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Metabolic syndrome and the risk of coronary artery disease among the physicians

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Background: Physicians, due to their work and lifestyle patterns, can be at risk for metabolic syndrome (MetS). We aimed to evaluate the prevalence of MetS among physicians and its association with coronary artery disease (CAD).

Materials and methods: This retrospective cross-sectional study collected data on Thai physicians who had medical examination including cardiovascular testing from 14 February to 31 October 2022, in our hospital. Inclusion criteria were those who had complete data for MetS diagnosis per Adult Treatment Panel III criteria and CAD diagnosis information. Outcome measures were prevalence of MetS and CAD prevalence in affected vs non-affected physicians.

Results: Of 1194 physicians, the median age was 48.0 ± 10.29 years. The authors found 4.5% were obese, 30.6% having high blood pressure, 26.6% high fasting blood sugar (FBS), 12.7% high triglycerides, and 13.7% low high-density lipoprotein (HDL). The prevalence of MetS was 8.9%. Increasing age, systolic blood pressure, body mass index, FBS, triglyceride, and decreasing HDL were identified as independent risk factors of MetS. The prevalence of CAD was 11.4%: 47.2% vs. 7.9% among the physicians with and without MetS respectively (odds ratio 10.41: 95% CI, 6.70–16.16%, $P < 0.001$).

Conclusion: The prevalence of MetS among Thai physicians in this study was 8.9%. Those physicians with MetS were associated with a 10-fold higher risk of CAD. Physicians who were at risk of developing MetS should consider modifying their health habits and being vigilant about the potential consequences of CAD. Further prospective cohort studies are warranted to validate these results.

Keywords: coronary artery disease, metabolic syndrome, physician

Introduction

Metabolic syndrome (MetS) is a cluster of disorders comprising obesity, hypertension, and dyslipidemia[1]. These three problems are the major health problems worldwide with an increasing prevalence over the years. The WHO states that the prevalence of obesity has tripled since 1975, with over 1.9 billion adults overweight and over 650 million obese[2]. Similarly, the global prevalence of diabetes mellitus (DM) was estimated to be 10.5% (536.6 million people) in the population aged 20–79 years in 2021 and is expected to be 12.2% (783.2 million) by 2045[3,4].

Among many criteria for a diagnosis of MetS, the two common systems used are by the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III)[5] which was updated by the American Heart Association (AHA) and the National Heart Lung and Blood Institute (NHLBI) in 2005[6] and the International Diabetes Federation (IDF)[7]. The ATP III requires any three of the five factors of high waist circumference, high blood pressure, high level of fasting blood sugar (FBS) or triglycerides, and low level of high-density lipoprotein (HDL)[6]. Although the IDF 2006 criteria used the same indicators, high waist circumference is a pre-requisite before considering any two of the other four factors[7]. With a recognition of the different criteria, the representatives from the IDF and AHA/NHLBI held discussions and agreed for the harmonized criteria that abdominal obesity should not be a pre-requisite for diagnosis, so the presence of any three of five risk factors constitutes a diagnosis of MetS[8].

MetS is a common health condition affecting over one billion people globally. A national survey in the United States reported a MetS prevalence of 35% among adults[9]. The prevalence of MetS can vary due to several factors, such as ethnicity,

HIGHLIGHTS

- The prevalence of metabolic syndrome (MetS) among Thai physicians was 8.9%.
- Increasing age, systolic blood pressure, BMI, fasting blood sugar, triglyceride, were identified as independent risk factors of MetS.
- The physicians affected with metabolic syndrome had 10 folds higher prevalence of coronary artery disease compared to the unaffected physicians, 47.2% vs. 7.9%.

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geographic location, genetic vulnerability, aging, unhealthy lifestyles leading to higher prevalence of MetS components (obesity, hypertension, dyslipidemia, insulin resistance), and the specific diagnostic criteria used in each study[1,6,7,9–13]. Trillions of USD of medical care cost and potential loss of economics were reported with an increasing prevalence of MetS[10].

