

Prevalence, Risk Factors, and Perception of Metabolic Syndrome Among Thai Buddhist Monks in a Rural Community, Central Thailand: A Mixed-Methods Study

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Abstract

Background

Metabolic syndrome (MetS) is described as a cluster of cardiometabolic risk factors that can increase the possibility of developing atherosclerotic cardiovascular diseases. According to monastic rules, Thai Buddhist monks are not allowed to cook meals and do exercise. This unique lifestyle generally encompasses low physical activities and may cause several noncommunicable diseases. Thus, in this study, we aimed to examine the prevalence, risk factors, and perception of MetS among Thai Buddhist monks.

Methods

This was a cross-sectional study conducted among Thai Buddhist monks living in Tha Luang District, Lopburi Province, Central Thailand. Study participants completed a questionnaire inquiring about personal and health data, and they also underwent physical examination, including anthropometric measurements, before undergoing biochemical blood tests. MetS was defined based on the National Cholesterol Education Program ATP III (NCEP ATP3) criteria. A qualitative study using in-depth interview was conducted to determine the knowledge and perceptions regarding MetS among Thai Buddhist monks.

Results

In total, 96 Thai Buddhist monks were included in this study. The prevalence of MetS was 28.1%. Participants who had a body mass index of ≥ 25 kg/m² were determined to have a higher risk of developing MetS (OR, 4.5; 95% CI, 1.6–13.3). The in-depth interview revealed that participants' perceptions were directly associated with their beliefs, experience, and basic healthcare knowledge. A qualitative study identified two primary factors of MetS among Thai Buddhist monks, viz., unhealthy diet and low physical activity.

Conclusions

MetS prevalence in Thai Buddhist monks was moderate compared with that reported by other studies. Medical providers and Buddhist devotees should cooperate in providing health promotion by donating healthy food, conducting annual health checkups, and arranging alternative exercises in a private area that correspond with the monastic rules. Therefore, early screening, treatment, and patient education are the most important factors to manage MetS in Thai Buddhist monks.

Background

Metabolic syndrome (MetS) is described as a cluster of cardiometabolic risk factors that increase the possibility of developing atherosclerotic cardiovascular diseases and multiple chronic diseases in the future (1). Although there are several different definitions for MetS, all of them require the presence of three of five components (1, 2). MetS was defined according to the National Cholesterol Education Program ATP III (NCEP ATP3) criteria, which requires the presence of three of the following five components (1): (1) fasting glucose ≥ 5.6 mmol/L (100 mg/dL) or drug treatment for elevated blood glucose; (2) high-density lipoprotein cholesterol (HDL-C) level < 1.0 mmol/L (40 mg/dL) in men and < 1.3 mmol/L (50 mg/dL) in women or drug treatment for low HDL-C (treatment with one or more of fibrates or niacin); (3) triglyceride level ≥ 1.7 mmol/L (150 mg/dL) or drug treatment for elevated triglyceride levels (treatment with one or more of fibrates or niacin); (4) abdominal obesity (using the South Asian waist circumference cutoff points of ≥ 90 cm for men and ≥ 80 cm for women); or (5) blood pressure $\geq 130/85$ mmHg or drug treatment for hypertension.

Considering the increasing possibility of developing cardiovascular diseases in the future, MetS should be considered a significant public health burden worldwide, as its prevalence increases every year (1, 3–5). The prevalence of MetS varies according to geographic location, nationality, population characteristics, and MetS criteria (4, 6). The prevalence of MetS increased by $> 35\%$ from 1988–1994 to 2007–2012, increasing from 25.3–34.2% in the United States (4), and among Europeans, the prevalence was in the range of 20–30% during 1990–2006 (3, 5). In Asia-Pacific countries, the estimated prevalence of MetS in adults ranged from 11.9–49.0% during 2005–2013 (7–11). In Thailand, the prevalence of MetS in adults aged ≥ 35 years in 2011–2016 was approximately 27–33% (12, 13).

Regarding the risk factors for MetS, the study that examined the US population from the Third National Health and Nutrition Examination Survey (NHANES), 1988–1994 (14), found that an increase in body weight is a major risk factor for MetS. In addition, other factors associated with an elevated risk of developing MetS in the NHANES included age, race, postmenopausal status, smoking, low household income, high carbohydrate diet, no alcohol consumption, and physical inactivity (14, 15). In the Framingham Heart Study, consumption of soft drinks and sugar-sweetened beverages was also associated with an elevated risk of developing adverse metabolic traits and MetS (16, 17). The use of atypical antipsychotic medications, especially clozapine, significantly increases the risk of developing MetS (18). Furthermore, poor cardiorespiratory fitness is an independent and strong predictor of MetS (19). Parental history of MetS increases the risk, and genetic factors may account for as much as 50% of

variation in the levels of MetS traits in the offspring (20–23). Other studies conducted in Asia have reported that known risk factors for MetS were sleep duration (9), physical activity (10), alcohol consumption (12), diabetes (24), and family history of hypertension (25).

