Cardiometabolic comorbidities across obesity classes among adults attending a general outpatient clinic in South-South Nigeria: a hospital-based cross-sectional study

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Abstract

Background: Obesity is strongly associated with hypertension, diabetes mellitus, dyslipidaemia, and metabolic syndrome, but the burden and distribution of these conditions vary by population and care setting. Evidence from semi-urban outpatient populations in South-South Nigeria remains limited. This study assessed cardiometabolic comorbidities among adults with obesity attending a general outpatient clinic and examined their distribution across obesity classes.

Methods: A hospital-based cross-sectional study included 300 adults aged 18 years or older with body mass index (BMI) >=30 kg/m2 who attended the General Outpatient Department of Irrua Specialist Teaching Hospital, Edo State, Nigeria, between February and May 2024. Participants were selected using systematic sampling. Sociodemographic and clinical data, anthropometric indices, blood pressure, fasting plasma glucose, and fasting lipid measurements were obtained. Categorical variables were summarised as frequencies and percentages, with Wilson 95% confidence intervals (CIs) for principal prevalence estimates. Associations between obesity class and cardiometabolic outcomes were assessed using Pearson chi-square tests.

Results: The mean age was 51.6 +/- 8.9 years, and 215 participants (71.7%) were women. Class I obesity was most frequent (194/300, 64.7%), followed by Class II (79/300, 26.3%) and Class III (27/300, 9.0%). Hypertension affected 250 participants (83.3%; 95% CI 78.7-87.1), dyslipidaemia 158 (52.7%; 47.0-58.2), diabetes mellitus 98 (32.7%; 27.6-38.2), and metabolic syndrome 79 (26.3%; 21.7-31.6). Obesity class was associated with hypertension (chi-square=8.91, p=0.012), metabolic syndrome (chi-square=32.58, p<0.001), dyslipidaemia (chi-square=7.12, p=0.028), total cholesterol >=200 mg/dL (chi-square=10.76, p=0.005), and triglycerides >=150 mg/dL (chi-square=31.16, p<0.001). Diabetes mellitus and HDL cholesterol were not significantly associated with obesity class.

Conclusion: Cardiometabolic comorbidities were common in this selected outpatient population with obesity. Metabolic syndrome and raised triglycerides increased markedly across obesity classes, whereas other associations were non-linear. Routine, integrated cardiometabolic assessment should accompany obesity care in general outpatient practice. The cross-sectional, hospital-based design and unresolved lipid-coding details require cautious interpretation.

Keywords: obesity, hypertension, diabetes mellitus, dyslipidaemia, metabolic syndrome, Nigeria

Introduction

Obesity has become increasingly common across most regions of the world. Global pooled analyses show that the rise in obesity has been a major driver of the growing double burden of abnormal body weight, while underweight remains important in parts of Africa and South Asia [1]. Obesity

contributes to cardiovascular disease through interrelated haemodynamic, metabolic, inflammatory, and thrombotic pathways [2]. High body mass index, high blood pressure, hyperglycaemia, and adverse lipid profiles are also major contributors to preventable morbidity and mortality [3].

The cardiometabolic consequences of obesity are especially important in low- and middle-income countries, where rapid nutritional and social transitions coexist with constrained prevention, detection, and long-term disease management [4]. Nigeria has experienced a substantial increase in overweight and obesity. National syntheses estimate a higher burden among women and residents of southern geopolitical zones, although prevalence varies according to setting, measurement period, and sampling frame [5,6].

Primary-care studies in Nigeria have consistently identified hypertension, glucose abnormalities, and lipid disorders among adults with obesity, but the reported prevalence varies considerably [7]. Similar heterogeneity affects estimates of metabolic syndrome because studies use different diagnostic definitions and cut-offs [8]. A Nigerian systematic review also found marked regional variation in hypercholesterolaemia, with relatively high estimates in South-South populations [9]. These findings support locally grounded studies that apply transparent case definitions and report the distribution of individual cardiometabolic components.

