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Original Article

Inequality in Workplace Conditions and Health Outcomes

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Abstract: This paper examines the relationship between the inequality in workplace conditions and health-related outcomes in Japan. It analyzes the effect of changes in the work conditions and work arrangements on the subjective health, activity restriction, and depression symptoms, using the Japanese Life Course Panel Survey (JLPS). The 2007 JLPS consists of nationally representative sample of the youth (20 to 34 yr old) and the middle-aged (35 to 40 yr old). The original respondents were followed up in 2008, and 2,719 respondents for the youth panel and 1,246 for the middle-aged panel returned the questionnaires. The first major conclusion is that there are substantial changes in health conditions between the two waves even though the distributions of health-related outcomes are very similar at two time points. The second major conclusion is that the effects of work conditions depend on different health-related outcomes. Self-reported health and depression symptoms are affected by a variety of job-related factors. The atmosphere of helping each other and the control over the pace of work are two important factors which affect both depression and self-reported health. All these findings suggest that the workplace conditions and job characteristics have profound influence on the workers' health.

Key words: Work environments, Psychological stress, Self-reported health, Depression, Activity restriction, Panel survey

Introduction

The relationship between various work-related conditions and health outcomes is well-documented especially in the United States and Europe. A classical study by Karasek[1)] advocates the job strain model which claims that demanding work conditions and a lack of autonomy in decision-making at workplace lead to deteriorating health outcomes. Many empirical studies[2, 3)] report findings which are consistent with the job strain model. Work-related stress and depressive symptoms are associated with the increase in psychosocial work demands and low control at the workplace[4, 5)]. Borg and Kristensen[6)] show that the changes in the self-reported health were affected not only by social class but also by various work environment factors, including repetitive work, skill discretion, job demands, social support, and job insecurity. Brand *et al.*[7)] report that physical and psychological job characteristics affect self-assessed health, cardiovascular and musculoskeletal health problems, and depression, and that job characteristics mediate the association between socio-economic status and health outcomes. Niedhammer *et al.*[8)] take into account psychological demands, decision latitude, and social support, in addition to occupation, work contract and occupational exposures, in assessing the impact on self-reported health, absence by long sickness, and work injury. They report that all these work factors except for psychological demands affect health outcomes

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and that occupational differences in health were reduced after adjusting for work factors.

Recent research paid attention to the mediating role of work-related conditions and psychosocial job characteristics in explaining the effect of education and socio-economic status on health. The positive association between education and health outcomes is explained by higher psychosocial rewards and less physical demands at work among the highly educated[9, 10]. Qiu *et al.*[11], however, claim that psychosocial job characteristics and work demands have conflicting mediating effects on the relationship between education and health. Highly-educated workers are more likely to enjoy greater autonomy and challenge but, at the same time, to suffer from overtime work and work-family conflict. The study shows the importance of highlighting various aspects of work-related conditions and characteristics and their differing effects on the education-health relationship.

The topic of socio-economic inequality in health conditions has not received much attention in the Japanese academic disciplines until 1990s. More recently, however, there is an emerging body of literature that documents the relationship between socio-economic conditions and health outcomes in Japan, both by researchers in medical profession and in the social sciences. Shibuya, Hashimoto, and Yano[12] utilized the comprehensive survey of the living conditions of people about health and welfare conducted by the former Ministry of Health and Welfare, and found that people who lived in prefectures with higher medium income are more likely to report good self-reported health than people who lived in prefectures with lower medium income level. Kojima[13] used the same survey and concluded that there is no clear relationship between income and subjective health among the elderly.

Tsutsumi[14] documents the relationship between occupation on the one hand and job strain and hypertension on the other. Kondo[15] shows that education and income affect depression symptoms, subjective health, and the need for long-term care among the elderly population in Japan. Ishida[16] examines the national survey of the elderly who were 65 yr old or over and finds that there are clear differentials in physical discomfort, activity restriction, depression, and subjective perception of health by social class and income. Katase[17] using the 2005 Social Stratification and Social Mobility National survey claims that those with low education are more likely to engage in health-risk behaviors (smoking and drinking) than the highly-educated especially among men and that education is positively related with subjective health. Kondo *et al.*[18] claim that relative income deprivation is related to poor self-reported health independently of absolute level of income in Japan. Inoue *et al.*[19] examined the association between interpersonal conflict at work and depression among Japanese men and women. Morikawa *et al.*[20] document the occupational class inequalities in risk factors associated with cardiovascular disease. Kagamimori *et al.*[21] provide a literature review of the recent studies about the relationship between socio-economic status and health outcomes in Japan. There are also studies on socio-economic differentials in health that compare Japan and other nations[22–24]. Therefore, all these studies imply recent accumulation of the empirical studies on social inequality of health in Japan.

This study aims to contribute to the research on social determinants health in Japan in two respects. First, it uses panel survey to identify the effect of the socio-economic positions on health-related outcomes. By taking full-advantage of the panel-type research design, it focuses on the impact on health of the changes in socio-economic positions within the individual, rather than the difference between individuals with varying socio-economic positions. Second, the study incorporates a wide range of work-related conditions and workplace arrangements, in addition to the typical socio-economic outcomes of education, employment status, and income. These include indicators of autonomy and authority at workplace, flexible work arrangements, relationship with co-workers, and opportunities for training and upgrading skills. None of the studies cited above about health inequality in Japan used detailed measures of working conditions.

