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Cross-sectional Internet-based survey of Japanese permanent daytime workers' sleep and daily rest periods

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Abstract: Objectives: This study aimed to describe the sleep quantity, sleep quality, and daily rest periods (DRPs) of Japanese permanent daytime workers. **Methods:** Information about the usual DRP, sleep quantity, and sleep quality (Japanese version of the Pittsburgh Sleep Quality Index: PSQI-J) of 3,867 permanent daytime workers in Japan was gathered through an Internet-based survey. This information was analyzed and divided into the following eight DRP groups: <10, 10, 11, 12, 13, 14, 15, and ≥16 h. **Results:** The sleep durations for workers in the <10, 10, 11, 12, 13, 14, 15, and ≥16 h DRP groups were found to be 5.3, 5.9, 6.1, 6.3, 6.5, 6.7, 6.7, and 6.9 h, respectively. The trend analysis revealed a significant linear trend as the shorter the DRP, the shorter was the sleep duration. The PSQI-J scores for the <10, 10, 11, 12, 13, 14, 15, and ≥16 h DRP groups were 7.1, 6.7, 6.7, 6.3, 6.0 (5.999), 5.6, 5.2, and 5.2, respectively. The trend analysis revealed a significant linear trend as the shorter the DRP, the lower was the sleep quality. **Conclusions:** This study described sleep quantity, sleep quality, and DRP in Japanese daytime workers. It was found that a shorter DRP was associated with poorer sleep quantity as well as quality.
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Introduction

Working for long hours causes adverse health effects[1,2]. Japan indicated the longest paid working hours among all the 26 member countries of the Organization for Economic Co-operation and Development[3]. Measures are necessary to prevent long working hours in Japan.

Daily rest period (DRP) is an interval between the end of one workday and the beginning of the following workday. Sufficient DRP is necessary to prevent long working hours. The European Union's (EU's) working time directive states that EU workers have the right to take "a minimum DRP of 11 consecutive hours every 24 hours."[4] Although, to our knowledge, there was no scientific basis that EU has defined DRP as more than 11 h, this interval is expected to directly secure the minimum acceptable consecutive rest time and indirectly limit working hours in a day for improved workers' health. According to a survey by the Ministry of Health, Labour and Welfare Japan, only 2.2% of 1,743 Japanese companies introduced an interval system[5]. The Japanese government encourages the introduction of the interval system[6].

DRP contains sleep duration, leisure time, and commuting time. Among them, it is well known that adequate amount of sleep is needed to recover from work, with poor sleep quantity and quality being found to be associated with several health problems such as stroke[7], coronary heart disease[8], depression[9], and death[10]. However, little is known about the relation between DRP, sleep quantity, and sleep quality in not only the EU but also Japan. Ikeda et al.[11] categorized 54 Japanese daytime employees at an information technology (IT) company into long and short DRP groups of 12, 13, and 14 h and compared them in order to find the differences. The results

showed that a short sleep duration and poorer sleep quality were found in the short DRP group compared with the longer DRP groups for the 12 h DRP criteria; however, no differences were found between the 13 and 14 h DRP groups; however, sleep duration and quality for the 11 h DRP groups could not be compared because of the small sample size. Further, as this study focused only on IT workers, the results could not be generalized to the wider business community. Therefore, the actual relation between DRP and sleep duration and quality in Japanese daytime workers is unclear.

The aim of this study was to describe DRP and sleep quantity/quality of Japanese permanent daytime workers. We hypothesized that workers with a longer DRP had longer sleep duration and better sleep quality.

