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Metabolic syndrome among adults undergoing first-time comprehensive health screening

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ABSTRACT

Background and aims: Metabolic syndrome (MetS) is characterized by central obesity, dyslipidemia, hypertension, and disorders of glucose metabolism. MetS increases the risk of type 2 diabetes and cardiovascular disease. This study aimed to estimate the prevalence of MetS and identify associated factors in adults undergoing their first comprehensive health screening at the Can Tho International Stroke Service Center, Can Tho City, Vietnam, from January to December 2025.

Methods: A cross-sectional study was conducted among 522 adults having their first comprehensive health screening. MetS was defined according to the National Cholesterol Education Program - Third Adult Treatment Panel (NCEP-ATP III) criteria, with adjustments for Asian waist circumference. Demographic, anthropometric, and biochemical variables associated with MetS were analyzed using logistic regression, with statistical significance set at $p < 0.05$.

Results: The prevalence of MetS was 35.6% (95% CI: 31.5–39.9). Individuals with MetS were more likely to be older, male, have a higher BMI, elevated blood pressure, adverse lipid profiles, and a greater intake of salt, sugar, and fat-rich foods ($p < 0.05$). Multivariable analysis identified age, sex, elevated BMI, increased triglycerides, low HDL cholesterol, and higher glucose levels as the strongest associated factors of MetS ($p < 0.05$).

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Conclusions: More than one-third of adults undergoing their first comprehensive health screening are diagnosed with Mets, highlighting the potential burden of previously unrecognized metabolic cardiovascular risk. This emphasizes the necessity of early detection and targeted lifestyle interventions in preventive healthcare settings. (www.actabiomedica.it)

Key words: metabolic syndrome, health screening, hdl-c, triglycerides, abdominal obesity, vietnam

Introduction

Metabolic Syndrome (MetS) is a combination of closely related cardiovascular and metabolic abnormalities, including central obesity, hypertension, dyslipidemia, and glucose metabolism disorders (1). These components are not merely individual risk factors; they reflect a syndrome of metabolic disorders with a common pathophysiological mechanism, where insulin resistance and visceral fat accumulation play a central role (2, 3). Visceral fat functions as an endocrine organ, secreting adipokines and cytokines that are crucial for regulating metabolic processes and the body's inflammatory response (4, 5). These substances promote a state of chronic low-grade inflammation. The inflammation and abnormal adipokines lead to impaired insulin signaling in target tissues such as muscle and liver (4-6). This insulin resistance directly results in disturbances in glucose and lipid metabolism, contributing to the development of metabolic syndrome (7, 8). The consequence of this process is the simultaneous occurrence of elevated triglycerides and reduced HDL cholesterol, which increases the atherogenicity. Elevated fasting blood glucose indicates impaired glucose control and acts as a mediator in the progression to type 2 diabetes (5, 7). Furthermore, hypertension arises from endothelial dysfunction, activation of the sympathetic nervous system, and the renin-angiotensin system, which are closely associated with insulin resistance (9, 10). In addition to increasing the risk of type 2 diabetes and cardiovascular diseases, Metabolic Syndrome also heightens the risk of other related chronic conditions (9, 11, 12). The global prevalence of metabolic syndrome varies widely, estimated to range from approximately 14% to 39% across countries, depending on demographic characteristics, lifestyle factors, and diagnostic criteria applied (13). Numerous studies have shown that the prevalence of MetS progressively increases with age, particularly among older adults, especially those over 60 years old (14). Additionally, there are notable geographic and socioeconomic differences in MetS prevalence, reflecting variations in lifestyle patterns, living conditions, urbanization levels, and access to healthcare services (15). In Vietnam, the prevalence of MetS in adults, according to the National Cholesterol Education Program - Third Adult Treatment Panel (NCEP-ATP III) criteria (16), varies significantly with age. In a population with a median age of 60, the prevalence of MetS is 40.6%, rising to 53.1% in those aged over 65 (17). In contrast, this rate is markedly lower in the working-age population. Specifically, a study of faculty members at Hanoi Medical University reported a prevalence of MetS of 12.5% (18), while a study of 57,997 employees in the Vinmec health system indicated a prevalence of around 16% (14). These results demonstrate that MetS tends to increase with age and is significantly influenced by occupational characteristics, physical activity levels, and access to healthcare services. Regular health screenings play a crucial role in early detection of metabolic disorders before clinical symptoms manifest, especially in adults who may be less inclined to seek preventive healthcare services (19). However, in Vietnam, many current health screening packages do not adequately include the necessary indicators for diagnosing metabolic syndrome, leading to a lack of evidence regarding its prevalence and epidemiological characteristics in the community. Therefore, implementing community-wide screening studies for metabolic syndrome is essential to provide a scientific basis

for developing prevention, management, and early intervention strategies for metabolic syndrome and associated chronic diseases.

