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Original research article

Prevalence and factors affecting metabolic syndrome in Burmese type 2 diabetic patients in Thailand: a single-center, cross-sectional study

May Myat Thwe Khin[1], Chanchira Choppradit[2], Kulwara Meksawan[1*]

[1]*Department of Food and Pharmaceutical Chemistry, Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok, 10330, Thailand*
[2]*Pharmacy Department, Samutsakhon Hospital, Samut Sakhon, 74000, Thailand*

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ABSTRACT

Nowadays, the prevalence of metabolic syndrome (MetS) is increasing worldwide, and it was also found among type 2 diabetic patients. The objective of this study was to investigate the prevalence and factors affecting MetS in Burmese type 2 diabetic patients by using two different MetS criteria. In this cross-sectional study, information on general characteristics, anthropometry, laboratory parameters, and dietary intake was collected from Burmese patients with type 2 diabetes at Samutsakhon Hospital, Samut Sakhon Province, Thailand. The prevalence and factors affecting MetS were determined. The prevalence of MetS was 78.1% and 67.2% according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) and the International Diabetes Federation (IDF) criteria, respectively. According to the NCEP ATP III criteria, comorbid diseases (AOR: 3.96, 95%CI: 1.75-8.94) and time spent sitting >3 hours on a typical day (AOR: 5.40, 95%CI: 1.66-17.62) affected MetS. Based on the IDF criteria, the factors influencing MetS were female (AOR: 3.06, 95%CI: 1.31-7.19), comorbid diseases (AOR: 2.62, 95%CI: 1.27-5.41) and time spent sitting >3 hours on a typical day (AOR: 3.83, 95%CI: 1.29-11.35). Participants with MetS consumed more energy and all macronutrients than those without MetS (all $p<0.05$). The results of this study indicate the high prevalence of MetS in Burmese type 2 diabetic patients. Several factors affect MetS and these should be taken into consideration to develop strategies for prevention and management of MetS and type 2 diabetes in these patients.

Keywords: Burmese, metabolic syndrome, type 2 diabetes, dietary intake

***Corresponding author:** Kulwara.M@chula.ac.th

1. Introduction

Diabetes mellitus (DM) is a metabolic disease characterized by persistently elevated blood glucose levels.[1] DM prevalence in 20 to 79-year-olds is projected to be 783.2 million people worldwide in 2045.[2] Type 2 DM, previously known as non-insulin-dependent diabetes, accounts for about 90% of all cases of diabetes that become a global public health issue.[1,3] In addition to insulin resistance and a relative insulin deficiency that is present in these patients,[1] the cluster of cardiovascular risks referred to as metabolic syndrome (MetS)[4] has also been found widely in patients with type 2 DM.[5]

MetS is a constellation of inter-connected elements that includes abdominal obesity, insulin resistance, impaired glucose tolerance, dyslipidemia, and high blood pressure (BP).[4] Several criteria have been established to identify the presence of MetS.[4] Based on the diagnostic criteria, the global prevalence of MetS ranged from 12.5% to 31.4% in the general adult population.[6] Moreover, the prevalence of MetS has been increasing in the Asian population.[7] According to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria, 29.1% of Burmese adults in Myanmar were found to have MetS.[8] The prevalence was even as high as 83% among type 2 diabetic Burmese patients based on the International Diabetes Federation (IDF) criteria.[9] Patients with both MetS and type 2 DM are more at risk for cardiovascular diseases (CVD) than those with only type 2 DM or MetS.[10] Age, gender, marital status, educational level, history of smoking, physical activity level, BMI, and duration of diabetes were found to be risk factors associated with MetS among type 2 diabetic patients.[5,11]

The importance of controlling MetS and type 2 DM is to reduce the modifiable, basic risk factors (obesity and physical inactivity) through lifestyle modifications.[12] Moreover, diet is also considered a strong modifiable risk component for several chronic health problems including obesity and diabetes. However, beyond weight management and calorie restriction, the diet for treating and preventing MetS is still unclear. It should generally be low consumption of some food items such as red meat, refined grains, fast foods, and pickled foods that are in dietary patterns associated with an increased risk for MetS.[13] Traditional Burmese cuisine is an Asian style of cooking that consists primarily of rice and various oily foods eaten with family while popular Burmese street foods are instant noodles and fried snacks.[14] Such eating habits without regard for health among Burmese people may lead to overweight and associated health problems such as diabetes.[14,15]

Many Burmese people are currently migrating to Thailand.[16] A large number of Burmese migrants reside in Samut Sakhon Province.[17] Their lifestyle may be changed which could affect their health. The experience of migration might have a detrimental impact on risky behaviors including smoking, drinking alcohol and physical inactivity that are associated with health problems.[18,19] One of the most common lifestyle-related diseases is DM. Although the prevalence of hyperglycemia (13.4%) and its associated factors were reported among Myanmar migrant workers in Thailand[20], information on the prevalence of MetS and factors affecting MetS in Burmese type 2 diabetic migrants who are residing in Thailand is still lacking. Therefore, this study aimed to determine the prevalence and factors affecting MetS in Burmese type 2 diabetic patients in Thailand. Understanding the factors affecting MetS in these patients facilitates better treatment and also provides initial valuable information for promoting a more inclusive healthcare system for Burmese migrants in Thailand.

