ORIGINAL ARTICLE

Gender Differences Relevant to Metabolic Syndrome in a Working Population in Phetchaburi Province, Thailand

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Background: The prevalence of metabolic syndrome (MetS) is increasing in the Thai working population. Thus, there is a need for an analysis of factors relevant to metabolic syndrome comparing the differences between females and males to improve, prevent, and reduce the risk of metabolic syndrome in the working population.

Objective: To investigate the factors and the prevalence to identify gender-specific risk factors for MetS.

Materials and Methods: The authors performed a cross-sectional study of 2,076 working adults living in the Phetchaburi Province in Central Thailand, defining MetS according to the International Diabetes Federation criteria. The authors used a self-administered structured questionnaire to collect the data, and calculated odds ratios (OR) with 95% confidence intervals (CI) stratified by gender.

Results: The median age of participants was 50 years. The overall prevalence of MetS was higher in females (28.13%) than males (22.25%). MetS was associated with high body mass index (BMI), education, and exercise in both genders. Advanced age was a MetS risk factor in males (adjusted OR 3.22, 95% CI 1.42 to 7.32, p=0.005). The main MetS protective factors in females were nutrition literacy (adjusted OR 0.65, 95% CI 0.43 to 0.99, p=0.046) and behavior (adjusted OR 0.40, 95% CI 0.27 to 0.62, p<0.001).

Conclusion: MetS risk factors are gender specific. Therefore, gender-specific public health strategies are required to prevent MetS.

Keywords: Metabolic syndrome; Gender differences; Thai working

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Over 800 million individuals are affected by metabolic syndrome (MetS) worldwide. The global prevalence of MetS is estimated to increase by 60% by 2030, affecting 250 million individuals[1]. The World Health Organization (WHO) has reported the prevalence of MetS is high in most Southeast Asian countries, affecting 28% to 50% of working adults in Thailand[1,2]. MetS risk factors include insulin resistance, diabetes mellitus, cardiovascular disease, and stroke[3]. The prevalence of MetS is highest in working adults, particularly in males and those aged 50 and over[4,5].

MetS risk factors are correlated with demographic, socioeconomic, lifestyle, and health behavior[6]. Some studies have shown that lifestyle and health behaviors are the risk factors beginning in childhood, reflecting interactions among genetic, social class, and environmental factors[7]. Moreover, MetS risk factors are associated with gender differences due to environmental factors. Therefore, gender differences in MetS prevalence reflect socioeconomic factors, social characteristics, health behavior, and lifestyle[8]. Indeed, poor nutrition literacy is a risk factor for developing MetS, such as consuming fewer vegetables and fruits and more sweets and fatty and salty food[9]. Gender differences in MetS risk factor patterns may reflect health behavior and lifestyle differences in males and females[6].

Phetchaburi Province is a part of Health Region 5 in Central Thailand that has a high prevalence of obesity in working adults in 2020[10]. The UNESCO world heritage announced that Petchaburi was the city of creative food for 2021.The basic socio-economic factors in Petchaburi are different from the other

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provinces nearby due to its diversity of geography with available agriculture, marine, and fresh-water fishery, mining, various industries, tourism, hotels, an entrepreneurial spirit, and known as the city of dessert production[11]. Hence, Petchaburi Province is passionate and was the focus for the present research priority.

Gender differences in related health behaviors, such as dietary habits and an increasingly sedentary lifestyle, may lead to MetS development[6]. Previous Korean studies found gender-specific MetS risk factor patterns, such as education level and household income in females and alcohol consumption in males[6]. Therefore, the influence of gender should be considered when determining MetS risk factors. Additionally, public health strategies for MetS may need to be more gender specific. However, gender differences in MetS risk factors in rural Thailand are poorly understood. Therefore, the present study examined gender differences in MetS risk factors of the Thai working population.

Materials and Methods

Study design and setting

The authors performed a cross-sectional analytical study of 2,076 working adults aged 18- to 59-year-old who came to Phetchaburi Hospital (a total of populations 248,767) in Phetchaburi Province, Thailand. A proportional size estimation sampling formula was used from a study stating that 48.9% of the provincial gender were male[10]. All subjects were recruited using multistage random sampling from outpatient ward services at hospitals in eight districts of Health Region 5 in Phetchaburi Province, Central Thailand, which had a high prevalence of obesity in working adults in 2020[10].

