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Cardiovascular risk factors and 10-year CV risk scores in adults aged 30-70 years old in Amnat Charoen Province, Thailand

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Abstract

Cardiovascular disease (CVD) is the number one cause of death globally. Over three quarters of CVD events take place in low-and middle-income countries, and the CVD rate in Thailand is higher relative to other Asian countries at 32.3 percent. This research aimed to examine Thai Cardiovascular (CV) risk scores in a population aged 30-70 years old residing in Amnat Charoen Province, a northeastern province of Thailand. This cross-sectional study used sampling conducted by probability proportional to size, with 382 participants from 2 of Amnat Charoen's 7 districts. Data were collected using anthropometric measurement, blood tests, and face-to-face interviews. At baseline, the mean Thai CV risk scores were at a low level (6.1 ± SD 5.5%). The research illustrated that 83.0 percent of the participants had low CV risk scores, while 17.0 percent had high CV risk scores. Logistic regression analysis illustrated that the significant predictors of CV risk scores were age (Odds Ratio (OR) 81.74; 95% Confidence Interval (CI) 28.65-233.18), systolic blood pressure (SBP) (OR, 5.90; 95% CI 2.28-15.29), smoking status (OR, 4.12; 95% CI 1.15-14.69), average time to fall sleep at night (OR, 2.81; 95% CI 1.17-7.09), and participation in health activities (OR, 3.89; 95% CI 1.62-9.36). The findings of this research imply that certain behaviors could contribute to CVD events. Therefore, it is recommended that these results be applied toward creating guidelines for emphasizing therapeutic healthy lifestyles and establishing appropriate interventions or health education programs to raise knowledge about and awareness of CVD events among Thai adults.

Keywords: Thai CV risk score, Adults, Amnat Charoen, Thailand

1. Introduction

Cardiovascular disease (CVD) is the first leading cause of death worldwide [1]. The proportion of deaths caused by CVD has increased sharply from 12.8 percent in 1957 to 35.8 percent in 1990 [2]. In 2016, the prevalence of CVD mortality was 31 percent [1]. Of these deaths, over three quarters took place in low-and middle-income countries [1], and CVDs are expected to account for seven out of every 10 deaths in developing countries by 2020 [2]. In the Asia-Pacific region, CVDs range from less than 20 percent in the Philippines and Indonesia to 20-30 percent in urban mainland China, Hong Kong, and Japan [2]. Meanwhile, the proportion of CVD-related deaths in Thailand is relatively higher than in other Asian countries, at 32.3 percent [3]. Furthermore, certain types of CVDs, such as stroke and ischemic heart disease (IHD), have been among the top ten disease burdens for the Thai population for the past 15 years [4].

Several models for predicting CVD risk, such as Framingham risk models [5] that use data from the United States and the QRISK2 [6] that uses data from the United Kingdom, have been applied toward estimating a patient's 10-year risk of developing a cardiovascular disease according to certain known risk factors [7]. These models are recommended as equations that produce a single risk score for healthcare personnel and enable selection of suitable tools for further prediction of CVD incidence in Western populations. However, the models have not had the same degree of success in validating CVD events in certain populations. In Thailand, the Thai

CV risk score is a similar tool developed to estimate a 10-year CV risk prediction using a large general practice database [8]. The score includes traditional risk factors, such as age, sex, systolic blood pressure (SBP), total cholesterol levels, smoking status, and presence of diabetes [9]. All continuous risk factors are carefully evaluated and have remained continuous throughout the model-building process. Categorical risk factors have been validated to model non-linear risk associations where appropriate [9].

The Thai CV risk score is useful in estimating 10-year incidence of myocardial infarction, as well as fatal and non-fatal stroke in the Thai population. The technical details of the Thai CV risk score can be found on the website *Thai CV risk score*. The Thai CV risk score model was initially used among populations in Bangkok in the central region of Thailand but requires further external validation [8,10]. Populations in other regions of Thailand have not yet been subjected to the model in order to investigate and evaluate its applicability. To answer the need for this research, this study aims to examine Thai CV risk scores in a population aged 30-70 years in Amnat Charoen Province, a low-income province in the northeastern region of Thailand where CVD events are among the top five disease burdens [11].

