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Comparison of metabolic syndrome prevalence among Igbos using two definitions-a population-based study in Enugu

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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's prevalence in a given population varies with definition used.

Objectives: This study aimed at comparing the prevalence of metabolic syndrome in Enugu metropolis using two well established definitions and to ascertain the concordance between them.

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 IDF and the NCEP-ATP III definitions. Stratified random sampling technique was used in the selection of participants. The data obtained were coded and analyzed into frequencies and percentages using the Statistical Package for Social Sciences (SPSS) version 23. Chi-square (x) test was used to compare categorical variables for associations while Cohen kappa coefficient was used to determine concordance. Statistical significance is set at $p<0.05$ and 95% confidence interval

Result: The study showed metabolic syndrome prevalence of 24.09% and 23.02% using IDF and NCEP definitions, higher female prevalence was seen compare to male with both definitions which is (M=8.78%; F=36.00%) and (M=9.76%; F=33.71%) for IDF and NCEP respectively. Increase in prevalence with age was also noted which was 5.61%%, 9.24% and 68.00% using IDF definition and 5.28%, 9.24% and 64.00% using NCEP for age groups 18-30years, 31-50years and 51-75years respectively.

Conclusion: Metabolic syndrome is already a public health menace in Enugu metropolis with prevalence that depends on the definition used however, spike in prevalence was seen after the age of 50.

Keywords: Metabolic syndrome; Igbos; Enugu; Obesity; Insulin resistance

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1. Introduction

The metabolic syndrome (MetS) refers to the co-occurrence of several known cardiovascular risk factors, including insulin resistance, obesity especially central obesity, atherogenic dyslipidemia and hypertension [1]. It was initially called syndrome X by Raeven in 1988 who observed that that a significant proportion of individuals with or without diabetes were characterised by insulin resistance causing high predisposition to cardiovascular disease [2]. Though the pathogenesis of the metabolic syndrome and its components is complex, abdominal obesity is a key contributory factor however, patients of normal weight can also be insulin resistant and are termed metabolically obese, normal-weight individuals, typically having increased amount of visceral adipose tissue and this explains why abdominal obesity is a key component in the IDF definition [3]. Aside central obesity, some studies have shown that other predisposing factors to metabolic syndrome include: female gender, increasing age, middle socioeconomic status; illiteracy, and unemployment while others have identified sedentary lifestyle, positive family history, omnivore diet; stress, insomnia and increased BMI as major contributors to Metabolic syndrome [4-8].

Prevalence of metabolic syndrome in a given population and clime is multifactorial and heavily influenced by the definition used. Various organizations and institutions have common up with different definitions of metabolic syndrome; the first was the world health organization (WHO) in 1998, and in this definition, evidence for insulin resistance which includes impaired fasting glucose (IFG), impaired glucose tolerance (IGT). Other measures that could serve as evidence of insulin resistance include elevated homeostatic model assessment of insulin resistance (HOMA-IR) and fasting insulin and fasting glucose level. Also, euglycemic hyperinsulinemic clamp studies could be used as evidence of insulin resistance [9].

This definition was quickly followed by another from the European group for the study of insulin resistance (EGIR), who in 1999 proposed a definition similar that of WHO. The EGIR also felt that insulin resistance is central to the pathophysiology of the metabolic syndrome, and as such is a mandatory requirement for the definition. Here, insulin resistance is defined by a fasting plasma insulin value that is greater than the 75th percentile and the use of elevated fasting insulin alone as a reflection of insulin resistance simplifies the definition, but this excludes patients with type 2 diabetes (T2D) since fasting insulin may not be a useful measure of insulin resistance T2D patients. Moreso, obesity criteria were simplified to waist circumference, whereas the WHO definition used a choice of waist-to-hip ratio or body-mass index. Microalbuminuria was equally eliminated as a diagnostic criterion [10].

