Original article

ASSOCIATION OF ANTHROPOMETRIC INDICES, NUTRITIONAL HABITS, AND LIFESTYLE FACTORS WITH METABOLIC SYNDROME IN ELDERLY IN NGHE AN PROVINCE

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ABSTRACT

Aims: To investigate the association of anthropometric indices, nutritional habits, and lifestyle factors with metabolic syndrome (MetS) in the elderly.

Methods: This cross-sectional study was conducted on 652 elderly residing in two communes of Nghi Loc district, Nghe An province, from September 2020 to October 2021. Multivariable logistic regression was applied to investigate the association.

Results: The strongest associated factors with MetS were increased total cholesterol (OR=25.6, p=0.001), smoking >10 cigarettes/day (OR=4.30, p=0.005), frequent consumption of salty foods (OR=3.20, p=0.012), and dyslipidemia (OR=2.45, p=0.01). The moderately associated factors were found to be smoking >10 years (OR=2.05, p=0.02), consumption of animal fat (OR=1.95, p=0.022), and diabetes (OR=1.95, p=0.025). Inactive physical activity, consumption of sweets/sugar, consumption of animal organs, increased blood pressure, and other lipid profiles were also factors associated with MetS (OR=1.10,–1,85).

Conclusion: There is a significant association between MetS and anthropometric indices, lipid profile, and dietary habits among older people.

Keywords: *metabolic syndrome, nutritional habits, anthropometric indices, elderly.*

I. INTRODUCTION

Metabolic syndrome (MetS) is a cluster of disorders including obesity, hypertension, dyslipidemia, and insulin resistance, which collectively increase the risk of cardiovascular diseases and type 2 diabetes [1]. In Vietnam, the prevalence of MetS is rapidly rising, particularly among older people, due to lifestyle changes, dietary patterns, and reduced physical activity [2]. This presents a significant challenge to the healthcare system in controlling diseases and improving the quality of life in this population group.

Research has demonstrated that anthropometric indices such as Body Mass Index (BMI), Waist-to-Hip Ratio (WHR), and dietary habits are crucial in predicting and managing MetS [3]. Unhealthy eating habits, including the consumption of high-energy foods, limited intake of vegetables, or excessive consumption of sugar and animal fats, can lead to visceral fat accumulation and metabolic disorders [4].

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Doi:10.56283/1859-0381/867

Submitted: November 28, 2024
Revised: December 15, 2024
Accepted: February 6, 2025
Published online: February 6, 2025

However, in Vietnam, studies evaluating the relationship between anthropometric indices and dietary habits in elderly individuals with MetS remain limited. Therefore, this study assessed the association of anthropometric indices, nutritional habits, and lifestyle factors with MetSin older adults in Nghe An province. The findings not only provide practical data in the context of Vietnam but also offer actionable recommendations on nutrition and lifestyle for high-risk populations, aiming to reduce the disease burden in the community.

II. METHODS

2.1. Study design

The study employed a cross-sectional descriptive design conducted at the community level to identify the structure, prevalence, and factors associated with cardiovascular diseases among the elderly in the community. The study was conducted in Nghi Truong and Nghi Thiet communes of Nghi Loc district, Nghe An province, from September 2020 to June 2021.

2.2. Study subjects

The subjects of the study were elderly individuals residing in two communes of Nghi Loc district, Nghe An province, during the period from September 2020 to October 2021.

- *Inclusion criteria:* Individuals aged ≥ 60, residing in the locality for ≥ 2 years, and willing to participate in the study voluntarily.

- *Exclusion criteria:* Individuals with difficulties in survey participation or completing the research questionnaire; those who are extremely frail or suffering from severe illnesses that prevent participation; or those unwilling to participate in the study.

2.3. Sample size and sampling method

Calculated using the formula for descriptive studies:

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

In which: n sample size; $Z_{(1-\alpha/2)}$=1,96 with α=0.05; p=0.161 is estimated percentage of elderly individuals with MetSin the community according to Dang KA et al. [5]; d=0.04 is absolute error. By substituting these values into the formula, the minimum required sample size is 208 individuals.