Evidence remains limited for adults with obesity attending semi-urban general outpatient services in Edo State. Understanding the pattern of comorbidities in this setting may help clinicians prioritise integrated assessment and identify subgroups requiring closer follow-up. This study therefore assessed the prevalence of hypertension, diabetes mellitus, dyslipidaemia, metabolic syndrome, and selected lipid abnormalities among adults with obesity attending the General Outpatient Department of Irrua Specialist Teaching Hospital. It also examined whether these outcomes differed across BMI-defined obesity classes.

Methods

Study design and setting

This hospital-based cross-sectional study was conducted in the General Outpatient Department of Irrua Specialist Teaching Hospital, Irrua, Edo State, Nigeria. Irrua is the administrative headquarters of Esan Central Local Government Area. The department provides first-contact and continuing care and receives referrals for adult medical conditions. Data collection took place from February to May 2024.

Study population and eligibility

Eligible participants were consenting adults aged 18 years or older with BMI >=30 kg/m2 who attended the clinic during the study period. Pregnant or puerperal women, people receiving systemic corticosteroids or antiretroviral therapy, patients with a diagnosed psychiatric eating disorder, people too unwell to complete the study

procedures, and those with previous bariatric surgery were excluded.

Sample size and sampling

The minimum sample size was estimated with the single-proportion formula n=Z2p(1-p)/d2, using a 95% confidence level, 5% precision, and an anticipated cardiometabolic-comorbidity proportion of 22.9% from a Nigerian outpatient study [10,11]. This gives approximately 271 participants. After allowing for about 10% non-response, the recruitment target was rounded to 300.

Hospital records were reported to show approximately 360 eligible clinic attendances each month, giving an estimated four-month sampling frame of 1,440 attendances. The source manuscript states that a random start was selected from the first four eligible patients and every fourth eligible patient was subsequently invited. However, 1,440/300=4.8 rather than 4.0; the interval and field implementation therefore require confirmation from the recruitment log. Non-consenting patients were reportedly replaced by the next eligible patient.

Data collection

A pretested, interviewer-administered semi-structured questionnaire was used to obtain age, sex, marital status, religion, ethnicity, education, occupation, income, smoking, alcohol use, diet, physical activity, relevant family history, previous diagnoses, and current use of antihypertensive, glucose-lowering, or lipid-lowering medicines. Trained clinicians reviewed completed forms for completeness before data entry. The source document did not provide psychometric properties, pretest findings, or a copy of the questionnaire; these details should accompany a final submission.

Anthropometry and blood pressure

Measurements followed standardised procedures. Weight was measured with a calibrated digital scale while participants wore light clothing and no footwear. Height was measured with a stadiometer. BMI was calculated as weight in kilograms divided by height in metres squared. Obesity was classified as Class I (30.0-34.9 kg/m2), Class II (35.0-39.9 kg/m2), or Class III (>=40.0 kg/m2), consistent with World Health organisation classification [12]. Waist circumference was measured at the midpoint between the lowest palpable rib and the iliac crest, and the mean of two measurements was recorded.

Blood pressure was measured after at least five minutes of seated rest using an appropriately sized cuff. Three measurements were reportedly obtained at five-minute intervals, and the mean of the final two readings was used. Hypertension was defined as systolic blood pressure >=140 mmHg, diastolic blood pressure >=90 mmHg, or current antihypertensive treatment [13].

Laboratory procedures

Venous blood was obtained after an overnight fast of 8-12 hours, generally between 08:00 and 10:00. Plasma glucose was analysed using a glucose oxidase-peroxidase enzymatic method. Total cholesterol and triglycerides were measured enzymatically, while HDL cholesterol was measured after precipitation of apoB-containing

lipoproteins. The original manuscript states that internal control material and calibration standards were used, but analyser models, reagent manufacturers, lot numbers, and within-run or between-run coefficients of variation were not supplied.

Outcome definitions

Diabetes mellitus was defined as fasting plasma glucose >=7.0 mmol/L or a previous physician-confirmed diagnosis, consistent with established diagnostic criteria [14].

