Socioeconomic Determinants of Physical Inactivity among Japanese Workers

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January 2012

Abstract

Background: Half of Japanese workers are physically inactive, but there are no studies on the relation between the leisure-time physical inactivity of Japanese workers and their socioeconomic status. The proportion of female workers who are physically inactive has been larger than that of male workers.

Objectives: Using micro-data from nationwide surveys in Japan, this study explored the gender differences in socioeconomic determinants of leisure-time physical inactivity.

Methods: We first estimated two-stage probit least squares models to examine whether simultaneous relationships between physical inactivity and working hours existed. Second, endogenous switching models were estimated to analyze whether physical inactivity depended on poor health status. We took into account the existence of unobserved factors affecting poor health status and physical inactivity.

Results: The results of two-stage probit least squares estimation did not confirm simultaneous relationships between physical inactivity and working hours. The estimation results of the endogenous switching models showed that working hours had a positive effect on poor health status, and poor health status had a positive effect on physical inactivity. Physical inactivity was strongly associated with low educational attainment and marital status. For male workers, income had a negative effect on physical inactivity at the 5 percent significance level. In contrast, female income had no effect on physical inactivity.

Conclusions: There are gender differences in the association of income and physical inactivity among Japanese workers. Workers in poorer health were likely to be physically inactive. To reduce chronic diseases due to physical inactivity, more attention should be paid to the influence of income reduction on poor health in males.

1 Introduction

Half of Japanese workers are physically inactive because they do not engage in enough physical activity during their leisure time and because of an increase in sedentary behavior on the job. Physical inactivity is a risk factor for chronic diseases, and thus increasing physical activity is one of the effective public policies that policy-makers can implement to improve the dietary habits and physical activity levels of populations.

Previous studies have found a positive relationship between socioeconomic status (SES) and health-enhancing activities such as regular physical activity (Ford *et al.*1991; Giles-Corti and Donovan 2002; Jeffery *et al.* 1991). According to Kagamimori *et al.* (2009), SES represents one of the fundamental bases of health. They argued that education, employment and income are among the most powerful components of SES and that lower levels of education can lead to insecure income, hazardous work conditions, and poor housing, which can increase the risk of death due to external causes.

Lower SES individuals are more likely to report engaging in job-related physical activity and walking compared to higher SES individuals, who are more likely to report engaging in leisure-time physical activity and sports-related activity (Ford *et al.* 1991). Takao *et al.* (2003) examined the distribution of physical activity among different occupations in Japan. They showed that monthly leisure-time physical activity for males was significantly different among occupations, with clerks having greater physical activity than managers and blue-collar workers. The difference among occupations for females was not clear. They suggested a barrel shaped distribution of leisure-time physical activity among occupations in Japan, as it was highest for the intermediate class.

The effects of educational attainment on health can be partly explained through health behaviors. There is evidence of an inverse association of education and smoking. Using a questionnaire survey in 1998, Nishi *et al.* (2004) revealed that higher chances of smoking were observed in females with lower educational levels. Diabetes was also inversely associated with educational level in males. The subjects of their study were 1361 civil servants aged 35–64 years. Wang *et al.* (2005) revealed gender differences in the association of income and health using a cross sectional study on 9650 participants aged 47-77 years who completed a self-administered questionnaire in 2000. They found that household income, physical activity, sleeping, smoking habit, and BMI had a strong association with self-assessed fair or poor health in middle-aged and elderly

Japanese. Males tended to report more fair or poor health as household income decreased.

Kumagai (2011) estimated endogenous switching ordered models of weekly leisure-time physical activity (regular physical activity) and concluded that individuals with more education might be more efficient in producing health.[1] The estimation results showed that workers who completed junior high school had negative effects on regular physical activity at the 1 percent significance level and males who completed college or university had positive effects on regular physical activity at the 1 percent significance level.

Previous studies found two important facts. First, individuals at the highest levels of income, education, and job classifications were more likely to engage in regular physical activity during their leisure time than those with lower job status and incomes. Second, several important behavioral risk factors for poor health are more common among people in lower SES groups. Adults with lower incomes or less education are more likely to smoke and be obese than adults with higher incomes and more education. However, to our knowledge, no studies have revealed the relationship between the leisure-time physical inactivity of workers and their working hours.

Japan possesses specific characteristics such as an intense work environment (Kagamimori *et al.* 2009). Hours of market work which are likely to affect both income and health is one of the components of SES. For regular workers, working hours longer than the prescribed 40 hours per week are major constraints on leisure-time physical activity.[2] The proportion of physical inactivity of female workers has been larger than that of male workers because of their non-market work responsibilities. Using micro-data from nationwide surveys in Japan, this study explores the gender differences in socioeconomic determinants of leisure-time physical inactivity.

The paper is organized as follows. In Section 2, we show that the proportion of physical inactivity of female workers has been larger than that of male workers. The Japanese male-female gap in non-market domestic working hours plays a role in determining lifestyle. In Section 3, we estimate two-stage probit least squares models to examine whether simultaneous relationships between physical inactivity and working hours existed. In Section 4, endogenous switching models were estimated to analyze whether physical inactivity depended on poor health status. We took into

[1] If regular physical activity leads to improved health, then the estimated parameters on the education variables could be one mechanism by which individuals produce health.

[2] Kumagai (2011) revealed that working hours had a negative impact on regular physical activity at the 1 percent significance level for males and females, and argued that female workers may not increase the time spent in physical activity when their working hours decline.

account the existence of unobserved factors affecting poor health status and physical inactivity. We offer conclusions and discuss policies with regard to the physical inactivity in Section 5.

