Trends of Blood Pressure Distributions in a Northeast Rural Japanese Population

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In Japan recently there has been a rapid change in living and eating patterns along with accelerated urbanizations in rural communities. This provides an unique opportunity to observe a critical "natural experiment" of change in both risk factors and disease. Data on blood pressures and time trends were obtained in population-based surveys conducted in rural Japan; the first survey from 1963-66, the second from 1972-75, and the third from 1980-83. This report describes the population trends over 20 years for blood pressure distributions and its related factors. Between the 1960s and the 1970s, the prevalence of a higher blood pressure level declined although no remarkable shift of the blood pressure distribution was observed. However, between the 1970s and the 1980s, there was a significant downward shift of the blood pressure distribution. The decline in blood pressure between the 1960s and 1970s was primarily related to a fall in the prevalence of elevated blood pressure, attributable in turn to the greater use of anti-hypertensive medications and improved blood pressure control. In contrast, the large downward shift in the whole blood pressure distribution between the 1970s and the 1980s was attributable partly to improved hypertension control and apparently also to changes in environmental factors of associated behaviors that affected the whole distribution. The correlation between blood pressure and relative weight index was weak in the 1960s but became stronger in the 1970s and the 1980s. The significant blood pressure trend in a whole population are consistent with the reported decline in stroke incidence in this population. J Epidemiol, 1993; 3: 63-70.

blood pressure trend, antihypertensive medication, lifestyle change, overweight, population survey

Stroke and coronary heart disease (CHD) in populations are strongly related to the underlying prevalence of hypertension and atherosclerosis that are influenced by risk characteristics, their related behaviors, and associated socio-environmental factors. Japan has recently experienced rapid change in living and eating patterns. This provides an unique opportunity to observe a natural experiment of possibly changing population risk. We have carried out surveys of population-based samples over the past two decades in an attempt to characterize cardiovascular disease trends over time.

This report describes the time trends for blood pressure measured by population-based, cross-sectional surveys in the 1960s, 1970s, and 1980s. Detailed trend analysis was carried out by age and sex, and associations with relative weight index were examined. Trends of stroke and CHD rates, and other cardiovascular risk factors are reported elsewhere.

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METHODS

The surveyed population

The survey population is residents of Ikawa town, a farming community in Akita Prefecture, northeast Japan, with a total census of 7,030 in 1965, 6,427 in 1975, and 6,380 in 1985. This report deals with cross-sectional surveys conducted in the years 1963-66, 1972-75, and 1980-83. Samples of all men and women in the area aged 40 to 69 were invited to cardiovascular risk surveys and participation rates for each survey period are displayed in Table 1.

The industry of the community was predominantly rice farming until the 1960s. During the past two decades, however, farming has been extensively mechanized; people now have time for other jobs, and lifestyles are increasingly urbanized. The traditional diet, low in animal fat, relatively low in protein, and high in salt, has changed, as documented elsewhere. In addition, a community-based hypertension control program was established in 1963.

Measurement of blood pressures and relative weight index

A physician measured first and fifth phase diastolic blood pressures with a standard mercury sphygmomanometer (cuff width: 13 cm) on the right upper arm of participants, who had sat quietly in a chair for at least five minutes. Room temperature was maintained at about 20°C. The physicians had been trained in epidemiological methods of blood pressure measurement. Measurements of several subjects with different blood pressure levels were practiced on each arm simultaneously with separate sphygmomanometers, with a Y-connection to two stethoscopes, or, alternately, on the right arm in random order by a trainee and then an experienced observer. The training was repeated until systematic observer error was minimized. This procedure was repeated among observers for each survey period to reduce observer differences.

Relative body weight was calculated from Minowa’s standards based on medians of body weight distribution by height and sex for 5,086 healthy Japanese in 1960 to 1962. Regression equaltion of standard weights was $0.002235 \times \text{height(cm)}^2 - 0.1206 \times \text{height(cm)} + 15.92$ for men and $0.003578 \times \text{height(cm)}^2 - 0.5653 \times \text{height(cm)} + 52.81$ for women. Minowa’s relative weight index (RWI) was defined as percent deviation of actual weight from standard weight. For example, a man with 160 cm in height and 65 kg in weight shows 20% in RWI and 25 in body mass index calculated as weight(kg)/height(m)^2.