In the year 2001, the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) conceived a definition for the metabolic syndrome, which was updated by the American Heart Association and the National Heart Lung and Blood Institute in 2005 and according to this definition, metabolic syndrome is present if three or more of the following five criteria are met: waist circumference over 102cm (men) or 88cm (women), blood pressure over 130/85 mmHg, elevate fasting triglyceride (TG) triglycerides: >150 mg/dL, decreased fasting high-density lipoprotein (HDL) cholesterol level: HDL-c <40 mg/dL in men and <50 mg/dL in women and elevated fasting blood glucose: ≥110 mg/dL or being under treatment for reduced HDL-c levels; BP ≥130/85 mm Hg or under antihypertensive treatment; fasting glucose ≥100 mg/dL or previous diagnosis of type 2 diabetes [11-12].

In 2005, the International Diabetes Federation (IDF) published new criteria for metabolic syndrome, although it includes the same general criteria as the other definitions, it requires that obesity, but not necessarily insulin resistance, be present and mandatorily requires that population-specific cutoff points for obesity be met. This accounts for the fact that different ethnicities and nationalities have different distributions of norms for body weight and waist circumference and some are more adversely affected by adiposity example, South Asian populations have an increased risk for T2D and CVD at smaller waist circumferences that would not be considered to meet the criteria in a Western population [13-16].

AHA/NHLBI which is a modified ATP III recently introduced makes only minor changes to the NCEP-ATPIII definition, most notably the lowering of the threshold for elevated fasting glucose (≥100mg/dl) [17-18].

Owing to the multiplicity of definitions of metabolic syndrome, effort was made by several major organizations, such as, the IDF Task Force on Epidemiology and Prevention, AHA/NHLBI, American Heart Association, World Heart Federation, International Atherosclerosis Society, and International Association for the Study of Obesity to harmonize criteria of metabolic syndrome and unify definition in 2009, this gave rise the Joint Interim Statement (JIS) definition which is also a modified ATP III definition. Here, a single set of cut points would be used for all components except waist circumference where ethnic or regional cut points for waist circumference can be used [19].

In spite of the efforts by the major organizations in harmonizing the criteria, there is still no accord between the organizations, on the WC threshold to define abdominal obesity in people of European origin (Europid); while the IDF recommended a WC ≥ 94 cm for men and ≥ 80 cm for women, the NCEP preferred cut points of ≥102 cm and ≥ 88 cm, respectively, for the two genders. Moreover, the JIS suggested using ethnic or regional cut-off points for WC until more evidence from research work become available. The difference in prevalence of metabolic syndrome using different definition could be explained on the emphasis laid on different criterion by different definitions for example World Health Organization (WHO) emphasizes insulin resistance, while the International Diabetes Federation (IDF) has a prerequisite of central obesity [9,20].

Similar studies in the past have shown variations in prevalence of metabolic syndrome using different definitions. In a study by do Vale et al., 2020[21] in Brazil, prevalence was found to be 36.1%, 35.1% and 29.5% using the JIS, the IDF and Modified NCEP respectively while, another study that compared prevalence using WHO and NCEP criteria found obtained prevalence of 23.9% and 25.1% for NCEP and WHO criteria [22]. Similarly, another study in Finland among elderly people recorded prevalence of 24.7%, 35.2%, and 37.2% in men and 20.9%, 33.1%, and 47.8% in women using NCEP, modified NCEP, and IDF definitions respectively [23]; whereas, in a study of children age 9-10years in Iran, prevalence of metabolic syndrome was shown to be 1.5%, 5.9%, 17.8%, and 5.8% using the IDF, NHANES III, AHA; and ATP III [24], a finding which is in agreement with findings in the literature that showed that prevalence is higher in the elderly compare to the younger people across the globe.

Despite the differences in definitions, the prevalence of MS is well established in different populations and ethnic groups worldwide [25]. Since NCEP and IDF use different cut off point for WC and their performance as metabolic syndrome rater has not been compared in our environment, this study aims at comparing the performance of the two definitions in the detection of metabolic syndrome, gender and age group variations in prevalence and their concordance in so doing.

