Prevalences and Association of ECG Findings and Cardiovascular Risk Factor in Shinawatra Employees

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Objectives: *There is significant incline trend in cardiovascular disease (CVD) mortality in developing countries such as Thailand and it is also the major contributor to the burden of premature mortality and morbidity throughout the world. In order to have well-stratified primary prevention plan, this study reports the prevalence of Electrocardiogram (ECG) abnormalities, as categorized by ECG Minnesota coding, and the association with major cardiovascular risk factors in Thailand.*
Material and Method: *In this study, we use the same data from a previous survey at Shinawatra Employee but only subjects with available ECG's were recruited in our study. Standard supine 12-lead ECG data were collected; all amplitude and intervals were measured and entered into a computer manually. Then the ECG was coded according to Minnesota Coding system. The study characteristics, the prevalence of major cardiovascular risk factors and ECG abnormalities were calculated.*
Results: *A total of 1,485 subjects were recruited in this study 638 (43.0%) were male and 847 (57.0%) were female. The overall mean aged was 34.4 (5.4). The level of major cardiovascular risk factors among men and women respectively were: total Cholesterol 215.6 (41.0) mg/dl (5.6 (1.1) mmol/l), 202.8 (35.3) mg/dl (5.3 (0.9) mmol/l); LDL-cholesterol 139.1 (37.0) (3.6 (1.0) mmol/l), 123.6 (31.9) (3.2 (0.8) mmol/l). Hypercholesterolemia was 65.3%, 49.8%. The mean systolic and diastolic blood pressures were 121.5 (13.9) mmHg and 81.4 (10.5) mmHg, 111.7 (12.2) mmHg and 74.5 (8.6) mmHg; hypertension 21.0%, 4.2%; fasting blood sugar 95.5 (15.8) mg/dl (5.3 (0.9) mmol/l), 88.0 (8.6) mg/dl (5.1 (0.5) mmol/l); diabetes mellitus 3.3%, 0.5%; body mass index 23.5 (3.5) (kg/m^2), 21.3 (3.1) (kg/m^2); obesity 30.7%, 11.0%; smoking 12.3%, 14.0%. The prevalence of ECG abnormalities, as categorized based on the Minnesota coding criteria, among men and women respectively were: Q/QS wave abnormalities (Code 1) 2.2%, 0.8%; S-T-J segment depression (Code 4) 0.5%, 1.4%; T-wave inversion (Code 5) 1.4%, 9.6%; atrioventricular conduction abnormalities (Code 6) 2.5%, 0.8%; and ventricular conduction abnormalities (Code 7) 0.2%, 0.2%.*
Conclusions: *This study reports higher prevalence of having major cardiovascular risk factors as compared to previous epidemiological studies in Thailand which should heighten the Ministry of Public Health concern to launch a better stratified preventive plan to combat the rising of coronary artery disease in the future. Moreover, this study is also the first study to report the prevalence of ECG abnormalities, as determined on the basis of the Minnesota coding criteria, and the association between major cardiovascular risk factors and the prevalences of several electrocardiographic findings in adult men and women in Thailand.*

Keywords: *Coronary artery disease, Electrocardiogram, risk factors, Thailand, Minnesota code, prevalence, Asia*

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Some previous studies have shown that there is significant upward incline trend in cardiovascular disease (CVD) mortality in developing countries such as countries in Asia-Pacific and Eastern Europe[1]. In contrast to the decline trend in the west, CVD is the major contributor to the burden of premature mortality and morbidity and accounted for 85 million disability-adjusted life years (DALYs-sum of the life years lost due to premature mortality and the years lived with a disabling condition adjusted to severity)[2] and it will still be the leading cause in year 2020 as well. The DALY attributed to CVD will rise to approximately 140-160

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million with the majority of about 80% occurring in those developing countries[3]. The increase in incidence of CVD in developing countries is associated with changing lifestyles which will make people more prone to major cardiovascular risk factors. Therefore, the main effective strategy to combat the rising in incidence of the CVD is well-stratified primary prevention plan which is required the understanding of the population at risk, and the associated risk in different ethnic group and geographic regions. In Thailand, there were several studies concerning the prevalence of CVD in different geographic areas and the association between CVD and major cardiovascular risk factor[4-10]. A national survey study in Thailand demonstrated that the prevalence of CHD, as defined by routine ECG, as well as the major cardiovascular risk factor levels were ranked below the medians of those found among many developing countries[9]. There was also a preliminary prevalence survey in Shinawatra Employees[5] which exhibited a level of conventional risk factors of CVD in a large company group, which could be representative of urban population. This study also planed to conduct 5-year prospective study to investigate the association of the conventional risk factors and coronary artery diseases but this has not yet been published. The purpose of our study is to determine the prevalence of coronary artery disease, as suggested by routine EKG coding by Minnesota coding system[11], in Shinawatra employees, which is the same population of Bhuripanyo et al conducted in 2000[5]. We hope that the information will help Thailand to ascertain the preventive strategies for coronary artery disease. Moreover, the prevalence of this data could be compared to other studies which use Minnesota coding system to determine the prevalence of CVD.

