

Prevalence of coronary heart disease and major cardiovascular risk factors in Thailand

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Background Coronary heart disease (CHD) is expected to become one of the major health problems in developing countries such as Thailand where prevalence data are scarce. This study reports the prevalence of CHD, as indicated by electrocardiogram (ECG) Minnesota coding, and its risk factors in Thailand.

Methods In 1991 we conducted a cross-sectional ECG survey in a multistage random sample of the Thai population, aged ≥ 30 . All major cardiovascular risk factors were measured. Standard supine 12-lead ECG data were collected; amplitudes and intervals were measured manually and entered into a computer. Abnormal tracings were verified by five cardiologists, and agreement among at least three of them was accepted as final.

Results The total sample included 3822 men and 4967 women aged ≥ 30 years. The age-standardized prevalence rate of CHD was 9.9/1000 (men 9.2/1000, women 10.7/1000). The age-standardized level of major cardiovascular risk factors among men and women respectively were: total cholesterol 4.8 mmol/l (187.3 mg/dl), 5.1 mmol/l (197.7 mg/dl); hypercholesterolaemia (≥ 6.2 mmol/l) 12.2%, 16.9%; systolic blood pressure (mmHg) 117.8, 117.7; diastolic blood pressure (mmHg) 76.9, 75.8; body mass index (kg/m^2) 21.7, 22.8; fasting blood sugar 4.8 mmol/l (87.9 mg/dl), 5.0 mmol/l (90.3 mg/dl); hypertension ($\geq 160/95$ \pm on antihypertensive drugs) 6.3%, 8.1%; smoking 65.1%, 8.5%; diabetes mellitus (≥ 7.8 mmol/l) 2.4%, 3.7%; obesity (>25 kg/m^2) 15.2%, 27.2%.

Conclusions Most of the age-adjusted mean values and proportion of major cardiovascular disease risk factors as well as the prevalence of total CHD in the Thai population were much lower than the median of those values found in developing countries.

Keywords Coronary heart disease, electrocardiogram, risk factors, developing countries, Thailand, Minnesota code, prevalence

Accepted 8 October 1997

Cardiovascular disease, one of the major non-communicable diseases, has become a major public health problem in many developing countries.^{1,2} About two-thirds of the estimated 14.3 million annual cardiovascular disease deaths occur in the developing world.³ In the next decade, possible determinants of the increase in cardiovascular diseases, particularly ischaemic

heart disease, in newly industrialized countries include: (1) epidemiological transition from infective to degenerative diseases, (2) increase in the prevalence of cardiovascular risk factors, (3) ageing of the population which eventually leads to an increase in the absolute numbers of coronary heart disease (CHD) and (4) increased health awareness and the demand for health care facilities.^{4,5} However, reports on the prevalence or incidence of ischaemic heart disease in developing countries are very scarce, and routinely collected data are often incomplete and unreliable. For Thailand, although cross-sectional surveys on cardiovascular risk factors have been conducted in many areas,⁶⁻¹⁰ there had never been a national survey before 1991 when the first Thai National Health Examination Survey was carried out with the collaboration of many health organizations and coordinated by the National Epidemiology Board of Thailand. This report is a subsection of the survey and shows the prevalence of CHD determined electrocardiographically. One previous

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epidemiological study on CHD was limited to a small district in the central part of the country and was done a decade ago.⁸

Materials and Methods

Populations

Data were collected by multistage random sampling of the total population of Thailand in the year 1991 (August–December), using the sampling frame of the National Statistical Office of Thailand. The household was used as the sampling unit and all family members aged ≥ 30 years were included in the study.

Variables measured

Fasting blood samples were taken from all study subjects. Plasma glucose and serum cholesterol levels were measured on the day of the survey at the hospital laboratories in the catchment area. Two experienced technicians from each laboratory were specifically trained in the standardized procedures. The standard solution and control serum were provided by the Department of Medical Sciences of the Ministry of Public Health. Trained interviewers used a structured closed-ended questionnaire to collect medical history, smoking habits and alcohol consumption data. The chest pain questionnaire used was modified from the London School of Hygiene cardiovascular questionnaire.¹¹ Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Obesity was defined as BMI $> 25 \text{ kg/m}^2$, diabetes mellitus when fasting plasma glucose $\geq 7.8 \text{ mmol/l}$ (140 mg/dl) and hypercholesterolaemia when serum total cholesterol was $\geq 6.2 \text{ mmol/l}$ (240 mg/dl).

