

Association between long work hours and depressive state: a pilot study of propensity score matched Japanese white-collar workers

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Abstract: Although long work hours have been associated with various physical health problems, studies of their association with mental health have yielded inconsistent results, due to differences in study settings, study outcome and/or unmeasured background factors. In this study, we used a propensity score method to evaluate the association between work hours and depressive state. A total of 467 Japanese white-collar workers were surveyed and divided into long and regular work hour groups according to overtime work records. Propensity score matching was performed based on 32 individual background and workplace factors, yielding 74 pairs of propensity-matched subjects. CES-D score, an indicator of depressive state, did not differ significantly among the two groups ($p=0.203$). However, work motivation, work control, social support and emotional stability correlated with CES-D score. These findings suggest that work control and social support factors are more associated with depressive state than control of work hours. These results also suggest that it is possible to use propensity score matching to evaluate the association between work hours and mental health in occupational study settings. Further studies, in larger populations, are required to determine the association between work hours and mental health parameters.

Key words: Long work hours, Mental health, Depressive state, Propensity score, Occupational health

Introduction

Long work hours have been associated with various health problems. Many observational epidemiological studies have shown associations between long work hours and the incidence of physical disorders, including cardiovascular disease^{1, 2)} hypertension³⁾, and patient mortality⁴⁾. In contrast, other studies have not shown a consistent association between long work hours and mental health disorders⁵⁾, because of confounding background factors⁶⁾,

such as personality⁷⁾, or unmeasured factors.

A recent review article examined the association between long work hours and mental health, especially depressive state, and reported significant associations⁸⁾. However, the evidence has limitations due to factors of self-reported work time, evaluation of extremely long work hours, and significance of association shown in only subgroup analysis, therefore, further studies are required including a wide variety of study settings.

Accurate research methods, yielding consistent results, are required to assess whether long work hours affect subjects' mental health. In general, intervention study methods, including randomized controlled trials (RCTs), are considered superior in evaluating factors to which subject are exposed. Randomization is a reliable method to

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create homogenous comparison groups and reduce the risk of confounding variables. However, subjects cannot be randomized by number of work hours, and interventional study methods are difficult to use in occupational health. Moreover, for ethical reasons, subjects cannot be randomly assigned to longer work hours.

Propensity score matching is often used in clinical research instead of RCT. Propensity scores in individuals are calculated based on various individual background factors obtained from observational studies and expressed as one dimensional scores^{9, 10}. Because propensity score is regarded as one factor associated with the probability of assignment to a group within a study, the selection of matched pairs is considered useful. This pilot study evaluated the association between long work hours and depressive state in propensity score matched groups of Japanese white-collar workers.

Subjects and Methods

Study subjects

Our previous cross-sectional study, performed in 2012, evaluated the association between personality factors and long work hours in Japanese white collar workers⁷. Data from that study were re-evaluated to assess the association between long work hours and depressive state. In brief, questionnaires were distributed to 467 workers in the service industry. The questionnaire was constructed according to previous studies, and some questions were added after evaluation of validity⁷. The questionnaire included questions on 14 individual background factors (age, sex, educational level, BMI, hours of sleep per night, alcohol drinking, smoking, physical exercise, hobbies, meal times, meal balance, current illnesses, marital status and stress at home), 10 occupational factors (occupational position, commuting time, taking paid holiday, stopping work, going home during work, fear of boss, work motivation, work purpose, success motivation and gratitude for employment), five personality factors (extraversion, agreeableness, conscientiousness, emotional stability and openness) and three job-strain factors model (job demand, decision latitude and social support)⁷. Depressive state was evaluated using CES-D test and raw score was used as an objective variable.

