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Original Research

Prevalence of Hypertension and Type 2 Diabetes Mellitus among Patients with Metabolic Syndrome in Rural Southern Nigeria: Gender and Age Disparities

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Abstract

Background: Metabolic syndrome (MetS) is a cluster of interconnected risk factors, including obesity, hypertension, elevated blood sugar, and abnormal lipid profiles. Its increasing prevalence globally poses a significant public health concern. This study investigated the prevalence of hypertension and type 2 diabetes mellitus (T2DM) in patients with MetS, considering age and gender in a rural teaching hospital.

Methodology: Conducted at Igbinedion University Teaching Hospital, Edo State, the study involved 75 patients selected through simple random sampling using the 2009 Joint Interim Statement (JIS) criteria of the IDF/AHA/NHLBI. It utilised an observational, cross-sectional, and retrospective design, focusing on individuals aged 18 years and older who consented to participate. Data was analysed using IBM SPSS version 23, with $p < 0.05$ considered significant.

Results: The findings indicated that 60% of patients with MetS had hypertension, 17.3% had T2DM, and 22.7% were diagnosed with both conditions. Among hypertensive patients, 57.3% were female (P = 0.110). For T2DM, 25.3% of patients were female (P = 0.766). The prevalence of both T2DM (P = 0.106) and hypertension (P = 0.708) was higher in middle-aged patients compared to other age groups.

Conclusion: This study highlights the significant prevalence of hypertension and T2DM among patients with MetS in a rural teaching hospital, with notable variations across gender and age groups. While hypertension was more common in females, T2DM showed no significant gender disparity. Middle-aged individuals exhibited a higher prevalence of both conditions, underscoring the need for targeted screening and intervention strategies in this demographic.

Keywords: Hypertension; Type 2 Diabetes Mellitus; Metabolic Syndrome; Gender; Age.

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Introduction

Metabolic syndrome (MetS) is a risk factor for cardiovascular diseases (CVDs) even without concomitant T2DM and it includes insulin resistance (IR), hyperinsulinemia, dysglycemia, dyslipidemia, and hypertension. Several diagnostic criteria for metabolic syndrome (MetS) have been established, with the most widely used criteria currently provided by the World Health Organization (WHO), the European Group for the Study of Insulin Resistance (EGIR), the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III).[1] The American Association of Clinical Endocrinologists (AACE), [2] and the International Diabetes Federation (IDF).

The prevalence of metabolic syndrome (MetS) in African populations exhibits considerable variability, ranging from as low as 0% to as high as 50% or more, depending on the specific population studied. [3,4] Among hypertensive Nigerians, the prevalence of MetS was 34.3% according to the ATP III criteria, 35% based on the WHO criteria, and 42.9% according to the IDF criteria. [5] These prevalence rates are comparable to those observed in non-diabetic Turkish adults, where the rates were 38% according to NCEP-ATP III, 42% based on ACE and IDF criteria, 20% according to EGIR, and 19% per WHO criteria. This comparative analysis highlights the widespread impact of MetS across different populations and underscores the importance of utilising various diagnostic criteria to accurately assess its prevalence in diverse settings. Hypertension presents a substantial challenge within the general population, contributing to heightened cardiovascular morbidity and mortality and resulting in negative health outcomes. Additionally, the combination of hypertension with dyslipidemia, obesity, and insulin resistance—collectively known as metabolic syndrome—further amplifies an individual's overall cardiovascular risk. [6] Despite the known prevalence of MetS, limited data exists on age and gender-specific patterns of hypertension and diabetes in rural Nigerian settings. This study contributes to understanding age and gender disparities in MetS within rural settings.

This study aimed to explore the gender and age prevalence of hypertension and type 2 diabetes mellitus among patients with metabolic syndrome in developing communities to provide relevant health data to guide practitioners and researchers in delivering informed health action, services, and opportunities for further research.

