Original Article

Metabolic Syndrome of Thai Buddhist Monks in Bangkok Metropolitan Temples

Kwancharoen R, MD[1], Leewattanapat P, MD[1], Suraamornkul S, MD[1]

[1] Division of Endocrinology, Department of Internal Medicine, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand

Objective: To evaluate the prevalence of metabolic syndrome in Thai monks in Bangkok.

Materials and Methods: This cross-sectional study included the monks who lived in Bangkok temples and consented to participate in the study. The participants filled up the questionnaire queried about personal and health data and underwent physical examination including anthropometric measurement before biochemical blood test. The diagnosis of metabolic syndrome was defined by the International Diabetes Foundation (IDF) 2005 and Harmonization 2009 criteria.

Results: Among 190 Thai monks included in the present study, the median age was 44 years old [range, 27 to 58 years]. The median body mass index was 24.95 kg/m^2 [range, 22.3 to 27.8 kg/m^2]. The prevalence of metabolic syndrome by IDF 2005 and Harmonization 2009 criteria were 16.8% and 28.4%, respectively.

Conclusion: The prevalence of metabolic syndrome in Thai monks was moderate. To reduce the consequences of these metabolic abnormalities, an improvement of health system to develop strategies for prevention, detection, and treatment of metabolic syndrome is important.

Keywords: Thai monk, Metabolic syndrome

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Thai monks are individuals who dedicate themselves to Buddhism, and have unique lifestyle. Few major differences from those of laymen are daily activities which emphasize on self-consciousness including meditation and pattern of food consumption which are generally provided by laymen. Another restriction is that no solid food is allowed after noon, and only beverages are allowed. These particular activities may lead to an increased risk of health problems especially in urban areas where the types of food provided by the laymen and physical activities are generally different from rural area.

Metabolic syndrome (MetS) is defined as a cluster of metabolic abnormalities. Although it has been widely accepted that the conditions included in the syndrome are abdominal obesity, impaired fasting glucose, high blood pressure, elevated triglycerides and low high-density lipoprotein (HDL) level, the diagnostic criteria vary among organizations[1-7].

The original terminology for the condition was first proposed in 1992 as 'Syndrome X'[1]. The World Health Organization (WHO), in 1998, defined this syndrome as the presence of glucose intolerance or insulin resistance or diabetes mellitus with any 2 of the following components: obesity, high serum triglycerides, low serum high density lipoprotein cholesterol and hypertension[2,3]. Later in 2001, the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) defined MetS as a presence of any 3 of the following components: abdominal obesity, dyslipidemia (high levels of triglycerides, low HDL), hypertension, and elevated fasting glucose[4]. These criteria are widely considered useful for assessing the magnitude of MetS in the general population. Of note, there were different cut-off points of blood chemistry levels despite of the same diagnostic criteria of MetS. In 2005, the International Diabetes Federation (IDF)[6] emphasized on central obesity (measured by waist circumference) as an essential criteria of MetS along with the other 2 components of hypertension, abnormal blood glucose, high serum triglycerides and low high density lipoprotein cholesterol. In the same year, the NCEP-ATP III criteria were also modified by taking the ethnic-specific waist circumference into additional consideration[5].

In recognition of the perplexing criteria of MetS, several organizations including the IDF; the National Heart, Lung and Blood Institute (NHLBI); the American Heart Association (AHA); World Heart Federation (WHF); the International Atherosclerosis Society (IAS); and the International Association for the Study of Obesity (IASO)

Correspondence to:

Suraamornkul S.

Department of Endocrinology, Faculty of Medicine Vajira Hospital Navamindradhiraj University, Bangkok 10300, Thailand.

Phone: +66-2-2443490, **Fax:** +66-2-6687061

E-mail: swangjit@nmu.ac.th

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have proposed a new definition of MetS requiring any 3 of the 5 components in the IDF definition regardless of central obesity (based on ethnicity-specific waist circumferences) with uniform cut points for all risk factors[7], Harmonization 2009 criteria.