This study will assess the effect of various job characteristics, in addition to education, employment status, and income, on health conditions. Job characteristics include psychological and physical demands, social support and relationship with co-workers, autonomy and authority at the workplace, training opportunities and skill upgrade, and flexibility and security. The key question in this study is whether the changes in job characteristics affect the changes in health conditions within the individual. The study will pay attention to the changes within the individual, taking into account unobserved differences between individuals. By using the panel-type research design, the study will employ statistical models which attempt to control for unobserved heterogeneity to identify the effect of work conditions and job characteristics on health outcomes.

Data, Variables, and Methods

The data set used in this paper comes from the Japanese

Life Course Panel Surveys (JLPS). The first wave JLPS was conducted in Japan from January to April, 2007. It consists of the youth panel (20 to 34 yr old) and the middle-aged panel (35 to 40 yr old). The 2007 JLPS sampled respondents from the population of men and women aged 20–34 (for the youth panel) and aged 35–40 (for the middle-aged panel) residing in Japan in November 2006, using the electoral and resident registry. The sampled individuals were first contacted by mail and asked to take part in the survey. The enclosed letter explained ethical issues and privacy policies including the statement that the participation in the survey is voluntary and that there would be a follow-up after the initial survey. Those who agreed to take part in the survey received the questionnaires by mail, and the consent to take part in the survey was determined by return of a completed questionnaire. For the youth survey, 3,367 respondents returned the questionnaires and for the middle-aged survey 1,433 respondents returned the questionnaires. The response rates were 34.5% for the youth survey, and 40.4% for the middle-aged survey[25–27].

The second wave of JLPS was conducted from January to March, 2008. It followed up all the respondents who returned the questionnaires in 2007. The initial inquiry mail was sent in December 2007, and the questionnaires were sent in January 2008. The staff from a professional survey company collected the questionnaires by visiting respondents from January to March. For the youth survey, 2,719 respondents returned the 2008 JLPS questionnaires, and for the middle-aged survey 1,246 respondents returned the questionnaires. The retention rate was 80.1% for the youth survey and 86.9% for the middle-aged survey. Because we are interested in the change of health and work conditions across two waves, our analysis is restricted to the respondents who completed the second wave and had valid responses to work-related questions. The youth survey and the middle-aged survey are combined and analyzed together since the two surveys had identical questionnaires and sampling procedures.

The JLPS asked a number of questions related to the respondents' health conditions. Three health-related outcomes are used in this paper. The first variable is self-reported health. The respondents were asked to report their present health condition: "how do you feel about your present health?" The responses were: "1 very good," "2 good," "3 ordinary," "4 not good," and "5 bad." The higher the score, the worse the self-perceived health condition. The second variable measures activity restriction due to health. The respondents were asked: "were daily housework and activities related to your job restricted because of health reasons in the last month?" The following four-point scale is used to record the responses: "1 not at all," "2 seldom," "3 sometimes," and "4 always or almost always." The third variable is a measure of depression symptoms. The respondents were asked: "were you heavily depressed during the last month?" and the responses were coded as: "1 not at all," "2 seldom," "3 sometimes," and "4 always or almost always." All three variables are scored in the way that the highest score corresponds to the worst health conditions.

Socio-economic variables include the following: education, employment status, and income. Education is measured by the attendance in higher education. The respondents who attended junior colleges, technical colleges, universities, and graduate schools are given the score of one and zero otherwise. Education variable was originally included in the analysis as a years-of-schooling variable, but the difference between those who went to higher education and those who did not seem to be the major threshold. Instead of using the linear specification, this paper focuses on the difference between the two.

Employment status is based on the condition of employment at the time of the survey in 2007 and 2008. The 2007 JLPS asked respondents who worked at the time of the survey to report the job characteristics about the current work, and asked respondents who did not work at the time of the survey to report the job characteristics about the last job they held. The 2008 JLPS asked the job characteristics to only those who worked at the time of the survey. Therefore, the respondents who did not work at wave 2 are excluded from the analysis although the respondents who did not work at wave 1 but had previous job were included in the analysis. The following categories are used to distinguish employment status: employer, full-time employee (base category), part-time and temporary employee, and self-employed and family worker. Individual income is measured by the approximate yen amount (in ten thousand). The respondents were asked to choose one of 13 categories representing their individual income. The midpoints of each category are used to estimate the individual income of the respondent in each category.

The JLPS contains rich questions about the working conditions, work environments, and work arrangements. The 2007 JLPS asked respondents who worked at the time of the survey to report the job characteristics about the current work, and asked respondents who did not work at the time of the survey to report the job characteristics about the last job they held. The 2008 JLPS asked the job characteristics to only those who worked at the time of

the survey. Therefore, the respondents who did not work at wave 2 are excluded from the analysis although the respondents who did not work at wave 1 but had previous job were included in the analysis. The following questions are asked about the characteristics of the workplace. If it applies to the workplace of the respondent, the score of one is given to the variable, zero otherwise. Variable names are shown in parentheses.

(1) over-time work (overt) − almost everyday people do over-time work
(2) labor shortage (labshort) − there is chronicle labor shortage
(3) deadline (deadl) − always chased at the deadline
(4) help each other (helpo) − there is an atmosphere of helping each other
(5) independent work (indepw) − most work is done independently
(6) coordinating work (coordw) − most work is done by coordinating with each other
(7) guidance to juniors (guidej) − there is an atmosphere of seniors guiding juniors
(8) transfer (transf) − there is a mechanism for moving positions based on people's preference
(9) advice to young people (advicey) − there is a designated advisor for giving advice to young workers
(10) advice for future work (advicef) − there are opportunities for getting advice about the future work

The following questions are asked about autonomy and authority at the workplace, training opportunities, flexibility, and security. When the respondent believes that it strongly applies or applies to his/her work, a score of one is given to the variable, zero otherwise.