Thai Buddhist monks (26) are 20-year-old or older men who dedicate themselves to Buddhism. According to monastic rules (27), they are not permitted to cook or buy meals for themselves. They can only have a meal provided by Buddhists or laymen. Most of the food that is donated to these monks is processed as well as high in fat, sugar, and calories. Another restriction is that no solid food is allowed after noon, and only clear beverages are allowed. The daily activities of monks (28) consist of praying in the early morning and evening, alms-rounds in the morning, having a meal once or twice a day before midday, and doing meditation (sitting or walking), as well as taking care of the temple. Alms-rounds or almsgiving is a religious rite that involves giving materially to another as an act of religious virtue. In Buddhism, during the morning alms-rounds around the village, the monks give people their blessings in exchange for food. Monks always focus on self-consciousness and perform a sermon to help people. The relationship between monks and laymen in Thai Buddhism is very strong. This type of Buddhism could not, in fact, exist in its present form without this interaction. It is a way of mutual support—laymen supply food, medicine, and cloth for robes, while monks offer spiritual support, blessings, and teachings. Monks are not allowed to request anything from laymen, and laymen cannot demand anything from the monks. The spirit of it is more in the nature of open-hearted giving (29). These unique activities appear to involve only low-intensity physical activity. Moreover, Buddhist monks are not allowed to do exercise due to inappropriate body posture (27). Therefore, the particular lifestyle and daily routines that a Buddhist monk must follow may increase the possibility of developing MetS and other health problems in the future.

According to a previous study (30), the prevalence rates of MetS among Thai monks in 2015 based on the International Diabetes Federation (IDF) 2005 (31) and Harmonization 2009 criteria (1) were 16.8% and 28.4%, respectively. Moreover, another previous study reported that smoking, low HDL-C level, elevated fasting plasma glucose (FPG) level, and ordination period (monkhood) were associated with MetS in Thai monks (32). Despite such previous studies of MetS in Thailand, only a few studies were based on the Buddhist monks. This target population has a unique lifestyle as a consequence of the Buddhist monk rules. Therefore, this present study emphasizes the prevalence and risk factors of MetS in Thai Buddhist monks by deeply understanding the problems through in-depth interviews.

Methods

Study population

This community-based cross-sectional study was conducted in Tha Luang District in 2016. Tha Luang is a rural district in the eastern part of Lopburi Province, Central Thailand (33). In total, there were 149 Thai Buddhist monks from 33 temples in Tha Luang District, according to data from the census of the monk population surveyed by health-promoting hospitals in Tha Luang District in 2015 (34).

We included all the Thai Buddhist monks in Tha Luang District from May to June 2016. There were 96 Thai Buddhist monks aged ≥ 20 years who were included in this study, while 53 were excluded due to unavailability. Hence, the response rate of the study was 64.4%. All methods were carried out in accordance with relevant guidelines and regulations.

Data collection

This study was conducted using a mixed-methods design. First, this cross-sectional study was performed to identify the prevalence and risk factors of MetS among Thai Buddhist monks. The research instruments consisted of a standardized questionnaire, anthropometric measurements, and laboratory measurements. The questionnaire was related to demographic data (age, duration of monkhood, educational level, monastic education, and monastic educational level), smoking status (never or former smoker and current smoker), alms-rounds, exercise (< 3 times/week, ≥ 3 times/week), annual medical checkup, and sleep duration (< 6 or > 8 hours/day, 6–8 hours/day). Previous studies (35–37) have shown that both short duration and long duration of sleep could be the cause of weight gain. A medical history of diabetes mellitus (DM), hypertension (HTN), and dyslipidemia (DLP) was recorded if the participant was previously diagnosed by a physician or was taking medication.

Anthropometric and blood pressure (BP) measurements and blood examination were conducted according to standard procedures. Waist circumference (WC) was measured twice in centimeters at the reference point of the anterior superior iliac spine, and the average value was calculated. Body weight was measured using an analog scale, with all participants being dressed in light clothing and barefoot. Body mass index (BMI) was derived from body weight in kilograms divided by body height in square meters (kg/m^2). All participants were seated quietly for 15 minutes before BP measurement. BP was obtained twice by well-trained attendants in a seated position using a standard sphygmomanometer at 5-minute intervals, and the average value was then calculated. If the two BP readings differed by more than 5 mmHg, a third BP reading was then recorded, and the three BP readings were averaged (38). Participants' blood samples were collected (7 ml) from the antecubital vein in the morning after a 12-hour overnight fast by trained registered nurses. Then, 2.5 ml of each participant's blood sample was used for examining lipid profiles, and another 2.5 ml was used for examining glucose levels. FPG level was determined using the glucose oxidase method. Serum TG levels were determined using a standardized enzymatic procedure by the glycerol phosphate oxidase assay. HDL-C level was measured using an automated direct method. Serum creatinine levels were measured using a Roche Diagnostics Creatinine plus enzymatic assay. Alanine aminotransferase (ALT) levels were then measured using the International Federation of Clinical Chemistry (IFCC) method, and complete blood count was evaluated using

the BC-5300 Auto Hematology Analyzer machine. All laboratory tests were conducted with no knowledge of the participant's medical history, and the blood samples were analyzed at the central laboratory of Tha Luang Hospital.

Second, the qualitative study was conducted using an in-depth interview process to examine the perception of MetS among Thai Buddhist monks in Tha Luang District. Data were obtained through an interview guideline, audio recordings, and notes. The information-gathering process consisted of the following four aspects: (1) perception of MetS, (2) risk factors and cause of MetS, (3) effect of MetS, and (4) management and prevention of MetS in Thai Buddhist monks. The conversation was recorded using a voice recorder, and these were then transcribed into text. Data were collected continuously until content saturation was reached.

Statistical and data analysis

Data were analyzed using SPSS for Windows version 26.0. Descriptive statistics such as mean, standard deviation (SD), and percentage were used to describe all study variables. For intergroup comparison of study variables among participants, a chi-square test was used for categorical data. The pattern of MetS component combination was determined from abnormal MetS components, i.e., abdominal obesity, low HDL-C level, elevated triglyceride level, high BP, and elevated fasting glucose level. The pattern ranged from the presence of zero to five MetS component combinations. Multiple logistic regression was used to examine the association between study factors and MetS. A p -value of ≤ 0.05 was considered to be statistically significant.