2 Male-female gaps in non-market domestic working hours

Differences in non-market working times, defined as time spent on child care, housework and other activities that do not generate income may affect lifestyle and self-assessed health. Increases in non-market time make it less costly to undertake health-producing activities such as exercise or the consumption of a healthy diet (Ruhm 2005). In Japan, women often specialize in non-market domestic work such as child care and food preparation. This is an example of the well-known male-female difference in non-market working times in Japan. Juster and Stafford (1991) argued that the joint tax system, which continues to promote after-tax wage inequality between men and women, makes Japanese men concentrate on market work. Yamada *et al.* (1999) showed that economic and cultural forces play equally important roles in determining the patterns of time allocation. They proposed that (1) the persistent male-female gap in non-market domestic working hours in Japan is better explained by the Japanese culture than the Japanese tax system or male-female wage differential, and (2) the relatively low wage elasticity of the labor supply of Japanese young males is an indication of the fact that young males enjoy considerable amounts of on-the-job leisure. Due to insufficient data, Yamada et al. (1999) could not reveal the difference in the lifestyle of lower income workers as opposed to higher income workers, although data shows that the total Japanese work time (market plus non-market working time) increased from 1976 to 1986.

Time spent on daily activities by all persons, and broken down by gender, were obtained from the Survey on Time Use and Leisure Activities published by the Statistics Bureau of the Ministry of Internal Affairs and Communications in Japan. This survey focuses almost exclusively on economic aspects of living. These data show the male-female gap in time allocation in Japan.[3] The reported time allocations in Table 1 are weekly averages of time per day. Cross-sectional data in 1991, 1996, 2001 and 2006 are used. Table 1 shows the allocation of time spent on work, sleep, the newspaper, radio and television, sports, medical care, housework and child care. The

[3] All persons aged 10 and over in the sample households were asked to respond to the survey. The number of persons responding thus totaled around 200,000. Foreigners living in Japan were included in the survey. The sample was selected through a two-stage stratified sampling method, with the primary sampling unit being the enumeration district of the Population Census. The survey defined a worker as a person whose purpose for performing market work was to gain earnings.

non-worker category includes housewives and students. The market working hours of both males and females decreased over the period from 1991 to 2001. The hours that workers devoted to sports remained flat during this 15-year period.

Table 2 shows the proportion of time spent participating in sports to the sum of market work and housework in 2006. Female workers had the smallest value, 0.012, which was half that of male workers. This may represent a part of the persistent male-female gap in the time allocated for investing in physical health. While married women in Japan normally spent most of their non-market time in household production, females without a job had a value of 0.018 for the proportion of time spent participating in sports, which was larger than that of female workers.

Figures 1 and 2 present the life-cycle patterns of time allocated to work and sports. For males with a job, Figure 1 indicates that working hours decreased during the period from 1991 to 2001, except for the working hours of males in their forties in 2006, which increased over a 15-year period. The increase in working hours of males in their forties in 2006 was mainly caused by both the uneven age structure demographically in Japan and by long-term economic stagnation. In contrast, the working hours of females aged thirty and over are about 60 percent of that of females in their twenties. This implies that most married women in Japan have chosen to be homemakers. Figure 2 shows that time allocated to sports by males with a job gradually decreased with time from 1991 to 2006. This tendency does not apply to female workers. Male non-workers spent more time participating in sports than male workers, except for men in their forties.

Using aggregate data of the time use survey, we revealed that males spent more time doing some type of exercise than females in Japan. This trend was stable from 1991 to 2006. However, the aggregate data did not allow us to compare the relationship between the working hours and leisure-time physical activity of full-time employed and part-time workers. To explore the differences in the leisure-time physical activity of workers, we used the data on individuals in Section 3.

3 Working hours and physical inactivity

Decreases in working hours are associated with reductions in smoking, severe obesity, physical inactivity and multiple health risks.[4] Individuals are also more likely to defer health investments in response to temporary than lasting increases in work hours

[4] Sokejima and Kagamimori (1998) found that a U-shaped relation existed between mean working hours and risk of acute myocardial infarction using 199 male patients who had been admitted to three university hospitals and one general hospital between November 1990 and November 1993.

(Ruhm 2005). Workers usually decide on the duration of their work before deciding on the time to be spent on physical activity. We estimated two-stage probit least squares models to examine whether simultaneous relationships between physical inactivity and working hours existed.

3-1. Data

It is well known that standard errors are large whenever large variations between individuals exist in repeated cross-sectional analysis and the benefits of a longitudinal data (panel data) analysis over a repeated cross-sectional study include increased statistical power. However, in longitudinal surveys, the attrition rates are known to be higher among lower income people than higher income ones. Consequently, we consider repeated cross-sectional analysis more effective for researchers when complete sets of new respondents are continually selected, ensuring a steady level of reliability for each successive sample.[5]

Table 3 shows the summary statistics of all variables at an individual level for the estimation of working hours. The data were obtained from nationwide surveys in Japan. The data were drawn from the Japanese General Social Survey (JGSS), a questionnaire survey conducted by the Institute of Regional Studies at the Osaka University of Commerce in collaboration with the Institute of Social Science at the University of Tokyo. We pooled the data of the surveys conducted in the years 2002, 2003, 2005, and 2006. Data were collected through a combination of interviews and self-administered questionnaires. The JGSS asked each respondent about his/her occupational status. From these surveys, we obtained information about demographic variables, lifestyle and educational background.