Statistical analyses

T-tests were used for continuous variables and chi-square tests for comparisons of prevalences. All p-values are two-tailed.

| Table 1. The number of subjects and participants, and participation rates by age and sex, in 1963-1966, 1972-1975 and 1980-1983. |
|---------------------------------------------------------------|
| **Men** | **Women** | **Men** | **Women** |
| 40-49 | 50-59 | 60-69 | Total | 40-49 | 50-59 | 60-69 | Total |
| 1963-1966 | Subjects (n) | 336 | 313 | 214 | 863 | 444 | 349 | 251 | 1,044 |
| | Participants (n) | 287 | 279 | 199 | 765 | 400 | 325 | 229 | 954 |
| | Participation Rates (%) | 85.4 | 39.1 | 93.0 | 88.6 | 90.1 | 93.1 | 91.2 | 91.3 |
| 1972-1975 | Subjects (n) | 475 | 325 | 271 | 1,071 | 538 | 410 | 308 | 1,256 |
| | Participants (n) | 357 | 249 | 222 | 828 | 472 | 365 | 262 | 1,099 |
| | Participation Rates (%) | 75.2 | 76.6 | 81.9 | 77.3 | 87.7 | 89.0 | 85.1 | 87.5 |
| 1980-1983 | Subjects (n) | 443 | 398 | 259 | 1,100 | 477 | 472 | 348 | 1,297 |
| | Participants (n) | 283 | 323 | 216 | 822 | 367 | 404 | 302 | 1,073 |
| | Participation Rates (%) | 63.9 | 81.2 | 83.4 | 74.7 | 76.9 | 85.6 | 86.8 | 82.7 |
RESULTS

Trends of blood pressure by age and sex

Figures 1 to 3 show the systolic blood pressure distributions by age and sex during the three survey periods. Between the 1960s and the 1970s, there was no distinct shift in distribution, but the prevalence of systolic blood pressure greater than or equal to 180 mmHg declined for all age-sex groups. Remarkable downward shifts of the distribution were seen in all age-sex categories between the 1970s and the 1980s, with the larger distribution shifts among the older age groups.

A similar trend was observed in the distribution of diastolic blood pressure (not shown). Between the 1960s and 1970s, the distribution of diastolic blood pressure did not shift remarkably for any age-sex group, although the prevalence of diastolic blood pressure greater than or equal to 100 mmHg declined. Between the 1970s and the 1980s, blood pressure distributions declined for all age-sex groups.

The prevalence of hypertension by age and sex is shown in Table 2, defined as the percent of participants systolic blood pressure ≥ 160 mmHg and/or diastolic blood pressure ≥ 95 mmHg, regardless of antihypertensive medication use. The prevalence declined significantly between the 1960s and the 1980s for all age-sex groups, with the greater decrease occurring between the 1970s and the 1980s.

Table 3 depicts the frequency of antihypertensive medication use, defined as: (a) the percent of all hypertensives taking antihypertensive medication (hypertensives defined as those with systolic blood pressure ≥ 160 mmHg, or diastolic blood pressure ≥ 95 mmHg, and/or taking antihypertensive medication), and (b) the percent of persons with antihypertensive medication among all survey participants. Frequency (a) was less than 23.0% in the 1960s and increased significantly for every age-sex group between the 1960s and the 1980s. Frequency (b) was less than 9.0% in the 1960s and also rose significantly for all age-sex categories between the 1960s and the 1980s. The increased frequency (b) was more remarkable in the first decade than in the second.