2. Materials and methods

2.1 Study design

This cross-sectional study was conducted in Amnat Charoen Province, a low-income province located in the northeastern region of Thailand. The province is located approximately 585 km from the capital, Bangkok [12]. The total population aged 35-70 years is 155,599 people [13]. Amnat Charoen Province has 7 districts and 56 sub-districts. Two of the seven districts, Lueamnat and Chanuman, were randomly selected to serve as the study area. The sample size estimation was calculated using a single finite population correction factor [14].
The following formula was employed:

$$N = \frac{Z^2 P(1-P)}{d^2} \quad (1)$$

Proportion of CVDs was determined using the nationwide prevalence of CVDs, 32.3 percent [3]. Precision was set at 5 percent for the 95-percent confidence interval (95% CI). The sample required 336 participants. To allow for an approximate 20-percent non-response rate, the final sample size was set at 403 subjects. The participant selection criteria included people aged between 35 years and 70 years who were able to communicate orally in Thai and who resided in the study area at the time of data collection. Twenty-one participants with known CVDs (including myocardial infarction, angina coronary, heart disease, stroke, and transient ischemic stroke) were excluded. In all, 382 participants participated in this research with a response rate of 94.7 percent. Two-stage stratified sampling was used to recruit research subjects. In the first stage, two districts were chosen using simple random sampling. In the second stage, probability proportion to size (PPS) was applied and participants from 18 villages located in the two chosen districts were recruited into the research. One eligible participant was chosen per household to rank well-being and to identify broad indicators of household vulnerability. Participants from each village ranged from 18 to 25 people.

2.2 Questionnaires

Research instruments consisted of structured questionnaires and clinical measurements.

Baseline characteristics collected included age, sex, body mass index (BMI), current diabetes mellitus treatments, current anti-hypertensive treatments, education, monthly income, smoking status, alcohol consumption levels, exercise habits, average time to fall asleep at night, snoring habits, use of any sleep medication, and participation in health activities.

Education and Monthly Income-Education was measured as ≤ primary school, secondary school and ≥ diploma/degree. Monthly income was measured as a continuous variable.

Smoking Status and Alcohol Consumption Levels - In this research, a non/never-smoker refers to an individual who had never smoked cigarettes in their lifetime or had smoked less than 100 hand-rolled cigarettes, brand-name cigarettes, pipes, cigars, etc. A current smoker refers to either a daily smoker who currently smoked hand-rolled cigarettes, brand-name cigarettes, pipes, cigars, etc. at least once a day or a continuing occasional smoker who did not smoke daily, but had smoked 100 or more cigarettes throughout their lifetime and had smoked within the last 28 d [15]. A non/never-drinker refers to a lifetime abstainer who had never drank beer, wine, or hard liquor. A current drinker refers to a participant who currently drank beer, wine, or hard liquor at the rate of up to one drink daily for women and up to two drinks daily for men [16]. There were a few cases of former smokers and former drinkers in this research. Such cases were included with the non/never-smokers and non/never-drinkers, respectively.

Exercise was measured as <30 min/d and ≥30 min/d during the week previous to data collection [17].

Sleep quality was evaluated using the following questions: 1) "How long (in minutes) does it take you to fall asleep at night?" 2) "How often did you snore during the past month?" and 3) "How often did you use sleep medication during the past month?"

Participation in health activities, such as participation in disease prevention campaigns, was measured as never and within the past six months.