The detrimental effects of MetS on general health involved various pathways[14–16]. For example, lymphoid tissues disruption with deranged distribution of leucocyte subsets and phenotypes, and microvascular dysfunction demonstrated in MetS can lead to an immunity impairment and the development of chronic diseases including various cardiovascular conditions, for example coronary atherosclerosis and calcification, cardiac dysfunction, myocardial infarction, and heart failure[16,17]. The insulin resistance and adipose tissue expansion could promote chronic inflammation and oxidative stress leading to kidney injury and chronic kidney disease[14].

Individuals can be at risk for MetS according to their lifestyles. Sedentary behaviour, a significant risk, is common among professionals who engage in prolonged sitting or standing, such as office workers or healthcare practitioners. In Asia, only a few studies focusing on health personnel reported prevalence of MetS ranging from 18 to 39%[18–20]. One study in Thailand also revealed a 2.08-fold increased risk of cardiovascular diseases (CVDs) among the health personnel affected with MetS compared to healthy personnel[20].

Among the health personnel, the physician as a leader of other colleagues has a distinctive role in healthcare service with more tendency for sedentary work habits. This may lead to a higher risk of one or more components of MetS or MetS itself. One study from Taiwan reported the prevalence of MetS was highest among physicians compared to other hospital employees[18].

To our knowledge, no studies in Thailand were conducted to investigate the prevalence of MetS among Thai physicians. This study aimed to evaluate the prevalence of MetS, clinical characteristic features which were the risk factors of MetS, and the prevalence of coronary artery disease (CAD) among the physicians affected with MetS and the risk magnitude of each MetS component.

Materials and methods

Our hospital, which is a private tertiary hospital, conducted the corporate social responsibility (CSR) project, "Save Doctors' Heart" from February 14 to October 31, 2022, for Thai physicians who aged between 35 and 70 years. This age range was selected because previous data have shown that the incidence of heart disease and CVD mortality may have started to rise since middle adulthood[21].

This retrospective cross-sectional study collected data of the physicians who participated in the CSR project of the hospital. Ethical approval for this study (COA-MPIRB 001/2023) was provided by the Institutional Review Board of the hospital on 30 May 2023. Informed consent from the participants was waived due to being a retrospective study. The study was registered to the Thai Clinical Trials Registry (TCTR20230830003). This work has been reported in line with the STROCSS criteria[22].

Inclusion criteria were the physicians who had had complete data on components of MetS which included waist circumference or body mass index (BMI), blood pressure, FBS, triglycerides, and HDL, and had sufficient data of cardiac testing for a confirmation of CAD diagnosis. In brief, cardiac testing included non-invasive testing [chest X-ray, 12-lead electrocardiogram, coronary artery calcium (CAC) scanning, exercise stress tests and/or echocardiogram or stress echocardiogram] and invasive testing [computed tomography angiography (CCTA) or coronary angiogram (CAG)]. The diagnosis of CAD was established based on evidence of luminal stenosis observed from CCTA or CAG according to the Society of Cardiovascular Computed Tomography (SCCT)[23] and/or definite findings from non-invasive cardiac testing, with or without personal history of CAD. The CVDs, which referred to any disorders of the heart or its vessels, were determined based on their presence obtained from the non-invasive cardiac testing including chest X-ray (cardiac lesions), EKG, exercise stress tests, echocardiogram, stress echocardiogram, and invasive cardiac testing of CCTA or CAG.

Data were retrieved from the electronic database of the hospital between 1 June and 10 July 2023. Collected data included age, gender, smoking, fibre diet, exercise habit, BMI, blood pressure, FBS, triglyceride, HDL, history of medications (for hypertension, diabetes mellitus, or dyslipidemia), and the presence of CAD. The diagnosis of CAD was made on evidence of luminal stenosis observed from CCTA and/ or CAG and/or definite findings from non-invasive cardiac testing. Various cardiac testing to assess CVDs and CAD were described in our other work focusing on CVDs/ CAD which was presented in detail elsewhere.

