Prevalence of Metabolic Syndrome in Rural Areas of Vietnam: A Selected-Randomized Study

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Abstract

Background: This study accounted for the prevalence of metabolic syndrome and its determinants in rural areas of Thai Binh Province, Vietnam. Methods: The study was conducted in 2012 through a multi-stage (province-district-commune) stratified cluster random sampling to choose a representative sample of non-institutionalized adults from four communes in Thai Binh Province. A structured questionnaire was administered, collecting information on personal medical history, demographic, and behavioral characteristics. Anthropometrics, blood pressure, and venous blood samples were obtained. Metabolic syndrome (MetS) was defined according to three operational definitions. The prevalence ratios and their respective 95% confidence intervals were calculated. Results: The prevalence rates of metabolic syndrome in this sample of adults were 19.6. As expected, participants with MetS had significantly higher mean values of weight, body mass index, and waist circumference. The prevalence of metabolic syndrome was significantly higher in women ($p < 0.001$) and older participants ($p < 0.001$), as well as in those who reported hypertension ($p < 0.001$) or dyslipidemia ($p < 0.001$). Conclusions: This study showed that metabolic syndrome is highly prevalent in the Vietnamese adult population. As age increases and base metabolism and mobility decrease, obesity rates and risk factors for MetS appear to increase.

Keywords: Metabolic syndrome, Prevalence, Rural, Risk factors, Vietnam

INTRODUCTION

Metabolic syndrome (MetS) is a growing public health concern worldwide. MetS-related risk factors include abdominal obesity, increased triglycerides (TG), hypertension, an elevated fasting blood glucose (FBG) level, and reduced high-density lipoprotein (HDL) cholesterol [1]. Widely accepted definitions for the diagnosis of MetS include criteria developed by the National Cholesterol Education Program's Adult Treatment Panel III (ATP III), the International Diabetes Federation (IDF), and the American Heart Association/National Heart, Lung, and Blood Institute (Harmonization) [2-4]. In addition to serving as a predictive tool for the onset of cardiovascular disease and type 2 diabetes, identifying MetS allows for the development and evaluation of targeted lifestyle interventions to combat the rising burden of non-communicable diseases.

The overall prevalence of MetS varies according to geographic and socio-demographic factors, as well as diagnostic criteria. Globally, the prevalence of MetS ranges from 10% to 40% [5]. MetS increases the risk of developing type 2 diabetes mellitus by five-fold and the risk of developing CVD by two-fold [3]. Also, patients with MetS are two-to-four times more likely to die from cardiovascular events than those without MetS [6]. Frequently, MetS results from a combination of several factors, which increase cardiovascular risk beyond any individual factor [7]. This risk increases with the number of MetS components present [8]. The syndrome occurs most often in populations characterized by a high prevalence of obesity and physical inactivity [3]. The major causes leading to MetS are insulin resistance, obesity, unhealthy lifestyles, and genetic predispositions [9, 10].

According to the World Health Organization, 73% of deaths in Vietnam are from non-communicable diseases, of which half are from cardiovascular diseases (33%) and diabetes (3%) [11]. The 2008 nationwide survey showed that the

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prevalence of MeTS in adults was 18.4%, out of which the rate of high blood cholesterol was 29.1%, high triglycerides were 34.2%, low HDL-cholesterol (HDL-C) was 29.3%, high LDL-cholesterol (LDL-C) was 60.8%, high blood glucose levels were 7.7%, and abdominal fat was 12% [12]. The incidence of MetS gradually increased with age: it was highest in the age groups of 45–54 and 55–74 years (30%). A national survey of risk factors for non-communicable diseases in adults 2010 and 2015 showed that the rate of hypertension increased from 15.3% to 20.3%, hyperglycemia increased from 2.6% to 4.1%, hypercholesterolemia was 30.2% (unchanged), low HDL-C was 67.0% for men and 72% for women, and the overweight rating increased from 12% to 17.5% [13]. Therefore, to prevent the rapid increase in incidence of cardiovascular disease and diabetes and the slow progression of their risk factors, appropriate measures should be taken to reduce the incidence of MeTS for each risk factor of this condition.

