原　著

Prefectural mortality in relationship to socioeconomic status and long-term care in Japan

日本における都道府県別に見た死亡率と要介護状況と社会経済状況との関連

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Abstract

Objectives: The purposes of this study were to explore the distribution of mortality, long-term care (LTC) and socioeconomic status (SES) among prefectures in Japan, and to elucidate the association between SES, LTC, and mortality indictors by using aggregated panel data. Methods: Prefectures in Japan were used as units of analysis and 7 indicators were obtained from multiple data sources, which were published by government organizations and public institutions for years centering on 1995, 2000, and 2005. The quintile distributions of the main variables are presented using the Map Win program. Data analyses were performed using the statistical package SPSS 19.0 for Windows. Results: As a result of correlation analysis, a decreased mortality was found to be associated with higher percentage of SES and lower rate of certification for LTC. With respect to gender differences, male mortality was predicted by SES and LTC more strongly than female mortality. According to the linear regression analysis, the effect of SES on the death rate of elderly became stronger and more significant in 2005. Conclusions: In conclusion, the factors that explain the mortality, LTC, and SES variations in Japan demonstrated that prefectures that had higher socioeconomic levels and lower LTC application rates had lower death rates. Future studies with individual-level analyses should be conducted to provide more conclusive evidence.

目的：本研究の目的は、日本の 47 都道府県別で見た死亡率、要介護認定割合そして社会経済的要因との関連を明確にすることである。
研究方法：日本国が提示した、1995、2000 と 2005 年の情報を活用し、Map Windows と SPSS 19.0 で解析した。
結果：経年的に見た死亡率の低減化と要介護割合の低減化は、社会経済的要因と統計学的にみて有意に関連し、女性よりも男性の方が強く関連していた。社会経済的要因が優れ要介護割合が低い地域では、総死亡率が少ない傾向を示した。

Key words：mortality, socioeconomic status, Long-term care
キーワード：死亡率、社会経済学的状態、要介護状況

1. Introduction

Populations are aging and life expectancy continues to increase throughout most of the world due to the profound changes in the prevailing patterns of disease and morbidity. As one of the fastest aging developed countries, Japan has the longest life expectancy and healthy life expectancy (HALE) at birth in the world. These achievements in the Japanese population, particularly in the 1960s and 1970s, are suggested to be based not only on improvement in the standards of living due to economic growth but also on a relatively smaller socioeconomic disparity[1),2)]. Nonetheless, significant geographical variation in health levels is found even in Japan. According to the prefectural estimates published by the Ministry of Health, Labour and Welfare (2012), HALE at birth by prefecture was found to vary from 68.95 (Aomori Prefecture) to 71.74 (Aichi Prefecture) for males and from 72.37 (Shiga Prefecture) to 75.32 (Shizuoka Prefecture) for females in 2010.

In Japan, systematic studies using municipal data regarding all causes and cause-specific mortality along with several socioeconomic indicators showed significant relationships between regional mortality and socioeconomic characteristics[3),4),5)]. Socioeconomic status (SES) reflects different aspects of social stratification, and people with low SES have a higher mortality than those with better SES. Because no SES index has yet been established for research in Japan, this study used the traditional SES indicators for analysis, including income, education, and occupation at the prefectural level. A small but growing body of literature on socioeconomic inequality in morbidity among older individuals suggests that social inequality in health persists into old age. Moreover, frailty among elderly individuals is associated with their SES and is strongly associated with their health- and home-care utilization[6)]. SES indicators such as education, income, wealth, and homeownership are also predictors of long-term care (LTC) use; however, the evidence for each indicator being a predictor of LTC is inconclusive. For example, the income effect refers to the possibility that people with a higher income might find it easier to pay for LTC, and might therefore, ceteris paribus, be more inclined to enter residential care. However, a higher income might also facilitate access to home care services and might therefore assist in delaying residential care entry[7)]. In 2000, the Japanese government introduced LTC insurance for older people requiring nursing care, and citizens age $\geq$ 40 years can receive insurance benefits after application and certification that they require such care. Although the costs of LTC are covered by public programs for people regardless of their income level, few studies have been conducted on the association between SES and the LTC application rate. Since LTC insurance unions are managed by municipalities in Japan, the LTC data require an application rate so that they can be collected at the prefectural level.

The study of the socioeconomic factors that determine prefectural mortality variations in Japan is a matter of great interest, because it helps to provide rational guidance on possible activities to reduce such differences and, in short, to increase the level of health in the whole population. The purposes of this study were to explore the distribution of mortality, LTC, and SES among prefectures in Japan from 1995 to 2005, and to elucidate the association between them by using aggregated panel data. Finally, time trends and gender differences were explored.