Methodology

Study Framework

An observational study incorporating both cross-sectional and retrospective components was carried out among 75 adult patients (≥18 years old) who met the 2009 Joint Interim Statement (JIS) of IDF/AHA/NHLBI definition for metabolic syndrome (MetS) at Igbinedion University Teaching Hospital (IUTH) in Okada, Edo State, Nigeria. [7]The Joint Interim Statement (JIS) defines metabolic syndrome (MetS) as the presence of three or more of the following criteria in an individual: central obesity, indicated by a waist circumference ≥102 cm for men or ≥88 cm for women; serum triglycerides ≥150 mg/dL or treatment for hypertriglyceridemia; high-density lipoprotein cholesterol (HDL-C) levels <40 mg/dL in men or <50 mg/dL in women, or medication to address low HDL-C; systolic blood pressure ≥130 mmHg and/or diastolic blood pressure ≥85 mmHg or ongoing antihypertensive treatment; and fasting glucose levels ≥100 mg/dL or treatment for elevated fasting glucose. Patients were randomly selected each week over 16 months as follow-up patients and reviewed their health records at the General Outpatient Unit of IUTH until the target sample size was achieved.

Okada, the headquarters of the Ovia North-East Local Government Area, is located at a latitude of 6.323°N and a longitude of 5.6212°N. The region spans 2,301 km² and had a population of 153,849 according to the 2006 census.

Selection Criteria

Inclusion Criteria

Patients were included if they were 18 years or older, of either sex with a new diagnosis of metabolic syndrome based on the JIS criteria, were relatively stable clinically, and provided informed consent.

Exclusion Criteria

Patients that did not meet JIS criteria for metabolic syndrome were pregnant, had ascites, or had life-threatening conditions that would interfere with study participation. In addition, patients who did not give consent were excluded.

Data Collection

Blood pressure (BP) was assessed using the auscultatory technique with a validated manual mercury sphygmomanometer, adhering to the American Heart Association's guidelines. [8] Participants were seated comfortably on a chair equipped with a backrest, with their legs uncrossed and feet flat on the floor. After a 5-minute rest, an appropriately sized cuff was positioned on the bare, supported upper arm at heart level. Conversation during measurement was discouraged. The first Korotkoff sound (SBP) and the fifth sound (DBP) were recorded to the nearest 2 mmHg. BP was measured on both arms, with initial readings excluded. The final BP value for each participant was determined as the average of the subsequent two readings from the arm with the higher measurement.

Venous blood samples were collected in the morning following an overnight fast, adhering to ethical guidelines. Fasting was defined as abstaining from caloric intake for at least 8 hours, though water consumption was permitted. Blood was drawn into a sodium fluoride/potassium oxalate container and a lithium heparin tube for biochemical analysis. To ensure proper anticoagulation, the labelled samples were gently mixed, and centrifuged, and the plasma was stored at -20°C until further analysis.

Each participant's sample was tested for serum triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and fasting blood sugar (FBS) levels using the Beckman Coulter AU5400 Chemistry System (Beckman Coulter, Brea, CA). The FPG measurement utilised the glucose oxidase method, which involves glucose oxidation to gluconic acid and hydrogen peroxide. The hydrogen peroxide produced reacts with a chromogen to form a coloured compound. To prepare the samples, they were diluted with phosphate buffer, mixed with glucose oxidase and peroxidase reagents, and incubated at 37°C. Absorbance was then measured at 500 nm. [9] Hyperglycemia was defined as an increase in blood glucose levels, which includes conditions such as prediabetes (impaired fasting glucose [IFG], impaired glucose tolerance [IGT]) and diabetes.

Data Analysis

Data was carefully reviewed for completeness, assigned serial numbers, and coded before being entered into SPSS version 23 for analysis. The results were summarized in frequency tables. Bivariate analysis was performed using the chi-squared test to assess associations, with a p-value of <0.05 considered statistically significant. Notably, the data were obtained through self-reported information, which may be subject to recall or reporting bias.

Ethical Consideration

Ethical approval for the study was obtained from the Ethics and Research Committee of Igbinedion University Teaching Hospital. Participants were assured of privacy and confidentiality. This was done following the Helsinki Declaration regarding medical research involving human subjects. [10]

Results

Prevalence of Hypertension and T2DM among Patients with MetS

The health status of the participants in the study was comprehensively evaluated. The incidence of diabetes mellitus, hypertension, or both conditions was identified among the patients to assess the prevalence of both hypertension and T2DM among this population. The pie chart below Figure 1) illustrates the distribution of patients across various health categories, emphasising the coexistence of diabetes and hypertension within the cohort. The findings revealed that the majority (60%) of the patients in this study had hypertension alone, 17.3% had T2DM alone, and 22.7% had both hypertension and type 2 diabetes mellitus (T2DM).