Subjects and Methods

Survey and Sample

An Internet survey was conducted in Japan in November 2016. Data were collected through an Internet-based investigation through a research company that randomly sent e-mail participation requests to workers enrolled by the research company. The workers then accessed the web site URL attached to the e-mail and completed the survey, and all of them received reward points from the company. The first 10,000 workers (age range: 20-64 years) who adapted the sample population selection that was based on a composition ratio of sex, age group (20-29, 30-39, 40-49, 50-59, and 60-64 years), and major industry (16 industry types) as reported in the Labour Force Survey were recruited; this survey is conducted every month by the Statistics Bureau, Ministry of Internal Affairs and Communications, Japan, to elucidate the current state of employment and unemployment. Employee types are as follows: self-employed, family worker, or employee (permanent worker, part-time worker, dispatched worker, contract employee, entrusted employee, and other). According to the Labour Force Survey, the 16 industry types are as follows: 1: agriculture and forestry; 2: construction; 3: manufacturing; 4: information and communications; 5: transport and postal activities; 6: wholesale and retail trade; 7: finance and insurance; 8: real estate and goods rental and leasing; 9: scientific research and professional and technical services; 10: accommodations and eating and drinking services; 11: living-related and personal services and amusement services; 12: education and learning support; 13: medical, health care, and welfare; 14: compound services; 15: services, not elsewhere classified; 16: government, except elsewhere classified.

As the present study was focused on the relation between DRP and sleep in permanent daytime workers, nighttime shift workers (n=1,946) were excluded. Non-permanent workers such as part-time workers, dispatch workers, contract employees, and entrusted employees (n=3,126) were also excluded as the working style for non-permanent workers is diverse and could potentially have caused wider DRP and sleep duration distributions. Workers who had clearly different patterns from daytime workers and did not meet the following conditions were also excluded (n=1,061), for example, beginning of work between 5:00 am and 11:59 am, end of work between 3:00 pm and 4:59 am, bedtime between 9:00 pm and 3:00 am, waking time between 3:01 am and 9:59 am, a DRP longer than sleep duration, and a leisure time and round-trip commute time ≥0 min. The final sample, therefore, comprised 3,867 permanent daytime workers.

All participants provided web-based informed consent, and this study was approved by the Research Ethics Committee of the National Institute of Occupational Safety and Health, Japan.

Measures

The demographic data collected were sex, age (years), employment type [permanent worker, part-time worker, dispatched worker, contract employee, entrusted employee, and other], presence or absence of midnight shift, industry type (16 types), smoking status (0 = current smoker, 1 = non-smoker or ex-smoker), alcohol frequency (1 = almost never, 2 = 1-2 days/week, 3 = 3-5 days/week, and 4 = more than 6 days/week), job tenure (years), and years of experience (years).

The workers' living activity-time questionnaire (JNIOSH-WLAQ)[12] was used to gather information about the average DRP, sleep durations, leisure times, and round-trip commute times during the previous month. The questionnaire asked about the average in the previous month for bedtime of the previous work day, waking time on work days, and presence or absence of the need to commute; if commuting, the beginning and end times of the commute and the work end time; and if not commuting, the work beginning and end times. DRP was calculated as the interval from the "end of working hours" to the "beginning of working hours (no commute)" or "end time after the commute (commute)." Sleep duration was calculated from "bedtime of the previous work day" to the following "waking time on workdays." The commute time for commuting participants was the duration from the "beginning time of the commute" in the mornings to the "end time of the commute" in the evening; the commute time for participants who did not commute was set at 0 h. Leisure time was calculated as the time remaining after sleep and commute times were subtracted from DRP.

The Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J)[13] was used to determine sleep quality during the previous month. The PSQI-J includes 18 items-bedtime, sleep onset latency, waking time, sleep duration, sleep disturbances, sleep quality, use of sleep medication,

and daytime dysfunction during the previous month. The total PSQI-J score (range 0 to 21) indicates sleep quality with higher scores indicating greater sleep complaints. Although the cutoff point for primary insomnia was set at 5.5, the actual cutoff point was ≥6 as the PSQI-J is calculated in 1-point intervals. The reliability and validity of the PSQI-J has been confirmed[13].

