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Evidence from workers' longitudinal data in Japan**

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Abstract

Overwork is widely acknowledged as the main culprit behind mental health issues, but research in social science and epidemiology seldomly considers an adequate range of factors when investigating that connection. Using longitudinal data of Japanese workers over four consecutive years, this study investigates how the number of hours worked, job characteristics, and workplace circumstances affect workers' mental health. Using widely used scores in epidemiology to measure the degrees of mental health (General Health Questionnaire), our main findings are as follows. First, long work hours contribute significantly to deteriorations in respondents' mental health, even after controlling for individual fixed effects and other characteristics. Second, the relationship between work hours and mental health is not linear. Working more than 50 hours per week notably erodes the mental health of workers. Third, clear job descriptions, ability to exercise discretion in performing tasks, and workplace atmosphere significantly influence respondents' mental health after controlling for hours worked. Fourth, if a coworker is suffering from mental illness at the workplace, the mental health of other workers are also likely to be poor. These findings suggest that proper workplace practices, including management of work hours, would affirmatively improve workers' mental health.

Keywords: Mental health, Long work hours, Work-life balance, Workplace management

JEL classification: I12, J22, J81

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I. Introduction

In his 1930 essay “Economic possibilities for our grandchildren”, Keynes speculated that people might need work no more than 15 hours per week by 2030. But over 85 years after his thoughts were introduced, people seem to be working harder than ever in many developed countries. For example, Kuhn and Lozano (2008) report that the share of US male employees working more than 48 hours per week rose from 16.6% in 1986 to 24.3% between 1980 and 2005. The trade union council (2015) states that the number of UK workers working more than 48 hours per week has risen by 15 per cent since 2010 and warns that working such excessively long hours massively increases risk of harming people’s health. Japanese workers work even more excessively – the *Labour Force Survey* (Statistics Bureau) reports that in 2014 the share of male full-time workers who work more than 60 hours per week was 15.7%. At the same time, many advanced economies have witnessed the increasing number of working age population who suffer from mental health issues during these several decades. For example, OECD (2012) reports that on average around 20 percent of the working-age population in OECD countries suffer from a mental disorder in a clinical sense.

To our knowledge, however, while there are growing concerns in many advanced economies for both workers who work excessively long work hours and who suffer from mental health issues, there is far less agreement about the link between long work hours and workers’ mental health problem. Given these backgrounds, the main purpose of our paper is to investigate the effect of working long hours on the incidence of mental health problems using four-year longitudinal data of Japanese full-time workers.

Overwork is widely acknowledged as the main culprit behind mental health issues in Japan. This belief has spread widely since Japan’s Supreme Court ruled in favor of a worker who died from overwork (*karoshi*) in 2000. Yet, as discussed more in the next section, there is no strong evidence on epidemiology studies which links long work hours to deteriorating mental health.

Our study differs from previous studies both in epidemiology and economics in three ways. First, previous studies, especially in epidemiology, seldom control for worker-specific fixed effects. This may lead to a serious estimation bias due to the simultaneous relationship between work hours and mental health, since if there exists large difference on stress tolerance or power of resilience among individuals – “mentally tough” worker may work longer hours without harming his/her mental health, while “mentally weak” worker may harm one’s mental health even with less hours. In order to cope with this problem, this paper identifies a causal relation between long work hours and mental health using longitudinal data that captures worker-specific fixed effects. In addition, we consider the possibility of time-varying reverse causality — i.e., workers’ mental health influences the number of hours worked by controlling for time-variant factors. Second, we also use ample information on job and workplaces to identify the main factors that damage workers’ mental health other than work hours, which is controlled rarely in epidemiology studies. Third, mostly used mental health measures among studies in economics are subjective indices such as “stress” or “job satisfaction.” Instead, we incorporate the General Health Questionnaire (GHQ), a scale widely used in epidemiology to assess workers’ mental health.

Our main findings are followings. First, even after controlling for both worker-specific time-invariant and time-variant fixed effects, long work hours is one of the principal causes of deterioration in workers’ mental health. Second, job characteristics (such as clear job description and discretionary power) and workplace atmosphere significantly affect respondents’ mental health even after controlling for the number of hours worked. Third, more than 50 hours a week notably erode mental health of workers suggesting that 50 hours may be a clinical threshold. Fourth, when there is someone who suffer from mental illness at ones’ workplace, mental health of other coworkers are also likely to be bad. Findings suggest that proper workplace practices, including management of work hours, can improve employees’ mental health.

This paper proceeds as follows. Section II reviews previous literature concerning relations between work and mental health. Section III explains the study’s

data, the GHQ measure, and basic statistics. Section IV investigates causality among hours worked, job-related information, and respondents' mental health. Section 5 concludes the study.

II. Literature review and situation in Japan

1. Long work hours and mental health

There are not so many studies in epidemiology that investigate the impact of long work hours toward workers' mental health, and the results reported in those studies are mixed. For example, by searching PubMed, Fujino et al. (2006) assessed 131 papers that consider work-related factors and mental health and found only 17 papers that examine causality between hours worked and mental health. Among the 17 identified papers, only three report that long work hours erode workers' mental health, and 14 other papers find no evident causality. Moreover, the three papers that do report statistical causality between hours worked and mental health use cross-sectional data.¹ Results obtained by cross-section data, however, may contain some biases. Some workers are inherently more resilient, therefore working long hours may not cause any major erosion in their mental health (omitted variable bias). In addition, workers with bad mental health may be less productive and work longer hours to complete tasks. In such cases, causality runs from mental health to hours worked, not vice versa (reverse causality).^{2,3}

Literature survey done by Bannai and Tamakoshi (2014) cover more recent epidemiology papers which relates work hours and health (both physical health and mental health). Virtanen et al. (2011, 2012) are the two recent papers in epidemiology

¹ Ten of those 17 use cross-sectional data and eight use panel data.

² Among the 17 papers selected by Fujino et al. (2006), three (Kawakami et al. [1989], Sugisawa et al. [1994], Shields [1999]) use large panel data involving more than 1,000 workers. All three papers report no causality between hours worked and mental health, although Shields (1999) found a weak correlation among female workers.

³ Results suggested by some previous epidemiology studies contain severe sample selection bias because they use data collected from doctors, medical students, and residents to investigate causality between long hours worked and mental health. According to Fujino et al. (2006), six of the 17 studies use data from medical practitioners.

introduced in the survey which have done cohort studies for British civil servants. By their follow-up study for five to six years, they found that workers who worked quite longer hours (11 hours per day or 55 hours per week) are more likely to face major depressive episode than those who worked less hours in later years. To our understanding, however, these studies neither control for fixed effects among individuals or any possible changes of work characteristics or at workplace during the follow-up period which may affect workers' mental health.

