Trends of cardiovascular disease risk factors were evaluated through comparison of three national surveys in Japan, 1971-1990. Data from three Japanese national surveys on circulatory disorders, conducted in 1971, 1980, and 1990, were analyzed. Variables common to the three national surveys were selected for analysis. Serum total cholesterol was also examined only in 1980 and 1990. Age- and sex-specific mean values, standard deviations, median values, and proportions in extreme categories were determined for all continuous variables and proportions in categories interest for all discrete variables. Trends from 1971-1990 and 1980-1990 were estimated by linear regression analysis for continuous variables, and logistic regression analysis for binary variables. Systolic blood pressure was decreasing constantly during three surveys in both men and women (β=-0.22 in men and -0.34 in women, p<0.01 in both). Total cholesterol was increasing rapidly in both men and women between 1980 and 1990 (β=1.27 in men and 1.41 in women, p<0.01 in both). For other risk factors, the results were less consistent among age- or sex-specific groups. Continued monitoring of risk factor trends in Japan will be important for predicting and explaining future trends in the occurrence of coronary heart disease and stroke in this population.

cardiovascular disease risk factors, trends, serum total cholesterol, systolic blood pressure, Japan

Atherosclerotic and hypertensive cardiovascular diseases are a major cause of death in both developed and developing countries. A great deal of interest in their prevention has been expressed, nevertheless, preventive efforts remain insufficient since cardiovascular risk factors, such as high blood pressure, adverse lipid profiles, cigarette smoking, and obesity are highly prevalent in many populations.

In Japan, cerebrovascular mortality, though falling, is still relatively high, while that for coronary heart disease is the lowest for any industrialized country and has declined since 1970. These changes have been thought to result primarily from high blood pressure control, including both primary and secondary preventive measures, and from dietary changes reflected, for example, by reduced frequency of extremely low serum total cholesterol concentrations, which have been associated with the risk of cerebral hemorrhage. On the other hand, the role of serum total cholesterol as a major risk factor of coronary heart disease requires that changes in its distribution be carefully monitored. Okayama et al. reported previously, on increasing serum cholesterol concentrations in Japan. Several studies have also reported increases in the prevalence of diabetes mellitus in Japan, a trend suggesting increased, and not decreased, cardiovascular disease risks. The Ni-Hon-San Study showed that Japanese suffer from coronary heart disease at a higher rate when exposed to western culture, and although the incidence is still not as high as that of Americans in general, Japanese are clearly susceptible to the effects of adverse risk factor changes.

Understanding the trends of cardiovascular disease risk factors in Japan is important if potentially epidemic coronary heart disease is to be prevented. Previously, Ueshima et al. showed the trends of coronary risk factors based sex and age specific mean values from the National Nutrition Survey and other national surveys between 1956 and 1980. They found that decline in blood pressure levels and in prevalence of hypertension and increasing treatment rate for cardiovascular disease might contribute to declining mortality from ischemic heart disease. Okayama et al. showed changes in total cho-
Design of the surveys

The Ministry of Health and Welfare in Japan conducted National Surveys on Circulatory Disorders in 1971 and 1972, 1980, and 1990. The 1972 survey was a follow-up of participants in the study of 1971 and is therefore excluded from the present analysis.

Two-hundred districts were selected randomly from the total of 420 National Health Survey districts, which were selected randomly from 10,787 census districts, for the survey in 1971. These districts represented all Japan; however, three districts could not contribute to the survey. All 19,128 individuals who resided in these districts and were 30 years of age or older as of September 30 were regarded as eligible subjects for the study. The survey was conducted on October 14 and October 20. The questionnaires were collected from 18,401 individuals, 96.2% (18,401/19,128) of all subjects. The main reasons for non-response were reporting of being “busy” (55.3% of non-respondents) or “sick at home” (7.7%). Being “busy” was more frequent in the younger age groups, and being “sick at home” was more frequent in the older age groups. Due to incomplete answer and inadequate data collection, the number of data suitable for analysis was 12,964, 67.8% of total eligible subjects (12,964/19,128). The exact frequencies of available data by sex and age were not obtainable, but the estimated response rates in the age groups 50-59 and 60-69 were three to four percent higher and those in the age groups 30-39 and 70+ were two to three percent lower than the average. The survey consisted of a questionnaire and a health examination. The questionnaire included the medical history of the examinees and family members, subjective symptoms, smoking status, drinking status, and other variables. The health examination included height, weight, skin fold thickness, blood pressure, urinary protein, urinary glucose, electrocardiogram (ECG), an examination of the fundus of the eye, and a general examination by a physician.

Data were collected mainly by medical and paramedical staff of health centers, such as physicians, public health nurses, and laboratory technicians, all trained in advance of the survey. The questionnaire was conducted by the trained public health workers. The blood pressure was measured by a mercury sphygmomanometer on the right upper arm in a seated position. The diastolic blood pressure was recorded at phase V of the Korotkoff sounds. Urinary protein and glucose were determined by paper colorimetry using respective standard color charts. Slight color changes between positive and negative findings were classified as false positive.