2. Materials and Methods

2.1 Study design

A cross-sectional study was carried out on Burmese type 2 diabetic outpatients at Samutsakhon Hospital in Samut Sakhon

Province, Thailand between November 2021 and July 2022. Participants' demographic data and information about duration of having DM, comorbid diseases, and physical activity were collected. Anthropometry, BP and laboratory parameters were assessed. In addition, daily dietary intake was evaluated. Prevalence and factors affecting MetS were investigated.

2.2 Participants

Burmese outpatients, aged 18-60 years old, who were diagnosed with type 2 DM by a physician were recruited in the study. Both men and women were included. Pregnant and lactating women and patients having serious complications, infection, cancer, and chronic use of systemic glucocorticoids were excluded. The patients with incomplete required data were also excluded from the study. There were 183 Burmese type 2 diabetic outpatients in the study. This sample size was considered appropriate for multivariate logistic regression analysis.[21]

2.3 Data collection procedures

A consent form was signed by the patients who met the inclusion/exclusion criteria and agreed to participate in the study. The participants completed a questionnaire consisting of general information, health information and physical activity. The questionnaire was constructed based on the factors that could influence MetS according to previous studies.[5,22,23] The constructed questionnaire was reviewed by three experts for content validity and was revised according to the experts' comments before collecting the data. Measurements of BP and anthropometry including height, weight, and waist circumference (WC) were performed. The participants' BP was measured once using a digital BP monitor (TERUMO, ES*H2655, Tokyo, Japan) with the participants in the sitting position. WC was measured at the midpoint between the lowest rib and the iliac crest with the participants standing and breathing out gently. Body mass index (BMI) was calculated based on height and weight.

The information on biochemical parameters measured on the study day was obtained from participants' medical records. In brief, blood samples were collected from each participant after an overnight fasting period of 8-12 hours. Fasting blood sugar (FBS) and lipid profile including total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and triglyceride (TG) were determined using a Cobas pro c513 analyzer (Roche, Bangkok, Thailand). The data of the latest hemoglobin A1c (HbA1c) measured within 6 months were also collected. Participants' food consumption was assessed using 24-hour dietary recall, and dietary intake was then analyzed by using the INMUCAL-Nutrients software (Institute of Nutrition, Mahidol University, Thailand).

2.4 Diagnostic criteria of MetS

In this study, MetS was defined following the NCEP ATP III criteria and the IDF criteria. Based on the NCEP ATP III criteria with the WC cut point for Asians, the MetS was defined by the presence of central obesity (WC ≥80 cm in females and ≥90 cm in males) together with two of the following MetS factors including (1) FBS ≥5.6 mmol/L (100 mg/dL) or previously diagnosed type 2 DM, (2) TG ≥1.7 mmol/L (150 mg/dL) or on drug treatment for this abnormality, (3) HDL-C <1.04 mmol/L (40 mg/dL) in males and <1.30 mmol/L (50 mg/dL) in females or on drug treatment for this abnormality, and (4) systolic BP (SBP) ≥130 mmHg or diastolic BP (DBP) ≥85 mmHg or on drug treatment for either one of these abnormalities.[12, 24]

According to the IDF criteria with the WC cut point for Asians, participants who meet at least three of the following criteria are defined as having MetS: (1) WC ≥80 cm in females and ≥90 cm in males, (2) FBS ≥5.6 mmol/L (100 mg/dL) or on drug treatment for elevated blood glucose, (3) TG ≥1.7 mmol/L (150 mg/dL) or on drug treatment for this abnormality, (4) HDL-C <1.04 mmol/L (40 mg/dL) in males and <1.30 mmol/L (50 mg/dL) in females or on drug treatment for this abnormality, and (5) SBP ≥130 mmHg or DBP ≥85 mmHg or on drug treatment for either one of these abnormalities.[24, 25]

2.5 Data analysis

All statistical analyses were carried out using IBM SPSS Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp.). The categorical variables were shown as numbers and percentages, while the continuous variables were expressed as means and standard deviations (mean ± SD). The factors affecting MetS were analyzed by logistic regression and odds ratio (OR) with 95% confidence interval (CI) (OR, 95%CI) were reported. An independent t-test was used to examine the differences between continuous variables in participants with and without MetS. Nonparametric statistics were used when the data were not normally distributed. The statistical significance was set at $p<0.05$.