Study participants and sampling

The sample size of the present study full cohort of 2,076 working adults aged 18 to 59 years was assessed using the G*power 3.1.9.7 software with the analytical Z-test logistic regression method considering an R^2 deviation from zero and odds ratio of 1.28[12], indicating 80% power with α=0.05. Exclusion criteria included incomplete questionnaires. MetS diagnosis was based on the proposed International Diabetes Federation criteria[13]. Nutritional status was assessed using an anthropometric body mass index (BMI) indicator calculated using the World Health Organization (WHO) Quetelet index (Asian BMI classification)[14]. The data were collected between March 2021 and March 2022.

Data collection tool and technique

Data were collected through a self-administered questionnaire that included demographic information as age, marital status, education, and working time, and health behaviors as smoking, alcohol consumption, and exercise. A Thai nutritional literacy assessment tool focusing on three components as functional nutrition literacy, interactive nutrition literacy, and critical nutrition literacy, was developed based on Deesamer et al.[15]. The instrument's 14 nutrition literacy items assessing functional (5 items), communicative (5 items), and critical (4 items) showed a Cronbach's alpha of 0.80 and were scored on a 5-point scale from strongly disagree (1) to strongly agree (5). The final section on nutritional behavior was systematically developed to measure 20 items assessing dietary practices on a 5-point scale from strongly disagree (1) to strongly agree (5), showing a Cronbach's alpha of 0.78.

Statistical analysis

Statistical analyses were performed with IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were reported as frequencies and percentages. All continuous variables were reported as mean and standard deviation (SD). Univariate logistic regression was used to estimate the association of each independent variable and MetS status. All independent variables with p-value less than 0.25 in the univariate analyses were included in a multivariate logistic regression analysis to estimate their associations while controlling for the effect of other covariates. Associations between MetS risk factors were presented as adjusted odds ratios (OR) with 95% confidence intervals (CI).

Ethical consideration

The present study was approved by the Ethics Committee of Mahasarakham University (reference no. ECMSU109398; Kham Riang, Thailand).

Results

The 2,076 working adults' subjects were aged 18 to 59 and 48.94% comprised of male and 51.06% of female (Table 1). The MetS prevalence in working adults was found to be 0.44 (1,010 cases), and higher in working females 0.51 (548 cases). The mean age was 48.5 (SD 10.7, median 50, min 18, max 59). Over 50% of working males and females with MetS were aged over 50 and obese at 60.40%. Their mean working time was eight hours (SD 1.65, min 6, max 12). Most were married at 81.19%. Nutrition

Table 1. Sex differences in demographic and risk factors among participants with metabolic syndrome (n=2,076)

Description	Total; n (%)	Male; n (%)	Female; n (%)
Participant	2,076 (100)	1,016 (48.94)	1,060 (51.06)
Cases	1,010 (48.65)	462 (45.74)	548 (54.26)
Age group			
<50 years	428 (42.37)	176 (38.10)	252 (45.98)
>50 years	582 (57.63)	286 (61.90)	296 (54.02)
BMI for Asia			
Normal	238 (23.56)	164 (35.50)	74 (13.50)
Overweight	162 (16.04)	64 (13.85)	98 (17.88)
Obese	610 (60.40)	234 (50.65)	376 (68.62)
Marital status			
Married	820 (81.19)	346 (74.89)	474 (86.50)
Others (single, separated, divorce, widowed)	190 (18.81)	116 (25.11)	74 (13.50)
Education			
Primary school or lower	446 (44.16)	248 (53.68)	198 (36.13)
Secondary school or above	564 (55.84)	214 (46.32)	350 (63.87)
Working time			
<8 hours	82 (8.11)	30 (6.50)	52 (9.49)
≥8 hours	928 (91.89)	432 (93.50)	496 (90.51)
Smoking			
No	806 (79.80)	322 (69.70)	484 (88.32)
Yes	204 (20.20)	140 (30.30)	64 (11.68)
Alcohol drinking			
No	772 (76.43)	312 (67.53)	460 (83.94)
Yes	238 (23.56)	150 (32.47)	88 (16.06)
Exercise			
No	680 (67.33)	326 (70.56)	354 (64.60)
Yes	330 (32.67)	136 (29.44)	194 (35.40)
Nutrition literacy			
Inadequate	602 (59.60)	270 (58.44)	332 (60.58)
Adequate	408 (40.40)	192 (41.56)	216 (39.42)
Nutrition behavior			
Unhealthy	536 (53.07)	228 (49.35)	308 (56.20)
Healthy	474 (46.93)	234 (50.65)	240 (43.80)

BMI=body mass index

literacy was inadequate in 59.60% of Thai working adults. Most working adults had unhealthy nutrition behavior.

The prevalence of each MetS variable in each gender is presented in Table 1. Obesity affected more females at 68.62% than males at 50.65%. Married and secondary school education statuses were higher in females than males. More females had adequate status of health behaviors than male, such as smoking, alcohol consumption, and exercise. More males had adequate status of nutritional behaviors than females.