Subjects and Methods

Study subjects

The study population consisted of adults undergoing first-time comprehensive health screening at Can Tho Stroke International Services, Can Tho city, Vietnam, from January to December 2025.

Inclusion criteria

Adults aged 18 years and older undergoing their first comprehensive health screening, with complete data available for metabolic syndrome assessment according to NCEP-ATP III criteria (16).

Exclusion criteria

Previous health screening, pregnancy, acute illness, chronic liver or kidney disease, endocrine disorders affecting metabolism, or incomplete data.

Study design

A cross-sectional study.

Sample size

The sample size was calculated using the formula for estimating a proportion:

$$n = \frac{z^2_{1-\alpha/2} p(1-p)}{d^2}$$

Where: n is the required sample size; α = 0.05, statistical significance level; Z(1-α/2) = 1.96, Z value from the Z table corresponding to the chosen α; p = 0.359 is the estimated prevalence of MetS in adults (20). We anticipated a 5% margin of error, yielding a minimum sample size of 354. A design effect of 1.5 was used to adjust the sample size. After excluding ineligible samples, the final analytical sample consisted of 522 participants.

Data collection

Data were collected using standardized research tools, including structured questionnaires, anthropometric measurements, blood pressure assessment, and fasting biochemical analyses conducted in an accredited laboratory. Metabolic syndrome was defined according to the National Cholesterol Education Program – Adult Treatment Panel III (NCEP-ATP III) (16) criteria for Asian populations.

Research variables

- Demographic Characteristics: age, sex, education level, occupation, marital status and economic status.
- Dietary habits: Intake of salty condiments (e.g., soy sauce, fish sauce, dipping salt), high-sugar foods and beverages (e.g., soft drinks, sweetened tea, milk tea, coffee with condensed milk), and high-fat foods (e.g., fatty meat, fried dishes, fat-rich soups) was assessed using a structured self-reported questionnaire with a 7-day recall period. For each category, consumption frequency was classified into four levels: never, 1–2 days per week, 3–4 days per week, and daily.
- Smoking Status: Tobacco use
- Biochemical Indicators: ALT (SGPT), AST (SGOT), Creatinine, Uric Acid, Total Cholesterol, Triglycerides, LDL Cholesterol, HDL Cholesterol, Glucose, HbA1c, GGT (Gamma-Glutamyl Transferase), eGFR (Estimated Glomerular Filtration Rate), Microalbuminuria.
- The Metabolic syndrome: In this study, metabolic abnormalities, including dyslipidemia, were defined according to the diagnostic criteria for metabolic syndrome proposed by the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) (16). In addition, metabolic syndrome was also identified based on the criteria of the International Diabetes Federation (IDF) (21), which were applied as supplementary criteria for comparison with the NCEP-ATP III definition. The primary difference between these two diagnostic systems lies in the role of central

Table 1. Comparison of diagnostic criteria for metabolic syndrome according to NCEP-ATP III and IDF

Criterion	NCEP-ATP III Definition (16)	IDF Definition (21)
Diagnostic principle	Metabolic syndrome is diagnosed when ≥ **3 of 5** components are present	**Central obesity is mandatory**, plus ≥ **2 of 4** additional components
Triglycerides (TG)	≥ 1.7 mmol/L	≥ 1.7 mmol/L or receiving treatment for elevated triglycerides
HDL-cholesterol (HDL-C)	< 1.03 mmol/L in men < 1.29 mmol/L in women	< 1.03 mmol/L in men < 1.29 mmol/L in women
Central obesity (waist circumference)	≥ 90 cm in men ≥ 80 cm in women *(Asian-specific cut-offs)*	**Mandatory**: ≥ 90 cm in men, ≥ 80 cm in women *(Asian-specific cut-offs)*
Blood pressure	Systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg or current antihypertensive treatment	BP ≥ 130/85 mmHg or current antihypertensive treatment
Fasting plasma glucose	≥ 5.6 mmol/L or treatment for hyperglycemia	≥ 5.6 mmol/L or previously diagnosed type 2 diabetes
Role of central obesity	One of five diagnostic components	A prerequisite for diagnosis

obesity: according to the IDF criteria, central obesity is a mandatory component for the diagnosis of metabolic syndrome, whereas under the NCEP-ATP III criteria, central obesity is considered one of several diagnostic components and is not required. The diagnostic criteria according to both definitions are presented in Table 1.

Data collection method

Data were collected through structured face-to-face interviews, clinical examination, and review of medical records. The questionnaire obtained information on demographic characteristics, lifestyle behaviors, and dietary habits. Fasting blood samples were collected after at least 8 hours of fasting, and biochemical analyses were performed in an accredited laboratory using standardized methods.

Error control methods

Potential sources of bias were minimized through standardized participant selection, uniform measurement protocols, and multivariable adjustment. Anthropometric and biochemical measurements were conducted by trained personnel using calibrated equipment and standardized laboratory assays. Information bias was reduced through structured questionnaires. Confounding was addressed using multivariable logistic regression with assessment of multicollinearity (VIF = 1.53).