Analysis

Participants were categorized into the following eight DRP groups: (1) <10 h, (2) 10 h (10 h-10 h59 min), (3) 11 h (11 h-11 h59 min), (4) 12 h (12 h-12 h59 min), (5) 13 h (13 h-13 h59 min), (6) 14 h (14 h-14 h59 min), (7) 15 h (15 h-15 h59 min), and (8) ≥16 h group. Sleep durations, PSQI-J scores, leisure times, round-trip commute times, and workday bedtimes and waking times were analyzed using a one-way analysis of covariance, in which the independent variable was the DRP group and the covariates were sex, age, industry type, smoking status, and alcohol consumption frequency. Post hoc comparisons were performed using the Bonferroni procedure. The trend analysis was used to assess the relation between DRP duration and sleep duration, PSQI-J score, leisure time, bedtime, wake-up time, and round-trip commute time. Pearson's correlation analyses were conducted to examine the relation between DRP and sleep duration, leisure time, and round-trip commute time. All the statistical analyses were conducted using SPSS version 24.0 for Microsoft Windows (IBM Company, New York, USA).

Results

Of the 10,000 initial participants enrolled by the research company, this study analyzed 3,867 permanent daytime workers. Table 1 provides the demographic data for the participants of whom 35% were females, the mean age was 42.7 ± 11.0 years, and the average work day was 10.1 ± 1.4 h. The sample was roughly similar to the average ratio of Japanese workers in each industry types as reported in the Labour Force Surveys in November 2016[14]. The number of participants in each of the DRP groups was as follows: <10 h-49 (1%), 10 h-94 (2%), 11 h-187 (5%), 12 h-470 (12%), 13 h-857 (22%), 14 h-1,488 (38%), 15 h-588 (15%), and ≥16 h-134 (3%).

Fig. 1 depicts the sleep durations for each DRP group. As can be seen, sleep duration varied from around 5 h for the <10 h DRP group to nearly 7 h for the ≥16 h DRP group. The analysis of covariance for sleep duration revealed a significant main effect for the group [$F(7, 3859) = 29.397$, $p<0.001$]. Post hoc tests revealed that although sleep duration was significantly longer in the 14, 15, and ≥16 h groups than in the <10-13 h groups (all $p<0.001$), there were no significant differences found between the 14, 15, and ≥16 h groups.

Fig. 2 shows the PSQI-J scores for each group. The analysis of covariance for the PSQI-J score revealed a significant main effect for the group [$F(7, 3859) = 12.890$, $p<0.001$]. Post hoc tests revealed that the PSQI-J scores were lower for the 14 and 15 h groups than for the <10-13 h DRP groups (all $p<0.05$) and were also lower for the ≥16 h group than for the <10-12 h groups (all $p<0.01$). There were no significant differences in other pairs.

Table 2 shows the leisure time, round-trip commute time, bedtime, and wake-up time for each group. The analysis of covariance for leisure time revealed a significant main effect for the group [$F(7, 3859) = 382.523$, $p<0.001$], and post hoc tests revealed that there were significant differences between all pairs (all $p<0.01$). The analysis of covariance for round-trip commute time revealed a nonsignificant main effect for the group [$F(7, 3859) = 1.814$, n.s.]. In addition, Pearson's correlation analyses revealed that sleep duration ($r=0.208$, $p<0.001$) and leisure time ($r=0.682$, $p<0.001$) were significantly correlated with DRP, but round-trip commute time was not significantly correlated with DRP ($r=-0.008$, n.s.). There was a significant difference in the correlation coefficient between sleep duration and leisure time ($t=23.57$, df=3864, $p<0.001$), suggesting that DRP was more associated with leisure time than with sleep time.