2. Methods

2.1 Study Unites

According to Local Autonomy Law, local public entities in Japan are divided into two categories. The prefectures of Japan are the country's 47 first-order subnational jurisdictions on a state or provincial level: 1 "metropolis" (in Japanese, "*to*"), Tokyo; 1 "circuit/territory" ("*do*"), Hokkaido; 2 urban prefectures ("*fu*"), Osaka and Kyoto; and 43 other prefectures ("*ken*"). There are currently 47 prefectures, increased from 46 in 1972 with the reversion of the Okinawa Prefectures to Japan. Another category consists of cities, towns, and villages ("*shi*," "*cho*," and "*son*"). The 47 prefectures in Japan were used as units of analysis, which are grouped into nine regions based on their geographic divisions: Hokkaido, Tohoku, Kanto, Chubu, Kansai, Chugoku, Shikoku, Kyushu, and Okinawa.

2.2 Data collection

This study adopts a prefecture-based data analysis, considering the influence of SES on mortality and LTC. We selected seven indicators obtained from multiple data sources, which were published by government organizations and public institutions for specific years: 1995, 2000, and 2005. Every conceivable variable of interest was considered.

Mortality as a dependent variable was explained by a series of indicators in this study: age-adjusted death rate (per 1,000 people) for males, age-adjusted death rate (per 1,000 people) for females, and death rate for people ≥ 65 years (per 1,000 people). As the age distributions were different over the study period, age-adjusted death rates by gender were calculated using Population Censuses data from Ministry of Internal Affairs and Communication in 1995, 2000, and 2005; however, the death rates of people ≥ 65 years old were available only for 2000 and 2005.

Rates of certification for LTC need were calculated by dividing the number of applications for certification of need for LTC (or support) by the number of insured people age ≥ 65 years. Data were not available in 1995, because LTC insurance was not introduced until April 2000. Data were collected from the Report on Long-term Care Insurance Operation, Ministry of Health, Labour and Welfare in 2000 and 2005.

Three prefectural SES indicators were used as independent variables: enrollment rates in higher education (%), per capita income (1,000 yen), and total employment rate (%). Data for all indicators were obtained in 1995, 2000, and 2005. Enrollment rates in higher education referred to the percentage of upper secondary school graduates that moved on to higher education, which were collected from School Basic Survey, Ministry of Education, Culture, Sports, Science and Technology. Per capita income was calculated by dividing the aggregated annual taxable income by the total prefectural population from National Accounts of Japan, Cabinet Office. Total employment rates reflected the percentage of employed people age 15–65 years in the total workforce, which were collected from Population Census, Ministry of Internal Affairs and Communication.

2.3 Statistical methods

Statistical analysis was conducted separately for each of the dependent variables for each year. First, basic descriptive statistics were calculated. For descriptive observations and screening purpose, variations of the selected variables in different years were measured, including the mean, minimum, maximum, standard deviation (SD), and coefficient of variance (CV). Then, Pearson's correlation coefficients between mortality, LTC, and the composite indices of socioeconomic factors were calculated. Third, variables showing a statistically significant association with dependent variables in different years were used in linear regression analysis. The regression model described the linear association between a single SES indicator, LTC application rate, and mortality. Considering the multicollinearity effects among the three independent variables, only the simple (univariate) regression analysis was applied. Various tests were then employed to determine whether the model is satisfactory. If the model is deemed satisfactory, the estimated regression equation can be used to predict a value of each dependent variable given known values of the independent variable.

The quintile distributions of the main variables are presented using the Map Win program. All variables used contained no missing data. All p values are two-tailed. Data analyses were performed using the statistical package SPSS 19.0 for Windows.

3. Results

3.1 Descriptive characteristics

The mortality, SES, and LTC characteristics of the 47 prefectures in 1995, 2000, and 2005 are summarized in Table 1. From 1995 to 2005, the average levels (mean) of three variables were found to continuously increase: death rate of individuals ≥ 65 years old, rate of certification for LTC need, and enrollment rate in higher education; in contrast, four variables were found to continuously decrease: age-adjusted death rate of both genders, prefectural per capita income, and total employment rate. Large geographic variations in select variables were observed in each year. For example, the age-adjusted death rate of the 47 prefectures in 2005 ranged from 5.39 to 7.33 for men, 2.71 to 3.24 for women, and 31.18 to 38.22 for individuals age ≥ 65 years.

By Map Win program, the distributions of each indicator in the 47 prefectures in 1995, 2000, and 2005 can be shown. For example, each map in Figure 1, Figure 2 and Figure 3 shows the clear geographical difference of age-adjusted death rate for male, per capita income, and rate of certification for LTC need, respectively. In accordance with the CV, the variations of death rate of people age ≥ 65 years and per capita income continuously widened among the 47 prefectures; in contrast, the variations in age-adjusted death rates for females, rate of certification for LTC need, and enrollment rate in higher education narrowed from 1995 to 2005 (Table 1).

