Cardiovascular Risk Factors and 10-Year Risk for Coronary Heart Disease in Thai Adults

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Abstract- We evaluate cardiovascular risk factors (CVD) and 10-year risk for coronary heart disease (CHD) in Thai adults living in Bangkoknoi district. Total number of 194 subjects (51 M, 143 F) aged 35-59 years were enrolled into this study. Information on the martial status, education, occupation, living condition, physical activities, smoking, consumption and drinking habits as well as history of diseases were obtained through a questionnaire. Anthropometric and biochemical assessment were done at the beginning of the study. We estimated 10-yr risk of CHD by using Framingham Risk Score, and the proportions for three levels of 10-year risk were presented, the risk functions by gender, age group in account of level of blood pressure, serum lipids, diabetes and smoking status. There were significant differences between men and women for serum HDL-C, TG, BMI, %BF and WHR ($p<.05$). Women had higher mean age, TC, LDL-C, HDL-C, BMI, %BF and also higher prevalence of DM and hypertension whereas higher prevalence of smoking, drinking and physical inactivity found in men. The proportion of the participants with a 10-year risk for CVD of 10-20% and >20% increased with advancing age and was higher among men than women in our study. The prevalence and combination of CVD risk factors increased after the age of 46. These findings may provide useful information for public health planner to estimate CVD prevention cost and to monitor Thai adult population for preventing risk factors that could lead to CVD in the future.

Index Terms- Framingham Risk Score (FRS), cardiovascular risk factors (CVD), 10-yr coronary heart disease(CHD), prevalence, risk factor

I. INTRODUCTION

Cardiovascular diseases (CVD) causes an estimated 17 million deaths each year (1), accounting for one-third of all deaths worldwide. CVD prevention in Asia is an important issue for world health, because half of the world's population lives in Asia (2). The Seven Countries Study (3) in 1957 found that Japanese populations had lower fat intake (10%), lower serum total cholesterol, and lower CHD than populations in the United States and Scandinavia, in spite of higher smoking rates. This study analyzes the effect of health-risk factors such as demographics data, serum lipid, blood pressure and body mass index (BMI) on the prevalence of CVD as well as to determine reliability of the questionnaire in Thai middle-aged adults in Bangkoknoi district. The Framingham Risk Score was developed to estimate the 10-year risk of developing CHD (4) by a gender-specific algorithm (5, 6). The National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) (NCEP/ATP III) has incorporated the use of risk assessment to provide clinicians with guidelines to treat dyslipidemia (7). It is estimated that 80-90% of people dying from CHD have one or more major risk factors that are influenced by lifestyle (8). The major modifiable risk factors for the development of CHD include: hypertension, raised serum lipids, smoking, DM, high consumption of saturated fats, cholesterol, salt together with low intake of fruit and vegetable, decrease physical inactivity and obesity etc which may reverse downward trends in CVD mortality. In the face of the enormous public health burden imposed by CVD, risk assessment tools should be used to identify high- and low-risk people for preventive measure.

II. MATERIALS AND METHODS

1) Subjects

2) A total of 194 participants (51 males, 143 females) aged of 35-59 years, living in Bangkoknoi district agreed to take part in a cross-sectional study of CVD risk factors and 10 yr. CHD risk prediction. Subjects completed their personal history questionnaire. Physical examination, anthropometric, biochemical and dietary assessment were done at the beginning of the study.

3)

4) Ethical aspects

5) Written informed consent was obtained from the patient. The study protocol had been reviewed and approved by the Ethical Committee on Human Rights Related to Researches Involving Human subjects of Ramathibodi Hospital, Mahidol University.

Dietary Assessment

Dietary assessments were determined by 3-day 24 hrs dietary records. The quantitative calculation was analyzed using the computer program IMMUCAL.

Serum biochemical assessment

Biochemical assessment of serum lipid profiles included total cholesterol (TC), triglyceride (TG), high-density lipoprotein

cholesterol (HDL-C) were analyzed at the beginning of the study by the department of pathology Siriraj hospital. Serum low-density lipoprotein cholesterol (LDL-C) level was calculated from Friedewald's formula (9) provided that serum TG is less than 400 mg/dL.