2.6 Ethical declaration

The study was approved by the Research Ethics Review Committee for Research Involving Human Research Participants, Group 1, Chulalongkorn University (COA No. 200/2021). The participants provided their signatures on the informed consent form before data collection.

3. Results

There were 183 Burmese type 2 diabetic patients participating in this study. Most of the participants were women (72.7%). The average age of the participants was 44.95±6.56 years (44.80±6.22 years for men and 45.01±6.71 years for women). The characteristics of the participants with and without MetS according to NCEP ATP III and IDF definition are shown in Table 1. According to the NCEP ATP III criteria, the prevalence of MetS in participants was 78.1%. There were 33 men (23.1%) and 110 women (76.9%) having MetS. Most of the participants with MetS were more than 40 years old (75.5%) and did not complete high school (95.1%). About 63% of the participants with MetS were workers in factories. Most of the participants with MetS lived in Thailand for more than 6 years (81.8%), had diabetes for less than or equal to 3 years (60.8%) and had comorbid diseases (67.8%). Hypertension and dyslipidemia were the most common comorbid diseases among the type 2 diabetic patients in this study.

When MetS was diagnosed by IDF criteria, the prevalence of MetS in participants was 67.2%. There were 22 men (17.9%) and 101 women (82.1%) having MetS. Most of the participants with MetS aged more than 40 years (77.2%), did not complete high school (95.9%) and worked in the factories (58.5%). The majority of the participants with MetS lived in Thailand for longer than 6 years (83.7%), had diabetes for less than and equal to 3 years (57.7%) and had comorbid diseases (68.3%). It was found that 81.8% and 78.9% of participants with MetS, according to the NCEP ATP III and the IDF criteria respectively, did not have obesity classified by BMI. Using WC to assess central obesity, all participants with MetS based on the IDF criteria had central obesity. When MetS was defined by the NCEP ATP III criteria, 14% of the participants with MetS had no central obesity.

The results from univariate logistic regression analysis showed that the factors affecting MetS based on the NCEP ATP III criteria were female (OR: 2.46, 95%CI: 1.18-5.15, p=0.017), smoking status (OR: 0.34, 95% CI: 0.14-0.88, p=0.026), comorbid diseases (OR: 3.16, 95%CI: 1.53–6.52, p=0.002), and time spent sitting of more than 3 hours on a typical day (OR: 3.43, 95%CI: 1.17-10.08, p=0.025), while female (OR: 4.02, 95%CI: 2.02-7.97, p<0.001), occupation (OR: 0.43, 95%CI: 0.21-0.86, p=0.018) smoking status (OR: 0.23, 95%CI: 0.09–0.58, p=0.002), comorbid diseases (OR: 2.30, 95%CI: 1.22-4.34, p=0.010), and time spent sitting of more than 3 hours on a typical day (OR: 3.04, 95%CI: 1.17-7.89, *p*=0.022) were factors affecting MetS based on the IDF criteria.

The variables that significantly affected MetS in the univariate logistic regression model were included in multivariate logistic regression analysis. The results are presented in Table 2. According to the NCEP ATP III criteria, the participants with comorbid diseases were 3.96 times more likely to have MetS than those without comorbid diseases (AOR: 3.96; 95% CI: 1.75-8.94, *p*=0.001). The participants who sat for more than 3 hours on a typical day had 5.40 times more chance of having MetS than those who sat for 30 minutes - 1 hour (AOR: 5.40; 95%CI: 1.66-17.62, *p*=0.005). Based on the IDF criteria, women had 3.06 times greater chance of having MetS than men (AOR: 3.06, 95%CI: 1.31-7.19, *p*=0.010). The participants with comorbid conditions were 2.62 times more likely to develop MetS than participants without comorbid conditions (AOR: 2.62; 95%CI: 1.27-5.41, *p*=0.009). Moreover, the participants who spent time sitting longer than 3 hours per day were 3.83 times more likely to have MetS compared to those who spent time sitting for 30 minutes - 1 hour per day (AOR: 3.83, 95%CI: 1.29-11.35, *p*=0.015).

Table 3 shows the anthropometry and BP of the participants with and without MetS based on the NCEP ATP III and IDF definition. There were significantly higher values of weight (*p*=0.011), BMI (*p*<0.001), WC (*p*<0.001), SBP (*p*<0.001), and DBP (*p*<0.001) in type 2 diabetic patients with MetS than in those without MetS according to NCEP ATP III criteria. In accordance with IDF criteria, significantly greater weight (*p*<0.001), BMI (*p*<0.001), WC (*p*<0.001), SBP (*p*<0.001), and DBP (*p*=0.001) in the patients with MetS than in those without MetS were found.