For qualitative study, the method described by Miles and Huberman (39) was used to guide content analysis with a three-stage process of data reduction, data display, and drawing conclusions/verification. The content analysis began with reading transcripts, initiating data line-by-line coding of phrases and concepts, and looking for potential concerning material. Then, the codes were linked in order to create themes and subthemes.

Results

Quantitative study

In total, 96 Thai Buddhist monks were included in this study, whose mean age was 57.9 ± 14.7 years, and 53.1% of them were aged <60 years. The mean duration of monkhood was 10.2 ± 10.3 years, and 72.9% of the duration of monkhood was 15 years. There were 70.8% monks graduating from primary school, 70.8% studying monastic education, 35.4% graduating from foundation level, 57.3% current smokers, 66.7% with sleep duration of <6 hours/day or >8 hours/day, 61.5% not having an annual medical checkup, 63.5% doing exercise 3 times/week, 91.7% doing alms-rounds, and 72.9% having a BMI of <25 kg/m² with a mean BMI of 23.8 ± 7.7 kg/m² (Table 1).

Table 2 shows the prevalence of each component of MetS. The most prevalent component was determined to be elevated triglyceride level (66.7%), followed by elevated fasting glucose level (62.9%) and abdominal obesity (50.0%).

Table 3 presents the proportions of participants positive for different numbers of MetS components. There were 19.8%, 8.3%, and 0% of participants positive for 3, 4, and 5 components, respectively.

Table 4 shows the distribution of MetS in subgroups defined by basic characteristics of participants and depicts the prevalence of MetS components defined according to the NCEP ATP3 criteria (1). The overall prevalence of MetS was 28.1%. The prevalence of MetS was determined to be higher in the age group of <60 years than in the age group of 60 years. The prevalence of MetS also increased with the increasing duration of monkhood, having an annual medical checkup, doing exercise, and BMI status. In contrast, the prevalence of MetS decreased with educational level, studying in monastic education, having a sleep duration of 6–8 hours/day, and doing alms-rounds. When considering the distribution of MetS components, the MetS component with the highest prevalence in the age group of <60 years was high BP (60.8%), followed by elevated triglyceride levels (45.5%) and abdominal obesity (35.3%), whereas in the age group of 60 years, it was high BP (80.0%), followed by elevated fasting glucose levels (43.2%) and abdominal obesity (32.6%).

Table 5 presents the results of multiple logistic regression analyses conducted to evaluate the independent effects of various factors. After adjusting for all other variables in the model, the significant predictor was BMI ≥ 25 kg/m² (adjusted OR 4.5; 95% CI, 1.6–13.3).

Qualitative study

As shown in Table 6, there were seven Thai Buddhist monks who participated in the in-depth interview. They were men, with age ranging from 44 to 89 years, who have been monks for 4 to 20 years and have graduated monastic education (57.1%). Three participants (42.9%) were found obese, as per the BMI calculation [19]. Four participants (57.1%) had BP $\geq 130/85$ mmHg or drug treatment for hypertension, three participants (42.9%) had fasting glucose level ≥ 100 mg/dL or drug treatment for elevated blood glucose levels, three participants (42.9%) had triglyceride levels ≥ 150 mg/dL or drug treatment for elevated triglyceride levels, one participant (14.3%) had HDL-C levels <40 mg/dL or drug treatment for low HDL-C levels, and three participants (42.9%) had waist circumference ≥ 90 cm. Three participants (42.9%) were diagnosed with MetS.

Findings

Theme1: Perception of MetS

The perceptions of most participants were directly associated with their beliefs, basic healthcare knowledge, and feelings. Although a few Thai monks could clearly describe some major points of meaning in MetS, most of them were unaware about the exact meaning of MetS.

Subtheme 1.1: *Inappropriate fatty deposits in the body.*

Participants mentioned that their awareness and understanding of MetS were derived from their personal experiences and knowledge. The healthcare provider played an important role in passing on the basic healthcare knowledge to participants and giving them a perception of MetS.

For instance, some participants stated the following:

"I think MetS means excessive fatty deposits in the body and a big belly. When I see the doctor for my routine follow-up, both doctor and nurse pass on a lot of basic healthcare knowledge. They always make sure that I can take care of myself. I think I can deal with it very well." (40 years, duration of monkhood 20 years)

"I think MetS is inadequate fatty metabolism due to lack of exercise, and it can be the cause of obesity. I think this condition is a very common problem in Thai monks because normally, Thai monks who have obesity usually go to the hospital for an annual health checkup." (44 years, duration of monkhood 5 years)

Subtheme 1.2: *Obesity can cause many diseases in the future, but I do not know exactly.*

Most participants shared that they did not understand MetS and obesity exactly, but they had some awareness and perception from the experiences of other monks who had obesity or other medical problems and lived in the same temple.

For instance, some participants stated the following:

"Sorry, I have no idea about it. From my experience, I can see Thai monks in our temple would resign from the monkhood due to their health problems, even though we have an annual health checkup. I have been diagnosed with diabetes for many years, but my blood sugar levels are well controlled." (56 years, duration of monkhood 4 years)

"I think MetS is obesity that can cause many diseases in the future, but I do not know exactly about the definition, causes, and management. I just try to have a healthy diet like having a lot of vegetables with chili sauce." (89 years, duration of monkhood 20 years)

Theme 2: Risk factors and causes of MetS

The results from the in-depth interview showed that there were two primary causes of MetS in Thai monks, viz., unhealthy diet and lack of physical activity. These primary causes were related to the Buddhist monk rules, their unique lifestyle, social interaction, and environment.