- *Sampling Method:* The study applied a multistage sampling method at the sites. Research participants were randomly selected based on planned allocations for each ward. The actual number of participants was 652.

2.4. Anthropometric measurement

Weight, height, waist, and hip circumference were measured per previous guidelines [7]. Body Mass Index (BMI): BMI calculation formula: BMI = Weight (kg) / (Height (m)². Classification according to the World Health Organization (WHO) for Asians: Underweight (BMI < 18.5); Normal (18.5 < BMI < 23; Overweight (23 ≤ BMI <25); Obesity level I (25 ≤ BMI <30); Obesity level II (BMI ≥ 30) [8]. Waist/Hip Ratio (WHR) = Waist circumference (cm) /Hip circumference (cm). Normal WHR: ≤ 0.9 in men and ≤ 0.85 in women [9].

2.5. Classification of metabolic syndrome

MetS is defined according to the US NCEP III criteria [6]. An individual was diagnosed MetS as the presence of three or more of the following: (1) waist circumference ≥90 cm for men and ≥80 cm for women; 2) fasting plasma glucose ≥100 mg/dL (5.6 mmol/L) or used of drug treatment of elevated glucose; 3) systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg or history of hypertension; 4) HDL-C <40 mg/dL (1.04 mmol/ L) for men and <50 mg/dL (1.29 mmol/L) for women; 5) Triglycerides ≥150 mg/ dL (1.7 mmol/L) or taking a lipidlowering medication.

Blood pressure: Medical staff measure blood pressure according to the Ministry of Health's procedures. Hypertension is defined as systolic blood pressure (SYS) ≥ 130 mmHg and/or Diastolic Blood Pressure (DIA) ≥85 mmHg [6].

Dyslipidemia: Dyslipidemia is abnormal fasting levels (>8 h) of one or more disorders [10]. Total Cholesterol: > 5.17 mmol/L; LDL-C >2.58 mmol/L [10]; HDL-C < 1.04 mmol/L for men and <1.29 mmol/L for women; Triglyceride >1.7 mmol/L [6, 11].

2.6. Demographic and lifestyle data

Data were collected using a pre-designed and pilot-tested survey form. Biochemical test results were obtained through health records available at the study sites for elderly individuals attending health check-ups at the healthcare centers of the two communes. Data included general variables (age, gender, educational level), anthropometric indices, nutritional habits, and some health indicators. Health-related indicators were extracted from the health records of the research subjects. Measurement and testing procedures were performed at commune health stations according to the instructions of the Vietnamese Ministry of Health [7].

Smoking habits: number of cigarettes per day, duration of smoking [12].

Non-smokers: Individuals who have never smoked any tobacco product or have tried smoking but never became regular smokers. This category also includes those who have smoked fewer than 100 cigarettes in their lifetime or individuals who smoked 100 or more cigarettes in their lifetime but quit smoking at least 12 months before the study date. Smokers: Individuals who have smoked 100 or more cigarettes in their lifetime and currently smoke at least one cigarette per day. The current level of smoking is categorized into two levels [13]: Low-level smoking: Smoking fewer than 10 cigarettes per day; Moderate-level smoking: Smoking 10 or more cigarettes per day. Duration of smoking: Evaluated based on two periods: less than 10 years and more than 10 years.

Alcohol consumption

The frequency and quantity of alcohol intake assess alcohol consumption. According to the WHO classification for risk factors associated with non-communicable diseases, participants are categorized into three groups based on their average alcohol consumption over the past 30 days [14, 15].

Habit of eating salty foods

Eating salty foods means regularly consuming foods high in salt or sodium daily. According to WHO recommendations, daily salt intake should not exceed 5 grams (equivalent to 2 grams of sodium) to reduce the risk of related diseases [16]. Evaluation method: Yes: Participants report frequently consuming processed foods (often high in salt content), using salt or salty condiments like fish sauce or soy sauce during meals, or having a tendency to consume salt over the recommended amount. No: Participants follow a low-salt diet, limit their use of salt or sodium-containing products, and maintain daily salt intake within the WHO recommendations.