The survey in 1980 was conducted on November 1 and 30 in three hundred survey districts selected randomly from the health statistics survey districts of 1980, which were selected from whole census districts. If the residents of the districts were 30 years or older as of November 1980, then they were regarded as subjects for the study. The total number of eligible residents by the same age criterion as in 1971 was 13,771. The survey methods were generally the same as in 1971, except that a blood examination, which included serum total cholesterol, total protein, albumin, uric acid, creatinine, and blood glucose, was introduced. The main reasons for non-response in 1980 were reports of being “busy” (41.2% of non-respondents) or “being out for a long period” (13.5%). The participation rates were 79.1% (10,897/13,771) as a whole, 73.5% for men and 84.2% for women. The rates by age were 76.8%, 79.1%, 82.6%, 84.1%, and 74.0% for ages 30-39, 40-49, 50-59, 60-69, and 70+, respectively. The regional participation rate was the highest in Hokuriku-Tokai (87.5%) and the lowest in Minami Kanto (67.3%).

For the survey in 1990, 300 districts were drawn at random from 1,040 districts designated for the 1990 National Livelihood Survey of households and house members, which were randomly selected from census districts in all parts of Japan. The total number of eligible residents by the same criterion as in 1971 and 1980 was 10,956. The number of individuals who were examined was 8,926 and the participation rate was 81.5% (8,926/10,956). The main reasons for non-response were, as in 1971, reports of being “busy” (59.0% of non-respondents), or being “sick at home” (6.5%). The participation rates by sex were 76.1% for men and 86.0% for women. The rates by age were 77.7%, 79.0%, 82.9%, 86.7%, and 82.9% for ages 30-39 through 70+ as in 1980, respectively.

The methods of examination were described in the report of the survey. Blood tests were conducted for 11 items: hemoglobin, GOT, GPT, GTP, total cholesterol, HDL-cholesterol, total protein, blood glucose, fructosamine, creatinine, and uric acid. For this survey, cooperation was obtained from the Department of Epidemiology and Mass Examination for Cardiovascular Diseases, Osaka Medical Center for Cancer.
and Cardiovascular Diseases, which has 16 years of experience in the U.S. CDC-NHLBI Lipid Standardization Program of the Centers for Disease Control. This quality control program showed that the lipid determinations in the 1980 and 1990 surveys were comparable.

Statistical Methods

Variables to these three national surveys were selected for analysis: smoking rate, height, weight, systolic and diastolic blood pressure, urinary protein and glucose, and certain broad classes of ECG abnormalities. Serum total cholesterol was added for 1980 and 1990. Information on alcohol consumption was excluded from the analysis because the data were not comparable across surveys. Analysis was performed separately by sex and age or was age-adjusted in multivariate analysis.

First, sex- and age-specific mean, standard deviation, and median values by survey year were determined for each continuous variables: systolic blood pressure (mm Hg), diastolic blood pressure (mm Hg), serum total cholesterol concentration (mg/dl), and body mass index (kg/m²). The prevalence ratios for high systolic blood pressure (140 mm Hg and over and 160 mm Hg and over), high diastolic blood pressure (90 mm Hg and over and 100 mm Hg and over), low serum total cholesterol concentration (lower than 150 mg/dl), high cholesterol (220 mg/dl and over and 260 mg/dl and over), and high body mass index (25 kg/m² and over and 30 kg/m² and over) also were calculated. Second, age-specific prevalence ratios were estimated for each categorical variable: smoking rate, ECG findings, urinary protein, and urinary glucose. Cigarette smoking status was analyzed in three categories: non-smokers, smokers, and ex-smokers. Urinary protein and glucose findings were classified as negative, false positive, and positive according to the results of paper colorimetry. ECG abnormalities were classified as none, minor, and major, in accordance with the Minnesota Code (Appendix).

The trends of continuous variables were analyzed by multiple linear regression models to control age effects, by use of the SAS REG procedure. Year was coded as 0, 9, and 19 for 1971, 1980, and 1990, respectively, to calculate the trends over the survey period. In every age group in both men and women, smoking rates increased and decreases in prevalence were calculated. Second, age-specific prevalence ratios were estimated for each categorical variable: smoking rate, ECG findings, urinary protein, and urinary glucose. Cigarette smoking status was analyzed in three categories: non-smokers, smokers, and ex-smokers. Urinary protein and glucose findings were classified as negative, false positive, and positive according to the results of paper colorimetry. ECG abnormalities were classified as none, minor, and major, in accordance with the Minnesota Code (Appendix).

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The changes in the distributions of risk factors by sex and age groups are summarized in Table 1 through Table 8.

Mean and median values of systolc blood pressure by age and the prevalence of high systolic blood pressure, at 140 mm Hg and over and 160 mm Hg and over, are shown in Table 1. In every age group in both men and women, mean systolic blood pressure declined over the survey period, especially at older ages, and in most age-sex groups the decrease in mean values was greater than in median values. The prevalence of high systolic blood pressure at 140 mm Hg and over and especially at 160 mm Hg and over also declined remarkably, in every age-sex group.

The mean and median values of diastolic blood pressure by age and the prevalence of high diastolic blood pressure, at 90 mm Hg and over and 100 mm Hg and over, are shown in Table 2. These results are contrary to those for systolic blood pressure: mean values of diastolic blood pressure did not decrease consistently among age-sex groups and increased in some; prevalence ratios for high diastolic pressure did generally decrease, but not for men at ≥90 mm Hg.

Mean and median values of serum total cholesterol concentration by age and prevalence ratios for values lower than 150 mg/dl, 220 mg/dl and over, and 260 mg/dl and over are shown in Table 3. In every age group in both men and women, marked increases were observed, except for the decreasing prevalence of values below 150 mg/dl in every age-sex group.