Anthropometric and Blood Pressure (BP) Measurements and Blood Tests - BMI was evaluated based on body weight in kilograms divided by body height in square meters, where measurements within a range of 18.5-22.9 kg/m^2 were considered as normal; 23.0-24.9 kg/m^2 as overweight; and ≥ 25 kg/m^2 as obese [18]. Current smokers were asked to refrain from smoking cigarettes for 30 min before BP measurement. Blood pressure was measured by the principal investigators twice after 15 min of rest. The measurement was conducted using a pre-calibrated Omron HEM 7310 digital sphygmomanometer (Omron Corporation, Kyoto, Japan). The second BP measurement took place at least 15 min after the first. The appropriate bladder size (a standard cuff with 12.5 cm bladder or a large adult cuff with 15.5 cm bladder for obese subjects) was placed around the right arm while participants were seated. Systolic and diastolic blood pressure (DBP) measurements were calculated based on the average of the first and second measurements. A diastolic BP ≥85 and a systolic BP ≥130 mm/Hg were considered to be elevated BP. Panel blood tests were conducted, for which blood samples were drawn by five trained registered nurses after participants had fasted for 10-12 h [19]. Two point five milliliter-samples were used for fasting plasma glucose (FPG) measurements and 2.5 ml-samples were used for lipid profiles. FPG was measured using the Hexokinase mediated reaction roche/Hitachi modular P chemistry analyzer method [20]. Triglyceride level (TG) was measured using the automated enzymatic method [19], and high-density lipoprotein cholesterol level (HDL-C) was measured using the automated direct method [19]. The blood samples were stored in a closed and sterile system at 2-8 ˚C to avoid contamination before delivery to the central laboratory in Ubon Ratchathani Province and were processed on the same day for further analysis.

CVD Risk Prediction Tools

The Thai CV risk score is a 10-year prediction of risk for CVDs and a composite of myocardial infarction and fatal and non-fatal stroke. Scores were assessed using the WHO/ISH risk prediction chart for SEAR B, 2007 (Thai version) [9], ranging from <10% (low risk) to ≥10% (high risk). The chart-based guidelines for assessment of cardiovascular risk included age, sex, smoking status, diabetes history, systolic blood pressure, waist circumference, and height. The chart-based categorization was appropriated for the purpose of CV risk prediction in the Thai population. The receiver operating characteristic curve (ROC) (area under the ROC curve: AUC) was 0.72 in men and 0.85 in women.

2.3 Data Collection

The principal investigators and five registered nurses were trained in standard procedures before collecting data. Data collection was conducted between October and December 2017 after written informed consent had been obtained. Interviews were followed by anthropometric and BP measurements, blood samples/testing, and completion of structured questionnaires through face-to-face interviews.

2.4 Data Analysis and Ethical approval

Descriptive statistics, such as mean, standard deviation (SD), and percentage, were used to describe all variables. The Chi-Squared test for categorical data was used. The absence of multicollinearity was determined according to the magnitude of the standard error (SE), where SEs in this research hovered around 0.01-0.04[21]. Factors associated with CV risk scores were examined using 3 models. Univariate analysis (crude odds ratio) was carried out on all predictors in the study. Multivariate analyses, Model I, were carried out on general characteristics and anthropometric measurements. All variables were adjusted and re-evaluated in Model II. The results were explained using odds ratios (OR) with a 95% confidence interval. Statistical significance was set at $p \leq 0.05$. Data entry and clearance were performed using Stata for Windows 12.0. Research protocol was approved by the Ethics Review Committee of Amnat Charoen Provincial Hospital (No.05-2017, September 28, 2017).

3. Results

3.1 Baseline Characteristics of Participants

Table 1 describes the anthropometric and socio-economic characteristics of the 382 participants. At baseline, the mean Thai CV risk score was at a low level (6.1 ± SD 5.5%). The participants had 10-year CV risk scores ranging from 0.6 to 28.7 percent. The mean age of the participants was 51.5 ± SD 8.7 years. Mean BMI was higher

than the standard at 24.6 kg/m^2. The means for SBP, DBP, HDL-C, and FPG were within normal ranges. Meanwhile, TG levels were high (170.3 ± SD 145.1 mg/dl). Baseline characteristics are shown in Table 2. One point three percent of the participants were receiving treatment for diabetes and 5.2 percent were receiving anti-hypertensive treatments. The majority (73.8%) of the participants had completed primary school. Eleven point three percent of participants smoked cigarettes. The proportion of current drinkers was 46.3 percent. Thirty-four point three percent of the participants exercised ≥30 min/d. Thirty-six point one percent of participants spent an average of more than 15 min to fall asleep at night. Twenty-five point nine percent of the participants had snored ≥1 time overnight during the previous week and 4.2 percent of them had used sleep medication ≥1 time/week. Thirty point four percent of participants had never participated in health activities such as disease prevention campaigns.