The analysis of covariance for bedtime revealed a significant main effect for the group [$F(7, 3859) = 8.335$, $p<0.001$]. Post hoc tests revealed that bedtime was later for the <10 and 10 h groups than for the 12 to ≥16 h groups (all $p<0.05$). In addition, bedtime was later for the 11 h group than for the 14 h group ($p<0.05$). The analysis of covariance for waking time revealed a significant main effect for the group [$F(7, 3859) = 14.503$, $p<0.001$]. Post hoc tests revealed that waking time was earlier for the <10, 11, and 12 h groups than for the 14 to ≥16 h groups (all $p<0.05$).

The trend analyses revealed significant linear trends for sleep duration, PSQI-J score, leisure time, bedtime, and wake-up time (all $p<0.001$), indicating that the shorter the DRP, the shorter is the sleep duration and leisure time, the worse is the sleep quality, the later is the bedtime, and the faster is the wake-up time. On the other hand, no significant linear trends were found for round-trip commute times (n.s.). In addition, although gender differences were analyzed in all variables, almost the same results were found.

Discussion

This study aimed to describe the DRP, its components, and sleep quality in Japanese permanent daytime workers. Those with a shorter DRP tend to show shorter sleep duration and lower sleep quality, as we hypothesized. We also found that workers with a shorter DRP had shorter leisure time, went to bed later, and woke up earlier on a

Table 1. Demographic data for participants (n = 3,867)

	Mean (SD) or %		
	All (n = 3,867)	Men (n = 2,512)	Women (n = 1,355)
Age (years)	42.7 (11.0)	44.2 (10.7)	40.0 (11.0)
Job tenure (years)	13.6 (10.6)	14.7 (10.9)	11.4 (9.5)
Year of experience (years)	9.0 (8.4)	9.2 (8.7)	8.6 (7.9)
Working hours (hours)	10.1 (1.4)	10.4 (1.4)	9.6 (1.2)
Daily rest period (hours)	13.9 (1.4)	13.6 (1.4)	14.4 (1.2)
PSQI-J score	5.8 (2.9)	5.7 (2.8)	6.0 (2.9)
Sleep duration (hours)	6.5 (1.1)	6.5 (1.1)	6.6 (1.1)
Leisure time (hours)	6.0 (1.7)	5.7 (1.7)	6.6 (1.7)
Round-trip commute time (hours)	1.4 (1.0)	1.4 (1.0)	1.2 (0.9)
Start of working hours	8.3 (0.8)	8.3 (0.8)	8.5 (0.7)
End of working hours	18.4 (1.3)	18.6 (1.3)	18.1 (1.1)
Bedtime	23.7 (1.1)	23.7 (1.2)	23.7 (1.1)
Wake-up time	6.3 (0.9)	6.2 (0.9)	6.3 (0.9)
Smoking status (Current smoker)	26%	20%	6%
Frequency of alcohol drinking			
almost never	46%	26%	20%
1-2/3-5/6 days (per week)	22/11/21%	15/8/17%	8/3/4%
Industry types			
Agriculture and forestry	1%	2%	1%
Construction	10%	8%	13%
Manufacturing	20%	20%	21%
Information and communications	5%	4%	5%
Transport and postal activities	4%	4%	4%
Wholesale and retail trade	16%	18%	14%
Finance and insurance	3%	4%	3%
Real estate and goods rental and leasing	3%	3%	3%
Scientific research, professional, and technical services	4%	4%	4%
Accommodations, eating, and drinking services	3%	3%	2%
Living-related and personal services and amusement services	3%	3%	3%
Education, learning support	5%	6%	4%
Medical, health care, and welfare	12%	12%	13%
Compound services	1%	1%	1%
Services, not elsewhere classified	6%	7%	5%
Government, except elsewhere classified	4%	4%	4%

Footnote. SD: standard deviation. PSQI-J: Pittsburgh Sleep Quality Index (Japanese version).

work day.

