

**Table 1.** Mean and coefficient of variance (CV) of per capita income, life expectancy, and age-adjusted mortality of 46 prefectures in Japan, 1955 to 2000

Year	Per capita income		Life expectancy (years)				Age-adjusted mortality (per 100,000)			
	(thousand yen)		Men		Women		Men		Women	
	Mean	(CV)	Mean	(CV)	Mean	(CV)	Mean	(CV)	Mean	(CV)
1955	68.7	(22.0)	62.95	(2.03)	67.13	(1.93)	-		-	
1960	112.2	(26.6)	65.19	(1.66)	70.07	(1.37)	-		-	
1965	215.5	(23.4)	67.49	(1.44)	72.88	(1.01)	632.0	(9.31)	375.9	(6.37)
1970	495.4	(21.7)	69.41	(1.35)	75.05	(0.71)	566.7	(10.64)	321.8	(5.84)
1975	1019.1	(14.2)	71.44	(1.06)	76.84	(0.64)	459.1	(9.65)	255.0	(5.50)
1980	1575.0	(12.7)	73.34	(0.92)	78.92	(0.54)	402.0	(9.92)	206.2	(6.06)
1985	1960.9	(14.6)	74.82	(0.80)	80.73	(0.53)	365.2	(9.50)	176.6	(6.46)
1990	2634.7	(15.9)	75.96	(0.78)	82.10	(0.47)	335.5	(9.01)	155.2	(5.57)
1995	2865.5	(13.2)	76.66	(0.76)	83.30	(0.54)	319.9	(10.38)	148.9	(9.12)
2000	2867.6	(12.4)	77.62	(0.75)	84.70	(0.48)	297.7	(8.82)	135.6	(6.28)

CV = Standard deviation/Mean × 100

Okinawa Prefecture to Japan. Okinawa Prefecture was excluded from the current analyses to ensure comparability of time trends.

Municipalities include cities (“shi”), towns (“machi”), villages (“mura”), and wards (“ku”). The number of municipalities fluctuated and numbered almost 3350 during the observed periods because of mergers and dissolutions of municipalities.

The entire observation period was 1955 to 2000, but the analytical period depended upon variables because of limited data availability.

*Data*

Health indicators were life expectancy (LE) and mortality. In prefectural analyses, LE and age-adjusted mortality among populations aged 20 to 64 years were used. The data were obtained from the Prefectural Life Table and Vital Statistics (15-18).

In municipal analyses, the observed number of deaths was obtained from Vital Statistics (19,20) and aggregated in intervals of five consecutive years (1973-77, 1978-82, 1983-87, 1988-92, 1993-97, and 1998-2000). The expected number of deaths was estimated using the age-specific population of the municipality and age-specific mortality of the entire country (19-21). Analysed municipalities numbered 3346, 3348, 3356, 3346, 3361, and 3356, respectively, for the five observation periods.

Per capita income served as a socioeconomic indicator. Per capita income by prefecture and municipality was obtained from a published database (21,22).

*Analyses*

In prefectural analyses, the slope index of inequality (SII) served as a measure of the association between health indicators and income. The SII is estimated from the slope of the linear regression line between income

ranking and health indicator and the mean of the health indicator (23). Since the SII is independent of absolute values of health and its predictive variables, it is useful for comparison of the magnitude of health inequalities, and especially for comparing time trends and different indicators (23).

First, the prefectures were ranked according to per capita income, and ranking values ranging from 0 (lowest income) to 1 (highest income) were assigned to prefectures. Then, the linear regression line was fitted with the health indicator as the dependent variable and the ranking value as the explanatory variable. The SII was estimated by dividing the slope by the mean of the health indicators and presented as a percentage (× 100). The observation period was 1955 to 2000 for LE and 1965 to 2000 for mortality.

In municipal analyses, Poisson regression was used with the number of observed and expected deaths and per capita income, and the rate ratio (RR) of income for mortality was estimated. Two income variables were separately introduced. First, per capita income was introduced as a continuous variable (in units of a million yen). Second, an ordinal variable was used: the lowest decile = 0.05 to the highest decile = 0.95. The observation period was 1975 to 2000. Municipal per capita income in 1975 was not available, so that in 1980 was used for the 1975 analysis.

SPSS 15.0J was used for linear regression analysis and MLwiN 2.02 for Poisson regression analysis.

**Results**

Table 1 summarizes the health indicators and per capita income of 46 prefectures from 1955 to 2000. Income markedly increased, and especially until 1990, with narrowing of the variation in accordance with the coefficient of variance (CV). LE continuously increased with narrowing variation. Age-adjusted mortality continuously decreased but was not accompanied by narrowing variation.