Subtheme 2.1: *Donated foods from alms-rounds are often high in salt, sugar, and fat.*

The participants had some reservations about their donated foods constituting an unhealthy diet. They can only have a meal provided by Buddhists or laymen, due to which they did not have many healthy options. They were also not permitted to eat anything after lunch due to the Buddhist monk rules. Therefore, the monks tried to eat their foods as much as they can have per meal.

For example, some participants stated the following:

"I think the food is the main cause of MetS and obesity. We usually have unhealthy food that is high in salt, sugar, and fat. The Buddhists in this area are very kind. They take and donate many foods like chicken curry, many kinds of Thai desserts, and fruits. We cannot order them about their foods; therefore, we do not have many options." (65 years, duration of monkhood 10 years)

"Due to Buddhist monk rules, I have only meal a day and am unable to select the food. This rule makes me try to eat a lot, although I am able to recognize most of the foods as being unhealthy." (37 years, duration of monkhood 7 years)

Subtheme 2.2: *Exercise is not permitted due to Buddhist monk rules.*

Participants have absolutely recognized the lack of physical activity that can eventually result in MetS and obesity. The reason for their limited physical activity was related to the Buddhist monk rules and urbanization. Thai Buddhist monks were not allowed to do exercises such as running, jogging, or swimming. They were allowed to walk around the temple to do meditation, go for alms-rounds in the morning, and sweep the temple grounds. In the past, Thai Buddhist monks constructed their buildings or facilities such as toilets and residences by themselves, but today, they prefer to employ a building contractor.

For instance, some participants stated the following:

“Exercise is commonly inappropriate behavior for Buddhist monks. In the past, we made our buildings by ourselves, but nowadays we employ a building contractor, so I do not spend my energy so much on my daily routine. On top of that, my bedroom just had a fan in the past. I think it helps me have a good metabolism when I stay in a room with hot weather, but now I have already had an air conditioner.” (40 years, duration of monkhood 20 years)

“I do not think Thai Buddhist monks’ daily activity is enough to prevent us from obesity. My doctor recommended that I should walk at least 1 hour a day. One more thing, Thai monks are permitted to do exercise in their private room, like arm swinging for one hour.” (56 years, duration of monkhood 4 years)

Theme 3: Effect of MetS

All participants were aware of the harmful effects of MetS and obesity; moreover, most of them understood that MetS was significantly associated with obesity and other medical problems in the future. They also recognized the negative effects of MetS and the symptoms occurring from the disease.

Subtheme 3.1: *It would be related to many comorbidities in the future.*

Some participants who were diagnosed with noncommunicable diseases had basic healthcare education from their medical providers. They recognized and explained that MetS is significantly associated with obesity and other medical problems in the future.

For example, some participants stated the following:

“I think if it were poorly controlled, it would cause kidney disease, high blood pressure level, and diabetes. My doctors always ensure that if my blood pressure level is well-controlled, it can prevent me from kidney disease, heart disease, and diabetes. Therefore, I think that would occur in the same way with MetS or obesity.” (40 years, duration of monkhood 20 years)

“I think it is related to obesity, but I am not sure about it. If you have just obesity, it can cause many medical problems. It is not a normal condition.” (65 years, duration of monkhood 10 years)

Subtheme 3.2: *It can cause many symptoms like dizziness, shortness of breath, and tiredness.*

Participants mentioned that MetS has directly affected their daily activities due to limited physical activity. Although few participants could not tell us about any abnormal symptoms of MetS, most participants were aware and able to report several symptoms of MetS. Their perceptions were derived from personal experience and other monks living in the same temple.

For instance, some participants stated the following:

“I think *dizziness, shortness of breath, and tiredness* are suggestive of MetS and obesity. From my experience, Monks who have obesity are unable to do many tasks like cleaning their rooms and sweeping the temple ground. They always complain of easy tiredness.” (37 years, duration of monkhood 7 years)

“I am not sure about their complications, but they may be tiredness and exercise intolerance.” (89 years, duration of monkhood 20 years)

Theme 4: Management and prevention of MetS

All participants could recognize and understand how to deal with MetS and obesity. They also raised some sample methods to prevent the disease. There were two primary aspects, and these include (1) making some lifestyle changes and (2) basic healthcare knowledge and public health promotion. The participants also mentioned that laymen or Buddhists should cooperate together for health promotion.

Subtheme 4.1: *Making some lifestyle changes*

All participants mentioned about increasing physical activities and changing the eating behavior. Although Thai Buddhist monks were not permitted to exercise in a general way, they had alternative activities such as cleaning around the temple or doing a low-intensity exercise in their own private room. As regards eating behavior, they will try to select only a healthy diet to eat. They were sure that they could do it.

For example, some participants stated the following:

“I will try to avoid eating dessert, sweetened beverage, and Thai curry. I will select only a healthy diet and eat more vegetables as well. Although I am not permitted to exercise, I will do housework or tasks like sweeping the temple grounds and watering plants. I believe that if I have a lot of sweating, that means I spend energy from the food appropriately.” (44 years, duration of monkhood 5 years)

“I do exercise in my bedroom every day; for example, I like to swing my arms for 1 hour a day and walk around the temple to do meditation. My doctors suggested these methods to me. Thai Buddhist monks are allowed to do exercise in their own private room in a calm manner. For a healthy

diet, I try to eat mild, not too sweet, not too salty, and not too oily food. One more thing, the laymen or Buddhists should recognize this problem as well; hopefully, they will donate a healthy diet for us.” (65 years, duration of monkhood 10 years)

Subtheme 4.2: Basic healthcare knowledge and public health promotion

Most participants mentioned that an annual healthcare checkup every year for Thai monks was beneficial, as they can receive early screening and diagnosis. Moreover, participants learned the basic healthcare knowledge and health education from medical providers.

