between the log of individual income and that of mean income), (iii) squared coefficient of variation (SCV) (which is the squared ratio of the standard deviation to the mean income), (iv) 90P/10P ratio (which is the ratio of the income of the 90 percentile household to that of the 10 percentile household), (v) 50P/10P ratio, and (vi) 90P/50P ratio. We use CSLCPHW data to calculate all these measures.

For area-level poverty, we consider the FGT index of order *n* (Foster, Greer & Thorbecke, 1984), which is generally defined in a continuous form as:

$$FGT(n) = \int_0^z \left(\frac{z-y}{z} \right)^n dF(y),$$

where *y* and *F*(*y*) are income and its cumulative distribution, respectively, and *z* is the poverty line, which is usually defined as income equivalent to half of the median income. The term (*z-y*)/*y* in this formula indicates a degree of income deprivation relative to the poverty line, and the parameter *n* shows the degree of emphasis put on income deprivation. *FGT* (*n*) is a relative poverty measure, as the poverty line on which it is based is linked to mean income rather than given as an absolute value. We calculate *FGT* (0), *FGT* (1), and *FGT* (2); *FGT* (0) and *FGT* (1) are often called the headcount and poverty gap ratios, respectively. With a higher value of *n*, this measure puts more emphasis on the depth of poverty, which is captured by the income gap below the poverty line.

We now consider the following four groups of control variables, which have been used as key and conventional confounders in the previous literature.[4]

Household income. The JGSS asked respondents to choose their household annual income for the previous year from among nineteen categories. We take the median value of each category and equivalize it as in the case of household income obtained from the CSLCPHW. We then transform it into log, considering the non-linear association between income and health (Kawachi, Subramanian, & Almeida-Filho, 2002).

Age, gender, and marital status. Ages are categorized into four groups: aged 20-44, 45-59, 60-79 and 80+. For gender, we set one for females; marital status is categorized into three types: married, never married, and separated/divorced.

Educational background. We consider three types of educational background: graduated from junior high school, graduated from high school, and graduated from college and beyond.

Prefecture median income. We control for (pre-tax and equivalized) prefecture median income, which is calculated from the CSLCPHW. It is a matter of debate whether regional median (or mean) income should be included as an independent variable. As suggested by Wagstaff and van Doorslaer (2000), however, regional median income should be a key factor if we contend that relative income or position affects self-rated health. More generally, as discussed by Stjärne et al. (2006), median income and inequality capture two key social aspects of the residential environment: the level of economic resources and the degree of socio-economic homogeneity. It is of interest to examine how this mixture affects self-rated health.

Share of people aged 65 and above. The demographic composition at a prefecture level is likely to directly affect self-rated health and also to confound the association between prefecture health capital and self-rated health (see below). A higher share of elderly people may depress individual health assessments in general and also raise per capita health care spending by local governments and demand for medical services.

In addition to these key and/or conventional confounders, we consider the following variables as controls. All of them can be viewed as either confounders or mediators, and there is no well-established theory that identifies their characteristics. Instead of characterizing them in advance, we include them one by one in a list of explanatory variables, and examine how they affect the association between inequality and health.

Smoking and drinking. Many previous studies have shown that behavioral risk factors, especially smoking, affect health status significantly (see for example, Kennedy et al., 1998; Lopez, 2004). We focus on two health-related questions: smoking (yes=1), and drinking alcoholic beverages (almost every day=2, sometimes=1). It is debatable whether they mediate between income inequality and health or reflect the scale of social stratification, rather than being genuine confounders. Stress from living in an unequal society may affect health indirectly by leading to a more adverse profile of behaviors.

Social capital. It is reasonable to hypothesize that social capital significantly affects health assessment as well as life satisfaction, as already pointed out by many empirical studies in the United States (Fujiwara & Kawachi, 2008; Kawachi et al., 1997; Kim & Kawachi, 2006; Subramanian, Kim, & Kawachi, 2002). The core concepts of social capital consist of civic engagement and levels of mutual trust among community members (Kawachi et al., 1997). Moreover, we consider social capital at both individual and prefecture levels, because it is likely to differently affect the association between inequality and health at the two levels.

Following previous studies that have examined the impact of these factors on health, we focus on the four variables available from the JGSS to capture an individual assessment of social capital: (i) whether the individual belongs to any hobby group or club (yes=1); (ii) whether he/she is satisfied with relationships with friends (yes=1); (iii) whether he/she is satisfied with the place where he/she lives (yes=1); (iv) whether he/she thinks that most people can be trusted (yes=1). For (ii) and (iii), the JGSS asks a respondent to choose from among 1 (=satisfied), 2, 3, 4 and 5 (=dissatisfied). We categorize 1, 2 and 3 as "yes." At a prefecture level, we take the prefecture averages of these variables, based on sampling weights provided by JGSS.

We recognize that the sample size of JGSS is not large enough to precisely generate prefecture-level variables of social capital. Adding them to the list of explanatory variables, however, is expected to give some hint as to how different a role social capital plays at individual and prefecture levels. It is reasonable to assume that an unequal area tends to hinder the accumulation of favorable social capital, which in turn leads to a negative impact on self-rated health. It is equally possible, however, that individual access to social capital is determined largely by household income rather than income inequality; individuals with higher income levels may have easier access to social capital, which in turn improves their health assessment.

Prefecture health capital. The effect of income inequality on health may reflect underinvestment across a wide range of human, physical, health, and social infrastructures (Kaplan et al., 1996; Lynch et al. 2000). If this is the case, an aggregate association between inequality and health is contingent on the level and distribution of other aspects of social resources. To verify the relevance of this argument, we consider some variables that can reflect heath-related social infrastructure at a prefecture level, and examine how the association between inequality and health is affected by including them in the estimation models.