Each component of MetS generally develops in any conditions which can cause insulin resistance. These conditions include genetic predisposition, sedentary lifestyle, unhealthy diet, physical inactivity, and obesity. Public health concern to assess the prevalence of MetS in their own country and region is important. So, the strategy to modify the prevalence and risk factors of MetS should be implied to reduce obesity, overt type 2 diabetes mellitus, coronary artery disease (CAD), nonalcoholic fatty liver disease and other consequences[1,8-10].

The prevalence of MetS is rapidly increasing worldwide due to the modern lifestyle including excess calories intake and lack of physical activity. Previous studies reported 12 to 69%[11-19] prevalence of MetS. Aside from the definition criteria used in each study, the different prevalence of MetS from previous studies may also lie on the ethnic and population studied. Many previous studies reported the monks' health problem and behavioral risk factors as well as modification or interventions which may prevent or reduce the risk of illnesses[20-23]. To date, little information is available regarding the prevalence and characteristics of MetS in Thai monks who live in Bangkok.

The present study primarily aimed to assess the prevalence of metabolic syndrome in Thai monks who live in Bangkok district. The second objectives were to compare the prevalence of each component of MetS by using the IDF 2005 and Harmonization 2009 criteria.

Materials and Methods

This cross sectional survey study was approved by Ethical Committees on human rights related to researches involving human subjects, Faculty of Medicine Vajira Hospital, Navamindradhiraj University.

Subjects and data collection

The present study was conducted from mid-September 2015 until the end of December 2016. Approximately total number of 250 monks living in temples in Bangkok was planned. The temples in Dusit and Nong Chok districts were arbitrarily selected. Inclusion criteria were Thai monks aged 35 years old and above, having been ordinated for at least 1 year, and being literate in Thai. Exclusion criteria were the monks who were not willing to participate or were not in the temple at the day of survey.

The abbots of each temple in Dusit and Nong Chok districts were communicated by the research assistants for the information of this health survey project. The monks who volunteered to participate in the study were scheduled for the sites visit. The health survey questionnaire was provided and comprehensibly explained with the monks who were requested to complete the questionnaire prior to the scheduled day. All volunteer monks who met the inclusion criteria signed written informed consent and were invited to fasting for 8 hours on the previous night of the scheduled day.

On the scheduled day, the research team consisting of physicians, nurses, and research assistants went to the participating temple. The physicians performed physical examination in each part of interest. The nurses collected the vital status and blood samples in the morning. The research assistants collected and verified the completion of questionnaires. The vital status included assessment of weight, height, waist circumference, and blood pressure measurement. All physical and laboratory findings together with the recommendation of individual health concern would be summarized in the provided personal health books given back to each participating monk within a month.

Data were collected by systematic sampling and conducting interviews using the survey questionnaire. The survey questionnaire included assessment of socio-demographics (sex, age groups, duration in monk, behavioral risk factors (smoking, physical activity, fruit and vegetable intake and harmful alcohol consumption), and anthropometric measurements (height, weight, waist and hip circumference), blood pressure and blood drawn for laboratory investigation were carried out at the following time.

Metabolic syndrome was defined by IDF 2005[6] and Harmonization 2009[7] criteria. Briefly, the criteria are met when there are at least 3 of the following components: 1) central obesity (waist circumference: WC $\geq$90 cm, 2) triglyceride concentration $\geq$150 mg/dL or on triglyceride-lowering medication, 3) HDL-cholesterol <40 mg/dL or on medication for low HDL-cholesterol, 4) systolic blood pressure $\geq$130 mmHg and/or diastolic blood pressure $\geq$85 mmHg or on antihypertensive medication, and 5) fasting plasma glucose (FPG) concentration $\geq$100 mg/dL or on drug treatment for hyperglycemia. Waist circumference was measured midway between the inferior margin of the last rib and the iliac crest.

The major difference between IDF 2005 and Harmonization 2009 is that the IDF 2005 MetS requires central or abdominal obesity (waist circumference greater than 90 cm) as an essential component whereas the Harmonization 2009 MetS requires only 3 of the 5 components regardless of obesity.

