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Cardiometabolic risk profiles and metabolic syndrome among adults with hypertension attending a chronic care clinic in Eastern Uganda: A Cross-Sectional Study

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Abstract

Background

Metabolic syndrome (MetS) is a growing public health burden associated with increased cardiovascular morbidity and mortality, particularly among patients with hypertension (HTN). Comprehensive cardiometabolic risk profiling, including estimation of 10-year cardiovascular (CVD) risk, provides an estimate of overall cardiovascular risk. However, data on MetS and cardiovascular risk profiles among HTN patients in Uganda are limited. Understanding the prevalence, associated factors, and cardiovascular risk profile is critical for designing preventive and management strategies.

Objective

To determine the prevalence and factors associated with MetS and to describe the 10-year cardiovascular risk profile among patients with HTN attending the Chronic Care Clinic at Mbale Regional Referral Hospital in Eastern Uganda.

Methods

A cross-sectional study that involved 384 patients with HTN was conducted between December 2024 and April 2025, using a structured questionnaire modified from the WHO STEPwise instrument®. Physical measurements and laboratory investigations were systematically collected. MetS was defined using the harmonized 2009 criteria. Ten-year CVD risk was estimated using three published algorithms: QRISK3, the ASCVD Pooled Cohort Equation, and the Framingham Risk Score. Data were summarized as proportions, means, and standard deviations. Adjusted prevalence ratios (APR) and their 95% confidence intervals (CI) were calculated using modified Poisson regression.

Results

Of 384 participants, 74.5% (286/384) had MetS. Independent factors associated with MetS were female sex (APR 1.44; 95% CI 1.25–1.66; $p < 0.001$) and increasing age (APR 1.004 per year; 95% CI 1.001–1.008; $p = 0.027$). Central obesity (81.3%), low HDL-C (59.4%), and hypertriglyceridemia (44.5%) were the most prevalent components. The proportion of participants classified as high 10-year cardiovascular risk was 17.8% by QRISK3, 19.6% by ASCVD, and 43.8% by Framingham.

Conclusion

MetS was highly prevalent in this hypertensive population and was associated with female sex and increasing age. A substantial proportion of participants were classified as having elevated 10-year

cardiovascular risk. Routine assessment and management of MetS components in HTN clinics is warranted for early risk stratification and intervention.

Background

Globally, metabolic syndrome (MetS) affects approximately 20–25% of the adult population, with prevalence rising steadily as obesity rates grow, sedentary lifestyles increase, and the population ages [1, 2]. MetS is characterized by the presence of at least three metabolic components, including dyslipidemia, hyperglycemia, elevated blood pressure, and central obesity [3]. MetS has been associated with approximately a doubling of the risk of cardiovascular events and a 1.5-fold increase in all-cause mortality [4].

Hypertension (HTN) affects approximately 31.1% of the global population, while the burden in sub-Saharan Africa is about 35% [5]. According to the 2023 STEPwise approach to NCDs risk factor surveillance (STEPS) survey, over 22% of Ugandans have HTN [6], and another study by Kiggundu et al. (2023) showed an increase of 12% from 2016 to 2021 [7]. The burden of HTN is high in Eastern Uganda, with a study by Kanyike et al. (2024) among people living with HIV (PLHIV) reporting a prevalence of 37.5%, of whom 68% were unaware of their condition [8]. Mbale Regional Referral Hospital (MRRH) serves a large, predominantly rural catchment population and is a major referral Centre for chronic disease care; understanding the cardiometabolic profile of patients attending this clinic is therefore critical for regional health planning.

HTN is one of the five components of MetS. Patients with HTN frequently have additional metabolic components (central obesity, dyslipidemia, or hyperglycemia) due to shared risk factors such as sedentary lifestyle, unhealthy diet, and elevated body mass index as well as shared pathophysiological pathways including insulin resistance [9, 10]. Early detection of MetS in individuals with HTN is therefore critical to prevent complications like coronary artery disease and type 2 diabetes [3, 10].