The problem is that there is neither well-established definition of area-level health capital nor its synthetic proxy. To capture major aspects of area-level health capital, we tentatively select the following five variables: (i) per-capita health care spending in the local government budget, (ii) the number of doctors per area (1 km^2 inhabitable area), (iii) the share of people who undergo official health checkups, (iv) the share of individuals covered by public water supply services, and (v) the share of individuals covered by public sewage services. (i) generally reflects the policy effort in the area of health care, (ii) and (iii) are key indicators of health care provisions to individuals, and (iv) and (v) are key examples of health-related infrastructure[5]. All of these variables are basically determined by the local authorities at a prefecture level. As noted above, we also control for the share of people aged 65 and above, because the factors (i) and probably (ii) are likely influenced by the prefecture age distribution.

Per capita social welfare and inequality aversion. In addition to estimations focusing on income inequality and area-level poverty, we construct a measure of per capita social welfare and use it to replace the inequality or poverty measure. Following Atkinson (1970), we define (per capita) social welfare, W_i, in prefecture i, as:

$$W_i = \frac{1}{H_i}\sum_{h=1}^{H_i}\frac{y_{ih}^{1-\varepsilon}}{1-\varepsilon} \quad \text{for} \quad \varepsilon \geq 0, \varepsilon \neq 1; \qquad (*)$$

$$W_i = \frac{1}{H_i}\sum_{h=1}^{H_i}\ln y_{ih} \quad \text{for} \quad \varepsilon = 1, \qquad (*)'$$

where y_{ih} and H_i are the equivalized income of household h in prefecture i and the total number of households in prefecture i, respectively. We normalize y_{ih} by dividing it by its nationwide mean. The parameter e indicates the degree of inequality aversion; with a higher e, individuals are reluctant to accept income inequality. Inequality aversion is the extent to which society dislikes inequality. The greater the level of inequality aversion is, the higher the loss in social welfare is caused by any given degree of income inequality.

The social welfare function given by (*) or (*)' corresponds to the utility function $U(y)=y^{1-e}/(1-e)$ or $U(y)=\ln y$ at an individual level. Individuals who are risk averse want to avoid uncertainty about income, and their degree of risk aversion is indicated by the amount of concavity of the utility function, e. In addition, assuming that individuals know the distribution of incomes but do not know which income they will receive, they evaluate the existing income distribution using expected utility, which can be expressed as (*) or (*)'. The more risk averse they are, the more they prefer an income distribution with less variation. In this sense, inequality aversion at the level of society corresponds to risk aversion at an individual level (Dahlby, 1987; Harsanyi, 1955).

The problem is that we do not know the degree of inequality aversion, *e*, which should be empirically estimated (Amiel et al., 1999). We estimate it by an iterative process, where we: (i) gradually raise the value of *e* from zero with a small ridge; (ii) calculate per capita social welfare at each prefecture, W_i with this *e* using CSLCPHW data; and (iii) estimate the ordered logit and logit A models with this W_i, to search for the value of *e* that maximizes the likelihood of the models. In other words, we produce a backward estimation to obtain the degree of risk aversion that is most consistent with actual health assessment.

Analytic strategy

Our estimation methodology follows previous multilevel analyses, attempting to explain the self-rated health of each individual by an area-level income inequality measure and a set of individual- and area-level socioeconomic variables. We estimate three types of estimation models, on ordered logit and two logit models, and check the robustness of our empirical findings.

Most multilevel studies have dichotomized self-rated health, using a value of zero for "excellent," "very good" and "good" and one for "fair" and "poor," and applied the binomial logit model. Idler and Benyamini (1997) showed that the dichotomization of "poor" and "fair" versus three other responses has strong predictable validity for mortality. However, there is not necessarily a conceptual rationale for the dichotomization, and it is also important to examine distributions of well-being, rather than focusing on high-risk groups. It should also be noted here that JGSS asks respondents to choose among 1 (=good), 2, 3, 4 and 5 (=poor) instead of explicitly using words such as "excellent" or "fair" in these five choices. Hence, we consider three models: (i) an ordered logit model with five categories, (ii) a logit model with one for 3, 4, and 5 (referred to as logit A) and (iii) a logit model with one for 4 and 5 (referred to as logit B hereafter), and compare the results of their estimations.[6]

For multilevel analyses, we use random effect models, and compute robust standard errors to correct for potential heteroscedasticity, as well as potential correlation of the error terms across observations (Moulton, 1986). In addition, we include indicator variables for eleven regional blocks, each of which comprises three to six prefectures (except Hokkaido). This is because unspecified characteristics of a region wider than a prefecture might confound the relationship between individual health and prefecture-level inequality (Mellor & Milyo, 2003; Shibuya et al., 2002; Subramanian & Kawachi, 2003).

3. Results and discussion

Basic results

The top panel of Table 2 reports the changes in the odds ratios for reporting one health status category versus all the better categories (in the ordered logit model) or the better category (in the logit A model) in response to a one-standard-deviation increase of the Gini coefficient.

We start with the benchmark model, (1), which controls for (log-transformed) household income and demographic variables (age and gender). Next, we add each individual-level variable one by one to the benchmark model (see (2) to (5)), and include all of them to establish the individual-level full model, (6). To this model, we add the share of people aged 65 and above to build a prefecture-level benchmark model, (7). We further add each of other prefecture-level variables one by one to it (see (8) to (10)). Then, we include all of prefecture-level variables to establish the prefecture-level full model, (11). Finally, we add regional block indicators to it, (12). For comparison, the bottom panel reports the changes in the odds ratios for reporting poorer health for a one-standard deviation *decrease* in log-transformed household income.

There are several noteworthy findings in this table. First, an increase in the Gini coefficient significantly raises the probability of reporting poorer heath in all of logit A models and more than a half of the ordered logit models, but not in logit B model. The latter result is consistent with Shibuya et al. (2002), who used only data from CSLCPHW and controlled for a limited number of confounding variables. Thus, it is fair to conclude that income inequality *matters* for self-rated health in Japan, assuming that we do not limit our analysis to high-risk individuals.

Second, the bottom panel shows that higher household income significantly improves self-rated health, which is consistent with Shibuya et al.'s results again. We also find that the sensitivity of health to inequality is little affected by specifications of household income (log-transformed, linear, or categorized as four groups), as the odds ratio of the Gini coefficient varies by 0.01 at most (not reported in the table). This suggests that the relation between area-level inequality and individual health is virtually independent of the income-health relation at the individual level.