We also evaluated the association between sleep duration and DRP. Sleep duration was shorter than 6 h in workers with a DRP of less than 11 h. Sleep duration of workers with a DRP of 14 h and more was longer than for workers with a DRP of less than 14 h. There were no significant differences in the sleep durations among the 14, 15, and ≥16 h DRP groups. The National Sleep Foundation[15] recommends 7-9 h of sleep duration and has stated that less than 6 h sleep is not recommended for adults (26-64 years). Sleep duration of less than 6 h was reported as a risk for several health outcomes such as stroke[7], coronary heart disease[8], and common cold[16]. Therefore, given the link between short sleep duration and these health problems, it is expected that the groups with a DRP of less than 11 h, comprising those who have short sleep duration, might be at a risk for these future diseases. As well as sleep duration, both bedtime and wake-up time linearly associated with DRP. It suggests that shortage of sleep duration was caused by not only later bedtime but also earlier wake-up time.

We examined the association between average sleep

quality and DRP. The mean PSQI-J score for workers with a DRP of less than 13 h was above 6 points. As the PSQI-J's cutoff point for the primary insomnia score is 5.5 (i.e., ≥6) points, these results indicated that some daytime workers with a DRP of less than 13 h may deteriorate sleep quality. Workers with a DRP of 14 h and those with more than 14 h were found to have a higher sleep quality than workers with a DRP of less than 14 h. No significant differences were found in the sleep quality among workers with a 14, 15, and ≥16 hour DRP. Poor sleep quality has been associated with several health issues such as cardiovascular disease[17], depression[9], and death[10]. Therefore, given the link between poor sleep quality and these health problems, it is expected that the groups with a DRP of less than 13 h, comprising those who have poor sleep quality, might be at a risk for these future diseases.

Although we described the relationships between DRP and sleep duration and quality in Japanese permanent daytime workers, a weekly working hour limit should be discussed. The minimum 11 h DRP a day allows a maximum work duration of 65 h a week (five weekdays), which is excessively long working hours. The EU's Working Time Directive recommend a minimum DRP along with a limit to weekly working hours, which must not exceed 48 h on average, including any overtime[4]. It is necessary to establish both a minimum DRP and a weekly working hour limit also in Japan.

For the relation among DRP, sleep duration, leisure time, and commute time, DRP correlated with sleep duration and leisure time, suggesting that workers with longer DRP have longer sleep duration and leisure time. On the other hand, the correlation between DRP and sleep dura-

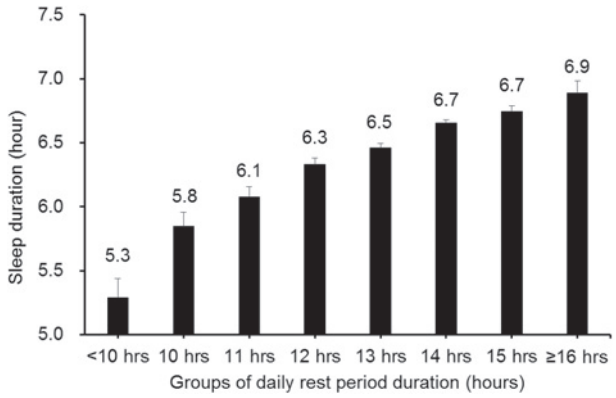

Fig. 1. Relation between daily rest periods and sleep duration. Mean sleep duration is an estimated marginal value that is adjusted for sex, age, industry type, smoking status, and alcohol frequency. The error bars indicate the standard error.