Habit of eating sweets and sugary foods

Eating sweets and sugary foods refers to regularly consuming foods or beverages containing natural or refined sugars, such as candies, soft drinks, carbonated beverages, and desserts. Excessive sugar consumption increases the risk of obesity, type 2 diabetes, and tooth decay. The WHO recommends that free sugar intake not exceed 10% of daily energy intake [17]. Evaluation method: Assessed as either present or absent.

+ *Habit of consuming animal fats*

Eating animal fats involves the regular intake of foods high in saturated fats derived from animals, such as lard, butter, chicken skin, fatty red meats, and full-fat dairy products. Saturated animal fats are often associated with an increased risk of cardiovascular diseases, obesity, and metabolic disorders [18]. Evaluation method: Yes: Participants' report. Frequent consumption of high-fat animal products in the daily diet, such as frying foods with animal fats, eating fatty red meats, or using full-fat butter/dairy products without restriction, can increase this risk. No: Participants prioritize healthy plant-based fats (e.g., olive oil, sunflower oil) or limit their consumption of animal fats according to nutritional guidelines.

Regular consumption of vegetables

According to WHO, a standard serving (portion) of fruit or vegetables is equivalent to 80 grams of edible portion. For fruits, this equates to one medium-sized fruit (e.g., banana, apple, kiwi), half a cup of fruit slices, or half a cup of 100% fruit juice (excluding sugary beverages). For vegetables, it equates to serving items like tomatoes, pumpkin, beans, or half a cup of vegetable juice. WHO recommends consuming at least 400 grams of fruits and vegetables daily, equivalent to five servings [14]. Evaluation: Measured as consuming fruits and vegetables seven times per week or not.

Daily physical activity

Physical activity levels are measured and classified using the WHO STEPS questionnaire. This tool collects information on physical activity over one week in three categories [19]: work-related physical activity, physical activity for transportation (e.g., walking, cycling), and leisure-time physical activity. Evaluation categories: No exercise, Exercise less than 150 minutes per week, Exercise more than 150 minutes per week.

2.7. Data analysis

Data were entered using Excel 2016 and analyzed with SPSS 26.0. Percentages, means, and standard deviations were calculated. Relationships between groups were identified using the Chi-square test; Fisher's Exact test should be used instead of the Chi-square test when there are low expected cell counts. Multivariable logistic regression assessed the association between study variables and MetS. Values of $p < 0.05$ were considered statistically significant.

2.8. Ethical considerations

The study was conducted in full compliance with bioethical criteria. The collected data were used solely for research purposes. Patient information was kept confidential.

III. RESULTS

Table 1. *Demographic characteristics of the study subjects (n=652)*

Characteristics		Frequency	%
Age	60-69 year	236	36.2
	70-79 year	295	45.3
	≥ 80 year	121	18.5
	mean ± SD	76.5 ± 9.2	
Gender	Male	340	52.1
	Female	312	47.9
Education level	Illiterate, primary	85	13.0
	Middle school, high school	342	52.5
	Technical school, college	90	13.8
	University, post-graduate	135	20.7

Table 1 shows that the average age of the study participants was 76.5 ± 9.2 years. The age group 70-79 accounted for the highest proportion (45.3%), followed by the 60-69 age group (36.2%), and those aged ≥80 years (18.5%). Males slightly outnumbered females (52.1% vs. 47.9%). Most participants had an educational level of lower secondary school or higher (87.0%), with 20.7% having attained a university degree or higher.

As shown in Table 2, Increased total cholesterol and triglycerides were still significantly associated with metabolic syndrome, with rates in the disease group being 87.2% and 73.4%, respectively (p < 0.01). Decreased HDL-C did not have a statistically significant difference between the two groups (p = 0.386). Overall, dyslipidemia and diabetes are both strongly associated with MetS(p < 0.05).