Third, including marital status, educational background, smoking and drinking, the share of people aged 65 and above, and prefecture health capital causes limited changes in the odds ratios. It is noteworthy that prefecture health capital has limited impact on the sensitivity to inequality. It does not support the view that area-level health capital mediates the impact of inequality.

Fourth, including prefecture median income substantially raises the sensitivity of health to inequality. The Gini coefficient captures the relative magnitude of average absolute variation of income across individuals to mean income, so higher mean income tend to reduce the Gini coefficient with other things being equal. Hence, the fact that controlling for median income, which is close to mean income, raises the sensitivity to the Gini coefficient underscores the importance of income inequality in assessing self-rated health.

Fifth, social capital affects the association between income inequality and self-related heath differently at individual and prefecture levels. Individual social capital raises sensitivity to inequality, while prefecture social capital lowers it. Meanwhile, individual social capital raises sensitivity to household income, while prefecture social capital has little impact on it. These findings are consistent with the view that social capital mediates the impact of household income on health at an individual level, while it mediates the impact of inequality on health at a prefecture level. However, we should be cautious when interpreting these results, because cross-sectional analysis cannot differentiate confounders and mediators in general and social capital could affect individual income.

Finally, including regional block indicators raises sensitivity to inequality, while it keeps that to household income almost unchanged. This result contrasts with those of Mellow and Milyo (2003) and Subramanian and Kawachi (2004), who showed that including regional fixed effects attenuates the association between inequality and health using US data. In Japan, however, Shibuya et al. (2004) reported that including the regional fixed effects generates a gradient effect of the Gini coefficient, which is consistent with our result. Thus, it is likely that the direction of the impact of regional fixed effects differs across countries.

Table 3 compares the results of the ordered logit model and the two logit models, with all independent variables included. A positive coefficient on each independent variable indicates a positive association with poor health. The coefficient on the Gini coefficient is positive and significant in the ordered logit model and logit A model, while it is positive but insignificant in the logit model B. The pattern of the significance of control variables is almost the same across the three models. Higher household income and higher educational background reduce the probability of reporting poorer health. Among demographic factors, only age is significant. Smoking tends to result in lower self-rated health being reported, while alcoholic drinks tend to improve it.

More interestingly, social capital is very important for determining health at an individual level but is insignificant at a prefecture level. It indicates that social capital affects self-rated health through individual relations with them rather than at an aggregated level. Prefecture health capital is generally insignificant, but comparisons of z values suggest that the number of health checks is somewhat more important than other health-related variables. Prefecture median income and share of people aged 65 and above tend to deteriorate health assessments, but their effects are not significant.

Replacing the Gini coefficient with other inequality/poverty measures

Table 4 summarizes the estimated odds ratios for reporting poorer health in response to a one-standard-deviation increase of each inequality/poverty measure, along with the log likelihood, to compare the goodness-of-fit across the models. To check the robustness of the results, the table compares the results of the models without and with regional block indicators, for both the ordered logit model (top panel) and logit A model (bottom panel).

From the results given in this table, we first notice that, compared to the results for the Gini coefficient, the odds ratios tend to be higher and more significant for MLD. MLD is widely known to be sensitive to the bottom end of the distribution. In contrast, the odds ratios tend to be lower and less significant for SCV, which is known to be relatively sensitive to the top end of the distribution. Consistently, the odds ratios tend to be higher and more significant for the 50P/10P than for the 90P/10P; moreover, they are not significant for the 90P/50P. In addition, poverty measures tend to be more significant in terms of z values than inequality measures and the goodness-of-fit measured by the log likelihood is somewhat better for inequality measures, especially for logit A model and when regional block indicators are not included.

These facts imply that there is more concern about income inequality among lower income individuals or those in poverty than income inequality in society as a whole. However, it might be the case that self-rated health is not a temporal psychological reflection of income inequality or area-level poverty, but a consequence of long-term exposures to physical and mental health hazards due to the social context and altered actual health status. Further research is needed to precisely capture people's attitudes toward income inequality and area-level poverty when assessing health.

Estimating inequality aversion consistent with self-rated health

Our estimation results point to an association between income inequality or area-level poverty and self-rated health. Notably, we obtained these results even after controlling for various individual- and prefecture-level variables, suggesting that people's subjective assessment of income distribution appears to have a direct impact on their health assessments. Table 5 presents the estimation results for different values of e from zero to three, with a ridge of 0.25 for the ordered logit and logit A models, with all variables controlled for. For both models, both the log likelihood and the absolute value of z-value of the coefficient for the social welfare measure are maximized when e is equal to 2.25.

Our estimated values of inequality aversion are not far from previous estimates of the relative risk aversion, which have been derived from models of household consumption or portfolio selection under uncertainty. Indeed, Kitamura and Fujiki (1997), Shimono (1998), and Noda and Sugiyama (2007) found relative risk aversion in the range of 1.16-3.72 (estimation period: 1971-1993), 2-4 (1987-1995), and 2.59-3.95 (1994-2006), respectively, based on time-series data of household consumption expenditure or demand for risky assets in Japan.

It is likely, however, that we can obtain another value for inequality aversion if we focus on an aspect of subjective well-being other than self-rated health. In fact, there have been a growing number of empirical studies investigating the factors that determine life satisfaction and happiness (see Easterlin, 2000; Ferrer-i-Carbonell, 2005; Frey & Stutzer, 2002). A more comprehensive estimation of inequality aversion based on a wide variety of aspects of subjective well-being should be a topic for future research.

4. Conclusion

Our multilevel study analyzed how regional income inequality affects self-rated health in Japan based on two nationwide surveys—the CSLCPHW and JGSS. Although, given the relatively small sample, we should be cautious in interpreting estimation results, the following two findings are noteworthy.

First, regional income inequality has a negative association with health assessments in general in Japan. We derived this result even after controlling for various factors at both individual and prefecture levels, a result that is not consistent with the preceding study of Shibuya et al. (2002), who found no significant relationship between inequality and health. This is probably because we examined area-level distributions of well-being rather than focusing on high-risk groups.