Mean and median values of body mass index by age and the prevalence of body mass index of 25 kg/m² and over and 30 kg/m² and over are shown in Table 4. In men, mean body mass index increased in every age group; the prevalence of 25 kg/m² and over also increased in all but the youngest men over the period of the three surveys, but the prevalence ratio for 30 kg/m² and over did not. In women, changes in body mass index varied with age: in the age groups younger than 50 years and median values decreased and increased in older women, but all changes were small. For women under age 60, percentages with high body mass index decreased.

The prevalence of smokers and ex-smokers by sex and age group is shown in Table 5. The prevalence of smoking in men decreased consistently in all age groups. In women, smoking rates increased in the age groups younger than 50 years, and decreased in the age groups 50 years and older. At all ages, smoking was much less frequently reported by women than by men.

The prevalence of abnormal ECG findings by sex and age is shown in Table 6. The prevalence of major abnormal findings decreased in all but the oldest men and in every age group of women. In both men and women, the proportions with normal ECGs were greatest in 1990, in all age groups.

The prevalence of positive tests for urinary protein by sex and age group over the survey years is shown in Table 7. In men, the percent positive increased slightly in all but the youngest age group. In women, decreases in prevalence...
Table 1. Changes in systolic blood pressure (mm Hg) by sex and age

| Sex   | Age (years) | Survey year | n   | Mean ± SD | Median | ≥140 mm Hg (%) | ≥160 mm Hg (%) |
|-------|-------------|-------------|-----|-----------|--------|----------------|----------------|
| Men   | 30-39       | 71          | 1692| 128.9     | 128    | 23.8           | 4.5            |
|       | 80          | 1262        | 127.9| 14.6      | 126    | 19.2           | 3.9            |
|       | 90          | 670         | 126.2| 13.4      | 126    | 14.5           | 1.9            |
|       | 40-49       | 71          | 1489| 134.8     | 130    | 36.1           | 12.4           |
|       | 80          | 1245        | 134.5| 18.7      | 130    | 36.6           | 10.5           |
|       | 90          | 853         | 132.2| 16.9      | 130    | 30.3           | 6.9            |
|       | 50-59       | 71          | 1006| 142.1     | 140    | 51.6           | 23.0           |
|       | 80          | 1066        | 141.3| 20.9      | 140    | 52.5           | 18.7           |
|       | 90          | 807         | 139.4| 19.8      | 138    | 46.3           | 16.0           |
|       | 60-69       | 71          | 863 | 151.6     | 150    | 65.8           | 38.1           |
|       | 80          | 711         | 148.1| 21.6      | 146    | 65.1           | 28.6           |
|       | 90          | 714         | 145.4| 20.9      | 144    | 59.5           | 24.4           |
|       | 70+         | 71          | 537 | 158.3     | 158    | 76.2           | 49.7           |
|       | 80          | 511         | 153.9| 22.9      | 152    | 75.0           | 39.5           |
|       | 90          | 494         | 148.4| 20.9      | 148    | 68.0           | 29.6           |
| Women | 30-39       | 71          | 2230| 122.0     | 120    | 12.2           | 2.5            |
|       | 80          | 1656        | 120.2| 13.8      | 120    | 8.0            | 1.5            |
|       | 90          | 1043        | 118.3| 14.0      | 118    | 7.2            | 1.2            |
|       | 40-49       | 71          | 1934| 132.6     | 130    | 34.2           | 10.6           |
|       | 80          | 1541        | 129.9| 18.3      | 128    | 27.5           | 8.2            |
|       | 90          | 1192        | 127.8| 17.0      | 126    | 24.1           | 5.5            |
|       | 50-59       | 71          | 1491| 143.2     | 140    | 50.7           | 25.2           |
|       | 80          | 1357        | 138.7| 20.6      | 138    | 47.7           | 16.4           |
|       | 90          | 1056        | 136.7| 19.5      | 136    | 43.1           | 12.4           |
|       | 60-69       | 71          | 1057| 152.3     | 150    | 68.1           | 38.0           |
|       | 80          | 946         | 145.0| 22.3      | 144    | 63.0           | 27.2           |
|       | 90          | 928         | 143.5| 19.1      | 142    | 59.2           | 21.3           |
|       | 70+         | 71          | 665 | 160.0     | 160    | 77.4           | 53.2           |
|       | 80          | 602         | 152.0| 24.3      | 150    | 72.1           | 37.9           |
|       | 90          | 713         | 148.8| 20.1      | 150    | 69.0           | 31.8           |

occurred for all but the 40-49 year age group.

The prevalence of positive tests for urinary glucose by sex and age group over survey years is shown in Table 8. Increases were observed except in men aged 30-39 and women aged 40-49.

Trends of Risk Factors over the Survey Periods

Table 9 shows the trends of systolic blood pressure, diastolic blood pressure, and body mass index by multiple regression analysis with control for age over the three surveys. Systolic blood pressure decreased significantly in both men and women over the period; however, diastolic blood pressure increased for men and decreased for women. Body mass index increased
in men but did not change in women.

Table 10 shows the trends of systolic blood pressure, diastolic blood pressure, total cholesterol, and body mass index between 1980 and 1990. The trend of systolic blood pressure between 1980 and 1990 was the same as that over the three surveys. For diastolic blood pressure in men, no significant change was found between 1980 and 1990. Total cholesterol increased significantly in both men and women from 1980 to 1990. Body mass index again showed no significant trend in women, as in the three-survey analysis, above.