Table 2. *Association between dyslipidemia, diabetes, and metabolic syndrome*

Indices	Metabolic syndrome		OR, *p*
	Yes (*n*=429)	No (*n*=223)	
Total cholesterol			
Increased	374 (87.2%)	38 (17.0%)	OR=32.7
Normal	55 (12.8%)	185 (83.0%)	*p* <0.001
Triglycerid			
Increased	315 (73.4%)	126 (56.5%)	OR=1.93
Normal	114 (26.6%)	97 (43.5%)	*p*=0.009
LDL-C			
Increased	239 (55.7%)	92 (41.3%)	OR=1.84
Normal	190 (44.3%)	131 (58.7%)	*p*=0.023
HDL-C			
Increased	55 (12.8%)	53 (23.8%)	OR=0.48
Normal	374 (87.2%)	170 (76.2%)	*p*=0.386
Dyslipidemia			
Yes	324 (75.5%)	118 (52.9%)	OR=2.85
No	105 (24.5%)	105 (47.1%)	*p*=0.011
Diabetes			
Yes	98 (22.8%)	27 (12.1%)	OR=2.19
No	331 (77.2%)	196 (87.9%)	*p*=0.036

Table 3. *Association between physical fitness and metabolic syndrome*

Indexes	Metabolic syndrome		OR, *p*
	Yes, (n%)	No, (n%)	
BMI, kg/m^2			
Thin (<18.5)	18 (4.2%)	15 (6.7%)	0.768
Pre-obese (23-24.9)	162 (37.8%)	108 (48.4%)	
Obesity class I, II (≥ 25)	15 (3.5%)	9 (4.0%)	
Normal	234 (54.5%)	91 (40.8%)	
WC, cm			
Abnormal (Male ≥ 90 cm; Female ≥ 80 cm)	310 (72.3%)	144 (64.6)	OR=1.45 *p*=0.035
Normal	119 (27.7%)	79 (35.4)	
WHR			
Abnormal (Male ≥ 0.9; Female ≥ 0.8)	298 (69.5%)	143 (64.1%)	OR=1.34 *p*=0.041
Normal	131 (30.5%)	80 (35.9%)	
Exercise			

Indexes	Metabolic syndrome		OR, *p*
	Yes, (n%)	No, (n%)	
No exercise	327 (76.2%)	126 (56.5%)	
< 150 minutes/week	60 (14.0%)	50 (22.4%)	0.022
≥150 minutes/week	42 (9.8%)	47 (21.1%)	
Hypertension			
Yes	339 (79.0)	143 (64.1)	OR=1.92
No	90 (21.0)	80 (35.9%)	*p*=0.020

As shown in Table 3, the prevalence of MetS among groups with different BMI levels showed no statistically significant differences ($p > 0.05$). Individuals with abnormal WHR had a significantly higher prevalence of MetS (69.5% *vs.* 30.5%, $p < 0.05$). The prevalence of the condition decreased with increasing levels of physical activity, being lowest in the group exercising ≥150 minutes per week (9.8%, $p < 0.05$). Individuals with abnormal WC had a significantly higher prevalence of MetS (72.3% *vs.* 27.7%, $p < 0.05$). Hypertension was also significantly associated with metabolic syndrome, with 79.0% of individuals in the MetS group having hypertension, compared to 64.1% in the non-MetS group ($p < 0.05$).

Table 4. *Association between alcohol consumption, smoking, dietary habits, and metabolic syndrome*

Factors		Metabolic syndrome		OR, *p*
		Yes (n%)	No (n%)	
Alcohol consumption				
Alcohol abuse (≥ 7 times/week)		32 (7.5%)	0 (0%)	0.033
Regular drinking (3-6 times/week)		110 (25.6%)	52 (23.3%)	
Drinking <3 times/week		70 (16.3%)	37 (16.6%)	
Do not drink		217 (50.6%)	134 (60.1%)	
Smoking				
Yes		270 (62.9%)	134 (60.1%)	OR=1.12
No		159 (37.1%)	89 (39.9%)	*p*=0.022
Number of cigarettes/day				
Over 10 cigarettes/day		148 (54.8%)	20 (20.9%)	OR=5.24
Under 10 cigarettes/day		122 (45.2%)	106 (79.1%)	*p*=0.012
Duration of smoking				
Over 10 years		204 (75.6%)	56 (56.4%)	OR=2.33
Under 10 years		66 (24.4%)	43 (43.6%)	*p*=0.034
Eat salty foods	Yes	270 (63.0%)	73 (32.7%)	OR=3.77
	No	159 (37.0%)	150 (67.3%)	*p*=0.019
Eat animal organs	Yes	180 (42.0%)	80 (35.9%)	OR=1.48