Blood pressure was measured from the right arm after the subject had been sitting for longer than 5 minutes using a standard mercury sphygmomanometer with cuff 13 cm wide and 42 cm long and using Korotkoff sounds I and V. Systolic and diastolic blood pressure values were recorded to the nearest 2 mmHg. Three measurements were done at intervals of at least one minute. Average values were used for the report. The WHO criteria for hypertension (HT) were used: blood pressure $\geq 160 \text{ mmHg}$ systolic and/or 95 mmHg diastolic or both or self-reported antihypertensive medication during the past week.

Electrocardiograms (ECG)

Standard supine 12-lead ECG were recorded using ECG equipment fulfilling the recommendations of the American Heart Association for technical specifications.

All ECG records (25 mm/second) were mounted and measured manually by five cardiovascular and intensive care unit nurses. They were trained in the recognition of ECG wave form and in the measurement of amplitudes and intervals, based on the Minnesota Classification of the ECG for population studies.¹¹ The first 500 ECG records were used for training. Differences in measurement were repeatedly discussed and clarified in groups. They were not asked to code the ECG. The measurements of all ECG records were separately entered into a computer by two assistants and the results compared. The criteria modified from the Minnesota code 1.1, 1.2, 4.1 and 5.1¹¹ were used to detect abnormalities and were applied to all leads except a VR: (1) Q duration of ≥ 0.03 second, (2) S-T-J segment depression $\geq 2 \text{ mm}$, (3) T wave amplitude negative $\geq 5 \text{ mm}$.

The ECG screened initially as abnormal (referred to as M-ischaemic) were duplicated and distributed to five experienced

cardiologists (each with > 10 years clinical practice). Based on the pattern reading, they were asked to assess the tracings twice with at least a 7-day interval between each reading. They were blinded with regard to the subject's age and sex and were required to categorize each record as showing either: (1) Ischaemic heart disease: when the abnormalities in the ST segment and/or T wave were suggestive. (2) Myocardial infarction: indicated by the presence of a pathological Q wave. (3) Uncertain: when uncertainty exists as to diagnosis of ischaemic heart disease or myocardial infarction. (4) Others: none of the preceding three.

The final diagnosis rested on the pattern of disagreement: If there was intra-observer disagreement, the diagnostic pairs between 1 and 3, or 1 and 4 would be treated as diagnosis 1 and the diagnostic pairs of 2 and 3, or 2 and 4 would be treated as diagnosis 2. For inter-observer disagreement, the agreement of at least three cardiologists was accepted as final. Myocardial infarction and ischaemic heart disease were considered as CHD. The ECG from subjects with chest pain or history of myocardial infarction as obtained from the modified chest pain questionnaire were analysed separately as part of a study to evaluate the modification of the questionnaire. For the same reason, we did not use the result of the questionnaire as a criteria for CHD. As will be seen, this group turned out to be similar with regard to CHD to the main group.

Statistics

To allow comparison with reports from the other developing countries,¹² prevalence rate of CHD, mean values and the proportion of the major cardiovascular risk factors for the total sample population (age ≥ 30 years) and 35–59 years old subgroup were calculated. Age-standardization was performed using the world standard population.¹³ The Kappa statistic for multiple rating per subject was used for inter-observer agreement.¹⁴ The prevalence rate ratios of having CHD from ECG given a specific risk factor was also estimated.¹⁵ Chi-squared as well as Fisher exact probability statistics were applied where appropriate. All *P*-values were two sided.

Results

Among the 17 provinces surveyed there were 5881 households and 23 884 family members. In all 8791 were ≥ 30 years (43.5% male) and all had a 12-lead surface ECG. The response rates for each cardiovascular risk factor assessment varied from 95% to 99%. The distribution ratio of respondents by urban over rural areas was 0.6. According to the Minnesota coding criteria, 323 subjects were initially screened as M-ischaemic (probable myocardial infarction or ischaemic heart disease) and 82 cases (25.4% of the M-ischaemic) were finally diagnosed with CHD by the cardiologists (Kappa = 0.46) (95% CI: 0.42–0.49). Table 1 shows the unadjusted and age-standardized level of major risk factors and the proportion of population with high risk levels.

