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Original Article

Associations of employment status, working time and job satisfaction with sleep duration and sleep quality among the 50+ population in Japan

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Abstract: Few studies have addressed the relationship between sleep and employment in Japan. We use four waves of the Japan Study of Aging and Retirement (JSTAR) to address the relationship between weekday sleep duration, self-reported sleep quality and four self-reported indicators of sleep quality and employment status (model 1, full sample), working hours and job satisfaction (model 2, working sample) among individuals aged 50 and over (N=7,082). We apply mixed effects models for the linear outcome of sleep duration and cumulative link mixed models for the sleep quality variables, controlling for socio-demographic and health characteristics. In model 1, our findings show that, compared to full-time employees, all categories of workers and non-workers report longer sleep hours. Some sub-groups, such as contract workers, report higher odds of waking up at night or in the early morning, and taking a longer time to fall asleep. In model 2, we find a positive association between working time and sleep hours but including job satisfaction in the model absorbs such a relationship, indicating the job satisfaction somehow reflects working time. Poor job satisfaction is linked to higher odds of experiencing difficulties in four of the five sleep quality measures.

Key words: Sleep duration, Japan Study of Aging and Retirement (JSTAR), Sleep quality, Working hours, Job satisfaction

Introduction

Sleep duration is low in Japan in comparison with other top economies. On average, 56 percent of the Japanese population sleeps less than seven hours compared to 45 percent in the US, 35 in the UK, 30 in Germany, and 26 in Canada[1)]. This is not a new trend as sleep duration in Japan has been declining since the 1960s[2)]. In 2014, 'good sleep' became a policy priority, with specific sleep guidelines published for different generations[3)], although they mainly focus on individuals' behaviours rather than addressing the social mechanisms leading to poor sleep quality and short sleep duration, such as work and employment are often seen as detrimental factors[4, 5)]. Despite regulations passed over the past decades to prevent long working hours, working time remains high in Japan[6)] and the labour market is fragmented with many women—particularly among the oldest generations—remaining out

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of the labour market (as housekeepers)[7] and older workers sometimes downgraded to specific employment statuses (contract work)[8, 9]. The relationship between work and employment and sleep is of particular interest in this context as both low sleep duration and poor sleep quality have detrimental effects. Sleep disturbances are associated with depressive symptoms among the older population[10] and both short (<6 h) and long (>9h) sleep durations are linked to higher mortality risks[11]. However, despite many studies on sleep in Japan, little attention has been paid on the explanatory role of work and employment, especially among the ageing population.

Typically, when questioning such a relationship, two different dimensions are examined.

On the one hand, Employment status—defined as an individual's relationship with an employer, indicating whether they are employed, unemployed, self-employed, or inactive in the labour force—plays a crucial role in shaping sleep patterns. Research has shown that the transition from work to retirement is associated with short-term improvements in sleep, including reductions in sleep difficulties and increases in sleep duration over one to two years[12–14]. These benefits appear to persist over time, particularly for issues such as non-restorative sleep, premature awakening, and restless sleep[15]. The positive effects of retirement on sleep are more pronounced among women and those retiring from part-time jobs[16].

In contrast, certain employed groups, such as white-collar workers, exhibit a higher prevalence of poor sleep quality compared to the general population[17]. Factors contributing to poor sleep include stress, job dissatisfaction, being unmarried, lower education levels, and younger age. Poor sleep quality has also been linked to broader consequences, such as absenteeism, poor health, work and relationship problems, and workplace accidents. Interestingly, higher-ranking civil servants tend to report better sleep quality[18], while employment insecurity has been consistently associated with an increased risk of sleep disturbances across various contexts[19]. Non-employed individuals, including those who are unemployed or inactive in the labour force, also face sleep-related challenges. Unemployment, in particular, is associated with a high prevalence of insomnia-related symptoms, especially among men, though the effect is less pronounced among women[20, 21]. Both employment and non-employment can influence sleep duration and quality through distinct mechanisms, though the evidence remains limited when comparing short sleep duration and poor sleep quality across different employment statuses[20]. Differences exist also when looking at sleep time with, for instance, less short sleep duration (<5 h per night) among the self-employed workers compared to those in regular employment[22].