Table 1 Anthropometric and socio-economic characteristics of the 382 participants aged 35-70 years old.

Variables	Mean	SD
Thai CV Risk Score[1]	6.1	5.5
Range 0.6 - 28.7 %		
Age (years)	51.5	8.7
Body Mass Index, kg/m^2	24.6	4.2
Systolic Blood Pressure, mmHg	123.2	14.2
Diastolic Blood Pressure, mmHg	76.8	11.2
HDL-C[2], mg/dl	50.1	13.4
Triglyceride, mg/dl	170.3	145.1
Fasting Plasma Glucose, mg/dl	86.5	21.7
Income (baht)	4,286	6,026

Data are expressed as mean ± SD

[1]Thai CV risk scores: <10% = low risk; ≥10% = high risk; [2]HDL-C, High-density lipoprotein cholesterol.

Table 2 Baseline characteristics of the 382 participants aged 35-70 years old.

Variables	n	%
Receiving Diabetes Treatments		
No	377	98.7
Yes	5	1.3
Receiving Anti-Hypertensive Treatments		
No	362	94.8
Yes	20	5.2
Education		
Primary school	282	73.8
Secondary school	74	19.4
≥Diploma	26	6.8
Smoking Status		
Non/Never-Smoker	339	88.7
Current Smoker	43	11.3
Alcohol Consumption		
Non/Never-Drinker	205	53.7
Current Drinker	177	46.3
Exercise		
<30 min/d	251	65.7
≥30 min/d	131	34.3
Average time to Fall Asleep at Night		
≤15 min	244	63.9
>15 min	138	36.1
Snoring Habits		
<4 times/month	283	74.1
≥1 time/week	99	25.9
Use of Sleep Medication		
Not in the past month	366	95.8
≥1 time/week	16	4.2
Participation in Health Activities (e.g., disease prevention campaigns)		
Within the previous 6 months	266	69.6
Never	116	30.4

Data are expressed as n (%)

3.2 Thai CV Risk Prediction

In unadjusted analyses, age, sex, and all anthropometric factors excluding BMI were significantly associated with 10-year CV risk scores. Likewise, smoking status, snoring, and frequency of participation in health activities were significantly associated with Thai CV risk score predictions. Meanwhile, receiving anti-hypertensive treatments, alcohol consumption, exercise, average time to fall asleep at night, and use of sleep medication were not associated with 10-year CV risk scores [Table 3].

Table 3 Percentages of anthropometric and lifestyle characteristics of the 382 participants aged 35-70 years old associated with low and high Thai CV risk scores.

