

Prevalence Rates of Major and Minor Electrocardiogram Abnormalities in the Singapore General Population

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Abstract

A cross-sectional survey on the general population was carried out in Singapore, with each of the 2143 persons (Chinese, Malays and Indians) aged 18 to 69 years having a 12-lead resting electrocardiogram (ECG). The tracings were coded according to the Minnesota Code with major abnormalities being Q wave changes (I-1 and I-2), complete atrio-ventricular (A-V) block (6-1), and left bundle branch block (7-1) and minor abnormalities being lesser Q wave changes (I-3), ST depression of at least 1 mm (4-1), and T wave inversion of at least 1 mm (5-1 and S-2). In all age groups the prevalence rates of any major abnormality were higher in males than females. In the age-adjusted 18-69 age group the prevalence rates in males and females were 2.0% and 0.5% respectively ($P = 0.001$). The prevalence rates of any minor abnormality (without any major abnormality) were higher in females than males in all age groups and in the age-adjusted 18-69 age group the prevalence rates in males and females were 3.5% and 5.4% respectively ($P = 0.027$). The prevalence rates of any minor abnormality (without any major abnormality) in the 18-29 age group in males and females were 2.2% and 4.7% respectively, indicating that these proportions of the population have minor abnormalities as a normal physiological variant. It is estimated in the 50-69 age group that 33.8% of males and 50.0% of females with any minor abnormality (without any major abnormality) have these changes as a normal physiological variant,

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Introduction

The resting electrocardiogram (ECG) is being increasingly used in epidemiological surveys and screening for coronary heart disease (CHD). The Minnesota Code has been devised to standardise the reading and coding of the ECG.¹ For CHD there are major abnormalities indicating probable cardiac ischaemia and minor abnormalities indicating possible cardiac ischaemia.² The ECG is particularly useful for comparing prevalence rates of CHD in different populations, mainly because of good repeatability. However its validity has been questioned.³ No pattern is completely specific for ischaemia as changes, particularly minor ones, may result from other cardiac conditions or as normal physiological variants.

It would be useful to have measures of the prevalence of major and minor ECG abnormalities in different populations. This is particularly so if these include females and younger persons as most surveys to date have been on middle-aged men, which may have led to an over emphasis of minor abnormalities as an indicator or predictor of cardiac ischaemia.

Singapore is an island state of 620 sq km which in June 1984 had a population of 2.53 million composed of

Chinese, Malays, Indians and Others, whose origins have been described.⁴ This country has undergone rapid economic development. The commonest causes of death now are cardiovascular diseases and cancers.⁵ A cardiovascular risk factor survey was carried out on a cross-sectional random sample of the general population to measure cardiovascular risk factors. This paper describes the prevalences of major and minor ECG abnormalities indicative of ischaemia in Asians (Chinese, Malays, and Indians).

Materials and Methods

The sampling and basic methodology of the survey have been described.⁶ It was a random sample of the whole population of Singapore with 2143 persons aged between 18 and 69 years responding (response rate 60.3%), and comprising 65.3% Chinese, 20.7% Malays, and 14.0% Indians. Reasons have been given for believing there was no significant bias from the non-responders.⁶

All clinics were held on Saturday mornings between 0900 and 1200 hours from 1982 to 1985. A 12-lead resting ECG was carried out by a trained technician under the

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supervision of the author, on the Hewlett-Packard 4700 A Pagemriter Cardiograph, at 25 mm per second with the subject lying supine. The procedure and conditions were as recommended.⁷ Room temperature was kept uniform at 21 °C by central air-conditioning, and smoking and physical exercise were avoided for at least 30 minutes prior to the recording. Full attention was paid to cleaning and placing the electrodes.

Subsequently all tracings were read and coded (blind of any demographic and medical details of the subjects) by the author (a physician) according to the Condensed Minnesota Code,⁸ in conjunction with two texts.^{9,10} The relevant categories of ischaemia according to the Minnesota Code are as follows:

Major abnormalities: Q wave changes (1-1 and 1-2); complete atrio-ventricular block (6-1); complete and intermittent left bundle branch block (7-1).