Studies in economics that try to explore relations between work hours and mental health are even scarcer. Compare to literature in epidemiology, the economic studies mostly use longitudinal or retrospective data, which report statistically significant relations between the number of hours worked and mental health (for example, Yasuda [2008], Yamaoka [2012]). These studies however, use ambiguous proxies for mental health such as "stress" or "job satisfaction" instead of globally standard measures.⁴

In summary, there are a few studies both in epidemiology and economics that report the association between overwork and mental health, however the relationship is still ambiguous since a causal relation between long hours worked and impaired mental health is not yet clearly established.

In what follows, we use longitudinal data tracing Japanese workers over four consecutive years to control for respondents' unobservable, time-invariant, fixed effects such as natural resilience. In addition, by using instrumental variables that related to hours worked but not to mental health, we also consider time-variant factors that may

⁴ Other recent economic literature that investigate the association between work hours and mental health include for example, Bardasi et al. (2004), Dockery(2006) and Llana-Nozal (2009). To our understanding, however, their main purposes are to investigate whether there is a statistical differences in workers' mental health between full-time and part-time workers. For example, using BHPS, Bardasi et al. (2004) estimates fixed effect logit model and reports that there is no statistical difference in mental health between workers who work less than 30 hours and those who work more than 30 hours per week. On the other hand, Dockery (2006) uses data from HILDA and reports that mental health of full-time workers is worse than that of part-time workers using random effect model. Llana-Nozal (2009) uses four longitudinal data (BHPS, HILDA, NHPS, SHP) to estimate fixed effect model and reports mixed results regarding work hours and mental health: when men in Canada, the United Kingdom and Australia move from a full-time job into one where they work overtime their mental health worsens, however, working fewer hours is associated with increased mental health problems for women in Canada and the United Kingdom.

cause reverse causality.

2. Job characteristics, evaluation systems, workplace environment, human resource management, and mental health

Causality between hours worked and mental health remains undetermined possibly because mental health is not exclusively a matter of hours worked. Job characteristics, workplace environments, and evaluation systems may also be significant contributors.

In his influential job-strain model, Karasek (1979) categorizes jobs into four types—high-strain, low-strain, passive, and active—based on their demands and workers' latitude in making decisions. High-strain jobs are demanding and grant workers little discretion in making decisions. Low-strain jobs are undemanding and offer relatively high decision-making discretion. Passive jobs entail low demands and relatively little discretion. Active jobs are demanding and feature relatively high decision-making discretion. OECD (2012) surmised that workplace-related mental disorders are increasing in OECD countries because high-strain jobs are becoming more prevalent. Kambayashi et al. (2013) reported that Japanese workers in high-strain jobs are more likely to experience greater stress than other workers.

Siegrist's (1996) effort–reward imbalance model captures occupational reciprocity, noting that high-cost/low-gain conditions are especially stressful. High-cost/low-gain jobs combine low status control (few promotion prospects, job insecurity) with high extrinsic (work pressure) or intrinsic efforts (personal coping patterns). Although his study originally examines whether such combinations increase stress-related cardiovascular events, his model has been extended to mental health research. For example, Yamaoka (2012) reports less stress among Japanese workers whose consent to their evaluations is reflected in their wages.⁵

To our knowledge, there are very few studies that investigate the relationship

⁵ Another active area of research extends the importance of “work engagement.” The opposite of “burn out,” work engagement, consists of three factors: *dedication*, *absorption*, and *vigor* toward work. It is considered that improving work engagement improves mental health and firms' profits by increasing worker motivation (Schaufeli et al. [2002]). See Salanova et al. (2005) and Xanthopoulou et al. (2009).

among workplace environment, human resource management and workers' mental health (see Eriksson [2012]). A few research in this theme includes Godard (2001, 2004), who found no evidence that fatigue and stress correlate significantly with performance pay using data from a small Canadian telephone survey. Using data from the Finnish Quality of Work Life Survey, Böckerman et al. (2011) also found that high-performance workplaces have little effect on overall employee health. However, Askenazy and Caroli (2010) used data from a survey that supplemented the French *Labour Force Survey* and found that practices like quality norms, job rotation schemes, and work time flexibility system are associated with greater mental strain.

Given these findings in previous literature, we use ample information on job characteristics and workplace to investigate whether these is any major factor that impair workers' metal health besides long work hours.

3. Situation in Japan

Before turning to our analysis, we briefly discuss the recent mental health issues in Japan based on official statistics.

Similar to many industrialized countries, the number of people suffering from mental illness has been increasing in Japan. In Figure 1, we plot the number of patients with mental disorder over two decades based on *Patient Survey* (Ministry of Ministry of Health, Labour and Welfare). From the figure, the number of people suffering from mental illness in a clinical sense has increased, especially in the last decade.⁶ In particular, the percentage of people suffering from mood disorder (including depression and bipolar disorder) increased over the period. Note that the slight decline in the most recent survey, that of 2011, is due to the fact that patients residing in three prefectures that were severely damaged by the Great East Japan Earthquake were excluded from the

⁶ According to Yamaoka's (2012) investigation of public health insurance data, 5.49 per 1,000 Japanese workers suffered mental disorders in 1983, 7.86 in 1993, and 11.47 in 2003. His calculations tied to the most recent available data suggest that more than 1% of Japanese workers consult doctors for mental health reasons.

data. Thus, the number would have been much larger but for the earthquake.

In Figure 2, we plot the number of applications and the number of approved claims for insurance due to industrial accidents from workers' compensation insurance data (provided by the Ministry of Health, Labour and Welfare). While the total number of claims for physical diseases, like those affecting the brain and heart, has been stable since 2000, the total number of claims for mental disorders increased steadily during that time. Claims for mental disorder include suicides presumably triggered by mental disorder.

In the meantime, the total number of suicides has also increased rapidly, from around 25,000 in the end of the 1990s to 35,000 in the 2000s. The Japanese government estimates that the economic and social loss from suicides and mental disorders was at least 2.7 trillion yen for 2009, which is equivalent to 0.7 percent of GDP⁷ (Kaneko and Sato 2010).

III. Data

Data in our analysis are from an original longitudinal survey (Survey of Companies and Employees on Human Capital Development and Work-Life Balance) conducted every February since 2012 by the Research Institute of Economy, Trade and Industry. The first wave was administered to firms employing more than 100 persons. Each firm chose at least five white-collar, regular employees for the employee survey. Selected employees completed and returned the questionnaires by mail. Information from the first wave survey became available for 4,439 employees. Since 2013, questionnaires have been sent directly to employees who participated in the first wave. Refreshment samples were added to the third and fourth waves, and we asked firms to choose at least five

⁷ Note that this calculation does not include the economic loss from presenteeism. Gustavsson et al. (2011) estimate that, in the Euroarea, the economic loss due to mental disorders range from three to four percent of GDP.

white-collar, regular employees to participate in the employee survey.

We used information collected from 2,187 observations, among which 870 employees responded for at least two consecutive years. Information included respondents' self-assessments of their mental health, individual characteristics (occupation, tenure, education, number of hours worked), job characteristics, and information related to mental health in the workplace.