Material and Method

Populations

We use the same data from the previous survey in Shinawatra Employee[5] but only subjects with ECG available were recruited in our study. The subjects were selected from those Shinawatra employees who were located in the urban area in Bangkok, Thailand. All employees were relatively young, highly educated and had high socioeconomic status. A self administered questionnaire concerning demographic, education, family income, presence of heart disease, coronay artery disease (CAD) risk factors (*i.e.* smoking, history of known hypertension, history of known diabetes mellitus, family history of early myocardial infarction), history of abnormal ECG, physical activity, stress and alcoholic consumption was conducted. This study was approved by the Ethics committee of Siriraj Hospital. All subjects gave written informed consent.

Variables measured

Standing height was measured with the subject in bare feet, back square against the wall and eyes looking straight ahead and weight was measured in undergarments using a balanced scale to the nearest 200 grams. The scale was standardized to 0 before each use. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Obesity was defined as BMI >25 kg/m^2.

Waist and hip circumference was performed to the nearest 0.1 cm using a non-stretchable standard tape measure attached to a spring balance exerting a force of 750 grams (Ohaus tape). The waist circumference was taken over the unclothed abdomen at the smallest diameter between the costal margin and the iliac crest. The tape measure was kept horizontal and just tight enough to allow the little finger to be inserted between the tape and the subject's skin. The hip circumference was taken at the level of greater trochanters (usually the widest diameter around the buttocks).

The blood pressure was done using a standard mercury sphygmomanometer twice on the right arm after the subject had been sitting for longer than 5 minutes and the exact values were recorded to the nearest 2 mmHg. A third measurement would be performed if there was 10 mmHg, or more, difference between the first two readings and the average of the two closest values was used for the analysis. The correlation coefficients between the two measurements of systolic blood pressure (SBP) and diastolic blood pressure (DBP) were 0.94 and 0.89 respectively. Average values were used for the report. The WHO criteria for hypertension (HT) were used: blood pressure $\geq$ 140 mmHg in SBP and/or $\geq$ 90 mmHg in DBP or both or self-reported antihypertensive medication during the past week.

Blood samples were taken after 10-12 hours fasting and were processed within 4 hours and serum stored in -70 C for further analysis. The DNA material was extracted from the WBC and stored for further analysis. The laboratory performance included a complete blood count, fasting blood sugar, serum lipids (cholesterol, triglycerides and HDL-cholesterol), serum creatinine and uric acid using Hitachi 717 and 917 automation system. The coefficients of variation between run and within run were performed every day and were less than 5%. The external quality control was performed every 4 weeks by joining the QAP (quality assurance program) from Roche Diagnostics. The coefficients of variation for serum cholesterol, triglycerides and HDL-cholesterol were 2.3%, 3.1% and 3.5% respectively.

The data were recorded twice in the Dbase Foxpro II by two separate research assistants. If there was any discrepancy between the two values, the data would be checked and corrected. The completeness of our data ranged from 99.0-99.9 percent.

Subjects would be categorized as having diabetes mellitus when fasting plasma glucose $\geq$ 7.0 mmol/1 (126 mg/dl) and hypercholesterolemia when either serum total cholesterol was $\geq$ 5.2 mmol/1 (200 mg/dl) or serum LDL-cholesterol was $\geq$ 4 mmol/l (160 mg/dl).

Electrocardiograms (ECG)

Standard supine 12-lead ECG was recorded using the HP-playwriter Xli with auto-analyzer. All ECG records (25 mm/second) were mounted and measured manually by a General Practitioner. He was trained in the recognition of ECG wave forms and in the measurement of amplitudes and intervals, based on the Minnesota Classification of the ECG for population studies[11]. Then the ECG was coded according to Minnesota Coding System, the criteria modified from the Minnesota code 1.1, 1.2, 4.1, 4.2, 5.1, 5.2, 6.1, 6.2, 6.3, 7.1 and 7.2 were used to detect abnormalities and were applied to all leads except a VR.

According to the Minnesota Classification System, code 1.1, 1.2 referred to Q/QS wave abnormalities, code 4.1, 4.2 referred to S-T-J segment depression, code 5.1, 5.2 referred to T-wave amplitude negative or inversion, code 6.1, 6.2, 6.3 referred to third degree Atrioventricular (AV) block, second degree AV block and third degree AV block, respectively and code 7.1, 7.2 referred to left bundle branch block (LBBB) and right bundle branch block (RBBB), respectively.

The ECG screened initially as abnormal were duplicated and distributed to an experienced cardiologist (with >20 years clinical practice) for confirming the abnormalities. They were blinded with regard to the subject's age and sex.

Statistical analysis

The statistical analysis was performed by a biostatistician and the investigator using the SPSS for windows. All the data were initially categorized in to groups regarding to sex and age groups for easy comparison of the variation in major cardiovascular risk factor. The prevalence rate ratios among those having major and minor ECG abnormalities and the association between ECG abnormalities and specific risk factors were also estimated. Chi-squared as well as Fisher exact probability statistics were applied where appropriate. Multiple logistic regression analysis was used to detect independent factors associated with ECG abnormalities. All p-values were two sided and were considered significant when p-values $\leq$ 0.05.