The proportions of respondents with regard to occupational status were as follows: regular employees 0.51 (males 0.64, females 0.37); management executives 0.07 (males 0.10, females 0.04); part-time and casual workers 0.23 (males 0.09, females 0.40); self-employed 0.12 (males 0.17, females 0.07); family workers 0.05 (males 0.01, females 0.10) and dispatched workers 0.02 (males 0.01, females 0.03). Homemakers, unemployed persons and retired people are not a part of the labor force and are not paid. Approximately 16 percent of workers spent less than 24 hours per week (mean=39.99, SD=15.91) performing market work. With respect to demographic

[5] In longitudinal data analysis, it is possible to focus on changes occurring within subjects and to make population inferences that are not as sensitive to variations between subjects. In studies comparing trends with time, longitudinal data have an advantage over repeated cross-sectional data because it facilitates use of methodologies such as the Generalized Estimating Equations (GEE). The GEE approach accounts for the individual correlation and separates the nuisance variation due to population-wide behavior from variation related to trends with time.

variables, we considered age, gender, number of children and marital status (married, unmarried, divorced and widowed). The proportion of unmarried workers was about 0.37.

We divided the workplace groups into four classes: "small" (fewer than 30 employed), "middle" (30-999 employed), "large" (more than 1000 employed) and the remainder (government official workers and "Don't know"). In addition to workplace size, we considered educational attainment. Half of the workers self-reported completing high school.

For lifestyle variables, we summarized the answers into dichotomous variables (yes=1) as follows: physical inactivity, drinking alcoholic beverages almost every day and smoking. We used physical inactivity as a dummy variable, which took on the value one if respondents hardly engaged in any sports (baseball, swimming, walking, etc.) per year during their leisure time, and zero otherwise. Both regular physical activity and irregular physical activity are in the same category. The proportions of respondents with regard to participating in physical activity were as follows: regular physical activity 0.29 (males 0.31, females 0.27); irregular physical activity 0.15 (males 0.18, females 0.11) and physical inactivity 0.56 (males 0.51, females 0.62).[6] The JGSS did not ask the amount of time devoted to physical activity. The data for physical activity was available from 2002. We were able to use the data from the 2002, 2003, 2005 and 2006 surveys; this survey was not conducted in 2004.

We also obtained real income and self-assessed health. With respect to self-assessed health, the JGSS asked the respondents to choose from among 1 (=excellent), 2, 3, 4 and 5 (=poor) in response to the question, "How would you assess your health status?" Following Oshio and Kobayashi (2010), we reversed the order of choices so that "poor" equaled 1 and "excellent" equaled 5. We dichotomized the categories into (1, 2) versus (3, 4, 5) as the unhealthy takes one (unhealthy=1, 2; healthy=3, 4, 5). The proportion of unhealthy workers was 0.14. The proportion of people participating in physical activity to unhealthy workers was 0.34, which was smaller than the proportion of 0.46 in the case of healthy workers.

The JGSS asked the respondents to choose their annual pre-tax income for the previous year from nineteen categories. We took the median value of each category and transformed it into a natural log, considering the non-linear association between income and health. Annual income was deflated by the consumer price index. The consumer price index in Japan decreased from 2001 to 2005 as follows: 101.5 in 2001;

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[6] The proportion of people participating in physical activity to smokers was 0.42, which was smaller than the proportion of 0.46 in the case of non-smokers. The smoking rate of this data set was 0.34 (males 0.48, females 0.16).

100.6 in 2002; 100.3 in 2003, 100.3 in 2004 and 100.0 in 2005.

Certain limitations of this study should be acknowledged. It relied on self-reports and may therefore be subject to reporting biases. People with a worse objective health status may tend to overstate their subjective health.[7]

3-2. Simultaneous relationships between working hours and physical inactivity

Standard estimation methods in the presence of simultaneity will result in biased and inconsistent estimates, and this bias can be corrected by choosing one of two popular methods: indirect least squares or two-stage least squares. To obtain consistent estimates for the coefficients and their corrected standard errors, we followed the procedure developed by Omar (2003).

If y_1^* and y_2^* are observed as follows

$$y_1 = y_1^*$$
$$y_2 = 1 if\ y_2^* > 0, = 0\ otherwise$$

and neither γ_1 nor γ_2 equal zero, then we have a simultaneous equation model in which one of the endogenous variables is continuous and the other endogenous variable is dichotomous. The null hypothesis is neither γ_1 nor γ_2 equals zero, while the alternative hypothesis is γ_1 =0 or γ_2 =0. When we accept that the alternative hypothesis and the error terms are not contemporaneously correlated, then we should estimate each equation separately by OLS.[8]

$$y_1 = \gamma_1 y_2^* + X_1^{'}\beta_1 + \varepsilon_1 \quad (1)$$
$$y_2^* = \gamma_2 y_1 + X_2^{'}\beta_2 + \varepsilon_2 \quad (2)$$

where y_1 is a continuous endogenous variable (working hours), y_2^* is a dichotomous endogenous variable (physical inactivity), which is observed as 1 if y_2^* > 0, and 0 otherwise. $X_1^{'}$ and $X_2^{'}$ are matrices of exogenous variables, β_1 and β_2 are vectors of parameters, γ_1 and γ_2 are the parameters of the endogenous variables in (1) and (2). ε_1 and ε_2 are the error terms of (1) and (2). Because y_2^* is not observed, the structural equations (1) and (2) are rewritten as

[7] If poorer people responded that they were healthier than they really were, the effect of self-assessed health on income might be underestimated. Lindeboom and van Doorslaer (2004) used objective health data and found evidence of age- and sex-related reporting bias in self-assessed health, but found no evidence of income-related reporting bias.