2. Materials and method

This was a cross-sectional community-based descriptive survey carried out in Enugu Metropolis. A total of 469 apparently healthy subjects with no physical deformity were selected in this study using stratified random technique. The cohort consists of 264 females (56.3%) and 205 males (43.7%) with age range 18-75 years group into three age-groups. Ethical approval was obtained from the Ethical Committee of Enugu state University Teaching Hospital, in accordance with the declaration of Helsinki while informed verbal and written consents were obtained and only those who volunteered took part in the study.

A brief medical assessment was carried out on each participant followed by anthropometric measurements, blood pressure check and venous blood sample collection. The main findings were filled into the study questionnaire while measurements were 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. Only participants of Igbo ethnic nationality who have stayed up to a year in Enugu and within the age range of 18-75 were included in the study. Physically challenged persons, pregnant women, those with clinical evidence of abdominal mass or ascites; malignancy, active or chronic liver disease, chronic kidney disease; history of alcohol or drug abuse, hormone replacement therapy and epileptics were excluded from the study. Anthropometric measurements were collected directly by me and with the help of trained research nurses and students while phlebotomists were recruited for blood sample collection.

2.1. Waist circumference

The subject is lightly dressed and 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 one can palpate the hip area to identify 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 was made at the end of a normal expiration to the nearest 0.1cm [26-27].

2.2. Blood pressure measurement

Blood pressure was measured using beurer (BM 28 HSD-Medaval: OBL Beurer GmbH, Germany) automatic blood pressure monitor 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 to make

it too tight by sliding a finger freely between the cuff and the skin. Blood pressure was measured twice and the average recorded.

2.3. Blood sample collection and biochemistry

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 in the right arm and stored in fluoride and plain bottles. The samples were transported to the Laboratory for analysis. The enzymatic method was used in the analysis of serum TC, TG and glucose, HDL-C was assessed using the direct/automated homogeneous method while LDL-C was calculated through the Friedewald formula [28]. Metabolic syndrome was determine using two definitions viz: NCEP and IDF.

- **NCEP definition**: A participant is said to have metabolic syndrome if he/she have any three or more of the five criteria viz: 1) increased waist circumference (>102 cm [>40 in] for men, >88 cm [>35 in] for women); 2) elevated triglycerides (≥150 mg/dl); 3) low HDL cholesterol (<40 mg/dl in men, <50 mg/dl in women); 4) hypertension (≥130/≥85 mmHg); and 5) impaired fasting glucose (≥110 mg/dl) or being under treatment for reduced HDL-C levels; or under antihypertensive treatment; or previous diagnosis of type 2 diabetes [29].
- **IDF definition**: A participant is said to have metabolic syndrome if central obesity=ethnic specific i.e. increased waist circumference which in this case is >94 cm for men, >80 cm for women is present plus any two of 2) elevated triglycerides (≥150 mg/dl); 3) low HDL cholesterol (<40 mg/dl in men, <50 mg/dl in women); 4) hypertension (≥130/≥85 mmHg); and 5) impaired fasting glucose (≥100 mg/dl) or being under treatment for reduced HDL-C levels; or under antihypertensive treatment; or previous diagnosis of type 2 diabetes [20].

2.4. Statistical analysis

The data obtained was coded and analysed into frequencies and percentages using the Statistical Package for Social Sciences (SPSS), version 23. Chi-square (x^2) test was used to compare categorical variables for associations while Cohen's kappa coefficient (κ) was used to examine concordance between the definitions. Statistical significance was set at $p< 0.05$ and 95% confidence interval.