Second, our estimation results suggest that when assessing health status, there is more concern about income disparity among lower income individuals or those in poverty than income inequality in society as a whole. In fact, health assessment is affected more by inequality measures that are sensitive to the bottom end of the income distribution, as well as poverty measures that capture the depth of area-level poverty. Consistently, the observed association between income inequality and self-rated health indicates a high degree of inequality aversion.

Although it is of interest to examine the extent to which these trends are observed in other advanced countries, it should be noted that this study has limitations. Most of all, our empirical analysis, which is based entirely on cross-sectional data, cannot precisely distinguish confounders and mediators. Nor can it capture a long-term association or potential feedback between inequality and poverty. The robustness of the findings in this analysis should ideally be examined using a larger volume of panel data. In addition, the roles played by social and health capital should be further investigated because their definitions and choices of variables are basically tentative in this study.

Endnotes

1. Nakaya and Dorling (2005) compared the relationship between income inequality and age-grouped mortality in Britain and Japan. They revealed that, in Britain, mortality is lower where income inequality is lower, while there is no obvious correlation in Japan. However, their analysis was limited to the relationship between area-level aggregated data on mortality and income inequality.
2. Using post-tax incomes, we obtain virtually the same pattern of estimation results, although the statistical significance of the coefficients for inequality and poverty measures turned out to be somewhat smaller.
3. The 2003 JGSS used both the interview and placement (self-administered) methods for each respondent. There were two forms of self-administered questionnaire: *Question Form A* and *Form B*. They had both common and different questions, and each of them was randomly distributed to a half of the sample.
4. Information about an individual's occupation is also available from the JGSS, but we do not control for this due to the risk of endogeneity. In fact, many empirical studies, including those of Bound (1991) and Dwyer and Mitchell (1999), show that the choice of occupation status is affected by health status, especially for the elderly.
5. We also tried the numbers of physicians + dentists and/or pharmacists, hospitals, beds, etc. as prefecture health capital variables but found no significant difference in the results.
6. Lopez (2002) applied the multinomial logit model, comparing respondents with good and fair/poor health with the excellent/very good self-rated group in the case of US metropolitan areas. We also estimated the ordered logit model with three categories: 1-2, 3, and 4-5, which yielded almost the same pattern of results as the ordered logit model with five categories.

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Table 1
Selected descriptive statistics (*N* =1,305)

Variables	Mean	S.D.	Min	Max
(1) Prefecture-level variables (not weighted)				
Gini coefficient	0.355	0.029	0.302	0.409
Mean log deviation (MLD)	0.263	0.039	0.171	0.324
Squared coefficient of variation (SCV)	0.744	0.104	0.563	1.017
90P/10P ratio	5.717	0.949	4.151	7.975
50P/10P ratio	2.662	0.300	2.184	3.583
90P/50P ratio	2.140	0.188	1.767	2.643
FGT(0): Headcount ratio	17.06	2.83	11.44	23.08
FGT(1): Poverty gap ratio	5.876	1.148	4.035	8.470
FGT(2)	2.983	0.736	1.839	4.749
Prefecture median income (million yen)	2.808	0.421	1.744	3.669
Per capita health-care spending (thousand yen)	14.57	6.30	6.30	43.84
Number of physicians in 1 km^2 inhabitable area	2.94	3.94	0.51	23.43
Number of health checks per person	0.106	0.049	0.022	0.216
Water supply coverage ratio (percent)	95.3	4.1	83.2	100.0
Sewage coverage ratio (percent)	54.5	19.5	11.0	98.0
Share of people aged 65 and above (percent)	20.8	2.8	14.9	26.4
(2) Individual-level variables				
Household income (equivalized, in thousand yen)	3,240	2,349	0	32,200
Age	53.6	15.8	20	89

Variables	Share	Variables	Share
Self-rated health status (1=good, 5=poor)		Female	0.526
1	0.231	Never married	0.103
2	0.254	Divorced/widowed	0.117
3	0.287	Graduated from high school	0.470
4	0.185	Graduated from college and beyond	0.293
5	0.044	Smoking (yes=1)	0.470
Equivalized household income (million yen)		Drinking (sometimes=1)	0.349
1 (-1.99)	0.250	(almost everyday=2)	0.390
2 (2.00-2.84)	0.264	Belonging to hobby groups/clubs	0.203
3 (2.85-4.19)	0.247	Satisfied with relationships with friends	0.874
4 (4.20-)	0.240	Satisfied with the area where he/she lives	0.838
Age (years)		Trust in people	0.211
1 (20-44)	0.304		
2 (45-59)	0.284		
3 (60-79)	0.384		
4 (80+)	0.028		

(3) Regional blocks
Hokkaido, Tohoku, Kanto-1, Kanto-2, Hokuriku, Tokai, Kinki-1, Kinki-2, Chugoku, Shikoku, Kyushu

Table 2
The odds ratios for reporting poorer health
(A) In response to a one-standard-deviation increase in the Gini coefficient (*N* =1,305)

Independent variables	Ordered logit		Logit A (3, 4 and 5=1)		Logit B (4 and 5=1)	
	OR	*z*-value	OR	*z*-value	OR	*z*-value
(1) Benchmark model	1.08	(1.48)	1.14	(2.04) **	1.04	(0.49)
(2) (1) + Marital status	1.08	(1.47)	1.14	(2.06) **	1.03	(0.45)
(3) (1) + Educational background	1.09	(1.52)	1.14	(2.01) **	1.03	(0.43)
(4) (1) + Smoking and drinking	1.08	(1.46)	1.14	(2.11) **	1.03	(0.42)
(5) (1) + Individual social capital	1.12	(2.01) **	1.17	(2.40) **	1.06	(0.78)
(6) Individual-level full model	1.12	(2.05) **	1.18	(2.50) **	1.05	(0.65)
(7) (6) + Share of people aged 65 and above	1.12	(2.00) **	1.18	(2.46) **	1.04	(0.54)
(8) (7) + Prefecture median income	1.19	(2.20) **	1.28	(2.61) ***	1.07	(0.61)
(9) (7) + Prefecture social capital	1.09	(1.41)	1.13	(1.72) *	1.04	(0.51)
(10) (7) + Prefecture health capital	1.12	(1.92) *	1.16	(2.17) **	1.07	(0.92)
(11) Prefecture-level full model	1.20	(2.12) **	1.25	(2.19) **	1.13	(1.01)
(12) (11) + Regional block indicators	1.30	(2.52) **	1.36	(2.54) **	1.18	(1.21)