Minor abnormalities: Lesser Q wave changes (1-3); ST depression of at least 1 mm (4-1); T wave inversion of at least 1 mm (5-1 and 5-2). Lesser degrees of ST depression (4-2 and 4-3) and T wave inversion (5-3) were not included.

It should be noted that in the evaluation of these abnormalities by the Minnesota Code, consideration is given to aspects such as leads and the shape of the ST segment depression (it must be horizontal or downward sloping).

Comparison of age-specific prevalence rates was by the chi square test. While the age distributions were virtually the same in the 2 genders, age-adjustment for the 18-69 age group was carried out by direct standardisation to the total population of both genders, with the Z test used for significance testing.**

Results

The results in Table I show the prevalence rates (i.e. proportions of the population) with any major abnormality

(indicating probable cardiac ischaemia) and any minor abnormality in the absence of any major abnormality (indicating possible cardiac ischaemia). None of the 26 persons found to have congenital heart disease or chronic rheumatic carditis fulfilled the criteria for major or minor abnormalities and hence remained in the study population.

The prevalence rate of any major abnormality increased with age, with just one case (a male) in the 18-29 age group. Prevalence rates were higher in males than females, with male to female ratios of 2.5 and 5.4 in the 30-49 and 50-69 age groups, respectively. The gender difference in the 50-69 age group (5.3%) was statistically significant ($P = 0.019$), while age-adjusted rates in the 18-69 age group showed a gender difference of 1.5% which was highly statistically significant ($P = 0.001$).

Table I also shows that the prevalence rates of any minor abnormality (with no major abnormality) steadily increasing with age in males, while for females there was no change from the age group of 18-29 to the age group of 30-49 but an increase in the 50-69 age group. Rates were higher in females than males in all age groups, with female to male ratios of 2.1, 1.3 and 1.4 in 18-29, 30-49, and 50-69 age groups, respectively. In the 18-69 age group, age-adjusted rates showed that females had a higher prevalence rate than males by 1.9% ($P = 0.027$) with a gender ratio of 1.5.

Discussion

This survey in Singapore is based on the Minnesota Code which standardises the reading and coding of the ECG, allowing comparisons with other surveys. The clinician, in evaluating whether or not a person has CHD, does consider aspects beyond the Minnesota Code in addition to the abnormalities in the Code. Hence the information provided in this survey is essentially epidemiological but does have clinical relevance.

When comparing this survey to other surveys on ECG abnormalities, a number of points should be noted. Firstly, the findings in this survey referred to persons

TABLE I: PREVALENCE RATES OF ANY MAJOR* AND MINOR** (WITHOUT ANY MAJOR*) ELECTROCARDIOGRAM ABNORMALITIES BY GENDER AND AGE GROUP

Age group	Males			Females		
	No.	Major abnormality % (95% CI)	Minor abnormality % (95% CI)	No.	Major abnormality % (95% CI)	Minor abnormality % (95% CI)
18-29	403	0.2 (-0.2 to 0.6)	2.2 (0.8 to 3.6)	379	0 (0)	4.7 (2.6 to 6.8)
30-49	458	1.5 (0.4 to 2.6)	3.3 (1.7 to 4.9)	518	0.6 (-0.1 to 1.3)	4.4 (2.6 to 6.2)
50-69	215	6.5 (3.2 to 9.8)	6.5 (3.2 to 9.8)	170	1.2 (-0.4 to 2.8)	9.4 (5.0 to 13.8)
18-69#	1076	2.0 (1.2 to 2.8)	3.5 (2.4 to 4.6)	1067	0.5 (0.1 to 0.9)	5.4 (4.0 to 6.8)

* Minnesota Codes 1-1, 1-2, 6-1, 7-1

** Minnesota Codes 1-3, 4-1, 5-1, 5-2

Age-standardised to the total sample population

CI: Confidence interval

with any major abnormality (indicating probable ischaemia) and to persons with any minor abnormality (without any major abnormality (indicating probable ischaemia)). In other words, persons with both major and minor abnormalities were categorised under major. Secondly, in many surveys, prevalences of individual abnormalities were reported (allowing individuals to be counted more than once) rather than persons with any abnormality as in this study. Thirdly, in this survey, for minor abnormalities, lesser degrees of ST depression (Minnesota Codes 4-2 and 4-3) and T wave inversion (Minnesota Code 5-3) were not included unlike some surveys. For these reasons, comparisons were precluded with some surveys.^{12,13}