3. Result

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

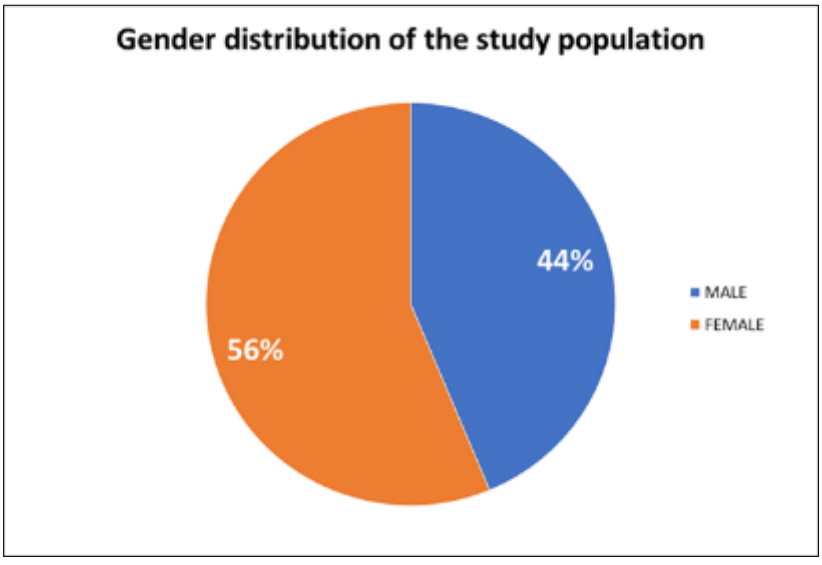

Figure 1 Pie Chart Showing Gender Distribution of the Participants. More than half of the participants were female 264 (56%) while 205 (44%) were male

Table 1 Distribution of participants by age range and gender

	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)

Table 1. showed that 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 where more male participation was seen.

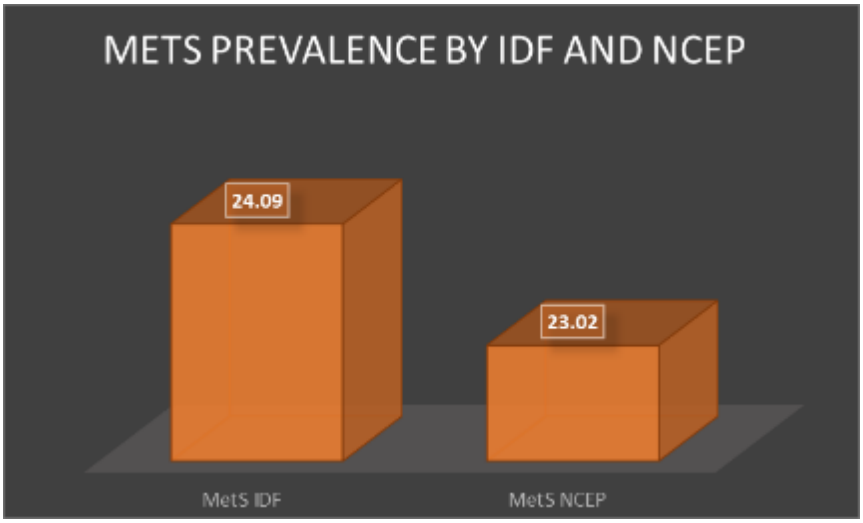

Figure 2 Bar chart shows the prevalence of metabolic syndrome in the study population using the two definitions. It shows that 24.09% and 23.02% met the criteria for metabolic syndrome using IDF and NCEP definitions