Results

A total of 1,485 subjects were recruited in this study 638 (43.0 %) were men and 847 (57.0%) were women. We then categorized sample population in to four age groups. The overall mean aged was 34.4 (5.4) and the distribution of age in the two sexes is given in Table 1. Most of the subjects in the study population were aged 30-39 years. The level of major cardiovascular risk factors among men and women respectively were: total Cholesterol 215.6 (41.0) mg/dl (5.6 (1.1) mmol/l), 202.8 (35.3) mg/dl (5.3 (0.9) mmol/l); LDL-cholesterol 139.1 (37.0) (3.6 (1.0) mmol/l), 123.6 (31.9) (3.2 $\pm$ 0.8 mmol/l); mean systolic and diastolic blood pressures were 121.5 (13.9) mmHg and 81.4 (10.5) mmHg 111.7 (12.2) mmHg and 74.5 (8.6) mmHg; fasting blood sugar 95.5 (15.8) mg/dl (5.3 (0.9) mmol/l), 88.0 (8.6) mg/dl (5.1 (0.5) mmol/l); body mass index 23.5 (3.5) (kg/m^2), 21.3 (3.1) (kg/m^2).

The prevalence of hypertension by measurement was 21.0% (133) in men, 4.2% (36) in women and 11.4% (169) overall. The prevalence of diabetes mellitus, as categorized by fasting blood sugar $\geq$ 126 mg/dl, were 3.3% (21) in men, 0.5% (4) in women and 1.7% (25) overall. The prevalence of impaired fasting glucose, as categorized by fasting blood sugar range between 100 and 125, were 23.9% (152) in men, 7.7% (65) in women and 14.6% (217) overall. The prevalence of hypercholesterolemia was 65.3% (416) in men, 49.8% (421) in women and 56.4% (837) overall. The prevalence of obesity, as defined by body mass index (BMI) $\geq$ 25 kg/m^2 were 30.7% (195) in men, 11.0% (93) in women and 19.4% (288) overall. The prevalence of smoking was 12.3% (75) in men, 14.0% (113) in women and 12.7% (188) overall.

In Table 2 the prevalence of electrocardiographic findings are given in the two sexes and age-group format. The overall abnormal ECG findings were higher in women. The highest prevalence of electrocardiographic abnormalities is code 5.2 (T-wave segment abnormalities). Moreover, only code 7 showed rising with age in both sexes (p-value $\leq$ 0.001). Regardless of age, significantly higher prevalences in women were found for code 5 (T-wave segment abnormalities).

Table 1. Characteristic and major cardiovascular risk factor in the population categorized by sex and age.

major cardiovascular risk factors	Male (n = 638) [a]				Female (n = 847) [a]			
	20-29 y	30-39 y	40-49 y	>50 y	20-29 y	30-39 y	40-49 y	>50 y
Systolic blood pressure (mmHg)	119.1(10.7)	119.4 (12.3)	128.1 (16.4)	136.5 (18.8)	110.8 (13.9)	111.1 (11.5)	118.0 (15.4)	125.8 (9.0)
Diastolic blood pressure (mmHg)	80.4 (9.7)	80.4 (9.8)	84.6 (12.1)	89.6 (11.9)	74.8 (10.2)	74.1 (8.3)	78.08 (9.9)	80.3 (5.5)
Body mass index (kg/m2)	24.1 (4.5)	23.2 (3.4)	24.8 (3.1)	24.4 (2.5)	20.4 (2.2)	21.1 (3.1)	22.9 (3.1)	21.2 (4.2)
Fasting blood sugar (mg/dl)	88.4 (9.8)	94.47 (15.7)	100.5 (16.6)	100.8 (11.3)	85.3 (6.8)	91.5 (59.0)	92.2 (8.3)	85.7 (12.4)
Total cholesterol (mg/dl)	204.2 (39.1)	214.08 (41.0)	229.6 (39.6)	226.0 (44.3)	201.9 (38.7)	206.7 (35.3)	207.6 (30.6)	266.7 (61.7)
Low-density lipoprotein (LDL) (mg/dl)	131.6 (35.6)	138.26 (37.1)	150.3 (88.1)	147.4 (32.3)	126.1 (35.3)	127.8 (31.9)	128.0 (27.0)	178.3 (55.5)
Diabetes millitus, n (%)	0 (0)	13 (2.8)	7 (6.1)	1 (5.3)	0 (0)	4 (0.6)	0 (0)	0 (0)
Impaired fasting glucose, n (%)	2 (6.5)	92 (19.5)	48 (41.7)	10 (52.6)	0 (0)	55 (7.5)	9 (12.2)	1 (33.3)
Hypertension, n (%)	5 (16.1)	81 (17.1)	38 (33.0)	9 (47.4)	3 (7.9)	24 (3.3)	9 (12.2)	0 (0)
Hypercholesterolemia, n (%)	18 (58.1)	296 (62.9)	88 (70.4)	5 (27.8)	15 (39.5)	356 (48.9)	46 (62.2)	3 (100.0)
Smoking, n (%)	4 (12.9)	54 (11.4)	16 (13.9)	1 (5.3)	3 (7.9)	103 (14.1)	7 (9.5)	0 (0)
Obesity, n (%)	5 (16.1)	131 (27.7)	52 (45.2)	7 (36.9)	1 (2.6)	77 (10.5)	14 (18.9)	1 (33.3)
study population, n (%)	31 (4.9)	473 (74.1)	115 (18.0)	19 (3.0)	38 (4.5)	732 (86.4)	74 (8.7)	3 (0.4)

[a] Values presented as mean (SD) except where noted.