Working hours were obtained from subjects' records at their place of employment. The regular working time for all subjects was from 08:30 to 17:15 five days a week, with no day-night shifts or flexi-time system. We defined over 45 h overtime work as long work hours for

the following two reasons. First, in Japan, both employer and employee must agree that overtime work is necessary and overtime work should not be beyond 45 h per month. Therefore, 45 h overtime work is regarded as the maximum permissible in normal circumstances. Second, adverse health effects due to overtime work are believed to occur if overtime is worked beyond 45 h per month according to several epidemiological studies. Therefore, subjects were assigned to the long work hour group if they had worked ≥ 45 h overtime per month at least once during the previous 12 months; all others were assigned to the regular work hour group. After excluding subjects with insufficient answers or missing data, 267 workers (57.2%) were analyzed.

Propensity score

Propensity score is a mathematical analysis method representing the probability of assignment to a defined group^{9, 10}. This score is calculated based on individual background factors acquired by observational study, and is expressed as a number from 0.0 to 1.0. Subjects in different groups with similar scores can be regarded as matched pairs. Because confounders or biasing factors can be adjusted between matched pairs, the results of these studies are regarded to have similar validity and reliability as those of RCTs. In this study, propensity scores were calculated using MatchIt package R software¹¹. Subjects were classified as working long or regular hours, and all 32 individual background factors were used as matching covariates to calculate propensity scores. Subjects in the two groups with similar propensity scores were matched 1:1 using the neighbor matching method. Then, to confirm the validation of assignment after matching, the balance level was evaluated (Table 1). In general, assignment bias is discounted if the absolute balance level is below 0.1^{10, 12}. In the present study, although five factors (BMI, meal-times, paid holiday, decision latitude and extraversion) showed slightly above 0.1, all of the other factors were below. Thus, we regard the assignment to be valid.

Statistical analysis

Because CES-D scores were not distributed normally, the Wilcoxon signed rank test was used for comparisons between matched groups. Spearman's test was used for correlation analysis. R software (ver. 3.3.0) was used for all statistical analyses, with $p < 0.05$ regarded as statistically significant.

Table 1. Improvement of balance level between groups after matching

Factors	Before matching	After matching
Age	-0.2299	-0.0405
Sex	-0.3112	-0.0811
BMI	0.1864	0.1081
Sleep hours	0.0700	0.0541
Drinking	-0.0352	-0.0676
Smoking	0.0119	0.0135
Exercise	0.0274	0.0811
Hobbies	-0.0188	0.0135
Meal times	0.1739	0.1081
Meal balance	0.0529	0.0135
Illness	-0.1041	-0.0405
Marriage	0.1351	0.0270
Home stress	-0.0289	-0.0135
Occupational position	-0.6617	-0.0270
Commuting time	-0.0499	0.0000
Educational level	-0.1024	0.0270
Paid holiday	0.2509	0.1351
Stopping work	0.1632	0.0676
Going home	0.1076	0.0541
Fear of boss	0.1804	0.0541
Work motivation	0.0306	-0.0135
Work purpose	0.0567	0.0270
Success motivation	-0.0193	0.0000
Gratitude	-0.0629	-0.0405
Job demand	0.1942	0.0270
Decision latitude	0.0939	0.1081
Social support	0.0995	0.0811
Extraversion	-0.2675	-0.1622
Agreeableness	-0.1751	-0.0676
Conscientiousness	-0.1357	0.0000
Emotional stability	-0.2197	-0.0676
Openness	-0.0765	0.0270

Table 2. Characteristics of study subjects

Factors	Subjects (n=267)	
Sex	Male	142
	Female	125
Age	Average	40.3 ± 10.0
	20–29	35
	30–39	102
	40–49	76
	≥50	54
Long work hours	Yes	74
	No	193
CES-D score	Average	14.1 ± 8.3
	0–15	172
	16–60	95

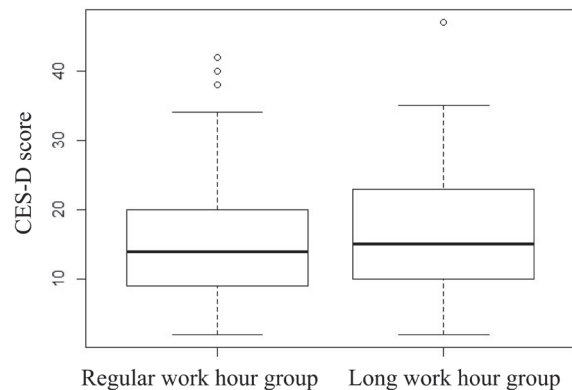


Fig. 1. CES-D scores in the propensity-matched groups of subjects with long and regular work hours. The Wilcoxon signed rank test showed no significant difference in CES-D scores between these two groups ($p=0.203$).