We measured employees' mental health using the GHQ screening survey developed at Maudsley Hospital in London (Goldberg [1972])). A self-completion questionnaire translated into several languages, including Japanese (translated by Nakagawa and Ohbo [1985]), it has been used worldwide for decades. Although GHQ features 60 questions in total, the abbreviated GHQ-28 and GHQ-12 versions contain 28 and 12 questions, respectively.⁸ We used GHQ-12. Its 12 questions are as follows.

Question: Have you recently...

1. been able to concentrate on whatever you're doing?
2. lost much sleep over worry?
3. felt that you were playing a useful part in things?
4. felt capable of making decisions about things?
5. felt constantly under strain?
6. felt you couldn't overcome your difficulties?
7. been able to enjoy your normal day-to-day activities?
8. been able to face up to problems?
9. been feeling unhappy or depressed?
10. been losing confidence in yourself?

⁸ Goldberg et al. (1997) compared the long and short versions in an experiment involving 5,438 patients. They concluded "if investigators wish to use a screening instrument as a case detector, the shorter GHQ (GHQ-12) is remarkably robust and works as well as the longer instrument." Since GHQ is a self-completion questionnaire and not diagnosed by medical doctors, it is subjective to respondents. However, Goldberg et al. (1997) note that both *sensitivity* (test's ability to classify respondents correctly as "diseased") and *specificity* (test's ability to classify respondents correctly as "disease-free") of GHQ-12 are 70% to 90% and valid for screening. Other major screening methods include CES-D and K6.

11. been thinking of yourself as a worthless person?
12. been feeling reasonably happy, all things considered?

Respondents selected among four responses describing their feelings over the previous four weeks such as “Not at all,” “No more than usual,” “Rather more than usual,” and “Much more than usual.”

There are two ways to score responses to GHQ-12 questions: GHQ scoring (0-0-1-1) and Likert scoring (0-1-2-3). The former scores 0 for responses “Not at all” and “No more than usual” and 1 for responses “Rather more than usual” and “Much more than usual.” Totals range from 0 to 12. Likert scoring accords 0, 1, 2, and 3 for “Not at all,” “No more than usual,” “Rather more than usual,” and “Much more than usual,” respectively. Totals span 0 to 36. Although GHQ scoring is generally used in epidemiology, Banks et al. (1980) found Likert scoring more appropriate for parametric analysis. We use Likert scoring.

Figures 3(1) and (2) present distributions of GHQ-12 scores from our observations. In Figure 3(1), distributions span 0 to 36, indicating widely varying degrees of mental health among respondents. Figure 3(2) shows distributions by age group and sex. Medians for all groups are substantially identical, but the distribution widens for males and narrows for females in older age groups.

Figures 4(1)–(3) show changes GHQ-12 for two consecutive years. Figure 4(1) indicates that samples are generally distributed around 0, implying that mental health among a certain amount of workers is stable. However, a number of workers reported changes within two years. Figure 4(2) is a scatter diagram relating mental health in the current and previous years. If respondents’ mental health did not vary significantly for two years, responses cluster around the solid 45° line. However, many observations cluster around its upper or lower segment, indicating changes in self-reported mental health for the same respondents within two years.⁹ Figure 4(3) shows changes in the

⁹ Whiteford et al. (2012) report that among adult samples recruited from primary care settings, 23% of cases of untreated depression remit within three months, 32% within six months, and 53% within 12 months. This finding indicates that the degrees of mental health fluctuate widely over time.

degree of mental health by age group and sex. Basic data for the analysis appear in Table 1.

Note that this study does not survey workers who are required extended sick leave or needs to quit their jobs because of mental illness. Rather, we examine to what extent the level of mental health changes for workers in general and identify whether there are any work-related causes for mental health detriment.¹⁰

IV. Mental health, hours worked, and job and workplace characteristics

1. Empirical specification and initial results

This section identifies major work-related impairments to mental health by estimating the following equation:

$$MH_{it} = \beta_0 + \beta_1 L_{it} + \mathbf{X}_{it} \boldsymbol{\delta} + f_i + v_{it}, \quad (1)$$

where MH_{it} is the mental health of worker i in year t , L_{it} is the number of hours worked, \mathbf{X}_{it} is a vector of control variables including job characteristics and workplace-related information, f_i is unobservable heterogeneity among individual respondents, and v_{it} is the error term.

Table 2 reports initial results. The dependent variable is GHQ-12 scores. Explanatory variables are the number of weekly hours worked, hourly wage, individual characteristics (sex, age, education, tenure, marriage dummy, number of children, status as an exempt employee, and occupation dummies), information regarding job characteristics, evaluation at workplace, workplace atmosphere, and work-related specific events occurred within a year.

¹⁰ Using Probit model, we checked in advance whether there exists attrition biases by respondents who reported impaired mental health in previous years dropped out of the survey. The dependent variable was a dummy that takes 1 for respondents who continued to respond in the survey next year and 0 for respondents who has been dropped out from the survey. The explanatory variables included each respondent's self-reported mental health of the previous year. Probit estimation denies the likelihood that respondents who dropped out from the survey tended to suffer from impaired mental health in the previous year.

Columns (1)–(3) show results using only hours worked, hourly wage, and personal characteristics. The columns (1)–(3) show results from OLS, fixed-effects and random-effects models respectively. Column (4) includes information about job characteristics, workplace evaluation, and atmosphere as explanatory variables. Column (5) adds other work-related events occurred within a year. Among Columns (1)–(3), the random-effects model (column (3)) is chosen by the Hausman test. When we added explanatory variables in columns (4) and (5), the fixed-effects model was chosen, therefore we showed only its results.

The first row of Table 2 reveals that number of hours worked is positive at 1% statistical significance irrespective of other control variables. These results are confirmed even after controlling for respondents' fixed effects (columns (4) and (5)). This indicates that working long hours erodes respondents' mental health even after controlling for individual fixed effects. For reference, we distinguish paid and unpaid overtime hours per week and put both information instead of total weekly work hours. The result is shown in column (6). We interpret that the coefficient of the number of paid overtime hours reflect the *net* effect on mental health from extra work hours; working long hours enables a worker to consume more while reduces his/her time of leisure, therefore it would affect his/her mental health both in good and bad ways. On the other hand, the number of unpaid overtime hours directly reflects the disutility (i.e., the deterioration of mental health) by reducing the worker's leisure. Looking at column (6), both paid and unpaid hours are statistically significant and the coefficient of unpaid overtime is larger than paid overtime, which accord with our interpretation.

Other than work hours, our results indicate that job characteristics and workplace atmosphere also affect workers' mental health. When a worker's job is assigned to clear job description and when a worker has discretion when carrying out his/her task, the degree of mental health becomes better. Conversely, mental health tends to deteriorate if workers are often assigned unexpected tasks. These findings support Karasek's (1979) job-strain model. In addition, we also incorporated information on workplace atmosphere by asking respondents whether they find it

difficult to leave while other colleagues remain in the office even after his/her completed its own tasks. Estimation results show that such an atmosphere adversely affects their mental health as well.