(11) determine pace (pace) − I could determine the pace of my work
(12) decide work pattern (decide) − I could decide my work pattern
(13) decide subordinate's work (boss) − I could decide the subordinate's work
(14) opportunities for training (train) − I have opportunities for training
(15) opportunities for upgrading skills (upskill) − I have opportunities for upgrading my job skills
(16) flexibility in work (flex) − I could arrange my work schedule to fit the needs for child-care, housework, and study
(17) insecurity in work (unsecure) − there is a possibility that I could be unemployed in a year

Finally, the respondent's gender, age and age square are included as control variables. Gender is included as the time invariant exogenous variable since it does not change within the individual. Gender is assumed not to co-vary with other time-varying variables.

As to analytical strategy, three different statistical models are fitted to the data. The first model is the fixed effects (FE) model and can be written as:

$$y_{it} = \alpha_i + X_{it}\beta + \varepsilon_{it} \quad (1)$$

where i stands for individual and t stands for time or panel wave. α_i is a set of intercept for the i-th individual, and it is treated as a parameter to be estimated for each cross-section observation i. X_{it} is the value on explanatory variables for the i-th individual at time t, and ε_{it} denotes the disturbance term.

The important feature of the fixed effects model is that we allow for arbitrary correlation between explanatory variables and unobserved unit (individual) effect[28], and the main advantage of using the panel data is "the ability to remove a time-invariant unobservable"[29]. The parameters of the fixed effects model uses information on the effect of the changes in the explanatory variables on the changes in the dependent variable, so that the parameters of the fixed effects model are not affected by the unobserved heterogeneity bias.

The second model is the random effects (RE) model and can be written as:

$$y_{it} = a + X_{it}\beta + \theta_i + \varepsilon_{it} \quad (2)$$

where θ_i denotes the unit (individual) effects. The key feature of the random effects model is that the unobserved θ_i are assumed to be uncorrelated with explanatory variables and the unit effects θ_i are treated as a random effect. The random effects models are prevalent in sociological research. The attraction of the random effects model is that it can include time-invariant explanatory variables so that variation between individuals may be assessed at the same time as the change within the individual.

Finally, the third model is the Hausman and Taylor (HT) estimation. The model can be written as:

$$y_{it} = X_{it}\beta + Z_i\gamma + \theta_i + \varepsilon_{it} \quad (3)$$

where Z_i are cross-sectional time-invariant variables. Hausman and Taylor[30] split X and Z into two sets of variables: $X=[X_1 ; X_2]$ and $Z=[Z_1 ; Z_2]$. The major advantage of this model is that we are able to break down X and Z variables into two components: those which are correlated with θ_i and those which are independent of θ_i . X_1 and Z_1 are assumed to be exogenous and are not correlated with θ_i and ε_{it} . In contrast, X_2 and Z_2 are endogenous be-

cause they are correlated with θ_i but not with ε_{it} . The fixed effects model would sweep θ_i and "remove the [heterogeneity] bias, but in the process it would also remove the $\mathbf{Z}_i$ and hence the Within [fixed effects] estimator will not give an estimate of γ"[31]. The HT estimation will include time-variant variables while relaxing the assumption of the random effects model on time-invariant variables. The HT estimation, "which involves mixing estimators that have the desirable properties of fixed effects for time-varying explanatory variables with random effects estimators for time-invariant explanatory variables, goes to the heart of the resistance many researchers have shown to fixed effects estimation"[32]. Because the individual unit effects are likely to be correlated with some time-variant explanatory variables, the HT estimation has a practical appeal. The HT estimation will allow the researchers to take advantage of the fixed effects model (i.e., removing the heterogeneity bias) while retaining the ability to identify the parameters of the time-invariant variables (i.e., estimating the unit individual effects). These statistical models are estimated by using Stata (special edition, version 10.0).

Results

Distribution of health-related outcomes and other variables

Table 1 presents descriptive statistics for the variables used in this paper. The first set of variables presents the distributions of three health-related outcomes. First, with regard to the self-reported health, 15 percent of our respondents reported that their health was "very good," 35 percent "good," 39 percent "ordinary," 11 percent "not good," and 1 percent "bad" at wave 1. The distribution of self-rated health changed very little between wave 1 (2007) and wave 2 (2008). Second, almost 70 percent of our respondents had no activity restriction due to health conditions while 13 percent experienced some restriction at wave 1. The proportion of those who had restriction seems to have increased slightly from wave 1 to wave 2. Third, respondents with depression symptoms (sometimes and always) amount to 34 percent at wave 1, and the proportion increased slightly to 37 percent at wave 2. These one-way distributions of health outcomes show little changes between the two waves.

There are significant correlations among the health-related variables. However, these correlations are not exceptionally high: between self-reported health and activity restriction (r=0.283 at wave 1 and r=0.264 at wave2), between self-reported health and depression (r=0.283 at wave 1 and r=0.251 at wave2), and between activity restriction and depression (r=0.265 at wave 1 and r=0.288 at wave2). These results suggest that these variables are related but tap different aspects of respondent's health condition.