Trends of smoking rate, the prevalence of major abnormal findings on ECG, the prevalence of positive tests for urinary
Table 3. Changes in total cholesterol (mg/dl) by sex and age

| Sex | Age (years) | Survey year | n   | Mean ± SD | Median | <150 mg/dl (%) | ≥220 mg/dl (%) | ≥260 mg/dl (%) |
|-----|-------------|-------------|-----|-----------|--------|---------------|---------------|---------------|
| Men | 30-39       | 80          | 1240| 186.7     | 30.8   | 184.0         | 11.0          | 13.8          | 1.8          |
|     |             | 90          | 620 | 196.4     | 35.1   | 191.0         | 6.5           | 22.7          | 5.5          |
|     | 40-49       | 80          | 1219| 188.4     | 33.5   | 186.0         | 12.2          | 17.8          | 2.5          |
|     |             | 90          | 788 | 204.2     | 36.5   | 200.0         | 4.2           | 31.1          | 6.2          |
|     | 50-59       | 80          | 1046| 188.6     | 34.8   | 186.0         | 10.5          | 16.4          | 2.9          |
|     |             | 90          | 758 | 200.0     | 36.5   | 197.0         | 7.1           | 29.3          | 6.1          |
|     | 60-69       | 80          | 696 | 185.1     | 32.1   | 183.0         | 13.1          | 14.5          | 1.6          |
|     |             | 90          | 674 | 197.4     | 37.7   | 194.0         | 7.7           | 26.3          | 6.5          |
|     | 70+         | 80          | 489 | 177.8     | 31.3   | 175.0         | 19.2          | 9.6           | 0.8          |
|     |             | 90          | 456 | 191.2     | 36.6   | 186.5         | 11.2          | 22.2          | 4.2          |
| Women| 30-39       | 80          | 1632| 176.9     | 29.7   | 174.0         | 16.5          | 8.2           | 1.2          |
|      |             | 90          | 992 | 185.9     | 31.9   | 183.0         | 11.1          | 13.1          | 2.5          |
|      | 40-49       | 80          | 1507| 185.7     | 30.7   | 183.0         | 10.7          | 12.3          | 1.9          |
|      |             | 90          | 1124| 200.0     | 34.5   | 197.0         | 4.7           | 25.5          | 4.8          |
|      | 50-59       | 80          | 1329| 202.7     | 33.0   | 201.0         | 4.2           | 30.0          | 4.8          |
|      |             | 90          | 995 | 218.0     | 36.8   | 216.0         | 2.0           | 46.1          | 12.0         |
|      | 60-69       | 80          | 927 | 203.1     | 35.4   | 201.0         | 4.4           | 30.3          | 6.8          |
|      |             | 90          | 870 | 222.6     | 37.9   | 221.0         | 2.0           | 52.5          | 15.4         |
|     | 70+         | 80          | 578 | 199.8     | 34.5   | 197.5         | 4.3           | 25.6          | 4.8          |
|     |             | 90          | 629 | 214.9     | 41.9   | 212.0         | 3.8           | 42.0          | 13.7         |

protein, and the prevalence of positive tests for urinary glucose over the three surveys are presented in Table 11. The trends were estimated using multiple logistic regression models to control age effects. The smoking rate declined in men, but not in women, over the three surveys. The prevalence of major abnormal findings on ECG decreased in both men and women. The trend of the prevalence of the positive tests for urinary protein in women was significantly negative. The prevalence of positive tests for urinary glucose increased in both men and women.

The decrease in the smoking rate in women between 1980 and 1990 became significant in contrast to the change from 1971 (Table 12). The trend of the prevalence of major abnormal findings on ECG was no longer significant in men between 1980 and 1990. The urinary glucose positivity rate in men between 1980 and 1990 was no longer significant.

### DISCUSSION

This study, based on individual data from three national surveys in 1971, 1980, and 1990, shows that cardiovascular disease risk factors in Japan are changing in a complex manner.

The observed decrease in systolic blood pressure is consistent with other studies. Treatment of high blood pressure has become popular in Japan since the 1960s, because the Health Insurance Law became effective in 1961, and every Japanese has been covered under the insurance. The main reason for the decline seems to be the treatment of high blood pressure. It should be noted, however, that for systolic blood pressure the median values decreased and this measure, unlike the mean, would not be expected to reflect treatment effects at the upper extreme of the distribution. Changes in salt intake may partly explain the changes in systolic pressure, yet per
CVD Risk Factor Changes in Japan