Variables	Total (n= 382)	Low risk (<10%) (n = 317)	High risk (≥10%) (n= 65)	p-value[1]
Age (years)				<0.001***
35-59	299	287 (96.0)	12 (4.0)	
≥60	83	30 (36.1)	53 (68.9)	
Sex				0.002**
Male	163	124 (76.1)	39 (23.9)	
Female	219	193 (88.1)	26 (11.9)	
Body Mass Index, kg/m^2				0.82
Normal (18.5-22.9)	148	123 (83.1)	25 (16.9)	
Overweight (23.0-24.9)	95	77 (81.1)	18 (18.9)	
Obese (≥ 25)	139	117 (84.2)	22 (15.8)	
Systolic Blood Pressure, mmHg				<0.001***
<130	265	233 (88.0)	32 (12.0)	
≥130	117	84 (71.8)	33 (28.2)	
HDL-C, mg/dl				0.02*
<40	76	56 (73.7)	20 (26.3)	
≥40	306	261 (85.3)	45 (14.7)	
Triglyceride Level, mg/dl				0.03*
<150	223	193 (86.6)	30 (13.4)	
≥150	159	124 (78.0)	35 (22.0)	
Fasting Plasma Glucose Level, mg/dl				0.009**
<100	332	282 (85.0)	50 (15.0)	
≥100	50	35 (70.0)	30 (30.0)	
Receiving Anti-Hypertensive Treatments				0.31
No	362	302 (83.4)	60 (16.6)	
Yes	20	15 (75.0)	5 (25.0)	
Smoking Status				0.01
Non/Never-Smoker	339	287 (84.7)	52 (15.3)	
Current Smoker	43	30 (69.8)	13 (30.2)	
Alcohol Consumption Habits				0.56
Non/never-drinker	205	168 (82.0)	37 (18.0)	
Current drinker	177	149 (84.2)	28 (15.8)	
Exercise Habits				0.71
<30 min/d	251	207 (82.5)	44 (17.5)	
≥30 min/d	131	110 (84.0)	21 (16.0)	
Average time to Fall Asleep at Night				0.19
≤15 min	244	208 (85.3)	36 (14.7)	
>15 min	138	109 (79.0)	29 (21.0)	
Snoring Habits				0.01*
<4 times/month	283	243 (85.9)	40 (14.1)	
≥1 time/week	99	74 (74.8)	25 (25.2)	
Use of Sleep Medication				0.12
Not in the past month	366	306 (83.6)	60 (16.4)	
≥1 time/week	16	11 (68.8)	5 (31.2)	
Participation in Health Activities (e.g., disease prevention campaigns)				<0.001***
Within the previous 6 months	266	236 (88.7)	30 (11.3)	
Never	116	81 (69.8)	35 (30.2)	

[1]p-value by chi-square; *p<0.05, **p<0.01, ***p<0.001

Table 4 indicates that the mean Thai CV risk score of participants with two or more chronic diseases was higher than that of participants who had no chronic disease (11.3 vs. 5.9%).

Table 4 Thai CV risk scores among participants grouped according to the presence of chronic diseases.

Variables	Mean ± SD
No. of Chronic Diseases	
None	5.9 ± 5.4
One	6.1 ± 4.7
Two or more	11.3 ± 3.0

3.3 Factors Associated with Thai CV Risk Scores

In the univariate analysis, 9 factors were found to be significant to CV risk scores: age (OR,42.25; 95% CI 20.35-87.75), being female (OR, 0.43; 95% CI 0.25-0.74), SBP (OR, 2.86; 95% CI 1.66-4.94), HDL-C (OR, 0.48; 95% CI 0.26-0.88), TG (OR, 1.82; 95% CI 1.06-3.11), FPG (OR, 2.42; 95% CI 1.23-4.75), smoking status (OR, 2.39; 95% CI 1.17-4.89), snoring habits (OR, 2.05; 95% CI 1.17-3.61), and participation in health activities (OR, 3.40; 95% CI 1.96-5.89).

To account for the possibility of confounding factors, multivariate analyses were conducted using 2 models. In Model I, the 3 significant factors were age (OR, 60.44; 95% CI 24.73-147.71), being female (OR, 0.42; 95% CI 0.19-0.92), and SBP (OR, 4.58; 95% CI 1.97-10.67). The Hosmer-Lemeshow goodness of fit test indicated that the data fit the model (p = 0.66) [21].

In Model II, the 5 significant factors were age (OR, 81.74; 95% CI 28.65-233.18), SBP (OR, 5.90; 95% CI 2.28-15.29), smoking status (OR, 4.12; 95% CI 1.15-14.69), average time to fall sleep at night (OR, 2.81; 95% CI 1.17-7.09), and participation in health activities (OR, 3.89; 95% CI 1.62-9.36). The Hosmer-Lemeshow goodness of fit test indicated a good fit (p = 0.77) [Table 5].