Body Composition

Anthropometric measurement including weight, height, BMI, triceps skin-fold thickness (TSF), biceps skin-fold thickness (BSF), subscapular skin-fold thickness (SST), supra iliac skin-fold thickness (SI) as well as waist and hip circumference (10). Percentage of body fat (%BF) was calculated by using Durnin and Womersley calculation (11). The BMI and waist/hip ratio were calculated.

Cardiovascular risk factors

Demographics data such as age, marital status, educational level, occupation, living condition, physical activities, smoking, consumption and drinking habits as well as their past and present history of diseases were obtained through a questionnaire. Hypertension was defined as a BP > 140/90 mmHg or taking antihypertensive medications (12). Serum total serum cholesterol > 200 mg/dL, HDLC < 50 mg/dL, LDL-C level > 130 mg/dL, and triglyceride level > 150 mg/dL were defined as risk factors for CVD in this study (13). Overweight and obesity were defined as BMI 23-24.9 and >25 kg/m2 respectively according to WHO criteria for Asian populations (14).

Sensitivity and specificity analysis

The Receiver Operating Characteristics (ROC) curve analysis was done using SPSS version 12 to determine the sensitivity, specificity and area under ROC curve. The sensitivity, specificity and area under ROC curve more than 0.70 was considered as having an acceptable predictive and discriminative value (15). The negative and positive predictive values were calculated manually via Microsoft Excel software.

Statistical analysis

Baseline characteristics, serum lipid profiles of the subjects were reported by using mean ± SD. Statistical analysis was conducted using SPSS software version 13.0 for windows. All outcome measurements among baseline and each period data including questionnaire were assessed using two way repeated measures ANOVA. $p < 0.05$ was considered statistically significant.

III. RESULTS

Table 1. Demographic characteristics of 194 Thai middle-aged adult.

Demographic characteristics	Male (n=51) Mean±SD or n (%)	Female (n=143) Mean±SD or n (%)
Age *(yrs)*	45.6±6.7	46.5±7.8
Weight *(kg)*	61.9±8.7	58.0±10.1*
Height *(cm)*	1.63±0.05	1.52±0.05*
Marital status (married and living together)	40	104
Education		
High school or less	45	134
Vocational education and Diploma or higher	6	9
Occupation		
Civil officer	7	7
Privatization	5	30
Merchant	8	37
Employment	31	69

Table 1 shows the demographic characteristics of 194 Thai middle-aged adults. Their mean ages were 45.6 and 46.5 years in male and female. Table 2 reveals cardiovascular risk factors of the participant. There were significant differences between men and women for serum HDL-C, TG, BMI, %BF and WHR ($p<.05$). Women had higher mean age, TC, LDL-C, HDL-C, BMI, %BF and also higher prevalence of DM and hypertension whereas men had higher prevalence of smoking, drinking and physical inactivity than women. Distribution of 10-year risk for CVD of our study was shown in Table 3. Men had 10-20% and >20% 10-year risk for CVD much higher than women. The percentage distribution of risk factor by age group and sex were graphically in Figure 1. Hypertension and overweight as well as obesity generally increased with age especially after age 46 in both sex. The prevalence of dyslipidemia increased with age in female, but in male was found at age under 46. Table 4 and Figure 2 showed the questionnaire's score at 23 had the optimum sensitivity and specificity which were 62.5% and 78.24% respectively with area under the curve of 0.7037. The analysis showed that our questionnaire was considered as having an acceptable predictive and discriminative value in detecting 10-year CVD risk prediction.

IV. DISCUSSION

By the year 2020, CVD are expected to account for seven out of every 10 deaths in the developing countries. As a proportion of total deaths from all-causes, CVD in the Asia-Pacific region ranges from less than 20% in countries such as Thailand to 20-30% in urban China, Hong Kong (16). The CVD death rate rapid rise in most of the low and middle income countries is due to socio-economic changes, increase in life span and lifestyle related risk factors. It is estimated that 80-90% of people dying from CVD have one or more major risk factors that are influenced by lifestyle (8) including age, hypertension, raised serum lipids, DM, cigarette smoking, physical inactivity, dietary consumption, obesity etc.