Table 4. Changes in body mass index (kg/m²) by sex and age

| Sex   | Age (years) | Survey year | n         | Mean ± SD | Median  | ≥25 kg/m² (%) | ≥30 kg/m² (%) |
|-------|-------------|-------------|-----------|-----------|---------|---------------|---------------|
| Men   | 30-39       | 71          | 1677      | 22.5 ± 3.9 | 22.0    | 16.4          | 1.6           |
|       | 80          | 1264        | 22.6 ± 2.8 | 22.4      | 13.0    | 0.7           |
|       | 90          | 753         | 22.9 ± 3.0 | 22.7      | 16.0    | 1.5           |
|       | 40-49       | 71          | 1469      | 22.5 ± 3.4 | 21.9    | 16.8          | 1.2           |
|       | 80          | 1247        | 23.1 ± 2.9 | 22.9      | 17.1    | 0.9           |
|       | 90          | 947         | 23.4 ± 2.9 | 23.2      | 19.5    | 1.5           |
|       | 50-59       | 71          | 991       | 22.3 ± 3.3 | 21.8    | 17.6          | 1.6           |
|       | 80          | 1069        | 22.6 ± 2.8 | 22.3      | 15.6    | 0.7           |
|       | 90          | 870         | 23.3 ± 2.8 | 23.1      | 20.2    | 0.8           |
|       | 60-69       | 71          | 851       | 21.8 ± 3.2 | 21.4    | 12.8          | 1.2           |
|       | 80          | 710         | 22.0 ± 2.9 | 21.8      | 12.0    | 0.5           |
|       | 90          | 745         | 22.6 ± 3.1 | 22.5      | 15.8    | 1.5           |
|       | 70+         | 71          | 536       | 21.0 ± 3.8 | 20.5    | 9.9           | 0.9           |
|       | 80          | 508         | 21.3 ± 2.9 | 21.1      | 8.7     | 0.5           |
|       | 90          | 507         | 22.0 ± 3.1 | 21.9      | 14.3    | 0.7           |
| Women  | 30-39       | 71          | 2207      | 22.4 ± 3.6 | 21.9    | 16.1          | 2.0           |
|       | 80          | 1657        | 22.1 ± 3.1 | 21.7      | 12.8    | 1.4           |
|       | 90          | 1081        | 21.8 ± 3.0 | 21.3      | 11.5    | 1.5           |
|       | 40-49       | 71          | 1914      | 23.1 ± 3.6 | 22.7    | 23.1          | 3.1           |
|       | 80          | 1545        | 23.2 ± 3.4 | 22.9      | 20.7    | 3.3           |
|       | 90          | 1234        | 22.8 ± 3.2 | 22.4      | 18.2    | 2.4           |
|       | 50-59       | 71          | 1483      | 23.2 ± 4.5 | 22.7    | 26.7          | 4.3           |
|       | 80          | 1356        | 23.3 ± 3.4 | 23.0      | 25.4    | 2.8           |
|       | 90          | 1084        | 23.4 ± 3.2 | 23.3      | 24.9    | 2.8           |
|       | 60-69       | 71          | 1048      | 22.8 ± 3.8 | 22.5    | 25.7          | 3.7           |
|       | 80          | 947         | 23.0 ± 3.6 | 22.8      | 20.9    | 3.5           |
|       | 90          | 946         | 23.5 ± 3.5 | 23.2      | 27.9    | 3.9           |
|       | 70+         | 71          | 651       | 22.2 ± 4.0 | 21.8    | 20.9          | 2.4           |
|       | 80          | 597         | 22.5 ± 3.5 | 22.2      | 15.5    | 1.9           |
|       | 90          | 738         | 22.7 ± 3.5 | 22.5      | 21.3    | 2.1           |

Capita salt intake has been rising since 1987\(^{28}\).

The trends of diastolic blood pressure in men showed a different pattern from that of women. The reason is still unknown; however, several factors may be considered. First, the difference of the treatment for hypertension between men and women may explain the difference in the trends between men and women. The treatment rate is higher in women than in men\(^{7}\). Second, body mass index is increasing in men, but it is not increasing in women. It is well known that obesity is related to hypertension\(^{28}\). Third, the increase in alcohol consumption may partly explain the discrepancy. Alcohol consumption as ethyl alcohol was 6870 ml per capita in 1970 in adults and 8290 ml in 1990\(^{30}\). The rate of increase over the last 20 years was 20.7%. In Japan, 55.4% of men and 6.5% of women were habitual drinkers in 1990\(^{21}\). Therefore, men are subject to the influence of alcohol more than women by the increase of alcohol consumption. However, it is uncertain whether these factors affected systolic blood pressure and diastolic blood pressure differently.

Serum total cholesterol concentrations increased remarkably in both men and women between 1980 and 1990. Since elevated total cholesterol concentration is a major risk factor for
This trend may be critical for strategies to prevent cardiovascular diseases in Japan in the years ahead. The Ni-Hon-San Study showed men of Japanese ancestry living in Hawaii and California as of the early 1960s to have higher cholesterol concentrations than men living in Japan, consistent with different dietary intakes of saturated fat, animal protein, and dietary cholesterol. The fact that the per capita intake of animal protein in Japan has been increasing is similarly in accord with the increase in total cholesterol shown in the present study.

 Although the prevalence of obesity in Japan (defined by body mass index equal or higher than 25 kg/m²) is still low compared with other countries, the upward trend for men especially notable because of the concomitant increases in serum total cholesterol concentrations and the prevalence of diabetes mellitus. A possible explanation of the discrepancy between men and women in trends of body mass index is cosmetic preference for leaner appearance in younger women.

The smoking rates in men, though decreasing, are still high in comparison with those in other countries. In women, the