Estimation results for other work-related events occurring within a year indicate that mental health tends to decline among respondents whose job tasks had changed. We incorporated a cross term for job characteristics and number of hours worked but found no significant result for the cross term.

Using the same explanatory variables, Table 3 shows results of the fixed-effect model by using instrument variables to account for time-variant factors that could cause endogeneity with work hours. Instrument variables are average hours worked by age, occupation, and firm size (aggregate data collected from the *Labour Force Survey*, Statistics Bureau). Since aggregate working hours are less likely to affect individual worker's mental health but likely to affect his/her work hours, these variables can be regarded as valid instruments. Results in Table 3 generally replicate those in Table 2. The coefficient for number of hours worked remains positively significant, confirming that causality runs from overwork to mental health even after controlling for respondents' time-invariant and time-variant factors.

2. Long work hours and mental health

Results in the previous section suggest that, on average, adding work hours erodes respondents' GHQ score by 0.07. However, perhaps the degree of erosion differs with the number of additional hours. For example, mental health of respondents who work 35 hours per week may be unaffected by working an additional hour, yet be significantly eroded by working more than 60 hours. To consider this possibility, we estimate the fixed-effects model by using five-hour interval dummies for work hours. The remaining explanatory variables are same as the one reported in column (5) in Table 2. The result is reported in column (1) in Table 4. The reference group is 35-40 hours per week, which is the typical standard work week for Japanese regular employees. The result shows a non-linear relationship between work hours and workers' mental health in that

the coefficients of work hour groups less than 50 hours are not statistically significant while those of above 50 hours become positively and statistically significant with relatively large coefficients. This finding suggests that although mental health may not deteriorate by working long hours until 50 hours a week, the working excessively long hours above 50 hours certainly erodes workers' mental health. Given this result, 50 hours per week may be regarded as a reference point or threshold to maintain workers' mental health condition.

In column (2) in Table, 4, we incorporated a dummy taking 1 if respondents worked more than 50 hours a week and 0 otherwise, instead of the hour group dummies. Columns (3) and (4) also include a dummy that takes 1 for respondents who worked 50+ hours per week the previous year and a dummy that takes 1 for respondents who worked 50+ hours per week for two consecutive years. These estimations investigate whether the accumulated mental fatigue appears in the data. Columns (3) and (4) confirm no additional significant coefficients for those dummies. The results that variables that intent to capture accumulated mental deterioration did not become significant may have something to do with the fact that we have only used information of work hours on same time points each year, and not included information during the two time points. More specifically, our survey collects information every February, therefore we have no information whether the respondents who answered that he/she workers more than 50 hours a week for two consecutive years at the time of survey have worked such long hours for entire year or just being busy temporarily due to some seasonal factors. More thorough investigation remains for the future.

3. Work-related factors and mental health

Results shown above imply that work-related factors such as hours worked or workplace management considerably affect respondents' mental health even after controlling for unobservable individual heterogeneity. In other words, mental health is subject to several common workplace factors alongside individual factors. Accordingly, we investigated whether the degree of respondents' mental health differs depending on

the presence of coworkers who suffer from bad mental health.

Table 5 shows the regression result by taking the GHQ-12 score as a dependent variable and the explanatory variables appearing in previous tables. In addition, we incorporated variables regarding mental health of respondents' coworkers. More specifically, we asked each respondent three questions: Did your coworker take more than a month of sick leave due to a mental health problem last year? Did your coworker quit due to mental health issues last year? Has the number of workers with mental health issues risen compared to three years ago at your workplace? Since this information was collected only in the third and second waves, sample sizes are smaller than that in other tables.

In Table 5, GHQ scores of respondents who report that colleagues quit due to mental health issues is about one score higher than that among respondents reporting no such incident—other things being equal, including hours worked and job characteristics. We interpret that unobservable workplace factors may erode respondents' mental health as reflected in the resignations of coworkers. OECD (2012) refers to a Swiss study showing that most employers consider a mental health-related problem to be “solved” when the worker in question has been dismissed. However, our findings suggest that worker who left the workplace due to mental health problem is only the tip of the iceberg, and if there is a certain person at the workplace, it should be considered as a proxy variable for the mental health of all workers at the workplace. Since we are not able to identify exactly the unobservable workplace factors, detailed investigation regarding remains for future research.

4. Quantile regression

Lastly, we considered whether the influence of working long hours differs with respondents' self-reported mental health via quantile regression. Estimation results appear in Table 6 where “q25,” “q50,” and “q75” indicate quintiles 0.25, 0.5, and 0.75, respectively.

All the results of 0.25, 0.5, 0.75 quintiles indicate that the coefficients of work

hours are significantly positive, as is the case of mean regressions above. It looks that the coefficients gradually increases as the quintiles get higher, indicating working long hours notably erodes mental health of respondents whose mental health is already troubled. However, the differences in the coefficients are not statistically significant. Looking at Figure 5, in which we plot the coefficients of work hours for every quantiles, we find that the coefficients do not differ beyond the confidence intervals. Therefore, we confirm that the effect of work hours does not depend on the GHQ-12 score and the conditional variance of GHQ-12 score exhibits homoscedasticity.

V. Conclusion

As the number of workers suffering mental disorders rises, speculation increases that overwork is the underlying cause. Even so, previous studies which investigated relation between work hours and mental health were mixed. By examining longitudinal data of Japanese regular workers over four consecutive years, this study reached four conclusions about work-related causes of mental health difficulties.

First, even after controlling for respondents' fixed effects and other characteristics, long work hours emerge as one of the significant causes of declining mental health.

Second, the relationship between work hours and mental health is not linear. Working more than 50 hours per week notably erode mental health of workers. In Japan, in order to being approved for the mental illness of workers' compensation insurance caused by work related factors, the current standard criteria requires workers to prove that he/she worked more than 160 hours of overtime work for the most recent month or more than 120 hours of overtime work per month for the last several consecutive months (Kawahito 2014). Given the fact that standard work week is around 40 hours per week, this means that working more than 80 hours per week (or 70 hours per week for several months) is the official criteria to being approved for the insurance. However, our

results suggest that working less hours such as 50 hours per week already shows the sign of mental health deterioration.

Third, job characteristics (clear job description and discretion in making decisions) and workplace atmosphere influence respondents' mental health significantly even after controlling for number of hours worked. In Japan, many employers believe that work hour is the only factor that needs to be care for, however, our results suggest that other workplace factors are also very important determinants for workers' mental health.

Fourth, when there is someone who suffers from mental illness at workplace, mental health of other workers are also likely to be bad. This result can be interpreted as the presence of a worker with mental illness at workplace is also a sign of mental health deterioration of other workers.