Aim of study

This study accounts for the recent prevalence among Vietnamese populations of MetS, as defined by ATP III criteria, and examines associated risk factors for cardiovascular diseases.

Materials and Methods

Subjects and study design

This study was conducted in 2012 in Thai Binh Province, Vietnam. A multi-stage (province- district-commune) stratified cluster random sampling was employed to choose participants. First, one district (Vu Thu District) was identified as having a distribution of population that could represent the Thai Binh Province. Second, four communes were randomly selected in the Vu Thu District. Finally, a cluster sampling method was used to select 500 corresponding villages in each commune. The residents of these selected villages were then investigated. The selection criteria for participants were as follows: (1) above 30 years of age and living in the village; (2) with clear consciousness and without mental diseases; (3) for women, not pregnant or lactating for 12 months; (4) able to perform anthropometric measurements; and (5) with no deformities that affect body shape. A total of 2000 participants met the selection criteria and were asked to complete questionnaires, anthropometric measurements, and blood tests. The overall response rate was 95.5%.

Data collection

A trained nurse administered a structured questionnaire with only closed-ended questions; information was collected on personal medical history and socio-demographic and behavioral characteristics. Then, this information was compared to the patient's medical records and the health management book of the commune health station. The study subjects were clinically examined to detect specific symptoms for a number of related diseases, such as hypertension, cardiovascular disease, kidney disease, and metabolic disorders. The medical examination process was undertaken by doctors at the Thai Binh University of Medicine and Pharmacy.

Measurements

All measurements were taken by the nurse's staff. Anthropometric measures were recorded, namely weight, height, and waist and hip circumferences. Body weight was measured to the nearest 0.1 kilogram using a SECA scale, and height was measured to the nearest centimeter in the standing position using a three-piece wooden ruler. Body mass index (BMI) was calculated as weight in kilograms divided by the square height in meters. Waist circumference (WC) was measured midway between the lower limit of the rib cage and the iliac crest, and hip circumference (HC) was measured as the maximum circumference of the buttocks. Blood pressure was measured on a single occasion using a standard mercury sphygmomanometer (ALPK2, Japan) with the cuff on the upper right arm after a 15-minute rest. Two blood pressure readings were taken, and the mean of the two readings was calculated. If the difference between the two measures was larger than 5 mmHg for systolic or diastolic blood pressure, a third measurement was acquired, and the mean of the two closest values was registered.

A 3 ml fasting blood sample was collected from each participant, with participants fasting overnight for 12–14 hours before blood sampling (but not over 16 hours). The sample was centrifuged at 3000 rpm for 30 minutes, and plasma was stored at -80 °C. The serum glucose, total cholesterol HDL-C, and triglycerides were tested using an Olympus AU 480 Biochemical Automatic Analyzer in the Biochemistry Laboratory, Thai Binh University of Medicine and Pharmacy. All participants with triglyceride levels below 400 mg/dl had their LDL-C level computed. This value was estimated by subtracting the HDL-C value plus 20% of the triglycerides from the total cholesterol. Quality control was strictly followed in the processes of blood collection, storage, and measuring.

Definitions

ATP III defines METS as having three or more of the following conditions: an HDL of <1.0 mmol/dl in men and <1.3 mmol/dl in women, a systolic/diastolic blood pressure (BP) of ≥130/85 mm Hg, a triglyceride level at least 1.7 mmol/dl, an FBG level of ≥6.1mmol/dl, and a WC >90 cm in men and >80 cm in women [14]. The method of blood pressure measurement and the criteria for diagnosis of hypertension followed JNC VII guidelines, that is, SBP ≥140 mmHg, DBP ≥90 mmHg, or use of anti-hypertensive medicines [15]. Diabetes was defined as a fasting glucose of ≥126mg/dL or use of antidiabetic medication. Hypercholesterolemia was defined as a total cholesterol of ≥240 mg/dL or use of lipid-lowering medication. The information on body mass index (underweight: <18.5 kg/m^2; optimal weight: 18.5-22.9 kg/m^2; overweight/obese: ≥23 kg/m^2) was computed using standard measurement and diagnostic procedures [16]. Waist-hip ratio

(WHR) was considered high if the ratio was >0.9 in men or >0.8 in women.