For example, some participants stated the following:

“There is healthcare checkup every year. The healthcare provider visits our temple and checks our blood pressure, together with blood study. If someone has an abnormal report, they will invite them to follow up at the hospital. It is a good way for us to get the management immediately.” (66 years, duration of monkhood 7 years)

“Even though I have been suffering from high blood pressure for several years, my doctors pass on a lot of basic healthcare knowledge to me. I think I can take care of myself and prevent from MetS.” (40 years, duration of monkhood 20 years)

Discussion

Although this study did not examine a large number of participants, to our knowledge, it is the first study on MetS conducted among Thai Buddhist monks using a mixed-methods study design. The results have clearly demonstrated that 28.1% of the total study population was diagnosed with MetS based on the NCEP ATP3 criteria. Compared with other studies, the prevalence of MetS among Thai Buddhist monks was moderate in this study.

Prevalence of MetS among Thai Buddhist monks compared with previous studies

Previous studies have reported that the prevalence of MetS ranged from 16–58% during 2008–2012 (40–43). When compared with other previous studies conducted among Thai Buddhist monks in Thailand according to the IDF 2005 criteria (1), the prevalence of MetS in this study was higher than that (13.0%) reported in 2009 (32) and (16.8%) in 2015 (30). The reason for the higher prevalence of MetS based on the NCEP ATP3 criteria than that based on the IDF 2005 criteria was obvious, and it was attributed to the differing criteria. According to the IDF 2005 criteria, MetS diagnosis must include central obesity plus any other two additional components. The previous studies (12, 44) compared the prevalence of MetS using the IDF 2005 criteria and NCEP ATP3 criteria. They found that the NCEP ATP3 criteria might be more appropriate to classify MetS, as those criteria are more sensitive to capture those who have a combination of metabolic risk.

Prevalence of MetS among Thai Buddhist monks categorized by baseline characteristics

The prevalence of MetS in this study tended to be higher in participants aged < 60 years and with longer duration of monkhood, higher BMI, and undergoing an annual medical checkup. These findings were similar to those of a previous study conducted on Thai Buddhist monks (32). As per the unique lifestyle of Thai Buddhist monks, those who had a long duration of monkhood would probably have more low physical activities and sedentary lifestyle corresponding with the monastic rules. In the same manner, the latest Malaysian National Health and Morbidity Survey III (NHMS III) conducted in 2015 (45) found that a low level of physical activity was associated with the risk of being overweight/obesity.

Prevalence of MetS among Thai Buddhist monks categorized by each different component

The prevalence of each different component of MetS in this study was dominated by elevated triglyceride levels (66.7%), followed by elevated fasting glucose levels (62.9%), abdominal obesity (50.0%), high BP (38.8%), and low HDL levels (33.3%). However, the other previous study conducted among Thai Buddhist monks (30) reported high BP (87%), followed by elevated triglyceride levels (81.5%), elevated fasting glucose levels (70.4%), abdominal obesity (59.3%), and low HDL levels (55.6%). When the baseline characteristics of each study were compared, we found that participants in this study tended to be older and had a longer duration of monkhood and lower education level. According to the difference in baseline characteristics in each study, this reason would probably explain the difference of prevalence of MetS by each component between this study and the previous study.

Prevalence of MetS among Thai Buddhist monks compared with other studies conducted among laymen

The prevalence of MetS in this study (28.1%) was determined to be moderate when compared with previous studies conducted in Thailand, which reported a prevalence range of 27.5–32.6% during 2016–2011 (12, 13), and previous international studies, which reported prevalence rates of 24.8–38.5% during 2008–2012 in Korea (8), India (40), China (7), the USA (4), and Brazil (41).

The reason for this difference might be that the study population of the InterASIA survey (12) covered four regions of Thailand, and the prevalence of MetS varied across those regions, with higher prevalence rates being recorded in Bangkok and the central region. In contrast, the northeastern part (13) had the lowest MetS prevalence. Due to urbanization, the levels of physical activity and diet patterns were affected. Moreover, the InterASIA survey of Thailand found that the prevalence of MetS was found to be higher in women than in men, and the prevalence increased with age. In contrast, this present study was conducted on Thai monks who were only men. In the previous international studies, besides using different criteria for defining MetS, a possible explanation for the difference in the prevalence of MetS among each country was related to genetic background, racial or ethnic differences, and the difference in behavioral and environmental risk. The previous studies reported that racial or ethnic differences in the relationship between BMI and MetS risk have been previously documented among Asian Americans, African Americans, and Hispanics in the USA (4, 46–49).

Risk factors of MetS

Regarding the risk factors of MetS in Thai Buddhist monks, this study showed that a BMI of ≥ 25 kg/m² (obesity) (50) can increase the possibility of developing MetS among Thai Buddhist monks (OR, 4.53; 95% CI, 1.55–13.29, $p = 0.006$), whereas the previous study conducted among Thai Buddhist monks (32) showed that a duration of monkhood of >15 years was associated with an increase in the number of MetS cases among Thai Buddhist monks (OR, 2.0; 95% CI, 1.30–3.20, $p = 0.001$). Not surprisingly, obesity could increase the possibility of developing MetS in Thai monks. This study found that monks in the obesity group with MetS also had a much larger waist circumference ($n = 16$, 50.0%), higher triglyceride levels ($n = 22$, 66.7%), higher FBS ($n = 22$, 62.9%), and lower HDL-C levels ($n = 3$, 33.3%) than those of nonobese monks (BMI <25 kg/m²) with MetS.