The laboratory parameters of the participants with and without MetS based on NCEP ATP III and IDF definition are presented in Table 4. According to NCEP ATP III criteria, the results showed that the patients with MetS had significantly higher levels of TC (*p*=0.046), LDL-C (*p*=0.048) and TG (*p*<0.001) but lower HDL-C level (*p*<0.001) than those without MetS. Based on the IDF definition, the results were significantly higher only for LDL-C level in the patients with MetS compared to those without MetS (*p*=0.013).

The daily dietary intake of type 2 diabetic patients with and without MetS is shown in Table 5. According to the NCEP ATP III definition, the patients with MetS consumed more energy, carbohydrate, fat, and protein than those without MetS (all *p*<0.001). Significantly higher consumption of energy, carbohydrate, fat, and protein were also found in participants in the MetS group compared to those in the non-MetS group (*p*<0.001, *p*<0.001, *p*=0.003, and *p*<0.001 respectively) according to the IDF criteria.

4. Discussion

The aim of this study was to investigate the prevalence of MetS and factors affecting this condition among Burmese type 2 diabetic patients residing in Thailand. The results showed that the prevalence of MetS in these participants were 78.1% and 67.2% according to NCEP ATP III and IDF criteria respectively. Comorbid diseases and time spent sitting more than 3 hours on a typical day were factors affecting MetS for both criteria with female as an additional affecting factor when defining MetS by the IDF criteria.

The NCEP ATP III and IDF criteria identify MetS differently but share the same components of affecting factors. Participants who meet at least three of the following MetS components including central obesity, elevated FBS, high TG, low HDL-C, and high BP are defined as having MetS according to the NCEP ATP III criteria[12] while the MetS was defined by the presence of central obesity together with two of the

MetS components based on the IDF criteria.[25] The results revealed a higher prevalence of MetS in Burmese type 2 diabetic patients when diagnosed by the NCEP ATP III. Similar results were found in the previous study conducted among the diabetic population in Malaysia which presented a higher prevalence of MetS defined by the NCEP ATP III (85%) than that defined by the IDF criteria (73%).[26] However, the prevalence of MetS among the diabetic population in Sri Lanka was shown to be higher according to the IDF (44%) than the NCEP ATP III (29%) criteria.[27] The discrepancies in findings among the studies could be attributed to differences in sample size, sampling method, socio-economic status, and lifestyle of study participants. The greater prevalence of MetS based on the NCEP ATP III compared to the IDF in the present study appeared to be owing to a lack of central obesity in some patients who also had other abnormal risk components.

According to the IDF criteria, the prevalence of MetS among Burmese type 2 diabetic patients in Myanmar (83.0%)[9] was higher than that among Thai type 2 diabetic patients in Thailand (69.8%).[28] The present study found that based on the IDF criteria, the prevalence of MetS in Burmese type 2 diabetic patients in Thailand was 67.2%, which was lower than that in Burmese type 2 diabetic patients in Myanmar (83.0%).[9] This may be due to different lifestyles when they resided in different countries.

In the present study, gender appeared to associate with MetS in Burmese type 2 diabetic patients with a higher prevalence in women. This finding agreed with the results from previous studies conducted in type 2 diabetic patients.[5,29] In the present study, the proportion of female patients was higher than male patients, therefore it was possible to observe more prevalence of MetS in women. Women with type 2 DM were more likely to have central obesity in comparison to men with type 2 DM.[30] As abdominal obesity is a required risk factor in the diagnosis of MetS by the IDF criteria, this may be a reason for finding that women were more likely than men to develop MetS when diagnosed by the IDF criteria in the current study. Moreover, most of the female participants worked in the factories and were responsible for sedentary tasks such as shrimp peeling and fish chopping. This might have contributed to a higher prevalence of MetS observed in women in this study.

The risk of developing CVD is increased by MetS.[31] MetS is found in 15-20% of primary hypertensive adolescents.[32] Globally, obesity is a serious problem for public health.[33] Compared to the general population, patients with obesity have considerably higher rates of morbidity and mortality.[33] The development and rising prevalence of type 1 and type 2 DM are mostly attributed to weight gain and increased body mass.[34] The strong links between obesity and each of the other MetS components such as hypertension, dyslipidemia, and insulin resistance, contribute to the elevated health risks of obesity. One of the factors that had an impact on MetS based on both criteria in the present study was comorbid diseases. Hypertension and dyslipidemia which were commonly found in type 2 DM patients were reported to be risk factors of MetS.[12,25] Therefore, Burmese type 2 diabetic patients who have more than one disease might be at risk of MetS or might worsen their conditions.