The overall prevalence of ECG abnormalities, as categorized based on the Minnesota coding criteria, among men and women respectively were: Code 1 2.2%, 0.8%; Code 4 0.5%, 1.4 %; Code 5 1.4%, 9.6%; Code 6 2.5%, 0.8%; Code 7 0.2%, 0.2%.

In Table 3, odds ratios (OR) (95% CI) adjusted for age and p-value relating ECG findings with each major cardiovascular risk factor and lifestyle characteristic were given. Only three variables showed significant association with the prevalence of having major and minor EKG abnormalities. Women are shown to have a higher risk for developing code 5 abnormalities more often than men (OR = 7.19, 95% CI = 3.58-14.44, p-value < 0.001) whereas shows protective role against having code 1, 6 abnormalities. (OR = 0.37, 95% CI = 0.15-0.93, p-value = 0.047) and (OR = 0.28, 95% CI = 0.11-0.71, p-value = 0.009) respectively. Those with obesity showed higher risk for having code 1 abnormalities (OR = 3.87, 95% CI = 1.63-9.20, p-value = 0.003). Those with hypertension showed higher risk for having code 7 abnormalities (OR = 15.67, 95% CI = 1.41-73.8, p-value = 0.036).

Discussion

The ECG's usage in epidemiological research has been on the increase after the introduction of the Minnesota code classification system[11]. There were several reports regarding the prevalence of ECG abnormalities, as determined by the Minnesota coding criteria[9,12-15]. The most updated study in Thailand, which reported some ECG abnormalities, as described by the Minnesota coding criteria, was conducted in 1991 as a national survey[9], however, it emphasized only the prevalence of coronary heart disease. The data we reported will help update the prevalence of ECG abnormalities in the primary urban area in Thailand and show the results of our investigation of the association between ECG abnormalities and conventional cardiovascular risk factors and other lifestyle characteristics.

Reported prevalence of ECG abnormalities and major cardiovascular risk factor in this study, as compared to previous study in Thailand[4,6-8,16-21], showed both a relatively younger age and more females. Furthermore, the subjects recruited in this study also had better education and higher socioeconomic status and were representative of the population in main urban area in Thailand.

In comparison with the previous national survey in Thailand[9], and despite of younger age subjects in our population, this study population exhibits

Table 2. Prevalence (numbers and rates per thousand) of electrocardiographic findings.

Electrocardiographic finding (and Minnesota Code)	Male (n = 638) n (%)				Female (n = 847) n (%)			
	20-29 y	30-39 y	40-49 y	>50 y	20-29 y	30-39 y	40-49 y	>50 y
Q/QS wave								
Major (1.1)	0 (0)	2 (0.4)	0 (0)	0 (0)	0 (0)	1 (0.1)	0 (0)	0 (0)
Minor (1.2)	2 (6.5)	9 (2.0)	1 (0.9)	0 (0)	0 (0)	6 (0.8)	0 (0)	0 (0)
Total Code 1	2 (6.5)	11 (2.3)	1 (0.9)	0 (0)	0 (0)	7 (1.0)	0 (0)	0 (0)
ST depression								
Major (4.1)	0 (0)	1 (0.2)	1 (0.9)	0 (0)	1 (2.6)	4 (0.6)	1 (1.4)	0 (0)
Minor (4.2)	0 (0)	1 (0.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total Code 4	0 (0)	2 (0.4)	1 (0.9)	0 (0)	1 (2.6)	4 (0.6)	1 (1.4)	0 (0)
T-wave inversion								
Major (5.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Minor (5.2)	0 (0)	4 (0.8)	5 (4.4)	0 (0)	2 (5.3)	71 (9.7)	8 (10.8)	0 (0)
Total Code 5	0 (0)	4 (0.8)	5 (4.4)	0 (0)	2 (5.3)	71 (9.7)	8 (10.8)	0 (0)
A-V conduction defect								
Third degree AV block (6.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Second degree AV block (6.2)	1 (3.2)	1 (0.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
First degree AV block (6.3)	1 (3.2)	11(2.3)	1 (0.9)	1 (5.3)	0 (0)	6 (0.8)	1 (1.4)	0 (0)
Total Code 6	2 (6.5)	12 (2.5)	1 (0.9)	1 (5.3)	0 (0)	6 (0.8)	1 (1.4)	0 (0)
Ventricular conduction defect								
Left BBB (7.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Right BBB (7.2)	0 (0)	0 (0)	0 (0)	1 (5.3)	0 (0)	1 (0.1)	1 (1.4)	0 (0)
Total Code 7	0 (0)	0 (0)	0 (0)	1 (5.3)	0 (0)	1 (0.1)	1 (1.4)	0 (0)
Total positive Code	4 (13.0)	29 (6.1)	8 (7.0)	2 (10.5)	3 (7.9)	89 (12.2)	11 (14.9)	0 (0)
Study population	31	473	115	19	38	732	74	3

AV = Atrioventricular, BBB = Bundle Branch Block, y = year

Table 3. The prevalence rate ratios of having major and minor electrocardiographic abnormalities with each major cardiovascular risk factor (adjusted for age).