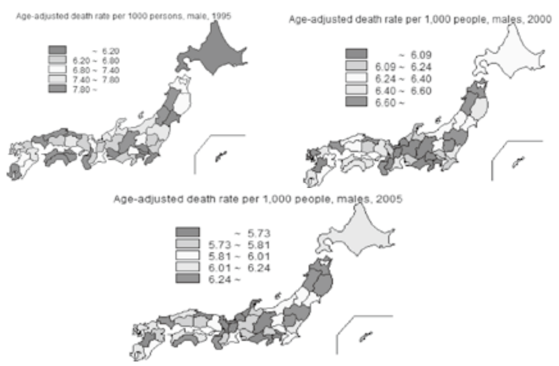

Figure 1　Distributions of age-adjusted death rate for male in Japan in 1995, 2000, and 2005

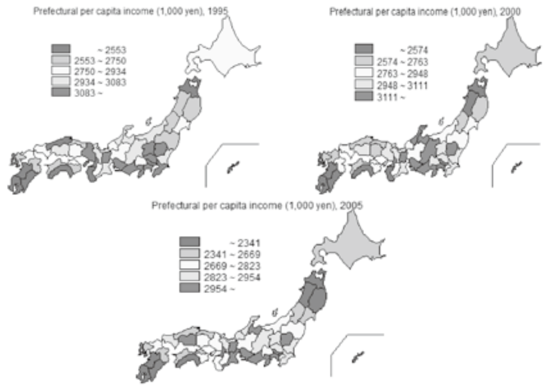

Figure 2　Distributions of prefectural per capita income in Japan in 1995, 2000 and 2005

Figure 3　Distributions of rate of certification for LTC need in Japan in 2000 and 2005.

Based on the quintile distribution data, each SES indicator was divided into five levels from lowest (I) to highest (V). The mean and SD of mortality and LTC application rate by different levels of education, income, and employment in 1995, 2000, and 2005 are shown in Tables 2, 3, and 4, respectively. The mean and SD of mortality by different LTC application level is shown in Table 5.

Table 6 shows the mean and rank of each mortality and LTC indicator of the nine Japanese regions in 1995, 2000, and 2005. During this period, variations in mortality indictors in different regions were identified. A stable, higher age-adjusted death rate for both males and females was observed in Tohoku, whereas stable, lower age-adjusted death rates were observed for both males and females in

Table 1　Prefectural mortality, SES, and LTC characteristics of Japan

Variables	1995					2000					2005				
	Mean	Minimum	Maximum	SD	CV	Mean	Minimum	Maximum	SD	CV	Mean	Minimum	Maximum	SD	CV
Mortality															
Age-adjusted death rate, males	7.16	6.18	8.62	0.41	5.77	6.36	5.80	7.56	0.32	5.07	5.98	5.39	7.33	0.34	5.64
Age-adjusted death rate, females	3.78	3.23	5.01	0.26	6.74	3.20	2.87	3.48	0.15	4.72	2.96	2.71	3.24	0.13	4.52
Death rate of people ≥ 65 years old	—	—	—	—	—	34.82	32.04	37.24	1.21	3.47	35.50	31.18	38.22	1.69	4.77
LTC															
Rate of certification for LTC need	—	—	—	—	—	11.49	8.27	16.23	1.81	15.77	16.56	12.70	20.93	1.96	11.83
SES															
Enrollment rate in higher education	37.00	22.90	47.20	6.62	17.88	43.64	31.10	55.60	6.78	15.53	45.48	31.10	58.40	6.71	14.74
Prefectural per capita income	2867.70	2136.00	4273.00	397.79	13.87	2866.64	2106.00	4573.00	404.24	14.10	2733.28	2040.00	4497.00	431.52	15.79
Total employment rate	63.60	58.30	68.00	2.32	3.65	61.74	56.90	66.10	2.27	3.68	61.10	56.40	64.90	2.05	3.36

Table 2　Descriptive characteristics of mortality and LTC indicators by prefectural education levels

Year	Mortality and LTC indicators	Enrollment rate in higher education: Mean (SD)					Corrlation coefficient
		I	II	III	IV	V	
1995	Age-adjusted death rate, males	7.24 (0.44)	7.18 (0.44)	7.28 (0.31)	6.96 (0.18)	7.14 (0.59)	-0.076
	Age-adjusted death rate, females	3.71 (0.21)	3.77 (0.22)	3.83 (0.18)	3.76 (0.15)	3.87 (0.45)	0.239
2000	Age-adjusted death rate, males	6.48 (0.44)	6.54 (0.20)	6.33 (0.32)	6.26 (0.30)	6.17 (0.13)	-0.399**
	Age-adjusted death rate, females	3.17 (0.17)	3.19 (0.14)	3.28 (0.14)	3.19 (0.17)	3.19 (0.14)	0.088
	Death rate of people ≥ 65 years old	34.12 (1.29)	35.43 (1.28)	35.27 (1.12)	34.78 (1.38)	34.66 (0.51)	0.105
	Rate of certification for LTC need	11.88 (1.88)	12.65 (2.02)	10.6 (1.88)	11.49 (1.53)	10.97 (1.31)	-0.287
2005	Age-adjusted death rate, males	6.22 (0.49)	6.12 (0.22)	5.96 (0.27)	5.86 (0.24)	5.73 (0.14)	-0.502**
	Age-adjusted death rate, females	2.98 (0.12)	2.88 (0.12)	3.05 (0.15)	2.94 (0.14)	2.94 (0.10)	0.007
	Death rate of people ≥ 65 years old	35.37 (1.78)	36.60 (0.73)	35.84 (2.08)	34.88 (1.95)	34.78 (1.08)	-0.210
	Rate of certification for LTC need	16.79 (1.22)	17.49 (1.54)	15.60 (2.47)	16.99 (2.44)	15.99 (1.55)	-0.146

$**p<0.01$.