Data entry and analysis methods

Data were entered using Epidata 3.1 and processed in SPSS 22.0. Each medical record was entered twice for comparison to reduce errors.

- Descriptive Statistics: For quantitative variables, mean, standard deviation, and min-max values were presented. For qualitative variables, frequency and percentage were provided.
- Related Factor Analysis: Variables potentially associated with the outcome were first examined using univariable logistic regression analysis. Variables with a p-value < 0.10 in the univariable analysis (22) were subsequently entered into the multivariable logistic regression model. were subsequently entered into the multivariable logistic regression model. Statistical significance was defined as a two-sided p-value < 0.05.

Research ethics

Participation is completely voluntary, and patients are clearly informed about the objectives and benefits of

Table 2. Metabolic Syndrome and Component Indicators

Component Indicators	Number (n = 522)	Percentage (%)	95% CI
Triglycerides ≥ 1.7 mmol/L	313	60.0	55.6-64.2
Decreased HDL-cholesterol, defined as < 1.03 mmol/L in men or < 1.29 mmol/L in women	167	32.0	28.0-36.2
Abdominal obesity, defined as a waist circumference ≥ 90 cm in men or ≥ 80 cm in women	166	31.8	27.8-36.0
Systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg	236	45.2	21.8-49.6
Fasting blood glucose ≥ 5.6 mmol/L	205	39.3	35.1-43.6
Metabolic syndrome - NCEP-ATP III	**186**	**35.6**	**31.5-39.9**
Metabolic syndrome - IDF	**98**	**18.8**	**15.5-22.4**

Abbreviations: CI: Confidence Interval

the study. They also have the right to decline participation without it affecting their treatment. All collected information is solely for research purposes, coded, and secured to protect the participants' identities.

Results

Prevalence of metabolic syndrome and its components

The results show that the prevalence of metabolic syndrome components in the study group (n = 522) is quite high and uneven across the indicators (Table 2). Specifically, hypertriglyceridemia (TG ≥ 1.7 mmol/L) is the most common component, observed in 60.0% of subjects (95% CI: 55.6–64.2). This is followed by hypertension (systolic blood pressure ≥ 130 mmHg and/or diastolic blood pressure ≥ 85 mmHg), accounting for 45.2% (95% CI: 21.8–49.6). Fasting hyperglycemia (≥ 5.6 mmol/L) was recorded in 39.3% of subjects (95% CI: 35.1–43.6). The remaining components have lower rates, including reduced HDL cholesterol (32.0%; 95% CI: 28.0–36.2) and abdominal obesity (31.8%; 95% CI: 27.8–36.0). Regarding the prevalence of metabolic syndrome, when applying the NCEP-ATP III criteria, 35.6% of subjects were identified as having metabolic syndrome (95% CI: 31.5–39.9). Meanwhile, according to the IDF criteria, this rate is significantly lower, at only 18.8% (95% CI: 15.5–22.4).

Demographic characteristics and metabolic syndrome

In univariable analyses, sex was not significantly associated with MetS prevalence (OR = 0.9; 95% CI: 0.7–1.4; p = 0.736). In contrast, age demonstrated a clear association with MetS. Participants aged 40–59 years and those aged ≥60 years had higher odds of MetS compared with individuals aged <40 years (OR = 2.2; 95% CI: 1.2–4.2; p = 0.011 and OR = 2.5; 95% CI: 1.3–4.8; p = 0.006, respectively).

When analyzed as a continuous variable, age remained significantly associated with MetS (OR = 1.02 per year; 95% CI: 1.01–1.04; p = 0.003). No significant associations were observed between MetS and occupation, educational level, or economic status (Table 3).

History of hypertension, bmi, smoking, dietary habits, and metabolic syndrome

Participants with MetS had a longer duration of hypertension than those without (mean ± SD: 1.7 ± 3.4 years vs. 0.6 ± 1.6 years). Each additional year of hypertension increased the odds of developing MetS by 30% (OR = 1.30; 95% CI: 1.20–1.40; p < 0.001). Body mass index also correlated with MetS, showing a 7% increase in risk for each kg/m² rise (OR = 1.07; 95% CI: 1.02–1.13; p = 0.009). Smoking duration had a modest association with MetS, where each additional year raised the odds by 3% (OR = 1.03; 95%