Physical activity plays an important role in the management of diabetes[35], and it was found significantly associated with a lower prevalence of obesity.[36] It also reported the negative relationship between MetS and physical activity level.[37] The earlier study noted that the likelihood of developing MetS increased with extended sitting and a sedentary occupation.[22] According to the findings of the present study, Burmese patients with type 2 diabetes who spent more than 3 hours sitting on a typical day had a greater chance of having MetS based on both criteria than those who spent 30 minutes to 1 hour sitting per day. This could be due to the fact that most of the participants in this study worked in the factories and were responsible for sedentary jobs that require them to sit for a long period of time. They probably spent most of their waking hours at the workplace, where they were more susceptible to the negative health effects from prolonged sitting like MetS.

In this study, the participants with MetS had higher body weight and BMI than those without MetS according to both criteria. The outcome was in agreement with the study by James et al[38] which revealed that type 2 diabetic people with MetS had higher weight and BMI than those without MetS. Another risk factor of MetS is WC, and its measurement is frequently used to determine abdominal obesity.[39] The cutoff points of WC are different based on different ethnic groups.[24] A previous study discovered that WC was highly correlated to type 2 DM and dyslipidemia, and this may be because visceral fat in abdominal obesity serves as the major source of free fatty acids and inflammatory cytokines, which potentially induce insulin resistance and type 2 DM.[40] In this study, the participants with MetS based on the NCEP ATP III and the IDF criteria showed greater WC than those without MetS. This result was consistent with the previous study.[41]

The patients with MetS based on both NCEP ATP III and IDF criteria in the present study had higher SBP and DBP compared to those without MetS. This outcome was in line with a study by James et al[41] that found significantly higher BP in patients with MetS compared to those without MetS based on the IDF definition. Hypertension is one of the modifiable risk factors of MetS, and the prevalence of hypertension was more common in people with diabetes.[42] In 2017, approximately 27.8% of Burmese migrants in Thailand suffered from hypertension.[43] The process of developing hypertension in people with MetS is complicated and involves a variety of pathophysiologic pathways. Individuals with type 2 DM exhibit high blood glucose levels and a significantly increased CVD risk due to a collection of metabolic and vascular abnormalities that include hyperglycemia, dyslipidemia and hypertension.[44] In obesity, renin-angiotensin-aldosterone system is activated and sympathetic nervous activity is also stimulated.[45] The increase in sympathetic nervous system increases cardiac output as well as peripheral vascular resistance. By increasing peripheral vascular resistance and circulatory fluid volume, these alterations ultimately raise BP. Similar to what was found in the previous study[41], the patients with MetS according to both NCEP ATP III and IDF criteria in this study had higher SBP and DBP than those without MetS.

It was found that the participants with MetS according to the NCEP ATP III criteria had statistically higher TC, LDL-C and TG levels, but lower HDL-C level than those without MetS. This finding agreed with the study of Janghorbani and Amini[23], which observed significantly higher TC, LDL-C and TG levels, and significantly lower HDL-C values based on the modified NCEP ATP III criteria in type 2 diabetic patients with MetS, compared to those without MetS. In addition, it was not unexpected to observe these results because normal or slightly - raised LDL-C level, substantially decreased HDL-C level, and high TG level are common blood lipid abnormalities in type 2 diabetic patients.[46] However, when MetS was defined by the IDF criteria, only significantly higher LDL-C level was observed in patients with MetS than in those without MetS. This finding disagreed with the results of a previous study.[5] Different outcomes may be due to different cut-off points and sets of criteria used to identify MetS, as well as different populations in different research.

The presence of impaired fasting glucose together with other cardiovascular risks as usually observed through MetS may be associated with the development of diabetes and overall mortality.[47] In this study, no differences in FBS levels between the patients with and without MetS were observed, which was in contrast with the results from the previous study.[23] It seemed that most of the participants could not control their blood sugar well, as the average FBS levels appeared to be above the normal range and did not meet the target level according to Thai guideline for the management of diabetes.[48] Several factors such as medication use and dietary intake may have an impact on blood glucose levels.