(B) In response to a one-standard-deviation decrease in log of household income

Independent variables	OR	*z*-value	OR	*z*-value	OR	*z*-value
(1) Benchmark model	1.20	(3.77) ***	1.31	(4.29) ***	1.16	(2.36) **
(2) (1) + Marital status	1.21	(3.70) ***	1.32	(4.26) ***	1.14	(2.08) **
(3) (1) + Educational background	1.17	(3.20) ***	1.28	(3.89) ***	1.13	(1.83) *
(4) (1) + Smoking and drinking	1.18	(3.32) ***	1.29	(4.01) ***	1.13	(1.90) *
(5) (1) + Individual social capital	1.13	(2.55) **	1.23	(3.21) ***	1.10	(1.45)
(6) Individual-level full model	1.10	(1.89) *	1.20	(2.87) ***	1.03	(0.48)
(7) (6) + Share of people aged 65 and above	1.10	(1.87) *	1.20	(2.87) ***	1.03	(0.45)
(8) (7) + Prefecture median income	1.10	(1.88) *	1.21	(2.90) ***	1.03	(0.46)
(9) (7) + Prefecture social capital	1.11	(2.05) **	1.22	(3.04) ***	1.04	(0.58)
(10) (7) + Prefecture health capital	1.11	(2.10) **	1.22	(3.02) ***	1.04	(0.54)
(11) Prefecture-level full model	1.12	(2.19) **	1.23	(3.08) ***	1.05	(0.65)
(12) (11) + Regional block indicators	1.11	(2.04) **	1.22	(2.92) ***	1.04	(0.60)

[a] Self-rated health is categorized from 1(=good) to 5 (=poor).

[b] Benchmark model includes the Gini coefficient, household income (log-transformed), age, and gender as independent variables.

[c] Individual-level full model adds marital status, educational background, smoking and drinking, and individual social capital to Benchmark model.

[d] Prefecture-level full model adds the share of people aged 65 and above, prefecture median income/social capital/health capital to Individual-level full model.

[e] ***, **, * significant at the 1, 5, and 10 percent levels, respectively.

Table 3

Ordered logit and logit models for self-rated health using the Gini coefficient (*N*=1,305)

Independent variables	Ordered logit		Logit A (3,4 and 5=1)		Logit B (4and 5=1)	
	Coef.	*z*-value	Coef.	*z*-value	Coef.	*z*-value
Gini coefficient	8.911	(2.52) **	10.590	(2.54) **	5.803	(1.21)
Household income (log-transformed)	-0.125	(-2.04) **	-0.231	(-2.92) ***	-0.051	(-0.60)
Prefecture median income (million yen)	0.660	(1.50)	0.620	(1.28)	0.548	(0.97)
Demographics						
Age 2 (young=1, old=4; base=1)	0.345	(2.50) **	0.388	(2.39) **	0.096	(0.47)
Age 3	0.519	(3.56) ***	0.470	(2.71) ***	0.511	(2.49) **
Age 4	1.022	(2.33) **	0.636	(1.50)	1.322	(3.27) ***
Female	0.145	(0.99)	0.103	(0.65)	0.143	(0.72)
Marital status						
Never married	-0.065	(-0.32)	-0.033	(-0.16)	0.304	(1.23)
Divorced/widowed	-0.025	(-0.14)	-0.179	(-0.92)	0.108	(0.50)
Educational background						
Graduated from high school	-0.394	(-2.66) ***	-0.292	(-1.76) *	-0.434	(-2.29) **
Graduated from college and beyond	-0.249	(-1.50)	-0.176	(-0.92)	-0.286	(-1.30)
Smoking and drinking						
Smoking	0.560	(4.07) ***	0.511	(3.40) ***	0.509	(2.70) ***
Drinking	-0.186	(-2.33) **	-0.082	(-0.94)	-0.338	(-3.29) ***
Individual social capital						
Belonging to hobby groups/clubs	-0.270	(-1.97) **	-0.342	(-2.21) **	-0.191	(-0.98)
Satisfied with relationships with friends	-0.945	(-5.03) ***	-0.795	(-3.86) ***	-0.964	(-4.85) ***
Satisfied with the area where he/she lives	-0.393	(-2.47) **	-0.437	(-2.44) **	-0.295	(-1.51)
Trust in people	-0.574	(-4.31) ***	-0.659	(-4.39) ***	-0.378	(-2.01) **
Prefecture social capital (prefecture averages)						
Belonging to hobby groups/clubs	0.275	(0.27)	-0.273	(-0.24)	0.740	(0.55)
Satisfied with relationships with friends	-0.610	(-0.51)	-0.687	(-0.52)	-0.596	(-0.38)
Satisfied with the area where he/she lives	0.683	(0.99)	0.045	(0.06)	0.976	(1.04)
Trust in people	0.884	(0.86)	0.705	(0.59)	0.516	(0.35)
Prefecture health capital						
Per capita health-care spending (thousand yen)	-0.014	(-0.63)	-0.037	(-1.51)	-0.017	(-0.59)
Number of physicians in 1 km^2 inhabitable area	0.010	(0.55)	0.031	(1.44)	-0.001	(-0.06)
Number of health checks per person	-2.416	(-1.11)	-3.892	(-1.60)	1.336	(0.45)
Water supply coverage ratio	0.632	(0.32)	0.927	(0.40)	0.910	(0.32)
Sewage coverage ratio	0.251	(0.36)	-0.628	(-0.75)	0.249	(0.25)
Share of people aged 65 and above	0.045	(1.02)	0.051	(1.07)	0.006	(0.11)
Log likelihood	-1858.720		-834.005		-641.769	
Pseudo R^2	0.0463		0.0774		0.0847	

[a] Self-rated health is categorized from 1(=good) to 5 (=poor).