Table 3　Descriptive characteristics of mortality and LTC indicators by prefectural income levels

Year	Mortality and LTC indicators	Prefectural per capita income: Mean (SD)					Corrlation coefficient
		I	II	III	IV	V	
1995	Age-adjusted death rate, males	7.34 (0.46)	7.32 (0.21)	6.95 (0.21)	7.11 (0.70)	7.11 (0.29)	-0.164
	Age-adjusted death rate, females	3.71 (0.27)	3.77 (0.06)	3.73 (0.14)	3.86 (0.50)	3.88 (0.15)	0.270
2000	Age-adjusted death rate, males	6.64 (0.43)	6.40 (0.17)	6.26 (0.26)	6.26 (0.18)	6.21 (0.32)	-0.385**
	Age-adjusted death rate, females	3.19 (0.17)	3.15 (0.12)	3.22 (0.15)	3.22 (0.14)	3.22 (0.19)	0.191
	Death rate of people ≥ 65 years old	35.05 (1.57)	34.6 (1.23)	35.42 (0.91)	34.77 (1.07)	34.14 (0.97)	-0.192
	Rate of certification for LTC need	13.41 (1.47)	11.92 (1.20)	11.57 (1.52)	10.17 (1.75)	10.14 (0.72)	-0.595**
2005	Age-adjusted death rate, males	6.27 (0.48)	5.97 (0.16)	5.94 (0.29)	5.86 (0.24)	5.83 (0.28)	-0.431**
	Age-adjusted death rate, females	2.96 (0.14)	2.90 (0.11)	2.96 (0.14)	3.00 (0.13)	3.00 (0.16)	0.107
	Death rate of people ≥ 65 years old	35.76 (1.63)	36.11 (1.33)	35.93 (1.29)	35.30 (1.83)	34.33 (2.04)	-0.352*
	Rate of certification for LTC need	17.59 (1.23)	17.40 (1.49)	16.83 (2.22)	15.35 (2.19)	15.46 (1.61)	-0.407**

$*p<0.05$; $**p<0.01$.

Table 4　Descriptive characteristics of mortality and LTC indicators by total employment levels

Year	Mortality and LTC indicators	Total employment rate: Mean (SD)					Corrlation coefficient
		I	II	III	IV	V	
1995	Age-adjusted death rate, males	7.35 (0.52)	7.32 (0.45)	7.11 (0.25)	7.03 (6.94)	6.94 (0.42)	-0.398**
	Age-adjusted death rate, females	3.85 (0.45)	3.80 (0.17)	3.78 (0.10)	3.76 (3.71)	3.71 (0.18)	-0.201
2000	Age-adjusted death rate, males	6.49 (0.21)	6.41 (0.32)	6.46 (0.44)	6.22 (6.19)	6.19 (0.30)	-0.365*
	Age-adjusted death rate, females	3.27 (0.08)	3.16 (0.17)	3.19 (0.16)	3.22 (3.16)	3.16 (0.18)	-0.141
	Death rate of people ≥ 65 years old	35.56 (0.94)	34.34 (1.48)	34.92 (1.38)	34.49 (34.68)	34.68 (0.93)	-0.200
	Rate of certification for LTC need	12.91 (1.48)	12.68 (1.53)	11.37 (1.56)	9.67 (10.65)	10.65 (1.18)	-0.602**
2005	Age-adjusted death rate, males	6.16 (0.19)	5.91 (0.27)	6.12 (0.46)	5.93 (5.75)	5.75 (0.25)	-0.345*
	Age-adjusted death rate, females	3.03 (0.07)	2.92 (0.12)	2.93 (0.15)	2.97 (2.95)	2.95 (0.17)	-0.173
	Death rate of people ≥ 65 years old	36.18 (1.55)	34.76 (1.59)	36.52 (0.86)	35.13 (34.73)	34.73 (1.78)	-0.195
	Rate of certification for LTC need	18.23 (1.58)	17.75 (1.14)	16.90 (1.39)	14.75 (14.94)	14.94 (1.39)	-0.691**

$*p<0.05$; $**p<0.01$.