Ethics

The study objectives and information were shown at the top of each questionnaire and written informed consent was obtained from all participants. The study design and procedure was reviewed and approved by the committee for Medical Ethics of Shinshu University (approval number 1790).

Results

The 267 study subjects included 142 men and 125 women, of mean age 40.3 ± 10.0 yr (Table 2). Their mean CES-D score was 14.1 ± 8.3 and the most frequent score was 12. Of these subjects, 74 were assigned to the long work

hours group and 193 to the regular work hours group. Propensity score matching yielded 74 pairs of subjects, with no significant difference in CES-D score between the propensity matched groups ($p=0.203$) (Fig. 1).

We also assessed the correlations between individual background factors and CES-D scores in the 148 matched subjects. We found that low work motivation ($\rho=0.307$), low job control ($\rho=0.463$), low social support ($\rho=0.380$) and low emotional stability ($\rho=0.400$) were correlated with higher CES-D scores, whereas all other factors had coefficients below 0.3, indicating a lack of correlation.

Discussion

This pilot study compared CES-D scores in propensity matched subjects with long work hours and regular work hours, but found no significant difference between these

two groups. However, we found that CES-D scores correlated with several factors associated with work and personality.

Previous studies have evaluated associations between long work hours and workers' mental health^{5, 6, 8}), but the evidence is inconsistent. Our previous epidemiological study suggested that long work hours may affect health both directly, by inducing health disorders, and indirectly, by interactions with factors associated with work and/or personality⁷). Because long work hours have been reported to be associated with work load¹³), occupational position¹⁴), immersion¹⁵) and type A personality¹⁶), we investigated associations between several individual background factors and long work hours. In the present study, we focused on the association between long work hours and depressive state, and all other factors examined were used for adjustment. We found no significant difference between the two groups of workers. Because long work hours is a complex factor, it should not be regarded only as an independent variable. Further longitudinal studies are necessary to understand the relationship between long work hours and mental health.

Several recent laws in Japan have attempted to reduce the number of hours worked, and other measures are pending¹⁷). These measures are important in maintaining workers' health and ensuring quality of life. However, if long work hours do not directly affect workers' mental health, policies designed to reduce the number of hours worked will have little effect on workers' mental health. Moreover, reducing the number of hours worked may intensify workloads, making workers busier while on the job. This pilot study showed that work motivation, job control, social support and emotional stability are key factors associated with depressive state. These results suggest that work purpose, control over the job and strong relationships among workers may be more important than the number of hours worked for workers' mental health. Therefore, we believe that not only limiting work hours but promoting the above factors will make a better work place environment in the future.

This study had several limitations. First, because this was a pilot study, subjects were limited to white-collar workers from a single organization and the response rate was only around half of those surveyed. This may limit interpretation of the study results and their generalizability to all workers. Workers from a wider variety of occupations and a larger sample size are required in a future study to counter these limitations. Second, extremely long work hours could not be evaluated. In this study, the number of subjects with longer work hours was small. We checked

the number of hours worked across workers using histograms and found that 193 workers (72%) never worked 45 overtime hours per month during the year. Also, we found that only 9 (3%) workers worked over 45 overtime hours every month during the year. If we used a greater number of hours as the long overtime work threshold, analysis of the results might have been restricted. Therefore, we used a threshold of relatively moderate overtime work hours. We supposed that this organization had few long overtime workers, therefore, the study result may not be generalized to companies with many long overtime workers. However, many Japanese white-collar workers work moderately long hours, therefore, the subjects in this study may be representative of the majority of current Japanese workers. Third, because we used many qualitative yes/no questions⁷), quantitative evaluations could not be performed, thereby limiting the interpretation of our results. More detailed questions should be employed in a future study. Fourth, the present study focused on depressive state and applied the CES-D score. To understand any association between work hours and mental health more broadly, further mental health scales should be evaluated.