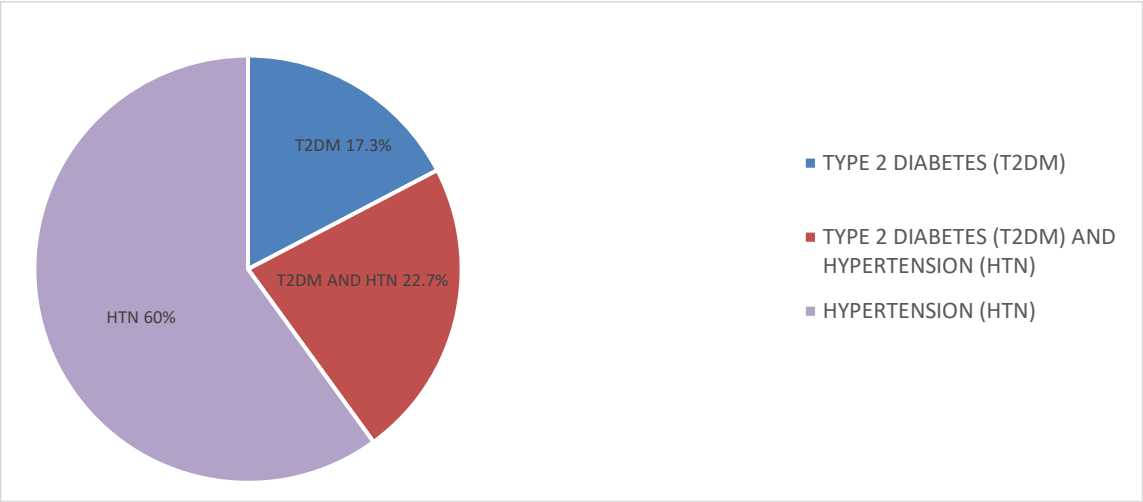

Figure 1: Distribution of Hypertension and Type 2 Diabetes Mellitus among Patients with MetS

Gender Prevalence of Hypertension among Patients with MetS

Figure 2 offers a detailed view of the relationship between gender and blood pressure, highlighting crucial aspects of cardiovascular risk within the study population. The percentage of all patients with hypertension (including those with only HTN and those with both HTN and T2DM) was summed up giving a total of 82.7% of participants being hypertensive, with females making up 57.3% of this group. However, at a 95% confidence level, there was no significant association between gender and hypertension ($\chi^2 = 2.554$, df = 1, P = 0.110).

Age Prevalence of Hypertension among Patients with MetS

The chart in Figure 3 illustrates the dynamics between age categories and blood pressure, contributing to a comprehensive characterisation of cardiovascular health in our study population. There was a climb in blood pressure from the age group 18-25 years which peaked at middle age (46-65 years). 37.3% of hypertensive patients (82.7%) fell within the age range of 46-65 years. At a 95% confidence level, this result was not statistically significant ($x^2 = 1.391$, df = 3, P = 0.708).