Table 4 shows the prevalence of normotension according to past or present antihypertensive medica-
past or present antihypertensive medication use were considered as an indicator of hypertension control. Normotension was defined as systolic blood pressure $< 140$ mmHg and diastolic blood pressure $< 90$ mmHg, regardless of antihypertensive medication use. The prevalence of normotension with past or present medication use increased significantly for every age-sex group between the 1960s and the 1980s. The proportion of normotensives without medication did not change between the 1960s and 1970s but increase significantly for all age-sex groups between the 1970s and the 1980s.

**Trends of prevalence of overweight and associations between blood pressures and relative weight index (RWI)**

Prevalence of overweight (RWI $\geq 20\%$) and the proportion of hypertensive persons among the non-overweight and among the overweight was shown at three survey periods (Table 5). Hypertensive persons are defined as those with systolic blood pressure $\geq 160$ mmHg and/or diastolic blood pressure $\geq 95$ mmHg, and/or taking antihypertensive medications. Prevalence of overweight increased between the 1960s and the 1980s in all age-sex groups except for men aged 50-59 and 60-69. The increase in the prevalence occurred primarily between the 1960s and the 1970s.

At each survey, the proportion of hypertensive persons was higher among the overweight for all age-sex groups except for men ages 40-49. For men ages 40-49, the proportion of hypertensive persons did not differ between the overweight and the non-overweight in the 1960s, but increased significantly among the

| Table 2. The number and prevalence of hypertension by age and sex, in 1963-1966, 1972-1975 and 1980-1983. |
|---|---|---|---|---|---|---|
| | 40-49 | 50-59 | 60-69 | 40-49 | 50-59 | 60-69 |
| 1963-1966 | | | | | | |
| Number (n) | 75 | 105 | 108 | 46 | 91 | 102 |
| Prevalence (%) | 26.1 | 37.6 | 54.3 | 11.5 | 28.0 | 44.5 |
| 1972-1975 | | | | | | |
| Number (n) | 96 | 86 | 102 | 50 | 88 | 97 |
| Prevalence (%) | 26.9 | 34.5 | 45.9 | 10.6 | 24.1 | 37.0 |
| 1980-1983 | | | | | | |
| Number (n) | 60 | 66 | 53 | 24 | 45 | 58 |
| Prevalence (%) | 18.0 | 20.4 | 24.5 | 6.5 | 11.1 | 19.2 |

Hypertension is systolic blood pressure $> = 160$ mmHg, and/or diastolic blood pressure $> = 95$ mmHg regardless of antihypertensive medication use. Differences from the 1963-1966 values: *p<0.05, **p<0.01, ***p<0.001
Differences from the 1972-1975 values: *p<0.05, **p<0.01, ***p<0.001
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Table 3. The percent frequency of antihypertensive medication use by age and sex, in 1963-1966, 1972-1975 and 1980-1983.

|                | Men          |            | Women        |            |
|----------------|--------------|------------|--------------|------------|
|                | 40-49        | 50-59      | 60-69        | 40-49      | 50-59      | 60-69        |
| Frequency (a) (%) |              |            |              |            |            |              |
| 1963-1966      | 14.3         | 20.5       | 15.3         | 22.4       | 21.0       | 19.0         |
| 1972-1975      | 30.0*        | 49.1***    | 60.6***      | 41.7*      | 44.8***    | 69.5***      |
| 1980-1983      | 55.1***      | 67.2***    | 82.4***      | 72.3***    | 82.2***    | 84.3***      |
| Frequency (b) (%) |              |            |              |            |            |              |
| 1963-1966      | 3.8          | 8.2        | 8.5          | 2.8        | 6.5        | 8.7          |
| 1972-1975      | 9.2**        | 21.7***    | 36.0***      | 5.3        | 14.2***    | 34.7***      |
| 1980-1983      | 13.4***      | 26.0***    | 41.2***      | 9.3        | 24.0**     | 35.4         |

Frequency (a): the percent of persons taking antihypertensive medication among hypertensive persons (systolic blood pressure $\geq 160$ mmHg, and/or diastolic blood pressure $\geq 95$ mmHg, and/or antihypertensive medication use).

Frequency (b): the percent of persons taking antihypertensive medication among all participants.