Table 3. Demographic characteristics and metabolic syndrome

Demographic characteristics	**Total**	**MetS (n = 186)**		**None (n = 336)**		**OR (95% CI of OR)**	***p-value***
Sex (n,%)							
Female	239	87	36.4	152	63.6	1 (ref.)	
Male	283	99	35.0	184	65.0	0,9 (0,7-1,4)	0.736
Age group (n,%)							
< 40	72	15	20.8	57	79.2	1 (ref.)	
40 - < 60	286	106	37.1	180	62.9	2.2 (1.2-4.2)	**0.011**
≥ 60	164	65	39.6	99	60.4	2.5 (1.3-4.8)	**0.006**
***Mean** (SD)*	*522*	*55.5 (11.4)*		*52.0 (13.4)*		*1.02 (1.01-1.04)*	***0.003***
Occupation (n,%)							
Farmer	99	33	33.3	66	66.7	1 (ref.)	
Administrative	69	23	33.3	46	66.7	1.1 (0.5-1.9)	>0,999
Business	113	44	38.9	69	61.1	1.3 (0.7-2.2)	0.398
Worker	55	19	34.5	36	65.5	1.1 (0.5-2.1)	0.879
Self-employed	73	28	38.4	45	61.6	1.3 (0.7-2.3)	0.496
Retired/Elderly	113	39	34.5	74	65.5	1.1 (0.6-1.9)	0.856
Education level (n,%)							
Primary school	52	20	38.5	32	61.5	1 (ref.)	
Secondary & high school	254	91	35.8	163	64.2	0.9 (0.5-1.7)	0.719
Postsecondary	216	75	34.7	141	65.3	0.9 (0.5-1.6)	0.613
Economic status (n,%)							
Well-off	149	51	34.2	98	65.8	1 (ref.)	
Sufficient	332	123	37.1	209	62.9	1.1 (0.8-1.7)	0.552
Poor	41	12	29.3	29	70.7	0.8 (0.4-1.7)	0.551

Abbreviations: n: frequency; %: Percentage; OR: odds ratio; CI: Confidence Interval, ref.: reference value

CI: 1.01–1.05; p = 0.032). Dietary habits significantly affected MetS risk; those consuming salty foods 1–2 days, 3–4 days, and daily showed higher odds compared to non-consumers (OR = 4.20, 4.60, and 6.80, respectively; all p < 0.001), indicating a clear dose–response relationship. While no significant association was found for sugary food consumption 1–2 days per week, those eating sugary foods 3–7 days per week or daily had significantly higher odds (OR = 2.70 and 2.40, respectively). Likewise, frequent high-fat food consumption (3–7 days per week) was linked to an increased likelihood of MetS compared to lower frequencies (OR = 1.60; 95% CI: 1.10–2.40; p = 0.040) (Table 4).

Biochemical parameters and metabolic syndrome

The biochemical parameters associated with Metabolic Syndrome (MetS) showed significant differences compared to those without MetS. ALT (SGPT) levels were elevated, with females at 31.66 (SD 20.93) and males at 40.52 (SD 21.83), versus 25.46 (SD 18.27) and 33.42 (SD 22.84) in the non-MetS group, respectively (p = 0.021 for females, p = 0.015 for males). AST (SGOT) was also higher in the MetS group (30.53 vs. 28.26; p = 0.001). Triglycerides were significantly elevated (3.14 vs. 1.99; p < 0.001), while HDL-cholesterol was lower for females (1.17 vs. 1.42; p < 0.001) and males (1.16 vs. 1.25; p = 0.015). Fasting plasma glucose

Table 4. History of Hypertension, BMI, Smoking, Dietary Habits, and Metabolic Syndrome

Variables	Frequency	MetS		None		OR (95% CI of OR)	*p-value*
Years with hypertension, *mean (SD)*	522	1.7 (3.4)		0.6 (1.6)		1.3 (1.2-1.4)	< **0.001**
BMI, *kg/ m², mean (SD*	522	24.5 (5.5)		23.0 (4.9)		1.07 (1.02-1.13)	**0.009**
Years of smoking, *mean (SD)*	522	3.0 (9.0)		1.5 (6.6)		1.03 (1.01-1.05)	**0.032**
Frequency of consuming salty foods (n=505) (n,%)							
Never	219	36	16.4	183	83.6	1 (ref.)	
1–2 days/week	100	45	45.0	55	55.0	4.2 (2.4-7.1)	< **0.001**
3–4 days/week	97	46	47.4	51	52.6	4.6 (2.8-7.8)	< **0.001**
Daily	89	51	57.3	38	42.7	6.8 (3.9-11.8)	< **0.001**
Frequency of consuming sugary foods (n=505) (n,%)							
Never	104	65	29.8	73	70.2	1 (ref.)	
1–2 days/week	284	86	30.3	198	69.7	1.02 (0.63-1.67)	0.928
3–7 days/week	52	28	53.8	24	46.2	2.7 (1.4-5.5)	**0.004**
Daily	65	33	50.7	32	49.3	2.4 (1.3-4.6)	**0.007**
Frequency of consuming high-fat foods (n=503) (n,%)							
Never – 2 days/week	382	125	32.7	257	67.3	1 (ref.)	
3–7 days/week	121	52	43.0	69	57.0	1.6 (1.1-2.4)	**0.040**

Abbreviations: MetS: Metabolic syndrome; SD: Standard deviation; BMI: Body Mass Index; OR: Odd ratio; CI: Confidence Interval, ref.: reference value

(6.63 vs. 5.27; $p < 0.001$) and HbA1c (6.39 vs. 5.94; $p < 0.001$) were also significantly higher in the MetS group. GGT levels were notably elevated in both genders (females: 59.93 vs. 39.29, $p = 0.004$; males: 121.44 vs. 75.69, $p = 0.002$). These findings indicate significant biochemical differences in individuals with MetS.