The second set of variables pertains to socio-economic ones. The distribution of education shows that half of the respondents attended institutions of higher education. Since there is a rapid increase in the attendance rate to higher education (especially four-year universities) beginning in 1990s, these young respondents clearly benefited from the expansion of the higher education sector. Education variable is fixed and did not change between the two waves. As to the employment status, about 60 percent of the respondents are full-time employees and 30 percent part-time employees. Women are much more likely to engage in part-time work than men, since the proportion of part-time work reaches 47 percent among women while it is only 18 percent among men at wave 1. There are very few employers and self-employed/family workers among our respondents. As to the individual income, we see slight increase in the average level of income from 309 ten thousand yen to 319 ten thousand yen.

The third set of variables relate to job characteristics. There are seventeen detailed job characteristics (variable names are in parentheses) that are considered in this paper. Among the characteristics of the workplace, we learn that some characteristics are more prevalent than others. For example, overtime work (overt) is reported by almost 40 percent of our respondents and labor shortage (labshort) by about 30 percent at wave 1, while features related to advice (whether there is a designated advisor for young workers and whether there are opportunities for getting advice for future work) are reported by less than ten percent of our respondents. Helping each other (helpo) and coordination with co-workers (coordw) seem to be a prevalent feature since over 40 percent of the respondents report that there is an atmosphere of helping each other and that their work is done by coordinating with each other. With regard to autonomy and authority, over 60 percent of the respondents replied that they could determine the pace of their work (pace) and almost half replied that they could decide their work pattern (decide). Training (train) and opportunities for upgrading job skills (upskill) seem to be prevalent among our respondents, and about half of the respondents report that their work allows flexibility (flex). The prospect of losing their job (unsecure) is reported by some 13 percent of respondents.

When we compare the distribution of job characteristics between the two waves, there is no substantial change. If

Table 1. Descriptive statistics

	2007	2008
Health-related variables		
Self-reported Health		
1 very good	14.7	14.0
2 good	34.5	35.7
3 ordinary	39.3	37.4
4 not good	10.7	11.9
5 bad	0.8	0.9
Activity restriction		
1 not at all	68.9	66.0
2 seldom	17.6	18.5
3 sometimes	10.3	12.2
4 always/almost always	3.2	3.3
Depression		
1 not at all	35.5	33.4
2 seldom	30.2	29.4
3 sometimes	25.9	27.4
4 always/almost always	8.4	9.8
Socio-economic variables		
Education		
Middle school	1.4	1.4
High school/ vocational schools	47.9	47.9
Junior college/ technical college	13.1	13.1
University/ graduate school	37.5	37.5
Higher education attendance (education)	50.6	50.6
Employment status		
employer (employ)	1.4	1.9
full-time employee (base)	59.0	60.8
part-time employee (part)	33.0	30.6
self-employed, family worker (semp)	6.6	6.7
Income		
average income in ten thousand yen (income)	309.4	319.0
Job characteristic variables		
Overtime (overt)	38.1	39.7
Labor shoratge (labshort)	29.8	27.0
Deadline (deadl)	17.3	17.2
Help each other (helpo)	40.7	43.8
Independent work (indepw)	28.2	30.3
Coordinating work (coordw)	46.4	48.8
Guidance to juniors (guidej)	33.4	34.6
Transfer (transf)	9.9	11.8
Advice to young people (advicey)	3.3	4.0
Advice for future work (advicef)	7.6	9.2
Determine pace (pace)	60.2	63.7
Decide work pattern (decide)	45.9	49.4
Decide subordinate's work (boss)	19.2	21.3
Opportunities for training (train)	47.1	50.1
Opportunities for upgrading skills (upskill)	60.0	60.9
Flexibility in work (flex)	47.8	52.6
Insecurity in work (unsecure)	13.2	13.0
Gender (male)		
Male	46.4	46.4
Female	53.6	53.6
Age (age)		
20–24 in 2007	19.3	19.3
25–29 in 2007	21.4	21.4
30–34 in 2007	27.8	27.8
35–40 in 2007	31.5	31.5
average age	30.8	31.8

Variable names are in parentheses. For detailed explanations of the variables, see section on data, variables, and methods.

anything, the proportion of favorable job characteristics (such as helping each other, coordinating work, determining pace, and flexibility) seemed to have increased slightly, while the proportion of unfavorable job characteristics (such as labor shortage) seemed to have decreased slightly.

Changes in health-related outcomes

Table 2 reports the cross-tabulation of health conditions at wave 1 and those at wave 2. It shows how much health outcomes changed between 2007 and 2008 within the individual. There are substantial changes in health conditions between the two waves. Table 2a shows the respondents' responses to self-reported health at two waves. The numbers on the main diagonal indicate the cases in which the same responses were observed at two time points. The row percentages of those in the main diagonals, as shown in the second row, are not very high. Among those who reported "very good" health at wave 1, only 52 percent reported the same response at wave 2, and about a third (34%) reported "good." Among those who reported "bad" health at wave 1, only 42 percent remained "bad" at wave 2 and half shifted to "not good" category. If we compute the proportion of individuals who did not change their responses between the two waves, it is only 53 percent of all individual cases. The remaining 47 percent changed their response. Among those who changed responses, about half (23%) improved their self-rated health and the other half (24%) worsened their self-reported health. Furthermore, among those who changed responses, 85 percent changed response to adjacent category (such as between "very good" and "good"), and the remaining 15 percent experienced two-step changes. Individuals, therefore, seem to make small changes in reporting their health.