The diagnosis of MetS was made using the IDF and AHA/ NHLBI harmonized criteria disregarding the pre-requisite of central obesity[8] which were consistent with the NCEP/ ATP III criteria[5]. Three out of 5 of the following features had to be met: waist circumference of greater than or equal to 80 cm in female and greater than or equal to 90 cm in male or BMI greater than 30 kg/m^2, elevated triglycerides greater than 150 mg/dl or reduced HDL-cholesterol less than 40 mg/dl in males or less than 50 mg/dl in females, high blood pressure as systolic blood pressure greater than or equal to 130 or diastolic blood pressure greater than or equal to 80 mm Hg using the same digital machine assessed at least 15 minutes after resting in the sitting position, FBS greater than 100 mg/dl, or any specific treatment for lipid abnormality, previously diagnosed hypertension or type 2 DM. We used BMI greater than 30 kg/m^2 representing central obesity according to the International Diabetes Federation (IDF)[7] instead of waist circumference which was not available in our data archive.

Data were analyzed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corporation). Continuous variables were presented as mean ± SD for normally distributed data or median and ranges for non-normally distributed data. Categorical variables were presented as frequency and percentage. We utilized continuous data, including age, BMI, systolic blood pressure, FBS, triglyceride levels, and HDL levels, to evaluate the magnitude of their respective risks associated with MetS. Other features were categorized as the followings: sex as male or female, fibre diet as moderate/ high or none/ low, exercise greater than 3 days/ week or less, and smoking as yes/ ever smoking or no. Missing clinical data were presented as such, with presentation of only available data.

A univariate analysis was performed to identify factors that were associated with MetS. Multivariate analysis to explore independent risk factors of MetS was further conducted including factors identified from univariable analysis having *P* value less than 0.2 (in order not to leave out or excluded important clinical features for MetS). The risk of CAD according to each component of MetS was also studied. A *P* value less than 0.05 was considered statistically significant.

Results

A total of 1194 physicians who had adequate data, particularly the indicators of MetS, were included in this study. The median age was 45 years (IQR 40,56 years), with 68.1% were greater than 40 years. Slightly more than half were female (54.9%). Various numbers of physicians had available data of fibre diet, exercise, or smoking. Table 1 shows characteristic features of physicians.

Our study found nearly one-third or slightly over one-fourth of the physicians had high blood pressure and high blood sugar, respectively. High level of triglycerides or low HDL was found in slightly over 10%. A diagnosis of CAD was found in 11.4% based on various cardiac testing, as detailed in our work focusing on cardiovascular disorders, which would be presented elsewhere. Table 2 provides an overview of health findings of the physicians in this study. Out of 1194 physicians, 106 (8.9%) were determined to have MetS. The three most common components were high blood sugar, high blood pressure and high triglycerides (Table 2).

We conducted univariate analysis to examine various features of physicians which may be associated with MetS. Among these, male gender was found to have the highest risk for MetS (five-fold increased risk). Increasing age, systolic blood pressure, BMI, FBS, and triglyceride levels exhibited a slight increase in the risk of MetS with each incremental value. Conversely, higher levels of HDL were identified as a protective feature, with a decreased risk by 0.88-fold for each elevated unit of HDL. By multivariate analysis, the independent risk features were age, systolic blood pressure, BMI, FBS, and triglycerides (Table 3).

To evaluate the association of MetS and CAD, we conducted a univariate analysis and demonstrated all components of MetS and MetS itself were significantly associated with CAD. The highest risk feature was MetS itself, with a CAD prevalence of 47.2% among individuals with MetS compared to 7.9% among those without MetS. The odds ratio (OR) for CAD in individuals with MetS was 10.40: 95% CI, 6.70–16.16%, $P < 0.001$).