Multivariable analysis

Independent factors identified in Tables 4 and 5 were included in the multivariable logistic regression model, adjusted for gender and age (Table 6). The results showed that male gender had a statistically significantly lower likelihood of having metabolic syndrome (MetS) compared to females (OR = 0.51; 95% CI: 0.32–0.83; $p = 0.006$). Age was positively related to MetS; for each additional year, the risk of developing MetS increased by approximately 2% (OR = 1.02; 95% CI: 1.01–1.04; $p = 0.028$). BMI was also an independent risk factor, with a 1 kg/m² increase in BMI associated with an 8% increase in the risk of MetS (OR = 1.08; 95% CI: 1.02–1.14; $p = 0.009$). Among the biochemical blood indices, triglycerides had the strongest association with MetS; higher triglyceride levels increased the risk of MetS by 1.45 times (OR = 1.45; 95% CI: 1.23–1.71; $p < 0.001$). LDL cholesterol was also positively and statistically significantly related to MetS (OR = 1.31; 95% CI: 1.01–1.70; $p = 0.044$), whereas HDL cholesterol acted as a protective factor, with higher HDL levels significantly reducing the risk of MetS (OR = 0.15; 95% CI: 0.06–0.38; $p < 0.001$). Additionally, fasting plasma glucose (FPG) and HbA1c were independently associated with MetS; increased FPG raised the risk of MetS by 1.36 times ($p < 0.001$), and for each increase in HbA1c, the risk of MetS increased by 23% (OR = 1.23; 95% CI: 1.03–1.47; $p = 0.024$). Conversely, liver enzyme indices, including ALT, AST, and GGT, did not show statistically significant associations with MetS in the multivariable regression model ($p > 0.05$). Multicollinearity analysis indicated no multicollinearity among independent variables (VIF = 1.53).

Table 5. Biochemical Parameters and Metabolic Syndrome

Variables		MetS Mean (SD)	None Mean (SD)	OR (95% CI of OR)	*p-value*
ALT (SGPT), *U/L*	Female	31.66 (20.93)	25.46 (18.27)	1.02 (1.01-1.03)	**0.021**
	Male	40.52 (21.83)	33.42 (22.84)	1.02 (1.01-1.03)	**0.015**
AST (SGOT), *U/L*		30.53 (14.75)	28.26 (14.42)	1.01 (1.01-1.02)	**0.001**
Creatinine, *µmol/L*	Female	68.16 (14.13)	67.27 (12.74)	1.005 (0.98- 1.026)	0.614
	Male	91.32 (19.76)	89.63 (15.39)	1.006 (0.99-1.020)	0.427
Uric Acid, *µmol/L*	Female	309.96 (98.61)	301.80 (65.52)	1.001 (0.99-1.005)	0.443
	Male	384.41 (135.29)	382.21 (101.10)	1.001 (0.99-1.002)	0.877
Total Cholesterol, *µmol/L*		5.53 (1.43)	5.24 (1.21)	1.10 (0.96-1.27)	0.169
Triglycerides, *µmol/L*		3.14 (2.09)	1.99 (1.49)	1.60 (1.38-1.86)	< **0.001**
LDL–Cholesterol, *µmol/L*		3.30 (0.96)	3.20 (0.87)	1.12 (0.92-1.37)	0.248
HDL–Cholesterol, *µmol/L*	Female	1.17 (0.25)	1.42 (0.28)	0.023 (0.001-0.084)	< **0.001**
	Male	1.16 (0.30)	1.25 (0.27)	0.32 (0.12-0.80)	**0.015**
Glucose (FPG), *µmol/L*		6.63 (2.03)	5.27 (1.49)	1.5 (1.3-1.7)	< **0.001**
HbA1c, *%*		6.39 (6.16)	5.94 (1.15)	1.5 (1.3-1.7)	< **0.001**
GGT, *U/L*	Female	59.93 (43.69)	39.29 (48.17)	1.01 (1.003-1.017)	**0.004**
	Male	121.44 (92.0)	75.69 (123.49)	1.005 (1.002-1.009)	**0.002**

Abbreviations: SD: standard deviation; n: frequency; OR: Odd ratio; %: Percentage; CI: Confidence Interval

Table 6. Multivariable logistic regression model of factors including gender, age, BMI, biochemical indices, and Metabolic Syndrome