In sub-Saharan Africa, MetS prevalence is rising, with a meta-analysis estimating 32.4% across the region [11]. In Uganda, reported MetS prevalence ranges from 19.1% in rural settings [12] to 36% among general outpatients [13]. Moreover, data on both MetS and the cardiovascular risk profile of hypertensive patients in Uganda are limited. This study therefore aimed to determine the prevalence and factors associated with MetS and to describe the 10-year cardiovascular risk profile among adults with hypertension attending the chronic care clinic at MRRH in Eastern Uganda.

Materials and Method

A cross-sectional study was conducted between December 2024 and April 2025. The study was conducted in the chronic care clinic of MRRH (a government-funded facility that offers free services). It is located in the Eastern part of Uganda, within Mbale city. The chronic care clinic runs within the MRRH outpatient clinic and is one of the 16 regional referral public health facility treatment centers nationwide. The clinic runs every Thursday, attending to about 150–200 patients per clinic day. The study targeted all

adult patients with HTN. Patients with HTN enrolled for routine care in the chronic care clinic of MRRH were recruited. Our study included adult patients with HTN (≥ 18 years), who consented to participate in this study and excluded those patients who reported to have taken breakfast on the day of enrollment, pregnant women and those found to have hypertensive emergency.

Sample size and sampling procedure

The sample size was calculated using the Kish-Leslie formula for a single proportion: $n = Z^2 \times p\,(1-p) / d^2$. The expected prevalence of metabolic syndrome was taken as 48.7%, based on a cross-sectional study of hypertensive patients in Ethiopia [14]. With a margin of error of 5% and a 95% confidence level (Z = 1.96), the required sample was 384 participants. A total of 384 eligible participants were consecutively enrolled to meet the calculated sample size. Trained research assistants informed potential participants about the study in English or the local language. Those who consented and met the inclusion criteria were enrolled.

Data Collection Personnel and Tools

Participants were reviewed by the research assistants and the principal investigator. Data was collected using a WHO modified STEPwise approach® [15], adapted and contextualized for the Ugandan setting and this specific study on Metabolic Syndrome among patients with HTN. Those who fulfilled the study criteria were enrolled and assigned specific identification codes.

Clinical data was collected through chart reviews, medical history, and physical examination. This included patients' demographics, biophysical parameters, lifestyle, and social characteristics. Disease-specific characteristics were also ascertained, including the duration of HTN, type of anti-hypertensive agents used, and subjective adherence to anti-hypertensive drugs. Additionally, data on the components of Metabolic Syndrome (waist circumference, blood pressure, fasting blood glucose, triglyceride levels, and high-density lipoprotein cholesterol levels) and other relevant associated factors were collected. On average, 20 to 30 participants were interviewed per clinic day without interrupting routine patient care.

Blood pressure was measured using a standard mercury sphygmomanometer after participants rested for at least 5 minutes in a seated position. Blood pressure was initially measured in both arms to identify the arm with the higher reading. Subsequently, three consecutive readings were taken from that arm only, with a one-minute interval between each reading. For analysis, the mean of the second and third readings from the arm with the highest blood pressure was used. Blood pressure values ≥ 130/85 mmHg were considered elevated. All readings were double-checked for accuracy and completeness, and participants were informed of their final measurements.

Waist circumference was measured in a private space using a non-stretchable Seca® brand measuring tape. Measurements were taken directly over the skin, or over light clothing, if necessary, after removing bulky garments. The measurement point was the midpoint between the upper edge of the iliac crest and

the lower edge of the last palpable rib. Participants stood upright with feet together, arms relaxed, and weight evenly distributed, and the measurement was recorded after a normal expiration. Each measurement was taken once, recorded to the nearest 0.1 cm, ensuring the tape fit snugly without skin compression. Abdominal obesity was defined as a waist circumference greater than 80 cm for women and more than 94 cm for men.

For point of care fasting glucose analysis, a trained nurse aseptically drew a single 5 mL venous blood sample from the antecubital vein of each participant who had not eaten breakfast. Immediately after venipuncture, a drop of whole blood was applied to a OneTouch Select Plus® glucometer test strip (using the glucose dehydrogenase method). The glucometer was verified against the laboratory analyzer weekly. Plasma-equivalent glucose readings ≥ 5.6 mmol/L were classified as elevated; participants using anti-diabetic medication were also classified as having elevated fasting glucose.