[b] The indicators for regional block indicators are included in all specifications.

[c] The reference groups for marital status and educational background are "Married" and "Graduated from junior high school," respectively.

[d] ***, **, * significant at the 1, 5, and 10 percent levels, respectively.

Table 4
Comparisons of the odds ratio for reporting poor health
for a one-standard-deviation increase in inequality/poverty measures

(*N* =1,305)

Inequality/poverty measure	Regional block indicators			
	Not included		Included	
(A) Ordered logit				
Odds ratio	OR	*z* -value	OR	*z* -value
Gini	1.20	(2.12) **	1.27	(2.52) **
MLD	1.21	(2.39) **	1.28	(2.74) ***
SCV	1.15	(1.51)	1.15	(1.81) *
90P/10P	1.22	(2.08) **	1.31	(2.08) **
50P/10P	1.12	(2.15) **	1.14	(1.87) **
90P/50P	1.13	(0.85)	1.24	(1.26)
FGT(0)	1.26	(2.65) ***	1.25	(2.19) **
FGT(1)	1.23	(2.63) ***	1.27	(2.42) **
FGT(2)	1.20	(2.47) **	1.25	(2.45) **
Log likelihood				
Gini	-1862.166		-1858.720	
MLD	-1861.700		-1858.192	
SCV	-1862.956		-1859.959	
90P/10P	-1862.047		-1859.482	
50P/10P	-1861.770		-1859.934	
90P/50P	-1863.896		-1861.027	
FGT(0)	-1860.698		-1859.271	
FGT(1)	-1860.676		-1858.659	
FGT(2)	-1861.158		-1858.649	
(2) Logit A (3, 4 and 5=1)				
Odds ratio	OR	*z* -value	OR	*z* -value
Gini	1.25	(2.19) **	1.13	(2.54) **
MLD	1.30	(2.70) ***	1.15	(3.00) ***
SCV	1.15	(1.43)	1.09	(1.83) *
90P/10P	1.27	(2.22) **	1.12	(2.02) **
50P/10P	1.15	(2.37) **	1.10	(1.87) *
90P/50P	1.14	(0.75)	1.05	(1.12)
FGT(0)	1.32	(2.80) ***	1.19	(2.29) **
FGT(1)	1.31	(3.07) ***	1.20	(2.77) ***
FGT(2)	1.31	(3.12) ***	1.19	(3.01) ***
Log likelihood				
Gini	-837.962		-834.005	
MLD	-836.729		-832.649	
SCV	-839.233		-835.562	
90P/10P	-837.856		-835.105	
50P/10P	-837.448		-835.390	
90P/50P	-839.940		-836.536	
FGT(0)	-836.416		-834.588	
FGT(1)	-835.566		-833.283	
FGT(2)	-835.303		-832.510	

[a] Self-rated health is categorized from 1(=good) to 5 (=poor).

[b] ***, **, * significant at the 1, 5, and 10 percent levels, respectively.

Table 5
Performances of estimation models with different values of inequality aversion

(*N*=1,305)

Inequality aversion (e)	Ordered logit			Logit A (3, 4 and 5=1)		
	Log likelihood	Coef.	*z* -value	Log likelihood	Coef.	*z* -value
0.00	-1861.526	0.093	(0.72)	-837.083	0.611	(0.45)
0.25	-1861.693	-0.159	(0.49)	-837.168	0.252	(0.19)
0.50	-1861.788	-0.363	(0.27)	-837.185	-0.071	(-0.06)
0.75	-1861.828	-0.515	(0.07)	-837.144	-0.342	(-0.29)
1.00	-1861.820	-0.623	(-0.14)	-837.037	-0.566	(-0.54)
1.25	-1861.747	-0.699	(-0.39)	-836.816	-0.760	(-0.86)
1.50	-1861.540	-0.752	(-0.72)	-836.348	-0.924	(-1.28)
1.75	-1861.028	-0.764	(-1.19)	-835.357	-1.019	(-1.87)
2.00	-1860.047	-0.627	(-1.78)	-833.749	-0.879	(-2.58)
2.25	-1859.335	-0.304	(-2.14)	-832.990	-0.440	(-2.89)
2.50	-1859.568	-0.089	(-2.07)	-833.830	-0.129	(-2.61)
2.75	-1860.006	-0.021	(-1.88)	-834.794	-0.030	(-2.24)
3.00	-1860.310	-0.005	(-1.72)	-835.412	-0.007	(-1.93)

[a] Self-rated health is categorized from 1(=good) to 5 (=poor).

[b] All the individual and prefecture factors are controlled for and the regional block indicators are included.

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「所得・資産・消費と社会保険料・税の関係に着目した
社会保障の給付と負担の在り方に関する研究」
分担研究報告書

「Area-level income inequality and individual happiness: Evidence from Japan」

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研究要旨
本研究では，個人レベルの幸福度（perceived happiness）が都道府県レベルの所得格差とどのような関係にあるかを，「国民生活基礎調査」及び「日本版総合的社会調査」の個票データを用いて実証的に分析した。所得格差の程度が大きい地域に住む個人ほど，幸福度が低くなる傾向がある程度あることが確認された。ただし，地域格差と幸福度の間のマイナスの関係は，幸福かそうでないかを区別する水準を低めにすると有意になるが，高めでは有意にならない。さらに，非正規労働者など不安定な就業形態に置かれている者ほど，所得格差に敏感であることも明らかとなった。

A. 研究目的

地域レベルの所得格差と個人レベルの健康に関する主観的評価（SRH：self-rated health）の関係については社会疫学で盛んに研究がすすめられている。しかし，地域レベルの所得格差と個人レベルの幸福度（perceived happiness）の関係については，Alesina *et al.* (2004)を別にするとあまり研究が進んでいない。そこで本研究では，日本のデータを用いて，幸福度と所得格差との関係を分析することを目的としている。

B. 研究方法

「国民生活基礎調査」(2001 年，04 年，07 年)〔所得データはそれぞれ前年〕及び「日本版総合的社会調査」(2000 年，03 年，06 年）をそれぞれマッチングさせて，個人レベルのSRH と都道府県レベルの所得格差や貧困との関係を同時に分析する。すなわち，地域格差については「国民生活基礎調査」から都道府県別ジニ係数を計算し，幸福度については「日本版総合的社会調査」から得られる 5 値のカテゴリー変数を 2 値に集約して分析に用いる。