ECG finding (Minnesota Code)	sex (female) OR	p-value	smoking OR	p-value	Obesity OR	p-value	Diabetes OR	p-value	Impair fasting glucose OR	p-value	HT OR	p-value	Hypercholesterolemia OR	p-value
Qwave														
Major (1.1)	0.38 (0.03, 4.15)	0.81	0.87 (0.85, 0.89)	1	8.34 (0.75-92.32)	0.18	0.99 (0.98, 0.99)	1	11.71 (1.06, 129.72)	0.84	3.90 (0.35, 43.16)	0.78	1.53 (0.14, 16.89)	1
Minor (1.2)	0.37 (0.14, 1.00)	0.07	2.56 (0.90, 7.25)	0.14	3.38 (1.32, 8.65)	0.02	5.31 (0.67, 42.30)	0.52	1.16 (0.33, 4.05)	1	0.97 (0.22, 4.25)	1	1.54 (0.57, 4.11)	0.54
Code1	0.37 (0.15, 0.93)	0.047	2.07 (0.75, 5.72)	0.27	3.87 (1.63, 9.20)	0.003	4.50 (0.57, 35.59)	0.6	1.83 (0.67, 5.06)	0.38	1.30 (0.38, 4.45)	0.95	1.54 (0.62, 3.83)	0.48
ST depression														
Major (4.1)	2.27 (0.46, 11.27)	0.5	0.87 (0.85, 0.88)	0.56	0.59 (0.25, 5.74)	0.961	0.99 (0.98, 0.99)	1	1.94 (0.39, 9.70)	0.75	0.88 (0.87, 0.90)	0.64	0.76 (0.19, 3.06)	0.98
Minor (4.2)	0.43 (0.46, 0.89)	0.89	0.87 (0.85, 0.89)	1	-	0.44	0.99 (0.98, 0.99)	1	-	1	0.11 (0.10, 0.13)	0.23	-	0.89
Code4	1.51 (0.38, 6.06)	0.81	0.87 (0.85, 0.88)	0.5	1.19 (0.25, 5.74)	1	0.99 (0.98, 0.99)	1	1.67 (0.34, 8.07)	0.87	0.97 (0.12, 7.79)	1	0.61 (0.16, 2,28)	0.68
Twave inversion														
Major (5.1)	-		-	-	-	-	-	-	-	-	-	-	-	-
Minor (5.2)	7.19 (3.58, 14.44)	< 0.001	0.82 (0.40, 1.67)	0.7	0.92 (0.53, 1.60)	0.87	0.99 (0.98, 0.99)	0.6	0.66 (0.32, 1.33)	0.31	0.76 (0.36, 1.61)	0.59	1.09 (0.70, 1.69)	0.8
Code5	7.19 (3.58, 14.44)	<0.001	0.82 (0.40, 1.67)	0.7	0.92 (0.53, 1.60)	0.87	0.99 (0.98, 0.99)	0.6	0.66 (0.32, 1.33)	0.31	0.76 (0.36, 1.61)	0.59	1.09 (0.70, 1.69)	0.8
AVconduction defect														
3 block (6.1)	-		-	-	-	-	-	-	-	-	-	-	-	-
2 block (6.2)	0.43 (0.40, 0.46)	0.87	0.87 (0.85, 0.89)	1	0.81 (0.79, 0.83)	1	0.99 (0.98, 0.99)	1	-	1	0.89(0.87, 0.90)	1	-	0.6
1block (6.3)	0.33 (0.12, 0.83)	0.87	0.87 (0.85, 0.88)	0.15	1.04 (0.34, 3.13)	1	0.99 (0.98, 0.99)	1	0.64 (0.15, 2.79)	1	0.40 (0.05, 3.04)	0.58	0.93 (0.38, 2.26)	1
Code6	0.28 (0.11, 0.71)	0.009	0.87 (0.85, 0.88)	0.14	0.92 (0.31, 2.74)	1	0.99 (0.98, 0.99)	1	0.58 (0.13, 2.49)	0.66	0.37 (0.05, 2.73)	0.49	1.10 (0.47, 2.60)	0.99
Ventricular conduction defect														
Left BBB (7.1)	-		-	-	-	-	-	-	-	-	-	-	-	-
Right BBB (7.2)	1.51 (0.14, 16.66)	0.87	0.87 (0.85, 0.89)	1	8.34 (0.75, 92.32)	0.18	0.99 (0.98, 0.99)	1	11.71(1.06, 129.72)	0.84	15.67 (1.41, 173.82)	0.04	0.38 (0.03, 4.21)	0.81
Code7	1.51 (0.14, 16.66)	0.87	0.87 (0.85, 0.89)	1	8.34 (0.75, 92.32)	0.18	0.99 (0.98, 0.99)	1	11.71(1.06, 129.72)	0.84	15.67 (1.41, 173.82)	0.04	0.38 (0.03, 4.21)	0.81
Total	1.65 (1.16, 2.35)	0.007	0.74 (0.42, 1.29)	0.35	1.36 (0.92, 2.01)	0.16	0.54 (0.07, 4.08)	0.83	0.97 (0.60, 1.57)	1	0.96 (0.56, 1.63)	0.98	1.07(0.76, 1.50)	0.77