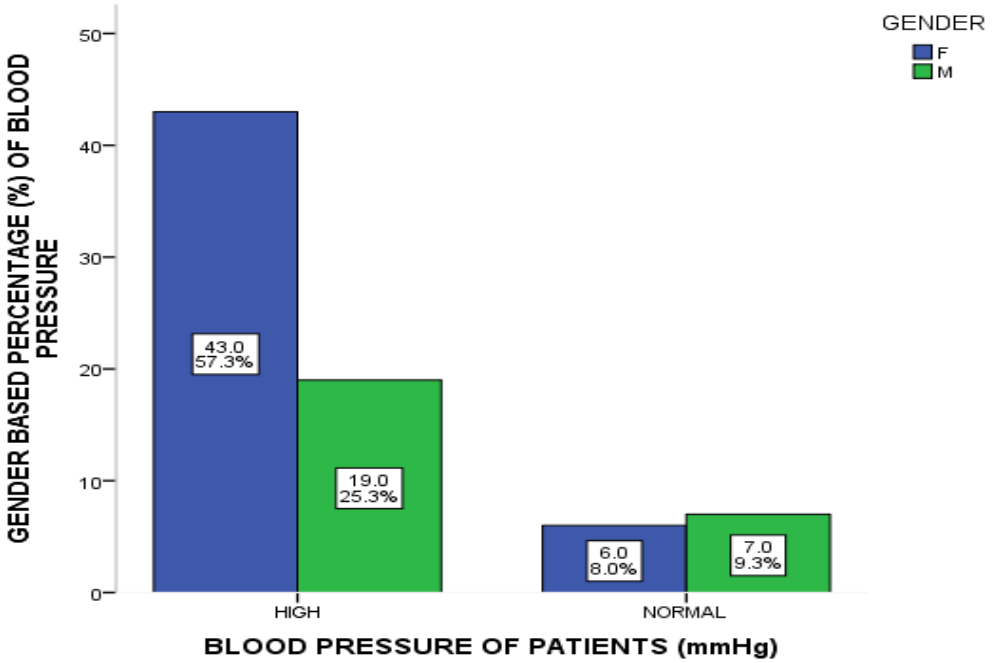

Figure 2: Relationship between Gender and Blood Pressure Patterns among Patients with MetS

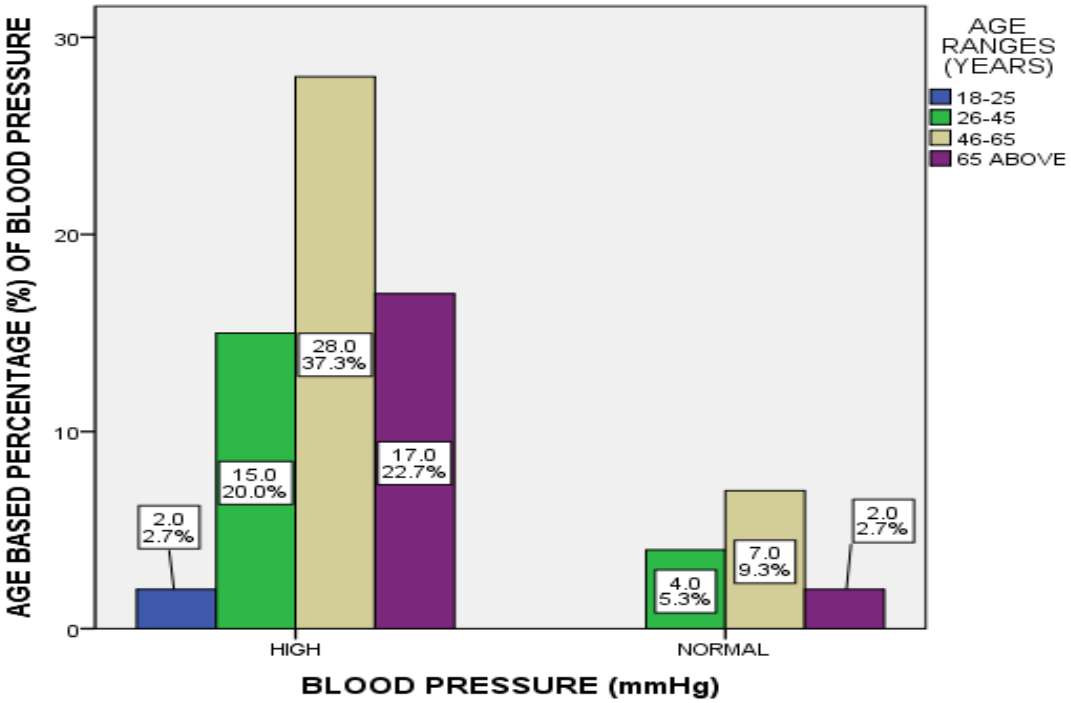

Figure 3: Relationship between Age and Blood Pressure Patterns among Patients with MetS

Gender Prevalence of T2DM among Patients with MetS

The clustered bar chart in Fig. 4 summed up all patients with T2DM in this cohort including those with comorbid T2DM and HTN and shows that out of 40% of patients with an elevated FBS, 14.7% were males leaving the remaining 25.3% to be females. At a 95% confidence level, this result was not statistically significant (x^2= 0.88, df = 1, P = 0.766).

