Coronary heart disease mortality trends in men in the post World War II birth cohorts aged 35–44 in Japan, South Korea and Taiwan compared with the United States

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Background Since World War II, people in Japan, South Korea, and Taiwan have been exposed to a westernized lifestyle. It is most likely that the post World War II cohorts (1950+) have been more exposed. We hypothesize that there would be an increase in mortality from coronary heart disease (CHD) in men aged 35–44 in these countries.

Methods and Results Mortality from CHD in men aged 35–44 in South Korea and Taiwan has recently increased, and in Japan it has decreased. Mortality from CHD in men aged 35–44 is lower in Japan than in either South Korea or Taiwan, and much lower than in the US. National sample data and several epidemiological studies have shown that risk factors for CHD including hypercholesterolaemia and hypertension in the past decade were not much different between young adult men in Japan and the US. Based upon these risk factors, CHD death rates among post World War II cohorts should be similar in Japan and the US. However, the rates are five times higher in the US for men aged 35–44. The majority of deaths in the category of diseases of the heart were from heart failure in men in this age group in Japan; the mortality from heart failure was about three times higher than the mortality from CHD. Heart failure was rarely used in men aged 35–44 in the US.

Conclusions The continued low mortality rates from CHD in young men in Japan may be an artifact. It is possible that CHD death rates in post World War II birth cohort in Japan are similar to US rates.

Keywords Coronary heart disease mortality, international epidemiology, Japan, South Korea, Taiwan, United States

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Mortality rates due to coronary heart disease (CHD) grew at a rapid rate early in the 20th century in the US and Western countries. By mid-century it had become the most common cause of death in many developed countries. In the past few decades, a dramatic decrease in mortality from CHD has been observed in many of these countries.1,2 Coronary heart disease, however, remains the leading cause of death in the US and most developed countries. Coronary heart disease is also emerging rapidly in most developing countries as they adopt similar lifestyles to Western countries in which the CHD death rates are higher.

Cross-cultural studies have generated hypotheses concerning environmental and genetic causes of disease.3–6 The Seven Countries Study was one of the earliest, most comprehensive investigations of cardiovascular disease.3 Among industrialized countries in the 1980s, age-standardized mortality from ischaemic heart disease in Japan was strikingly low for both men and women.7 The age-adjusted mortality in the US was more than five times higher than in Japan. The reasons for the
difference have been attributed in part to the lower fat intake and higher polyunsaturated/saturated (P/S) ratio, less stress, and protective factors such as omega-3 fatty acids and soy proteins in Japanese culture and cuisine.

Studies of Japanese migrants to the US revealed a substantial rise in mortality from CHD compared to population in Japan. The Ni-Hon-San Study showed that adopting westernized dietary habits and other lifestyle factors were significant determinants of CHD. The Honolulu Heart Program showed that risk factors for developing CHD among Japanese men were hypertension, hypercholesterolaemia, and smoking.

After the Second World War, people in South Korea, Japan, and Taiwan have been exposed to a westernized lifestyle. It is most likely that the post World War II cohort (1950+) has been most exposed. We hypothesize that there would be an increase in mortality from CHD in men aged 35–44 as of 1985–1992; the 35–44 age group born in 1950 in these countries. In this paper, we compared trends of mortality from CHD and acute myocardial infarction (AMI) in men aged 35–44 from 1985 to 1992 in these three countries and the US, and then trends in risk factors for CHD in young adult men in 1970–1980 between Japan and the US.

Materials and Methods

Mortality trends among Japan, South Korea, Taiwan and the US

Mortality data on CHD and AMI among men aged 35–44 during 1985 through 1992 from the four countries were obtained. For international comparison, the International Classification of Diseases, Ninth Revision (ICD-9) was employed: for CHD, ICD-9 codes 410–414.9 and for AMI, 410–410.9.

The data in Japan were obtained from the Vital Statistics by the Ministry of Health and Welfare, Japan. The data in South Korea were obtained by request to the National Statistics Office of the Ministry of Finance and Economy, South Korea. The data in Taiwan were obtained from Department of Health, Executive Yuan, Republic of China. The data in the US were obtained utilizing a database at Centers for Disease Control and Prevention available on the Internet (http://wonder.cdc.gov). Mortality data by age, sex, year, ICD-9 code, and others are available in the database.