On the other hand, work-related factors, particularly job satisfaction and working time, have received considerable attention in studies examining sleep patterns. However, much of the existing research on the Japanese workforce focuses on specific subgroups, such as factory workers or daytime employees, with limited representation of female workers, temporary workers, or the self-employed[23]. For instance, a study of factory workers aged 20–59 found that high work-related stress was associated with lower sleep quality, while lifestyle habits influenced various sleep characteristics[24]. Another survey of factory workers highlighted sleep differences by gender, age, and work patterns: women reported fewer awakenings and less napping, older men had shorter sleep durations but less sleep insufficiency, and shift workers experienced longer sleep onset times and more awakenings[25].

Job satisfaction, a key focus of this paper, has also been linked to sleep quality. A study of 334 female daytime workers at a Japanese electric equipment manufacturer explored the relationship between perceived job stress (including factors like job control, workload, and social support) and sleep habits[26]. The findings revealed that aspects of job satisfaction, such as skill utilization and cognitive demands, influenced sleep outcomes: skill underutilization was associated with longer sleep duration, while cognitive demands reduced daytime napping and sleepiness. Overtime work, however, was linked to shorter sleep duration and more frequent poor sleep quality. Social support from supervisors, co-workers, and family or friends was negatively correlated with poor sleep indicators, suggesting that supportive work environments may mitigate some sleep-related issues.

Working time is another critical factor influencing sleep. Studies consistently show that longer working hours are associated with shorter sleep duration[27, 28]. In Japan, however, research on working time and health remains limited, with most studies focusing on the impact of poor sleep on productivity[29] or workplace injuries[30]. For example, Mafune and Yokoya[31] found that workers logging over 100 h of overtime per month slept less than six hours, ate late dinners, and dined out more frequently. Night shift workers also reported more frequent awakenings during sleep. The study concluded that approximately 30% of temporary workers were at risk of overwork-related health issues, including insufficient sleep, late meals, and mental health symptoms, underscoring the need for regulations to limit

excessive overtime. Additionally, early work start times have been associated with lower sleep duration, increased sleep problems, and higher fatigue levels[32]. Generally, those working fewer than eight hours per day tend to sleep more than those working longer hours[33].

While previous studies have largely focused on specific segments of the Japanese population, this study aims to examine the associations between employment status, job satisfaction, and working time among a representative sample of individuals aged 50 and over across ten Japanese prefectures.

Subjects and Methods

Data source and samples

Data come from the Japanese Study of Aging and Retirement (JSTAR), a longitudinal dataset that currently contains four waves collected in 2007, 2009, 2011 and 2013. The original sample strategy is described in[34]. At the baseline (2007), JSTAR includes respondents aged 50 to 75 living in five municipalities in eastern area of Japan[34]: Takikawa in Hokkaido, Sendai in the Tohoku area, Adachi Ward within Tokyo, Kanazawa in Hokuriki and Shirakawa in the Chubu area. Two refreshment samples were collected in 2009 and 2011 to increase the number of cities. The 2009 wave includes a refreshment sample from two additional cities (Tosu and Naha) and the 2011 wave includes another refreshment sample from three additional cities (Chofu, Hiroshima and Tondabayashi). In total, the sample contains information on ten cities. Sample design is shown in Supplementary file 1. The full sample includes 18,762 observations over four time-points, including a total of 7,082 respondents.

Sleep duration and sleep quality

Information on sleep quality and sleep duration was not collected the same way in all waves.

Information on sleep quality was collected in each wave with a question on poor sleep frequency per week (not at all, one to two days a week, three to four days a week and five days a week or more). The variable was recoded over three modalities (not at all, one to two days a week, three days a week or more) because of low cases in the last modality.

Information on sleep duration on weekdays was collected in waves 2009 and 2011 (both follow-up and refreshment samples) as well as in wave 2013. The variable specifically asks respondents to report their sleep time on weekdays over the past month. It is numeric and measured in hours per day.

Finally, waves 2011 (refreshment sample only) and 2013 contain several specific questions on time to fall asleep, times waking up during the night, waking up in early hours and waking up to urinate. Times to fall asleep was recoded from five to four modalities (10 min or less, 11–30 min, 31–59 min, one hour or more). Times waking up during the night and times waking up in the early morning were recoded from five to four modalities (never, one time a week, two times a week, more than three times a week). Finally, times per night waking up to urinate was recoded from five to three modalities (never, one time, two times or more).

