Longitudinal Analysis of the Relationship between Social Stratification and Process of Worsening Health

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Contents

Ⅰ. Introduction

Social stratification and social status are concepts that imply some form of hierarchical ordering in society. A clear relationship between social stratification and health is now established in the research literature (Antonovsky, 1967). In addition, the idea of 'longer life but worsening health' has also been advanced, with further links to processes of social stratification (House et a1., 1997). Understanding social influences on health remains, however, complex, especially in terms of assembling data and methods of analysis.

In this study, I will examine this hypothesis using linear mixed models that can deal with longitudinal data that have been gathered as part of a cross-sectional survey.

Ⅱ. 'Longer life but worsening health' hypothesis

Numerous advance studies have attempted to identify a mechanism for the relationship between health and social stratification in the area of the sociology of health (Antonovsky, 1967). Some researchers have attempted to isolate the role played by the respondents' behaviors in terms of healthy lifestyles and attitudes. These have used psychological concepts within a functionalist framework, while using natural / social selectional explanation (see Townsend and Davidson, 1982). It is also the case that cross-sectional data has been used in the majority of studies.

At the same time, theories focused on theories that take 'time' into account have appeared in this field. One example of these concerns the study of 'accumulation effects'.

Key words: Inequality in health, Process of worsening health, Hierarchical linear model

This theory was derived from Merton's the Matthew effect that has known in the field of sociology of science (O'Rand, 1996). Ross and Wu (1995) explored the idea of accumulation of social status and showed that interaction term between age squared by itself and education has an impact on health in an analysis of health and social Stratification.

Another has examined differences in the process of worsening health between subgroups in a society. For example, Verbrugge (1984) argued that although average life expectancy has lengthened due to industrialization, on the other hands, condition of health in elderly people may have worsened. Recently a similar hypothesis has been advanced concerning a health process in relation to gender, that is to say, females live longer but are in a poor state of health in their old age (Laheuma et al., 2001).

There have been some points of controversy concerning the theories that take time or processes into consideration in this field of studies. First, every causal relationship must have temporality logically, namely temporal order that two concept happen naturally. Therefore this temporality is given up or presumed intentionally or accidentally in analyses using cross-sectional data in the strict sense. So when we make the causal relationship specify clearer, then we have to ignore covariation over time using longitudinal data beside from treating cross-national data.

Then, it is essential that to specify factors in deteriorating health in people's life, 'age' and 'cohort' must be identified as having distinctive influences (Riley et at., 1972, O'Rand 1996, Nakata, 1999b). However these are often confused or combined, especially in studies based on cross-sectional data. Some researchers take difference in age as time difference and treat it as a substitute for age stratification. However, as describe above, age merely denote elapse in individual and doesn't mean time in society. They should not be confused.

Finally, longitudinal study has meanings in association with 'ageing'. We have considerable knowledge concerning health at each life stage, for example health in infants, health in children and health in elderly People. However we seldom pay attention to processes of health though accumulated through the life course. This remains the next major task for researchers to consider.

The objective of this study is to examine dimensions of social stratification to the issue of 'longer life and worsening health'. Verbrugge (1984) showed that the hypothesis was developed in the USA from a comparison between health in various way of measurement and mortality in statistical materials. Fries (1980) argues that as medical and social interventions continue to promote a health middle age, so: '...the average period of diminished physical vigour will decrease, that chronic disease will occupy a smaller proportion of the typical lifespan, and that the need for medical case in later life will increase, (p.130). House et al. (1997), however, cast some doubt on whether all members of society can enjoy longevity in equal measure. These researchers focused on variations amongst subgroups within the population. In particular, they examined how socio-economic status affects a process of declining health. However it should be noted that they used cross-sectional data in their analysis and confounded age and cohort in the way described above.

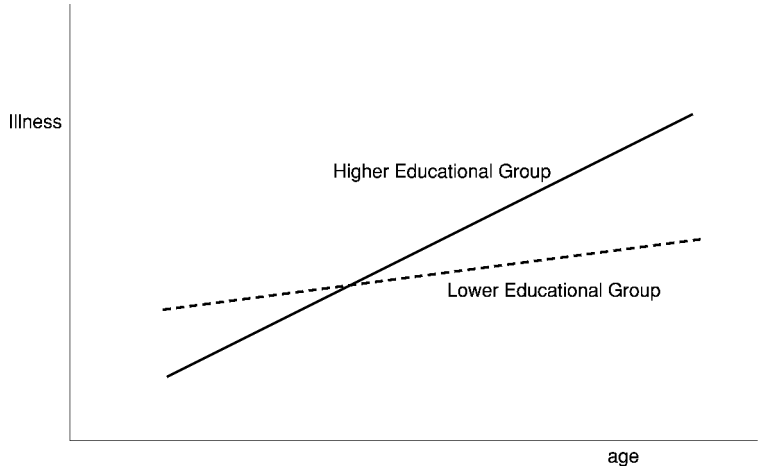

Figure 1. Processes fited in with the Hypothesis

Longitudinal data analysis raises complex issues of management as well as cost in terms of collection. In this study, respondents were asked retrospectively about the age that diseases developed and a variable was constructed analyzing the history of the disease. As reported in more detail below, a variety of measures were used in examining this data. This paper reports on the extent to which there were any differences on the issue of whether health varied by socio-economic group, utilizing a hierarchical linear model suitable for the analysis of longitudinal data.