Table 5 Multiple logistic regression analysis for cardiovascular disease estimation among a population aged 35-70 years old.

Variables	Crude	Model I[1]	Model II[2]	p-value
	OR (95% CI)	aOR (95% CI)	aOR (95% CI)	
Age (years)				
35-59	1.00 (reference)	1.00 (reference)	1.00 (reference)	
≥60	42.25(20.35, 87.75)	60.44 (24.73, 147.71)	81.74 (28.65, 233.18)	<0.001***
Sex				
Male	1.00 (reference)	1.00 (reference)	1.00 (reference)	
Female	0.43 (0.25, 0.74)	0.42 (0.19, 0.92)	0.62 (0.23, 1.67)	0.34
Body Mass Index, kg/m^2				
Normal (18.5-22.9)	1.00 (reference)	1.00 (reference)	1.00 (reference)	
Overweight (23.0-24.9)	1.15 (0.59, 2.25)	1.60 (0.58, 4.41)	1.21 (0.40, 3.63)	0.74
Obese (≥ 25)	0.93 (0.49, 1.73)	2.05 (0.77, 5.45)	1.87 (0.62, 5.53)	2.67
Systolic Blood Pressure, mmHg				
<130	1.00 (reference)	1.00 (reference)	1.00 (reference)	
≥130	2.86 (1.66, 4.94)	4.58 (1.97, 10.67)	5.90 (2.28, 15.29)	<0.001***
HDL-C, mg/dl				
<40	1.00 (reference)	1.00 (reference)	1.00 (reference)	
≥40	0.48 (0.26, 0.88)	1.15 (0.43, 3.07)	0.95 (0.32, 2.83)	0.92
Triglyceride Level, mg/dl				
<150	1.00 (reference)	1.00 (reference)	1.00 (reference)	
≥150	1.82 (1.06, 3.11)	1.15 (0.49, 2.73)	1.30 (0.51, 3.33)	0.58
Fasting Plasma Glucose Level, mg/dl				
<100	1.00 (reference)	1.00 (reference)	1.00 (reference)	
≥100	2.42 (1.23, 4.75)	1.74 (0.61, 4.99)	1.72 (0.57, 5.22)	0.34
Receiving Anti-Hypertensive Treatments				
No				
Yes	1.00 (reference)	1.00 (reference)	1.00 (reference)	0.38
	1.68 (0.59, 4.79)	1.52 (0.31, 7.40)	2.20 (0.38, 12.76)	
Smoking Status				
Non/Never-Smoker	1.00 (reference)	-	1.00 (reference)	
Current Smoker	2.39 (1.17, 4.89)		4.12 (1.15, 14.69)	0.03*
Alcohol Consumption Habits				
Non/never-drinker	1.00 (reference)	-	1.00 (reference)	
Current drinker	0.85 (0.50, 1.46)		1.26 (0.50, 3.17)	0.62
Exercise Habits				
<30 min/d	1.00 (reference)	-	1.00 (reference)	
≥30 min/d	0.90 (0.51, 1.59)		1.26 (0.49, 3.21)	0.63

Variables	Crude	Model I[1]	Model II[2]	p-value
	OR (95% CI)	aOR (95% CI)	aOR (95% CI)	
Average time to Fall Asleep at Night				
≤15 min	1.00 (reference)	-	1.00 (reference)	
>15 min	1.54 (0.89, 2.64)		2.81 (1.17, 7.09)	0.03*
Snoring Habits				
<4 times/month	1.00 (reference)	-	1.00 (reference)	
≥1 time/week	2.05 (1.17, 3.61)		1.36 (0.51, 3.65)	0.54
Use of Sleep Medication				
Not in the past month	1.00 (reference)	-	1.00 (reference)	
≥1 time/week	2.32 (0.78, 6.91)		1.81 (0.20, 16.75)	0.60
Participation in Health Activities (e.g., disease prevention campaigns)		-		
Within the previous 6 months	1.00 (reference)		1.00 (reference)	
Never	3.40 (1.96, 5.89)		3.89 (1.62, 9.36)	0.002**