Variables	OR	95% CI of OR	S.e	*p-value*
Male	0.51	0.32-0.83	0.13	**0.006**
Age	1.02	1.01-1.04	0.01	**0.028**
BMI	1.08	1.02-1.14	0.03	**0.009**
ALT ALT (SGPT), *U/L*	1.01	0.99-1.03	0.01	0.178
AST (SGOT), *U/L*	0.98	0.96-1.71	0.01	0.216
Triglycerides, *µmol/L*	1.45	1.23-1.71	0.12	< **0.001**
LDL–Cholesterol, *µmol/L*	1.31	1.01-1.70	0.18	**0.044**
HDL–Cholesterol, *µmol/L*	0.15	0.06-0.38	0.07	< **0.001**
Glucose (FPG), *µmol/L*	1.36	1.19- 1.57	0.10	< **0.001**
HbA1c, *%*	1.23	1.03-1.47	0.11	**0.024**
GGT, *U/L*	1.002	0.998-1.007	0.002	0.152

Abbreviations: OR: Odd ratio, CI: Confidence Interval, S.e.: standard error

Discussion

Among the study participants, more than one-third were identified as having Metabolic Syndrome (MetS). This rate reflects a high burden of metabolic abnormalities and the potential risk of undiagnosed chronic diseases within this population group. Our findings are consistent with a study in high-middle-income Asian countries, which reported a 35.9% prevalence, marking it as a significant public health issue

(20). Furthermore, this rate is higher in developed countries such as Qatar, where the overall prevalence is 48.8% (23), and in the U.S., at 41.8% (2017-2018) (24). Age shows a strong and consistent relationship with metabolic syndrome in both univariate and multivariate analyses. The increase in MetS prevalence with age aligns with previous epidemiological evidence, indicating that aging is associated with the accumulation of metabolic disorders such as insulin resistance, dyslipidemia, and hypertension over time (25). Obesity, assessed by BMI, is closely related to metabolic syndrome and is considered a chronic disease (26). This aligns with the hypothesis that the accumulation of fat, particularly visceral fat, plays a central role in the pathogenesis of this syndrome (27). Although gender did not show a statistically significant relationship with Metabolic Syndrome in univariate logistic regression, adjusting for confounding factors indicated that males had a lower prevalence of Metabolic Syndrome than females in the multivariate model. This finding may reflect gender differences in body fat distribution, as men tend to have more abdominal obesity than women, who are influenced by societal standards of beauty that emphasize a smaller waist in Vietnamese culture. This gender characteristic is consistent with several studies in Qatar, where men have a higher risk of MetS. This difference may be related to a sedentary lifestyle, a Western-style diet, and high obesity rates, factors considered primary causes of the increasing burden of MetS in the Middle East (23). Additionally, age-related metabolic changes may contribute, as previous studies have reported higher prevalence rates of MetS in older women (28-30), particularly after menopause (31). Among the biochemical indicators, elevated triglycerides show the strongest association with metabolic syndrome, while higher levels of HDL-cholesterol are protective. These findings align with previous studies analyzing the components of metabolic syndrome, where dyslipidemia, particularly elevated triglycerides and decreased HDL-cholesterol, are common and important characteristics of the syndrome (31, 32). Moreover, fasting plasma glucose and HbA1c demonstrate independent associations with Metabolic Syndrome, emphasizing the crucial role of glucose regulation disorders in the pathophysiology of this condition (32). Lifestyle factors, particularly eating habits, show a significant relationship with Metabolic Syndrome. The frequency of consuming foods high in salt, sugar, and fat tends to correlate with a higher prevalence of MetS, as these foods contribute to insulin resistance, dyslipidemia, and chronic disease (33). This is consistent with evidence indicating that an unhealthy diet contributes to the worsening of MetS (34, 35). These results emphasize the importance of integrating nutritional assessment and counseling into community health screening programs, especially for populations with limited access to preventive healthcare services. This study highlights the necessity of implementing screening programs to detect metabolic disorders early, particularly in high-risk adults with limited access to preventive healthcare services. Fully applying the diagnostic criteria for MetS as recommended internationally in regular health screening packages will provide reliable evidence regarding the burden and epidemiological characteristics of this syndrome in Vietnam, especially for those aged 40 and above. The screening results could serve as a scientific basis for developing and implementing prevention and management programs for MetS and other non-communicable diseases in the community, in line with the goals of the universal health insurance policy (36). The study has several limitations, including a cross-sectional design that does not allow for causal inferences, potential bias in self-reported lifestyle data, and the study sample being collected from a single screening facility, which limits generalizability.

5. Conclusion

The high prevalence of Metabolic Syndrome among adults participating in initial health screenings reflects a significant potential burden of metabolic disorders within the community. Lifestyle factors, particularly unhealthy diets, are clearly associated with MetS, while modifiable biochemical indicators such as triglycerides, HDL-cholesterol, and glucose dysregulation play an important role. The findings emphasize the necessity for interventions targeting lifestyle behavioral changes, coupled with early monitoring and management of metabolic risk factors. Integrating MetS screening into regular healthcare programs will

facilitate early detection and mitigate the progression of non-communicable diseases in the community.