Table 2 shows the age- and sex-adjusted and age-standardized prevalence rate of CHD as determined by the ECG. Older subjects had higher rates for both sexes ($P < 0.001$). Males had a lower overall CHD rate than females but the difference did not attain significance ($P = 0.94$). The age-specific rate differences between both sexes were insignificant ($P > 0.05$), except in the

Table 1 Unadjusted and age-standardized level of major risk factors and proportion of population with high risk levels^a

	Male (N = 3822)		Female (N = 4969)	
	Unadjusted	Age-standardization	Unadjusted	Age-standardization
Total cholesterol (mmol/l)	4.8 (4.8–4.9)	4.8	5.0 (5.0–5.1)	5.1
Systolic blood pressure (mmHg)	117.8 (117.2–118.4)	117.8	117.0 (116.5–117.6)	117.7
Diastolic blood pressure (mmHg)	77.0 (76.5–77.4)	76.9	75.8 (75.4–76.1)	75.8
Body mass index (kg/m ²)	21.7 (21.6–21.8)	21.7	23.0 (22.8–23.1)	22.8
Fasting blood sugar (mmol/l)	4.8 (4.8–4.9)	4.8	4.9 (4.9–5.0)	5.0
Hypertension (%) (\geq 160/95 ± antihypertensive)	6.3	6.3	7.7	8.1
Smoking (%)	65.2	65.1	8.4	8.5
Diabetes mellitus (%) (\geq 7.8 mmol/l)	2.4	2.4	3.6	3.7
Obesity (%) ($>$ 25 kg/m ²)	15.4	15.2	27.9	27.2
Hypercholesterolaemia (\geq 6.2 mmol/l)	12.4	12.2	16.7	16.9

^a The numbers represent mean and (95% confidence limit).

Table 2 Age-sex adjusted and age-sex standardized prevalence rate of coronary heart disease as determined by electrocardiogram (/1000)

Age group ^b	Male ^a		Female		Male versus female	Total	
	N	rate	N	rate	95% CI	N	rate
30–34	651	4.6	900	2.2	–0.004, 0.008	1551	3.2
35–44	1165	0.8*	1531	6.5	–0.010, –0.001	2696	4.1
45–54	867	8.1	1048	3.8	–0.003, 0.011	1915	5.7
55–64	676	13.3	854	9.4	–0.007, 0.015	1530	11.1
65–74	337	23.8	439	31.9	–0.031, 0.015	776	28.3
\geq 75	126	47.6	197	40.6	–0.039, 0.053	323	43.3
Total	3822	8.9	4969	9.2	–0.004, 0.004	8791	9.1
Age-standardized rate		9.2		10.7			9.9

^a Compared to female in each group, all were not different at $P > 0.05$ with Fisher exact probability and χ^2 tests, except the age group 35–44 (* $P = 0.03$).

^b Age group comparisons using χ^2 for linear trend, $P < 0.001$

35–44 year age group where the rate was significantly lower in males ($P = 0.03$). Age standardization raised the prevalence rate slightly.

The prevalence rate ratios of having electrocardiographic CHD for each major cardiovascular risk factor are shown in Table 3. The ratios tended to be greater than one but none of them reached statistical significance.

From the chest pain questionnaires, 5.3% had a history compatible with anginal pain and possible myocardial infarction. Among those with angina, 1.1% had ECG showing CHD as compared to 0.9% of those without angina, while 1.5% of subjects with possible infarction and 0.9% of those without had CHD on ECG respectively.

Discussion

The data reported are a cross-sectional survey of the prevalence rate of CHD and major cardiovascular risk factors among the

Thai population as it undergoes epidemiological transition. Thailand is becoming more affluent through industrialization, lifestyles are changing and life expectancy at birth has long been over 60 years for both sexes.¹⁶ Therefore, comparison of these data with the previous survey done in a small community in the central part of Thailand⁸ is difficult, especially in view of the differences in time and diagnostic methods. Also, the criteria for CHD in the present survey were determined by a preset level of agreement among cardiologists instead of on one opinion. Lastly we did not include subjects with complaints of anginal pain or history of previous myocardial infarction. As it turned out, this last group had similar distribution of CHD based on ECG.

In comparison with different countries and ethnic groups, the present Thai population shows a much lower rate of electrocardiographic CHD than many developed countries,^{17,18} some Indian populations^{19,20} as well as other ethnic groups.¹² Li¹² reported the prevalence of total CHD as the combination of both

Table 3 The prevalence rate ratios of having electrocardiographic coronary heart disease (CHD) with each major cardiovascular risk factor (adjusted for age)

	Male			Female		
	CHD with risk	CHD without risk	PRR ^a (95% CI)	CHD with risk	CHD without risk	PRR ^a (95% CI)
Smoking	25/2465	11/1317	1.5 (0.7–3.0)	6/414	40/4508	1.4 (0.5–3.5)
Hypertension	4/237	32/3548	1.3 (0.4–3.7)	7/376	39/4547	1.1 (0.4–3.0)
Diabetes mellitus	3/89	33/3696	2.8 (0.8–9.5)	2/179	44/4744	1.0 (0.2–4.2)
Obesity	6/572	30/3138	1.3 (0.5–3.0)	12/1347	30/3486	1.2 (0.6–2.3)
Hypercholesterolaemia	7/447	28/3186	1.7 (0.7–4.0)	7/787	37/3927	0.7 (0.3–1.7)

^a PRR = prevalence rate ratios; all *P* values were >0.05.