[8] If the error terms are contemporaneously correlated, then estimation can proceed by using seemingly unrelated regressions or other methods.

$$y_1 = \gamma_1 \sigma^2 y_2^{**} + X_1^{'} \beta_1 + \varepsilon_1 \qquad (1)'$$

$$y_2^{*} = \frac{\gamma_2}{\sigma^2} y_1 + X_2^{'} \frac{\beta_2}{\sigma^2} + \frac{\varepsilon_2}{\sigma^2} \qquad (2)'$$

In the first stage, models are fitted using all of the exogenous variables (i.e., the exogenous variables in both (1)' and (2)'). The variance of the residuals (σ^2) is normalized to 1 in probit models. The predicted values from each model are obtained for use in the second stage. In the second stage, the original endogenous variables in (1)' and (2)' are replaced by their respective fitted values in (3).

$$\begin{aligned} \bar{y}_1 &= X^{'} \hat{\Pi}_1 \\ \bar{y}_2^{**} &= X^{'} \hat{\Pi}_2 \end{aligned} \qquad (3)$$

where $X^{'}$ is a matrix of all the exogenous variables in (1)' and (2)', Π_1 and Π_2 are vectors of parameters. In the second stage, the following two models are fitted:

$$y_1 = \gamma_1 \bar{y}_2^{**} + X_1^{'} \beta_1 + \varepsilon_1 \qquad (4)$$

$$y_2^{**} = \gamma_2 \bar{y}_1 + X_2^{'} \beta_2 + \varepsilon_2 \qquad (5)$$

Equation (4) is estimated via OLS and Equation (5) is estimated via probit. The estimated standard errors in (4) and (5) may be incorrect, and we thus conducted the procedure developed by Omar (2003) to obtain consistent estimates for the coefficients and their corrected standard errors.

Self-assessed health status is a subjective measure of health, but is likely to encompass a broad range of aspects of health which may affect an individual's position on the labor market, including both physical and mental well-being (Haan and Myck 2009). Higher educational attainment is related to better general health, which may increase the likelihood of being more physically active.[9] Education was associated with increased physical activity for both males and females (Mullahy and Robert 2008;

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[9] Liang *et al.* (2002) showed that the effect of SES on health was greatest in middle and early old age. They also reported that educational differences in the risk of dying tend to converge in the 70–79 year age group. In contrast to Western countries, Liang *et al.* (2002) reported that an educational crossover effect on mortality was observed among old men such that at advanced age, those with less education live longer than those with more education. The educational crossover existing only among elderly men may be due to gender and SES differences in causes of death, morbidity and health behavior.

Mclnnes and Shinogle 2009).[10] Mclnnes and Shinogle (2009) argued that shocks in time use such as children, marriage and job change affected physical activity. Their estimation results revealed that individuals who report being married were generally associated with decreased participation in physical activity. Holding marital status constant, men were more likely to exercise than women across all income levels. We estimate models of physical activity, taking into account both educational attainment and marital status. In this paper, we consider the flow from working hours to health status, although poorer health may result in the reduction of total labor input, as the model of Grossman (1972) indicated.[11]

Table 4 shows the estimation results of equations (4) and (5). Being unhealthy, married and having low educational attainment had positive impacts on physical inactivity at the 1 percent significance level for males and females. In contrast, males who completed college or university had negative impacts on physical inactivity at the 1 percent significance level. Management executives also had negative impacts on physical inactivity at the 1 percent significance level for males and females. Individuals in a higher job status are more likely to engage in healthy behaviors.

Occupational status, except in the case of management executives, did not have significant effects on physical inactivity at the 5 percent level and we thus dropped these variables. The male age effect on physical inactivity was statistically significantly positive at the 1 percent level. In contrast, the female age effect was statistically significantly negative at the 5 percent level. The male income effect on physical inactivity was negative, but statistically significant at the 10 percent level. The number of children had negative effects on physical inactivity at the 10 percent significance level for males. Smoking had positive effects on physical inactivity at the 1 percent significance level for males.

We did not find a statistically significant relationship between poor health and hours of work, and thus dropped 'unhealthy' from the equation of working hours. With regard to the effects on working hours, there were differences between males and females. For males, age was statistically significant at the 1 percent level. Age had an inversely U-shaped impact on working hours. Based on the estimated coefficients, male working hours seemed to peak at 37 years old. This life-cycle pattern of time allocation to work corresponds to the working hours of people who were in their fifties in 2006 (see Figure

[10] Mullahy and Shinogle (2009) revealed that education was a positive and significant factor in all estimation functions, and the effects were fairly stable across gender and income.

[11] The relationship may be additionally stronger by the endogeneity of health. Geyer and Myck (2010) argued that the income effect of a lower wage rate of individuals in bad health could be compensated by longer working hours, but poor health might also increase the disutility of labor. Therefore, the direction of this effect is a priori indeterminate.

1). The smoking dummy variable of male workers was positive and statistically significant at the 1 percent level. This may imply that the labor productivity of smokers was lower than that of non-smokers. For females, dispatched, family worker and self-employed had negative effects on working hours at the 1 percent significance level.

Based on the results of two-stage probit least squares estimation, we accepted the alternative hypothesis. There were no simultaneous relationships between leisure-time physical inactivity and working hours for males and females. The estimation results may indicate that workers usually do not instantaneously change the time they spend on physical activity in response to a temporary decrease in working hours.