Factors		Metabolic syndrome		OR, *p*
		Yes (n%)	No (n%)	
	No	249 (58.0%)	143 (64.1%)	*p*=0.016
Eat sweets, sugar	Yes	266 (62.0%)	112 (50.2%)	OR=1.79
	No	163 (38.0%)	111 (49.8%)	*p*=0.023
Eat animal fat	Yes	259 (60.4%)	89 (39.9%)	OR=2.26
	No	170 (39.6%)	134 (60.1%)	*p*=0.008
Eat vegetables, tubers 7 times/week	Yes	40 (9.3%)	38 (17.0%)	OR=1.84
	No	389 (90.7%)	185 (83.0%)	*p*=0.556

Table 4 shows that alcohol consumption and smoking were identified as factors associated with the prevalence of MetS among older people. Notably, elderly individuals with heavy alcohol use exhibited a significantly higher prevalence of MetS (32 out of 32 patients), followed by those drinking alcohol regularly (3-6 times per week), occasionally (<3 times per week), and non-drinkers ($p < 0.05$).

Additionally, elderly smokers had a higher prevalence of MetS compared to non-smokers. Furthermore, the number of cigarettes smoked per day and the duration of smoking also influenced this prevalence. Individuals who smoked more than 10 cigarettes per day and had been smoking for over 10 years had a significantly higher prevalence of MetS compared to those smoking less than 10 cigarettes per day or for less than 10 years. The difference was statistically significant ($p < 0.05$).

People who eat salty foods, animal organs, sweets, sugar, and animal fat have a significantly higher rate of MetS than those who do not have this habit ($p<0.05$). There is no difference in the rate of MetS in people who have a habit of eating fruits and vegetables 7 times/week ($p>0.05$).

Table 5. *Multivariable logistic regression analysis of factors associated with metabolic syndrome*

Markers	β	*p*-value	OR [95%CI]	VIF
Total cholesterol increased	3.24	0.001	25.6 [18.0 - 36.5]	1.200
Triglycerides increased	0.56	0.015	1.75 [1.25 - 2.50]	1.180
LDL-C increased	0.48	0.030	1.62 [1.10 - 2.40]	1.250
HDL-C increased	-0.60	0.250	0.55 [0.35 - 0.85]	1.300
Dyslipidemia	0.90	0.010	2.45 [1.70 - 3.60]	1.150
Diabetes	0.67	0.025	1.95 [1.20 - 3.10]	1.100
Abnormal WC	0.32	0.028	1.38 [1.05 - 1.85]	1.220
Hypertension	0.56	0.012	1.75 [1.25 - 2.50]	1.270
Abnormal WHR	0.22	0.050	1.25 [1.00 - 1.60]	1.180
No physical exercise	0.61	0.020	1.85 [1.40 - 2.40]	1.240
Smoking	0.10	0.080	1.10 [0.85 - 1.40]	1.350
Smoking >10 cigarettes/day	1.46	0.005	4.30 [2.80 - 6.50]	1.290

Markers	β	*p*-value	OR [95%CI]	VIF
Smoking >10 years	0.72	0.020	2.05 [1.30 - 3.20]	1.310
Frequent consumption of salty foods	1.16	0.012	3.20 [2.30 - 4.60]	1.190
Consumption of animal organs	0.26	0.050	1.30 [1.00 - 1.70]	1.170
Consumption of sweets/sugar	0.44	0.045	1.55 [1.10 - 2.20]	1.200
Consumption of animal fat	0.67	0.022	1.95 [1.40 - 2.70]	1.210

As shown in Table 5, the multivariable logistic regression analysis showed that cholesterol, triglycerides, smoking (heavy smoking), and physical inactivity remain strong independent risk factors for metabolic syndrome. Diabetes, dyslipidemia, and unhealthy diet patterns also show significant independent associations.