Risk factors for CHD between Japan and the US

Levels of risk factors for CHD during 1970 to 1980 among young adults were compared between Japan and the US. These risk factors consist of mean values of total cholesterol, mean values of systolic and diastolic blood pressure, and prevalence of smoking. These data were obtained from the National Health and Nutrition Examination Surveys in the US, the National Nutrition Surveys of Japan, National Surveys of Circulatory Disorders, and others. These data are considered to be representative for the population of each nation. Since the way ages are grouped was different in almost all data sources, raw data are presented.

Results

Mortality trends

Figure 1 shows the trends in mortality from CHD (ICD codes 410–414) in men aged 35–44 in Japan, South Korea, and Taiwan. In 1985, the mortality from CHD in men aged 35–44 in Japan was the highest among these three countries: 5.9/100 000 (number of deaths: 587). During 1985 through 1992, the mortality from CHD in men aged 35–44 in South Korea and Taiwan increased very rapidly. It increased from 4.3/100 000 (no. of deaths: 106) to 11.4/100 000 (no. of deaths: 357) in South Korea and from 4.1/100 000 (no. of deaths: 43) to 7.8/100 000 (no. of deaths: 125) in Taiwan, while in Japan it slightly decreased from 5.9/100 000 to 5.4/100 000 (no. of deaths: 520). During 1985 through 1992, the mortality from CHD in men aged 35–44 in the US continuously decreased: from 38.8/100 000 (no. of deaths: 6051) to 26.5/100 000 (no. of deaths: 5374). The ratios of the mortality from CHD in men aged 35–44 between South Korea and the US, and between Taiwan and the US diminished substantially from 9 to 2.4 and

![Figure 1](image-url)
remained relatively constant: 5.2 in 1985 and 3.8 in 1992. The ratios between Japan and the US decreased from 6.1 in 1985 to 1.5 in 1992. The ratios between Taiwan and the US were reduced substantially from 9.5 to 3.5, respectively. The mean level of total cholesterol among young adult men remained almost the same or decreased in the US in men aged both 18–24 and 25–34 years. The mean levels of systolic blood pressure declined in the US in men aged both 18–24 and 25–34 years.

### Table 1: Trends in the mortality (per 100,000) from diseases of the heart (ICD codes 390–429) and its subcategories in men aged 35–44 in Japan, South Korea, Taiwan, and the US during 1985 through 1992

<table>
<thead>
<tr>
<th>Year</th>
<th>Japan</th>
<th>South Korea</th>
<th>Taiwan</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>24.0</td>
<td>81.3</td>
<td>18.7</td>
<td>39.0</td>
</tr>
<tr>
<td>1986</td>
<td>25.0</td>
<td>74.4</td>
<td>17.9</td>
<td>39.9</td>
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<tr>
<td>1987</td>
<td>23.5</td>
<td>62.3</td>
<td>21.6</td>
<td>39.9</td>
</tr>
<tr>
<td>1988</td>
<td>23.5</td>
<td>58.6</td>
<td>21.9</td>
<td>39.9</td>
</tr>
<tr>
<td>1989</td>
<td>22.9</td>
<td>53.8</td>
<td>21.3</td>
<td>39.9</td>
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<tr>
<td>1990</td>
<td>23.3</td>
<td>43.0</td>
<td>22.2</td>
<td>39.9</td>
</tr>
<tr>
<td>1991</td>
<td>25.1</td>
<td>44.7</td>
<td>18.8</td>
<td>39.9</td>
</tr>
<tr>
<td>1992</td>
<td>24.8</td>
<td>32.8</td>
<td>21.7</td>
<td>39.9</td>
</tr>
</tbody>
</table>

### Table 2: Levels of risk factors for coronary heart disease among young adult men during the period of 1970 and 1980 in Japan and the US