In conclusion, we used a propensity-matched scoring method to evaluate an association between depressive state and long work hours in Japanese white-collar workers. However, we found no significant association. Efforts to avoid depressive state in workers should include not only limiting the number of work hours but other worker support factors. Longitudinal studies involving larger numbers of subjects are needed.

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Conflict of Interest

None to declare.

References

- 1) Sokejima S, Kagamimori S (1998) Working hours as a risk factor for acute myocardial infarction in Japan: case-control study. *BMJ* **317**, 775–80.
- 2) Virtanen M, Ferrie JE, Singh-Manoux A, Shipley MJ, Vahtera J, Marmot MG, Kivimäki M (2010) Overtime work and incident coronary heart disease: the Whitehall II prospective cohort study. *Eur Heart J* **31**, 1737–44.
- 3) Hayashi T, Kobayashi Y, Yamaoka K, Yano E (1996) Effect

- of overtime work on 24-hour ambulatory blood pressure. *J Occup Environ Med* **38**, 1007–11.
- 4) Nylén L, Voss M, Floderus B (2001) Mortality among women and men relative to unemployment, part time work, overtime work, and extra work: a study based on data from the Swedish twin registry. *Occup Environ Med* **58**, 52–7.
 - 5) Fujino Y, Horie S, Hoshuyama T, Tsutsui T, Tanaka Y (2006) [A systematic review of working hours and mental health burden]. *Sangyo Eiseigaku Zasshi* **48**, 87–97 (in Japanese).
 - 6) Shima S (2008) Overwork and mental health focusing on long working hours. *Occup Health Rev* **20**, 161–73.
 - 7) Uchida M, Kaneko M, Kawa S (2014) Effects of personality on overtime work: a cross-sectional pilot study among Japanese white-collar workers. *BMC Res Notes* **7**, 180.
 - 8) Bannai A, Tamakoshi A (2014) The association between long working hours and health: a systematic review of epidemiological evidence. *Scand J Work Environ Health* **40**, 5–18.
 - 9) Rosenbaum P, Rubin D (1983) The central role of the propensity score in observational studies for causal effects. *Biometrika* **70**, 41–55.
 - 10) Austin PC (2011) An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behav Res* **46**, 399–424.
 - 11) Randolph J, Falbe K, Manuel A, Balloun J (2014) A step-by-step guide to propensity score matching in R. *Pract Assess, Res Eval* **19**, 1–6.
 - 12) Normand ST, Landrum MB, Guadagnoli E, Ayanian JZ, Ryan TJ, Cleary PD, McNeil BJ (2001) Validating recommendations for coronary angiography following acute myocardial infarction in the elderly: a matched analysis using propensity scores. *J Clin Epidemiol* **54**, 387–98.
 - 13) Shimomitsu T, Levi L (1992) Recent working life changes in Japan. *Eur J Public Health* **2**, 76–86.
 - 14) Brett JM, Stroh LK (2003) Working 61 plus hours a week: why do managers do it? *J Appl Psychol* **88**, 67–78.
 - 15) Beckers DG, van der Linden D, Smulders PG, Kompier MA, van Veldhoven MJ, van Yperen NW (2004) Working overtime hours: relations with fatigue, work motivation, and the quality of work. *J Occup Environ Med* **46**, 1282–9.
 - 16) Rhoads JM (1977) Overwork. *JAMA* **237**, 2615–8.
 - 17) Ministry of health Labour and Welfare. A measure to decrease long work hours. <http://www.mhlw.go.jp/kinkyu/151106.html>. Accessed July 1, 2017.

Appendix 1. Histograms of overtime work among workers. Most of workers showed no or moderate overtime work hours.