For internal consistency with the reported results, lipid components were categorised as total cholesterol <200 versus >=200 mg/dL, triglycerides <150 versus >=150 mg/dL, and HDL cholesterol <40 versus >=40 mg/dL. These thresholds differ from parts of the source methods, which cited total cholesterol >6.20 mmol/L and sex-specific HDL thresholds. The recorded composite dyslipidaemia variable (yes/no) was retained because its exact algorithm could not be reconstructed from the aggregate tables. Authors must confirm the final lipid definition, the role of lipid-lowering treatment, and whether sex-specific HDL thresholds were used [15].

Metabolic syndrome was reported as the presence of at least three of the following: waist circumference >102 cm in men or >88 cm in women; triglycerides >=1.70 mmol/L; HDL cholesterol <1.03 mmol/L in men or <1.29 mmol/L in women; blood pressure >=130/85 mmHg; or fasting plasma glucose >=6.1 mmol/L. This is broadly consistent with the Adult Treatment Panel III framework, although the exact version and treatment clauses should be confirmed [15,16]. Physical activity was classified against a threshold of at least 150 minutes of moderate-to-vigorous activity per week [17].

Statistical analysis

Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics version 25. Continuous variables were summarised as means and standard deviations, and categorical variables as frequencies and percentages. Wilson 95% CIs were calculated during editorial reconciliation for principal prevalence estimates. Pearson chi-square tests assessed associations between obesity class and categorical cardiometabolic outcomes. Two comparisons had at least one expected count below five; exact or Monte Carlo sensitivity analyses are recommended before submission if participant-level data are available. All tests were two-sided, and $p<0.05$ was considered statistically significant. The original reference to multivariable logistic regression was removed because no adjusted model outputs were supplied.

Ethics and reporting

The Health Research Ethics Committee of Irrua Specialist Teaching Hospital approved the study (ISTH/HREC/20231404/468). Written informed consent was reportedly obtained from each participant. Data were anonymised and stored in password-protected files, and participants with clinically important findings were referred for care. The manuscript was revised with reference to the

STROBE recommendations for cross-sectional studies [18].

Results

A total of 300 adults with obesity were included. The source manuscript did not report the number assessed for eligibility, excluded, declining participation, or completing each laboratory assessment; a participant-flow account is therefore required for final submission.

The mean age was 51.6 +/- 8.9 years. Participants were predominantly women (71.7%), married (89.7%), Christian (88.0%), of Esan ethnicity (73.3%), and traders (65.0%). Full sociodemographic characteristics are shown in Table 1.

Class I obesity was the most frequent BMI category (194/300, 64.7%), followed by Class II (79/300, 26.3%) and Class III (27/300, 9.0%) (Figure 1).

Hypertension was the most frequent cardiometabolic comorbidity (250/300, 83.3%), followed by dyslipidaemia (158/300, 52.7%), diabetes mellitus (98/300, 32.7%), and metabolic syndrome (79/300, 26.3%) (Table 2 and Figure 2). Total cholesterol >=200 mg/dL was present in 53.7%, triglycerides >=150 mg/dL in 42.0%, and HDL cholesterol <40 mg/dL in 15.3%.

Obesity class was significantly associated with hypertension, metabolic syndrome, dyslipidaemia, total cholesterol category, and triglyceride category (Table 3).

Table 1. Sociodemographic characteristics of adults with obesity (N=300)

Characteristic	Frequency, n	Percentage, %
Age, years		
<50	124	41.3
50-59	107	35.7
>=60	69	23
Sex		
Male	85	28.3
Female	215	71.7
Marital status		
Unmarried	31	10.3
Married	269	89.7
Religion		
Christianity	264	88
Islam	36	12
Ethnicity		
Esan	220	73.3
Etsako	41	13.7
Other	39	13
Education		
Primary or below	171	57
Secondary or above	129	43
Occupation		
Trader	195	65
Farmer	80	26.7
Civil servant	22	7.3
Unemployed	3	1