Blood samples were collected and immediately placed in an ice-packed cooler, then transported under strict cold chain conditions to the ISO-certified Biochemistry and Molecular Biology Laboratory at Busitema University Faculty of Health Sciences (BUFHS) within two hours of the blood draw. Upon arrival, samples were promptly centrifuged at 3000 rpm for 5 minutes to isolate serum. Subsequent lipid profile analysis for HDL-C and Triglycerides (TG) was performed using a semi-automatic Biobase BK200 chemistry analyzer and measured using an enzymatic colorimetric method, adhering strictly to the manufacturer's protocols. Hypertriglyceridemia was defined as TG ≥ 1.7 mmol/L, and low HDL-C was defined as < 1.03 mmol/L in men and < 1.29 mmol/L in women.

All laboratory test results were issued after a professional judgment and cross-checking by the designated laboratory quality assurance officer on duty.

The harmonized 2009 criteria require ≥ 3 of 5 components. Since all participants had hypertension (≥ 130/85 mmHg or on treatment), they already had 1 component. Therefore, MetS was present if they had ≥ 2 additional components, for a total of ≥ 3 [16].

Ten-year CVD risk was calculated using three algorithms: QRISK3, the ASCVD Pooled Cohort Equation and the Framingham Risk Score. QRISK3 incorporates age, sex, ethnicity (Black African), smoking, systolic blood pressure, total-to-HDL-C ratio, BMI, diabetes and several additional clinical variables; variables not collected were entered as absent [17]. The algorithm was developed for ages 25–84 years; participants outside this range were excluded. Scores were categorised as low (< 10%), moderate (10–20%) and high (> 20%).

The ASCVD Pooled Cohort Equation uses age, sex, race (Black), total cholesterol, HDL-C, systolic BP, hypertension treatment, diabetes and smoking [18]. The algorithm was developed for ages 40–79 years; scores were categorised as low (< 5%), borderline (5-7.5%), intermediate (7.5–20%) and high (≥ 20%). The Framingham Risk Score uses age, sex, total cholesterol, HDL-C cholesterol, systolic BP, hypertension treatment, smoking and diabetes [19]. The algorithm was developed for ages 30–74 years; scores were categorised as low (< 10%), moderate (10–20%) and high (≥ 20%).

All three tools were applied to the same study population to describe the cardiovascular risk profile.

Data Management

Electronic data were collected using Android tablets with KoBoToolbox and reviewed daily for completeness and consistency before being exported to Microsoft Excel® for initial screening and data capture checks. All digital data were stored on a password-protected external disk. Additionally, hard copy informed consent forms were collected, restricted to the Principal Investigator who was a student pursuing a Master of Medicine in Internal Medicine, and securely stored. Both digital and hard copy data utilized study identification numbers, containing no direct identifiers.

Statistical Analysis

Data from KoBoToolbox® were exported to Microsoft Excel® for initial screening and then transferred to STATA® version 17 for all statistical analyses. Descriptive statistics, including frequencies, percentages, means, standard deviations, medians, and interquartile ranges, were used to summarize participant characteristics and determine MetS prevalence, with graphical presentations using pie or bar charts. For identifying factors associated with MetS, bivariate analysis involved chi-square tests for categorical variables and t-tests for continuous variables. Variables with a p-value < 0.2 in bivariate analysis were considered for the multivariable model, together with selected a priori variables. Detailed bivariate screening of candidate variables is presented in Supplementary Table S1.

Adjusted prevalence ratios (APR) and their 95% confidence intervals (CI) were calculated using modified Poisson regression with robust variance estimation. This approach was selected because the outcome was highly prevalent (> 10%), making prevalence ratios more appropriate and interpretable than odds ratios. Statistical significance was set at $p < 0.05$.

This study adheres to the STROBE guidelines for cross-sectional studies (see Supplementary File 1).

Results

Throughout the study period, 411 patients were screened. After applying the inclusion and exclusion criteria, 384 participants were enrolled in the study.