The clinical guidelines recommends classifying asymptomatic individuals into low (FRS < 10%), intermediate (10-20%), and high risk groups (> 20%) for risk management purpose. People in the low-risk group can be reassured and

followed with reinforcement of lifestyle changes. Intermediate risk group may require further risk stratification with additional tests, whereas high-risk group are candidates for aggressive intervention (17). In this study, The Framingham Risk Score (FRS) was used to calculate 10-year risk of CVD at the same cut-points to categorize Thai middle-aged adult into three risk categories. In both sex most risk factors generally increasing the risk for CVD with advancing age except for serum TC and LDL-C level in male **(Figure 1)**.

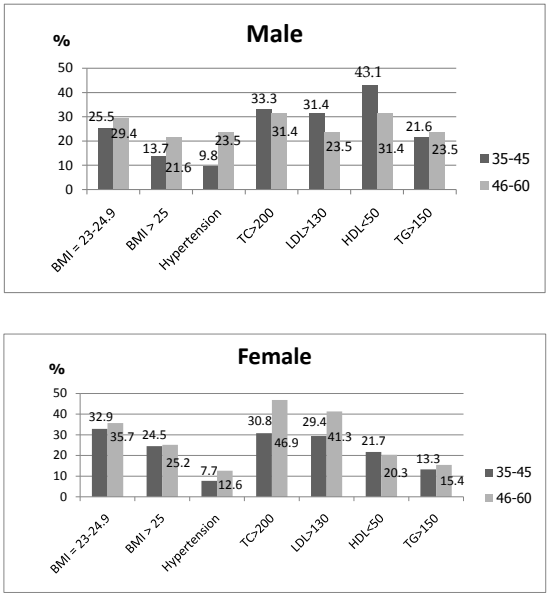

Figure 1. Percentage prevalence of cardiovascular risk factors in 194 Thai male and female by age group (male=51, female=143).

Obesity

Table 2. Cardiovascular risk factors in 194 Thai middle-aged adult.

Cardiovascular risk factors	Male (n=51) Mean±SD or n (%)	Female (n=143) Mean±SD or n (%)
Blood lipids		
Total cholesterol (mg/dL)	224.35±53.10	228.41+42.63
Total cholesterol ≥200 (mg/dL)	33 (64.71)	109 (76.22)
LDL-C (mg/dL)	143.24±47.26	147.59+39.01
LDL-C ≥130 (mg/dL)	28 (54.90)	101 (70.63)
HDL-C (mg/dL)	46.86±11.77	52.97+12.45*
HDL-C ≤50 (mg/dL)	38 (74.51)	60 (41.96)
Triglyceride (mg/dL)	171.24±89.62	139.26+81.02*
Triglyceride ≥150 (mg/dL)	23 (45.10)	41 (28.67)
Blood pressure		
Systolic BP (mmHg)	126.1±17.1	121.4±19.2
Diastolic BP (mmHg)	83.9±13.1	80.4±11.8
Hypertension	16 (31.37)	30 (20.98)
DM	5 (9.8)	17 (11.89)
Current smoking	13 (25.49)	10 (6.99)
Drinking Alcohol	12 (23.5)	9 (6.5)
BMI (kg/m^2)	23.20±3.28	25.16±4.27*
BMI 23-24.9 (kg/m^2)	11 (21.57)	28 (19.58)
BMI ≥25 (kg/m^2)	17 (33.33)	71 (49.65)
Physical inactivity	13 (25.49)	24 (16.78)
BF (%)	29.95±5.96	40.23±4.72*
Waist *(cm)*	82.40±8.71	79.73±12.65
WHR	0.88±0.06	0.82±0.11*