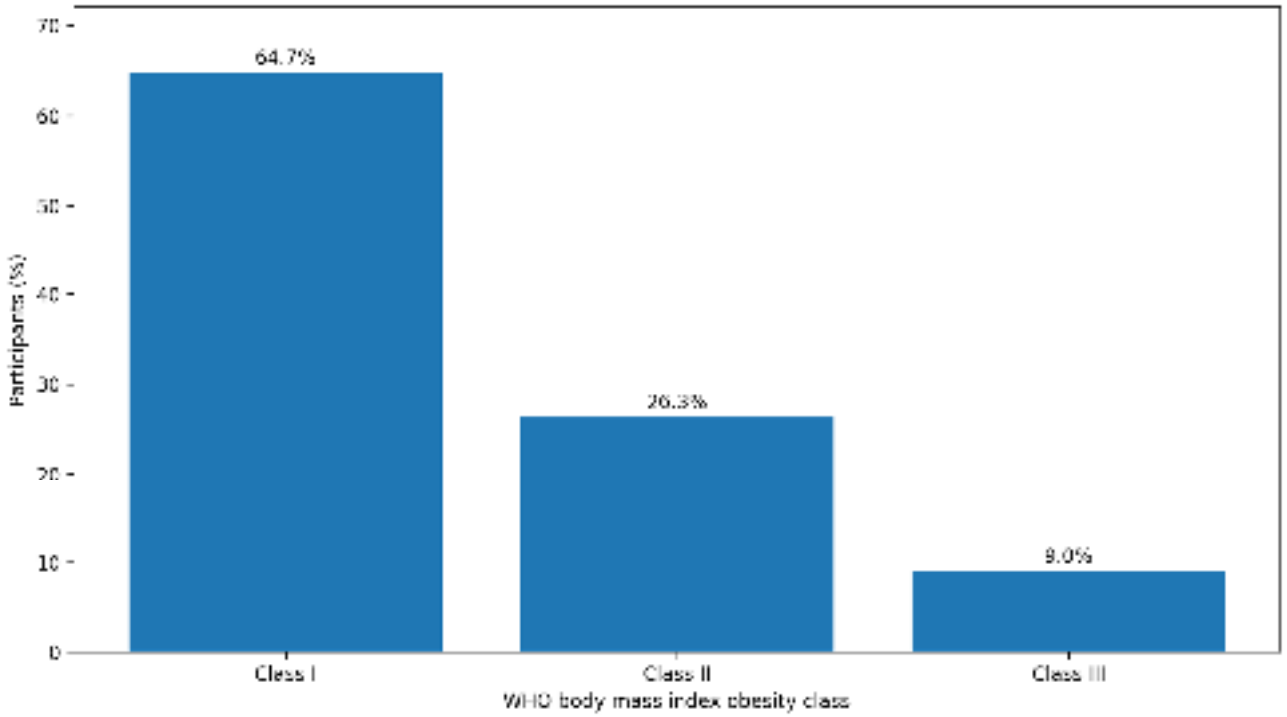

Figure 1. Distribution of participants by BMI-defined obesity class*

*=Class I: BMI 30.0-34.9 kg/m2; Class II: 35.0-39.9 kg/m2; Class III: >=40.0 kg/m2

Table 2. Cardiometabolic comorbidities and lipid abnormalities (N=300)

Outcome	Category	Frequency (n)	Percentage (%)	95% CI, %
Diabetes mellitus	Yes	98	32.7	27.6-38.2
	No	202	67.3	61.8-72.4
Hypertension	Yes	250	83.3	78.7-87.1
	No	50	16.7	12.9-21.3
Total cholesterol	>=200 mg/dL	161	53.7	48.0-59.2
	<200 mg/dL	139	46.3	40.8-52.0
Triglycerides	>=150 mg/dL	126	42	36.6-47.7
	<150 mg/dL	174	58	52.3-63.4
HDL cholesterol	<40 mg/dL	46	15.3	11.7-19.9
	>=40 mg/dL	254	84.7	80.2-88.3
Metabolic syndrome	Yes	79	26.3	21.7-31.6
	No	221	73.7	68.4-78.3
Dyslipidaemia	Yes	158	52.7	47.0-58.2
	No	142	47.3	41.8-53.0