Values are expressed as Odds ratio (95% CI), OR = Odds ratio, HT = hypertension higher level of many cardiovascular risk factors. The finding in our study showed a higher mean cholesterol level in both sexes which were 216.8 mg/dl (5.6 mmol/l) in men and 206.7 mg/dl (5.3 mmol/l) in women in this study and 185.6 mg/dl (4.8 mmol/l) in men and 197.2 mg/dl (5.1 mmol/l) in women in the Tatsanavivat et al study. In addition, there is also another difference in the mean of systolic blood pressure (SBP) and diastolic blood pressure (DBP). Moreover, our study reports higher arterial blood pressure and higher fasting blood sugar in men which were 121.4 and 81.4 for SBP and DBP respectively in men and 111.7 and 74.5 in women while Tatsanavivat et al reported 116 and 77 in men and 116 and 76 in women. The mean fasting blood glucose levels in our study were 5.3 mmol/l, 5.1 mmol/l in men and women, respectively and 4.8 mmol/l, 5.0 mmol/l in the Tatsanavivat et al study. This difference might be explained by the difference in the population characteristic. As discussed above subjects in this study had higher socioeconomic status, therefore due to their demanding job they might have less time for physical activity and had more stress at the workplace(5).

The data regarding the prevalences of ECG abnormalities, defined by Minnesota coding system, were very scarce in Thailand. Therefore, we report our findings and provide information given by other studies conducted in other geographic regions both in Asia and Western countries for comparison.

Q/QS findings (code 1) are usually seen in subjects with previous myocardial infarction and are considered as a component of "Ischaemia-Like ECG Changes", which associated with an about twofold increased risk of dying of coronary heart disease[12,22,23]. In our prevalence rates were 2.2% and 0.8% in men and women, respectively which were lower than those results reported in other published reports about Caucasians, especially in women(12-14,24) but were in concordance with a study done among Taiwanese(25,26). The prevalence of code 1 abnormalities were range between 3.2-5.5% in men and 1.7-2.3% in women among those studies(12-14,24). Additionally, sex (women) seemed to be a protective factor against having code I abnormalities in our study (OR = 0.37, 95% CI = 0.15-0.93, p-value = 0.047). Furthermore, our analysis also found the significant association between obesity and having code 1 abnormalities (OR = 3.87, 95% CI = 1.63-9.2, p-value = 0.003).

ST depression (code 4) and T wave abnormalities (code 5) are often seen as indications of silent myocardial ischemia and considered as components of "Ischaemia-Like ECG Changes" as well(12). ST and T wave abnormalities are observed by many epidemiological papers to have had large variation due to the less stringent codes 4-3, 4-4, 5-3, 5-4 which are more subject to personal interpretation(12). These are some examples of the results from previous published papers(13,25-28); the range of prevalence for code 4 abnormalities were ranged between 2.6-11.6 % and 2.4-5.4 % in men and women, respectively for Western countries[13,27,28] and were 0.2-3.5 % and 1.0-5.2% for Asian countries[25,26]. The range of prevalence for code 5 abnormalities was ranged between 3.4-5.9 % and 6.8-13.1% in men and women for Western countries and 0.7-6.6% and 3.67-10.8% for Asian countries. However, in our study, we collected only code 4-1, 4-2, 5-1 and 5-2, the prevalences in our study among men and women, respectively, were 0.5%, 1.4% for ST depression (code 4) and 1.4%, 9.6% for T wave inversion (code 5). Moreover, the prevalence of T wave abnormalities is associated with sex (women) (OR = 7.19, 95% CI = 3.58-14.44, p-value < 0.001). These differences between sexes are in accordance with the previous studies(27,28).

Atrioventricular conduction (AV block) abnormalities (code 6) receives little study in epidemiological reports. In a previous large sample as Framingham study(29), prevalence in 30-62 year old men and women were 0.7% and 0.8%, respectively. In our study, the prevalence of AV conduction abnormalities, as defined by code 6-1, 6-2 and 6-3, were 2.5% and 0.8% in men and women, respectively. Additionally, we also found a robust association between sex (women) and having AV conduction defect, as sex (women) seemed to be a protective factor (OR = 0.28, 95% CI = 0.11-0.71, p-value = 0.009). The reason why the prevalence of atrioventricular conduction abnormalities in our study, which were consistent with the finding in Taiwanese(25), are higher than other studies and why the protective role of women as observed in our study population is unclear.