4 Poor health and physical inactivity

Previous studies suggested that poverty reduces access to health care resources, which in turn results in poor health. By extension, people in poorer health are then less likely to be physically active than those in good health (McNeill *et al.* 2006).[12] We estimated endogenous switching probit models to analyze whether physical inactivity depended on poor health status, taking into account the existence of unobserved factors affecting poor health status and physical inactivity. Endogenous switching is a concern whenever the dependent variable of a regression model is a function of a binary regime switch. Assuming smoking and drinking had a strong association with self-assessed poor health, we investigated whether poor health status had a positive effect on physical inactivity and whether physical inactivity was associated with low educational attainment.[13]

In the endogenous switching problem, the response y_i of the ith individual is always observed, and it is assumed that y_i depends on the endogenous dummy S_i and a $K \times 1$ vector of explanatory variables, x_i. Similarly, the endogenous dummy S_i depends on an $L \times 1$ vector of explanatory variables including the constant term, z_i. No exclusion restrictions are needed to identify the model.[14] Following Miranda and Rabe-Hesketh (2006), the model can be formulated as a system of equations for two latent responses. In particular, y_i is assumed to be generated as

$$y_i^* = x_i^{'}\beta + \theta S_i + u_i \qquad (6)$$

[12] Poortinga (2006) found a strong gradient for age and social class: older age groups and people from lower socio-economic backgrounds were more likely to report poor health. Males, singles, economically inactive people, and non-homeowners were all more likely to report poorer health status.

[13] This assumption is based on the study by Wang et al (2005).

[14] Wilde (2000) showed that the existence of varying exogenous regressors avoids the identification problem.

$$y_i = \begin{cases} 1\ if\ y_i^* > 0 \\ 0\ otherwise \end{cases}$$

where y_i^* represents a latent continuous variable, $\boldsymbol{\beta}$ represents a $K \times 1$ vector of parameters to be estimated, θ is the coefficient associated with the endogenous dummy, and u_i is a residual term.

A bivariate normal distribution is assumed for u_i and v_i, which is a residual term of Equation (9). We consider a shared random effect (ε_i) to induce the dependence between u_i and v_i. ε_i, τ_i, and ξ_i are independently normally distributed with mean 0 and variance 1, and λ is a free parameter.

$$u_i = \lambda \varepsilon_i + \tau_i \tag{7}$$

$$v_i = \varepsilon_i + \xi_i \tag{8}$$

Consistent estimators of $\boldsymbol{\beta}$ and θ are obtained by fitting Equation (6) with ordinary probit regression. A similar latent response model is specified for the switching dummy,

$$S_i^* = z_i^{'}\gamma + v_i \tag{9}$$

$$S_i = \begin{cases} 1\ if\ S_i^* > 0 \\ 0\ otherwise \end{cases}$$

where S_i^* represents a latent continuous variable, $\boldsymbol{\gamma}$ an $L \times 1$ vector of parameters. A simple likelihood-ratio test can be used to test the null hypothesis that $\rho_\lambda = 0$. S_i is exogenous in Equation (6) if $\rho_\lambda = 0$. One free parameter, λ, is identified because the data provide information on the correlation, ρ_λ. The covariance matrix of the residuals is given by $Cov\{(u_i, v_i)^{'}\} = \begin{pmatrix} \lambda^2+1 & \lambda \\ \lambda & 2 \end{pmatrix}$ so that the correlation is $\rho_\lambda = \lambda \big/ \sqrt{2(\lambda^2+1)}$.

If $\rho_\lambda \neq 0$, S_i is correlated with u_i via the unobserved heterogeneity term ε_i. The presence of this bias is why we should use an endogenous switching model if S_i is suspected to be endogenous. The latent response y_i^* for the *i*th individual in an endogenous switching problem is assumed to be determined by Equation (10), where τ_i represents a random error.

$$y_i^* = x_i^{'}\beta + \theta S_i + \lambda\varepsilon_i + \tau_i \tag{10}$$

where y_i is physical inactivity and S_i is poor health (unhealthy).

We considered social environmental factors on physical activity as unobserved factors affecting poor health status and physical inactivity. Physical activity resources such as public open space, recreational centers and swimming pools might be distributed in favor of the rich. The regional difference in physical activity resources should be explicitly considered. However, we were not able to use the appropriate instrumental variables to estimate the equation of physical inactivity because we only obtained data on prefecture-level measures of physical activity resources and information about the prefecture where each respondent lives.

Endogenous switching models were estimated for males and females, assuming working hours had a direct effect on poor health but no effect on physical inactivity. The estimation results of the endogenous switching models are shown in Table 5. As a result of the likelihood-ratio test, our hypothesis that physical inactivity depended on poor health status was accepted at the 5 percent significance level for males and females. Working hours had a positive effect on poor health status, and poor health status had a positive effect on physical inactivity. There was an association between working hours and poor health at the 5 percent significance level for males, although we found no reverse causation in the previous section.[15] Physical inactivity was strongly associated with low educational attainment and marital status. For male workers, income had a negative effect on physical inactivity at the 5 percent significance level. In contrast, female income had no effect on physical inactivity.

5 Conclusions

Previous studies revealed the following findings: individuals at the highest levels of SES were more likely to engage in regular physical activity during their leisure time, several important behavioral risk factors for poor health are common among people in lower SES groups, and people in poorer health are less likely to be physically active. However, to our knowledge, no studies have examined the relationship between the leisure-time physical inactivity of Japanese workers and their working hours, and whether physical inactivity depended on poor health status.

We pooled the data of the surveys conducted in the years 2002, 2003, 2005, and 2006.

[15] When we assumed that working hours had a direct effect on physical inactivity but no effect on poor health, the hypothesis that physical inactivity depended on poor health status was rejected.

The data were drawn from the Japanese General Social Survey. We estimated two-stage probit least squares models to examine whether simultaneous relationships between physical inactivity and working hours existed. We could not confirm simultaneous relationships between physical inactivity and working hours. The estimation results may indicate that workers usually do not instantaneously change the time they spend on physical activity in response to a temporary decrease in working hours.