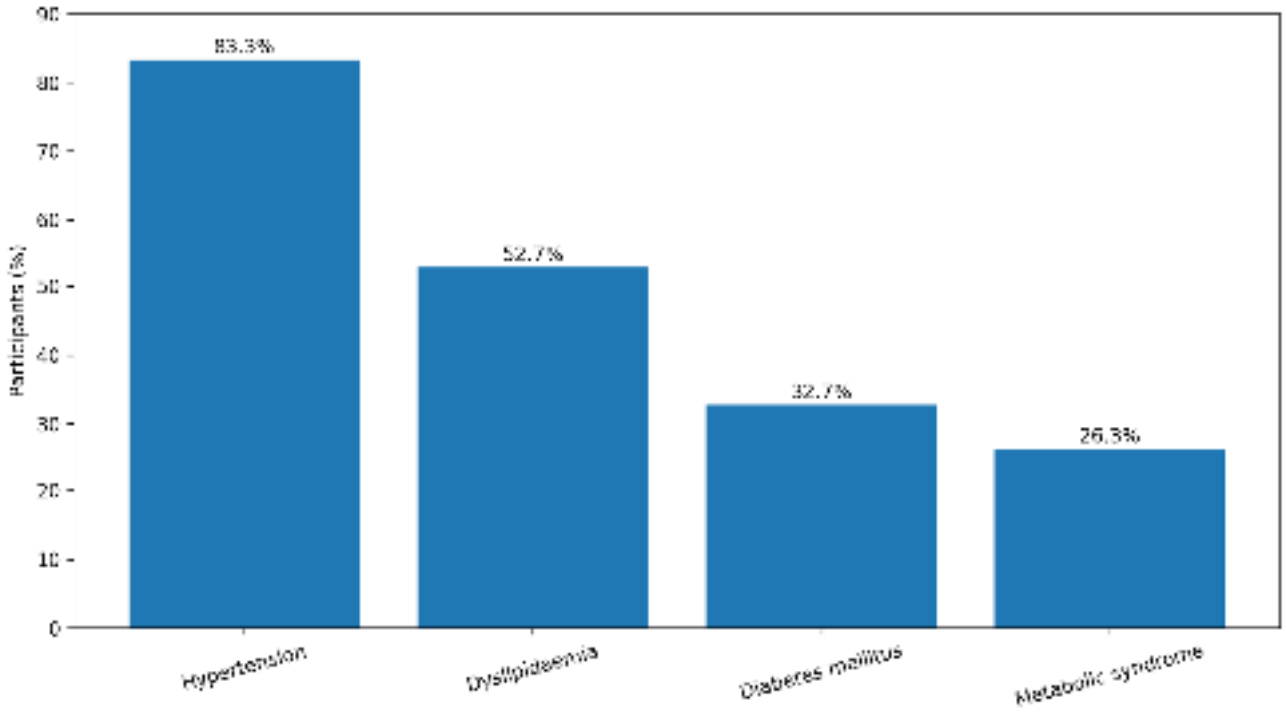

Fig 2. Prevalence of principal cardiometabolic comorbidities*

*=Categories are not mutually exclusive; a participant could have more than one comorbidity.