Dietary intake is one of the components linked with the factors of MetS. Changes in eating behavior may be influenced by differences in lifestyle characteristics when migrants leave their native countries. Assessment of patients' food consumption provides useful information in directing appropriate dietary recommendations to reduce and/or prevent the development of metabolic abnormalities in specific populations. Rice, a carbohydrate-rich source, is a staple food for Thais[49], much like it is in Myanmar.[15] Unlike Myanmar, the population in northeastern Thailand consumed a lot of glutinous rice which was associated with MetS.[49] In this study, white rice remained the main food that the Burmese patients consumed daily. Previous study reported a positive association of MetS with a high intake of carbohydrate pattern in Thai adults.[49] This might be the same for Burmese adults in Thailand. It appeared that the Burmese type 2 diabetic patients with MetS in this study had higher energy and carbohydrate intakes than those without MetS.

Thai and Myanmar cuisines both share key ingredients such as fish sauce, curry pastes, ginger, and lemongrass. Burmese people mainly use plenty of oil for cooking which may be unfavorable for patients with DM.[15] Consumption of a high-fat diet increases the likelihood of obesity[50] which is one of the risk factors for MetS. In the present study, although the percentage of energy contribution from dietary fat in the participants was less than the recommendations according to Myanmar healthy menu[51] and Thai dietary reference intakes [52], the amount of fat consumption was higher in patients with MetS than those without MetS. An association between a higher protein consumption and a lower prevalence of MetS and its components was observed in an earlier study.[53] It appeared that the participants with MetS in the present study consumed a higher amount of protein than those without MetS. However, the percentages of energy from protein did not differ between groups and they were within the range of recommendation.

To the best of our knowledge, this is the first study to examine the prevalence of MetS in Burmese type 2 diabetic patients in Thailand. Several factors were investigated including dietary intake which is a crucial modifiable factor for MetS. Although the information from this study can be integrated into the health care of Burmese diabetic patients in Thailand, this was a single-center hospital-based study. For further research, a multi-center study could be conducted. In addition, due to a lower proportion of male compared to female participants in this study, further research should include more male participants.

5. Conclusion

In conclusion, MetS was relatively prevalent in Burmese type 2 diabetic patients, and the prevalence was higher when MetS was defined by the NCEP ATP III criteria, compared to the IDF criteria. While comorbid diseases and time spent sitting more than 3 hours per day were the factors affecting MetS based on both criteria, female gender was a factor affecting MetS only when it was defined by the IDF criteria. Type 2 diabetic patients with MetS consumed more energy and all macronutrients than those without MetS. For the treatment or prevention of MetS in type 2 diabetic patients, lifestyle modification including dietary intake and physical activity should be

Table 1. The characteristics of the type 2 diabetes participants with and without metabolic syndrome according to the NCEP ATP III and the IDF criteria.

Parameters	NCEP ATP III			IDF		
	MetS group (n = 143) N (%)	**Non-MetS group (n = 40) N (%)**	**OR (95%CI)†**	**MetS group (n = 123) N (%)**	**Non-MetS group (n = 60) N (%)**	**OR (95%CI)†**
Gender						
Male	33 (23.1)	17 (42.5)	1.00	22 (17.9)	28 (46.7)	1.00
Female	110 (76.9)	23 (57.5)	2.46 (1.18-5.15)*	101 (82.1)	32 (53.3)	4.02 (2.02-7.97)*
Age (years)						
≤40	35 (24.5)	13 (32.5)	1.00	28 (22.8)	20 (33.3)	1.00
>40	108 (75.5)	27 (67.5)	1.49 (0.69-3.19)	95 (77.2)	40 (66.7)	1.70 (0.86-3.36)
Education						
High school and higher level	7 (4.9)	2 (5.0)	1.00	5 (4.1)	4 (6.7)	1.00
Less than high school	136 (95.1)	38 (95.0)	1.02 (0.20-5.13)	118 (95.9)	56 (93.3)	1.69 (0.44-6.52)
Occupation						
Non-factory manager/worker	53 (37.1)	12 (30.0)	1.00	51 (41.5)	14 (23.3)	1.00
Factory manager/worker	90 (62.9)	28 (70.0)	0.73 (0.34-1.55)	72 (58.5)	46 (76.7)	0.43 (0.21-0.86)*
Smoking status						
Non-smoker	130 (90.9)	31 (77.5)	1.00	115 (93.5)	46 (76.7)	1.00
Current/previous smoke	13 (9.1)	9 (22.5)	0.34 (0.14-0.88)*	8 (6.5)	14 (23.3)	0.23 (0.09-0.58)*
Duration in Thailand (years)						
≤6	26 (18.2)	3 (7.5)	1.00	20 (16.3)	9 (15.0)	1.00
>6	117 (81.8)	37 (92.5)	0.37 (0.10-1.28)	103 (83.7)	51 (85.0)	0.91 (0.39-2.14)
Duration of diabetes (years)						
≤3	87 (60.8)	26 (65.0)	1.00	71 (57.7)	42 (70.0)	1.00
>3	56 (39.2)	14 (35.0)	1.20 (0.58-2.48)	52 (42.3)	18 (30.0)	1.71 (0.89-3.30)
Comorbid diseases						
No	46 (32.2)	24 (60.0)	1.00	39 (31.7)	31 (51.7)	1.00
Yes	97 (67.8)	16 (40.0)	3.16 (1.53-6.52)*	84 (68.3)	29 (48.3)	2.30 (1.22-4.34)*
Time spent sitting on a typical day						
30 minutes – 1 hour	20 (14.0)	9 (22.5)	1.00	17 (13.8)	12 (20.0)	1.00
2–3 hours	62 (43.4)	23 (57.5)	1.21 (0.48-3.05)	50 (40.7)	35 (58.3)	1.01 (0.43-2.37)
>3 hours	61 (42.7)	8 (20.0)	3.43 (1.17-10.08)*	56 (45.5)	13 (21.7)	3.04 (1.17-7.89)*