Statistical analysis

The database was established using EpiData software (EpiData Association, Odense, Denmark, http://www.epidata.dk/). The data were analyzed using R version 8.0 software (R Foundation, Vienna, Austria). The normality of the data was analyzed using the Kolmogorov-Smirnov test. Continuous and discrete variables were presented with mean and ± SD, and number and percentage, respectively. Chi-square analyses were used to test the difference between biochemical variables between the two groups. Multiple logistic regression analysis was used to examine associations between risk factors of metabolic syndrome and sociodemographic factors as independent and dependent variables, respectively. Adjusted odds ratio and 95% confidence intervals were calculated for all metabolic syndrome parameters. P-values less than 0.05 were regarded as statistically significant.

Ethics approval

This study was approved by The Ethics Review Board. All procedures and experiments performed in studies involving human participants were in accordance with approved guidelines and regulations, and written informed consent was obtained from each participant.

Results

Demographic characteristics

This study included 1910 individuals: 374 participants with MetS and 1536 without. MetS was more frequent among the older age groups (10.5%, 10.8%, 20.2%, 24.2%, 27.5%, and 26.9%, respectively). MetS was more prevalent in women than in men (24.2% vs. 14.8%). The prevalence of MetS was also higher in the hypertension and dyslipidemia groups, but lower in smoking groups (Table 1).

Risk factors of metabolic syndrome

The results found that MetS was associated with being male, having a family history of hypertension or dyslipidemia, hypertension, and obesity by multivariate analysis. Multiple factors analysis demonstrated that hypertension and dyslipidemia were associated with a higher risk of MetS (OR = 4.0, 95%CI: 3.2–5.2) and (OR = 4.4, 95%CI: 3.4–5.9). However, smoking and alcohol consumption were associated with a lower risk of MetS (OR = 0.6, 95%CI: 0.5–0.8 and OR = 0.8, 95%CI: 0.6–1.0) (Table 2).

Prevalence of diagnostic criteria for metabolic syndrome by gender

The most prevalent feature of MetS in this sample was HDL-C (52.3%), and the lowest was WC (8.7%). Most participants with MetS had one or two features (32.7% vs. 33.8%). A minority had five features (3.2%). Significant differences in gender were observed in the prevalence rates of MetS ($p < 0.001$), MetS features ($p < 0.001$), and the number of MetS features ($p < 0.001$). Women showed a significantly higher prevalence of WC and low HDL-C; all the other features were more prevalent in men. The prevalence of the number of MetS features also varied according to gender. The presence of one or fewer components was higher in men, and the presence of three-to-four components was higher in women (Table 3).

Prevalence of metabolic syndrome components

In Table 4, results from the comparison between participants with and without MetS are presented according to demographic, behavioral, anthropometric, and analytical characteristics. As expected, participants with MetS had significantly higher mean values of weight, BMI, and WC. Regarding analytical characteristics, participants with MetS had significantly higher mean levels of glucose and triglycerides ($p < 0.001$). The mean (SD) levels of glucose, triglycerides, and HDL-C in the normal group and the MetS group were, respectively, 5.8 (0.1) / 3.2 (0.1) / 1.0 (0.1) and 4.9 (0.1) / 1.8 (0.1) / 1.2 (0.1) mmol/dL. The mean (SD) values of WC were 86.7 (0.12) cm in normal participants and 89.1 (0.3) cm in the MetS group. Systolic and diastolic blood pressure values (mean and SD) were, respectively, 124.5 (0.5) / 77.3 (0.3) mmHg in the normal group and 143.9 (1.1) / 86.9 (0.6) mmHg in the MetS group. Differences between the two groups were significant ($p < 0.001$) for all characteristics except glucose. In addition, individuals with MetS reported a higher prevalence of previously diagnosed type 2 diabetes ($p < 0.001$), hypertension ($p < 0.001$), and dyslipidemia ($p < 0.001$). MetS was significantly more frequent in women and older subjects ($p < 0.001$). However, MetS was less frequent in smokers ($p = 0.001$).