Sociodemographic and Lifestyle Characteristics of Study Participants

The study participants exhibited a mean age of 53.2 ± 13.8 years, with a significant female predominance of 232 (60.4%).

Table 1
Sociodemographic Characteristics of Study Participants (n = 384)

Variable	n (%)
Sex	
Female	232 (60.4)
Male	152 (39.6)
Age (years), mean ± SD	53.2 ± 13.8
Education level	
No formal schooling	133 (34.6)
Primary school	171 (44.5)
Secondary school	75 (19.5)
College/University	5 (1.3)
Marital status	
Currently married	242 (63.0)
Widowed	58 (15.1)
Divorced	54 (14.1)
Never married	30 (7.8)
Occupation	
Peasant	208 (54.2)
Self-employed	84 (21.9)
Retired	50 (13.0)
Other	42 (10.9)
Monthly income (UGX)	
< 250,000	334 (87.0)
250,000–500,000	46 (12.0)
> 1,000,000	4 (1.0)
Residence	
Rural	217 (56.5)
Urban	167 (43.5)

Variable	n (%)
Current tobacco use	
Yes	27 (7.0)
No	357 (93.0)
Ever consumed alcohol	
Yes	110 (28.6)
No	274 (71.4)
Physical activity ≥ 5 days/week	
Yes	108 (28.1)
No	276 (71.9)

Prevalence of Metabolic Syndrome.

The overall prevalence of MetS was 74.5% (286/384). The most prevalent components were central obesity (81.3%), low HDL-C (59.4%), hypertriglyceridemia (44.5%), and elevated fasting glucose (25.5%).

Table 2
Clinical and Metabolic Characteristics of Participants (n = 384)

Variable	Value
BMI (kg/m²), mean ± SD	28.5 ± 3.2
Waist circumference (cm), mean ± SD	94.6 ± 9.3
Systolic BP (mmHg), mean ± SD	153.9 ± 22.9
Diastolic BP (mmHg), mean ± SD	92.1 ± 14.4
Fasting blood glucose (mmol/L), mean ± SD	5.78 ± 2.65
Total cholesterol (mmol/L), mean ± SD	5.82 ± 1.34
HDL-C (mmol/L), mean ± SD	1.16 ± 0.66
LDL-C (mmol/L), mean ± SD	3.10 ± 0.29
TG (mmol/L), mean ± SD	2.13 ± 1.51
MetS components, n (%)	
Central obesity	312 (81.3)
Elevated TG	171 (44.5)
Low HDL-C	228 (59.4)
Elevated fasting glucose	98 (25.5)
MetS (≥ 2 components)	286 (74.5)

Factors Associated with Metabolic Syndrome

Table 3
Crude Prevalence Ratio (CPR) and Adjusted Prevalence Ratios (APR) for Factors Associated with Metabolic Syndrome (n = 384)

Variable	CPR (95% CI)	p value	APR (95% CI)	p value
Sex				
Male	1.00 (ref)		1.00 (ref)	
Female	1.43 (1.25–1.64)	< 0.001	1.44 (1.25–1.66)	< 0.001
Age (per year)	1.01 (1.00–1.02)	0.130	1.004 (1.001–1.008)	0.027
Education				
Secondary/College	1.00 (ref)		1.00 (ref)	
No formal/Primary	1.02 (0.90–1.15)	0.782	1.03 (0.89–1.20)	0.653

Note: The College/University reference group contained only 5 participants; education was therefore collapsed into two categories. Education was retained in the final model as a core sociodemographic variable despite its crude p-value exceeding 0.2. Smoking met the bivariate inclusion criterion (CPR 0.61; 95% CI 0.40–0.91, p = 0.015) but was excluded from the final multivariable model because of the small number of current smokers (n = 27) and the biologically implausible direction of effect. When included in an age- and sex-adjusted model, the association was attenuated (APR 0.75; 95% CI 0.49–1.14), suggesting confounding.

After adjustment, women had a 44% higher prevalence of MetS than men (APR 1.44; 95% CI 1.25–1.66; p < 0.001), and each one-year increase in age was associated with a 0.4% increase in MetS prevalence (APR 1.004; 95% CI 1.001–1.008; p = 0.027).