Table 2b presents the cross-tabulation of the responses to activity restriction at wave 1 and 2. Among those who had no activity restriction at wave 1, three-fourths (74%) remain in the same category after a year. In contrast, respondents who were in other categories at wave 1 tend to experience change of their health conditions; only about 30 percent remain in the same category. Among those who always or almost always had restrictions in daily activities due to health problems at wave 1, only 32 percent remained in the same category while about a half (48%) experienced two or three-step changes to either "seldom" or "not at all" categories. It is possible that some of these people had physical injuries at wave 1 and later recovered from the injuries. The proportion of individuals who did not change their health conditions with respect to activity restriction is 60 percent, so the remaining 40 percent

Table 2. Changes in health outcomes between wave 1 (2007) and wave 2 (2008)

a) Self-reported health		Wave 2 (2008)					
		1 very good	2 good	3 ordinary	4 not good	5 bad	Total
Wave 1 (2007)	1 very good	280	184	70	8	0	542
		51.7	33.9	12.9	1.5	0.0	100
	2 good	166	679	363	56	5	1,269
		13.1	53.5	28.6	4.4	0.4	100
	3 ordinary	69	391	802	178	6	1,446
		4.8	27.0	55.5	12.3	0.4	100
	4 not good	3	34	153	179	24	393
		0.8	8.7	38.9	45.5	6.1	100
	5 bad	0	3	0	15	13	31
		0.0	9.7	0.0	48.4	41.9	100
	Total	518	1,291	1,388	436	48	3,681
		14.1	35.1	37.7	11.8	1.3	100

b) Activity restriction		Wave 2 (2008)				
		1 not at all	2 seldom	3 sometimes	4 always/ almost always	Total
Wave 1 (2007)	1 not at all	1,861	402	214	51	2,528
		73.6	15.9	8.5	2.0	100
	2 seldom	303	186	121	35	645
		47.0	28.8	18.8	5.4	100
	3 sometimes	137	99	106	35	377
		36.3	26.3	28.1	9.3	100
	4 always/almost always	42	16	24	38	120
		35.0	13.3	20.0	31.7	100
	Total	2,343	703	465	159	3,670
		63.8	19.2	12.7	4.3	100

c) Depression symptom		Wave 2 (2008)				
		1 not at all	2 seldom	3 sometimes	4 always/ almost always	Total
Wave 1 (2007)	1 not at all	753	327	183	31	1294
		58.2	25.3	14.1	2.4	100
	2 seldom	297	439	300	66	1,102
		27.0	39.8	27.2	6.0	100
	3 sometimes	157	263	396	130	946
		16.6	27.8	41.9	13.7	100
	4 always/almost always	24	47	109	125	305
		7.9	15.4	35.7	41.0	100
	Total	1,231	1,076	988	352	3647
		33.8	29.5	27.1	9.7	100

The first row shows cell count, and the second row shows row percentage.

changed their conditions. However, it should be noted that the respondents who did not have any restriction at all are less likely to change their conditions than those who were in other categories at wave 1. With respect to the direction of change, among those who changed responses 58 percent of those did so toward the direction of worsening their health, while 42 percent changed toward the direction of improving their health.

Table 2c shows the cross-tabulation of the responses to the depression question at wave 1 and 2. The proportion of individuals who did not experience change in depression question is 47 percent, so more than a half (53%) of all individuals experienced change in depression symptoms. Among those who experienced change, 60 percent changed toward the direction of worsening depression while 40 percent toward the direction of improving the depression.

Table 3. OLS fixed effects (model 1), GLS random effects (model 2 and 3), and GLS Hausman/Taylor estimates (model 4) for self-reported health

	Model (1)		Model (2)		Model (3)		Model (4)	
	estimate	*p* value	estimate	*p* value	estimate	*p* value	estimate	*p* value
Time variant exogenous								
employ	–0.411	0.074	0.013	0.895	0.005	0.960	–0.117	0.288
part	–0.036	0.557	–0.030	0.341	–0.017	0.584	–0.022	0.594
semp	0.211	0.148	0.071	0.202	0.045	0.413	–0.056	0.432
helpo	–0.080	0.008**	–0.085	<0.001**	–0.082	<0.001**	–0.086	<0.001**
indepw	–0.015	0.642	–0.028	0.258	–0.022	0.370	–0.011	0.688
coopw	–0.038	0.210	–0.031	0.186	–0.034	0.142	–0.038	0.127
guidej	–0.009	0.765	–0.031	0.205	–0.033	0.172	–0.010	0.701
transf	0.054	0.272	–0.009	0.812	0.001	0.976	0.015	0.701
advicey	–0.025	0.709	0.013	0.812	0.010	0.859	0.010	0.856
advicef	–0.121	0.012*	–0.113	0.003**	–0.111	0.003**	–0.101	0.010*
decide	–0.068	0.028*	–0.071	0.003**	–0.070	0.003**	–0.074	0.004*
Time variant endogenous								
age	–0.048	0.591	0.009	0.717	0.010	0.697	–0.071	0.379
age2	0.002	0.265	0.000	0.874	0.000	0.947	0.002	0.169
income	–0.065	0.562	–0.130	0.033*	–0.121	0.059	–0.084	0.426
overt	–0.027	0.425	–0.010	0.688	–0.004	0.886	–0.024	0.484
labshort	0.043	0.178	0.088	<0.001**	0.088	<0.001**	0.045	0.149
deadl	0.095	0.022*	0.130	<0.001**	0.133	<0.001**	0.095	0.020*
pace	–0.062	0.049*	–0.083	<0.001**	–0.077	0.001**	–0.061	0.047*
boss	–0.027	0.486	0.026	0.361	0.010	0.715	–0.022	0.554
train	0.018	0.555	0.008	0.730	0.010	0.665	0.016	0.592
upskill	–0.037	0.245	–0.048	0.041*	–0.047	0.048*	–0.039	0.205
flex	–0.052	0.101	–0.086	<0.001**	–0.080	0.001**	–0.052	0.094
unsecure	0.017	0.689	0.064	0.041*	0.059	0.060	0.017	0.680
Time invariant exogenous								
male					0.055	0.067	0.065	0.067
Time invariant endogenous								
education					–0.188	<0.001**	–0.502	0.056
constant	2.591	0.070	2.342	<0.001**	2.415	<0.001**	3.309	0.008**
Hausman χ^2			39.45		35.34		10.05	
degrees of freedom			23		23		10	
p value			0.018		0.048		0.436	