aOR, adjusted odds ratio; CI, confidence interval.
*p<0.05, **<0.01, and ***<0.001 were set for univariate analysis (Crude OR) and multivariate analyses (Models I and II).
The enter method was used for multivariate analysis in Model I and in Model II.
[1] Model I: adjusted for age, sex, body mass index, systolic blood pressure, high-density lipoprotein cholesterol (HDL-C), triglyceride level, fasting plasma glucose level, and receiving anti-hypertensive treatments.
[2] Model II: adjusted for all other variables in the model.

4. Discussion

Most CV risk scores used around the world estimate the risk of cardiovascular disease events occurring within 10 years. The Framingham risk score is regularly used in western countries. Meanwhile, several studies [6, 22] have reported that Framingham risk scores over-predict CHD incidence and are poorly calibrated for the end point of major CHD [6, 22]. In this research, Thai CV risk scores were obtained to identify the effectiveness of routine risk assessment for primary prevention of CVDs in the Thai population. The Thai CV risk score is expected to be more accurate for identifying CVD risk in Thailand relative to the original Framingham risk score. The Thai CV risk score was initially used in a study by the Electricity Generating Authority of Thailand (EGAT) [8], for which only a Bangkok population, in the central region of Thailand, was represented in the study sample. To the best of the researcher's knowledge, this study provides the first evidence validating the use of Thai CV risk scores in Amnat Charoen Province, Thailand, where CVD events cause enormous health expenditures and represent one of the top five disease burdens in the province [11].

Regarding CV risk score predictions in Asian countries, one study found that 98.5, 1.4, and 0.1 percent of Korean female participants were at low, moderate, and high risk for CHD, respectively [23]. A study conducted on 950 subjects at Ramathibodi Hospital, Bangkok, reported that 68.9, 27.7, and 3.4 percent of the participants had low, moderate, and high CV risk scores, respectively [10]. The present study yields data showing that 83.0 percent of participants had low CV risk scores, while 17.0 percent had moderately high CV risk scores. These findings indicate that the participants in the present study area are at greater risk of having a CVD event than those from which data were collected in the central region of Thailand. In the unadjusted analysis, age, sex, and SBP had a strong association with CV risk scores. This can be explained by associated geriatric change and executive dysfunction that result from aging and can affect physical activities, simultaneously leading to co-morbidities such as high BP. Similarly, HDL-C and FPG were shown to have a secular trend, as the prevalence of high CV risk scores was high in participants with low HDL-C levels (≤40 mg/dl), at 26.3 percent, and high FPG levels (≥100 mg/dl), at 30.0 percent. These findings are consistent with conclusions by the World Health Organization (WHO) [1] that lipid profiles and high FPG levels contribute to a risk of CVDs.

High CV risk scores were more common among current smokers. Furthermore, participants who had snored ≥1 time/week in the month previous to data collection were at significantly greater risk of having a CVD event than those who had snored <4 times in the previous month. This finding is consistent with the Women's Health Initiative Observational Study [24] conclusion that habitual snoring is a sign of obstructive sleep apnea (OSA) [25], which raises the risk of obesity, diabetes, hypertension, stroke, heart attack, and any type of cardiovascular disease [24-25]. Other risk groups identified among the participants included those who used sleep medication, which has been shown to potentially heighten risk for CVDs. This research found that participants who used sleep medication ≥1 time/week presented with CV risk scores approximately two times higher than participants who had not used sleep medication in the month prior to data collection (31.2 vs. 16.4%). Malhotra and Loscalzo [26] also found that sleep problems were associated with cardiovascular diseases, and obstructive sleep apnea has been definitively proven to be a cause of systematic hypertension [27] or increased likelihood of myocardial infarction [28], congestive heart failure [29], and stroke [30].