When examining each component of MetS individually (Table 4), the following features in order of their risks (ORs) for CAD were: high blood pressure (OR 5.37), high FBS levels (OR 3.59), high triglyceride levels (OR 3.52), obesity (OR 2.34), and low HDL levels (OR 2.29). By multivariate analysis, the components of MetS which were independently associated with CAD were high blood pressure [adjusted OR (Aor) 3.94], high triglycerides (aOR 2.18), and high FBS (aOR 2.13).

Table 1

Basic characteristic features of the physicians

Characteristic features and health habits	*n* (%)
Age, years (*N* = 1194)	
≤ 40	381 (31.9)
> 40	813 (68.1)
Sex (*N* = 1194)	
Female	655 (54.9)
Male	539 (45.1)
Fibre diet (*N* = 709)	
Moderate to high	573 (80.8)
None to low	136 (19.2)
Exercise, days/week (*N* = 1153)	
≥ 3	343 (29.7)
1–2	566 (49.1)
None	244 (21.2)
Smoking (*N* = 1153)	
No	1145 (99.3)
Yes	8 (0.7)

Table 2

Health findings of the physicians

Health findings	All physicians *N* = 1194 (%[a]), *N* (%)	Physicians with metabolic syndrome *N* = 106 (%[b]), *N* (%)
Obesity		
No	1140 (95.5)	73 (68.9)
Yes	54 (4.5)	33 (31.1)
Blood pressure		
Normal	829 (69.4)	17 (16.0)
High	365 (30.6)	89 (84.0)
Blood sugar		
Normal	876 (73.4)	16 (15.1)
High	318 (26.6)	90 (84.9)
Triglycerides		
Normal	1042 (87.3)	34 (32.1)
High	152 (12.7)	72 (67.9)
High-density lipoprotein		
Normal	1031 (86.3)	44 (41.5)
Low	163 (13.7)	62 (58.5)
Coronary artery disease		
No	1058 (88.6)	56 (52.8)
Yes	136 (11.4)	50 (47.2)

Obesity if body mass index > 30 kg/m^2; high blood pressure if systolic blood pressure > 130 mmHg or diastolic blood pressure > 85 mmHg; high blood sugar if level > 100 mg/dl; high triglycerides if level > 150 mg/dl; and low high-density lipoprotein if level <40 mg/dl in males or <50 mg/dl in females. Any specific treatment for hypertension, DM, or lipid abnormality was considered as having such abnormality.

DM, diabetes mellitus

[a]Percentage among all physicians.

[b]Percentage among the physicians who had metabolic syndrome.

Discussion

Our study, focusing on Thai physicians, found a relatively low prevalence of MetS at 8.9% which was quite low compared to 18–39% reported from other studies from different Asian countries that employed the ATP III criteria (Table 5)[18,19,24,25]. For instance, studies in India and Bangladesh reported prevalence rates of 38% and 39% MetS among physicians[19,24,25], 23% in another study conducted in Thailand[20], and only 18% from a large study from Taiwan[18].

In addition to the ethnicity and geographic location, the variation in the prevalence of MetS across studies can also be attributed to the number, characteristics, and proportions of individuals with risk factors within each population. To facilitate comparison, we analyzed the percentages of MetS components in our study and other previous studies focusing on physicians in Asia (Table 5). The physicians in our study had lower frequency of each MetS component compared to those found in other studies[18,19,24,25]. Using BMI greater than 30 kg/m^2 as the cut-off