Differences from the 1963-1966 values: *p<0.05, **p<0.01, ***p<0.001

Differences from the 1972-1975 values: *p<0.05, ++p<0.01, +++p<0.001

Table 4. The prevalence of normotension according to past or present antihypertensive medication use by age and sex, in 1963-1966, 1972-1975 and 1980-1983.

|                | Men          |            | Women        |            |
|----------------|--------------|------------|--------------|------------|
|                | 40-49        | 50-59      | 60-69        | 40-49      | 50-59      | 60-69        |
| Normotension with medication (%) |              |            |              |            |            |              |
| 1963-1966      | 1.4          | 1.4        | 3.5          | 2.0        | 4.9        | 2.2          |
| 1972-1975      | 2.8          | 4.8        | 5.0          | 4.7*       | 7.4        | 7.7          |
| 1980-1983      | 5.7**        | 12.1***    | 13.0***      | 9.0***     | 12.1***    | 20.2***      |
| Normotension without medication (%) |              |            |              |            |            |              |
| 1963-1966      | 46.8         | 36.6       | 20.1         | 64.9       | 44.6       | 30.6         |
| 1972-1975      | 48.7         | 32.9       | 18.9         | 67.8       | 42.6       | 26.8         |
| 1980-1983      | 61.1***      | 44.3***    | 33.3***      | 74.7***    | 54.7***    | 38.7***      |

Differences from the 1963-1966 values: *p<0.05, **p<0.01, ***p<0.001

Differences from the 1972-1975 values: *p<0.05, ++p<0.01, +++p<0.001

overweight in the 1970s and the 1980s. In all age-sex-RWI groups except for overweight men ages 40-49, the proportion of hypertensives was lower in the 1980s than in the 1960s.

Table 6 shows the correlation between blood pressure levels and RWI. Correlation between diastolic blood pressure and RWI was generally stronger than with systolic, in both sexes, during every survey period. The correlation between blood pressure levels and RWI was weak for all men in the 1960s. The correlation between diastolic blood pressure and RWI became stronger, however, for men ages 40-49 in the 1970s and 1980s. For women the correlation was not so weak as for men in the 1960s, and it became stronger at the ages of 40-49 and thereafter.

DISCUSSION

Substantial changes in blood pressure distributions were observed for a rural Japanese between the 1960s and the 1980s by our population-based study with a high response rate. It was noteworthy that trends in blood pressure distributions between the 1960s and the 1970s were different from those in the 1970s and the 1980s. Between the 1960s and the 1970s, the prevalence of systolic blood pressure $\geq 180$ mmHg or that of diastolic blood pressure $\geq 110$ mmHg declined, although no remarkable shift of the blood pressure
distribution was observed. The frequency of antihypertensive medication use increased significantly. These data suggest that the decline in the blood pressure level during the early decade was primarily due to improvements in hypertension control with antihypertensive medication rather than a more general phenomenon.

However, between the 1970s and the 1980s, the blood pressure distribution shifted significantly downward while the prevalence of hypertension also declined, despite the relatively small increase in the use of antihypertensive medications. The youngest age group, both sexes, in which only about 10% of participants were taking antihypertensive medication, showed marked downward shifts of systolic and diastolic blood pressure means and distributions. Furthermore, the prevalence of normotension without past or present antihypertensive medication use, that had not changed during the early decade, increased significantly for every age-sex group in the later decade.

These data lead us to infer that the significant decline in population blood pressure levels between

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**Table 5.** Prevalence of overweight and the proportion of hypertensive persons by relative weight index (RWI), by age and sex, in 1963-1966, 1972-1975 and 1980-1983.