Table 4 Comparison of age-adjusted mean values and proportion of cardiovascular risk factors and prevalence rates in both sexes aged 35–39 in Thai population and nine developing countries¹²

	Male		Female	
	Thailand	Nine countries ^a	Thailand	Nine countries ^a
Total cholesterol (mmol/l)	4.8	4.7; 3.9–5.9	5.1	4.7; 3.9–5.9
Systolic blood pressure (mmHg)	116	128; 122–138	116	130; 121–138
Diastolic blood pressure (mmHg)	77	82; 76–91	76	78; 75–90
Body mass index (kg/m ²)	22.0	26.8; 22.9–32.9	23.5	27.6; 23.9–37.0
Fasting blood sugar (mmol/l)	4.8	5.7; 5.2–8.3	5.0	5.8; 5.2–8.3
Smoking (%)	66	61; 36–82	8.9	21; 1–65
Hypertension (%)	6.3	18; 7–35	7.2	16; 7–33
ECG-CHD ^b (%)	0.6	8.0; 0.8–17.3	0.6	18.7; 3.6–34.3

^a The numbers for the nine countries represent median and range.

^b ECG-CHD = electrocardiographic-CHD prevalence.

probable (Minnesota code 1.1–1.2) and possible CHD (Minnesota code 1.3, 4.1–4.4, 5.1–5.3 and 7.1:1) among the 15 population groups in nine developing countries aged 35–59 years. The rates varied from 0.8% to 16.6% among males and 3.2% to 34.3% among females (Table 4).

When data from the 35–59 year age groups were compared, the age-adjusted mean values and proportion of major cardiovascular disease risk factors and the prevalence of total CHD in the Thai population of both sexes, appear much lower than the median of those values found in those nine developing countries.¹² However, total cholesterol values for both sexes and smoking rates among males in Thailand are in the higher range of the nine countries. This lower prevalence and levels of these risk factors among the Thai population may partly explain the low CHD rate in Thailand. Ethnic difference may play a role in causing the variation of major coronary risk factors and CHD prevalence rates across different populations.^{21–23} The difference in diagnostic criteria on the ECG could be another reason for the difference in prevalence. Agreement of three out of five cardiologists' interpretations (by pattern reading) of the computer screened 'M-ischaemic' group decreased the numbers of CHD to about three-quarters. However, if the diagnostic criteria were changed to accept agreement of at least two cardiologists, the CHD rate will only be double which would still place Thailand in the lower range for these developing countries.

Several studies have shown that the prevalence rate of primary ST-T abnormalities was significantly higher in women than men,^{24,25} regardless of ethnic group. Inclusion of the Minnesota codes 4.2–4.4, 5.2–5.3 and 7.1.1 into the diagnostic

criteria would increase the sensitivity of the diagnosis of CHD in females more than males. This had been shown in previous surveys including a Thai community⁸ and the nine developing countries.¹² Although our survey shows that the rate in females is slightly higher than that of the males, the age-specific rate is higher in males in almost all age groups. Reducing the applicability of Minnesota codes as well as using cardiologists' interpretation in this survey result in a lower CHD prevalence rate in both sexes and a decrease in the magnitude of the difference of the rates of CHD between male and female.

Since 1989 it has been claimed that heart disease has been the leading cause of death in the Thai population and ischaemic heart disease mortality rises yearly. However, deaths from ischaemic heart disease contribute only 4% of the total heart disease mortality (2.4 out of 58.5 per 100 000 in 1993).¹⁶ This is much lower than reported in other developing countries both in Asia and America.^{21,23,26–28}

In summary, our survey at the national level demonstrates that CHD, as defined by routine ECG as well as the major cardiovascular risk factor levels and the prevalence (except smoking rate and mean cholesterol level), is ranked below the medians of those found among many developing countries.

Acknowledgements

This study is supported jointly by the National Epidemiology Board of Thailand (NEBT), the Thailand Health Research Institute (THRI), the Ministry of Public Health of Thailand, Khon Kaen University, Chulalongkorn University, Mahidol University,

Prince of Songkla University, the Royal College of Physicians of Thailand, the Thai Heart Association and the National Health Examination Survey teams. We wish to specially thank Dr Chanpen Chuprapawan for her superb co-ordination, Professor Richard F Heller and Professor Chitr Sitthi-Amorn for their comments on the manuscript. We also wish to thank the Clinical Epidemiology Unit, Khon Kaen University, particularly to Mrs Kaewjai Khumsuk for data processing and analysis.

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