Self-reported health is scored from "1 very good" to "5 bad", so the higher the score, the worse health condition. The coefficients for income are multiplied by 1,000. The explanations of the variables can be found in the main body. * significant at 5%; ** significant at 1%.

In summary, despite the fact that the distributions of health outcomes are very similar between wave 1 and wave 2, it does not necessarily imply that individuals did not experience a change of health conditions. On the contrary, our results suggest that there are substantial changes in health conditions between the two waves. Depression symptom is most volatile, followed by self-reported health, and then activity restriction. Even with the activity restriction, about 40 percent of individuals changed their responses between the two waves. In the next section, we will examine what factors account for these changes in health outcomes.

Determinants of health-related outcomes

Table 3 presents the results of predicting the self-reported health. Table 3 Model (1) presents the estimators of the fixed effects model for the self-reported health. The model does not distinguish between time-variant exogenous and time-variant endogenous since there is no time-invariant variable included in the equation. The distinction between the time-variant exogenous and the time-variant endogenous applies only to the Hausman and Taylor (HT) estimation model. Among the job characteristics, the following variables indicate significant effects: (1) helpo − when the respondent's workplace becomes more cooperative inducing the atmosphere of helping each other, there

is an improvement in the self-reported health (negative sign); (2) advicef − when the respondent's workplace changes in the way that there are opportunities for getting advice about future work, self-reported health tends to improve (negative sign); (3) decide and pace − when the respondent's workplace changed and he/she is now able to decide his/her work pattern and pace of work, there is an improvement in the self-reported health (negative sign); and (4) deadl − when the respondent's workplace becomes always chased at the deadline, his/her self-reported health tends to worsen (positive sign). It is important to notice that these effects of job characteristics are estimated after controlling for the heterogeneity bias. These effects pertain to the effect of the changes in the job characteristics within the individual, and unobserved differences between individuals (unit effects) are removed from the model.

Table 3 Models (2) and (3) are the random effects model. Model (2) includes time-variant explanatory variables, and Model (3) includes both time-variant and time-invariant (gender and education) variables in the equation. By comparing Model (2) and (3), the addition of the two time-invariant variables did not change the estimates of job characteristics, and these two variables did not contribute to eliminating the heterogeneity bias. At the bottom of the table, we show the results of the Hausman tests by comparing the estimates of the fixed effects model and the random effects model. Large values of the Hausman chi-square statistics will imply that the assumption of no correlation between the unit effects and the time-variant explanatory variables is rejected and hence the fixed effects model is preferred. Hausman tests are routinely used in econometrics analyses, while they are not popular in sociological research. The results of the Hausman tests lead us to reject the assumption of the null hypothesis, and the estimates from the random effects model are subject to heterogeneity bias.

By comparing the estimates of the fixed effects and the random effects models, there are two noticeable differences. Income and labor shortage (labshort) coefficients are significant in the random effects model, while they are not significant in the fixed effects model. This finding implies that the estimates of the random effects model tend to overestimate the "true" effect of the change because they confound the effect of the change in the time-variant explanatory variable with the effect of the difference between individuals. For example, the effect of income (−0.130) of the random effects model is about twice of the size of the effect of income (−0.065) of the fixed effects model because the effect of the random effects model include both the effect of the change in income between the two waves within the individual (i.e., increased income leads to improved self-reported health) and the effect of individual differences in income (i.e., people with higher income tend to have better self-reported health than those with lower income). Similarly, the effect of the labor shortage of the random effects model includes both the effect of the change of the workplace condition in which there is shortage of labor and the effect of difference between respondents who work in a workplace with short labor supply and those who do not.

Finally, Model (4) shows the estimates of the HT estimation model. Time-variant and time-invariant variables are each divided into two components: exogenous variables which are independent of θ_i and endogenous variables which are correlated with θ_i. HT model provides the estimates of the time-invariant variables in addition to time-variant explanatory variables, by allowing some of time-invariant variables to be endogenous. The Hausman test statistics indicate that the assumption of null hypothesis is not rejected, thereby preferring the HT model to the fixed effects model. The parameters of job characteristics variables are very similar between those of the fixed effects model and those of the HT model, and the coefficients which are significant are the same in the two models. By relaxing the assumption of the random effects model, the coefficients of income and labor shortage are no longer significant. The advantage of HT model over the fixed effects model is that the former provides estimates for the time-invariant effects, that is, the unit individual effects. Both gender and education are not significant at 5 percentage level, but they are significant at 10 percentage level. Males tend to show poorer self-reported health score than females (positive sign), and people with higher education tend to show better self-reported health score than those without higher education (negative sign).