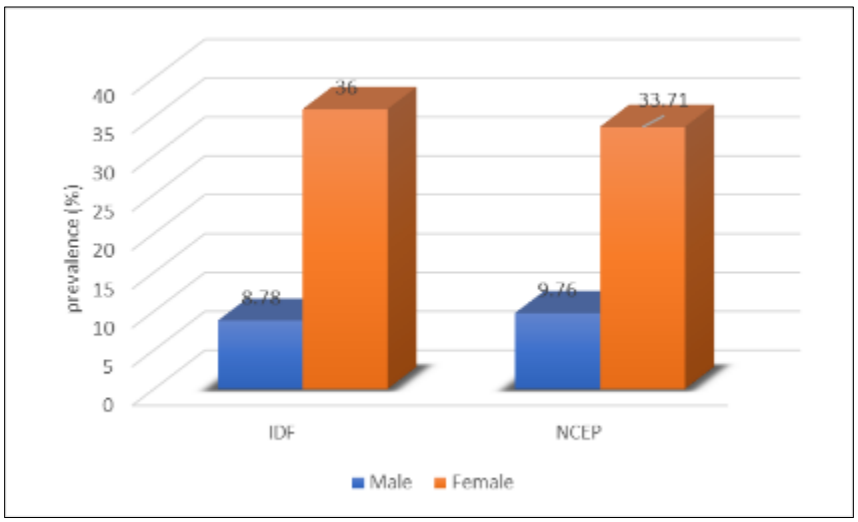

Figure 3 Bar chart compares gender prevalence of Mets using IDF and NCEP definitions. Significantly higher female prevalence ($p<0.001$) was seen compare to the male using both definitions but no significant difference was seen within the genders using both definitions. Cohen kappa coefficient calculated ($k = 0.86$) showed strong concordance between the two definitions

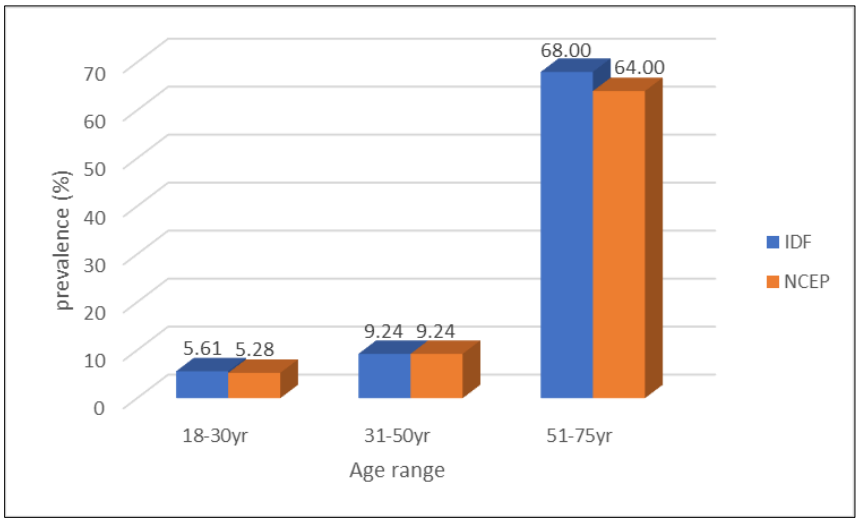

Figure 4 Comparison of age group prevalence of metabolic syndrome using IDF and NCEP. This shows 5.61% and 5.28% for age group 18-30 using IDF and NCEP; 9.24% for age group 31-50 year using both definitions while it was 68% and 64% for age group 51-75 using IDF and NCEP definitions. Significantly higher prevalence ($p<0.001$) was seen in age group 51-75years compare to the two younger age groups but no statistical difference in prevalence between the definitions in any age group. Strong agreement ($k=0.86$) was also seen between the two definitions using Cohen's kappa coefficient