Discussion

Metabolic syndrome is a serious health problem that continues to grow. This syndrome is associated with an increased risk of type 2 diabetes and cardiovascular disease. However, the cause of MetS is complex and multiple factors, including genetic, play important roles in the development of this syndrome [17]. In this study, the prevalence of MetS and its factors in rural populations was investigated.

Based on our findings, the Vietnamese population appears to have a relatively high burden of MetS compared to neighboring states and countries. A systematic review of MetS prevalence in South Asia from the IDF found age-adjusted rates starting from 15% in the Philippines and 18% in China [17]. The prevalence of MetS in Vietnam was higher among women, older individuals, and those with greater BMI in the multivariate model, which are established trends globally. The prevalence of MetS decreased with higher levels of education: prevalence was one-fourth in individuals who attended nine years of school or less, compared to one-sixth in those who completed twelve years and above. This finding suggests a need for lifestyle interventions targeting individuals with fewer years of schooling.

In this meta-analysis, the overall prevalence of MetS was 19.6%: 14.8% in men and 24.2% in women [18]. These results are consistent with the present study. It seems that, as age increases and base metabolism and mobility decrease, obesity rates and risk factors for MetS increase. The presence of MetS increases the risk of developing CVD and type 2 diabetes [19, 20]. This study shows that subjects with MetS significantly reported a higher prevalence of previously diagnosed type 2 diabetes, myocardial infarction, and stroke, demonstrating the association of MetS with CVD and diabetes. The present study also observes a significant correlation between incidence of MetS and increased BMI and age. A study by Kashani et al. (2016) in Mazandaran showed a similarly significant correlation between incidence of MetS and increasing BMI and age [21].

According to the results of this study, the prevalence of MetS in the female population is higher than that of men. In a review study, Ranasinghe et al. (2017) have investigated the prevalence of MetS among young people in South Asia and Oceania [17]; the results showed that MetS in more common in women than men, which is consistent with the present study. A study by Zhou B et al. (2017) evaluated factors for diabetes among men and women; the results showed that the incidence rates of diabetes were higher in women than in men, which is also consistent with the present study [22]. In general, the mass of fat is higher in women's physiology, and the fat content of women's bodies is much higher in the flank and in the abdominal region. In fatty tissue, cytokines produced by fat cells cause inflammation and insulin resistance, and diabetes is more often seen in them. Hormonal differences in women's bodies also cause differences in the prevalence of MetS between genders. Evidences suggests that estradiol, the main female gender hormone, has protective effects on the cardiovascular system.

Limitations

The present study carries the inherent limitations of a cross-sectional study: it prevents understanding the true temporal relationships between lifestyles and diseases. Cross-sectional data cannot assess the effects of lifestyle on the incidence of MetS, and longitudinal cohort studies are, therefore, needed. What's more, self-reported information might not be free from misclassification, social desirability bias, recall errors, and confounding factors. Another potential concern is that HDL-C, triglycerides, and blood glucose levels were measured only once, which may have led to random errors.