Ten-year cardiovascular risk profile

Table 4: Ten-Year Cardiovascular Risk Profile of the Study Population

Variable	QRISK3 (n = 377)	ASCVD (n = 306)	Framingham (n = 347)
Score (%), mean ± SD	11.2 ± 12.4	13.2 ± 13.5	22.9 ± 18.9
Risk category, n (%)			
Low	232 (61.5)	91 (29.7)	92 (26.5)
Borderline	_	47 (15.4)	_
Moderate / Intermediate	78 (20.7)	108 (35.3)	103 (29.7)
High	67 (17.8)	60 (19.6)	152 (43.8)

Note: QRISK3 was developed for ages 25 - 84 years (7 excluded: 5 <25 years, 2 >84 years); ASCVD for 40 - 79 years (78 excluded); Framingham for 30 - 74 years (37 excluded). QRISK3 and Framingham categories: low (<10%), moderate (10 - 20%), high (≥20%). ASCVD categories: low (<5%), borderline (5 - 7.5%), intermediate (7.5 - 20%), high (≥20%).

Discussion

This study found a MetS prevalence of 74.5% (286/384) among hypertensive patients at MRRH, substantially higher than the 58.4% reported in Ghana [20], and Ethiopia (48.7%) [14]. It is, however, similar to a Moroccan study (71%) among HTN patients [21]. These comparable findings are likely due to a shared focus on clinical HTN populations and a high prevalence of abdominal obesity, 81.3% in this study, higher than 74% found in Morocco [21]. The very high central obesity rate may reflect the high burden of abdominal adiposity in this clinic-based hypertensive population, although the waist-circumference thresholds used are the standard European cut-offs (> 94 cm men, > 80 cm women) recommended by the harmonized criteria for African populations [16], therefore, the prevalence of central obesity is not inflated by lower cut-offs.. The chronic HTN care setting, with prolonged exposure to metabolic risk factors, further explains the observed high prevalence.

Compared to other East African studies, our prevalence is significantly higher. Examples include Ethiopia (34.9% using NCEP/ATP III) [22], Tanzania (21% among adults with HIV) [23], and Rwanda (51.6% in general populations) [24]. In Uganda, a prevalence of 36% was found among general outpatients at Fort Portal Regional Referral Hospital [13], a rural Ugandan adult population showed a much lower prevalence of 19.1% [12], and among corporate employees in Kampala, prevalence ranged from 22.8% to 28.4% [9]. These discrepancies are likely due to differences in study populations, data-collection periods, and diagnostic criteria, including our use of the Harmonised 2009 criteria [16].

Globally, our prevalence resembles findings from India (83.7% using ATP III criteria) [25], despite varying contributions from individual components like central obesity. In contrast, lower prevalences, ranging from 24.2% reported in general adult populations in China [26], to 38.3% in Iran [27]. These variations could be partly explained by the fact that those studies focused on general adult populations and were conducted during earlier stages of dietary and lifestyle transitions.

The independent predictors of MetS were female sex and increasing age. This finding aligns with observations from other studies carried out in rural Uganda [12], Rwanda [24], and Ghana [20]. The female predominance may be explained by higher central obesity rates, lower physical activity, and dietary differences. Given the mean age of 53.2 years, a significant proportion of female participants were likely peri- or post-menopausal, a state associated with increased visceral adiposity and adverse lipid changes independent of chronological aging [28]. Additionally, survival bias cannot be excluded, as men with severe MetS may have experienced premature mortality, leaving a healthier male cohort in this age group. However, a study in Iran reported a contrasting pattern where men were more likely to develop MetS in multivariate analysis [29].

Each additional year of age was associated with a small but significant increase in MetS prevalence, indicating a gradual accumulation of metabolic risk over the life course. This finding is in agreement with the pattern reported by Peer et al among urban Black South Africans [30], where MetS prevalence rose steeply across successive ten-year age bands, and by Ahmed et al [31], who observed that each additional decade of age more than doubled the odds of MetS in an urban East African population. Both studies attributed the progressive age-related rise to the cumulative impact of sedentary behaviour, dietary transitions, and the high prevalence of hypertension, conditions that are also characteristic of our clinic-based population. In contrast, the rural Ugandan study by Ben-Yacov et al did not identify age as a significant determinant of MetS [12]. That study had a younger mean age (44.2 ± 13.1 years), a smaller sample (183 participants), and recruited from a rural setting where higher physical activity levels and limited dietary westernization may have attenuated age associated metabolic changes.