Table 4 presents the results of fitting various models predicting activity restriction. When we compare four models using the Hasuman statistics, we arrive at the conclusion that the fixed effects model is our preferred model. The assumption of the null hypothesis of no correlation for the random effects model and for the HT model is rejected at 5 percent significance level.

Using the fixed effects model as our representation, we find the following effects of job characteristics on activity restriction: (1) guidej − when the respondent's workplace is changed to have the atmosphere of seniors guiding juniors, the respondent is less likely to experience activity restriction (negative sign); and (2) labshort − when the respondent's workplace changes to experience chronicle

Table 4. OLS fixed effects (model 1), GLS random effects (model 2 and 3), and GLS Hausman/Taylor estimates (model 4) for activity restriction

	Model (1)		Model (2)		Model (3)		Model (4)	
	estimate	*p* value	estimate	*p* value	estimate	*p* value	estimate	*p* value
Time variant exogenous								
employ	0.035	0.890	0.005	0.957	0.012	0.892	–0.111	0.320
part	–0.011	0.876	0.045	0.123	0.032	0.277	0.063	0.126
semp	0.054	0.736	0.080	0.106	0.086	0.084	0.000	0.999
helpo	–0.019	0.566	–0.036	0.117	–0.040	0.077	–0.032	0.179
indepw	0.017	0.656	0.010	0.684	0.013	0.607	0.021	0.444
coopw	–0.029	0.398	–0.032	0.164	–0.038	0.104	–0.043	0.089
guidej	–0.116	0.001**	–0.060	0.014*	–0.064	0.008**	–0.056	0.040*
transf	0.034	0.528	–0.016	0.645	–0.020	0.577	–0.001	0.982
advicey	0.025	0.738	0.038	0.485	0.036	0.511	0.032	0.570
advicef	–0.085	0.115	–0.032	0.393	–0.026	0.485	–0.028	0.478
decide	–0.021	0.544	–0.034	0.151	–0.031	0.187	–0.035	0.182
Time variant endogenous								
age	0.090	0.366	0.044	0.054	0.040	0.074	–0.070	0.394
age2	0.000	0.975	–0.001	0.099	–0.001	0.115	0.002	0.200
income	0.111	0.373	–0.254	<0.001**	–0.164	0.007**	0.067	0.531
overt	–0.011	0.768	–0.042	0.083	–0.035	0.149	–0.008	0.819
labshort	0.091	0.012*	0.070	0.003**	0.067	0.004**	0.083	0.010*
deadl	–0.032	0.486	0.025	0.395	0.030	0.306	–0.030	0.460
pace	0.054	0.127	0.005	0.821	0.007	0.770	0.057	0.067
boss	0.001	0.973	0.039	0.161	0.048	0.087	0.002	0.966
train	0.040	0.241	0.032	0.155	0.033	0.147	0.053	0.074
upskill	–0.063	0.076	–0.002	0.917	0.001	0.963	–0.062	0.046
flex	0.011	0.752	0.023	0.302	0.019	0.407	0.013	0.675
unsecure	–0.009	0.857	0.121	<0.001**	0.125	<0.001**	–0.008	0.855
Time invariant exogenous								
male					–0.120	<0.001**	–0.150	<0.001**
Time invariant endogenous								
education					–0.027	0.258	–0.467	0.081
constant	–1.387	0.384	0.803	0.020*	0.922	0.007*	2.261	0.073
Hausman χ^2			75.66		72.59		24.21	
degrees of freedom			23		23		10	
p value			0.00		0.00		0.01	

Activity restriction is scored from "1 not at all" to "4 always or almost always", so the higher the score, the worse health condition. The coefficients for income are multiplied by 1,000. The explanations of the variables can be found in the main body. * significant at 5%; ** significant at 1%.

labor shortage, he/she is more likely to suffer from activity restriction (positive sign).

These two variables are the only factors affecting activity restriction. In other words, activity restriction is not much affected by job characteristics and workplace conditions. Because the analysis of the effect of job characteristics requires that the respondent is working at the time of the survey, those with severe activity restriction are likely to be out of the labor market and excluded from our analysis.

Table 5 presents the results of predicting depression symptoms. The comparison of four models suggests (1) that the null hypothesis used in the random effects model is rejected and the fixed effects model is preferred over the random effects model, and (2) the Hausman test is not significant for the HT model and the HT model is preferred over the fixed effects model. With regard to the effects of job characteristics, the following coefficients of the HT model are significant: (1) helpo − when the workplace changed to an atmosphere of helping each other, the depression symptoms are reduced (negative sign); (2) pace − when the workplace environment is changed and the respondent is more likely to decide his/her pace of work, there is an improvement in the depression symptoms (negative sign); and (3) when the respondent becomes to feel that there is a

Table 5. OLS fixed effects (model 1), GLS random effects (model 2 and 3), and GLS Hausman/Taylor estimates (model 4) for depression