Okinawa and Chubu from 1995 to 2005. The death rates of people age ≥ 65 years were consistently

Table 5　Descriptive characteristics of mortality indicators by prefectural LTC application rates

Year	Mortality indicators	LTC application rate: Mean (SD)					Corrlation coefficient
		I	II	III	IV	V	
2000	Age-adjusted death rate, males	6.20 (0.23)	6.20 (0.23)	6.36 (0.33)	6.61 (0.14)	6.46 (0.44)	0.334**
	Age-adjusted death rate, females	3.26 (0.14)	3.18 (0.14)	3.20 (0.16)	3.24 (0.08)	3.13 (0.19)	-0.208
	Death rate of people ≥ 65 years old	34.09 (1.27)	34.78 (0.64)	34.71 (1.10)	35.97 (1.34)	34.90 (1.20)	0.303
2005	Age-adjusted death rate, males	6.23 (0.26)	6.20 (0.16)	6.26 (0.28)	6.63 (0.44)	6.46 (0.19)	0.235
	Age-adjusted death rate, females	3.28 (0.14)	3.15 (0.13)	3.15 (0.12)	3.24 (0.18)	3.18 (0.16)	-0.152
	Death rate of people ≥ 65 years old	34.29 (1.30)	34.34 (1.30)	34.88 (1.41)	35.04 (1.29)	35.51 (0.86)	0.337*

$*p<0.05$; $**p<0.01$.

high in Shikoku and Chugoku, while they were low in Okinawa, Hokkaido, and Kanto from 2000 to 2005. In Kyushu and Chugoku, the rates of certification for LTC need remained stably high, while in Kanto, Chubu and Tohoku, the rates remained low from 2000 to 2005.

The mean and rank of each SES indicator of the nine Japanese regions in 1995, 2000, and 2005 are shown in Table 7. Okinawa, Hokkaido, and Tohoku had consistently lower higher education enrollment rates; conversely, Kansai and Chubu had stably higher enrollment rates in higher education from 1995 to 2005. In Okinawa, Kyushu, and Tohoku, the per capita income remained consistently low, while Kanto, Chubu, and Kansai had higher per capita income levels from 1995 to 2005. Hokkaido had the most stable lower total employment rate among the nine regions; in contrast, Kanto and Chubu had higher total employment rates during this period.

In general, the variations in the 47 prefectures and 9 regions showed higher SES levels and lower mortality and LTC application rates, like in the Kanto and Chubu regions; and lower SES levels and higher mortality and LTC application rates, as in Tohoku. However, other regions showed miscellaneous patterns for these two parameters; for example, Okinawa had a lower SES level and lower mortality and LTC application rates.

3.2 Correlation analysis

Correlation coefficients between mortality, LTC indicators, and enrollment rates in higher education are shown in Table 2. In 1995, education level showed no significant relationship with mortality. In contrast, in 2000, education level was statistically significantly and strongly (r=-0.40) associated with age-adjusted death rate for males. In 2005, the enrollment rate in higher education was also negatively and strongly

Table 6 Mortality and LTC indicators of 9 regions in Japan

Indicators	Regions	1995		2000		2005	
		Mean	Rank	Mean	Rank	Mean	Rank
Age-adjusted death rate, males	Hokkaido	7.08	3	6.37	4	6.13	8
	Tohoku	7.36	8	6.68	9	6.43	9
	Kanto	7.11	4	6.27	2	5.90	3
	Chubu	6.79	1	6.04	1	5.71	1
	Kansai	7.42	9	6.39	5	5.91	4
	Chugoku	7.19	6	6.43	5	6.04	6
	Shikoku	7.18	5	6.46	8	6.12	7
	Kyushu	7.31	7	6.45	7	6.00	5
	Okinawa	6.79	2	6.33	3	5.77	2
Age-adjusted death rate, females	Hokkaido	3.73	5	3.17	5	2.96	5
	Tohoku	3.80	7	3.28	8	3.05	8
	Kanto	3.89	8	3.31	9	3.08	9
	Chubu	3.67	3	3.09	2	2.87	2
	Kansai	4.07	9	3.27	6	3.03	7
	Chugoku	3.65	2	3.11	3	2.83	1
	Shikoku	3.71	4	3.27	7	3.00	6
	Kyushu	3.76	6	3.17	4	2.91	4
	Okinawa	3.23	1	2.88	1	2.88	3
Death rate of people ≥ 65 years old	Hokkaido	—	—	32.50	2	33.56	2
	Tohoku	—	—	34.90	6	36.38	7
	Kanto	—	—	34.17	3	34.33	3
	Chubu	—	—	34.44	4	35.21	5
	Kansai	—	—	35.23	7	35.17	4
	Chugoku	—	—	35.75	8	36.47	8
	Shikoku	—	—	36.07	9	37.21	9
	Kyushu	—	—	34.77	5	35.76	6
	Okinawa	—	—	32.38	9	31.78	1
Rate of certification for LTC need	Hokkaido	—	—	11.48	5	16.45	4
	Tohoku	—	—	11.08	3	16.22	3
	Kanto	—	—	9.23	1	13.99	1
	Chubu	—	—	10.37	2	15.15	2
	Kansai	—	—	11.16	4	17.27	5
	Chugoku	—	—	12.91	7	18.14	8
	Shikoku	—	—	12.53	6	18.57	9
	Kyushu	—	—	13.57	8	18.13	7
	Okinawa	—	—	16.23	9	17.32	6