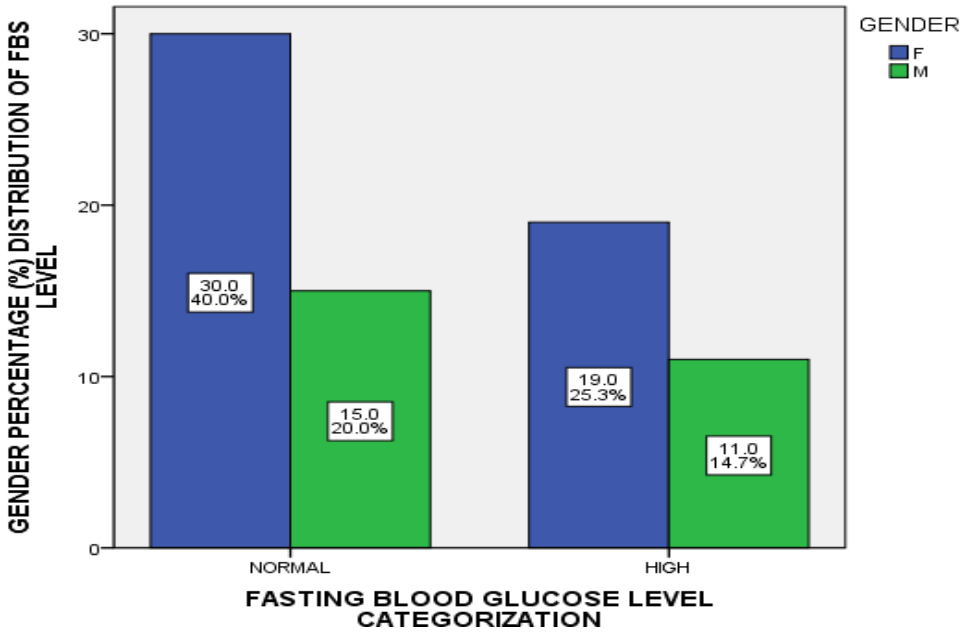

Figure 4: Relationship between Gender and T2DM among Patients with MetS

Age Prevalence of T2DM among Patients with MetS

The figure below shows the relationship between age and T2DM, indicating that 24% out of 40% of diabetic patients were in the middle age group (45-65 years) (x^2= 6.115, df = 3, P = 0.106).

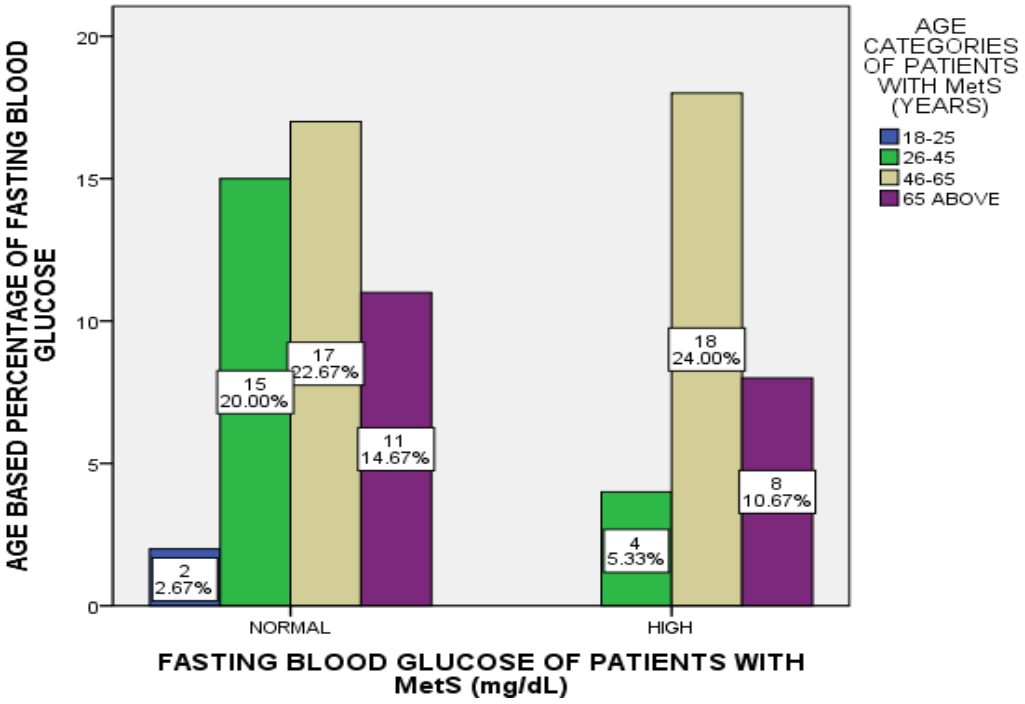

Figure 5: Relationship between Age and T2DM among Patients with MetS

Discussion

Prevalence of Hypertension and T2DM among Patients with MetS

This result demonstrates the significant burden of hypertension among individuals with MetS in this cohort, with 60% of participants diagnosed with hypertension alone. The high prevalence of hypertension compared to T2DM suggests that it is a predominant risk factor in this population. Additionally, the coexistence of both conditions in 22.7% of patients emphasises the need for comprehensive metabolic screening in individuals diagnosed with either hypertension or T2DM. The findings reinforce the importance of a holistic clinical approach, as many patients may present with multiple metabolic disorders rather than a single disease entity. Early detection and integrated management strategies could lead to better patient outcomes, reduced complications, fewer hospitalisations, and lower healthcare costs.