According to Kuroda and Yamamoto (2016), on average, firms introduce more than four firm-level policy measures to cope with workers' mental health problem such as introducing counselor to concerned worker or giving stress check to employees.¹¹ However, those policy measures are not effective to decrease the number of workers who suffer from mental illness. Our findings in this paper suggest that management of work hours as well as proper workplace practices in daily bases would be more necessary and effective to improve employees' mental health.

¹¹ Due to amendment of Industrial Safety and Health Act, from December 2015, establishments with more than 50 employees in Japan must provide their employees a proper stress check and being obliged to care for workers' mental health.

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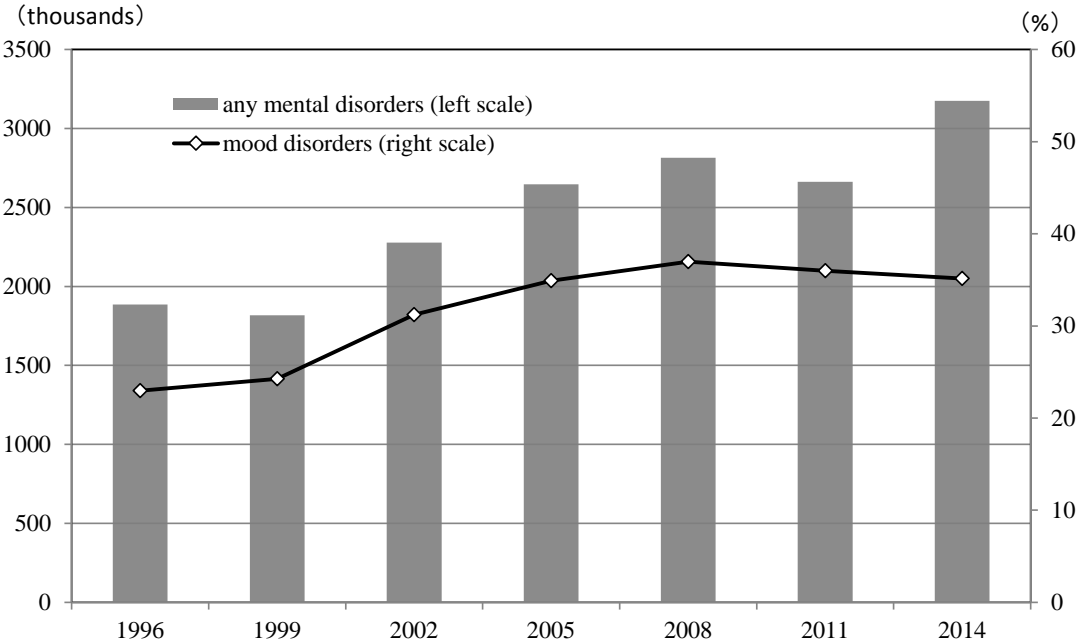
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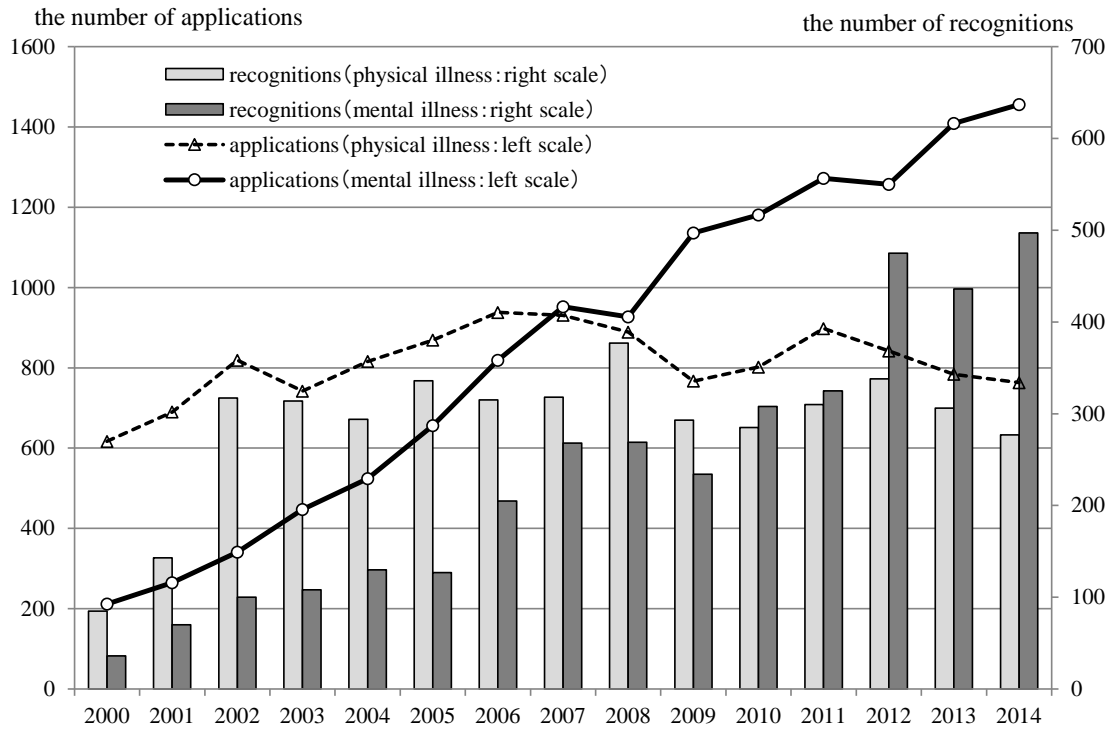
Figure 1. Number of Japanese who Consult Doctors for Mental Health Issues



Source: *Patient Survey*, Ministry of Health, Labor, and Welfare, Japan

Note: For 2011, areas that suffered from the severe damage caused by the Great East Japan Earthquake are excluded from the data.

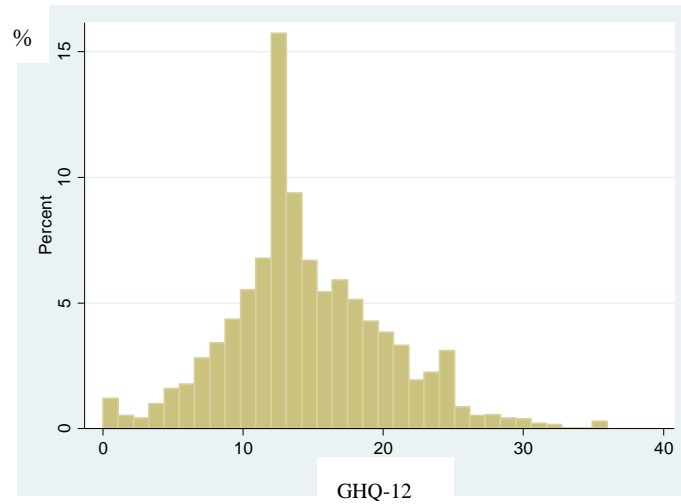
**Figure 2. Workers' Compensation Claims for Physical and Mental Conditions
(Number of Applications & Approved Claims)**