Table 7　SES indicators of 9 regions in Japan

Indicators	Regions	1995 Mean	1995 Rank	2000 Mean	2000 Rank	2005 Mean	2005 Rank
Enrollment rate in higher education	Hokkaido	28.50	7	35.40	7	36.40	8
	Tohoku	27.87	8	34.22	8	37.60	7
	Kanto	35.39	5	45.53	4	48.64	3
	Chubu	41.20	2	47.37	2	49.41	2
	Kansai	42.63	1	50.94	1	52.31	1
	Chugoku	39.36	4	44.76	5	45.58	5
	Shikoku	40.10	3	46.23	3	46.63	4
	Kyushu	35.16	6	38.44	6	39.81	6
	Okinawa	22.90	9	31.10	9	31.10	9
Prefectural per capita income	Hokkaido	2775.00	5	2714.00	5	2507.00	5
	Tohoku	2629.67	7	2623.00	7	2430.33	7
	Kanto	3371.29	1	3326.71	1	3196.14	1
	Chubu	3053.67	2	3102.56	2	2979.67	2
	Kansai	3023.71	3	2978.43	3	2905.29	3
	Chugoku	2776.60	4	2778.40	4	2657.40	4
	Shikoku	2637.50	6	2678.00	6	2473.25	6
	Kyushu	2487.43	8	2501.57	8	2375.43	8
	Okinawa	2136.00	9	2106.00	9	2040.00	9
Total employment rate	Hokkaido	61.60	7	59.70	7	58.70	9
	Tohoku	63.68	4	62.05	3	60.92	3
	Kanto	65.10	2	63.41	2	62.73	2
	Chubu	66.51	1	64.51	1	63.68	1
	Kansai	61.87	6	60.00	5	59.59	7
	Chugoku	63.92	3	61.64	4	60.78	4
	Shikoku	62.15	5	59.98	6	59.25	8
	Kyushu	61.23	8	59.61	9	59.60	5
	Okinawa	61.20	9	59.70	7	60.10	6

associated with age-adjusted death rate for males (r=-0.50); moreover, the coefficient in 2005 was larger than it was in 2000. Nevertheless, education level did not show a close or significant correlation with age-adjusted death rate in females over time.

Regarding prefectural income level (Table 3), in 1995, no close correlations were observed between per capita income and any mortality indicator. In 2000, per capita income was negatively and strongly associated with age-adjusted death rate for males (r=-0.39) and rate of certification for LTC need (r=-0.50). In 2005, per capita income had significant and strong relationships with age-adjusted death rate for males, and the coefficient was larger (r=-0.43) than it was in 2000. Moreover, significant correlations also appeared between per capita income and death rates of individuals age ≥ 65 years (r=-0.35) and rates of certification for LTC need (r=-0.41). Nevertheless, no association between per capita income and age-adjusted death rate was observed for females during this period.

Correlation coefficients between each mortality indicator and total employment rate are shown in Table 4. In 1995, a strong, significant correlation between total employment rate and age-adjusted death rate for males (r=-0.40) was identified. In 2000, total employment rate was found to be strongly and significantly associated with age-adjusted death rate for males (r=-0.37) and rate of certification for LTC need (r=-0.60). In 2005, total employment rate had significantly negative and strong associations with age-adjusted death rate for males (r=-0.35) and rate of certification for LTC need (r=-0.69). For women, total employment rate was not associated with age-adjusted death rate over time.

A stronger positive correlation between age-adjusted death rate for males and LTC application rate was identified in 2000 (r=0.33). In 2005, there was a stronger positive correlation between the death rate of people age ≥ 65 years and rate of certification for LTC need (r=0.34) (Table 5).

3.3　Regression analysis

Table 8 shows the final results of the simple regression analysis conducted on the age-adjusted death rate for males, including independent socioeconomic indicators and LTC, which have shown statistically significant associations in the correlation analysis. There were significant inverse associations between all the socioeconomic factors (enrollment in higher education, higher per capita income, and total employment rate) and the age-adjusted death rate for males. As shown in Table 8, the enrollment in higher education in 2005 was the variable that most strongly influenced the geographical distribution of age-adjusted death rate for males, which accounted for 24% of the variance in these rates. From 1995 to 2005, the effects of enrollment in higher education and per capita income on the variations in age-adjusted death rates for males increased. However, in the same period, the effect of total employment rate decreased. As the LTC application rate increased, the age-adjusted death rate for males was expected to increase, and 10% of the variance could be accounted for by the LTC application rate in 2000.