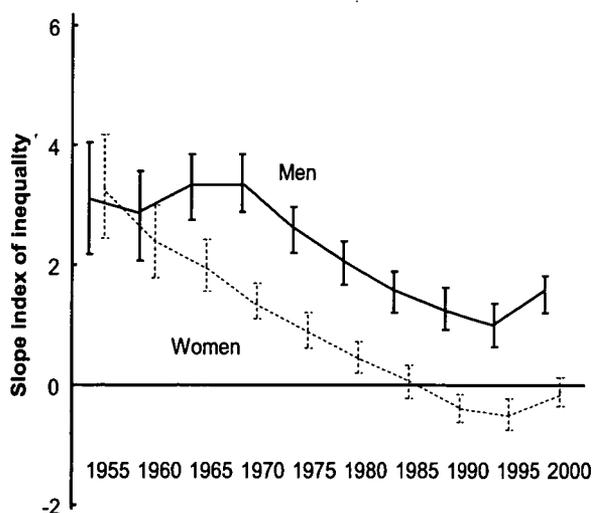


Figure 1. Slope index of inequality for income and life expectancy for 46 prefectures in Japan, 1955 to 2000. Vertical lines show the 95% confidence interval.

Figure 1 shows the SII for LE and per capita income in prefectural analyses from 1955 to 2000. A positive sign means that a prefecture with higher incomes had a longer LE. The SII decreased during 1955 to 1995 for women and during 1970 to 1995 for men. In contrast, the SII increased for both men and women from 1995 to 2000.

The SII for age-adjusted mortality and per capita income from 1965 to 2000 is shown in Figure 2. A negative sign means that a prefecture with higher incomes had a lower mortality rate. According to the SII, the association between income and mortality decreased until 1995 but increased from 1995 to 2000.

Table 2 shows the results of municipal analyses, demonstrating the RR of per capita income for mortality. An RR of less than 1.0 means that municipalities with higher incomes had a lower mortality rate. There were some differences in absolute values between continuous and categorical variables due to the different units, but the time trends were similar. The association between income and mortality decreased until 1995. For women in 1990 and 1995, the RR was more than 1.0, showing that municipalities with higher incomes had a higher mortality rate. From 1995 to 2000, RR increased in both

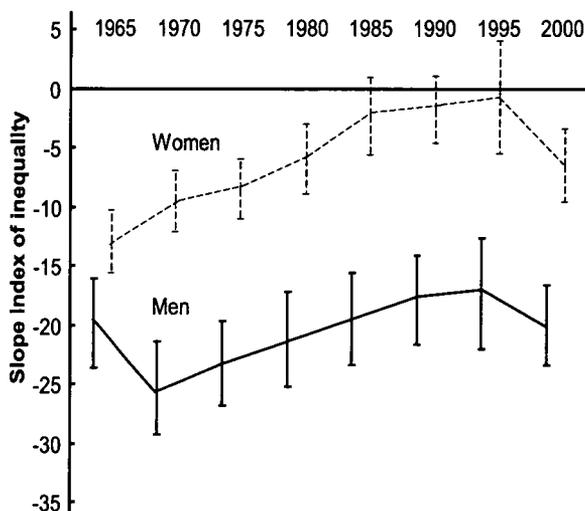


Figure 2. Slope index of inequality for income and age-adjusted mortality for 46 prefectures in Japan, 1965 to 2000. Vertical lines show the 95% confidence interval.

men and women.

### Discussion

This paper demonstrated the possibility of health inequalities increasing from 1995 to 2000 in Japan. An increase in health inequalities over the past few decades has been found in other industrial countries (24-26). The current findings offer the first suggestion of a recent increase in health inequalities in Japan.

Until 1995, the association between income and health indicators decreased, as shown in previous studies (8,9,27). The decrease in health inequalities was accompanied by significant LE extension and a decline in mortality. Possible contributors to the improved health of the Japanese population have been noted. An egalitarian social system and culture appears to contribute substantially through compulsory education, universal health insurance coverage, public health services, income adjustment policy, and strong social relationships (6,8-10). This is considered to be a good indication that fewer socioeconomic inequalities improve the health of the population (6,11).