It has been stated that T wave abnormalities have been reported in 0.5% to 4.2% of the normal population.¹⁴ In a study of healthy US airmen aged 16 to 50 years, a prevalence rate of 1.15% was found for non-specific T wave changes including just low amplitude.¹⁵ In a survey of British male civil servants aged 50 to 64 years, a summation of codes 1-1, 1-2 and 7-1, and codes 1-3, 4-1, 5-1 and 5-2 (the same codes as in this study in Singapore) was estimated at 3.8% and 4.1%,¹⁶ though obviously the prevalence rates of any of these codes (as presented here for Singapore) would be less due to overlap. This compares with the rates in Singaporean males aged 50 to 69 years for any of the major and minor ECG abnormalities which were 6.5% and 6.5% respectively (Table I). Hence, it seems that Asians have a greater prevalence of abnormalities than Caucasians, perhaps due to anthropometric differences such as thinner chest walls.

The validity of minor ECG abnormalities as an indicator or predictor of cardiac ischaemia is not clear. The British civil servants study showed that minor abnormalities are associated with a slightly increased risk of subsequent CHD.¹⁶ In the Framingham study for persons aged over 35 years the age-adjusted morbidity and mortality from CHD occurred at about twice the rate in those of either gender who exhibited T-wave or ST-segment abnormalities compared to those who did not.¹⁴ In the Chicago study, ST-T abnormalities were associated with a significantly increased CHD mortality in the middle-aged (40 to 64 years) but the excess was much greater for men than women.¹⁷ A review of the epidemiological evidence came to the conclusion that while minor ST segment and T wave abnormalities are associated with an increased risk of a subsequent coronary event, the excess risk is small for those without symptoms.¹⁸ Further it has been stated that the low attributable sudden death rates suggest that ST and T wave changes are not specific for CHD.¹⁹ This is supported by the fact that ST and T abnormalities are more common in women than men as found in the middle-aged¹⁷ and the elderly,²⁰ although in the

Framingham study little difference was found between the genders.¹⁴

This survey has also found minor abnormalities to be more common in females than males and to be present in young persons, in contrast to major abnormalities which were more common in males than females and were very infrequent at younger ages. Hence the evidence is that minor abnormalities are much less likely than major ones to be indicative or predictive of ischaemia.

This may well be due to the fact that minor ECG abnormalities can occur as a normal physiological variant and persons with these benign abnormalities form a proportion of any population with minor abnormalities. Probably benign minor abnormalities are more common in females than males at least partly due to anthropometric differences such as thinner chest walls. The greater prevalence of benign minor abnormalities in females than males is probably part of the explanation for the findings that males do not show a greater prevalence of ECG abnormalities compared to females despite their greater frequency of CHD which has been discussed by others,^{14,21} and that ST-T abnormalities are more predictive of CHD in males than females.¹⁷

It is not clearly known what proportion of the population have benign minor ECG abnormalities, though it would be important information. However this can be estimated from this study assuming that for all persons in the young age group of 18-29 years having these abnormalities are neither indicative nor predictive of ischaemia. While only a follow-up study can prove this point, it would seem to be reasonable as persons under 30 years are unlikely to have cardiac ischaemia. On this assumption, it can be estimated that for Asians in Singapore, 2.2% of males and 4.7% of females have some minor ECG abnormalities (without any major abnormality) as a normal physiological variant (Table I) and this should be considered in epidemiological surveys and screening for CHD. Using these prevalence rates it can be further estimated from Table I that, in the 50-69 age group (in which the resting ECG is commonly used in epidemiological surveys of and screening for CHD), 33.8% of males (i.e. a third) and 50.0% of females (i.e. half) with any minor abnormality (without a major one) have this abnormality as a benign condition.

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