Table 9 shows the linear regression model of death rate of people age ≥ 65 years in 2005. As the per capita income increased, the death rate of people age ≥ 65 years was expected to decrease; moreover, 10% of the variance of death rate of individuals ≥ 65 years could be accounted for by the per capita income in 2005. Moreover, as the LTC application rate increased, the death rate of people age ≥ 65 years was expected to increase.

Table 10 shows the final regression models on the rate of certification for LTC need in 2000 and 2005, respectively. There were inverse associations between two socioeconomic factors (per capita income, and total employment rate) and the rates of certification for LTC need. Total employment rate in 2005 was the most influential factor on geographic distribution, with a R^2 of 0.47. Per capita income in

Table 8. Results of univariate linear regression analysis: age-adjusted death rate for males associated with SES and LTC.

Year	Variables	B	SE	Exp (B)	*p*-value	95% CI		Adjusted R^2
						lower	upper	
1995	Total employment rate	-0.071	0.024	-0.398	0.006	-0.120	-0.022	0.140
2000	Enrollment rate in higher education	-0.019	0.007	-0.399	0.005	-0.032	-0.006	0.141
	Per capita income	0.000	0.000	-0.385	0.008	-0.001	0.000	0.129
	Total employment rate	-0.052	0.020	-0.365	0.012	-0.092	-0.012	0.114
	LTC application rate	0.059	0.025	0.334	0.022	0.009	0.110	0.092
2005	Enrollment rate in higher education	-0.025	0.006	-0.502	0.000	-0.038	-0.012	0.236
	Per capita income	0.000	0.000	-0.431	0.003	-0.001	0.000	0.168
	Total employment rate	-0.057	0.023	-0.345	0.018	-0.103	-0.010	0.099

Table 9. Results of univariate linear regression analysis: death rate of people ≥ 65 years associated with SES and LTC.

Year	Variables	B	SE	Exp (B)	*p*-value	95% CI		Adjusted R^2
						lower	upper	
2005	Per capita income	-0.001	0.001	-0.352	0.015	-0.002	0.000	0.104
	LTC application rate	0.291	0.121	0.337	0.021	0.047	0.535	0.094

Table 10　Results of univariate linear regression analysis: rate of application for LTC need associated with SES.

Year	Variables	B	SE	Exp (B)	*p*-value	95% CI		Adjusted R^2
						lower	upper	
2000	Per capita income	-0.003	0.001	-0.595	0.000	-0.004	-0.002	0.340
	Total employment rate	-0.480	0.095	-0.602	0.000	-0.672	-0.289	0.348
2005	Per capita income	-0.002	0.001	-0.407	0.005	-0.003	-0.001	0.147
	Total employment rate	-0.660	0.103	-0.691	0.000	-0.867	-0.452	0.466

2000 showed a larger influence on the geographic distribution of rate of certification for LTC need than it did in 2005 (R^2 of 0.34 vs. R^2 of 0.15).

4. Discussion and conclusion

We applied a time trend analysis between 1995 and 2005 using annual prefectural data to show SES, LTC, and mortality variations among the 47 prefectures in Japan. The study demonstrated that prefectural mortality was associated with SES factors such as education, income, employment, and LTC application rate, and gender differences between these associations were also observed during this time period.

4.1 SES, LTC, and mortality variations in Japan

Possible contributors to the improved health of the Japanese population have been noted in previous studies. An egalitarian social system and culture appear to contribute substantially through compulsory education, universal health insurance coverage, public health services, income-adjusted policy, and strong social relationships to further improve the health of the population[8), 9), 10)]. The egalitarian society, however, may be changing. The economic recession that followed 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. Following the crumbling of the lifetime employment system in Japanese companies, the increase in unstable employment, and the increase in social security costs might have also accelerated worries about increasing socioeconomic inequalities[11), 12), 13)].

SES has been shown, by cross-sectional, longitudinal, and ecological studies, to be a primary determinant of health[14), 15)]. The degree of socioeconomic inequalities in a society is closely linked to the health of the population. The results obtained by correlation analysis and regression analysis in this study revealed the explanatory socioeconomic factors for mortality and LTC indicators. In 1995, only the total employment displayed correlation with age-adjusted death rate for males; in 2000 and 2005, all three SES indicators were found to be inversely associated with age-adjusted death rate for males. The Pearson's coefficients showed complicated associations between SES and mortality over time; for example, the correlation between education and income and age-adjusted death rate for males became stronger from 1995 to 2005, while the association between total employment and age-adjusted death rate for males weakened.