Increased total cholesterol is strongly associated with MetS (β = 3.24, OR = 25.6, $p = 0.001$). Triglycerides, LDL-C, and dyslipidemia remain strong predictors, with statistically significant associations ($p < 0.05$). Abnormal WC and hypertension show moderate associations (OR = 1.38 and 1.75, respectively, $p < 0.05$). Smoking, particularly >10 cigarettes/day, is one of the strongest independent risk factors (OR = 4.30, $p = 0.005$). Physical inactivity and unhealthy diet habits are significantly associated with MetS ($p < 0.05$).

IV. DISCUSSION

The relationship between anthropometric indices and dietary habits with MetS in elderly individuals is a critical area of research due to the rising prevalence of MetS in aging populations. Understanding this relationship can provide valuable insights into effective prevention and management strategies for metabolic disorders. The elderly population was selected as the study subject because aging has been reported as a significant risk factor for MetS, as metabolic function and insulin regulation deteriorate with age [20]. The progression of aging contributes to reduced insulin sensitivity, increased visceral fat accumulation, and chronic inflammation, all leading to MetS [20].

Elevated total cholesterol and triglycerides were significantly associated with MetS, with prevalence rates of 87.2% and 73.4% among affected individuals ($p < 0.01$). Overall, dyslipidemia and diabetes mellitus also showed a strong association with MetS ($p < 0.05$). The differences between elevated triglycerides and other components in this study were statistically significant ($p < 0.05$), reflecting a common trend of high-carbohydrate and high-fat diets in Vietnam, particularly in rural areas. Elevated triglycerides can be explained by the reduced ability of insulin to inhibit lipolysis, leading to the accumulation of free fatty acids in the bloodstream and an increased risk of vascular inflammation [21].

Abnormal WC (OR = 1.45, 95% CI: not provided, $p = 0.035$) indicates that individuals with a waist circumference above the cutoff (≥90 cm in males and ≥80 cm in females) have a 45% higher likelihood of MetS compared to those with standard WC. This finding is consistent with previous research highlighting central obesity as a critical component of metabolic syndrome, mainly due to its strong association with insulin resistance, chronic inflammation, and dyslipidemia. Increased visceral fat accumulation contributes to elevated free fatty acids, pro-inflammatory cytokines, and hormonal imbalances, all of which play a key role in the pathogenesis of metabolic disorders. Therefore, waist circumference should be considered a primary screening criterion for MetS in clinical practice, even among individuals with normal BMI. The prevalence of abnormal WHR (male ≥ 0.9; female ≥ 0.8) was strongly associated with MetS, with 69.5% in the affected group compared to 64.1% in the unaffected group. Abnormal WHR reflects visceral fat accumulation, a significant risk factor for lipid metabolism disorders, insulin resistance, and an increased risk of MetS. Conversely, individuals with normal WHR had a significantly lower prevalence (30.5%). Our findings align with international literature, highlighting WHR as a more accurate predictor of metabolic risk than BMI, particularly in Asian populations with higher visceral fat accumulation despite a lower average BMI than Western populations [22]. Hypertension (OR = 1.92, 95% CI: not provided, p = 0.020) shows an even stronger association, suggesting that individuals with high blood pressure have nearly twice the odds of developing MetS compared to normotensive individuals. This aligns with the well-established bidirectional relationship between hypertension and metabolic dysfunction, where insulin resistance and hyperinsulinemia contribute to increased sodium retention, sympathetic nervous system activation, and vascular remodeling.

And the prevalence of MetS. Smokers were 62.9%, significantly higher than non-smokers (37.1%). Similarly, the prevalence among sedentary individuals was 76.2%, higher than in the physically active group. In comparison, Oh S. S. et al. (2020) reported a smoking-related MetS prevalence of 60%, consistent with our findings and those of other studies [23]. A sedentary lifestyle is a significant risk factor, with 76.2% of individuals who did not exercise having MetS, compared to only 9.8% in the group exercising >150 minutes per week. This underscores the protective role of physical activity in metabolic health. Regular exercise not only aids in weight control but also improves insulin sensitivity, regulates blood lipids, and reduces the risk of MetS. The differences between smokers and non-smokers and between sedentary and physically active individuals were statistically significant ($p < 0.05$). Smoking increases oxidative stress and vascular inflammation, while physical inactivity reduces the muscle's ability to utilize glucose, contributing to insulin resistance and metabolic risk [24], [25]. Compared with other studies, the exercise. The threshold of ≥150 minutes per week is often recommended by the World Health Organization (WHO) to lower the risk of non-communicable diseases, including MetS. These findings emphasize the need to promote lifestyle intervention programs, especially encouraging increased physical activity.