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Country</th>
<th>Age group</th>
<th>1970</th>
<th>1980</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean total cholesterol (mmol/L)</td>
<td>US</td>
<td>18–24</td>
<td>4.83</td>
<td>4.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25–34</td>
<td>5.44</td>
<td>5.15</td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>30–39</td>
<td>–</td>
<td>4.84</td>
</tr>
<tr>
<td>Mean systolic blood pressure (mmHg)</td>
<td>US</td>
<td>18–24</td>
<td>123.5</td>
<td>124</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25–34</td>
<td>125.5</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>15–19</td>
<td>–</td>
<td>122.5</td>
</tr>
<tr>
<td></td>
<td>Taiwan</td>
<td>20–24</td>
<td>128</td>
<td>127.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25–29</td>
<td>127</td>
<td>127.1</td>
</tr>
<tr>
<td>Mean diastolic blood pressure (mmHg)</td>
<td>US</td>
<td>18–24</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25–34</td>
<td>81.1</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>15–19</td>
<td>–</td>
<td>69.7</td>
</tr>
<tr>
<td></td>
<td>Taiwan</td>
<td>20–24</td>
<td>75</td>
<td>73.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25–29</td>
<td>76</td>
<td>74.9</td>
</tr>
</tbody>
</table>

### Prevalence of smoking (%)

<table>
<thead>
<tr>
<th>Prevalence of smoking (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
</tr>
<tr>
<td>18–24</td>
</tr>
<tr>
<td>25–44</td>
</tr>
<tr>
<td>Japan</td>
</tr>
<tr>
<td>20–29</td>
</tr>
<tr>
<td>25–39</td>
</tr>
</tbody>
</table>

#### AMI (ICD code 410) in Japan, Taiwan, and the US: it remained stable in Japan, increased slightly in Taiwan, and decreased in the US. However, contrary to the upward trend in mortality from CHD and AMI, mortality from diseases of the heart among men aged 35–44 (ICD codes 390–429) in South Korea declined substantially during this period from 81.3/100,000 to 32.8/100,000. This dramatic decline is attributed to the decline in mortality from hypertensive diseases (ICD codes 401–405) and other heart diseases (ICD codes 415–429).

### Levels of risk factors for CHD between Japan and the US

Table 2 shows the levels of risk factors for CHD during the period of 1970 and 1980 in Japan and the US. Mean levels of total cholesterol declined in the US in men aged both 18–24 and 25–34 years. The mean level of total cholesterol among men aged 30–39 in Japan in 1980 was 4.84 mmol/l and <5.15 mmol/l for men aged 25–34 in the US.

Mean levels of systolic blood pressure among young adult men remained almost the same in the two countries during this period. The levels were 2–4 mmHg higher in young adult men in Japan than those in the US. Mean levels of diastolic blood pressure among young adult men remained almost the same or declined slightly in the two countries during this period. The
levels were 2–4 mmHg higher in young adult men in the US than in those in Japan.

The prevalence of smoking was much higher in Japan than in the US and declined in both countries.

**Discussion**

Mortality data from CHD among men aged 35–44 provide a good estimate of recent cohort trends. The deaths among this age group are most likely to be incident, rather than from long-standing chronic clinical heart diseases. Cohort alternation in risk factors would emerge more rapidly in this age group than older age groups. It is also likely that mortality data are more reliable in this age group than older age groups.

Uemura et al. pointed out that the proportion of mortality from CHD (ICD codes 410–414) among mortality from diseases of the heart (ICD codes 390–429) varies widely among industrialized countries possibly due to physicians’ diagnostic practice. Some of the differences are due to specific heart diseases other than CHD which vary in prevalence by country. We reviewed the proportion of mortality from pulmonary circulation (ICD codes 415–417) and other forms of heart disease (ICD codes 420–429) among diseases of the heart (ICD codes 390–429) among men aged 35–44 in 1992. The proportion was 76% in Japan, 46% in South Korea, 56% in Taiwan, and 36% in the US. Investigations of the accuracy and validity of these death certifications are clearly needed in a standardized manner among these countries.

Koga et al. pointed out the possibility that death from heart attack has been reported in generic terms as ‘acute heart failure’ on the death certificate and thus is classified as ‘other heart disease’ instead of CHD in Japan. Among the industrialized countries the proportion of deaths due to heart failure (ICD code 428) in heart disease is the highest in Japan. Almost 50% of sudden deaths among people aged 40–64, (which are very likely to be classified as acute heart failure) autopsied in the Tokyo Medical Examiner’s Office in 1986, were found to be due to CHD. This implies strongly that the mortality from CHD in Japan is underestimated.