4.2 Gender differences in SES-mortality associations

With respect to gender differences in the correlation analysis, three SES indicators significantly associated with age-adjusted death rate for males (income, education, and employment) did not show significant differences for females during the period from 1995 to 2005. Although indicators such as death rate of people $\geq$ 65 years and rate of application for LTC were not differ by gender, the results suggested that prefectural SES influenced health level more strongly in men than in women. The finding that male mortality was predicted by SES more strongly than female mortality is supported by previous studies[16), 17)]. There are several plausible explanations for this tendency. Firstly, males were more sensitive to socioeconomic status than females. Secondly, it could be related to lifestyle factors such as smoking, unhealthy diet, and alcohol consumption. Lifestyle factors are important pathways through which SES adversely influences health[18), 19)]. In Japan, the percentage of individuals with unhealthy lifestyle characteristics, such as smoking and alcohol consumption, is strikingly lower in females than in males[20)]. The relatively healthy lifestyle in women may weak the association between SES and age-adjusted death rate for females. Thirdly, complicated associations existed between mortality and the different SES indicators. Fukuda et al. (2004) reported that male mortality is more strongly correlated with income- and education-related indictors than is female mortality; in contrast, female mortality showed a stronger correlation with living spacerelated indicators than did male mortality, due to a longer time spent at home by females[21]. Lastly, combined with some individual-level studies, men are more likely to die earlier than women are, and mortality may be strongly influenced by one's sense of well-being in men, while it is more likely caused by actual physical and mental health status in women[22, 23]. All the above factors may lead to the gender differences in the direct effect of SES on mortality.

4.3 SES effect on mortality and LTC of the elderly

The present study revealed that the association between death rate of people age ≥ 65 years and prefectural per capita income became stronger and significant in 2005. Two other SES indicators, education and employment, are associated in all age groups, while the death rate of people age ≥ 65 years was an indicator for this older population. Thus, this gap may explain the insignificant associations. Nevertheless, the SES effect on mortality of the elderly should be more closely examined, particularly in recent years. Previous studies on health inequality have primarily focused on the relationship between SES and premature mortality, and the association tended to be stronger in the younger population[24]. The weak relationship between SES and mortality in the elderly population could be primarily explained by selective survivor bias, in which vulnerable people are likely to die before becoming elderly; thus, elderly people are less vulnerable and represent healthier survivors[25, 26]. However, the relationship is not always weaker in the elderly people, and inconsistent but substantial evidence exists regarding a relationship between SES and mortality or morbidity in the elderly[27, 28].

In this study, rate of application for LTC need was chosen as the indicator of prefectural LTC level and disability status which was found to be significantly associated with mortality. In addition, the rate of application for LTC need of older people had associations with employment and income at the prefectural level, but it was not associated with education level in either 2000 or 2005. This suggests that in Japan, employment and income of older people are more important predictors for decreasing the LTC need compared to education level. There are a few plausible explanations for this tendency. One is the indicator for education that was used—enrollment rate in higher education—which has a weak effect on application for LTC services for the elderly. Another explanation addressed the indirect effect of education on LTC application, because educational attainment as a primary indicator of SES would shape the ability to get a good job, earn more money, and become informed about healthy lifestyles. Expected years of life without care needs were calculated and prefectural distributions were reported in previous studies[29, 30]; however, the association between SES and LTC need for the Japanese elderly remains unclear and warrants further examination. In the LTC field, a consensus exists that disability among the elderly is the primary factor driving the demand for LTC services, and there appears to be a consistent inverse relationship between SES and disability[31, 32].

4.4 Study limitations

The possible geographic differences among areas within a country are of great interest to public health and health policy as they show the potential for prevention that still exists. The finding of differences in health within a country, for example, should suggest consideration of what factors affecting such variations can be modified[33]. The national health plan in Japan, "Health Japan 21," accompanied by local actions plans, aims to prolong HALE and eliminate health inequality at both the national and local levels through disease prevention and health promotion. Thus, studying health disparities by different SES and their trends over time can play an important part in future health policy. Findings of this study were obtained with reliable mortality, LTC, and SES data at the prefectural level. Nonetheless, the results should be viewed with caution.

One limitation is the chosen indicators in this study. Because the selection of both mortality and

SES variables may produce different result patterns, more specific indicators should be selected for analysis, such as cause-specific death rate, which could help elucidate more detailed information of mortality. Prefectural indicators representing SES have not yet been established in Japan, unlike in some countries where indicators such as deprivation indices have been applied[34)]. In this study, the SES in a prefecture consists of various aspects (income, education, and employment) that are correlated with each other and influence mortality and LTC in complicated manners. Thus, univariate regression analysis was applied only considering the multicollineartiy effects. As a result, the development of prefecture-based socioeconomic indicators is an urgent challenge for the study of health inequalities in Japan.

The second limitation is that the observation period is too short to conclude that health inequalities increased since 1995. Health inequalities should be continuously monitored.

Thirdly, for natural phenomena, ecological studies have methodological limitations, including confounding factors and fallacy[35)]. However, the objective is neither to draw conclusions about the factors determining the health of people, nor to establish causal relationships of population health with its related factors, but rather to identify the socioeconomic factors involved in the differences in mortality distribution at the prefectural level, particularly in the long term.

4.5 Conclusions

In conclusion, the factors that explain the mortality, LTC, and SES variations in Japan demonstrated that prefectures that had higher socioeconomic levels and lower LTC application rates had lower death rates. Future studies with individual-level analyses should be conducted to provide more conclusive evidence.

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