Table 3

Metabolic syndrome by characteristic features of the physicians

	Metabolic syndrome value (IQR) or *n* (%)					
Features, median (IQR) or *n*	**No**	**Yes**	**Crude OR (95% CI)**	***P***	**Adjusted OR (95% CI)**	***P***
Age, 45 (40,56) years	44 (39,55)	58 (46,64)	1.08 (1.058–1.099)	< 0.001	1.12 (1.083–1.158)	< 0.001
SBP, 117 (107,129) mmHg	116 (106, 127)	132 (118.5, 143.0)	1.05 (1.039–1.065)	< 0.001	1.02 (1.003–1.041)	0.026
BMI, 22.8 (20.2,25.4) Kg/m^2	22.5 (20.3, 24.9)	24.5 (21.7, 27.1)	1.36 (1.285–1.441)	< 0.001	1.35 (1.239–1.473)	< 0.001
FBS, 94 (89,100) mg/dl	93 (88, 98)	106.5 (101.3, 121.8)	1.00 (1.001–1.004)	< 0.001	1.01 (1.004–1.011)	< 0.001
Triglycerides, 80 (59, 117) mg/dl	75 (57, 107)	174 (130, 228.8)	1.02 (1.017–1.024)	< 0.001	1.01 (1.008–1.017)	< 0.001
HDL, 59 (49,71) mg/dl	61 (51,73)	42.5 (37.3, 47)	0.88 (0.853–0.898)	< 0.001	0.91 (0.878–0.947)	< 0.001
Sex, *N* = 1194						
Female (655)	632 (96.5)	23 (3.5)	1	< 0.001	1	0.802
Male (539)	456 (84.6)	83 (15.4)	5.00 (3.103–8.061)	—	0.92 (0.461–1.818)	—
Fibre diet, *N* = 709						
Moderate/ high (573)	525 (91.6)	48 (8.4)	1	0.866	NA	
None/ low (136)	124 (91.2)	12 (8.8)	1.06 (0.546–2.052)	—	—	—
Exercise (day/week), *N* = 1153						
≥ 3 (343)	314 (91.5)	29 (8.5)	1	0.917	NA	—
≤ 2 (810)	740 (91.4)	70 (8.6)	1.02 (0.651–1.610)	—	—	—
Smoking level, *N* = 1153						
No (1145)	1048 (91.5)	97 (8.5)	1	0.145	NA	—
Yes (8)	6 (75.0)	2 (25.0)	3.60 (0.717–18.085)	—	—	—

BMI, body mass index; FBS, fasting blood sugar; metabolic syndrome; HDL, high-density lipoprotein; IQR, interquartile range; NA, not applicable; OR, odds ratio; SBP, systolic blood pressure.

value for obesity was probably too high for Thai population, who had smaller body built and different cultural habit of diet (non-butter or low dairy products) and might have led to low percentage of obesity in our study. Some suggested a lower cut-off for obesity in certain ethnic groups[26]. Further study focusing on the level of obesity in Asian population for a diagnosis of MetS should be carried out.

Our study identified high blood sugar, high blood pressure and high triglycerides as the 3 most common abnormal components of MetS. Other studies reported high blood pressure, high waist circumference, and low HDL as the most common components whereas high blood sugar as the least common component of MetS[18,19]. Different findings across studies could be attributed to the participant characteristics, such as age, sex, work patterns, physical activity levels, diet and exercise. It is plausible that the nature of physicians' work, which often involves sedentary activities, puts them at higher risk of developing MetS. For instance, a study conducted in Taiwan that examined MetS prevalence among hospital personnel reported an overall prevalence of 12%, with physicians exhibiting the highest prevalence of 18%, while the prevalence among nurses was the lowest (exact figures not shown)[18]. These findings highlight the complex

Table 4

Coronary artery disease according to metabolic syndrome and each of its component (N = 1194)