| Sex  | Age (years) | Survey year | n  | Non-smoker (%) | Smoker (%) | Ex-smoker (%) |
|------|-------------|-------------|----|----------------|------------|--------------|
| Men  | 30-39       | 71          | 1692 | 22.70          | 69.15      | 8.16         |
|      | 80          | 1736        | 18.78 | 68.55          | 12.67      |
|      | 90          | 754         | 21.88 | 63.93          | 14.19      |
|      | 40-49       | 71          | 1487 | 13.38          | 77.54      | 9.08         |
|      | 80          | 1604        | 19.89 | 62.97          | 17.14      |
|      | 90          | 947         | 25.87 | 57.13          | 17.00      |
|      | 50-59       | 71          | 1006 | 15.71          | 72.96      | 11.33        |
|      | 80          | 1925        | 14.75 | 66.95          | 18.30      |
|      | 90          | 871         | 29.28 | 50.40          | 20.32      |
|      | 60-69       | 71          | 862  | 22.39          | 64.85      | 12.76        |
|      | 80          | 814         | 17.94 | 59.21          | 22.85      |
|      | 90          | 745         | 17.99 | 51.81          | 30.20      |
|      | 70+         | 71          | 537  | 32.40          | 53.82      | 13.78        |
|      | 80          | 626         | 25.08 | 47.44          | 27.48      |
|      | 90          | 509         | 24.95 | 39.10          | 35.95      |
| Women| 30-39       | 71          | 2228 | 92.68          | 6.06       | 1.26         |
|      | 80          | 1872        | 85.58 | 11.81          | 2.62       |
|      | 90          | 1082        | 85.21 | 10.91          | 3.88       |
|      | 40-49       | 71          | 1934 | 91.47          | 7.34       | 1.19         |
|      | 80          | 1727        | 88.59 | 9.32           | 2.08       |
|      | 90          | 1236        | 87.22 | 11.41          | 1.38       |
|      | 50-59       | 71          | 1490 | 85.77          | 12.21      | 2.01         |
|      | 80          | 1482        | 87.52 | 10.12          | 2.36       |
|      | 90          | 1085        | 90.32 | 8.29           | 1.38       |
|      | 60-69       | 71          | 1056 | 86.27          | 12.03      | 1.70         |
|      | 80          | 1048        | 83.30 | 12.79          | 3.91       |
|      | 90          | 946         | 88.48 | 8.35           | 3.17       |
|      | 70+         | 71          | 665  | 86.32          | 11.58      | 2.11         |
|      | 80          | 775         | 85.03 | 10.19          | 4.77       |
|      | 90          | 741         | 88.12 | 7.29           | 4.59       |
smoking rates are low but increasing among those younger than 50 years. For both men and women, smoking prevention and cessation are needed to reduce risk of cardiovascular diseases, cancers, and respiratory diseases. Therefore, every effort should be made to eradicate the smoking habit.

Major abnormal findings on ECG are important indicators to trends in cardiovascular diseases, whose decrease in men was no longer significant between 1980 and 1990. In this period, age-specific trends were slightly upward in men younger than 60 years, coronary heart disease or other heart diseases may be starting to increase in frequency in Japan.

The trend of decreasing prevalence proteinuria in women but not in men generally could reflect multiple factors: the differences in control of high blood pressure; possible increases in the use of antibiotics in the early stages of urinary tract infection; and the increase in prevalence of diabetes in the older men.

So far, only urinary glucose data are available as a crude index of trends of diabetes mellitus in Japan. The urinary glucose positive rate showed a substantial increase in both men

| Sex    | Age (years) | Survey year | n  | 62.15 | 31.76 | 3.09 | 60-69 | 60.55 | 30.44 | 9.01 | 50-59 | 71.06 | 31.51 | 14.81 | 60.71 | 33.27 | 11.02 | 63.24 | 24.47 | 12.30 | 53.68 | 31.54 | 14.80 | 45.76 | 31.48 | 22.76 | 48.19 | 31.35 | 20.46 | 59.76 | 21.62 | 18.62 | 36.69 | 30.17 | 33.15 | 44.70 | 21.22 | 34.09 | 77.55 | 12.75 | 9.70 | 78.00 | 14.79 | 7.21 | 84.68 | 9.09 | 6.23 | 71.92 | 13.34 | 14.74 | 74.43 | 14.12 | 11.45 | 85.59 | 6.54 | 7.87 | 56.92 | 16.60 | 26.48 | 64.29 | 17.43 | 18.28 | 74.53 | 10.31 | 15.16 | 49.72 | 20.59 | 29.70 | 54.96 | 18.28 | 26.76 | 69.66 | 10.23 | 20.11 | 36.54 | 20.60 | 42.86 | 41.12 | 19.16 | 39.72 | 51.98 | 11.40 | 36.63 |

*Classification according to Appendix.
Table 7. Changes in positive tests for urinary protein by sex and age

| Sex   | Age (years) | Survey year | n   | Negative (%) | False positive (%) | Positive (%) |
|-------|-------------|-------------|-----|--------------|-------------------|--------------|
| Men   | 30-39       | 71          | 1686| 94.96        | 3.20              | 1.84         |
|       |             | 80          | 1251| 94.96        | 3.12              | 1.92         |
|       |             | 90          | 642 | 96.11        | 2.96              | 0.93         |
|       | 40-49       | 71          | 1487| 93.68        | 4.37              | 1.95         |
|       |             | 80          | 1232| 93.83        | 4.22              | 1.95         |
|       |             | 90          | 817 | 94.12        | 3.06              | 2.82         |
|       | 50-59       | 71          | 1004| 91.93        | 5.28              | 2.79         |
|       |             | 80          | 1061| 92.08        | 4.62              | 3.30         |
|       |             | 90          | 774 | 93.54        | 2.97              | 3.49         |
|       | 60-69       | 71          | 858 | 90.68        | 5.83              | 3.50         |
|       |             | 80          | 702 | 90.46        | 5.13              | 4.42         |
|       |             | 90          | 688 | 93.02        | 2.76              | 4.22         |
|       | 70+         | 71          | 533 | 84.99        | 9.76              | 5.25         |
|       |             | 80          | 500 | 86.80        | 6.00              | 7.20         |
|       |             | 90          | 469 | 89.13        | 3.41              | 7.46         |
| Women | 30-39       | 71          | 2221| 94.55        | 3.83              | 1.62         |
|       |             | 80          | 1672| 93.92        | 3.81              | 2.27         |
|       |             | 90          | 1004| 97.21        | 1.89              | 0.90         |
|       | 40-49       | 71          | 1924| 92.78        | 4.94              | 2.29         |
|       |             | 80          | 1509| 93.44        | 4.57              | 1.99         |
|       |             | 90          | 1144| 95.10        | 2.53              | 2.36         |
|       | 50-59       | 71          | 1488| 93.15        | 4.10              | 2.76         |
|       |             | 80          | 1351| 94.74        | 3.18              | 2.07         |
|       |             | 90          | 1032| 95.83        | 2.62              | 1.55         |
|       | 60-69       | 71          | 1053| 88.41        | 6.93              | 4.65         |
|       |             | 80          | 935 | 92.62        | 4.71              | 2.67         |
|       |             | 90          | 900 | 94.56        | 3.33              | 2.11         |
|       | 70+         | 71          | 660 | 85.91        | 7.27              | 6.82         |
|       |             | 80          | 581 | 88.47        | 6.20              | 5.34         |
|       |             | 90          | 681 | 92.36        | 5.14              | 2.50         |