|          | 40-49 | 50-59 | 60-69 | 40-49 | 50-59 | 60-69 |
|----------|-------|-------|-------|-------|-------|-------|
| Prevalence of overweight: RWI ≥ 20% (%) |       |       |       |       |       |       |
| 1963-1966 | 11.0  | 13.5  | 9.6   | 14.6  | 19.0  | 14.8  |
| 1972-1975 | 17.6* | 16.1  | 10.4  | 24.9*** | 26.0  | 23.0* |
| 1980-1983 | 22.7*** | 15.0  | 12.7  | 23.6**   | 31.0*** | 30.2*** |
| Proportion of hypertensive persons by RWI (%) |       |       |       |       |       |       |
| 1963-1966 |       |       |       |       |       |       |
| RWI < 20% | 28.5  | 39.1  | 53.5  | 11.7  | 28.8  | 43.6  |
| RWI ≥ 20% | 27.8  | 57.6* | 88.9; | 26.0; | 46.6; | 64.7; |
| 1972-1975 |       |       |       |       |       |       |
| RWI < 20% | 28.5  | 43.9  | 58.1  | 9.9   | 25.2  | 45.0  |
| RWI ≥ 20% | 43.6* | 45.7  | 73.7  | 21.4; | 50.5; | 67.2; |
| 1980-1983 |       |       |       |       |       |       |
| RWI < 20% | 20.7  | 37.9  | 48.6  | 9.3   | 22.1  | 33.3  |
| RWI ≥ 20% | 36.4; | 43.3  | 58.1  | 23.9; | 44.5; | 62.6; |

Differences from the 1963-1966 values: *p<0.05, **p<0.01, ***p<0.001
Differences from the 1972-1975 values: *p<0.05, **p<0.01, ***p<0.001
Differences from the values with RWI<20%: †p<0.05, ‡p<0.01, §§p<0.001

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**Table 6.** Pearson correlation coefficients between individual blood pressure and relative weight index by age and sex, in 1963-1966, 1972-1975 and 1980-1983.

|          | 40-49 | 50-59 | 60-69 | 40-49 | 50-59 | 60-69 |
|----------|-------|-------|-------|-------|-------|-------|
| Systolic blood pressure |       |       |       |       |       |       |
| 1963-1966 | 0.13* | 0.18  | 0.10  | 0.18*** | 0.25*** | 0.20*** |
| 1972-1975 | 0.07  | 0.07  | 0.13* | 0.22*** | 0.25*** | 0.24*** |
| 1980-1983 | 0.17** | -0.06 | 0.13* | 0.27*** | 0.31*** | 0.15*** |
| Diastolic blood pressure |       |       |       |       |       |       |
| 1963-1966 | 0.07  | 0.19*** | 0.14* | 0.20*** | 0.29*** | 0.24*** |
| 1972-1975 | 0.21*** | 0.14* | 0.24*** | 0.26*** | 0.33*** | 0.16*** |
| 1980-1983 | 0.23*** | 0.11* | 0.21** | 0.39*** | 0.32*** | 0.27*** |

Test of correlation: *p<0.05, **p<0.01, ***p<0.001
the 1970s and the 1980s was due not only to improvement in hypertension control with medications but also to changes in nonpharmacological factors. We speculate that overall improvement in nutrition, specifically better protein and fat intake, and lower salt intake, the lessening of hard manual work\textsuperscript{3-4,7,8} may have contributed to the blood pressure decline. Before the 1960s, people in Akita rural communities took a traditional Japanese diet: a large amount of rice (400 g or more per day) with salty miso soups and salt-preserved pickles\textsuperscript{9}. Dietary protein sources were limited to rice, fish and beans. They did not have access to meat and dairy foods. Salt-preserved fish and vegetables were not only for preservation itself but also for appetizer of plain rice. According to our nutrition studies for men aged 40-59 in Ikawa town, the percent of animal protein calories increased from 5.8% in the 1960s and 7.1% in the 1980s. The percent of animal fat calories doubled from 4.5% in the 1960s to 9.6% in the 1970s. Intake of salt declined from 20 g to 14 g. Percent calories of carbohydrate also declined from 67% to 57\textsuperscript{9}. A remarkable increase in animal protein and fat was due to increased consumption of meat and dairy foods, which was associated with socioeconomic development such as increased cash income, improved food transport and refrigeration, and in part with our community-based campaigns for dietary improvement. Although we do not have quantitative data on trends of physical activity, it is well documented that substantial mechanization of farming occurred in the mid-1970s\textsuperscript{8,10-17}. If these changes had an effect on blood pressure levels it probably occurred later than antihypertensive medication use. Apparently the combination of lifestyle and medical care change was sufficient to shift the entire blood pressure distribution downward.