The paper examines whether there are any significant differences between processes that affect health outcomes by social status. Figure 1 demonstrates the process when the data fit in this theory in linear model. This figure shows that both lines transact because higher status group postponed catching a disease until late old age.

The other subordinate problem exists, that is whether applying linear model to these processes is current or not. In advance studies, some researchers have regarded age as cohort as mentioned above or extract a few points of lifetime. But in this study, I have followed the health process over a long period of time. These studies have never had a place in this field.

III. Method

Sample

Analyses are based on data obtained from a Sapporo survey conducted in August 1999, a cross-sectional study of a random sample of 484 persons who were 60 and older when the survey was carried out. Data collection consisted of interviews. Distributions of basic variables are presented in Nakata (2001).

Table 1. Means and Standard Deviations of Chronic Illness by Age and Social Status

	10	20	30	40	50	60
Higher Education	.031	.086	.190	.331	.540	.834
(N = 163)	(.173)	(.302)	(.424)	(.648)	(.764)	(.884)
Lower Education	.030	.114	.220	.333	.500	.848
(N = 132)	(.212)	(.403)	(.529)	(.626)	(.746)	(.945)

Variables

Health status was constructed as the number of chronic diseases experienced until the time of interview. The range of possible diseases were arthritis/rheumatism, lung disease, hypertension, heart attack or heart trouble, cancer/malignant tumor, diabetes, fractures or broken bones, asthma or respiratory disorder, liver disease, alimentary disease kidney disease, and mental disability. This list was constructed using examples from House et al. (1994) and also with reference to the general cause of death among Japanese people.

Respondents were asked the age those that condition developed for each chronic disease. Data set consisted of average value of chronic illness in every five years of respondent's lifetime by education. Therefore database consists of respondent's number of chronic illness at their 10, 20, 30, 40, 50, and 60 years old. Means and standard deviations of chronic illness by age and social status are showed in Table 1.

It has been proposed that retrospective data have limited credibility. However this study focuses upon the onset of particular conditions rather than attitudes or behaviors. And history of diseases is important to every person in the sense that they are life-threatening crises and therefore, not forgotten (see, for example, Converse and Presser, 1986).

Social stratification. As an indicator of social status, the study used the number of years completed of formal education. It was known that education has close link with health (Ross and Wu, 1995). Years of education were divided into three categories; (a) more than thirteen years, (b) twelve years and (c) under twelve years. In this study, I used the

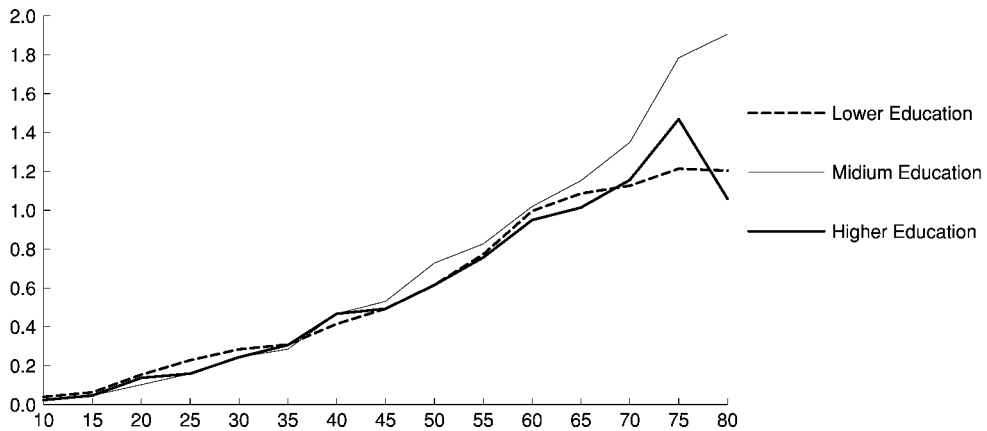

Figure 2. Means of N. of Illness by Social Status

two-category (a) and (c) for the sake of simplicity.

A number of chronic illnesses and age by years of education is illustrated in Figure 2. It is difficult to interpret whether we can accept the hypothesis, therefore I will solve this problem using multivariate analysis.