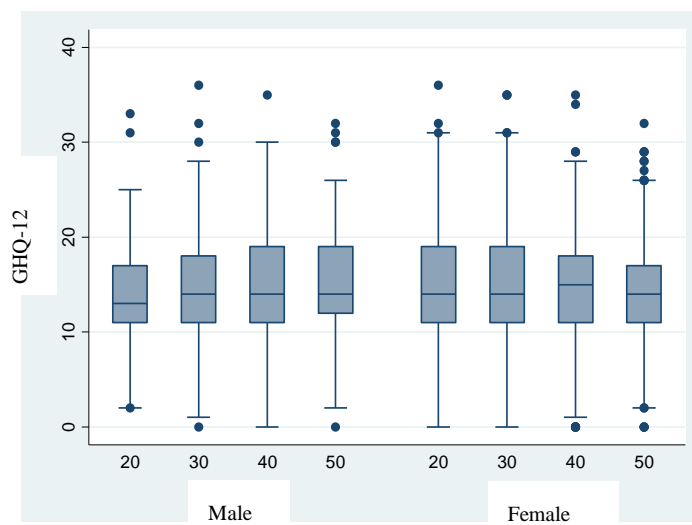
Source: Ministry of Health, Labor, and Welfare

Figure 3. Distributions of GHQ-12 Scores

(1) Histogram



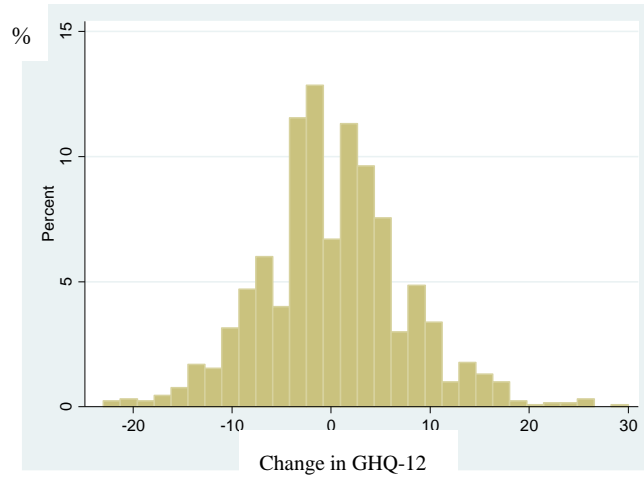
(2) Box diagram by sex and age groups



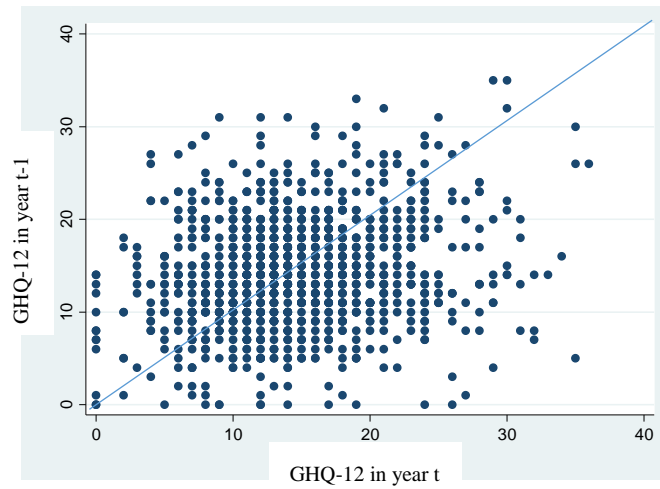
Note) The upper, middle, and lower lines of each box indicate the 25th, 50th, and 75th percentiles of GHQ-12 distribution for each group. Dots indicate outliers. Solid lines above and below each box indicate the maximum and minimum samples excluding outliers.

Figure 4. Distribution of Changes in GHQ-12 Scores over Two Years

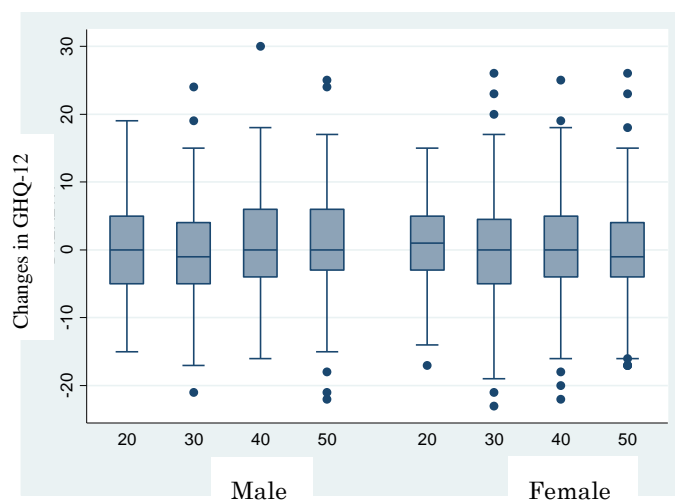
(1) Histogram



(2) Scatter plot of changes in GHQ-12

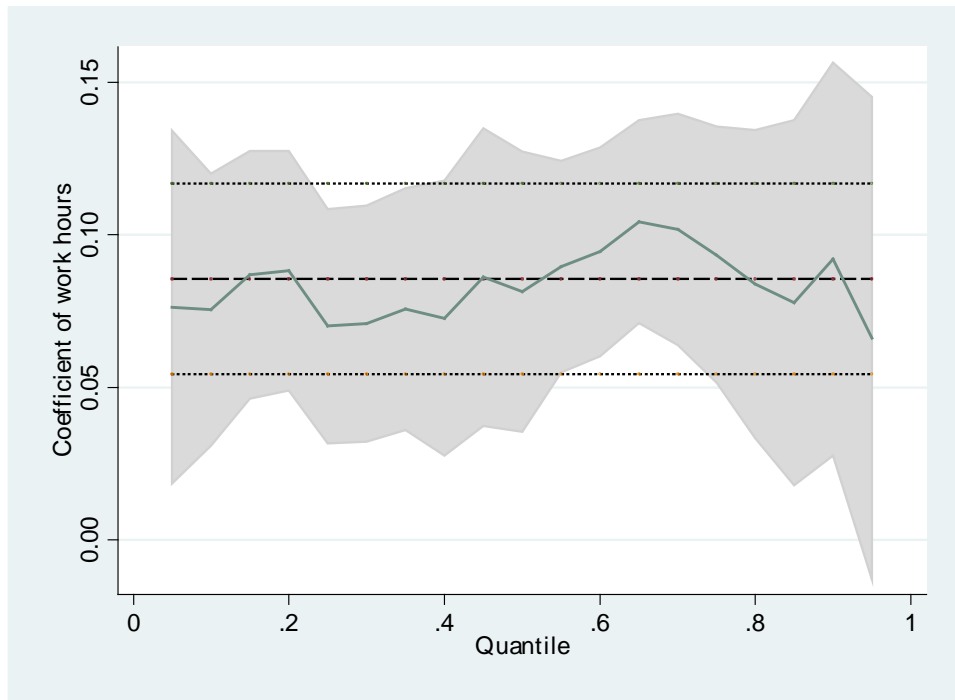


(3) Box diagram by sex and age groups



Note) The upper, middle, and lower lines of each box indicate the 25th, 50th, and 75th percentiles of GHQ-12 distribution for each group. Dots indicate outliers. Solid lines above and below each box indicate maximum and minimum samples excluding outliers.