Table 3. Association between obesity class and cardiometabolic outcomes (N=300)

Outcome	Category	Class I (n=194)	Class II (n=79)	Class III (n=27)	chi-square	p-value
Hypertension	Yes	165 (85.1)	68 (86.1)	17 (63.0)	8.91	0.012
	No	29 (14.9)	11 (13.9)	10 (37.0)		
Diabetes mellitus	Yes	62 (32.0)	23 (29.1)	13 (48.1)	3.44	0.179
	No	132 (68.0)	56 (70.9)	14 (51.9)		
Metabolic syndrome	Yes	37 (19.1)	23 (29.1)	19 (70.4)	32.58	<0.001
	No	157 (80.9)	56 (70.9)	8 (29.6)		
Dyslipidaemia	Yes	112 (57.7)	37 (46.8)	9 (33.3)	7.12	0.028
	No	82 (42.3)	42 (53.2)	18 (66.7)		
Total cholesterol	>=200 mg/dL	91 (46.9)	54 (68.4)	16 (59.3)	10.76	0.005
	<200 mg/dL	103 (53.1)	25 (31.6)	11 (40.7)		
Triglycerides	>=150 mg/dL	61 (31.4)	43 (54.4)	22 (81.5)	31.16	<0.001
	<150 mg/dL	133 (68.6)	36 (45.6)	5 (18.5)		
HDL cholesterol	>=40 mg/dL	162 (83.5)	71 (89.9)	21 (77.8)	2.84	0.242
	<40 mg/dL	32 (16.5)	8 (10.1)	6 (22.2)		

Metabolic syndrome increased from 19.1% in Class I to 70.4% in Class III obesity. Raised triglycerides increased from 31.4% to 81.5% across the same categories. In contrast, hypertension was less frequent in Class III than in Classes I and II, and the recorded composite dyslipidaemia outcome decreased across obesity classes. Diabetes mellitus and HDL cholesterol did not differ significantly across obesity classes.

Discussion

This study identified a substantial concentration of cardiometabolic morbidity among adults with obesity attending a general outpatient clinic in Edo State. More than four in five participants had hypertension, approximately half had dyslipidaemia or total cholesterol >=200 mg/dL, one third had diabetes mellitus, and one quarter met the recorded definition of metabolic syndrome. Class I obesity was the most frequent BMI category. The clearest gradients across obesity classes were observed for metabolic syndrome and triglycerides.

The predominance of Class I obesity is consistent with earlier Nigerian primary-care observations, where Class I obesity also accounted for most adults identified with BMI >=30 kg/m2 [7]. This pattern should not be interpreted as reassuring. Cardiometabolic complications were already frequent within Class I obesity, including hypertension in 85.1%, dyslipidaemia in 57.7%, and metabolic syndrome in 19.1%. Primary-care obesity management should therefore be guided by total risk and comorbidity assessment rather than BMI class alone.

Hypertension was the most frequent comorbidity, affecting 83.3% of participants. This estimate is much higher than the pooled prevalence of 34.2% reported for Nigerian adults in studies published from 2015 to 2025 [19]. The difference is clinically plausible because the present sample was restricted to adults with obesity attending a tertiary-hospital outpatient service and had a mean age above 50 years. Selection into care, previous diagnosis, treatment status, and referral patterns may also increase the observed prevalence. The non-linear association with obesity class requires caution: hypertension was recorded in 85-86% of Classes I and II but 63.0% of Class III. The small Class III subgroup, survivor and treatment effects, or unmeasured confounding could contribute. The cross-sectional data do not establish a dose-response relationship.

Diabetes mellitus affected 32.7% of participants. A 2024 Nigerian systematic review estimated a national prevalence of 7.0% and a South-South prevalence of 11.35%, with obesity among the important associated factors [20]. The higher estimate in this study likely reflects enrichment for obesity, older age, clinic attendance, and inclusion of previously diagnosed diabetes. Although diabetes was most frequent in Class III obesity (48.1%), the overall association with BMI class was not statistically significant. The limited Class III sample reduces precision and may have constrained statistical power.

The lipid findings also indicate substantial risk, but they require careful methodological interpretation. Dyslipidaemia was recorded in 52.7%, total cholesterol >=200 mg/dL in 53.7%, and triglycerides >=150 mg/dL in 42.0%. African evidence shows that dyslipidaemia prevalence varies markedly according to population, lipid component, and threshold; pooled general-population estimates include 23.6% for elevated total cholesterol at >=5.2 mmol/L and 16.5% for elevated triglycerides at >=1.7 mmol/L [21]. A Nigerian meta-analysis estimated the pooled prevalence of hypercholesterolaemia at 38%, with a higher estimate in South-South studies [9]. Direct comparisons remain limited because the present report used inconsistent lipid definitions across its methods and results.