We further reviewed the specific distribution of heart disease deaths between Japan and the US in men aged 35–44. Figure 2 shows the mortality rates from CHD (ICD codes 410–414), heart failure (ICD 428), and ill-defined description and complication of heart disease (ICD code 429). The overall mortality was about 21 per 100 000 in Japan and 33–44 per 100 000 in the US. Between 1985 and 1992, the rates increased slightly in Japan and decreased in the US. In the US, code 429.2 is used to describe sudden CHD deaths and accounts for about 10% of the overall heart disease mortality. This has been increasing slightly over time in the US, but is hardly used as a code in Japan. The majority of deaths in the heart disease category in Japan are due to code 428, heart failure, a very rarely used code in the US in these younger age groups.

It is possible that the majority of the heart failure deaths are related to hypertension, or cardiomyopathy, and not atherosclerosis. Detailed comparative epidemiological follow-up studies to evaluate heart disease and sudden death in Japan and the US are clearly needed in this 35–44 age group, as well as good population-based studies of atherosclerosis. We would suspect, however, that the unique low CHD rates in this young age group in Japan and the failure to increase over time, may be an artifact of the classification of causes of death.

There are no national sample data on levels of cholesterol available before 1980 in Japan. Several population-based and workplace-based studies showed that the mean levels of total cholesterol in men aged 40–59 were 3.62–4.14 mmol/l in 1960 and these increased continuously up to 1980. Mean levels of total cholesterol from the national sample in Japan increased in all age groups in men aged 30–39 years upwards in 1990 compared to those in 1980. The direction of the change was totally opposite in the US and the levels of total cholesterol decreased in all age groups during the same period. By 1990, the mean levels of total cholesterol were similar in Japanese and American adult men aged <50: 4.89 mmol/l for men aged
20–34 and 5.35 mmol/l for men aged 35–44 in the US;28 and 5.08 mmol/l for men aged 30–39 and 5.28 mmol/l for men aged 40–49 in Japan.29 Other data from the 1970s show that the mean levels of total cholesterol in school boys were similar between the two countries, at least for selected areas.30–33 Though differences in laboratory measures must be taken into account, these trends are most likely to reflect the actual change and the differences in levels of total cholesterol in young adult men became much smaller in the past three decades.

There were no national sample data on the risk factors for CHD among young adult men in South Korea and Taiwan during 1970 through 1980. Surveys conducted around 1990 in South Korea and Taiwan showed that levels of risk factors among young adult men were similar to those in Japan except for the lower level of mean systolic blood pressure in South Korea compared to that in Japan and Taiwan, and much lower prevalence of smoking in Taiwan compared to that in Korea and Japan.34–36 A national survey on blood pressure conducted in South Korea in 1990 revealed that the level of mean systolic pressure in men aged 30–39 was <120 mmHg and lower than that in Japan. The level of mean diastolic blood pressure in men aged 30–39 was almost similar to that in Japan.34 Prevalence of smoking among men aged 35–39 was >60% and was similar with that in Japan in men aged 30–39 in 1990.35 A population-based study conducted in Kin-Chen, Kinmen, Taiwan in 1992–1994 showed that mean levels of total cholesterol and systolic blood pressure among men aged 30–39 were similar with those in Japan in 1990.36 The prevalence of smoking in men aged 30–39 was <40%, similar to that in the US, and much lower than that in South Korea and Japan.

The possible increase in CHD in Japan, Korea, and Taiwan, if true, post World War II, in this younger age cohort, would mimic the experience for men in the US after World War I, with a substantial increase in smoking, dietary cholesterol, saturated fat, and an increase in mortality from CHD.

It is probable in the future that countries like Japan will have higher rather than lower death rates than those in the US, if they continue to have major change in their diet and heavy cigarette smoking. These changes may not be noted in the age-adjusted rate or in the older age groups because of the cohort effects in these populations.

It is possible, however, that the rise in CHD risk factors in Japan, and probably South Korea and Taiwan, will not result in an increase in CHD morbidity and mortality, even in the post World War II cohorts. Such an observation would likely suggest that there are powerful and important protective factors. The identification of these factors would clearly have great importance for prevention of cardiovascular diseases. The need to carefully monitor the trends in CHD rates, atherosclerosis, and risk factors in these countries is of great importance.

References


MALE CORONARY HEART DISEASE MORTALITY TRENDS