Epidemiological studies in the U.S. and Europe have associated hypertension with the low physical activity and overweight of affluent lifestyles\textsuperscript{18-20}. In contrast, several studies in rural Japan show opposite findings\textsuperscript{10-17}. For example, hypertension in rural northeast Japan was associated with hard manual work. A physiological study on habitual physical activity of farmers in the 1950s showed that rice farming, an exhausting exposure, was associated with a higher prevalence of hypertension and “early aging”\textsuperscript{18}. Geographic mortality rates for stroke and the prevalence of hypertension were positively correlated with the mean size of rice paddy fields per household, an index of the amount of manual work\textsuperscript{11-16}. After mechanization, size of field no longer showed a difference in rates for stroke mortality and hypertension probably because the size no longer affects significantly the amount of manual work\textsuperscript{17}. A large cohort study among male employees of the Japan National Railway, before its automation and mechanization, showed that the harder the manual work, the higher the mean systolic blood pressure and stroke incidence\textsuperscript{21}.

According to our population surveys in the rural northeast population, in suburban residents, and in urban industrial work groups in the 1960s, prevalence of hypertension was high in both the rural population and the urban executives\textsuperscript{11}. These two groups had starkly contrasting lifestyles: one traditional and the other westernized and sedentary. Among the executives there were strong positive correlations between blood pressures and RWI, while no such a correlation was found in the rural population\textsuperscript{22}. The findings in the executives correspond to those widely found in the U.S. and Europe\textsuperscript{18-20}.

A high prevalence of hypertension despite a low prevalence of overweight is unique for rural northeast Japan. For men ages 40-49 in the 1960s, there was no difference in the proportion of hypertensives according to RWI and no significant correlation between diastolic blood pressure and RWI. During the recent decades, however, the change in the association between blood pressure and RWI was observed with an increase in the prevalence of overweight: the increased proportion of hypertensive persons among the overweight and the significant correlation between diastolic blood pressure and RWI. The lack of correlation between blood pressure and RWI for men aged 40-49 in the 1960s was possibly due to small amount of body fat even in the higher RWI subgroup. That is, it is speculated that RWI was associated with muscle mass rather than fat mass. Unfortunately, we did not measure skinfold thickness or waist-hip circumferences in the 1960s to test this hypothesis.

Changes in traditional lifestyles and environmental factors apparently contributed to the population decline in mean blood pressure levels, while reduction of physical activity may have led to the increased prevalence of overweight and hypertension with overweight. Contradictory findings result: blood pressure levels fell despite an increase in the prevalence of overweight. This “favorable” change in lifestyles may, if continued, raise another problem: an increased prevalence of hypertension associated with overweight.

As we reported elsewhere\textsuperscript{23}, during the past two decades, a significant decline in the incidence of stroke, especially cerebral hemorrhage, has been observed among men ages 40-69 in rural northeast Japan. Although coronary heart disease incidence is relatively low and has not yet increased in this population, a rise in the prevalence of overweight and in the mean values

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of serum total cholesterol for young adults suggest that systematic surveillance of coronary heart disease rates should reveal, eventually, a rise of coronary heart disease rate. According to our collaborative study on physical activity and cardiovascular disease for middle-aged Japanese, there was a higher prevalence of physical inactivity in urban residents and rural clerical workers than rural farmers and manual workers\(^{23}\). From now on, however, attention should be paid to the prevention of overweight and elevated serum total cholesterol, for primary prevention of hypertension and coronary heart disease.