The cardiovascular risk estimates from the three tools were markedly different. QRISK3 classified most participants as low risk, whereas Framingham classified 43.8% as high risk. This pattern is consistent with comparative studies in African populations [32–35]. Framingham tends to overestimate risk in non-European populations [36], while QRISK3 incorporates ethnicity-specific adjustments and additional clinical variables that may yield lower estimates when some conditions are assumed absent, as was the case here. ASCVD was calibrated primarily for African American populations and has not been validated in sub-Saharan Africa. Despite this variability, all three tools identified a clinically meaningful burden of cardiovascular risk, supporting the integration of cardiovascular risk assessment into routine hypertension care to improve risk stratification and guide targeted prevention.

Study Strengths

Strengths of this study include the use of harmonized international diagnostic criteria, standardized laboratory measurements with strict quality control (cold chain transport, ISO-certified laboratory, enzymatic colorimetric methods), and the application of modified Poisson regression, which is appropriate for common outcomes and provides interpretable prevalence ratios. The application of three published cardiovascular risk prediction models to the same population allowed for a direct comparison of risk classification across tools, providing a more comprehensive characterization of cardiovascular risk in this setting.

Study Limitations

This study has several limitations. The cross-sectional design precludes causal inference, and the single-clinic sample limits generalisability. Data collection coincided with an Ebola outbreak, which may have introduced selection bias. Self-reported lifestyle variables are subject to recall and social-desirability bias. The exclusion of patients who had eaten breakfast was necessary for fasting glucose and lipid measurements but may have introduced selection bias. Additionally, residual confounding from unmeasured variables cannot be excluded. All three risk prediction tools were developed in Western populations and have not been calibrated for East African settings; therefore, the absolute risk estimates and risk categorization should be interpreted with caution, as risk categorization may be misclassified.

Conclusions

Metabolic syndrome was highly prevalent among hypertensive patients in this clinic, with female sex and increasing age as independent factors associated with its occurrence. A substantial burden of elevated 10-year cardiovascular risk was observed across three risk prediction tools. These findings demonstrate a high burden of clustered cardiometabolic risk and underscore the importance of comprehensive risk assessment in this setting. Routine evaluation of metabolic syndrome components alongside global cardiovascular risk may facilitate earlier identification of high-risk individuals and support more targeted prevention strategies.

Abbreviations

APR
Adjusted prevalence ratio
ASCVD
Atherosclerotic cardiovascular disease
BMI
Body mass index
BP
Blood pressure
BUFHS
Busitema University Faculty of Health Sciences
CI
Confidence interval
CPR
Crude prevalence ratio
CVD
Cardiovascular disease
GCP
Good Clinical Practice
HDL-C
High-density lipoprotein cholesterol
HTN
Hypertension
ISO
International Organization for Standardization
LDL-C
Low-density lipoprotein cholesterol
MetS
Metabolic syndrome
MRRH

Mbale Regional Referral Hospital
NIDA
National Institute on Drug Abuse
PLHIV
People living with HIV
QRISK3
QRISK3 cardiovascular risk algorithm
REC
Research Ethics Committee
SD
Standard deviation
STEPS
STEPwise approach to NCD risk factor surveillance
TG
Triglycerides
UGX
Uganda shillings
WHO
World Health Organization

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the Mbale Regional Referral Hospital Research Ethics Committee **(**MRRH REC-OUT-011/2020). All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All data and study documents were stored securely according to Good Clinical Practice per NIDA's Version 5 on secure storage of research materials [37]. Informed consent was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used during this study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

EK: Conceptualization, project administration, writing the original draft, data collection and methodology. DB, AM and RK: Conceptualization, supervision, validation, review and editing. JPM contributed to the design and ensured adherence to the research protocols in the implementation. EA, ON, JI, JK contributed to data collection, review and editing.