and women, although the increase in men between 1980 and 1990 was not significant. The prevalence of diabetes mellitus based on the fructosamine and hemoglobin A1c of the same subjects in 1990 was estimated to be 9% to 18% in men and 7% to 15% in women.\(^{39}\) This estimate also suggests an increase in prevalence of diabetes.\(^{11-13}\) Based on the next national survey of circulatory disorders, improved estimates of trends in diabetes will become possible.

Two advantage of this study over previous reports are the random selection of survey districts from the whole country and comparability of methods across surveys.

One possible bias of this study is the participation rate of the study: 67.8%, 79.1%, 81.5% for 1971, 1980, 1990, respectively. It is possible that those who did not visit the examination
Table 8. Changes in positive tests for urinary glucose by sex and age

| Sex | Age (years) | Survey year | n  | Negative (%) | False positive (%) | Positive (%) |
|-----|-------------|-------------|----|--------------|--------------------|--------------|
| Men | 30-39       | 71          | 1688 | 94.79        | 2.61               | 2.61         |
|     | 80          | 1251        | 97.76 | 0.56         | 1.68               |              |
|     | 90          | 642         | 97.98 | 1.09         | 0.93               |              |
|     | 40-49       | 71          | 1486 | 94.55        | 3.16               | 2.29         |
|     | 80          | 1232        | 95.70 | 1.30         | 3.00               |              |
|     | 90          | 817         | 94.00 | 1.71         | 4.28               |              |
|     | 50-59       | 71          | 1004 | 91.83        | 2.99               | 5.18         |
|     | 80          | 1061        | 93.87 | 1.51         | 4.62               |              |
|     | 90          | 774         | 90.70 | 2.45         | 6.85               |              |
|     | 60-69       | 71          | 858  | 92.66        | 3.61               | 3.73         |
|     | 80          | 702         | 92.17 | 1.71         | 6.13               |              |
|     | 90          | 688         | 90.26 | 2.47         | 7.27               |              |
|     | 70+         | 71          | 533  | 94.75        | 2.06               | 3.19         |
|     | 80          | 500         | 92.20 | 0.80         | 7.00               |              |
|     | 90          | 469         | 88.91 | 4.26         | 6.82               |              |
| Women| 30-39       | 71          | 2223 | 98.65        | 0.45               | 0.90         |
|      | 80          | 1627        | 98.40 | 0.31         | 1.29               |              |
|      | 90          | 1004        | 97.91 | 1.00         | 1.10               |              |
|      | 40-49       | 71          | 1925 | 98.03        | 0.36               | 1.61         |
|      | 80          | 1509        | 98.48 | 0.40         | 1.13               |              |
|      | 90          | 1144        | 97.64 | 1.14         | 1.22               |              |
|      | 50-59       | 71          | 1488 | 98.52        | 0.40               | 1.08         |
|      | 80          | 1351        | 98.08 | 0.37         | 1.55               |              |
|      | 90          | 1032        | 96.32 | 0.58         | 3.10               |              |
|      | 60-69       | 71          | 1053 | 97.34        | 0.76               | 1.90         |
|      | 80          | 934         | 96.68 | 0.75         | 2.57               |              |
|      | 90          | 900         | 95.33 | 1.11         | 3.56               |              |
|      | 70+         | 71          | 660  | 97.27        | 1.52               | 1.21         |
|      | 80          | 581         | 97.25 | 0.34         | 2.41               |              |
|      | 90          | 681         | 95.30 | 1.32         | 3.38               |              |

Affected the results of observation; however, the effect would not be a serious bias for the trends of major risk factors because the participation rates by age showed a similar pattern over the three surveys, and the trends were mostly similar to other studies. 6,8,10,40-42.

Finally, those who were inpatients were excluded from the subjects of the surveys. The prevalence of a rare risk factor could be affected considerably, although the inpatient rate in 1993 was 1.15%. 43. As a design feature common to the three surveys, this factor could not affect the estimation of trends in the non-institutionalized population.