Recommendations

Policy makers and healthcare providers can develop effective and equitable interventions by addressing the risk factors for MetS among high-risk populations as part of a strategy for cardiovascular health improvement. Knowledge and awareness of MetS can be imparted through appropriate Information, Education, and Communication (IEC) or Behavior Change Communications (BCC) activities about weight reduction, restricting alcohol intake and smoking, increasing physical activity, and regular screening of blood pressure, blood sugar, and serum cholesterol levels. If abdominal obesity and waist circumference are kept in check, the incidence of MetS can be controlled in young populations, which in turn lowers the chances of MetS incidence increasing with age. However, if three-to-six months of efforts at remedying risk factors prove insufficient, then drug treatment is frequently required. Early identification, prevention, and treatment of MetS present a major challenge for community physicians, public health policy makers, and stakeholders in the regional health sector.

Conclusion

MetS is a complex condition with high socioeconomic costs, and its consequences constitute a heavy burden. This study showed that MetS is highly prevalent in the Vietnamese adult population. A high prevalence of hypertension, obesity, and diabetes in Vietnam may contribute to these numbers. Our findings are alarming: policy makers should consider primary prevention through a public information campaign that will advise at-risk Vietnamese populations on the hazards of sedentary lifestyles and obesity. Because individuals with MetS can be easily screened according to the criteria included in this study, it is essential to identify and properly manage each of the syndrome's components to delay its appearance or avoid its complications. Educational and healthcare interventions seem necessary to reduce this syndrome's prevalence, especially among women and older populations.

Conflicts of interest

The authors declare that they have no conflict of interest.

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TABLES AND FIGURES

Table 1. Socio-demographic characteristics of the study participants with and without metabolic syndrome (n=1910)

Variables		Total (n = 1910)			
		Normal Group (n = 1536)	MetS Group (n = 374)	Chi-Square	p
Age (year)	30-39	214(89.5)	25 (10.5)	49.136	<0.001
	40-49	306(89.2)	37(10.8)		
	50-59	399(79.8)	101(20.2)		
	60-69	378(75.8)	121(24.2)		
	70-79	182(72.5)	69(27.5)		
	≥ 80	57(73.1)	21(26.9)		
Gender	Male	797(85.2)	138(14.8)	27.043	<0.001
	Female	739(75.8)	236(24.2)		
Hypertension	Normal	1291(85.9)	212(14.1)	138.067	<0.001
	Grade 1 hypertension	161(63.1)	94(36.9)		
	Grade 2 hypertension	84(55.3)	68(44.7)		
Dyslipidemia	No	770(91.8)	69(8.2)	122.558	<0.001
	Yes	766(71.5)	305(28.5)		
Smoking	No	1142(78.8)	307(21.2)	9.832	0.001
	Yes	394(85.5)	67(14.5)		

Table 2. Risk factors for MetS by adjusted odds ratio (OR) among study population by selected characteristics

Variables	Normal Group (n = 1536)	MetS Group (n = 374)		
	OR	OR	95%CI	p
Gender (Male)	1	1.8	1.5-2.3	<0.001
Family history of Hypertension	1	2.5	1.9-3.2	<0.001
Hypertension	1	4.0	3.2-5.2	<0.001
Family history of Dyslipidemia	1	2.5	1.7-3.6	<0.001
Dyslipidemia	1	4.4	3.4-5.9	<0.001
Obesity	1	2.1	1.5-3.0	<0.001
Smoking	1	0.6	0.5-0.8	0.001
Alcohol	1	0.8	0.6-1.0	0.021

Table 3. Age-adjusted prevalence of MetS according to different genders

Variable	n	Total %(95%CI)	Women %(95%CI)	Men %(95%CI)	p-value
Prevalence		19.6 (17.8-21.4)	24.2(21.5-26.9)	14.8 (12.5-17.1)	<0.001
			MetS feature		
Waist circumference	1910	8.7(7.4-9.9)	14.5(12.3-16.7)	2.7(1.7-3.7)	<0.001
Glucose	1910	8.3(7.1-9.5)	6.8(5.2-8.4)	9.9(8,0-11.8)	0.007
Triglyceride	1910	46.6(44.4-48.8)	46.6(43.5-49.7)	46.7(43.5-49.9)	0.488