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Figures

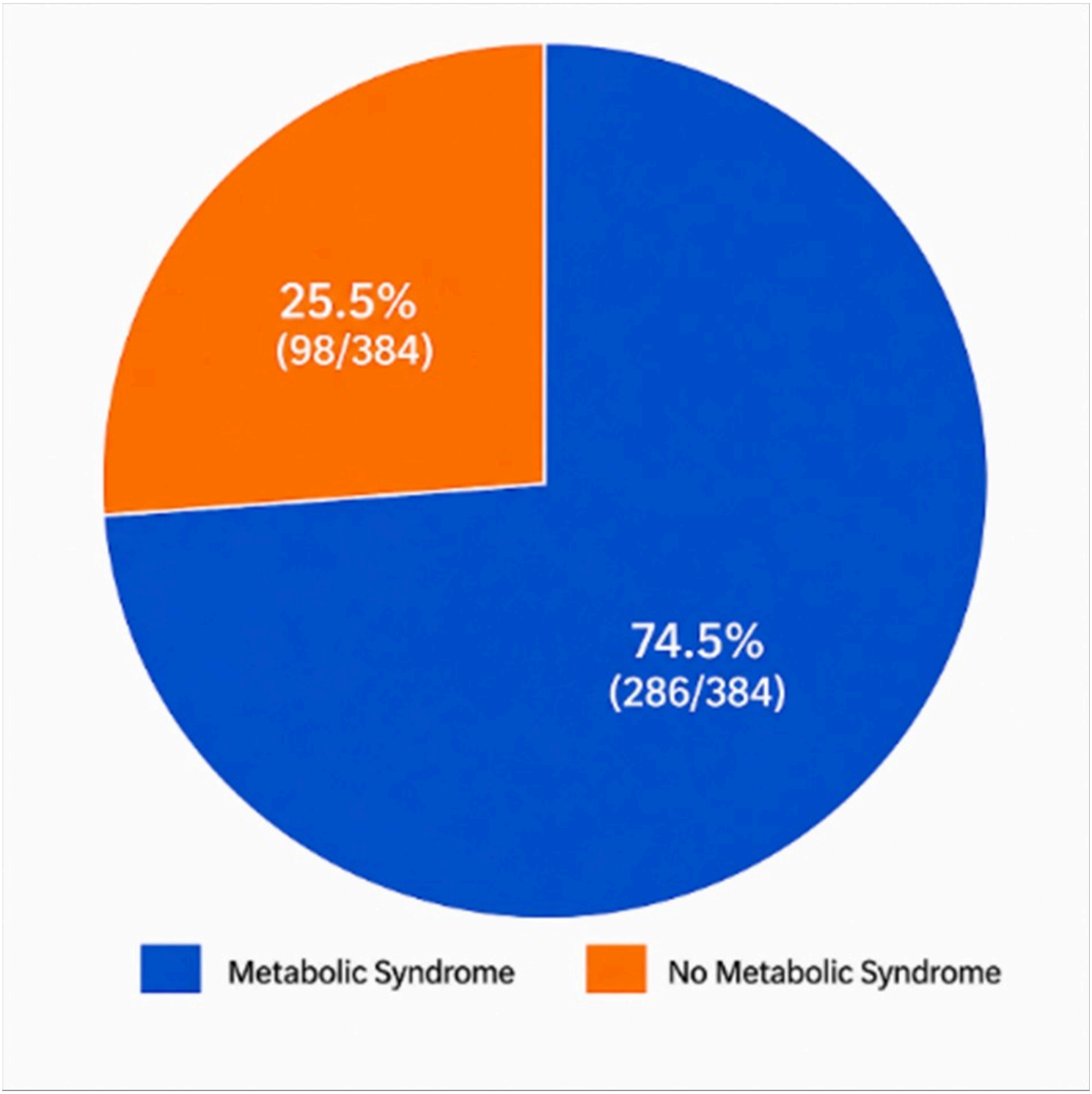


Figure 1

Prevalence of Metabolic Syndrome (n = 384)