Fasting blood samples were collected after 8-hour overnight fasting, before catheterization procedure, and sent for analysis within 3 hours of collection. Analysis of routine biochemical markers were performed on samples using the Siemen Dimension ExL200.

Main outcomes and measures

The primary outcome of the present study was the prevalence of metabolic syndrome. The secondary outcomes were the percentage of each component of IDF 2005 and Harmonization 2009 criteria.

Statistical analysis

Data were analyzed using SPSS for windows

version 22.0 (IBM Corp, Armonk, NY, USA). Descriptive continuous data were presented as median with interquartile ranges or mean with standard deviation. Data were compared between the patients who had or had no metabolic syndrome with Chi-square or Fisher exact tests as appropriate.

Results

Among 224 monks from 16 temples in the 2 districts of Bangkok Metropolitan, 190 monks (84.8%) who answered the questionnaire and had blood sampling were included in the study. Demographic data of the 190 monks are shown in Table 1. Most of the monks (n = 90, 47.4%) aged between 20 to 40 years old. Slightly more than half (n = 110, 57.9%) had been in monkhood less than 5 years. Nearly 3/4 had regular education of secondary school or higher (n = 137, 72.1%) or had Monastic education (n = 147, 77.3%). Regarding the health problems collected from the questionnaires, the 3 most common illnesses reported by the monks themselves were hypertension in 26 (13.7%), diabetes in 20 (10.5%), and dyslipidemia in 17 (8.9%).

The prevalence of MetS was diagnosed by IDF 2005 criteria 16.8%, meanwhile by Harmonization 2009 criteria 28.4%, respectively. Percentage of each component of MetS diagnosed by both criteria are shown in Figure 1. By Harmonization 2009 criteria, the abnormal metabolic disorders of MetS in order of frequency were high blood pressure (87%), hypertriglyceridemia (81.5%), dysglycemia (70.4%), central obesity (59.3%), and low HDL (55.6%). Among 32 monks with central obesity which is the pre-requisite to diagnose MetS by the IDF 2005 criteria, high blood pressure (93.8%), dysglycemia (75.0%), hypertriglyceridemia (68.8%), and low HDL (46.9%) were revealed.

Baseline characteristics and findings from physical examination and laboratory investigations of the monks who were diagnosed as having MetS were compared to those without MetS (Table 2) by using IDF 2005 and Harmonization 2009 criteria. Factors which were significantly different in the monks with MetS than those without were age, body mass index and waist circumference.

Laboratory abnormalities were significantly different in the monks with MetS were higher fasting blood sugar, lower HDL, higher triglyceride, lower eGFR, higher AST, and ALT level than those without MetS in each criteria. While serum cholesterol, LDL and uric acid level have no significant different in with or without MetS subgroup in both criteria.

Discussion

Previous studies reported various prevalence of MetS[11-19]. The differences may lie on the population and the definition criteria used in each study, but not in the monks as the special interest group. Furthermore, there had been no previous studies comparing the prevalence of MetS in Thai population especially using different criteria for diagnosis.

The present study found the prevalence of MetS in Thai monks was higher using the Harmonization 2009 criteria than the IDF 2005 criteria, 28.4% and 16.8%, respectively. The prevalence of MetS by the Harmonization 2009 criteria found in this study was slightly higher than 23.2% in urban Thai men from the report of the Thai national health and nutrition examination survey (NHANES) IV using Harmonization 2009 criteria[15]. The prevalence of MetS

Table 1. General demographic data of study subjects (n = 190)

Demographic data	
Age (year)	44 (27 to 58)
20 to 40	90 (47.4%)
41 to 60	64 (33.7%)
>60 years	36 (18.9%)
Monkhood (pansa)	5 (2 to 15)
1 to 5	110 (57.9%)
>5	80 (42.1%)
Education level	
Primary	53 (27.9%)
Secondary	88 (46.3%)
College	49 (25.8%)
Monastic education	
None	43 (22.6%)
Religious student	115 (60.5%)
Graduation in Buddhist theology	32 (16.8%)
Underlying disease	50 (26.3%)
Diabetes	20 (10.5%)
Coronary heart disease	5 (2.6%)
Hypertension	26 (13.7%)
Dyslipidemia	17 (8.9%)
Fatty liver	2 (1.1%)
Viral hepatitis B or C	6 (3.2%)
Renal disease	2 (1.1%)
Gout	6 (3.2%)
Osteoarthritis	6 (3.2%)
Others	3 (1.6%)