Previous studies focusing on multiple products discharged from adipocytes explained the underlying relationship between obesity and MetS. The presence of certain products, such as nonesterified fatty acids, inflammatory cytokines, PAI-1, adiponectin, leptin, and resistin, causes an increased risk of developing MetS components (51–54).

The qualitative study

In the qualitative study, the results from the in-depth interview revealed that participants' perceptions were directly associated with their beliefs, experience, and basic healthcare knowledge. There were two primary factors of MetS in Thai monks, viz., unhealthy diet and low physical activity.

As regards unhealthy diet, the monks believed that laymen should recognize this problem and cooperate in donating more healthy food for them. All participants realized that MetS was a major health concern and can cause several health problems in the future.

Regarding low physical activity, the results from the in-depth interview revealed that some participants had a misconception of the monastic rules related to exercises. This perception would probably be the cause of low physical activity among the Buddhist monks. Even though they were not permitted to do general exercises, they can do alternative exercises in their private area, for example, flexibility exercise (stretching, yoga), stability exercise (balance and core training), and aerobic exercise (arm swinging, walking around the temple) (27).

Compared with the other study of MetS in Thai laymen, the other study (55) showed that most participants were not concerned about the threat of MetS and believed that their condition was apparently normal and recognized their prominent visceral fat benign due to no obvious abnormalities or physical impairment. Inappropriate eating behavior was also mentioned as a risk factor of MetS. Emotions, socioenvironmental factors, and culture that interfere with eating behavior and thoughts related to eating behavior were associated with inappropriate eating behavior in laymen. Several participants began realizing that they needed to change their eating behavior when given information about how their harmful eating practices could lead to MetS. The other previous qualitative study (56) was conducted on Iranian adults with MetS and reported that participants had problems in their attitude toward MetS components and their relationship to nutrition. They also had wrong attitudes toward fats and oils, salt, dairy products, cereals, and sugary drinks. Both attitudes and adverse subjective norms could impede healthy behavior.

In conclusion, this study found that besides making lifestyle changes, participants have emphasized the importance of an annual health checkup. Early detection and treatment help them have good prognosis and quality of life. Furthermore, medical providers played a vital role in passing on their basic healthcare knowledge. They have made sure that their patients could take care of themselves and understood basic healthcare.

Limitations of this study

First, being a cross-sectional study, the causal relationship between each factor contributing to MetS, as well as the data of long-term follow-up, could not be elaborated in detail. Further research is thus necessary to collect more data on risk factors or features to predict the development of type 2 diabetes and cardiovascular disease in Thai monks. We plan to conduct a cohort study to exactly reveal the incidence and risk factors of MetS among Thai monks. Second, due to the small Thai Buddhist monk population in Thailand, this study had a small population size. However, we included all the Thai Buddhist monks in Tha Luang District from May to June 2016 with a response rate of 64.4%; we then also performed a qualitative study. Therefore, this study could provide an in-depth understanding and reveal the major problem, together with the outcome of the study from these mixed methods.

Recommendation

The results of this study showed that early screening, treatment, and patient education were important factors in managing MetS in Thai Buddhist monks. We should use a holistic healthcare model that we have adjusted from previous studies (57, 58) to prevent and control MetS and other noncommunicable diseases in Thai Buddhist monks. Holistic healthcare (59) is a form of treatment and management that considers the whole person; moreover, healthcare providers should use a variety of treatment techniques to help their patients take the responsibility for their own well-being and achieve optimal health.

A holistic healthcare model consists of health promotion, prevention, and treatment, as listed below.

1. Health promotion is divided into three components as follows:

1.1. Monks: The Thai Buddhist monks should make some lifestyle changes, for example, eating a healthy diet and having adequate physical activity.

1.2. Laymen: Buddhists have an important role in promoting Thai Buddhist monks' health by donating healthy food. They should support and participate in healthy activities that are conducted in their local temples.

1.3. Environment: Both Thai monks and laymen should follow sanitary measures and keep the temple area clean. The temple should be assigned as the local health center of the community, for example, the center of basic healthcare knowledge, herbal medicine, the temple medicine cupboard, monks' healthcare fund, and the end-of-life care center.

2. Prevention: The medical provider should focus on basic health knowledge and pass it on to local people and monks. The local healthcare system should conduct a health outreach program through a community healthcare service to provide health screenings and annual checkups.

3. Treatment: Apart from the appropriate treatment and management, the medical provider should provide transportation for them because Thai Buddhist monks are not permitted to drive a car by themselves. Local healthcare volunteers can remind Thai monks about their appointment to see a doctor and make sure that they have routine follow-ups, together with health checkups.

Conclusions

The prevalence of MetS among Thai Buddhist monks was moderate compared with that reported in other studies. Medical providers and Buddhist devotees should cooperate in providing health promotion by donating healthy food, conducting annual health checkups, and passing on the concept of alternative exercises in a private area that corresponds with the monastic rules. Therefore, early screening, treatment, and patient education are the most important factors to manage MetS in Thai Buddhist monks.

Abbreviations

BMI Body mass index

BP Blood pressure

DM Diabetes mellitus

FPG Fasting plasma glucose

HDL High-density lipoprotein

IDF International Diabetes Federation

IFCC International Federation of Clinical Chemistry

MetS Metabolic syndrome

NHANES National Health and Nutrition Examination Survey

NHMS National Health and Morbidity Survey

SD Standard deviation

SM Saad MF

WC Waist circumference

Declarations

Ethical Considerations

This study was approved by the Institutional Review Board of the Royal Thai Army Medical Department's committee on human research, and the approval number is R058h/59. All participants were provided all the information about this study by the investigators. Written informed consents were obtained from all participants and have been performed in accordance with the World Medical Association Declaration of Helsinki–Ethics principles (60) for medical research involving human subjects. For the in-depth interview process, the questions were treated sensitively and confidentially. When the participants were concerned about any question, participants could refuse to answer the question.