Figure 5. The Variation in the Coefficients of Work Hours from Quantile Regressions



Note) The dotted horizontal lines represent OLS estimates with 95% confidence intervals. Grey area indicates confidence intervals for the coefficients in each quantile. Graph is made using the 'grqreg' Stata module.

Table 1. Summary Statistics

	Mean	Std. Dev.	Min	Max
GHQ	14.532	5.688	0	36
the number of total hours worked	45.126	7.558	30	90
the number of overtime hours (paid)	2.732	5.197	0	30
the number of overtime hours (unpaid)	2.655	5.241	0	45
hourly wage (10 thousand yen)	0.228	0.110	0.059	0.863
age	43.167	10.130	19	68
male	0.731	0.444	0	1
Occupation				
Specialist/Technician	0.201	0.401	0	1
Management	0.241	0.428	0	1
Clerical	0.396	0.489	0	1
Sales/Marketing	0.025	0.157	0	1
Sale Representative	0.128	0.335	0	1
Service and Others	0.007	0.085	0	1
Exempt	0.399	0.533	0	3
Education (University or upper education=1)	0.530	0.499	0	1
Tenure of Current Job	13.477	9.573	0	46
Married	0.655	0.476	0	1
Child (having a child less than 6 years old=1)	1.020	1.085	0	5
Job Characteristics				
Clarity of Job Description	0.674	0.469	0	1
Discretionary Power	0.818	0.386	0	1
Team Work	0.567	0.496	0	1
Job often faces unexpected task	0.658	0.474	0	1
Workplace Evaluation				
Work overtime and on holidays valued highly	0.161	0.368	0	1
Workplace Environment				
if other people are still in the office, it is difficult to leave	0.227	0.419	0	1
when work long hours or on holiday, late arrival is allowed	0.109	0.311	0	1
Any changes from previous year				
being promoted	0.039	0.194	0	1
being transferred to other department	0.107	0.309	0	1
job task changed	0.274	0.446	0	1
the number of staffs has increased/decreased	0.298	0.458	0	1
boss has changed	0.203	0.403	0	1
Workplace's mental health				
at least one staff at my workplace took sick leaves more than a month due to mental problem last year	0.230	0.421	0	1
at least one staff at my workplace left office due to mental problem last year	0.165	0.371	0	1
the ratio of workers suffer from mental health problem has increased from three years ago	0.171	0.377	0	1
sample sizes		2187		
number of individuals		867		

Note: Information regarding workplace's mental health is only available from the third and fourth waves. The sample sizes are 1568.

Table 2. Work and Mental Health

	(1)	(2)	(3)	(4)	(5)	(6)
the number of total hours worked	0.1296*** (0.0177)	0.1054*** (0.0228)	0.1200*** (0.0179)	0.0797*** (0.0215)	0.0744*** (0.0214)	
the number of overtime hours (paid)						0.0713** (0.0317)
the number of overtime hours (unpaid)						0.0853*** (0.0314)
hourly wage	-0.1360 (1.4120)	-0.8655 (2.3522)	-0.3077 (1.6618)	-0.6756 (2.2167)	-0.6482 (2.2140)	-1.2707 (2.2067)
tenure	0.0207 (0.0143)	-0.0065 (0.0212)	0.0122 (0.0159)	0.0049 (0.0204)	0.0053 (0.0202)	0.0074 (0.0201)
married dummy	-0.8028*** (0.3097)	-1.2273** (0.4906)	-0.8961*** (0.3406)	-1.2282*** (0.4558)	-1.2121*** (0.4573)	-1.1958*** (0.4558)
number of children	-0.2820** (0.1328)	-0.3383 (0.2107)	-0.2817* (0.1468)	-0.2061 (0.2045)	-0.2099 (0.2053)	-0.2163 (0.2056)
exempted	0.2388 (0.3134)	0.5594 (0.3596)	0.3342 (0.3130)	0.5117 (0.3444)	0.4842 (0.3445)	0.4889 (0.3464)
Job characteristics						
a clear job description				-1.2015*** (0.3536)	-1.2008*** (0.3529)	-1.1863*** (0.3554)
a certain amount of discretionary power				-1.6651*** (0.3953)	-1.6707*** (0.3960)	-1.6813*** (0.3967)
job mostly involves team work				-0.5385* (0.2979)	-0.5629* (0.3001)	-0.5765* (0.3001)
faces sudden and urgent task once in a while				0.8472** (0.3325)	0.8502** (0.3311)	0.8722*** (0.3305)
Workplace evaluation						
work overtime is valued highly				0.5585 (0.4493)	0.5842 (0.4493)	0.5780 (0.4508)
Workplace atmosphere						
if other people are still in the office, it is difficult to leave				1.5383*** (0.4324)	1.5728*** (0.4314)	1.5560*** (0.4309)
when work late, next day's late attendance is allowed				0.1433 (0.5015)	0.1328 (0.4946)	0.1248 (0.4933)
Any changes from previous year						
being promoted					1.0917 (0.8282)	1.0494 (0.8268)
being transferred to other department					-0.8206 (0.6638)	-0.8319 (0.6648)
job task changed					0.7802** (0.3758)	0.7855** (0.3764)
the number of staffs has increased/decreased					-0.1979 (0.3247)	-0.1806 (0.3238)
boss has changed					0.6280 (0.4122)	0.6208 (0.4086)
R2	0.0459	0.0086	0.0451	0.0593	0.1295	0.1287
sample sizes	2187	2187	2187	2187	2187	2187
model type	OLS	FE	RE	FE	FE	FE
F-test (Prob > F)	0.000			0.000	0.000	0.000
hausman test (Prob > chi2)	0.1556			0.012	0.0379	0.0553

Notes: 1. Numbers in parentheses are robust standard errors.

2. ***, **, and * indicate statistical significance at 1%, 5%, and 10%.