Data are presented as n (%) or median (interquartile range)

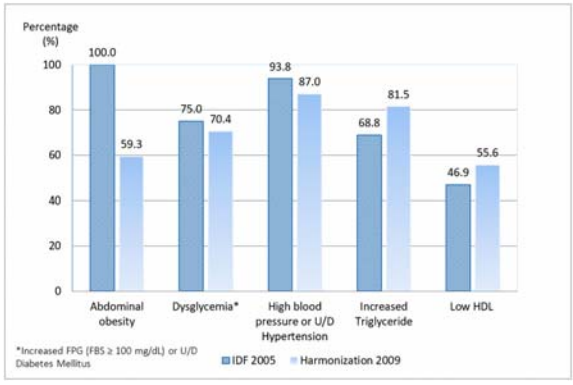

Figure 1. Characteristics of metabolic syndrome component by IDF 2005 vs. Harmonization 2009 criteria.

Table 2. Baseline Characteristics and laboratory results of Study Subjects

Variables	IDF 2005 criteria				p-value	Harmonization 2009 criteria				p-value
	Yes (n = 32)		No (n = 158)			Yes (n = 54)		No (n = 136)		
	Median	(IQR)	Median	(IQR)		Median	(IQR)	Median	(IQR)	
Age (yrs)	52	(39-65)	40	(26 to 56)	0.009	54	(40 to 62)	39	(25 to 54)	<0.001
Body weight (kg)	83.4	(78.5-95.4)	65.0	(56.4 to 73.0)	<0.001	79.3	(71.0 to 90.2)	64.6	(56.0 to 72.5)	<0.001
BMI (kg/m^2)	31.1	(28.1-33.2)	23.8	(21.9 to 26.3)	<0.001	28.5	(26.3 to 32.3)	23.5	(21.5 to 25.8)	<0.001
Waist circumference (cm)	99	(95.5-105)	80	(72.5 to 85)	<0.001	96	(85 to 101)	80	(70 to 85)	<0.001
Systolic blood pressure (mmHg)	142	(132-153)	127	(118 to 139)	<0.001	140	(129 to 151)	126	(118 to 137)	<0.001
Diastolic blood pressure (mmHg)	85	(78-95)	79	(71 to 86)	0.001	85	(78 to 92)	78	(70 to 85)	<0.001
Laboratory results										
FBS (mg/dL)	119	(97-173)	87	(80 to 97)	<0.001	108	(91 to 167)	85	(79 to 93)	<0.001
Cholesterol (mg/dL)	194	(164-246)	209	(175 to 237)	0.56	206	(167 to 251)	209	(174 to 233)	0.99
HDL (mg/dL)	45	(38-49)	51	(45 to 61)	<0.001	45	(38 to 50)	53	(46 to 63)	<0.001
LDL (mg/dL)	126	(111-173)	143	(112 to 168)	0.78	140	(114 to 165)	143	(111 to 168)	0.89
Triglyceride (mg/dL)	202	(142-280)	125	(83 to 176)	<0.001	206	(143 to 285)	118	(81 to 159)	<0.001
BUN (mg/dL)	15	(13-17)	12	(10 to 15)	<0.001	14	(12 to 17)	12	(10 to 15)	0.003
eGFR (ml/min)	89	(74 to 102)	98	(87 to 110)	0.01	90	(78 to 106)	98	(87 to 110)	0.03
Creatinine (mg/dL)	0.96	(0.85 to 1.14)	0.93	(0.85 to 1.01)	0.26	0.94	(0.84 to 1.09)	0.93	(0.86 to 1.02)	0.89
Uric acid (mg/dL)	6.0	(5.7 to 7.5)	6.0	(5.2 to 7.0)	0.103	6.0	(5.5 to 7.0)	6.0	(5.3 to 7.0)	0.59
AST (SGOT, U/L)	31	(25 to 35)	26	(20 to 32)	0.02	31	(26 to 36)	26	(19 to 32)	0.001
ALT (SGPT, U/L)	38	(28 to 57)	31	(22 to 44)	0.01	44	(30 to 57)	28	(21 to 41)	<0.001
ALP (U/L)	73	(59 to 79)	73	(62 to 90)	0.49	73	(61 to 81)	73	(62 to 90)	0.75