We estimated endogenous switching probit models to analyze whether physical inactivity depended on poor health status, taking into account the existence of unobserved factors affecting poor health status and physical inactivity. The estimation results of endogenous switching models showed that working hours had a positive effect on poor health status and poor health status had a positive effect on physical inactivity. Physical inactivity was associated with low educational attainment and marital status. For male workers, income had a negative effect on physical inactivity at the 5 percent significance level.

Before the conclusions are discussed, the limitations of our study will be considered. People living in higher SES areas were found to have better access to sporting and recreational spaces in industrialized countries. People living near green spaces, including parks, playgrounds and sports fields are more likely to walk and to have higher levels of physical activity. Poortinga (2006) found that positive perceptions of the social environment (i.e., social support and social capital) were associated with higher levels of physical activity using the 2003 Health Survey in England. In Japan, workers with greater disposable incomes may obtain social and material resources (e.g., gym memberships) that maintain physical activity. Cerin and Leslie (2008) confirmed their hypothesis that SES differences in leisure-time physical activity are explained by individual, social and environmental variables as well as SES differences in self-reported health status. They emphasized that physical barriers to walking and access to public open spaces partly explained the associations between income and walking for recreation. The influence of social environmental factors on physical activity should be investigated in future studies, although the use of area-level measures is currently very limited.

Despite these limitations, our findings provide some insights into the reasons that contribute to poorer health in workers. This study revealed gender differences in the association of income and physical inactivity among Japanese workers. Workers in poorer health were likely to be physically inactive. To reduce chronic diseases due to physical inactivity, more attention should be paid to the influence of income reduction on poor health in males.

Acknowledgements

The paper is part of the academic project on Economic Analysis of Intergenerational Issues: Searching for Further Development, funded by the Grant-in-Aid for Specially Promoted Research from Japan's Ministry of Education, Culture, Sports, Science and Technology (Grant Number 22000001). The Japanese General Social Surveys (JGSS) are designed and carried out at the Institute of Regional Studies at the Osaka University of Commerce in collaboration with the Institute of Social Science at the University of Tokyo under the direction of Ichiro TANIOKA, Michio NITTA, Noriko IWAI and Tokio YASUDA. The project was financially assisted by a Gakujutsu Frontier Grant from the Japanese Ministry of Education, Culture, Sports, Science and Technology for the 1999-2008 academic years, and the datasets were compiled and distributed by SSJ Data Archive, Information Center for Social Science Research on Japan, Institute of Social Science, the University of Tokyo.

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Table 1. Minutes per day spent on activities by males and females aged 15 and over

	1991		1996		2001		2006	
Activities	With a Job	Without a Job	With a Job	Without a Job	With a Job	Without a Job	With a Job	Without a Job
Males aged 15 and over								
Market								
Work	430	8	420	10	408	7	420	9
Non-market								
Sleep	463	498	463	506	459	504	454	503
Newspaper, Radio and TV	132	213	139	235	134	245	121	240
Sports	10	27	11	25	10	24	11	30
Medical Care	4	22	4	17	4	19	3	20
Housework	8	21	7	24	9	30	11	37
Child Care	3	1	3	1	4	2	5	2
All others	390	650	393	622	412	609	415	599
Females aged 15 and over								
Market								
Work	324	6	311	7	291	5	300	5
Non-market								
Sleep	442	468	443	471	440	472	436	471
Newspaper, Radio and TV	110	170	119	185	117	181	109	179
Sports	5	10	6	10	7	10	7	12
Medical Care	4	17	4	14	5	15	5	17
Housework	145	203	138	200	133	195	131	195
Child Care	11	35	9	33	12	35	15	33
All others	399	531	410	520	435	527	437	528

Note: Child care includes child care and house keeping, and Newspaper, Radio and TV includes time spent on reading magazines.

Medical care implies medical examination and treatment at clinics and hospitals.

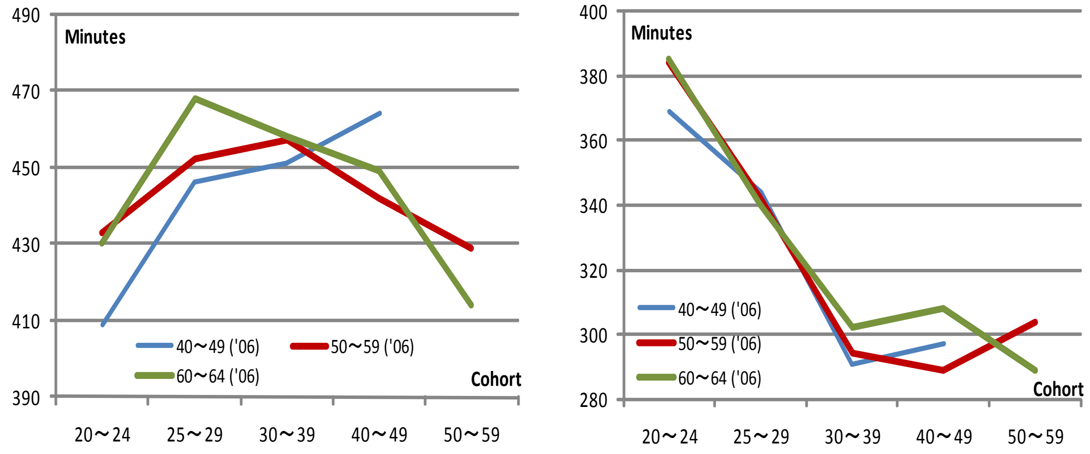
Sources: Statistics Bureau of Ministry of Internal Affairs and Communications in Japan, the Survey on Time Use and Leisure Activities: 1991, 1996, 2001, and 2006