Ethical Approval: The study protocol was approved by the Ethics Committee of Biomedical Research Can Tho Stroke International Services, Can Tho city, Vietnam - Approval No. 0924/GCN- S.I.S, dated December 30, 2024.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Authors' Contribution: C.C. Tran and D.D. Tran designed the study. D.D. Tran, T.K.A. Nguyen, and D.T. Vo conducted a data investigation and ensured accurate and stringent exclusions based on the study criteria. T.T.H. Nguyen and Q.S. Huynh handled the analysis, interpretation, and writing of the paper. K.H. Phan finalized the English version of the manuscript. C.C. Tran and T.K.A. Nguyen developed the final version, which was approved by all authors.

Declaration on the Use of AI: No AI-based tools or chatbots were used to create the content or analyze the data in this manuscript.

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References

1. Harzallah F, Alberti H, Ben Khalifa F. The metabolic syndrome in an Arab population: a first look at the new International Diabetes Federation criteria. Diabet Med. 2006;23(4):441-4. doi: 10.1111/j.1464-5491.2006.01866.x
2. Wang Y. Triglycerides, glucose metabolism, and type 2 diabetes. International Journal of Molecular Sciences. 2025; 26(20):9910. doi: 10.3390/ijms26209910
3. Heald AH, Bassett J, Puente-Ruiz N, Clayton P, Stepien KM. Endocrine disorders in adult patients with inherited metabolic diseases: their diagnosis and long-term management. Clinical Endocrinology. 2024;101(5):562-8. doi: 10.1111/cen.15100
4. Clemente-Suárez VJ, Redondo-Flórez L, Beltrán-Velasco AI, et al. The role of adipokines in health and disease. Biomedicines. 2023;11(5). doi: 10.3390/biomedicines11051290
5. Kwon H, Pessin JE. Adipokines mediate inflammation and insulin resistance. Front Endocrinol (Lausanne). 2013;4:71. doi: 10.3389/fendo.2013.00071
6. Masuo K, Rakugi H, Ogihara T, Esler MD, Lambert GW. Cardiovascular and renal complications of type 2 diabetes in obesity: role of sympathetic nerve activity and insulin resistance. Curr Diabetes Rev. 2010;6(2):58-67. doi: 10.2174/157339910790909396
7. Kaur J. A comprehensive review on metabolic syndrome. Cardiol Res Pract. 2014;2014:943162. doi: 10.1155/2014/943162
8. Le TAT, Tran AV, Tran SK, et al. The effectiveness of rosuvastatin in controlling LDL-C and non-HDL-C levels in hypertensive patients with or without diabetes mellitus. Endocrine and Metabolic Science. 2025;18:100230. doi: 10.1016/j.endmts.2025.100230
9. Jia G, Sowers JR. Hypertension in diabetes: an update of basic mechanisms and clinical disease. Hypertension. 2021;78(5): 1197-205. doi: 10.1161/HYPERTENSIONAHA.121.17981
10. Krzesinski JM, Weekers L. [Hypertension and diabetes]. Rev Med Liege. 2005;60(5-6):572-7.
11. Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation. 2009;120(16):1640-5. doi: 10.1161/circulationaha.109.192644
12. Phan MH, Huynh TC, La VP, et al. Risk factors for severe knee osteoarthritis and efficacy of diacerein in obese Vietnamese patients: a randomized, single-blind, noncontrolled clinical trial. Medicine (Baltimore). 2025;104(44):e45506. doi: 10.1097/md.0000000000045506
13. Obeidat AA, Ahmad MN, Ghabashi MA, et al. Developmental trends of metabolic syndrome in the past two decades: a narrative review. Journal of Clinical Medicine. 2025;14(7):2402. doi: 10.3390/jcm14072402
14. Ho NT, Tran MT, Tran CTD, et al. Prevalence of metabolic syndrome among Vietnamese adult employees. Nutrition, Metabolism and Cardiovascular Diseases. 2024;34(2): 326-33. doi: 10.1016/j.numecd.2023.10.002
15. Gurka MJ, Filipp SL, DeBoer MD. Geographical variation in the prevalence of obesity, metabolic syndrome, and diabetes among US adults. Nutrition & Diabetes. 2018;8(1):14. doi: 10.1038/s41387-018-0024-2
16. Third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in adults (Adult Treatment Panel III) final report. Circulation. 2002;106(25):3143. doi: 10.1161/circ.106.25.3143