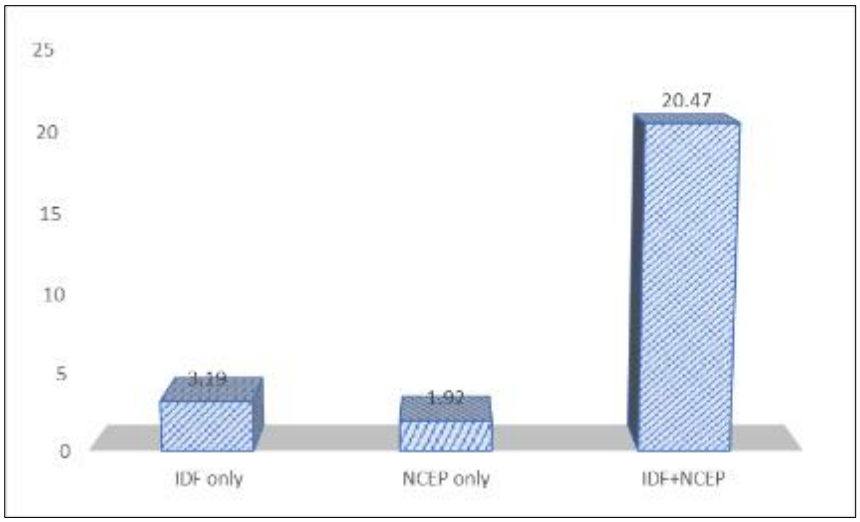

Figure 5 Relationship in prevalence between the two definitions of metabolic syndrome in the study population. Here, 3.19% and 1.92% were isolated prevalences by IDF and NCEP definitions only while majority of the cases 20.47% were detected by both IDF and NCEP together, this showed strong concordance ($k=0.86$) between IDF and NCEP definitions

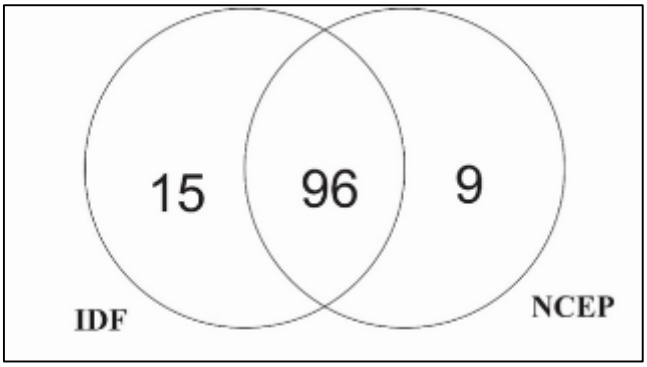

Figure 6 Venn diagram showing the number of participants with metabolic syndrome based on the two definitions (IDF and NCEP). 15 participants met the criteria for MetS by IDF definition only, 9 by NCEP definition only while the great majority (96) was detected by both IDF and NCEP definitions together

4. Discussion

This study was undertaken to determine the prevalence of metabolic syndrome in syndrome in Enugu Metropolis using the IDF and NCEP definitions and to ascertain the concordance between the two definitions. In this study, we recruited 469 apparently healthy subjects, the cohort consists of 205 Male (44%) and 264 Female (56%)) drawn from the age range 18-75years which was further divided into three age groups. Age group 18-30years recorded the highest participation with 305 participants from this group followed by age group 51-75years while age group 31-50 showed the least participation in the study which can be explained by this group being the most economically engaged age group. 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 [30].

In our study, prevalence was found to be 24.09% and 23.02% by IDF and NCEP definitions respectively. These findings are similar to the result obtained in a study in the US which found prevalence 23.9% and 25.1% for NCEP and WHO definitions [21] but somewhat lower than was obtained in a study do Vale et al [31] which was 36.1%, 35.1% and 29.5% using JIS, IDF and modified NCEP definitions. The prevalence in our study is also less than another result obtained in the US using two definitions which is 34.5% and 39.0% for NCEP and IDF respectively [31] but higher than was seen in a study of high school students in Iran which was 4.8% based on IDF definition and 12.7% based on Ferranti definition [32], the lower prevalence in the Iranian students is not surprising since metabolic syndrome increases with age, and is expected to be lower in younger age groups compare to older age groups. Our finding was equally noted to be lower than that was obtained by Zainuddin et al [33] in Malaysia which was 32.2% and 28.5% for IDF and NCEP ATP III definitions respectively.

Comparing prevalence between the genders using the two definitions, prevalence was found to be (M=8.78%, F=36.0%) and (M=9.76%; F=33.71%) using IDF and NCEP definitions, this showed significantly greater female prevalence ($p<0.001$) and this differs with the result obtained in northern Finland where the prevalence of MetS was (M=24.7%; F= 20.9%) and (M=37.2%; F=47.8%) using NCEP, and IDF definitions [23]. Our result also varies from the one obtained Ford [31] in the US where the prevalence was (M=33.7%; F=35.4%) and (M= 39.0%; F=38.1%) for NCEP and IDF definitions with no significant gender difference in prevalence.