Table 2. Differences in Time Allocation

2006

	With a Job	Without a Job
Males		
Work: Sleep	0.925	0.018
Sports: (Work+Housework)	0.024	0.056
Females		
Work: Sleep	0.688	0.011
Sports: (Work+Housework)	0.012	0.018

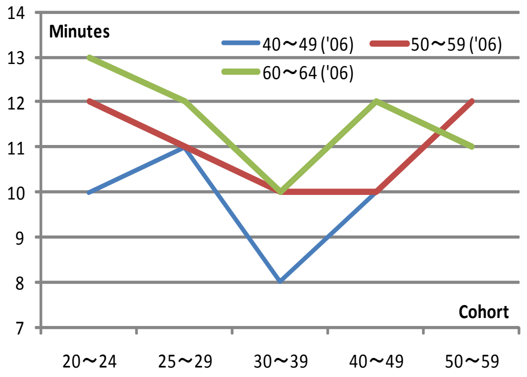
Sources: Table1



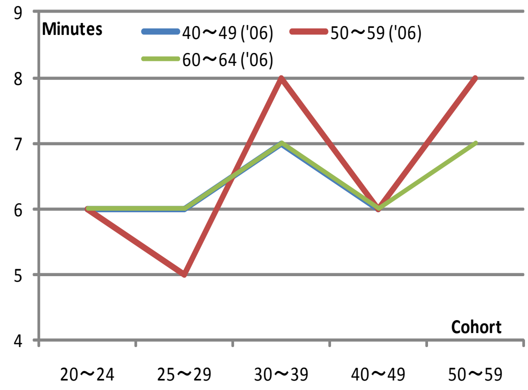
Males with a Job

Females with a Job

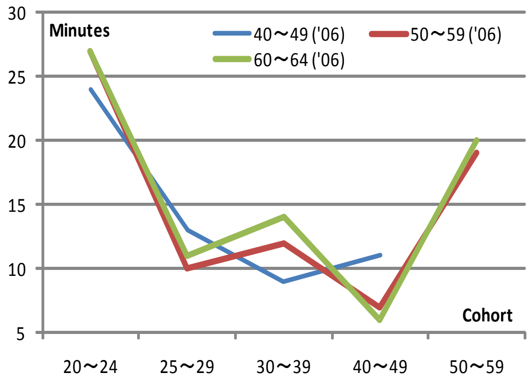
Figure 1. Changes in Working Hours Over Time (1991-2006)



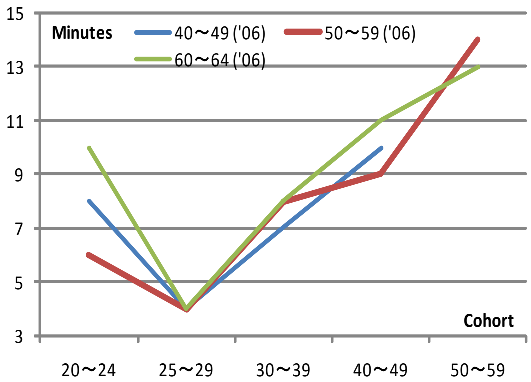
Males with a Job



Females with a Job



Males without a Job



Females without a Job

Figure 2. Changes in Sports Hours Over Time (1991-2006)

Table 3. Descriptive Statistics of Workers in Japan

	Definition	N	Mean	Std. Dev.	Min	Max	Male Mean	Female Mean
Dependent Variables								
Physial Inactivity	Inactivity=1	4569	0.56	0.50	0	1	0.51	0.62
Working Hours		4588	39.99	15.91	1	120	45.16	33.67
Independent Variables								
(1) Demographic variables								
Age		4588	46.43	13.94	20	89	47.12	45.59
Gender	Male=1	4588	0.55	0.50	0	1		
Marital Status	Married=1	4588	0.57	0.50	0	1	0.58	0.55
	Divorced=1	4588	0.05	0.22	0	1	0.02	0.08
	Widowed=1	4588	0.01	0.08	0	1	0.00	0.01
Children	Number of Children	4588	1.59	1.15	0	10	1.57	1.61
Educational Attainment	Junior High School	4588	0.13	0.33	0	1	0.14	0.11
	High School (Reference)	4588	0.49	0.50	0	1	0.47	0.53
	College or University	4588	0.30	0.46	0	1	0.29	0.31
	(University	4588	0.18	0.38	0	1)	0.22	0.12
	(College	4588	0.12	0.33	0	1)	0.06	0.19
	Graduate School	4588	0.07	0.26	0	1	0.99	0.04
(2) Workplace								
Occupational Status	Management Executive	4588	0.07	0.25	0	1	0.10	0.04
	Part-time and Casual Worker	4588	0.23	0.42	0	1	0.09	0.40
	Self-employed	4588	0.12	0.33	0	1	0.17	0.07
Scale of Workplace	Large	4588	0.13	0.34	0	1	0.16	0.10
	Medium	4588	0.25	0.43	0	1	0.27	0.23
	Small (Reference)	4588	0.30	0.46	0	1	0.29	0.31
(3) Lifestyle								
Drinking	Almost Everyday=1	4578	0.27	0.44	0	1	0.41	0.10
Smoking	Smoker=1	4588	0.34	0.47	0	1	0.48	0.16
(4) Other								
Real Income	Evaluated at 2005 prices, 10000yen	4588	366.82	337.13	0	3220	500.42	203.60
Self-Assessed Health	Unhealthy=1, Healthy=0	4588	0.14	0.35	0	1	0.15	0.14