Consent for publication

Not applicable

Availability of data and materials

The dataset analyzed is available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

A.K., P.W., W.W., N.A., and S.S., collected the data and reviewed the literature. A.K., N.A., S.S., P.P, W.K., T.T., M.M., R.R., and P.N. provided valuable input in study design and data collection. A.K., P.W., W.W., N.A., S.S., and P.N. drafted the article, and revised it critically. All authors read and approved the manuscript and met the criteria for authorship.

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Tables

Table 1: Characteristics of Thai Buddhist monks (n = 96)

	n	%
Age (years)* 57.9 ± 14.7(24–92)		
<60	51	53.1
60	45	46.9
Duration of monkhood (years)* 10.2 ± 10.3(0.5–50)		
15 years	70	72.9
>15 years	26	27.1
Education level		
Primary school	68	70.8
Secondary school	28	29.2
Monastic education		
No	28	29.2
Yes	68	70.8
Monastic educational level		
None	28	29.2
Foundation level	34	35.4
Intermediate level	13	13.5
Advanced level	21	21.9
Smoking status		
Never or former smoker	41	42.7
Current smoker	55	57.3
Sleep duration		
6–8 h	32	33.3
<6 or >8 h	64	66.7
Annual medical checkup		
No	59	61.5
Yes	37	38.5
Exercise		
<3 times/week	35	36.5
3 times/week	61	63.5
Alms-round		
No	8	8.3
Yes	88	91.7
BMI (kg/m ²) ** 23.8 ± 7.7(15.8–90.7)		
<25	70	72.92
25	26	27.08

*Mean ± SD (min–max)

** WHO/IASO/IOTF. The Asia-Pacific perspective: Redefining obesity and its treatment. Health Communications Australia: Melbourne, 2000

Table 2: Prevalence of each component of metabolic syndrome

	Total		Non-MetS (n = 69)		MetS (n = 27)		Odds ratio (95% CI)	p-value
	n	%	n	%	n	%		
High BP								
<130 and <85 mmHg	29	30.2	28	96.6	1	3.5	1	
130 or 85 mmHg	67	69.8	41	61.2	26	38.8	17.8 (2.3–138.5)	0.006
Fasting glucose								
<100 mg/dL	57	62.0	52	91.2	5	8.8	1	
100 mg/dL	35	38.0	13	37.1	22	62.9	17.6 (5.6–55.3)	<0.001
Triglycerides								
<150 mg/dL	56	62.9	51	91.1	5	8.9	1	
150 mg/dL	33	37.1	11	33.3	22	66.7	20.4 (6.3–65.7)	<0.001
HDL cholesterol								
40 mg/dL	81	90.0	57	70.4	24	29.6	1	
<40 mg/dL	9	10.0	6	66.7	3	33.3	1.2 (0.3–5.1)	0.818
Abdominal obesity								
WC <90 cm	62	66.0	52	83.9	10	16.1	1	
WC 90 cm	32	34.0	16	50.0	16	50.0	5.2 (2.0–13.7)	0.001

Logistics regression (chi-square test): p value² 0.05

CI = confidence interval

Table 3: Proportions of participants positive for different numbers of metabolic syndrome components

Number of positive components	Number of participants	Proportion (95% CI)
0	13	13.5 (7.8–21.4)
1	25	26.0 (18.1–35.4)
2	31	32.3 (23.6–42.1)
3	19	19.8 (12.8–28.6)
4	8	8.3 (4.0–15.1)

Table 4: Prevalence of MetS and its components among 96 participants

Variable	n	MetS (95% CI)	MetS components ¹				
			High BP	Fasting glucose	Triglycerides	HDL cholesterol	Abdominal obesity
Overall	96	28.1 (19.9–37.7)	38.8	62.9	66.7	33.3	50.0
Age							
<60	51	29.4 (18.3–42.8)	60.8	33.3	45.5	11.1	35.3
60	45	26.7 (15.5–40.8)	80.0	43.2	28.9	8.9	32.6
Duration of monkhood							
15 years	70	25.7 (16.6–36.8)	72.9	35.8	36.5	10.9	27.9
>15 years	26	34.6 (18.7–53.7)	61.5	44.0	38.5	7.7	50.0
Education level							
Primary school	68	29.4 (19.6–40.9)	75.0	37.3	38.2	12.1	32.8
Secondary school	28	25.0 (11.9–42.9)	57.1	40.0	33.3	4.2	37.0
Monastic education							
No	28	32.1 (17.3–50.5)	71.4	44.4	40.7	11.5	25.9
Yes	68	26.5 (17.1–37.8)	69.1	35.4	35.5	9.4	37.3
Monastic educational level							
None	28	32.1 (17.3–50.5)	71.4	44.4	40.7	11.5	25.9
Foundation level	34	26.5 (14.0–42.8)	67.7	28.1	34.4	15.6	30.3
Intermediate level	13	23.1 (7.0–49.7)	76.9	30.8	27.3	7.7	53.9
Advanced level	21	28.6 (12.9–49.7)	66.7	50.0	42.1	0.0	38.1
Smoking status							
Never or former smoker	41	31.7 (19.1–46.8)	70.7	41.5	40.5	7.5	37.5
Current smoker	55	25.5 (15.4–38.0)	69.1	35.3	34.6	12.0	31.5
Sleep duration							
6–8 h	32	25.0 (12.6–41.7)	59.4	41.4	36.7	16.7	36.7
<6 or >8 h	64	29.7 (19.6–41.6)	75.0	36.5	37.3	6.7	32.8
Annual medical checkup							
No	59	22.0 (13.0–33.8)	66.1	25.0	35.2	14.3	29.3
Yes	37	37.8 (23.6–53.9)	75.7	58.3	40.0	2.9	41.7
Exercise							
<3 times/week	35	22.9 (11.4–38.6)	68.6	39.4	29.0	12.5	34.3
3 times/week	61	31.2 (20.6–43.4)	70.5	37.3	41.4	8.6	33.9
Alms-round							
No	8	50.0 (19.9–80.1)	75.0	75.0	37.5	25.0	37.5
Yes	88	26.1 (17.8–36.0)	69.3	34.5	37.0	8.5	33.7
BMI (kg/m²)							
<25	70	20.0 (12.0–30.5)	68.6	36.4	32.8	9.4	17.4
25	26	50.0 (31.6–68.4)	73.1	42.3	48.0	11.5	80.0