The univariate logistic regression results of MetS-associated factors in each gender are presented in Table 2. Age, obese BMI, education, exercise, and nutrition literacy were associated with MetS in males, but not marital status, working time, smoking, alcohol consumption, and nutritional behavior. Significant variables associated with MetS in females were similar to males, except for marital status and nutritional behavior.

The multivariate analysis showed that BMI, education, and exercise were significantly associated with MetS in both males and females (Table 3). Age (adjusted OR 3.22, 95% CI 1.42 to 7.32, p=0.005), overweight (adjusted OR 6.20, 95% CI 2.00 to 9.23, p=0.002), obese (adjusted OR 8.55, 95% CI 3.72 to 18.31, p<0.001) BMI, education level (secondary school or above; adjusted OR 0.32, 95% CI 0.13 to

Table 2. Univariable logistic regression analyses on risk factors for the prevalence of metabolic syndrome in men and women (n=2,076)

Category	Reference	Male		Female	
		OR (95% Cl)	p-value	OR (95% Cl)	p-value
Age group	<50 years				
>50 years		1.02 (1.00 to 1.04)	0.021	1.00 (0.98 to 1.02)	0.873
BMI for Asia	Normal				
Overweight		1.32 (0.80 to 2.20)	0.282	4.26 (2.46 to 7.38)	<0.001
Obese		6.53 (4.19 to 10.17)	<0.001	8.68 (5.54 to 13.60)	<0.001
Marital status	Others				
Married		1.42 (0.93 to 2.16)	0.106	2.23 (1.43 to 3.47)	<0.001
Education	Primary school or lower				
Secondary school or above		0.61 (0.43 to 0.87)	0.006	0.59 (0.40 to 0.86)	0.006
Working	<8 hours				
>8 hours		1.43 (0.73 to 2.78)	0.293	1.22 (0.69 to 2.13)	0.488
Smoking	No				
Yes		1.05 (0.72 to 1.54)	0.794	1.24 (0.74 to 2.06)	0.413
Alcohol drinking	No				
Yes		1.01 (0.70 to 1.48)	0.935	1.53 (0.99 to 2.37)	0.055
Exercise	No				
Yes		0.62 (0.42 to 0.89)	0.010	0.57 (0.40 to 0.80)	0.001
Nutrition literacy	Inadequate				
Adequate		0.64 (0.45 to 0.91)	0.012	0.48 (0.34 to 0.67)	<0.001
Nutrition behavior	Unhealthy				
Healthy		0.99 (0.70 to 1.40)	0.955	0.94 (0.92 to 0.97)	<0.001

BMI=body mass index; OR=odds ratio; CI=confidence interval

Table 3. Multivariable logistic regression analyses on risk factors for the prevalence of metabolic syndrome in men and women (n=2,076)

Category	Reference	Male		Female	
		Adjusted OR (95%Cl)	p-value	Adjusted OR (95%Cl)	p-value
Age group	<50 years				
>50 years		3.22 (1.42 to 7.32)	0.005	1.11 (0.74 to 1.67)	0.611
BMI for Asia	Normal				
Overweight		6.20 (2.00 to 19.23)	0.002	3.64 (2.00 to 6.61)	<0.001
Obese		8.55 (3.72 to 18.31)	<0.001	9.32 (5.73 to 15.17)	<0.001
Marital status	Others				
Married		1.38 (0.60 to 3.15)	0.443	2.01 (1.21 to 3.36)	0.007
Education	Primary school or lower				
Secondary school or above		0.32 (0.13 to 0.78)	0.012	0.58 (0.38 to 0.90)	0.017
Working	<8 hours				
>8 hours		1.55 (0.42 to 5.64)	0.502	1.76 (0.91 to 3.39)	0.093
Smoking	No				
Yes		2.64 (0.67 to 10.45)	0.165	1.22 (0.60 to 2.50)	0.579
Alcohol drinking	No				
Yes		1.05 (0.28 to 3.93)	0.940	1.81 (0.94 to 3.49)	0.074
Exercise	No				
Yes		0.64 (0.42 to 0.98)	0.040	0.73 (0.59 to 0.91)	0.006
Nutrition literacy	Inadequate				
Adequate		0.57 (0.27 to 1.23)	0.154	0.65 (0.43 to 0.99)	0.046
Nutrition behavior	Unhealthy				
Healthy		0.60 (0.28 to 1.29)	0.193	0.40 (0.27 to 0.62)	<0.001