	Model (1)		Model (2)		Model (3)		Model (4)	
	estimate	*p* value	estimate	*p* value	estimate	*p* value	estimate	*p* value
Time variant exogenous								
employ	0.218	0.439	0.064	0.551	0.075	0.483	–0.040	0.747
part	–0.010	0.896	0.006	0.868	–0.012	0.737	0.032	0.492
semp	0.363	0.040*	0.136	0.023*	0.144	0.016*	0.068	0.404
helpo	–0.053	0.153	–0.052	0.051	–0.057	0.031*	–0.064	0.018*
indepw	–0.036	0.379	0.004	0.888	0.007	0.796	0.002	0.951
coopw	–0.052	0.160	–0.005	0.858	–0.011	0.684	–0.017	0.552
guidej	–0.056	0.149	–0.049	0.079	–0.054	0.055	–0.017	0.591
transf	–0.071	0.239	–0.069	0.095	–0.072	0.078	–0.083	0.068
advicey	0.158	0.057	0.105	0.096	0.102	0.105	0.131	0.050
advicef	0.010	0.869	–0.041	0.355	–0.034	0.439	–0.021	0.639
decide	–0.041	0.272	–0.047	0.087	–0.043	0.112	–0.058	0.051
Time variant endogenous								
age	0.164	0.133	–0.055	0.045*	–0.059	0.032*	0.070	0.457
age2	–0.002	0.345	0.001	0.172	0.001	0.150	–0.001	0.643
income	–0.206	0.131	–0.262	<0.001**	–0.150	0.036*	–0.236	0.054
overt	0.019	0.657	0.053	0.059	0.061	0.030*	0.029	0.460
labshort	–0.023	0.558	0.030	0.268	0.027	0.317	–0.023	0.530
deadl	–0.011	0.831	0.087	0.010*	0.093	0.006**	–0.007	0.887
pace	–0.114	0.003**	–0.117	<0.001**	–0.115	<0.001**	–0.116	0.001**
boss	0.051	0.276	0.050	0.122	0.062	0.059	0.047	0.281
train	0.033	0.377	0.034	0.197	0.034	0.190	0.045	0.190
upskill	0.024	0.538	–0.044	0.109	–0.040	0.144	0.019	0.599
flex	–0.004	0.925	–0.032	0.233	–0.038	0.155	–0.001	0.986
unsecure	0.160	0.002**	0.236	<0.001**	0.241	<0.001**	0.161	0.001**
Time invariant exogenous								
male					–0.158	<0.001**	–0.116	0.004**
Time invariant endogenous								
education					–0.027	0.357	–0.092	0.758
constant	–1.279	0.465	3.344	<0.001**	3.488	<0.001**	0.847	0.557
Hausman χ^2			53.87		54.48		15.74	
degrees of freedom			23		23		10	
p value			0.00		0.00		0.11	

Depression is scored from "1 not at all" to "4 always or almost always", so the higher the score, the worse health condition. The coefficients for income are multiplied by 1,000. The explanations of the variables can be found in the main body. * significant at 5%; ** significant at 1%.

possibility of unemployment in a year, there is a tendency for increased depression symptoms (positive sign).

The comparison of the estimates of the fixed effects model and the random effects model suggests that the effects of overtime and deadline in the random effects model are primarily the result of the differences in these job characteristics between individuals. Because the magnitudes of these effects are much smaller in the fixed effects model, the effects of the random effects model picked up the following effects: (1) the respondents who have a job in the workplace where people do over-time work almost every day are more likely to suffer from depression than those who do not work in such a place; and (2) the respondents who have a job in the workplace where workers are always chased at the deadline are more likely to suffer from depression than those who do not work in such a place.

Discussion

This paper examined the relationship between job characteristics and workplace conditions on the one hand and health-related outcomes on the other. We identified three different health-related outcomes and examined the effects of various job-related variables separately for each outcome. The main contribution of this study is to attempt to assess the impact of changes in job characteristics on health

conditions after taking into account unobserved differences between individuals. By taking advantage of the panel-type research design, the study examined the effect on health outcomes of the changes in a wide range of job-related conditions and workplace arrangements within the individual.

The first major conclusion from the analyses pertains to the finding that there are substantial changes in health-related outcomes between short periods of time. Although the distributions of health-related outcomes are very similar at two points in time, it does not necessarily imply that the individuals did not experience a change in health conditions. On the contrary, our results suggest that there are substantial changes in health conditions between the two waves. Depression symptom is most volatile, followed by self-reported health, and then activity restriction. Even with the activity restriction, about 40 percent of individuals changed their responses between the two waves. These findings were made apparent because our study is based on the panel-type research design.

The second major conclusion of this paper is that the effects of job characteristics depend on the different health-related outcomes. Self-reported health is affected by a variety of job-related factors. Changes in the workplace conditions and environments regarding the atmosphere of helping each other, getting advice for future work, being chased at the deadline affect the self-reported health. The ability to control work pace and work pattern tends to improve self-reported health.

Depression symptoms are also affected by a number of job-related characteristics. The atmosphere of helping each other and the control over the pace of work are two important factors which affect both depression and self-reported health. The possibility of unemployment tends to increase depression.

Activity restriction is not much affected by job characteristics. The only factors which had significant effects are the changes in the workplace conditions regarding the atmosphere of seniors guiding juniors and chronicle labor shortage. The guidance tends to reduce the experience of activity restriction, while labor shortage tends to increase the likelihood of activity restriction. As argued above, the lack of extensive effects of job characteristics on activity restriction may be due to the fact that only respondents working at the time of the survey are included in the analysis and those with severe activity restriction who are likely to be out of the labor market are excluded from our analysis.

In summary, all these findings suggest that the workplace conditions and job characteristics have profound influence on the workers' health. The findings are consistent with earlier studies which documented the effects of various work-related characteristics on health outcomes between individuals. This study shows that both the differences between individuals who occupy different conditions and jobs and the changes within the individuals in workplace conditions and characteristics of the job are related to their health conditions. The ability to distinguish the two components highlights the usefulness and originality of using the panel-type research design and statistical methods most appropriate for panel surveys.

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