Ventricular conduction defect or bundle branch block abnormalities (code 7), in contrast to AV conduction abnormalities, there were many epidemiological studies regarding with bundle branch block and the range were very wide and markedly variated throughout all previous studies. The prevalence of code 7 abnormalities were reported ranging from 1.2% in the Framingham study (20-62 years old men)(29) up to 11.6% in Wu et al(25). In our study, the prevalence of code 7-1 and 7-2 were 0.2% and 0.2% in men and women, respectively. Interestingly, our study also found that those with hypertension (SBP $\geq$ 140 mmHg or DBP $\geq$ 90 mmHg) showed a higher risk for having code 7 abnormalities (OR = 15.67, 95% CI = 1.41-73.82, p-value = 0.036). According to the fact that chronic hypertension could cause ventricular hypertrophy. We believe that this effect may further impair conduction, thus resulting in code 7 abnormality.

In summary, our study reports the prevalence of major cardiovascular risk factor in urban community in Thailand which show a rising of cholesterol level, arterial blood pressure, hypertension (men) body mass index (men) and fasting blood sugar (men) as compared to the previous national survey in 1991[9] despite the younger population in our study. Furthermore, this study also reports the prevalence of ECG abnormalities which is consistent with a study done in Taiwanese[25] but shows lower abnormalities rates when compared to other epidemiological studies in western countries except for code 6 (Atrioventricular conduction). However, the prevalence of ECG abnormalities could not be compared to any previous studies done in Thailand because there was no study which reports the prevalence of ECG abnormalities using Minnesota Coding System.

Limitation

This study has small population and was restricted only to the urban area in the capitol of Thailand; therefore the information should be interpreted with consideration. Nevertheless, this population was also recruited in an on-going study[5] which was once published as a preliminary prevalence survey; the 5-year prospective study result is not yet published. The prevalence of major cardiovascular risk factors and the prevalence of abnormal ECG findings, as determined by Minnesota Coding Criteria should be followed-up.

There was also another limitation in collecting data process. In this study, we use 2 persons to measure waist circumference and BP and there is no inter and intra-observer variability available.

Conclusion

Our study reports higher prevalence of major cardiovascular risk factors, as compared to the previous epidemiological studies done in Thailand. Even though this study was restricted to a small population and a limited area, this should alert Ministry of Public Health, Thailand to be concerned about launching a better stratified primary prevention plan to increase awareness of Thai people in order to combat the future rising incidence of coronary artery disease. This study is also the first study to report the prevalence of ECG abnormalities, as determined on the basis of the Minnesota coding criteria and the association between major cardiovascular risk factors and the prevalences of several electrocardiographic findings in adult men and women in Thailand. Our study is also one of the few that have reported prevalences of ECG findings in women as well as men in Asia, which further demonstrated that women tend to have fewer abnormalities from the resting ECG as compared to men[12].

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การศึกษาความชุกและความสัมพันธ์ระหว่างผลการตรวจคลื่นไฟฟ้าหัวใจ และปัจจัยเสี่ยงของโรคหัวใจและหลอดเลือดแดงในในกลุ่มพนักงานบริษัทชินวัตร

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วัตถุประสงค์: *อัตราการตายจากโรคหลอดเลือดและหัวใจ มีแนวโน้มสูงขึ้นในประเทศกำลังพัฒนา เช่น ประเทศไทย และจากภาวะดังกล่าวยังเป็นสาเหตุสำคัญที่เพิ่มอัตราตายและความพิการก่อนวัยอันควรในประชากรโลกอีกด้วย เพื่อที่จะกำหนดแผนการป้องกันโรคในประชากรกลุ่มเสี่ยงที่ยังไม่เกิดโรคให้มีแบบแผนที่ดี การศึกษานี้จึงได้รายงานอัตราความชุกของความผิดปกติในคลื่นไฟฟ้าหัวใจ ซึ่งจำแนกแบ่งกลุ่มโดยใช้ ข้อกำหนดของ มินิโซตา และรายงานความสัมพันธ์ระหว่างความผิดปกติในคลื่นไฟฟ้าหัวใจ และปัจจัยเสี่ยงของโรคหัวใจ และหลอดเลือดแดงในประเทศไทย*

วัสดุและวิธีการ: *การศึกษาครั้งนี้ คณะผู้วิจัยได้ใช้ข้อมูลที่ได้มาจากผลการสำรวจที่ทำในกลุ่มพนักงานบริษัทชินวัตร แต่เฉพาะพนักงานที่มีผลการตรวจคลื่นไฟฟ้าหัวใจได้ถูกคัดเลือกในการวิจัยครั้งนี้ คลื่นไฟฟ้าหัวใจมาตรฐาน 12 ขั้ว ถูกรวบรวม ขนาดและระยะเวลาได้ถูกวัดและบันทึกลงในคอมพิวเตอร์ หลังจากนั้นคลื่นไฟฟ้าหัวใจถูกกำหนดตามข้อกำหนด มินิโซตา ลักษณะสำคัญ, ความชุกของปัจจัยเสี่ยงของโรคหัวใจ, หลอดเลือด และความชุกของความผิดปกติของคลื่นไฟฟ้าหัวใจได้ถูกคำนวนโดยใช้โปรแกรม spss for windows*