（倫理面への配慮）

個票データの扱いについては，細心の注意を払った。特に，「国民生活基礎調査」については，本研究における実証分析及びその基礎となったデータ処理は小塩だけが排他的に行った。さらに，再集計した同調査のデータは回帰計算にのみ用い，その値は一切公表していない。

C. 研究結果

幸福度の回答をほぼ3分の1ずつの3段階に分け，上位1つとそれ以下，上位2つと残り1つという2種類の線引きで2値の変数にしたうえで，都道府県レベルの地域格差（ジニ係数）と幸福度の関係をロジット分析で推計した。その結果，幸福の線引きを下にすると有意なマイナスの相関が確認された。さらに，幸福度と地域格差のマイナスの相関は，非正規労働者など不安定な就業形態に置かれている者ほど強くなる傾向があることも分かった。

D. 考察

①地域レベルの所得格差が幸福度と有意なマイナスの相関をもつのは幸福が比較的低い水準にある場合であること，②非正規労働者など不安定な就業形態に置かれている者ほど所得格差に敏感であること，という2つの結果は，再分配政策が低所得層や不利な社会経済状態に置かれている者の主観的 well-being に大きな影響を及ぼすことを示唆している。

E. 結論

本研究の結果は，社会疫学が研究してきた所得格差と SRH と同じような関係が，所得格差と幸福度の間にも存在することを示している。これは，SRH と幸福度がいずれも個人の主観的 well-being の重要な構成要素であることを考えれば理解しやすい結果といえよう。

F. 健康危険情報

なし

G. 研究発表

1.論文発表

"Regional income inequality and happiness: Evidence from Japan," *Hitotsubashi University CIS Discussion Paper*, No.460. (*Journal of Happiness Studies* に投稿後，修正意見を踏まえて再投稿し，審査中)

2.学会発表

なし

H. 知的所有権の取得状況の出願・登録状況

1.特許取得

なし

2.実用新案登録

なし

3.その他

なし

厚生労働科学研究費補助金政策科学総合研究事業（政策科学推進研究事業）
「所得･資産・消費と社会保険料・税の関係に着目した社会保障の給付と負担の在り方に関する研究」

Area-level income inequality and individual happiness: Evidence from Japan

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1. Introduction

In this study, we investigate how area-level income inequality is associated with individual assessment of happiness. Are people happier when living in a more equal society? If so, how and to what extent do socioeconomic factors that surround individuals affect the association between income inequality and their happiness? We attempt to answer these questions using micro data from nationwide surveys in Japan.

Given that income inequality is perceived as being unpleasant and unfavorable, it is reasonable to hypothesize that income inequality in a society reduces subjective well-being of an individual. Social inequality aversion is often discussed in relation with individual risk aversion. Assuming that individuals are risk-averse, an increase in income inequality raises the risk to an individual behind a "veil of ignorance" entering to the economy (Vickrey 1945; Harsanyi 1955; Amiel, Creedy, and Hum 1999). This traditional view can explain the negative connotation of income inequality and why it reduces subjective well-being of an individual. Indeed, Atkinson (1970) constructed an inequality measure based on the social welfare function, which reflects risk aversion at an individual level. In reality, however, individuals have essentially already entered the economy, and accordingly the degree of their risk and inequality aversion is affected by several socioeconomic factors that surround them. Hence, these factors must be controlled for in order to gain a precise understanding of the association between inequality and subjective well-being in empirical analysis.

In keeping with these conventional discussions, Alesina, Di Tell, and MacCulloch (2004) compared the association of inequality and happiness between European countries and the United States and presented two plausible explanations regarding this association. First, individuals may possess a certain ideal picture of income distribution, and a deviation from it—particularly in the form of wider inequality or greater poverty—may reduce happiness. However, an ideal income distribution is likely to differ among individuals with different attributes—people under unfavorable socioeconomic conditions are probably more inequality-averse. Second, individuals may regard observed income inequality as a proxy for the uncertainty of the future. The more risk-averse they are, the greater is their sensitivity toward income inequality. These two views are closely but not exclusively related to each other , because inequality aversion and risk aversion are closely linked.

Undoubtedly, there can be numerous other pathways and mechanisms through which happiness is negatively associated with inequality. In fact, based on their experimental studies, Kroll and Davidvitz (2003) and Carlsson, Daruvala, and Johansson-Stenman (2005) distinguished inequality aversion from risk aversion and indicated that individuals possess inequality aversion independent of risk aversion. More broadly, or from a sociological viewpoint, mechanisms that are essentially tangible, such as considerations of social cohesion, fairness, equality, group-identity and others, can be considered as influencing people's perception of being happier when they live in a more equal environment. To establish a more comprehensive theory of social determinants of individual happiness, more findings must be accumulated.

There are a far greater number of empirical studies on the association between income inequality and subjective well-being of an individual in social epidemiology than in economics or sociology. A central variable focused upon in terms of its association with inequality in social epidemiology is self-rated health, which is the subjective assessment of health and is considered to be a major outcome of subjective well-being at an individual level. Indeed, there is a vast amount of literature that examines whether self-rated health is negatively associated with area-level inequality, as surveyed by Subramanian and Kawachi (2004) and Wilkinson and Pickett (2006). However, the results have been generally mixed. A substantial proportion of the studies conducted within the United States indicate an association between wide income inequality and poor health, while studies conducted outside the United States have a tendency to not support the income inequality hypothesis.

We can apply a similar approach for examining the association between area-level inequality and individual happiness—by replacing self-rated health with perceived happiness and controlling for various covariates at both area and individual levels. At the same time, it is natural that we experience the same difficulties as those encountered by researchers in social epidemiology: pathways and mechanisms linking area-level to subjective well-being have yet to be fully explored.