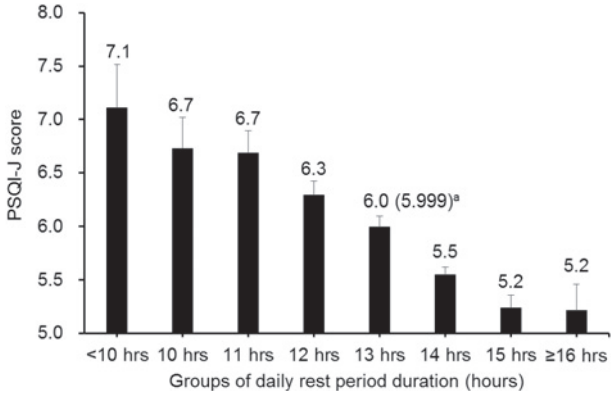

Fig. 2. Relation between daily rest periods and sleep quality (Pittsburgh Sleep Quality Index (PSQI-J) score). The mean PSQI-J score is an estimated marginal value that is adjusted for sex, age, industry type, smoking status, and alcohol frequency. The error bars indicate the standard error. [a]The cutoff point for primary insomnia was ≥6.0. The 13 h DRP group was not over the cutoff point.

Table 2. Mean (SE) bedtime, wake-up time, leisure time, and round-trip commute time in each group

Daily rest period	Mean (SE)			
	Leisure time (hour)	Round-trip commute time (hour)	Bedtime (hour)	Wake-up time (hour)
<10 hours	2.5 (0.2)	1.2 (0.1)	24.4 (0.2)	5.7 (0.1)
10 hours	3.4 (0.1)	1.3 (0.1)	24.3 (0.1)	6.1 (0.1)
11 hours	4.1 (0.1)	1.4 (0.1)	23.9 (0.1)	6.0 (0.1)
12 hours	4.7 (0.1)	1.4 (0.0)	23.8 (0.1)	6.1 (0.0)
13 hours	5.7 (0.0)	1.4 (0.0)	23.7 (0.0)	6.2 (0.0)
14 hours	6.5 (0.0)	1.3 (0.0)	23.6 (0.0)	6.3 (0.0)
15 hours	7.1 (0.1)	1.4 (0.0)	23.8 (0.0)	6.5 (0.0)
≥16 hours	8.5 (0.1)	1.2 (0.1)	23.7 (0.1)	6.6 (0.1)

Mean bedtime, wake-up time, leisure time, and round-trip commute time are estimated marginal values adjusted for sex, age, industry type, smoking status, and alcohol frequency.

tion was relatively weak compared with leisure time, and there were no significant differences in the sleep durations among the 14, 15, and ≥16 h DRP groups. These results suggest that Japanese daytime workers with a certain DRP (more than 14 h) may prioritize (or be prioritized) ensuring leisure time over sleep duration. Winwood et al.[18] reported that behavior during leisure time activities such as exercise, creative (hobby) activities, and social activities was associated with fatigue recovery; this suggests that ensuring leisure time is important to workers' health. On the other hand, as described above, 7-9 h of sleep duration were recommended for adults (26-64 years)[15]. Although Kosugo[19] reported that a DRP of more than 14 h is recommended to ensure an 8 h sleep duration, the actual mean sleep duration for daytime workers with a DRP of 14 h was 6.7 h in the present study. As a DRP of 14 h has a chance of ensuring 8 h sleep duration[19], it is desirable to obtain the leisure time with ensuring the recommended sleep duration (7-9 hours)[15].

This study had several limitations. First, we did not have information on whether the companies to which the participants belonged employed any interval systems. Second, in sample selection, we did not consider whether the participants were permanent workers. As a result, about 30% of the participants were nonpermanent workers, and thus, we did not use their data for the analyses. Third, leisure time would include unpaid work such as housekeeping and caregiving, which may also influence sleep duration and/or sleep quality. Fourth, the sleep duration was subjectively assessed. It could be longer than the objective sleep durations measured using objective measurements (e.g., polysomnography)[20]. Finally, a web survey would cause sampling biases. It could be possible that some workers were too busy to participate in this survey, which resulted in a biased sample that included fewer busy workers.

Although this study had some limitations, we describe sleep quantity, sleep quality, and DRP in Japanese daytime workers of a wider business community. Longer DRP was associated with longer sleep durations and better sleep quality. This finding is important because little is known about the relation between DRP and sleep for daytime workers.

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Conflicts of interest: The authors declare that there are no conflicts of interest.

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