively. In comparison, another study in the United States of America by Aguilar *et al*., [22], again shows a greater female prevalence (35.6%) compare to (30.3%) in male with overall prevalence of 30.3%; these high male prevalence in the Saudi Arabia and United States might be due the high socioeconomic status of the two countries and more sedentary life-style compared to Nigeria. Similar survey in China by Lu *et al*., [57], showed overall prevalence of 33.9% with yet again greater female prevalence (31.0% in men and 36.8% in women), this prevalence though higher is comparable in trend with the result of this study.

Though most of the studies in the literature reported greater female prevalence of metabolic syndrome however, some showed no significant difference between male and female prevalence such example is in a study from Kuwait by Al Rashdan and Al Nesef [58], which shows prevalence comparable to those found in Saudi Arabia and the US but with no significant gender difference in prevalence (Men = 36.2%; Women = 36.1%.). The high prevalence of Metabolic Syndrome in these affluent societies is most likely due to abundant high calorie food and sedentary lifestyle owing to the favorable economic situation and prosperity that guarantee easy access to food. Other studies showed reversal of the female/male trend where male prevalence is greater than female prevalence as seen in a study by Lan *et al*., [32], in a Chinese population with higher male prevalence (7.78%) compare to female (6.76%), Al-Rubeaan *et al*., [35], in Saudi Arabia (34.4% in men and 29.2% in women) and (45.0% in men and 35.4% in women) using IDF and NCEP ATP III criteria; Adegoke *et al*., [59], in Nigeria with males and females prevalences of 12.7% and 11.8%, respectively and 42% in male and 24% in female adolescents in Iran [60].

Age-range distribution of metabolic syndrome in this study showed rise in prevalence with age in the study population, the young age group (18-30years) reported the least prevalence of about 2% despite constituting the greatest participating population (65% of the study population) followed by middle age group(31-50years) with a prevalence of 22.73% more than ten-fold increase of young age group prevalence and the elderly age group(51-75years) giving a prevalence of 57.14% which is more than twenty eight-fold increase of the young age prevalence and more than double the middle age group prevalence, clearly demonstrating significant ($X^2=168.1027$, $p<0.001$) rise in prevalence with age. This finding is similar to the result recorded in almost all previous studies that sought to find the impact of increasing age on metabolic syndrome prevalence; Kuzuya *et al*., [61], in 2007, Razzouk and Muntner., [62] in 2009, Fulop *et al*., [63], in 2006 and more recently by Gui *et al*., in 2023 and Föhr *et al*., in 2024 [64, 65]. The rapid rise in prevalence with age is due to increase in obesity especially central obesity with age which results in increase insulin resistance leading to deranged glucose metabolism, atherogenic dyslipidemia and deranged neurohormonal activation that leads to decreased vascular reactivity and increased blood pressure. The rapid rise in metabolic prevalence especially the ten-fold rise in prevalence between the first two age groups means that preventive strategies can be brought to bear earlier in life to slow down or decrease it. Such intervention strategies include lifestyle modifications like exercise, reduction in alcohol consumption, adoption mediterranean dietary habits; and stress reduction by getting adequate sleep.

CONCLUSION

The result of this study has shown that metabolic syndrome is already a real health challenge in Enugu Metropolis with a prevalence of 16.4% and can no longer be ignored, it also showed more female prevalence compare to male (M= 8%, F= 23%) and that it increases rapidly with increase in age in both genders especially after the age of 30.

Limitations

This study is limited a single ethnic group however, the result is unlikely to be differ from those of other ethnic nationalities.

What Is Known About the Study

1. Central obesity is risk factor of metabolic syndrome.
2. Metabolic syndrome is global in distribution, increases with increase in obesity and showed variable prevalence across the globe.
3. Prevalence increases with increase in age.

What the Study Added

1. Metabolic syndrome is a genuine public heath challenge in Enugu Metropolis with an overall prevalence of 16.4%.
2. Rapid increase in metabolic syndrome is note beyond the age of 30.
3. Early intervention on or before the age of 30 by way of lifestyle modification should be encouraged to slow down the development metabolic syndrome and its complications.

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Competing Interests: The authors declare no competing interests.

Author's Contributions

- **Conceptualization and Design**:

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- **Methodology**:

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- **Writing – Review and Editing**:

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LIST OF ABBREVIATIONS:

AHA - America Heart Association
CHAOS – Coronary artery disease, Hypertension, Adult-onset diabetes, Obesity, Stroke
CI – Confidence interval
EGIR – European Group for study of Insulin Resistance
HDL – High Density Lipoprotein
IDF – International Diabetes Federation
JIS – Joint Interim Statement
MetS – Metabolic Syndrome
NHLBI – National Heart Lung and Blood Institute
NCEP ATP III – National Cholesterol Education Program Adult Treatment Panel III
SPSS – Statistical package for Social Sciencess
WC – Waist Circumference
WHtR – Waist-Height Ratio
WHO – World Health Organization
WHR – Waist Hip Ratio

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