†Odds ratio with 95%CI by univariate analysis

*$p<0.05$

NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III; IDF = International Diabetes Federation; MetS = Metabolic syndrome

Table 2. Factors affecting to metabolic syndrome by logistic regression analysis.

Parameters	NCEP ATP III				IDF			
	OR (95%CI)	***P***	**AOR (95%CI)**	***P***	**OR (95%CI)**	***P***	**AOR (95%CI)**	***P***
Gender								
Male	1.00		1.00		1.00		1.00	
Female	2.46 (1.18-5.15)	0.017	1.69 (0.66-4.32)	0.272	4.02 (2.02-7.97)	<0.001	3.06 (1.31-7.19)	0.010
Occupation								
Non-factory manager/worker	1.00				1.00		1.00	
Factory manager/worker	0.73 (0.34-1.55)	0.410	-		0.43 (0.21-0.86)	0.018	0.56 (0.25-1.24)	0.149
Smoking status								
Non-smoker	1.00		1.00		1.00		1.00	
Current/previous smoker	0.34 (0.14-0.88)	0.026	0.33 (0.10-1.10)	0.071	0.23 (0.09-0.58)	0.002	0.37 (0.12-1.17)	0.090
Comorbid diseases								
No	1.00		1.00		1.00		1.00	
Yes	3.16 (1.53-6.52)	0.002	3.96 (1.75-8.94)	0.001	2.30 (1.22-4.34)	0.010	2.62 (1.27-5.41)	0.009
Time spent sitting on a typical day								
30 minutes – 1 hour	1.00		1.00		1.00		1.00	
2-3 hours	1.21 (0.48-3.05)	0.681	2.00 (0.72-5.51)	0.182	1.01 (0.43-2.37)	0.985	1.31 (0.51-3.40)	0.573
>3 hours	3.43 (1.17-10.08)	0.025	5.40 (1.66-17.62)	0.005	3.04 (1.17-7.89)	0.022	3.83 (1.29-11.35)	0.015

OR = Odds ratio; AOR = Adjusted odds ratio; CI = Confidence interval; NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III; IDF = International Diabetes Federation

Table 3. Anthropometry and blood pressure of the type 2 diabetes participants with and without metabolic syndrome.

Parameters	**NCEP ATP III**			**IDF**		
	MetS group (n = 143)	**Non-MetS group (n = 40)**	***p* value†**	**MetS group (n = 123)**	**Non-MetS group (n = 60)**	***p* value†**
Height (cm)	157.00 (152.00–160.00)	158.00 (151.25–164.75)	0.451	157.00 (152.00–160.00)	158.00 (151.00–164.00)	0.382
Weight (kg)	63.00 (56.00–71.00)	58.50 (50.50–64.75)	0.011	64.00 (57.00–73.00)	58.00 (52.25–64.75)	<0.001
BMI (kg/m^2)	25.71 (22.90–29.01)	22.70 (19.98–26.11)	<0.001	25.97 (23.37–29.67)	22.88 (20.38–25.51)	<0.001
WC (cm)	91.19±9.48	82.69±9.96	<0.001	93.13±8.34	81.55±9.20	<0.001
BP (mmHg)						
Systolic	136.38±17.64	120.58±13.55	<0.001	136.31±17.05	126.00±18.14	<0.001
Diastolic	86.16±10.64	77.13±9.04	<0.001	86.06±10.62	80.35±10.70	0.001

†The data are presented as mean±SD when they were normally distributed and as median (interquartile range) when they were not normally distributed, and the comparison between groups were analyzed by independent t-test and by Mann-Whitney U test, respectively ($p < 0.05$).

NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III; IDF = International Diabetes Federation; MetS = Metabolic syndrome; WC = Waist circumference; BP = Blood pressure; WC = Waist circumference; BP = Blood pressure

Table 4. Laboratory parameters of the type 2 diabetes participants with and without metabolic syndrome.

Parameters	NCEP ATP III			IDF		
	MetS group (n = 143)	**Non-MetS group (n = 40)**	***p* value†**	**MetS group (n = 123)**	**Non-MetS group (n = 60)**	***p* value†**
FBS (mg/dL)	154.00 (129.00–189.00)	139.50 (103.25–177.75)	0.055	153.00 (128.00–189.00)	147.00 (116.00–183.25)	0.426
HbA1c (%)	8.10 (7.20–9.80)	8.25 (6.83–11.65)	0.725	8.20 (7.10–9.70)	8.10 (7.13–11.25)	0.464
TC (mg/dL)	193.56±38.01	179.88±38.42	0.046	194.36±39.36	182.80±35.45	0.056
HDL-C (mg/dL)	42.00 (36.00–48.00)	52.00 (41.25–57.75)	<0.001	43.00 (37.00–48.00)	46.00 (37.00–55.75)	0.160
LDL-C (mg/dL)	117.61±32.91	106.25±27.91	0.048	119.22±33.67	106.73±27.19	0.013
TG (mg/dL)	146.00 (112.00–209.00)	97.50 (74.25–134.50)	<0.001	134.00 (109.00–183.00)	130.50 (82.25–180.00)	0.138

†The data are presented as mean±SD when they were normally distributed and as median (interquartile range) when they were not normally distributed, and the comparison between groups were analyzed by independent t-test and by Mann-Whitney U test, respectively ($p<0.05$).
NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III; IDF = International Diabetes Federation; MetS = Metabolic syndrome; FBS = Fasting blood sugar; HbA1c = HemoglobinA1c; TC = Total Cholesterol; HDL-C = High-density lipoprotein cholesterol; LDL-C = Low-density lipoprotein cholesterol; TG = Triglyceride

Table 5. Dietary intake in the type 2 diabetes participants with and without metabolic syndrome.

Parameters	NCEP ATP III			IDF		
	MetS group (n = 143)	**Non-MetS group (n = 40)**	***p* value†**	**MetS group (n = 123)**	**Non-MetS group (n = 60)**	***p* value†**
Energy (kcal)	1293.28 (1150.73–1392.83)	1032.05 (984.99–1069.08)	<0.001	1299.14 (1149.41–1394.69)	1059.03 (998.24–1186.25)	<0.001
CHO						
gram	207.63±31.94	175.54±23.71	<0.001	208.35±32.11	184.77±29.34	<0.001
kcal	830.54±127.76	702.16±94.82	<0.001	833.40±128.43	739.09±117.36	<0.001
% TE	64.22±9.88	68.04±9.19	0.030	64.15±9.89	69.82±11.10	0.001
Fat						
gram	25.57 (19.41–33.78)	19.19 (15.10–25.09)	<0.001	25.57 (19.19–34.02)	21.24 (16.40–27.76)	0.003
kcal	230.13 (174.69–304.02)	172.71 (135.90–225.79)	<0.001	230.13 (172.71–306.18)	191.12 (147.62–249.80)	0.003
% TE	17.79 (13.51–23.51)	16.73 (13.17–21.88)	0.389	17.71 (13.25–23.57)	18.05 (13.94–23.59)	0.844
Protein						
gram	44.87 (34.53–67.22)	35.19 (28.81–41.70)	<0.001	44.91 (35.93–64.64)	36.27 (28.96–48.89)	<0.001
kcal	179.48 (138.12–268.88)	140.74 (115.22–166.80)	<0.001	179.64 (143.72–258.56)	145.08 (115.82–195.55)	<0.001
% TE	13.88 (10.68–20.79)	13.64 (11.16–16.16)	0.723	13.83 (11.06–19.90)	13.70 (10.94–18.46)	0.962
Energy contribution						
CHO: Fat: Protein	64:18:14	68:17:14		64:18:14	70:18:14	

†The data are presented as mean±SD when they were normally distributed and as median (interquartile range) when they were not normally distributed, and the comparison between groups were analyzed by independent t-test and by Mann-Whitney U test, respectively ($p<0.05$).
NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III; IDF = International Diabetes Federation; MetS = Metabolic syndrome; CHO = Carbohydrate; TE = Total energy

a part of their therapy. Healthcare professionals should consider weight loss management, particularly in women who have greater adiposity rates to reduce the prevalence of obesity. The findings from this study can be applied to develop policies and programs for preventing and managing MetS and type 2 DM among Burmese people in Thailand.

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Conflicts of Interest

There is no conflict of interest in this study.

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