3. Estimation also includes sex, age, education, and occupation dummies.

4. FE and RE indicate fixed- and random-effects models, respectively.

Table 3. Work and Mental Health (fixed IV estimation)

	(1)	(2)
the number of hours worked	0.8164**	0.7559**
	(0.3495)	(0.3496)
hourly wage	-2.5691	-2.4062
	(2.1464)	(2.1391)
tenure	0.0088	0.0090
	(0.0201)	(0.0200)
married dummy	-1.1383**	-1.1273**
	(0.4543)	(0.4557)
number of children	-0.1963	-0.2010
	(0.2069)	(0.2075)
exempted	0.5142	0.4885
	(0.3433)	(0.3435)
Job characteristics		
a clear job description	-1.2526***	-1.2491***
	(0.3565)	(0.3554)
a certain amount of discretionary power	-1.7273***	-1.7307***
	(0.3940)	(0.3944)
job mostly involves team work	-0.5353*	-0.5634*
	(0.2989)	(0.3011)
faces sudden and urgent task once in a while	1.0311***	1.0218***
	(0.3290)	(0.3277)
Workplace evaluation		
work overtime is valued highly	0.5934	0.6207
	(0.4570)	(0.4552)
Workplace atmosphere		
if other people are still in the office, it is difficult to leave	1.6205***	1.6480***
	(0.4371)	(0.4358)
when work late, next day's late attendance is allowed	0.1546	0.1410
	(0.5027)	(0.4953)
Any changes from previous year		
being promoted		1.0670
		(0.8437)
being transferred to other department		-0.8373
		(0.6619)
job task changed		0.8054**
		(0.3786)
the number of staffs has increased/decreased		-0.1934
		(0.3264)
boss has changed		0.7282*
		(0.4137)
R2	0.0298	0.1052
sample sizes	2187	2187
F-test (Prob > F)	0.000	0.000
hausman test (Prob>chi2)	0.0047	0.0277

Notes: 1. Numbers in parentheses are robust standard errors.

2. ***, **, and * indicate statistical significance at 1%, 5%, and 10%.

3. Estimation also includes sex, age, education, and occupation dummies.

4. Instrument variables are average hours worked by age, occupation, firm size, and year dummies (aggregate data reported in *Labour Force Survey*, Statistics Bureau).

Table 4. Excessively Long Work Hours and Mental Health

	(1)	(2)	(3)	(4)
below 35 hours (base=35-40 hours per week)	-0.4470 (1.3790)			
40-45 hours	0.2242 (0.3368)			
45-50 hours	0.6526 (0.4475)			
50-55 hours	1.0991* (0.5648)			
55-60 hours	1.6542** (0.7386)			
60 hours and above	2.2900*** (0.7661)			
more than 50 hours		1.0673*** (0.3599)	1.0995*** (0.3831)	1.0315*** (0.3648)
more than 50 hours in previous year			0.1035 (0.3942)	
more than 50 hours in two consecutive years				0.4512 (0.6740)
any changes from previous year	yes	yes	yes	yes
job characteristics + workplace infos	yes	yes	yes	yes
R2	0.1318	0.1243	0.1238	0.1237
sample sizes	2187	2187	2187	2187
F-test (Prob > F)	0.000	0.000	0.000	0.000
hausman test (Prob>chi2)	0.082	0.0451	0.0459	0.0613

- Notes:
1. Numbers in parentheses are robust standard errors.
 2. ***, **, and * indicate statistical significance at 1%, 5%, and 10%.
 3. Estimation also includes sex, age, education, and occupation dummies.
 4. Results in Columns (1)–(4) are obtained by fixed-effects estimation.

Table 5. Work and Mental Health (with Workplace Mental Health Data)

	(1)	(2)	(3)	(4)
the number of hours worked	0.0687** (0.0319)	0.0749** (0.0316)	0.0679** (0.0317)	0.0753** (0.0318)
Job characteristics				
a clear job description	-1.1232** (0.5446)	-1.1804** (0.5409)	-1.1514** (0.5382)	-1.1337** (0.5470)
a certain amount of discretionary power	-1.6274*** (0.6201)	-1.6371*** (0.6145)	-1.6431*** (0.6109)	-1.6283*** (0.6223)
job mostly involves team work	-0.3478 (0.4504)	-0.4200 (0.4470)	-0.4132 (0.4484)	-0.3602 (0.4468)
faces sudden and urgent task once in a while	1.1183** (0.5182)	1.0720** (0.5129)	1.0672** (0.5140)	1.1225** (0.5156)
Workplace evaluation				
work overtime is valued highly	0.3824 (0.6017)	0.4843 (0.6081)	0.3885 (0.5980)	0.4653 (0.6104)
Workplace atmosphere				
if other people are still in the office, it is difficult to leave	2.2671*** (0.6464)	2.2946*** (0.6436)	2.2739*** (0.6355)	2.2750*** (0.6361)
when work late, next day's late attendance is allowed	0.4219 (0.7667)	0.3913 (0.7502)	0.4273 (0.7522)	0.4077 (0.7616)
Workplace's mental health				
at least one staff at my workplace took sick leaves more than a month due to mental problem last year	-0.0202 (0.5813)	-0.0829 (0.5692)		
at least one staff at my workplace left office due to mental problem last year	0.9633* (0.4957)		0.9704** (0.4756)	
the ratio of workers suffer from mental health problem has increased from three years ago	0.0612 (0.6002)			0.1918 (0.5600)
R2	0.0598	0.0633	0.0648	0.0591
sample sizes	1462	1462	1462	1462
F-test (Prob > F)	0.000	0.000	0.000	0.000
hausman test (Prob>chi2)	0.0487	0.0591	0.0418	0.0601

Notes: 1. Numbers in parentheses are robust standard errors.

2. ***, **, and * indicate statistical significance at 1%, 5%, and 10%.

3. Estimation also includes hourly wage, tenure, experience, exempted, sex, age, education, occupation, spouse, and child dummies as well as information about changes from the previous year.

4. Results in Columns (1)–(4) are obtained by fixed-effects estimation.

Table 6. Coefficients of number of work hours (Quantile Regression)

	(1) q25	(2) q50	(3) q75	sample sizes
all samples (without year dummies)	0.0815*** (0.0223)	0.0847*** (0.0213)	0.0957*** (0.0247)	2187
all samples (with year dummies)	0.0701*** (0.0205)	0.0814*** (0.0196)	0.0934*** (0.0216)	2187
males	0.0743*** (0.0214)	0.0656*** (0.0242)	0.0925*** (0.0248)	1598
females	0.1733*** (0.0420)	0.1172*** (0.0447)	0.1500*** (0.0540)	589
age under 40	0.0627** (0.0293)	0.0879** (0.0351)	0.0821** (0.0352)	842
age above 40	0.1000*** (0.0338)	0.1029*** (0.0255)	0.0825*** (0.0298)	1345

Notes: 1. Numbers in parentheses are robust standard errors.

2. ***, and ** indicate statistical significance at 1% and 5%.

3. Independent variable is GHQ12. Explanatory variables also includes sex, age, education, occupation dummies, job characteristics, workplace information, other work related information regarding any changes from previous year.