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REFERENCES

1. Komachi Y, Iida M, Shimamoto T, et al. Geographic and occupational comparisons of risk factors in cardiovascular diseases in Japan. Jpn Cir J, 1971; 35: 189-207.
2. Komachi Y, Tanaka H, Shimamoto T, et al. A collaborative study of stroke incidence in Japan 1975-1979. Stroke, 1984; 15: 28-36.
3. Shimamoto T, Komachi Y, Inada H, et al. Trends for stroke and coronary heart disease and their risk factors in Japan. Circulation, 1989; 79: 503-515.
4. Shimamoto T. A community-based preventive program for stroke in rural population of Akita. I "Chiiki To Iryo" (Editor: Komachi Y), Tokyo, Kodansha Scientific Press, 1980 (in Japanese).
5. Rose GA, Blackburn H. Cardiovascular survey methods. Geneva, WHO, 1968.
6. Minowa S. Study on standard weights for Japanese adults, Charts of Minowa's body mass index. J Med J, 1962; 1988: 24-28 (in Japanese).
7. Komachi Y, Shimamoto T, Iida M, Konishi M. Changes in environmental factors and morbidity trends of stroke. Jpn J Stroke, 1981; 3: 82-85 (in Japanese).
8. Shimamoto T. Changes in physical activities and trends of stroke. Jpn Chron Disease, 1973; 14: 55-65 (in Japanese).
9. Ozawa H. Geographic variation on mortality of cerebrovascular diseases and dietary life at the past time. Jpn J Public Health, 1968; 15: 551-566.
10. Institutes for Science of Labor. Study on early aging of farmers. Tokyo, Institute of Science of Labor, 1954-1956. (in Japanese)
11. Akaishi H, Sugawara T. Hypertension and stroke in Iwate prefecture (1). Public Health, 1951; 10: 173-174 (in Japanese).
12. Kimura T, Terui H, Makino K, et al. Blood pressure surveys in farming and fishing villages. Jpn J Clin Med, 1955; 43: 709-710 (in Japanese).
13. Fukuda A. Epidemiology of hypertension, Proceedings of the 15th General Assembly of the Japan Medical Congress, 1959: pp. 535-541 (in Japanese).
14. Ito Y. Stroke mortality, hypertension prevalence, and lifestyles in farming and fishing villages. Jpn J Health and Human Ecology, 1962; 28: 1-17 (in Japanese).
15. Ono J. Epidemiological study on stroke mortality at Tsugaru district in Aomori prefecture (1) Geographical difference in stroke mortality rates for the middle aged. Hirosaki Igaku, 1960; 12: 382-388 (in Japanese).
16. Suzuki J. Study on etiology of hypertension and stroke in northeast part of Japan, Association between mortality rate of stroke and area of farming fields. Jpn J Health and Human Ecology, 1962; 28: 1-17 (in Japanese).
17. Kojima S. On the death rate from cerebral apoplexy and its relationship to the scale of agricultural management in Akita prefecture. Jpn J Public Health, 1961; 8: 783-790 (in Japanese).
18. Dawber TR, Moore FE, Mann GV. Coronary heart disease in the Framingham Study. Am J Public Health, 1957(Suppl): 4-24.
19. Kannel WB, Brand N, Skinner JJ, Dawber TR. The relation of adiposity to blood pressure and development of hypertension: The Framingham Study. Ann Intern Med, 1967; 67: 48-59.
20. Epstein FH, Francis T, Hayner NS, et al. Prevalence of chronic diseases and distribution of selected physiologic variables in a total community: Tecumseh, Michigan. Am J Epidemiol, 1965; 81: 307-322.
21. Fukuda Y. Epidemiology of the occurrence of cerebral stroke and heart attack, Tokyo, Rodoigaku-Kenkyukai, 1978 (in Japanese).
22. Komachi Y, Iida M, Shimamoto T, et al. Hypertension and stroke. Saishin Igaku, 1971; 26: 1897-1906 (in Japanese).
23. Iida M. A nutritional study on prevention of ischemic heart disease in Japanese populations, Annual Report of the Research on Cardiovascular Diseases 1988, Osaka, National Cardiovascular Center, 1989: pp. 321-335 (in Japanese).