Economists have been contributing large-scale empirical analyses on the determinants of happiness, as surveyed by Frey and Stutzer (2002). It is now a well-established view that happiness is determined not only by own-income but also by comparisons with the income of others (Clark and Oswald 1994; Ferrer-i-Carbonell 2005; Caporale, Georgellis, Tsitsianis, Yin 2009). Further, numerous economic researches—including Clark and Oswald (1994), Korpi (1997), Winkelmann and Winkelmann (1998), Di Tella, MacCulloch, and Oswald (2001)—have observed that unemployment or an unstable occupational status reduce subjective well-being of an individual even after controlling for income. Recent studies have provided greater clarity on the importance of social relations, particularly access to social capital (Putnam 2000; Bjornskov 2006; Winkelmann 2009; Ram 2009) for individual happiness.

However, much remains to be investigated with regard to the association between inequality and happiness. Alesina et al. (2004) found that inequality measures do not affect individual happiness in the US, while happiness decreases with inequality—particularly for the poor and left-wing people—in Europe. However, there has been little subsequent research, although there are numerous studies that focus on relative income or social status. As an exceptional example, Ebert and Welsch (2009) estimated prevailing inequality aversion among European citizens using micro data on life satisfaction; they found that European citizens are more inequality-averse than indicated by standard measures. However, their cross-country analysis used country-level inequality measures, and there has been little research based on inequality data at state-level or smaller area units within a country.

In this study, we employ an empirical analysis to explore the association between prefecture-level inequality and individual happiness in Japan, a non-Western advanced country, using micro data observed from large-scale nationwide surveys. We basically followed Alesina et al. (2004)'s methodology; however, we conducted three additional analyses.

First, we examined whether the sensitivity to inequality differs among different levels of happiness. If so, ordered logit models cannot produce reliable results. We estimated two logit models at high and low thresholds of happiness and compared the results.

Second, we examined how a choice of covariates to be controlled for at the individual level affects the sensitivity to inequality. This is because there is no rigorous theory that can identify the characteristics of these covariates and it is difficult to hypothesize the dynamics between individual-level variables and area-level inequality.

Third, we investigated how various key individual attributes change the sensitivity to inequality, thereby expanding Alesina et al. (2004)'s analysis, which focused only on income and political views. This may provide some indications with regard to the mechanism that links inequality to happiness.

An empirical analysis of the relationship between inequality and happiness will have the potential of yielding important implications for income redistribution in Japan as well as other advanced countries. Japan is considered to be a relatively homogeneous society, with small levels of inequality. However, in reality its Gini coefficient is now higher than the OECD average, and the ratio of people with income below the poverty line, which accounts for half of the mean income, ranks as one of the highest among OECD member countries (OECD, 2008). Indeed, numerous researchers have raised concerns regarding the trend of widening income inequality in Japan (Fukawa and Oshio 2007; Tachibanaki 2005). More recently, Oshio and Kobayashi (2009) and Ichida et al. (2009) found that self-rated health is negatively correlated with area-level inequality or poverty in Japan. However, the association between area-level inequality and happiness, an issue that is explicitly addressed in this study, must be explored thoroughly.

2. Data

Our analysis is based on micro data obtained from two nationwide surveys in Japan, following Oshio and Kobayashi (2009): (i) Comprehensive Survey of Living Conditions of

People on Health and Welfare (CSLCPHW), which was compiled by the Ministry of Health, Labour, and Welfare; and (ii) Japanese General Social Survey (JGSS), which was compiled and conducted by the Institute of Area-level Studies at the Osaka University of Commerce in collaboration with the Institute of Social Science at the University of Tokyo.

We used the CSLCPHW to construct prefecture-level variables and JGSS to construct individual-level variables. Japan has 47 prefectures that are the basic units of local government and administration in the country. The CSLCPHW yielded sufficiently large samples for obtaining reliable estimates of the Gini coefficient and mean household income in each prefecture; however, it yielded limited information regarding demographic and socioeconomic factors at the individual level. In contrast, JGSS yielded valuable individual-level information; however, its sample size was not sufficiently large for calculating prefecture-level variables. We conducted a multilevel analysis by matching data from the two abovementioned surveys on the basis of place of residence of each respondent.

We collected micro data from the CSLCPHWs conducted in 2001, 2004, and 2007, which include household income data of 2000, 2003, and 2006, respectively. This survey randomly selected 2,000 districts from the divisions of the Population Census, which were stratified in each of the 47 prefectures according to population size. Next, all households in each district were interviewed. The original sample size was 30,386, 25,091, and 24,578 households (with a response rate of 79.5%, 70.1%, and 67.7%, respectively) in 2000, 2003, and 2006, respectively.

It is doubtful whether the prefectures are reasonable ecological units. In fact, Subramanian and Kawachi (2004) and Wilkinson and Picket (2006) argued that the geographic scale at which income inequality is assessed is significant in terms of an association with health. Their surveys on empirical studies of social epidemiology in the United States found that the negative association between inequality and health tends to be more consistent at a state level as compared with lower levels of aggregation such as metropolitan areas, counties, and census tracts. Unfortunately, we were unable to apply other units due to data limitations in this study; thus, the estimation results must be interpreted cautiously, as they may not hold at a different level of aggregation.

In order to obtain detailed information on the socioeconomic background of each respondent, we collected data from the 2000, 2003, and 2006 JGSSs. The JGSS divided Japan into 6 blocks; these blocks were further subdivided according to population into three (in 2000 and 2003) or four (in 2006) groups. Next, the JGSS selected 300 (in 2000) or 489 (in 2003 and 2006) locations from each stratum and randomly selected 12–15 individuals aged between 20 and 89 from each survey location. The number of respondents was 2,893, 1,957, and 2,124 (with a response rate of 63.9%, 55.0%, and 59.8%, respectively) in 2000, 2003, and 2006, respectively.

In this empirical analysis, we excluded respondents aged below 25 and above 80 years, those whose sample sizes were limited—students, and those whose key variables were missing. As a result, there were a total of 4,393 respondents (aged between 26 and 80) in our estimation (1,833 in 2000; 1,221 in 2003; and 1,339 in 2006). The summary statistics of all variables are presented in Table 1. In the following account, we present a brief explanation of the dependent