¹Percentage was calculated from repeated count every MetS component combination pattern of all participants

Table 5: Factors associated with MetS of 96 participants

Variable	Non-MetS (n = 69)	MetS (n = 27)	p-value	Crude odds ratio (95 % CI)	p-value	Adjusted odds ratio (95% CI)	p-value
	n (%)	n (%)					
Age			0.765				
<60	36 (70.6)	15 (29.4)		1.2 (0.5–2.8)	0.765	1.5 (0.5–4.3)	0.464
60	33 (73.3)	12 (26.7)		1		1	
Duration of monkhood			0.389				
15 years	52 (74.3)	18 (25.7)		1		1	
>15 years	17 (65.4)	9 (34.6)		1.5 (0.6–4.0)	0.39	1.3 (0.4–4.5)	0.642
Education level			0.662				
Primary school	48 (70.6)	20 (29.4)		1.3 (0.5–3.4)	0.662	1.9 (0.6–6.3)	0.296
Secondary school	21 (75.0)	7 (25.0)		1		1	
Monastic education			0.574				
No	19 (67.9)	9 (32.1)		1.3 (0.5–3.4)	0.575	1.9 (0.6–5.6)	0.264
Yes	50 (73.5)	18 (26.5)		1		1	
Smoking status			0.500				
Never or former smoker	28 (68.3)	13 (31.7)		1.4 (0.6–3.3)	0.501	0.8 (0.3–2.5)	0.740
Current smoker	41 (74.6)	14 (25.5)		1		1	
Sleep duration			0.630				
6–8 h	24 (75.0)	8 (25.0)		1		1	
<6 or >8 h	45 (70.3)	19 (29.7)		1.3 (0.5–3.3)	0.631	1.6 (0.5–4.9)	0.390
Annual medical checkup			0.094				
No	46 (78.0)	13 (22.0)		1		1	
Yes	23 (62.2)	14 (37.8)		2.2 (0.9–5.3)	0.097	2.6 (0.9–7.7)	0.081
Exercise			0.385				
<3 times/week	27 (77.1)	8 (22.9)		1		1	
3 times/week	42 (68.9)	19 (31.2)		1.5 (0.6–4.0)	0.386	1.7 (0.6–5.3)	0.331
Alms-round			0.151				
No	4 (50.0)	4 (50.0)		2.8 (0.7–12.2)	0.165	2.6 (0.4–19.7)	0.345
Yes	65 (73.9)	23 (26.1)		1		1	
BMI (kg/m²)			0.004				
<25	56 (80.0)	14 (20.0)		1		1	
25	13 (50.0)	13 (50.0)		4 (1.5–10.5)	0.005	4.5 (1.6–13.3)	0.006

** multivariate, logistic regression using multivariate imputation by chained equations. Both directions after adjusted for age, duration of monkhood, educational level, monastic education, smoking status, sleep duration, annual medical checkup, exercise, alms-round, and BMI

Table 6: Baseline characteristics of participants in the qualitative study

No.	Age (years)	Duration of monkhood (years)	Monastic educational level	BMI (kg/m ²)	MetS components					Status
					High BP	Fasting glucose	Triglycerides	HDL cholesterol	Abdominal obesity	
1	44	5	Foundation level	23.3	No	No	No	No	No	Non-MetS
2	37	7	Foundation level	23.9	No	No	No	No	No	Non-MetS
3	65	10	No	22.6	Yes	No	No	No	No	Non-MetS
4	66	7	No	26.3	No	Yes	Yes	No	Yes	MetS
5	40	20	Foundation level	27.9	Yes	No	Yes	yes	Yes	MetS
6	89	20	No	16.8	Yes	Yes	No	No	No	Non-MetS
7	56	4	Advanced level	30.9	Yes	Yes	Yes	No	Yes	MetS

Table 7: Themes and subthemes

Themes	Subthemes
Perception of metabolic syndrome	1.1 Inappropriate fatty deposits in the body.
	1.2 Obesity can cause many diseases in the future, but I do not know exactly.
Risk factors and causes of metabolic syndrome	2.1 Donated foods from alms-rounds are high in salt, sugar, and fat.
	2.2 Exercise is not permitted due to the Buddhist monk rules.
Effect of metabolic syndrome	3.1 It would be related to many comorbidities in the future.
	3.2 It can cause many symptoms like dizziness, shortness of breath, and tiredness.
Management and prevention of metabolic syndrome	4.1 Making some lifestyle changes.
	4.2 Basic healthcare knowledge and public health promotion.