BMI=body mass index; OR=odds ratio; CI=confidence interval

0.78, p=0.012), and exercise (adjusted OR 0.64, 95% CI 0.42 to 0.98, p=0.040) were associated with MetS in males. Similarly, overweight (adjusted OR 3.64, 95% CI 2.00 to 6.61, p<0.001), obese (adjusted OR 9.32, 95% CI 5.73 to 15.17, p<0.001) BMI, marital status (adjusted OR 2.01, 95% CI 1.21 to 3.36, p=0.007), alcohol consumption, education level (secondary school or above; adjusted OR 0.58, 95% CI 0.38 to 0.90, p=0.017), nutrition (adjusted OR 0.65, 95% CI 0.43 to 0.99, p=0.046), and behavior (adjusted OR 0.40, 95% CI 0.27 to 0.62, p<0.001) were associated with MetS in females.

Discussion

The present study explored gender differences in MetS risk factors in the Thai working population. The authors found the overall prevalence of MetS was higher in females than in males, indicating gender differences in MetS that can be explained by physiological changes in females that make them more susceptible to MetS[16]. The previous studies found that menopause increased triglyceride and low-density lipoprotein levels and decreased high-density lipoprotein levels[17,18].

MetS risk factors differed by gender. Overweight and obese BMI, educational level, and exercise were MetS risk factors in both genders. Furthermore, age (older than 50 years) was a risk factor only for males. Moreover, marital status, alcohol consumption, and nutritional literacy and behavior were MetS risk factors only for females.

Advancing BMI from overweight to obese causes MetS and progression of non-communicable diseases such as atherosclerotic cardiovascular disorder, and type 2 diabetes[19]. A previous study found that an obesity-related diet is associated with MetS[20]. The present study also found that a higher BMI was associated with higher odds of MetS, indicating that weight gain in males enhances their MetS risk more than in females.

Educational level and exercise had protective effects on MetS risk in both genders. Educational level is the only factor related to socioeconomic status and MetS risk[21], since a high educational level is associated with good nutritional behavior and status[22]. Furthermore, education level is also potentially associated with a positive health attitude and status[23]. The authors found an adjusted OR of 0.32 in males and 0.58 in females, indicating a protective effect on MetS in those educated at secondary school and above. This finding suggests that educational level reduces MetS risk. A previous study found that a higher educational level was associated with significantly better metabolic health than a lower educational level[24]. The present study result showed that exercise has a protective effect on both males and females. This result is consistent with the previous studies that found exercise reduced total body fat and associated risk factors for MetS development[25] and is correlated with decreased MetS risk[26].

MetS prevalence increases with age. The study found that advanced age (older than 50 years) was a risk factor for MetS only in males. A previous study found that MetS risk increases after middle age since the aging process influences it[27], consistent with an earlier study showing that MetS prevalence increases with age and is higher in males than females[28].

Socioeconomic factors, such as marital status, were MetS risk factors mostly in females. Studies have suggested that socioeconomic factors and health behaviors dependent on marital status affect MetS prevalence[29]. Indeed, MetS was more common in widowed females than married females, potentially reflecting more inappropriate health behaviors[29,30].

Current MetS public health policy in Thailand focuses on nutrition literacy, which the authors found to be a protective factor for MetS only in females. Nutrition literacy is inversely associated with advanced BMI (overweight and obesity)[31]. Energy consumption behavior is a major contributor to obesity and MetS[19]. Therefore, nutrition literacy and obesity-related energy consumption behavior are directly associated with MetS, which can be shown by differences in energy consumption behavior and via interactions with other variables. This result highlights the need to develop a new MetS management program for females focusing on nutrition literacy.

The association between nutritional behavior and MetS, most often in females, can be explained by gender and educational status with components of socioeconomic status. Education had higher adjusted ORs in females than males and was a protective factor for MetS. Other studies suggest that females have good attitudes and behaviors in healthy eating, while a higher education level leads to good nutritional behavior[32-34]. The first major finding is that the marital status in female has a role with worse MetS, therefore, crucial suggestions should be to enhance physical activity and reduce calories consumption. The second major finding is that nutritional literacy and behavior are worse in male and nutritional education and behavioral change

should be implemented.

Limitation and recommendation

While the present study had a large sample size, it did not examine dietary-intake-related variables to MetS. In addition, its cross-sectional design was unable to provide causal inferences, thus, future studies with a longitudinal design are required to confirm the present findings.

Conclusion

The present study identified risk and protective factors for MetS in both genders, with females having more protective factors than males. Indeed, nutritional literacy and behavior could be factors for designing educational interventions to prevent MetS.

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Conflicts of interest

The authors declare no conflicts of interest.

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