This finding aligns with an analysis of 8,144 individuals who underwent general health screenings, where hypertension emerged as the most prevalent MetS risk factor among males and females (85% and 87%, respectively). [11] Similarly, Ogbera's 2010 study reported a hypertension prevalence rate of 67%, a finding consistent with reports from the Middle East and Nigeria. [12] Rural residency has also been associated with a higher prevalence of hypertension. [13] Das *et al* in 2023 highlights that hypertension is a predominant risk factor in individuals with MetS, underscoring its importance in the syndrome. [14] Another study emphasises that hypertension, along with abdominal obesity, hyperlipidemia, and hyperglycemia, is a crucial component of MetS. [6] These findings collectively underscore the critical role of hypertension in the context of MetS and its significance as a major risk factor in this metabolic disorder. These findings emphasise the need for clinicians to be more intuitive towards exploring other comorbidities that may exist with the disease of interest their clients present with. Since most clients present with more than one disease condition, they will get better care, recuperate/respond faster to treatment, suffer fewer complications for their diseases in the long run, have less hospitalisation, and have less healthcare financial burden on both the clients and the healthcare system.

Gender Prevalence of Hypertension among Patients with MetS

The high burden of hypertension may be attributed to factors such as dietary habits, sedentary lifestyles, genetic predisposition, and limited access to healthcare services in rural areas. Gender-specific analysis showed that both men and women with MetS are equally susceptible to developing hypertension. This contrasts with some studies that report a higher prevalence of hypertension among males, possibly due to differences in hormonal influences, lifestyle patterns, and health-seeking behaviours. The co-occurrence of hypertension and T2DM in 22.7% of patients underscores the complex interplay between metabolic disorders. The simultaneous presence of both conditions significantly increases the risk of cardiovascular complications, kidney disease, and other long-term health consequences. This finding reinforces the need for integrated screening and management strategies to address multiple metabolic abnormalities rather than treating each condition in isolation. Given the high prevalence of hypertension observed, clinicians in rural settings should adopt proactive approaches to screening, early intervention, and patient education on lifestyle modifications.

This finding is also consistent with Ogbera's 2010 study on patients with metabolic syndrome, which documented gender differences in the occurrence of hypertension. Significant differences were noted, with females having a notably higher incidence rate of hypertension than males. [13] Blood pressure is known to be a sexually dimorphic trait, with substantial variations in prevalence, pathophysiology, and outcomes between genders. [15] However, there is currently limited data supporting sex-specific blood pressure targets. Females tend to experience a sharper increase in blood pressure starting from their third decade of life, resulting in a higher prevalence of hypertension with advancing age. The mechanisms behind these blood pressure patterns may involve the long-term vascular effects of hypertensive disorders of pregnancy, interactions between the renin-angiotensin-aldosterone system and sex hormones, and

psychosocial factors such as socioeconomic deprivation. Additionally, hypertension's impact is not uniform, and females are at a greater risk of developing adverse cardiovascular outcomes at lower blood pressure thresholds. Therefore, it is crucial to identify and manage hypertension early in females to mitigate the risk of adverse cardiovascular events. [15]

Age Prevalence of Hypertension among Patients with MetS

An age-stratified analysis of blood pressure patterns among these patients revealed that 82.7% of hypertensive individuals experienced a rising prevalence of hypertension as they aged. The prevalence began at 2.7% in the 18-25 age group, increased to 20% in those aged 26-45 years, and peaked in middle-aged individuals (37.3%). This age-related rise in blood pressure is consistent with existing literature, which attributes it to factors such as vascular ageing, endothelial dysfunction, cumulative exposure to lifestyle risk factors, and reduced arterial compliance over time. The gradual rise in blood pressure with age is a well-recognized and multifaceted physiological phenomenon. Factors such as arterial stiffness, changes in vascular compliance, and alterations in the renin-angiotensin-aldosterone system contribute to this increase over time. [16] This age-related rise in blood pressure is known as "senescent hypertension," highlighting the need to understand blood pressure trends within the context of ageing. Focused cardiovascular healthcare channeled to individuals by health practitioners (Lifestyle physicians, geriatric physicians, and nutritionists) as they age especially in line with continuous health education on lifestyle modifications and dietary modifications will help curb morbidities, mortalities, and complications that may result from ageing-related complications associated with hypertension like stroke.