Thai CV risk scores were relatively high among participants who had two or more chronic diseases, such as hypertension (HT) and diabetes mellitus (DM). Participants who had two or more chronic diseases demonstrated a high risk (11.3%) of having a CVD event in the next 10 years. Kjeldsen [31] similarly showed that lifestyle and

chronic diseases, such as high BP and DM, are all intricately linked to CVDs. This finding is also consistent with a WHO report [1] warning that individuals at risk of CVDs may be overweight/obese and have high BP, lipid, and blood glucose levels. Diabetics are far more likely to develop CHD than non-diabetics, and CVD risk increases exponentially in overweight/obese people.

In the present research, core predictors such as age and SBP were strongly and significantly correlated with Thai CV risk scores. There is high prevalence of overweight and obese conditions in the Thai population, based on Asian weight cut-off points of 23-24.9 kg/m^2 for overweight and $\geq$25 kg/m^2 for obese [18]. In this research, overweight and obese people also had higher CV risk scores (18.9 vs. 15.8%). Obesity may have a higher correlation with sleep apnea than normal weight [30]. Multiple logistic regression analysis also predicted that the participants who had sleep problems, averaging longer than 15 min to fall asleep at night, would have a strong association with Thai CV risk scores. This indicates that sleep problems may contribute to CVD incidence [26, 28].

Although participation in health activities may help to increase knowledge and awareness of CVDs, there is a gap in previous research on this issue and its relation to CVDs. The present study reveals a strong association, where the predicted 10-year risk for CVDs increases fourfold among participants who never participated in health activities, such as volunteering for health campaigns, compared to those who often participate in health activities. This result may be attributed to participants who regularly participate in health activities being more likely to receive knowledge related to healthcare practices than those who never participate. Therefore, this finding should be highlighted and continued periodic risk assessment should be conducted. Individuals should collaborate based on their preferences in order to modify CVD risk factors.

According to this study's findings, the Thai CV risk score proves useful in predicting CVD diagnoses in individuals for whom the chances of developing certain types of CVDs, such as fatal and nonfatal stroke and myocardial infarction, increases with increasing CV risk scores. Hence, there is a need for CVD assessment among high risk populations in order to detect and reduce the cardiovascular risk distribution of the population in the next 10 years. From these results, participants with low CV risk scores are recommended and encouraged to maintain healthy lifestyles, such as keeping a healthy diet and regularly doing exercise. Those with high CV risk scores are encouraged to engage in discussions about possible lifestyle changes or primary prevention, may consider additional screening in order to prevent CVD events, etc. Statin therapy is one of the most important measures recommended for primary prevention in participants who are at high risk for further development of CVDs [32]. The strength of this research is that it reaffirmed the reliability of CV risk assessment using a large dataset in Thailand. There were some limitations, however. Firstly, the research was conducted in a single province and so results are not representative of the total Thai population. Secondly, as this was a cross-sectional study, there was a lack of casual relationship between predictive factors and Thai CV risk scores. Moreover, this research cannot provide an endpoint for CVD events. A cohort study may be effective in evaluating CVD events and conducting further analysis in the Thai population.

5. Conclusion

The mean Thai CV risk score was higher in participants who had two or more chronic diseases compared to those who had no chronic disease. In addition to the core predictive factors of CVD events, such as age and SBP, modifiable cardiovascular risk factors, namely, smoking status, average time to fall asleep at night, and participation in health activities, were significantly associated with CVDs. Therefore, CV risk scores should be evaluated regularly in the Thai population to emphasize therapeutic healthy lifestyles and to prevent further development of CVDs. This research implies that a lack of participation in health activities influences the estimation of 10-year risk for CVDs. Lack of participation in health activities has the potential to impact participants' lifestyle, leading to risky behaviors, such as smoking, alcohol consumption, and physical inactivity. It is recommended that this finding be used to guide healthcare providers in establishing appropriate interventions or health education programs that can build knowledge and raise awareness in order to reduce risks of CVD events among Thai adults.

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