Overweight and obesity is highly prevalent in Thai people. According to WHO cut point of BMI of overweight (BMI 23 – 24.9 kg/m^2) and obesity (BMI ≥ 25 kg/m^2) for Asians (1). In this study 21.57 and 33.33% of male and 19.58 and 49.65% of female were overweight and obesity **(Table 2)**. The percentage of body fat in male and female were 30.99 and 40.23%. BMI and %BF of female were significantly higher than male, although their total energy, fat, sugar intake were not significantly difference. Asians have a higher percentage of body fat and more centralized fat distribution compared to Caucasians of the same gender, age, and BMI so they are prone to obesity-associated diseases such as CHD or diabetes. Central obesity were slightly better associated with cardiovascular risk factors compared to BMI in Thai adults (18). Increasing rates of overweight and obesity worldwide have been considered a serious health problem. In Thailand, data from three consecutive National Health examination surveys (NHES) (19,20) have shown a secular trend, as the prevalence of obesity with BMI ≥25 kg m^2 in adults increased from 13.0% in men and 23.2% in women in 1991 to 18.6% and 29.5% in 1997 and 22.4% and 34.3% in 2004 respectively. Education was a strong predictor of overweight and obesity in women, whereas annual household income was significantly associated with a higher BMI in men (Ministry of Public Health, 2008). Furthermore, Thailand NHES (2009) (19) found that adult population who lived in Bangkok had high prevalence of obesity in male 38.76% and female 49.44%. This was corresponding to our study that prevalence of obesity (BMI ≥ 25 kg/m^2) were 33.33 and 49.65% in male and female **(Table 2)**, almost half of female population had obesity. Prevention of obesity by diet and regular physical activity remains the highest priority for maintaining cardiovascular health. A study of 2,536 male employees from the Electricity Generating Authority of Thailand (EGAT) (20) age 35 to 59 years at baseline to determine the association of simple anthropometric indices with CVD in Thai men. They found that WHR was most strongly associated with CVD events in Thai men. WHR had the largest area under ROC curve with the optimal cut-off estimated to be 0.51 (sensitivity, 55%; specificity, 61%). Our data showed that WHR in female was significantly lower than male however WHR in both sex were in normal limit.

Hypertension

The prevalence of hypertension in Thailand (18) increased from 18.2% for men and 33.0% for women in 2004 to 39.5 and 59.4% in 2009 respectively. Epidemiological studies have established a strong association between hypertension and CVD. In this study male had higher prevalence of hypertension (31.37 vs 20.98% **Table 2**) probably due to their high salt intake, excessive salt intake is a major cause of hypertension salt appears to link between hypertension and stroke in Asian patients. Hypertension is extremely important among the major risk factors of CVD in Thailand (19). Strictly control of hypertension and their metabolic risk factors especially obesity and hypercholesterolemia in Thai population would be benefit to reduce CVD.

Hyperlipidemia

The results of many studies showed a strong association between elevated LDL-C levels and increased risk for CVD. **Table 2** shows summary statistics at baseline for serum lipid variables. In this study, 54.90 and 70.63% of male and female participants had LDL-C $\geq$ 130 mg/dL as well as 64.71 and 76.22% had TC $\geq$ 200 mg/dL, the rate of LDL-C and TC levels increased with advancing age in female. Male aged 35-45 yr. had higher rate of LDL-C $\geq$ 130 mg/dL (31.4%) and TC $\geq$ 200 mg/dL (33.3%) than aged 46-59 yr. (23.5 and 31.4%). This was corresponded to their high cholesterol intake (348.18 vs 323.08 mg/dL). The prevalence of elevated LDL-C in our study was relatively high compared to the US (Rosamond, 2008) (32% for general population age > 20 yr.) and Korean women (23) (age 20-79 yr. 25.7% had LDL-C $\geq$ 130 mg/dL and 30% had TC $\geq$ 200 mg/dL). Data from Thailand NHES (2009) (19) demonstrated prevalence of dyslipidemia in Thai population aged 20-59 years in male and female for LDL-C $\geq$130 mg/dL were 29.4 and 29%, TC $\geq$ 240 mg/dL were 18.8 and 21.8% respectively. Our data indicated high prevalence of serum lipids may be due to less amount population study. The attention to TC and LDL-C is required with the current increases in dietary total fat as well as cholesterol intake. It is evident that Thai people consumed more fat in a past decade from the Thai National Nutrition Survey in 2003 (22) using a 24 hrs food intake recall. Fat intake in Thai adult increased from 21.8% of total calories (1986) to 22.2% (1995) and 23.9% (2003). Adult people who live in rural area consumed less fat than urban (22.9 vs 26.9% of total calories).