Analysis Method

In this study, I used linear mixed models (see, for example, Kreft and de Leeuw, 1998, Verbeke and Molenberghs, 2000). These models are generally called multilevel models or hierarchical linear models including both random effects and fixed effects. And these can be analyzed for hierarchical structured data and repeated measurement data similar to the data used in this study.

Verbeke and Molenberghs (1997) defined this model as follow,

$$Y_i = X_i\beta + Z_i b_i + \varepsilon_i \qquad (1)$$

where Y_i is response variable vector (n x 1), X_i is a design matrix containing the fixed effects (n_i X p), and Z_i is a design matrix of random effects with (n_i X q) dimensions. Beta is the p dimensional vector contains regression coefficients and b is the q dimensional random coefficient vector. Finally, epsilon is the n_i dimensional vector with residual components.

The paper will examine relations between regression lines concerning worsening health by educational categories as social status through growth data model and examine the 'longer life but worsening health' hypothesis.

Ⅳ. Results

I used SAS ver.8.02 in these analyses. Model selection is based on fitting information, −2 fold likelihood ratio statistics. A summary of analyses as well as for comparisons between models is given in Table 2.

(1) Model 1

At first, I will assume a separate mean for each age x educational level combinations. This model specifies the covariance structure type to be unstructured. This model is for the

Table 2. Model Fitting Summary of This Study

Model	Covar.	N. of par.	−2l	Ref.	G2	df.	P
Model 1	unstr.	42	1543.5				
Model 2	unstr.	32	1606.7	1	63.2	10	<0.001
Model 3	unstr.	31	1606.8	2	0.1	1	0.751
Model 4	toeplitz	11	2445.5	2	838.8	21	<0.001
Model 5	AR(1)	6	2461.4	2	854.7	26	<0.001
		4	15.9	5	0.007		
Model 6	random	8	2416.3	2	809.6	24	<0.001

Table 3. Predicted Means Gained form Model 1

	Higher Education	Lower Education
Age	Estimate	Estimate
10	0.016	0.045
20	0.100	0.100
30	0.206	0.204
40	0.319	0.345
50	0.486	0.554
60	0.834	0.848

sake of comparison with other models.

This model can be expressed as,

$$
\begin{aligned}
Y_{i1} &= \beta_0 + \beta_1 x_i + \beta_{0,10}(1-x_i) + \beta_{1,10} x_i + \varepsilon_{i1} \\
Y_{i2} &= \beta_0 + \beta_1 x_i + \beta_{0,20}(1-x_i) + \beta_{1,20} x_i + \varepsilon_{i2} \\
Y_{i3} &= \beta_0 + \beta_1 x_i + \beta_{0,30}(1-x_i) + \beta_{1,30} x_i + \varepsilon_{i3} \\
Y_{i4} &= \beta_0 + \beta_1 x_i + \beta_{0,40}(1-x_i) + \beta_{1,40} x_i + \varepsilon_{i4} \\
Y_{i5} &= \beta_0 + \beta_1 x_i + \beta_{0,50}(1-x_i) + \beta_{0,50} x_i + \varepsilon_{i5} \\
Y_{i6} &= \beta_0 + \beta_1 x_i + \beta_{0,60}(1-x_i) + \beta_{0,60} x_i + \varepsilon_{i6} \\
Y_{i7} &= \beta_0 + \beta_1 x_i + \varepsilon_{i7}
\end{aligned}
\qquad (2)
$$

And predicted mean in each age and subgroups that estimated from Model 1 were showed in Table 3.

(2) Model 2

Model 2 presume a linear trend within each educational category. This model can be expressed as follow;

$$Y_{ij} = \beta_0 + \beta_{01} x_i + \beta_{10} t_j (1-x_i) + \beta_{11} t_j x_i + \varepsilon_{ij} \qquad (3)$$

Here, beta0 is the intercept for lower educational group, beta0+beta01 is also the intercept for higher educational group, and beta10 and beta11 are the slopes respectively.

As compared to Model 1, Table 1 shows a difference of 63.2 (compare a deviance of 1543.5 in model with the deviance in this model of 1606.7). The likelihood ratio statistics comparing Model 2 to Model 1 rejects the null hypothesis of linearity. This result means that a process of worsening health is not so much simple as adjusting the linear model. This may be a consequence of this study. When we think about it, higher morbidity is, older we are with accelerating speed. This result is also apparent in Table 2. Therefore it is natural that it is difficult to apply the linear model to this data.

However the analytical method is severe comparing another method and we have never known concerning the process, so I will continue the analyses on the assumption that hypothesis of linear dose not reject.