Sources: Japanese General Social Survey 2002, 2003, 2005 and 2006

N=4588 (Male 2523, Female 2065; 1566 in 2002; 979 in 2003; 1005 in 2005; 1038 in 2006)

Table 4. Working hours and physical inactivity

	Males		Females	
	N=2501		N=2046	
F (15=Males, 19=Females)	37.23		36.98	
Prob > F	0.00		0.00	
Adj R-squared	0.1786		0.2505	
LR chi2(14)		138.85		79.65
Prob > chi2		0.00		0.00
Pseudo R2		0.040		0.0293
VARIABLES	Working Hours	Physical Inactivity	Working Hours	Physical Inactivity
Physical Inactivity	-2.890		0.574	
	(-2.267)		(2.937)	
Unhealthy		0.298***		0.274***
		(0.072)		(0.086)
Working Hours		0.0059		0.00605
		(0.007)		0.00598
Logged Real Income		-0.0683*		-0.03610
		(0.041)		0.03851
Age	0.740***	0.007***	0.08037	-0.005**
	(0.128)	(0.003)	(0.163)	(0.002)
Age Squared	-0.01***		-0.00138	
	(0.001)		(0.0016)	
Family Structure				
Married	-0.446***	0.164***	-2.442***	0.172***
	(0.729)	(0.060)	(0.911)	(0.072)
Divorced			-0.06331	0.453***
			(1.851)	(0.125)
Widowed			-2.49659	0.01143
			(2.896)	(0.289)
Children	0.30774	-0.051*	-0.24692	0.058*
	(0.328)	(0.028)	(0.371)	(0.031)
Educational Attainment				
Junior High	1.60498	0.219***	1.8368	0.372***
	(1.035)	(0.083)	(1.483)	(0.103)
College or University	-1.002325	-0.221***	-0.01592	-0.0969
	(0.842)	(0.061)	(0.743)	(0.067)
Graduate School	-3.074***	-0.168*	-2.35547	-0.21949
	(1.092)	(0.096)	(1.720)	(0.159)
Scale of Workplace				
Workplace Small	1.377*	0.08661	-0.60769	0.08363
	(0.734)	(0.063)	(0.707)	(0.065)
Workplace Large	-0.17	-0.08906	-1.55630	-0.05425
	0.841	(0.074)	(1.010)	(0.099)
Lifestyle				
Drinking	-0.3312472	-0.06108	0.21584	-0.11044
	(0.604)	(0.054)	(1.023)	(0.098)
Smoking	2.198***	0.252***	0.19091	0.0944257
	(0.814)	(0.053)	(0.874)	(0.081)
Occupational Status				
Management Executive	2.436*	-0.310***	4.782**	-0.504***
	(1.289)	(0.093)	(2.165)	(0.161)
Part-time and Casual Worker	-15.122***		-15.354***	
	(1.037)		(0.686)	
Dispatched			-8.335***	
			(2.054)	
Self-employed	0.7202		-5.584***	
	(0.882)		(1.359)	
Family Worker			-6.214***	
			(1.137)	
Constant	35.235***	-0.26869	42.128***	0.27613
	(2.916)	(0.287)	(3.888)	(0.194)

Note: Standard errors are in parentheses.
The number of asterisks means the significance of the variables
(*** p<0.01, ** p<0.05, * p<0.1).

Table 5. Endogenous Switching Probit Models

	Males		Females	
VARIABLES	Physical Inactivity	Unhealthy	Physical Inactivity	Unhealthy
Unhealthy	1.377***		1.389***	
	(0.113)		(0.110)	
Working Hours		0.00526**		0.00445*
		(0.00206)		(0.00264)
Age	0.00183	0.00621**	−0.00495**	0.00307
	(0.00207)	(0.00246)	(0.00240)	(0.00283)
Logged Real Income	−0.0416**	−0.0425	0.0176	−0.0248
	(0.0166)	(0.0315)	(0.0196)	(0.0324)
Family Structure				
Married	0.153***		0.179**	
	(0.0584)		(0.0815)	
Divorced			0.441***	
			(0.124)	
Widowed			−0.0486	
			(0.290)	
Children	−0.0502*		0.0563*	
	(0.0270)		(0.0315)	
Educational Attainment				
Junior High	0.242***		0.348***	
	(0.0851)		(0.0929)	
College or University	−0.244***		−0.0814	
	(0.0583)		(0.0694)	
Graduate School	−0.228***		−0.240	
	(0.0863)		(0.166)	
Scale of Workplace				
Workplace Small	0.0646		0.0877	
	(0.0599)		(0.0665)	
Workplace Large	−0.0714		−0.0415	
	(0.0705)		(0.104)	
Lifestyle				
Smoking		0.138**		0.229***
		(0.0585)		(0.0846)
Drinking		−0.198***		−0.0704
		(0.0604)		(0.109)
Occupational Status				
Management Executive		−0.235**		−0.332*
		(0.108)		(0.192)
Part-time and Casual Worker		−0.210*		0.0475
		(0.126)		(0.0887)
Dispatched		0.405		−0.0328
		(0.264)		(0.233)
Self-employed		0.0990		−0.0845
		(0.0826)		(0.143)
Family Worker				0.0452
				(0.126)
Constant		−1.283***		−1.296***
		(0.228)		(0.219)
Log likelihood	−2731.90		−2141.93	
ρ_λ	−0.619		−0.633	
	(0.0473)		(0.0407)	
Likelihood ratio test for ρ_λ=0: chi2(1)	6.31		4.42	
Prob > chi2	0.012		0.036	

Note: N=2513 (Male), 2056 (Female). Standard errors are in parentheses.
The number of asterisks means the significance of the variables (*** p<0.01, ** p<0.05, * p<0.1).