Triglycerides showed a strong, ordered increase across BMI classes, from 31.4% in Class I to 81.5% in Class III. This pattern is biologically plausible in the context of increasing insulin resistance and visceral adiposity, but waist circumference, treatment, dietary intake, and glycaemic control were not modelled. By contrast, the composite dyslipidaemia variable decreased across BMI classes. Because its recorded prevalence is lower than the number with total cholesterol >=200 mg/dL, the composite cannot simply represent the presence of any listed lipid abnormality. The finding should not be interpreted substantively until the coding algorithm is verified against the dataset and laboratory definitions.

Metabolic syndrome affected 26.3% overall and increased sharply with obesity class, reaching 70.4% in Class III. A large African meta-analysis reported an overall prevalence of 32.4%, with estimates varying from 29.3% to 44.8% according to the definition used [22]. The present estimate is therefore within the broad range reported across African studies, but diagnostic criteria, population selection, and sex distribution differ. The strong class gradient is compatible with clustering of central adiposity, blood pressure, glucose, and lipid abnormalities; nevertheless, the cross-sectional design cannot determine temporal or causal pathways.

These findings support integrated cardiometabolic assessment in obesity care. At a minimum, general outpatient services should measure blood pressure accurately, assess glycaemia, obtain a fasting or otherwise guideline-appropriate lipid profile, review medication and family history, and evaluate overall cardiovascular risk. Lifestyle support should be culturally and economically feasible, with referral for dietetic, medical, or specialist care according to risk and comorbidity. Because the study was not designed to test interventions, it cannot determine the effectiveness or cost-effectiveness of specific care pathways.

Strengths

The study evaluated several clinically relevant outcomes in the same defined outpatient population, used direct anthropometric and biochemical measurements, and provided obesity-class cross-tabulations that could be independently

checked. The revision also reconciled all published counts, percentages, chi-square statistics, and p-values.

Limitations

The hospital-based sample was selected from adults with obesity who sought care and cannot estimate population prevalence or be generalised to all adults with obesity in Edo State or Nigeria.

The cross-sectional design prevents conclusions about temporal sequence or causality.

Participant-flow data, response rate, and reasons for non-participation were not reported, creating uncertainty about selection bias.

The systematic sampling interval is internally inconsistent and requires confirmation from recruitment records.

The Class III subgroup was small (n=27), reducing precision and producing sparse expected cells in two chi-square analyses.

Lipid thresholds and the composite dyslipidaemia algorithm were inconsistent across the source methods and results. Medication use may also have altered measured lipid, glucose, and blood-pressure values.

The manuscript did not provide analyser and reagent details, laboratory precision estimates, questionnaire validation results, or participant-level data for independent verification and adjusted analysis.

Potential confounders, including age, sex, waist circumference, medication use, physical activity, smoking, alcohol use, diet, and socioeconomic characteristics, were not included in the reported association analyses.

Conclusion

Adults with obesity attending this general outpatient clinic had a high burden of hypertension, dyslipidaemia, diabetes mellitus, and metabolic syndrome. Metabolic syndrome and raised triglycerides increased substantially across BMI classes, whereas hypertension and the recorded composite dyslipidaemia outcome showed non-linear patterns. These findings support routine integrated cardiometabolic assessment alongside obesity management in outpatient practice. Interpretation should remain cautious because the study was hospital-based and cross-sectional, the Class III subgroup was small, and key sampling and lipid-coding details require confirmation.

Declarations

Ethics approval and consent to participate: The Health Research Ethics Committee of Irrua Specialist Teaching Hospital approved the study (ISTH/HREC/20231404/468). Written informed consent was reportedly obtained from all participants.

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Funding: Nil

Conflicts of Interest: Nil