		Coronary artery disease					
Features	***N***	**No, *n* (%)**	**Yes, *n* (%)**	**Crude odds ratio (95% CI)**	***P***	**Adjusted odds ratio (95% CI)**	***P***
BMI							
≤ 30	1140	1016 (89.1)	124 (10.9)	1	—	1	—
> 30	54	42 (77.8)	12 (22.2)	2.34 (1.200–4.566)	0.010	1.06 (0.516–2.182)	0.872
Blood pressure							
Normal	829	782 (94.3)	47 (5.7)	1	—	1	—
High	365	276 (75.6)	89 (24.4)	5.37 (3.672–7.839)	< 0.001	3.94 (2.638–5.886)	< 0.001
Fasting blood glucose							
Normal	876	811 (92.6)	65 (7.4)	1	—	1	—
High	318	247 (77.7)	71 (22.3)	3.59 (2.489–5.168)	< 0.001	2.13 (1.436–3.172)	< 0.001
Triglycerides							
Normal	1042	946 (90.8)	96 (9.2)	1	—	1	—
High	152	112 (73.7)	40 (26.3)	3.52 (2.318–5.344)	< 0.001	2.18 (1.368–3.485)	0.001
HDL							
Normal	1031	928 (90.0)	103 (10.0)	1	—	1	—
Low	163	130 (79.8)	33 (20.2)	2.29 (1.483–3.526)	< 0.001	1.26 (0.772–2.065)	0.352
Metabolic syndrome by ATP III							
No	1088	1002 (92.1)	86 (7.9)	1	—	—	—
Yes	106	56 (52.8)	50 (47.2)	10.4093 (6.697–16.159)	< 0.001	—	—

ATP III, Adult Treatment Panel III; HDL, high-density lipoprotein.

Table 5

Components of metabolic syndrome in our study and previous Asian studies

Components of metabolic syndrome (% of each feature among all participants)	Prevalence of metabolic syndrome by first author of the study, year[ref]				
	Yeh *et al.*, 2018[18] (Taiwan) (18.3%) $N=1608$	Manjareeka *et al.*, 2018[24] (India) (37.7%) $N=170$	Baul *et al.*, 2019[25] (Bangladesh) (38.8%) $N=500$	Awal, 2021[19] (Bangladesh) (39.2%) $N=255$	Our study (Thailand) (8.3%) $N=1194$
High blood pressure, %	29.6	75.0	52	40.0	30.6
Obesity, %	36.8	24.1	63	60.0	4.5
High fasting blood sugar, %	13.3	25.3	28	17.6	26.6
High triglycerides, %	18.8	29.4	38	51.8	12.7
Low high- density lipoprotein, %	30.5	38.8	56	71.8	13.7

interplay of various factors influencing the prevalence and composition of MetS components within different populations and professional groups.

Previous studies have reported inconsistent findings regarding the association of age and gender with MetS. In our study, we observed a five-fold higher prevalence of MetS in males compared to females; this was higher than 1.5–3.7 folds of MetS in males reported in previous studies[19,20,24,25]. In contrast, one study found slightly higher MetS prevalence in female (41%) compared to male physicians (39%)[19]. Inconsistent data of age group and MetS were also found, with one study reporting higher MetS in physicians over 40 years (50% vs. 25%), whereas another study found higher rates in younger age groups (40% in ≤ 40 years vs. 34% in older age)[25]. These discrepancies highlight the need for further research to better understand the relationship between age and sex, with MetS among physicians.

Aside from gender, other features were analyzed as continuous data to determine the extent to which they contributed to the development of MetS. From our analyses, BMI had the highest risk of 1.35-fold for MetS. Other features exhibited slightly increased risks, while HDL levels showed a decreased risk. It is crucial to emphasize that the magnitude of these changes was based on the impact of each unit increase or decrease in the respective feature. Therefore, it is important not to overlook the significance of these seemingly small figures, as they can have meaningful implications in the development and management of MetS.

A large body of evidence have shown that unhealthy dietary habits, sedentary lifestyles, lack of physical activity or exercise can lead to obesity, hypertension, dyslipidemia, insulin resistance or diabetes mellitus which are the MetS components[11,14,27,28]. However, we did not find any associations of exercise or fibre diet and MetS as well as any of MetS components. This lack of association may be attributed to the lack of detailed data on these specific health habits. Consequently, the potential associations, if they exist, could not be adequately demonstrated. Further research with comprehensive data collection on exercise and dietary habits is warranted to explore their potential impact on MetS and its components.