The association of income and health indicators

Table 2. Results of poisson regression of per capita income and mortality by municipal level: rate ratio with 95% confidence interval

Year	Men		Women	
	Continuous <sup>a</sup>	Categorical <sup>b</sup>	Continuous <sup>a</sup>	Categorical <sup>b</sup>
1975	0.779 (0.766, 0.793)	0.861 (0.851, 0.872)	0.877 (0.861, 0.893)	0.945 (0.933, 0.958)
1980	0.855 (0.841, 0.870)	0.920 (0.909, 0.931)	0.938 (0.921, 0.955)	0.987 (0.975, 1.000)
1985	0.876 (0.865, 0.887)	0.913 (0.902, 0.924)	0.959 (0.946, 0.972)	0.998 (0.878, 1.134)
1990	0.950 (0.943, 0.957)	0.941 (0.940, 0.942)	1.004 (0.996, 1.012)	1.042 (1.030, 1.055)
1995	0.944 (0.936, 0.951)	0.935 (0.925, 0.945)	1.012 (1.003, 1.020)	1.035 (1.023, 1.048)
2000	0.886 (0.883, 0.889)	0.853 (0.849, 0.857)	0.975 (0.972, 0.979)	0.972 (0.967, 0.977)

<sup>a</sup>Per capita income was used as the continuous variable in units of a million yen.

<sup>b</sup>Per capita income was used as the ordinal variable: from the lowest decile of 0.05 to the highest decile of 0.95.

increased from 1995 to 2000. This increase was consistent regardless of different health indicators and different geographic levels for both men and women. The recent data invite several warnings about Japanese health status. LE of some occupational classes declined in the past few years (28). LE of all Japanese men also declined from 2004 to 2005 (29). This is not conclusive, but the increase in health inequalities may be linked to the deterioration of the health of the population.

Although the explanation for the possible increase in health inequalities in recent years is beyond the scope of this study, increasing socioeconomic inequalities are a potential contributor to increasing health inequalities. Some measures such as the Gini coefficient suggest a widening of income distribution in Japan (14,30). The economic recession after the collapse of the bubble economy in the early 1990s and the subsequent policies on economics, taxation, and social security might have contributed to increased socioeconomic inequalities (12-14). Crumbling of the lifetime employment system found in Japanese companies, the increase in unstable employment, and the increase in social security costs might have also accelerated worries about increasing socioeconomic inequalities (12-14).

The health care system in Japan is considered among the best in the world in terms of fairness of financial contribution, health outcomes, and other indicators (31). The system is believed to contribute to the healthy status of the Japanese population (9). However, recent figures suggest an increase in inequality in access to and use of health care in Japan. Geographic disproportions in health care, such as in the number of obstetricians, gynecologists and pediatricians, and cancer care resources are increasingly receiving attention (32,33). A previous ecological study showed that the lack of resources for maternal and child health is associated with higher infant mortality in Japan (34). Other studies have noted that the postgraduate medical training system and recent health policies, mainly in relation to the postgraduate medical training system and control of health care expenditures, might trigger geographic disproportions and widening inequalities in health care (35). In addition, an increasing number of people who cannot afford insurance premiums appears to be endangering universal health insurance coverage (36). Circumstances concerning health care may widen health inequalities and consequently threaten improvements in the health of the Japanese population.

Analyses of health inequalities often suffer from methodological problems. The selection of both health indicators and socioeconomic variables and methods of analyzing their association are critical (37). The findings of this study were obtained using sophisticated methods with reliable health and socioeconomic variables at two different levels. Nonetheless, a few limitations are acknowledged below.

First, the observation period is too short to conclude

that health inequalities were increasing until 1995, and health inequalities should be continuously monitored. Second, another combination of health indicators and socioeconomic variables could demonstrate a different pattern from that of this study. More specified health indicators, such as cause-specific mortality, will elucidate more detailed situations including an explanation for increasing health inequalities. Area indicators representing socioeconomic conditions are critical in area-based analyses. Agreed-on area indicators have not been established in Japan, unlike in some countries where indicators such as deprivation indices have been applied (38). The development of area-based socioeconomic indicators is an urgent challenge for the study of health inequalities in Japan. Lastly, but of equal importance, ecological studies have methodological limitations, including confounding factors and the ecological fallacy (39). Nonetheless, geographical data can yield meaningful evidence on health inequalities, especially in the long term, since individual-level data are generally of limited use for such analyses (40). Further studies with individual-level analyses based on a system to monitor individual-level inequalities should be encouraged in order to provide more conclusive evidence.

In conclusion, this study showed a possible increase in socioeconomic inequalities in life expectancy and mortality from 1955 to 2000, following a decrease in inequalities from 1955 to 1995. Although conclusions should be carefully drawn from further studies and future monitoring, Japan's marked health improvement in the past half century may not enjoy an equal parallel in the future.

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