One of the most common risk factor was low HDL-C level. Percentage of serum HDL-C $\leq$ 50 mg/dL in male and female were 74.51 and 41.96% when compared to Thai population (NHES 2009) (19) were 31.1 and 31.8 %, Korean women (23) which were 48%. The effect of low level of HDL-C increase risk for CVD independent of total cholesterol or LDL-C, especially in women (Gordon et al, 1989). Percentage of serum triglyceride $\geq$ 150 mg/dL in male and female were 45.1 and 28.67% when compared to Thai population (NHES 2009) (19) were 44.4 and 32.8 %, Korean women (23) which were 16.4%. A prospective study showed that high carbohydrate intake may lead to dyslipidemia that increase the risk of CVD (25). High prevalence of cardiovascular risk factors especially hyperlipidemia was found in this study, assessing the overall effect of multiple risk factors on the development of CVD is useful in order to prevent CVD.

Lifestyles

Studies have demonstrated that unhealthy lifestyle and social environment are the underlying factors of cardiovascular diseases. There are many risk factors established, the factors which can be controlled are hypertension, hyperlipidemia, obesity, diabetes mellitus, unhealthy dietary habits, smoking, drinking alcohol and physical inactivity. Lifestyle is the key factor in community-based prevention programs since lifestyle modifications and behavioral changes are cheaper and more effective approaches (26). The high prevalence of unhealthy lifestyles in male needed attention for example smoking, drinking alcohol, physical inactivity etc. because prolong unhealthy lifestyles cause increase risk of CVD and to maintain healthy lifestyle is an essential aspect of CVD risk reduction (27). The smoking, drinking alcohol and physical inactivity habits in this study were high in male than in female. The data from World Bank report in 2009 (28), prevalence of smoking in male and females (% of adults) aged 15 and over in Thailand were 45.12 and 2.98%. Smoking among female was on the rise compared to the previous study. Educating to quit smoking will be long-term benefits for prevention of CVD.

10 yr.risk for CVD

In Korean women study (23); 98.5% had a 10-year risk for CVD of < 10%, 1.4% had a risk of 10-20%, and 0.1% had a risk of > 20%. Our data for male and female showed 41.18 and 70.63% had a 10-year risk for CVD of < 10%, 33.34 and 21.68% had a risk of 10-20%, and 25.49 and 7.69% had a risk of > 20% respectively. Ford (Ford et al, 2004) showed 10-Year risk for CVD among U.S. adults data from the National Health and Nutrition Examination Survey III (1988-1994) (27) including 13,769 participants; 81.7% had a 10-year risk for CVD of <10%, 15.5% of 10-20%, and 2.9% of >20%. The proportion of the participants with a 10-year risk for CVD of 10-20% and >20% increased with advancing age and was higher among men than women in our study.

Table 3. Distribution of 10-year risk[a] for CVD in 194 Thai adult.

Age (yr)	n M F	10-year risk <10% %M	%F	10-year risk 10-20% %M	%F	10-year risk >20% %M %F
35-45	27 70	29.41	48.95	15.69	-	7.84 -
46-60	24 73	11.77	21.68	17.65 21.68		17.65 7.69
Total	51 143	41.18	70.63	33.34 21.68		25.49 7.69

[a]Ten-year risk was estimated with the Framingham Risk Score. Values are presented in percentages.

This study indicated that the younger age group (35-45 yr.) in both sex had higher percentage of 10-Year risk for CVD of <

10%. The percentage of 10-Year risk for CVD of 10-20% and >20% in man exhibited higher than women **(Table 3)** and increased with advancing age in both sex. The prevalence and combination of CVD risk factors increased after the age of 46. Our population presented lower percentage of 10-Year risk for CVD of < 10% but higher 10-Year risk for CVD of 10-20% and >20% than US and Korean population. These findings may provide useful information for public health planner to estimate CVD prevention cost and to monitor Thai adult population for preventing risk factors that could lead to CVD in the future. This study also found that even in the younger age groups (35-45 yr.) cardiovascular risk factors were already present.

ROC analysis

Table 4. The area under ROC curve, sensitivity, specificity, positive and negative predictive values of different cut-off points for significant change.