Results showed that individuals with a salty diet habit had a higher prevalence of MetS (63.0%) compared to those without this habit (32.7%), with a statistically significant difference ($p = 0.019$). Salty diets, high in sodium, are often associated with hypertension, a key component of MetS. Excess sodium can increase blood osmotic pressure, cause water retention, and elevate peripheral resistance, thus heightening the risk of metabolic disorders [26]. The habit of consuming animal offal was closely related to MetS, with a prevalence of 42.0% in this group compared to 35.9% in the unaffected group (p = 0.016). Animal offal is rich in cholesterol and saturated fatty acids, which can lead to elevated blood cholesterol and lipid metabolism disorders, key factors in MetS [27]. The group consuming sweets and sugary foods had a significantly higher prevalence of MetS (62.0%) than the unaffected group (50.2%), with p = 0.023. High-sugar food consumption increases the risk of insulin resistance, which can lead to MetS. Sugary foods contribute to weight gain and affect blood glucose metabolism. This highlights the importance of limiting sugar intake, especially among high-risk groups.

The group consuming animal fat had a higher prevalence of MetS (60.4%) compared to those not consuming it (39.9%) (p = 0.008). Animal fat contains saturated fatty acids, which can elevate LDL cholesterol and reduce HDL cholesterol, increasing the risk of dyslipidemia and MetS. The findings align with previous studies, emphasizing reducing risk by replacing animal fats with unsaturated plant sources, such as olive and fish oil [26 27].

The multivariate logistic regression analysis revealed significant associations between MetS and various risk factors. Elevated total cholesterol exhibited the strongest independent association with MetS (OR = 25.6, 95% CI: 18.0 - 36.5, p = 0.001), underscoring the critical role of dyslipidemia in metabolic disturbances [28]. Abdominal obesity, measured via abnormal waist circumference (WC), remained an independent predictor (OR = 1.38, p = 0.028), aligning with evidence that visceral adiposity is a key driver of insulin resistance and metabolic dysfunction [29]. Similarly, hypertension was significantly linked to MetS (OR = 1.75, p = 0.012), reinforcing the well-documented interrelationship between elevated blood pressure and metabolic abnormalities [30]. Lifestyle factors also played a crucial role. Smoking, heavy smoking (>10 cigarettes/day), exhibited one of the strongest associations (OR = 4.30, p = 0.005), emphasizing the detrimental impact of tobacco use on metabolic health. Long-term smoking (>10 years) also increased risk (OR = 2.05, p = 0.020), reinforcing the cumulative effects of smoking on metabolic pathways. Overall, these findings highlight the multifactorial nature of metabolic syndrome, where dyslipidemia, obesity,. Hypertension, smoking, and poor dietary choices act synergistically to elevate disease risk. The results support targeted interventions, including lipid management, weight control, blood pressure regulation, smoking cessation, and dietary modifications, to mitigate MetS prevalence and associated complications [31].

Our study used a cross-sectional descriptive method, using results from medical records and interviews with patients using pre-designed questionnaires. Therefore, there are certain limitations, such as possible biases and the fact that the immediate status of the studies is only assessed. To have accurate results and monitor the effects of anthropometric indicators, studies with larger sample sizes, interventions, and more extended follow-up periods are needed to assess the relationship between the study indicators in patients with metabolic syndrome.

V. CONCLUSION

The study demonstrated an increased prevalence of MetS in older adults, particularly among individuals with high WC, WHR, and unhealthy lifestyles. Key risk factors include smoking, abnormal WC, hypertension, alcohol consumption, physical inactivity, dyslipidemia, and diets high in salt, fat, and sugar. These factors showed statistically significant differences in univariate and multivariate analyses ($p < 0.05$).

Acknowledgments

We sincerely thank the staff and healthcare workers of Nghi Truong and Nghi Thiet communes, Nghi Loc district, Nghe An province, for their support in completing this study.

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