Another study found the highest prevalence of hypertension in the 35-40 age group (27%) and the lowest in the 20-24 age group (5.3%). The consistent increase in hypertension prevalence with advancing age was statistically significant ($p < 0.001$). [17]

Gender Prevalence of T2DM among Patients with MetS

Although not statistically significant, the trend of higher T2DM prevalence among females aligns with previous research suggesting that biological, hormonal, and lifestyle factors may contribute to gender differences in diabetes risk. Women, particularly postmenopausal women, tend to have higher rates of central obesity and insulin resistance, which are major risk factors for T2DM. Additionally, sociocultural factors such as dietary habits, physical activity levels, and healthcare-seeking behaviour could influence the observed distribution.

It has been observed that higher visceral adiposity in men is associated with elevated postprandial insulin, free fatty acids (FFAs), and triglyceride (TG) levels. In contrast, the peripheral fat distribution typically found in women—measured by hip or thigh circumference or using dual-energy X-ray absorptiometry methods—is associated with improved insulin sensitivity compared to central fat distribution. [18] Although women also have higher intramyocellular TG content, which is associated with lower whole-body insulin sensitivity, [19] differences in body composition generally favour a more insulin-sensitive environment in women compared to men. However, in this study, females constituted 25.3% of the total patients with elevated blood glucose readings (40%). This finding aligns with a study by Beigh and Jain (2012), [20] which reported that hyperglycemia significantly differed between genders, with a higher prevalence of hyperglycemia in females with metabolic syndrome.

Certain factors, such as age, may explain why women had a higher percentage of Type 2 Diabetes Mellitus. In some age groups, women may have a higher prevalence due to factors such as menopause and hormonal changes. [21] Obesity is a major risk factor for type 2 diabetes, and women may exhibit different fat distribution patterns compared to men, influencing diabetes risk. Hormonal changes during pregnancy and menopause can also impact insulin sensitivity and glucose metabolism in women. [22] It is crucial to recognise that gender differences in diabetes prevalence are multifactorial, influenced by age,

hormonal factors, body composition, and lifestyle. The extent of these differences may vary across populations and regions. Enlightening the clinician on the existence of these comorbidities as a syndrome and being clinically intuitive in exploring and managing these interrelated health conditions will be crucial in ensuring the clients get optimal healthcare from the health providers.

Age Prevalence of T2DM among Patients with MetS

The higher prevalence of T2DM in middle-aged individuals aligns with existing literature, as metabolic dysfunction, insulin resistance, and pancreatic beta-cell decline typically worsen with age. Additionally, lifestyle factors such as dietary habits, physical inactivity, and obesity, which are more pronounced in middle age, contribute to an increased risk of developing T2DM.

As individuals age, changes in body composition, such as increased visceral fat and decreased muscle mass, contribute to insulin resistance. Obesity, particularly central obesity, is a significant risk factor for type 2 diabetes in this age group. [23] Ageing affects beta-cell function and insulin secretion. Hormonal changes, particularly in women post-menopause, may also influence glucose metabolism. [24] Enlightening the clients and populace at every opportunity especially when they present at the clinics for follow-ups, well-patient clinics, and through new media/mass media, by the health providers will empower the clients, would-be patients, the patients and the entire at-risk population on these expected health trends/changes with age and sex, will positively curb incidences, morbidities, mortalities, complications arising and the financial burden of these health challenges on the entire health system.

Conclusion

This study highlighted the critical role of hypertension in Metabolic Syndrome (MetS) and emphasised the need for targeted interventions. Given the observed patterns, public health strategies should focus on early screening, gender-sensitive approaches, and community-based education to promote healthier lifestyles. Integrating hypertension and diabetes care into routine healthcare services is essential to improving patient outcomes. Additionally, policies that encourage healthier dietary choices, increased physical activity, and improved access to healthcare can help mitigate modifiable risk factors and reduce the burden of MetS in affected populations.

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