among Thai monks in our study and Thai men from previous study were close to the prevalence found in one study from India which reported 30% or 14% of the industrial men workers in India had MetS by the Harmonization 2009 and IDF 2005 criteria, respectively[16]. The higher prevalence of MetS according to the Harmonization 2009 comparing to the IDF 2005 criteria may hold true regardless of ethnic or environmental factors. One study in Mexican urban population also found in 69% and 60% of their subjects had MetS by the 2 definition criteria, respectively[17].

The reason of a higher prevalence of MetS by Harmonization 2009 than by the IDF 2005 criteria was obvious from the difference of definition criteria of each. Harmonization 2009 defined the MetS by presence of any 3 or more out of the 5 dysmetabolic components. Whereas MetS by the IDF 2005 criteria was that one must have central obesity plus any of the other 2 additional components. The non-obese subjects would be readily excluded from having MetS regardless of the other abnormalities. The impact of abdominal obesity or large waist circumference can be seen in the studies among obese subjects from India wherein both criteria were applied resulting in similar prevalence across studies[18,19,24]. So, the Harmonization 2009 criteria using any 3 out of 5 components may be more appropriate for the non-obese individuals whereas either IDF or Harmonization criteria, which were in good agreement among obese population can be used.

Regardless of the criteria of MetS being used, the 3 most common metabolic abnormalities of high blood pressure, hypertriglyceridemia, and dysglycemia. These are non-communicable diseases which are epidemic in many urban areas of the world. The abnormalities can certainly increase risk of chronic illness, such as, cardiovascular diseases, neurovascular, and many related complications. Taken into consideration the impact of MetS on public health, sustainable lifestyle modification to prevent or control each metabolic abnormality to diminish the morbidity and mortality from metabolic syndrome must be emphasized.

Other observations in the present study were the monks who were affected with MetS had more frequent abnormal liver and renal functions than the others monks. This should alert the individuals and their care takers to have a close surveillance for liver and kidney problems in the future.

The present study had strength in being among the few studies which reported the prevalence of MetS in Thai monks in urban area of Bangkok. Being the first report in Thailand which compared the prevalence of MetS by IDF 2005 and Harmonization 2009 criteria, these data should be useful for the clinician practicing in this field. However, a few limitations were to be noted. Being a cross sectional study, the causal relationship between each factors contributing to MetS could not be elaborated in detail as well as data of long-term follow-up. Future research to collect more data of risk factors or features to predict development of type 2 diabetes and cardiovascular disease in Thai monk which is a unique population in urban area as Bangkok are needed.

Conclusion

The prevalence of metabolic syndrome in Thai monks was moderate. Higher prevalence with Harmonization 2009 criteria (28.4%) than by IDF 2005 criteria (16.8%) were found. To reduce the consequences of these metabolic abnormalities, an improvement of health system to develop strategies for prevention, detection, and treatment of metabolic syndrome is important.

What is already known on this topic?

Obesity and sedentary lifestyle are leading cause of metabolic syndrome especially in urbanized living. Thai monks are individuals who dedicate themselves to Buddhism, and have unique lifestyle. Monks' health problem and behavioral risk factors as well as modification or interventions which may prevent or reduce the risk of illnesses have been reported.

What this study adds?

The high prevalence of MetS in the monks who live in Bangkok. The older monks are likely to have the higher prevalence of MetS including obesity, diabetes, hypertension and dyslipidemia. These are all important non-communicable disease and needs to be intervened urgently.

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Potential conflicts of Interest

The authors declare no conflict of interest.

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