Cut point	Sensitivity	Specificity	Correctly Classified	LR+	LR-
(>= 13)	100.00%	0.00%	12.37%	1.0000	
(>= 14)	95.83%	0.59%	12.37%	0.9640	7.0833
(>= 15)	95.83%	2.94%	14.43%	0.9874	1.4167
(>= 16)	95.83%	5.29%	16.49%	1.0119	0.7870
(>= 17)	95.83%	11.76%	22.16%	1.0861	0.3542
(>= 18)	91.67%	22.35%	30.93%	1.1806	0.3728
(>= 19)	70.83%	34.12%	38.66%	1.0751	0.8549
(>= 20)	66.67%	47.06%	49.48%	1.2593	0.7083
(>= 21)	66.67%	60.59%	61.34%	1.6915	0.5502
(>= 22)	66.67%	71.18%	70.62%	2.3129	0.4683
(>= 23)	62.50%	78.24%	76.29%	2.8716	0.4793
(>= 24)	37.50%	83.53%	77.84%	2.2768	0.7482
(>= 25)	29.17%	88.24%	80.93%	2.4792	0.8028
(>= 26)	29.17%	89.41%	81.96%	2.7546	0.7922
(>= 27)	20.83%	91.76%	82.99%	2.5298	0.8627
(>= 28)	12.50%	92.94%	82.99%	1.7708	0.9415
(>= 29)	0.00%	94.71%	82.99%	0.0000	1.0559
(>= 30)	0.00%	97.06%	85.05%	0.0000	1.0303
(>= 32)	0.00%	98.82%	86.60%	0.0000	1.0119
(>= 33)	0.00%	99.41%	87.11%	0.0000	1.0059
(> 33)	0.00%	100.00%	87.63%	0.0000	1.0000

ROC	-Asymptotic Normal--			
Obs	Area	Std. Err.	[95% Conf. Interval]	
194	0.7037	0.0529	0.59998	0.80738

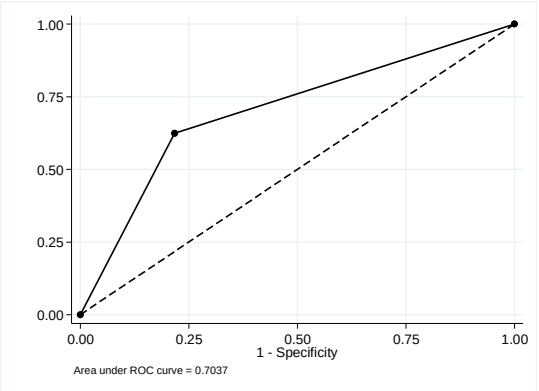

Figure 2. The area under ROC curve of the FRS score at cut-off points 23 for significant change.

Data from ROC curve analysis **(Table 4 and Figure 2)** demonstrated that our questionnaire was a valid and reliable screening tool in detecting CVD risk. The optimum cut-off point of the questionnaire to detect CVD risk was 23. In developing country like Thailand, the fast clinical implications, low-cost screening tools can lead to risk assessment results using the non-laboratory-based score will be benefit. Non-laboratory-based CVD risk assessment could be an effective and efficient primary CVD screening approach in Thailand.

V. CONCLUSION

The modifiable cardiovascular risk factors are highly prevalent in our study, and the combinations of risk factors were common especially in male. Thai adult should be regularly assessed for their CVD risk score and counseled to emphasize therapeutic lifestyle changes to prevent CVD since this study found that smoking and drinking alcohol was much more common in male less than 46 years old, and a high percentage of them were sedentary and overweight. The prevalence of dislipidemia in male also found in the younger age groups (35-45 yr.). Most risk factors generally became more prevalent with advancing age. This study provides estimates of 10-year risk to help whom needing watchfulness. For health care giver to provide appropriate interventions and health education and raise public awareness about CVD in Thai middle aged adult. The study was to demonstrate the reliability and accuracy of a CVD risk questionnaire. So, it may serve as a basis for the assessment of the effectiveness of interventions used in clinical practice by questionnaire before laboratory assessment to economize the expense.

ACKNOWLEDGMENT

The authors wish to thank the National Research Council of Thailand for grant and the study participants for taking part in this study and all of the colleagues who contributed for the study.

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