Form results of this analysis, predicted linear are as follow;

lower educational group: $y=-0.095+0.013x$
higher educational group: $y=-0.091+0.013x$

We may understand that it scarcely makes any difference between these slopes. And estimated lines show that average number of illness in lower educational group is fewer that higher group.

(3) Model 3

This model tests whether these lines showed in Model 2 are parallel or not significantly. Model 3 can be described as,

$$Y_{ij}=\beta_0+\beta_{01}x_i+\beta_1 t_j+\varepsilon_{ij} \qquad (4)$$

Table 1 clarifies that the likelihood ratio test dose not reject the common slope hypothesis (difference of 0.1 with 1 df.). This means that it also makes no difference in pace of increase between two educational groups.

Model 3 estimates the following lines;

lower educational group: $y=-0.094+0.013x$
higher educational group: $y=-0.091+0.013x$

(4) Model 4 and Model 5

In this section, other types of covariance structure are examined. Toeplitz covariance matrix in Model 4 and the first-order autoregressive model are tested. However Table 1 indicates that both covariance structures are rejected as a result of comparison with Model 2.

(5) Model 6

Finally, this model allows the intercept and slope parameters to be random. This model specifies unstructured covariance structure because other covariance was rejected in Model 4 and Model 5.

The result of analysis in Table 1 shows that the fit of models are improved when comparing Model 6 with Model 3, difference in likelihood ratio statistics 802.6 with 24 df. And the variances in slope of age that randomize here are significant statistically. This shows that support for the hypothesis of differences among individual in the relationship between the number of illness and age.

One of advantages in linear mixed model is to compare between individual-level effects and group-level effects to calculate a variance of slopes and intercepts of regression lines in each respondents. In this study they fall on points of respondents and social status respec-

tively. The results of this model show that covariances of both slopes and intercept are large significantly. This means that an individual-level effect is larger than group-level effect.

V. Discussion

The aim of this analysis was to clarify whether education has any influence on the process of worsening health through analyzing longitudinal data using linear mixed models.

The results suggest as follow; first of all, for the problem that applying the linear model to the processes of worsening health that I was mentioned in section II, I found that the linear trend can not be applied. This result means that we left to place with examining nonlinear models. Though I have not showed here, I found that estimated regression lines between two educational groups run parallel if the data contains only their 40 years old or less.

Second, in consideration of results of the analyses, though failed to put the linear model, and analysis the processes until respondents' 40 years old that I haven't showed here, it doesn't make significant differences in the processes between social status groups that I expected in Figure 1. But if it is considered that Japanese people mostly rate themselves as middle class, it is possible that it raise similar lifestyle concerning health and these results therefore may be logical conclusion.

But many still remain to be augured. First, measurement of health is open to question as pointed out in Nakata (2001). An indicator of health constructed by the number of chronic diseases has possibilities that it depends on just a respondent's behavior. For example, higher status people tend to develop diseases that only medical specialist can diagnose like heart disease and diabetes. It may show that they have opportunities to consult a doctor. And Kadushin (1964) hinted at the possibility that people in a lower status group are easy to catch sensate of diseases. It is true that some diseases in the list of chronic illness depend on how respondent feel.

Second, it is possible that worsening health in lower status group is underestimated due to the data that I collected. Respondents of the survey were male who were 60 years and older. As mentioned above, it is well known that lower status people hold a higher mortality rate, which is it is probable that they would die younger. If it is true, a part of the population that is requisite to analyze had already fallen off. I don't know how much lower status people underestimate at this time. Therefore it needs further consideration. And I showed that predicted means in lower educational groups are less than higher educational group and there exists no different processes in worsening health in the conclusion. These results might be affected by the underestimation of lower status group.

Studies concerning difference in processes in health have just begun. These researches come into the picture to solve fundamental problems in inequalities in health.

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[Abstract]

Longitudinal Analysis of the Relationship between Social Stratification and Process of Worsening Health

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The purpose of this study is to investigate whether the process of worsening health differs by social stratification. Recently in the attempts to clarify the differences in mortality between social classes, a new hypothesis emerged, that is to say, there is a difference in the process of worsening health by social status in this study area. In this study, the differences will be examined using hierarchical linear models that can treat longitudinal data. Analysis is based on data obtained from a Sapporo survey conducted in August 1999, a cross-sectional study of a random sample of 484 men who were 60 and older. As an indicator of social status, education, in number of years, was used. The number of chronic diseases experienced until now was used as health status. Respondents were asked the age at which each chronic disease developed. Then the dataset consisted of the average value of chronic illness in every five years of the respondent's lifetime by education. This analysis clarifies that education has no influence on the process of worsening health, i.e. the process of deteriorating health by education is parallel. But much still remains to be investigated in this study.

Key words: Inequality in health, Process of worsening health, Hierarchical linear model