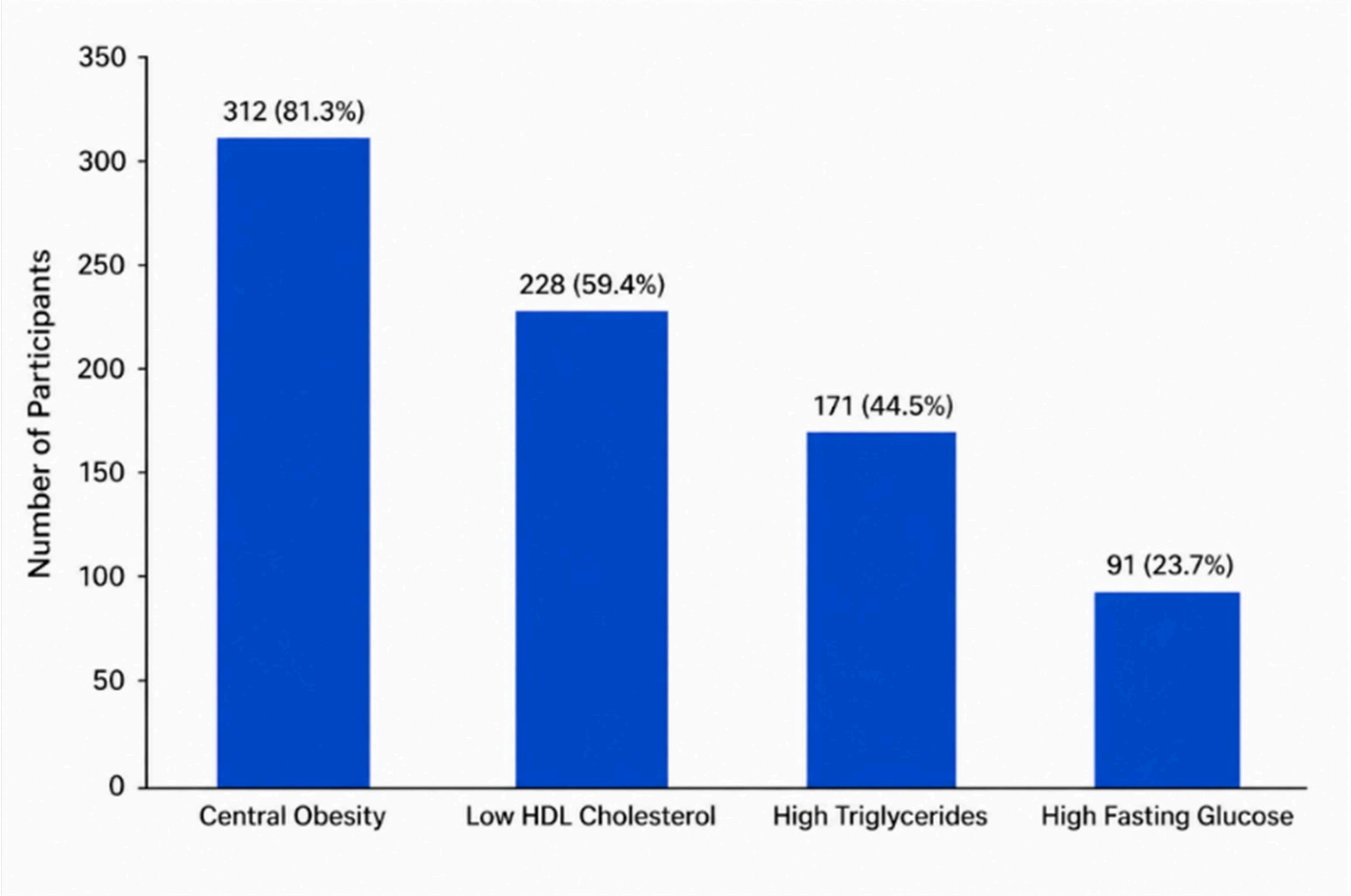


Figure 2

Bar chart of the prevalence of individual metabolic syndrome components among study participants (n = 384).

Supplementary Files

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- SupplementaryTableS1.docx
- SupplementaryFile1.doc