HDL-c	1910	52.3(50.1-54.5)	72.1(69.3-74.9)	31.6(28.6-34.6)	<0.001
Hypertension	1910	21.3(19.5-23.1)	19.3(16.8-21.8)	23.4(20.7-26.1)	0.016
		Number of MetS features			
0	265	13.9	8.7	19.3	
1	625	32.7	31.3	34.2	
2	646	33.8	35.8	31.8	
3	304	15.9	18.3	13.5	
4	64	3.2	5.1	1.3	
5	8	0.4	0.8	0.0	
Mean (95%CI)		1.6 (1.6-1.7)	1.8(1.8-1.9)	1.4(1.4-1.5)	<0.001

Table 4. Demographic, behavioral, and analytical characteristics of participants with MetS

Variable	MetS Group	Normal Group	Prevalence ratio (95%CI)	p
Gender				
Male	138(14.8)	797(85.2)	*	
Women	236(24.2)	739(75.8)	1.8(1.5-2.3)	<0.001
Age [years, n (%)]				
30-39	25 (10.5)	214(89.5)	*	
40-49	37(10.8)	306(89.2)	1.0(0.6-1.8)	0.507
50-59	101(20.2)	399(79.8)	2.2 (1.4-3.5)	0.001
60-69	121(24.2)	378(75.8)	2.7(1.7-4.4)	<0.001
70-79	69(27.5)	182(72.5)	3.3(2.0-5.3)	<0.001
≥ 80	21(26.9)	57(73.1)	3.2(1.6-6.0)	0.001
Education [years, n (%)]				
0-5	118(24.7)	360(75.3)	1.4(0.8-2.7)	0.265
6-9	186(19.1)	788(80.9)	1.0(0.5-1.9)	0.914
10-12	57(14.7)	331(85.3)	0.8(0.4-1.5)	0.407
>12	13(18.6)	57(81.4)	*	
Smoking status [n (%)]				
Non-smoker	307(21.2)	1142(78.8)	*	
Smoker	67(14.5)	394(85.5)	0.6(0.5-0.8)	<0.001
Prevalence of metabolic syndrome components				
SBP [mmHg, Mean (SE)]	124.5 (0.5)	143.9 (1.1)		<0.001
DBP [mmHg, Mean (SE)]	77.3 (0.3)	86.9 (0.6)		<0.001
Weight [kg, Mean (SE)]	53.2(0.4)	50.8(0.2)		<0.001
Body mass index [kg/m^2, Mean (SE)]	22.2(0.1)	20.8(0.1)		<0.001
Waist circumference [cm, Mean (SE)]	77.3(0.4)	72.5(0.2)		<0.001
Hip circumference [cm, Mean (SE)]	89.1(0.3)	86.7(0.1)		<0.001
WHZ	0.9(0.1)	0.8(0.1)		<0.001
Cholesterol [mmol/dL, Mean (SE)]	5.2(0.1)	4.7(0.1		<0.001
Triglycerides [mmol/dL, Mean (SE)]	3.2(0.1)	1.8 (0.1)		<0.001
HDL cholesterol [mmol/dL, Mean (SE)]	1.0(0.1)	1.2(0.1)		<0.001
LDL cholesterol [mmol/dL, Mean (SE)]	2.9(0.1)	2.8(0.1)		<0.001
Glucose [mmol/dL, Mean (SE)]	5.8 (0.1)	4.9 (0.1)		0.157

Diabetes [n (%)]	106 (66.7)	53 (33.3)	11.1 (7.8-15.8)	<0.001
Hypertension [n (%)]	325 (35.4)	592 (64.6)	10.6 (7.7-14.5)	<0.001
Dyslipidemia [n (%)]	305 (28.5)	766 (71,5)	4.4 (3.4-5.9)	<0.001
Previous stroke [n (%)]	3 (30.0)	7 (70.0)	1.7 (0.5-6.9)	0.309
Previous myocardial infarction [n (%)]	61 (21.9)	218 (78.1)	1.2 (0.9-1.6)	0.169