Another possible limitation is the quality of the data. Although most of the examiners were workers of public health centers and had experience for the survey, because of the large number of examiners, the problem of interobserver variability must be considered. To improve the quality of data, strict training is desirable. 44,45. In addition, the examination of blood pressure was performed only once. In order to reduce the intraindividual variation, it is desirable to measure twice or more. 46. Nevertheless, since the survey methods were common over the three surveys, trends themselves would not be distorted.
**Table 9.** Trends of systolic blood pressure, diastolic blood pressure, and body mass index by sex after controlling for age over three surveys in 1971, 1980, and 1990

| Parameter                          | β*   | SE  | P    | β   | SE  | P    |
|------------------------------------|------|-----|------|-----|-----|------|
| Systolic blood pressure (mm Hg)    | -0.219 | 0.023 | <0.001 | -0.342 | 0.019 | <0.001 |
| Diastolic blood pressure (mm Hg)   | 0.066  | 0.014 | <0.001 | -0.031 | 0.012 | 0.009  |
| Body mass index (kg/m²)            | 0.044  | 0.004 | <0.001 | 0.000  | 0.003 | 0.920  |

*Parameter estimates by linear regression models.

**Table 10.** Trends of systolic blood pressure, diastolic blood pressure, total cholesterol, and body mass index by sex after controlling for age between 1980 and 1990

| Parameter                          | β*   | SE  | P    | β   | SE  | P    |
|------------------------------------|------|-----|------|-----|-----|------|
| Systolic blood pressure (mm Hg)    | -0.260 | 0.042 | <0.001 | -0.230 | 0.036 | <0.001 |
| Diastolic blood pressure (mm Hg)   | -0.027 | 0.027 | 0.313 | -0.063 | 0.022 | 0.005  |
| Total cholesterol (mg/dl)          | 1.271  | 0.079 | <0.001 | 1.407  | 0.068 | <0.001  |
| Body mass index (kg/m²)            | 0.050  | 0.006 | <0.001 | -0.006 | 0.006 | 0.349  |

*Parameter estimates by linear regression models.

**Table 11.** Trends of smokers, major abnormal findings on ECG, positive tests for urinary protein, positive tests for urinary glucose by sex after controlling for age over three surveys in 1971, 1980, and 1990

| Parameter                          | β*   | SE  | P    | β   | SE  | P    |
|------------------------------------|------|-----|------|-----|-----|------|
| Smokers / others                   | -0.034 | 0.002 | <0.001 | 0.003  | 0.003 | 0.369  |
| Major abnormal findings on ECG / others | -0.010 | -0.004 | 0.003 | -0.030 | 0.003 | <0.001  |
| Urinary protein positive tests / others | 0.009  | 0.007 | 0.157 | -0.030 | 0.007 | <0.001  |
| Urinary glucose positive tests / others | 0.021  | 0.006 | <0.001 | 0.028  | 0.008 | <0.001  |

*Parameter estimates by logistic regression models.

**Table 12.** Trends of smokers, major abnormal findings on ECG, positive tests for urinary protein, positive tests for urinary glucose by sex after controlling for age between 1980 and 1990

| Parameter                          | β*   | SE  | P    | β   | SE  | P    |
|------------------------------------|------|-----|------|-----|-----|------|
| Smokers / others                   | -0.035 | 0.004 | <0.001 | -0.013 | 0.006 | 0.031  |
| Major abnormal findings on ECG / others | -0.003 | 0.007 | 0.650 | -0.027 | 0.006 | <0.001  |
| Urinary protein positive tests / others | -0.000 | 0.013 | 0.992 | -0.037 | 0.014 | 0.007  |
| Urinary glucose positive tests / others | 0.020  | 0.011 | 0.063 | 0.031  | 0.014 | 0.026  |

*Parameter estimates by logistic regression models.
So far controlling systolic blood pressure seems to have been successful; however, Japanese people are about to face a new problem, hypercholesterolemia, and still have high prevalence of smokers in men. Careful monitoring of these factors is essential. Further studies including children and adolescents are needed to detect more precise changes of risk factors and to provide effective preventive measures against cardiovascular diseases.

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### Appendix. Classification of electrocardiographic results

| Classification          | Electrocardiographic findings                                                                 | Minnesota Code     |
|------------------------|------------------------------------------------------------------------------------------------|--------------------|
| Normal                 | No abnormality, RR' pattern not indicative of incomplete right bundle branch block. Either of miscellaneous items (IX-codes) | 1-0, 7-5, 9-1 to 9-5 |
| Minor abnormality      | Code 3 Q, QS pattern, QRS axis deviation, high R, prolonged PQ, WPW syndrome, short PQ, incomplete right bundle branch block, incomplete left bundle branch block, sinus tachy-bradycardia, other arrhythmia | 1-3-1 to 1-3-6, 2-1 to 2-5, 3-1 to 3-3, 6-3 to 6-5, 7-3, 7-6, 8-7 to 8-9 |
| Major abnormality A    | Code 2 Q, QS pattern, depressed ST<0.5 mm I pattern, depressed ST≥1 mm J pattern, negative T<1 mm, T/R<1/20, 1/20≤T/R<1/10, atrioventricular node rhythm | 1-2-1 to 1-2-8, 4-3 to 4-4, 5-3 to 5-5, 8-6 |
| Major abnormality B    | 0.5 mm ≤ depressed ST<1 mm, 1mm ≤ negative T<5 mm, second degree atrioventricular block, complete right bundle branch block, intraventricular block, frequent extrasystoles (10% or more), ventricular tachycardia, atrial fibrillation, supraventricular tachycardia, atrioventricular rhythm | 4-2, 5-2, 6-2, 7-2, 8-1 to 8-5 |
| Major abnormality C    | Code 1 Q, QS pattern, depressed ST≥1 mm (I pattern), negative T≥5 mm, third degree atrioventricular block, complete left bundle branch block, complication by two or more types of arrhythmia | 1-1-1 to 1-1-7, 4-1, 5-1, 6-1, 7-1, two or more of code 8 |