17. Hương LT, Huy ĐQ, Khánh ĐN, Anh NT. The current status of metabolic syndrome and some related factors in adults in Hanoi in 2024-2025. Journal of Medical Research. 2025;195(10):514-23. doi: 10.52852/tcncyh.v195i10.4132
18. Nguyễn TN, Trần TPN. Prevalence of metabolic syndrome and some related factors among staff members at Hanoi Medical University. Journal of Nutrition and Food. 2017;13(2):12-8.
19. Wang Q, Chair SY, Wong EM-L, Taylor-Piliae RE, Qiu XCH, Li XM. Metabolic syndrome knowledge among adults with cardiometabolic risk factors: a cross-sectional study. International Journal of Environmental Research and Public Health. 2019;16(1):159. doi: 10.3390/ijerph16010159
20. Wan KS, Mohd Yusoff MF, Mat Rifin H, et al. The prevalence of metabolic syndrome and the associated factors in a multiethnic upper-middle-income country in Asia: findings from a nationwide community-based study in 2023. BMC Public Health. 2025;25(1):1482. doi: 10.1186/s12889-025-22762-9
21. International Diabetes Federation. The IDF consensus worldwide definition of the metabolic syndrome. 2006.
22. Wang H, Peng J, Wang B, et al. Inconsistency between univariate and multiple logistic regressions. Shanghai archives of psychiatry. 2017;29(2):124-8. doi: 10.11919/j.issn.1002-0829.217031
23. Syed MA, Al Nuaimi AS, Latif Zainel AJA, HA AQ. Prevalence of metabolic syndrome in primary health settings in Qatar: a cross sectional study. BMC Public Health. 2020;20(1):611. doi: 10.1186/s12889-020-08609-5
24. Liang X, Or B, Tsoi MF, Cheung CL, Cheung BMY. Prevalence of metabolic syndrome in the United States National Health and Nutrition Examination Survey 2011-18. Postgrad Med J. 2023;99(1175):985-92. doi: 10.1093/postmj/qgad008
25. Ranasinghe P, Mathangasinghe Y, Jayawardena R, Hills AP, Misra A. Prevalence and trends of metabolic syndrome among adults in the Asia-Pacific region: a systematic review. BMC Public Health. 2017;17(1):101. doi: 10.1186/s12889-017-4041-1
26. Młynarska E, Bojdo K, Bulicz A, et al. Obesity as a multifactorial chronic disease: molecular mechanisms, systemic impact, and emerging digital interventions. Curr Issues Mol Biol. 2025;47(10):787. doi: 10.3390/cimb47100787
27. Jin X, Qiu T, Li L, et al. Pathophysiology of obesity and its associated diseases. Acta Pharm Sin B. 2023;13(6):2403-24. doi: 10.1016/j.apsb.2023.01.012
28. Mabry RM, Reeves MM, Eakin EG, Owen N. Gender differences in prevalence of the metabolic syndrome in Gulf Cooperation Council countries: a systematic review. Diabet Med. 2010;27(5):593-7. doi: 10.1111/j.1464-5491.2010.02998.x
29. Bener A, Mohammad AG, Ismail AN, Zirie M, Abdullatef WK, Al-Hamaq AO. Gender and age-related differences in patients with the metabolic syndrome in a highly endogamous population. Bosn J Basic Med Sci. 2010;10(3):210-7. doi: 10.17305/bjbms.2010.2687
30. Scuteri A, Laurent S, Cucca F, et al. Metabolic syndrome across Europe: different clusters of risk factors. Eur J Prev Cardiol. 2015;22(4):486-91. doi: 10.1177/2047487314525529
31. Dang AK, Le HT, Nguyen GT, et al. Prevalence of metabolic syndrome and its related factors among Vietnamese people: a systematic review and meta-analysis. Diabetes Metab Syndr. 2022;16(4):102477. doi: 10.1016/j.dsx.2022.102477
32. Srikanthan K, Feyh A, Visweshwar H, Shapiro JI, Sodhi K. Systematic review of metabolic syndrome biomarkers: a panel for early detection, management, and risk stratification in the West Virginian population. Int J Med Sci. 2016;13(1):25-38. doi: 10.7150/ijms.13800
33. Thapsuwan S, Phulkerd S, Chamratrithirong A, et al. Relationship between consumption of high fat, sugar or sodium (HFSS) food and obesity and non-communicable diseases. BMJ nutrition, prevention & health. 2024;7(1):78-87. doi: 10.1136/bmjnph-2023-000794
34. Shu L, Zhang X, Zhou J, Zhu Q, Si C. Ultra-processed food consumption and increased risk of metabolic syndrome: a systematic review and meta-analysis of observational studies. Front Nutr. 2023;10:1211797. doi: 10.3389/fnut.2023.1211797
35. Lv JL, Wei YF, Sun JN, et al. Ultra-processed food consumption and metabolic disease risk: an umbrella review of systematic reviews with meta-analyses of observational studies. Front Nutr. 2024;11:1306310. doi: 10.3389/fnut.2024.1306310
36. The National Assembly of Vietnam. Law No. 25/2008/QH12 of the National Assembly of Vietnam: Health Insurance Law. 2008.