When the prevalence by age group was assessed, it was seen that metabolic syndrome prevalence increases with age and at the first age group (18-30years), it was 5.61% and 5.28% prevalence using IDF and NCEP definitions, 9.24% for both definitions at age group 31-50years while 68.0% and 64% prevalence were recorded for age group 51-75years using IDF and NCEP definitions respectively with no significant difference in prevalence within the age group using the definitions however, significant difference in prevalence ($p<0.001$) was seen between the elderly age group (51-75years) and the young age groups. This implies that age group 31-50years a span of twenty years is a great window of opportunity and enough time for lifestyle modification and weight reduction in the prevention and combating metabolic syndrome and its complications.

Similar increase in prevalence with age in this study was also noted in a study by Ervin [34] in the US where, prevalence was found to be (M=20%; F=16) for those under 40 years, (M=41%; F=37%) for those between 40-59 years and (M=52%; F=54%) for those 60 years and above however, unlike our study, metabolic syndrome was more in the male except for the last age group (60 years and above) where more female prevalence was recorded. Similar trend was also seen in study that compares prevalence using 2005 ATP III and IDF in Norway; in that study, prevalence was 29.6% and 25.9% using IDF and 2005 ATP III criteria, increased with age being 11.0% at age group 20-29 years and 47.2% in age range 80-89 years in men, and from 9.2% to 64.4% for women in the equivalent age groups using IDF definition [35]. Likewise, another study in Portugal that compared prevalence using ATP III, IDF and JIS found variation in prevalence which was 36.5%, 49.6%, and 43.1% using ATP III, IDF and JIS definitions, higher female prevalence and increase with age was also observed in the study [36].

5. Conclusion

This study demonstrated that metabolic syndrome is already public health challenge in Enugu, and that the two definitions (IDF and NCEP) used showed strong concordance with equal prevalence in the age group 31-50years. Greater female prevalence was also noted in study using the two definitions but no significant intragroup difference in prevalence using the two definitions. The study also showed that prevalence of metabolic syndrome increases with age with seven- fold increase in prevalence in those ≥ 51years compare to the younger age group.

Compliance with ethical standards

Acknowledgement

We grateful to all those that willingly participated in the study and to all the volunteers that assisted in the field during data collection.

Disclosure of conflict of interest

The authors have no conflict of interest to declare.

Statement of ethical approval

The study was duly approved by the ethical committee of the Enugu State University of Science and Technology Teaching Hospital Enugu.

Statement of informed consent

Written informed consent was obtained from all participants included in the study.

Author's Contributions

- **Conceptualization and design**: Maxwell Ubanagu Odumeh, Chike Ikechukwu Patrick Anibeze, Rosemary Ngozi Njeze, Augustine Chukwudi Onuh
- **Methodology**: Maxwell Ubanagu Odumeh, Chike Ikechukwu Patrick Anibeze, Augustine Chukwudi Onuh, Chinedu Philips Okere, Elizabeth Finbarr-Bello, Emmanuel Obinna Modebe.
- **Data acquisition, analysis and interpretation**: Maxwell Ubanagu Odumeh, Chike Ikechukwu Patrick Anibeze, Rosemary Ngozi Njeze, Chinedu Philips Okere.
- **Writing- original draft preparation**: Maxwell Ubanagu Odumeh, Chike Ikechukwu Patrick Anibeze, Elizabeth Finbarr-Bello, Rosemary Ngozi Njeze, Emmanuel Obinna Modebe
- **Writing – Review and Editing**: Maxwell Ubanagu Odumeh, Chike Ikechukwu Patrick Anibeze, Elizabeth Finbarr-Bello, Chinedu Philips Okere, Emmanuel Obinna Modebe, Augustine Chukwudi Onuh

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