Regarding the association of MetS and CAD, we found a significant association of MetS and CAD. Although the prevalence of CAD among the physicians with MetS was 47.2% which was lower than 61% reported among Indian population[28], the 10-fold higher risk of CAD among our affected physicians was much higher than the 2- fold increased risk of CVD compared to those without MetS reported in one study in Thailand among the hospital personnel[20]. Each of the MetS components as well as its predisposing factors as the risk of CAD are well-recognized[17]. Their association with CAD were discussed in detail in our other work focusing on CAD and would not be discussed here in detail.

Our study had some limitations. Firstly, as a retrospective study relying on data collected from a survey project, we utilized BMI greater than 30 kg/m^2 instead of waist circumference which is widely accepted as an indicator of central obesity[7]. Secondly, our study lacked information on other heart diseases, especially left ventricular hypertrophy as well as other organs damage (stroke, macrovascular and microvascular system e.g. renal vessels) as the sequalae of MetS[17,29]. Lastly, we had limited information to only exercise frequency and the relative amount of fibre diet with a lack of data on physical activity levels, the intensity of exercise, and other dietary patterns. Consequently, these limited information might have hindered our ability to establish their clear associations with MetS.

Nonetheless, our study had several strengths. Firstly, it stands as the pioneering research focusing on Thai physicians regarding the prevalence of MetS and its correlation with CAD. With a substantial dataset encompassing over 1000 physicians, our study provided informative data that is relevant to various stakeholders, including the physicians themselves. Secondly, the data concerning CAD had been validated through multiple cardiac testing procedures. Data on the prevalence of MetS (as well as each of its components) and the associated risk of CAD should raise awareness among Thai physicians regarding these health disorders. This, in turn, should prompt them to adopt and maintain a healthy lifestyle or make necessary modifications to unhealthy habits in order to proactively prevent these conditions.

In conclusion, the study found 8.9% prevalence of MetS among Thai physicians. Increasing age, systolic blood pressure, BMI, FBS, triglyceride, were identified as independent risk factors of MetS. The prevalence of CAD was 11.4%, which was 10 folds higher among the physicians affected with MetS compared to the physicians without (47.2% vs. 7.9%). The three components of MetS which were independent risk features for CAD were high blood pressure, high blood sugar, and high triglycerides. Further research should be expanded to study other target organs damage aside from CAD to have more data about the unfavourable impact of MetS. Moreover, details of other health features, such level of physical activity, exercise, and other dietary patterns should be explored to emphasize preventive behaviours to reduce the risk of MetS.

Our data should alert a precaution for physicians to minimize the risk of developing MetS. Adjustment to lifestyles and health habits to decrease the risk factors that contribute to MetS that is elevated blood pressure, high blood sugar, lipid levels, and especially excess body weight is recommended. Individuals already affected with MetS should also be vigilant regarding the potential consequences of CAD.

Ethical approval

The study had an approval from the Institutional Review Board (COA-MPIRB 001/2023).

Consent

Informed consent from the participants was waived by the Institutional Review Board of MedPark Hospital due to the retrospective nature of the study.

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Author contribution

S.T.: conceptualization, funding acquisition, investigation, methodology, supervision, validation; W.U.: conceptualization, investigation, supervision; P.P., W.K., and C.W.: data curation; S.T. and N.A.: formal analysis; S.T. and W.K.: writing original draft, reviewing and editing the manuscript; All authors: reviewing, editing, and approval the final version of the manuscript.

Conflicts of interest disclosure

All authors had no conflict of interest to declare.

Research registration unique identifying number

The study was registered to the Thai Clinical Trials Registry (TCTR20230830003) Link: https://www.thaiclinicaltrials.org/show/TCTR20230830003.

Guarantor

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Data availability statement

All data generated and analyzed during the current study will be available from the corresponding author upon reasonable request.

Provenance and peer review

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