ผลการศึกษา: *จำนวนพนักงานที่ถูกคัดเลือกเข้าร่วมเป็นตัวอย่างในงานวิจัยนี้มีจำนวนทั้งหมด 1,485 คน 638 คน (ร้อยละ 43.0) เป็นเพศชาย และ 847 คน (ร้อยละ 57.0) เป็นเพศหญิง อายุเฉลี่ยของกลุ่มตัวอย่างทั้งหมด 34.4 (5.4) ปี ค่ารายงานปัจจัยเสี่ยงต่อการเกิดโรคหัวใจและหลอดเลือดแบ่งตามเพศชายและเพศหญิงตามลำดับ มีดังนี้ ระดับคอเลสเตอรอลในเลือด 215.6 (41.0) มิลลิกรัม ต่อเดซิลิตร (5.6 (1.1) มิลลิโมลต่อลิตร), 202.8 (35.3) มิลลิกรัม ต่อ เดซิลิตร (5.3 (0.9) มิลลิโมลต่อลิตร); LDL-cholesterol 139.1 (37.0) มิลลิกรัม ต่อ เดซิลิตร (3.6 (1.0) มิลลิโมลต่อลิตร), 123.6 (31.9) มิลลิกรัม ต่อ เดซิลิตร (3.2 (0.8) มิลลิโมลต่อลิตร) ความชุกของภาวะไขมันในหลอดเลือด สูง ร้อยละ 65.3, ร้อยละ 49.8 ค่าเฉลี่ยความดันโลหิตตัวบน และตัวล่าง 121.5 (13.9) มิลลิเมตรปรอท 81.4 (10.5) มิลลิเมตรปรอท, 111.7 (12.2) มิลลิเมตรปรอท และ 74.5 (8.6) มิลลิเมตรปรอท; ความชุกของภาวะความดันโลหิตสูง 21.0%, 4.2%; ค่าเฉลี่ยระดับน้ำตาลก่อนอาหาร 95.5 (15.8) มิลลิกรัมต่อเดซิลิตร (5.3 (0.9) มิลลิโมลต่อลิตร), 88.0 (8.6) มิลลิกรัมต่อเดซิลิตร (5.1 (0.5) มิลลิโมลต่อลิตร); ความชุกของโรคเบาหวาน ร้อยละ 3.3, ร้อยละ 0.5; ค่าเฉลี่ยของดัชนีมวลกาย 23.5 (3.5) (กิโลกรัมต่อตารางเมตร), 21.3 (3.1) (กิโลกรัมต่อตารางเมตร); ความชุกของโรคอ้วน ร้อยละ 30.7, ร้อยละ 11.0; ความชุกของการสูบบุหรี่ ร้อยละ 12.3, ร้อยละ 14.0 อัตราความชุกของ ความผิดปกติคลื่นไฟฟ้าหัวใจซึ่งจัดกลุ่มตามข้อกำหนด มินิโซตา ในเพศชายและเพศหญิงตามลำดับ: ความผิดปกติของคลื่น "Q/QS" (รหัส 1) ร้อยละ 2.2 , ร้อยละ 0.8 ; การลดต่ำลงของคลื่น "S-T-J segment" (รหัส 4) ร้อยละ 0.5, ร้อยละ 1.4; การกลับหัวของคลื่น "T-wave" (รหัส 5) ร้อยละ 1.4, ร้อยละ 9.6; คลื่นการนำกระแสไฟฟ้า จากหัวใจห้องบนสู่ห้องล่าง (รหัส 6) ร้อยละ 2.5, ร้อยละ 0.8; และคลื่นการนำไฟฟ้าในหัวใจห้องล่าง (รหัส 7) ร้อยละ 0.2, ร้อยละ 0.2*

สรุป: *ผลการศึกษานี้รายงานการเพิ่มขึ้นของความชุกของปัจจัยเสี่ยงของการเกิดโรคหัวใจและหลอดเลือดเมื่อเปรียบเทียบกับผลการศึกษาระบาดวิทยาที่เคยมีการทำการศึกษาในประเทศไทยใน อดีตซึ่งน่าจะทำให้กระทรวงสาธารณสุขได้ตระหนักถึงความสำคัญ ในการวางแผนการป้องกันการเกิดโรคหลอดเลือด และหัวใจในประชากรกลุ่มเสี่ยงที่ยังไม่เกิดโรคให้มีประสิทธิภาพเพื่อการป้องกันโรคอย่างมีประสิทธิภาพ นอกจากนี้การศึกษานี้ยังเป็นการศึกษาแรกที่รายงานความชุกของความผิดปกติของคลื่นไฟฟ้าหัวใจ ที่ถูกแบ่งกลุ่มออกตามข้อกำหนด มินิโซตา และความสัมพันธ์ระหว่างความผิดปกติในคลื่นไฟฟ้าหัวใจ และความเสี่ยงต่อการเกิดโรคหัวใจ และหลอดเลือดในเพศชายและหญิงในประเทศไทย*