To include the maximum amount of information contained in JSTAR, we have generated three sub-samples. *Sample 1* focuses on poor sleep (sleep quality) across all the four JSTAR waves. *Sample 2* includes poor sleep as well as sleep time in weekdays across three waves (excluding wave 2007). Finally, *sample 3* includes all the six variables across two waves (the 2011 refreshment sample and the 2013 sample). Analyses were replicated on each sample. Differences across sub-samples are briefly discussed but only results flowing from the maximum size samples are reported in the result section.

Full information on coding and variables availability is shown in Supplementary file 2.

Employment status, working time and job satisfaction

Two models were used in this study. Model 1 looked at the relationship between employment status and sleep quality and duration, whilst Model 2 focused on the working population (employed full-time, part-time, temporary, self-employed or contract workers) and specifically looked at working time and job satisfaction.

Our employment variable is constructed using four variables from the JSTAR dataset. The first variable categorises respondents based on their employment status: working, temporarily not working, or not working. The second variable further classifies those who reported working into specific categories: employee, company executive, owner of an independent business, helper in an independent business, or engaged in a side job at home. The third variable distinguishes, among employees, their type of employment: full-time, part-time, temporary, contract work, or other forms of employment. Finally, for those not working, a separate question identifies the reason for not working, such as retirement, being a homemaker, receiving medical care, or other reasons. Our variable therefore includes 13 modalities distinguishing different self-reported positions

within and outside the labour market: (1) employed full-time, (2) company executive, (3) employed part-time, (4) employed under contract, (5) temporarily employed, (6) employed other, (7) owner of independent business, (8) help in independent business, (9) side job at home, (10) retired, (11) receiving medical care, (12) keeping house (13) inactive for other reasons. The first modality (employed full-time)—that is the most represented among the working population—was selected as the reference category. We kept the original distinction across inactivity statuses, including those receiving medical care, because respondents receiving medical care might have different sleep patterns which would bias the estimates observed for the non-working population.

Job satisfaction was assessed in two different ways. Model 2 uses a self-reported variable ('Overall, I am satisfied with my current job') with four response options: strongly agree, somewhat agree, do not really agree, and strongly disagree. Although distribution of this variable is skewed, with a high proportion of respondents selecting the second option, we use the variable as numeric to facilitate the interpretation of the estimates. We replicate the model using a job satisfaction index (Model 3). The index calculates a score based on seven variables: (a) whether the respondent's current job involves physical labour, (b) whether it involves feelings of time pressure, (c) whether the respondent has no autonomy in decision-making, (d) whether the respondent receives support from colleagues, (e) whether the respondent receives appropriate evaluations, (f) whether the respondent is satisfied with their pay relative to the work produced, and (g) whether the respondent fears losing their job in the near future. Each variable contains four response options, which are summed to create a job dissatisfaction index that follows a normal distribution. This variable is used as numeric.

Working time was calculated based on self-reported working time per week including overtime and was categorized over six modalities: less than 20 h/week, 21 to 30 h/week, 31 to 40 h/week (reference), 41 to 50 h/week, 51 to 60 h/week, more than 60 h/week. By doing so, we can capture a relationship between working hours and sleep quality or duration that may not be linear. For example, the effect of working very few hours on sleep might be different from the effect of working standard hours, and this might differ again for those working excessive hours (e.g., more than 51 h). By categorizing working time, we can capture these non-linear effects and better understand how different working-hour groups affect sleep.

Covariates and adjustment levels

We control for the following covariates: age (in years of age); gender (female, male—male being the reference category); highest level of education obtained (distinguishing elementary to middle school, high school, junior college, vocational school and university degree—the latter being the reference category); marital status (distinguishing those who are married or have a common law spouse versus those who are not); whether the household borrowed money to friends or family ('yes', 'no'—'no' being the reference category); whether the household rent their accommodation ('yes', 'no'—'no' being the reference category); self-reported health (coded on a 5-item scale ranging from 'good' to 'Not good and used as a numeric variable); report of a health condition (distinguishing respondents who declared having been diagnosed with at least one health conditions including heart disease, high blood pressure, hyperlipemia, cerebral accident, diabetes, chronic lung disease, liver disease, ulcer or stomach disorder, joint disorder, bladder disorder, depression or emotional disorder, cancer); psychological distress caseness that is based on the answers to nineteen items on mental health such has having no appetite or feeling like wanting to cry (coded from 1. Not at all to 5. 5 d a week or more) that are summed up and categorized into two categories across the time-point means ('yes' or 'no', 'no' being the reference category); whether the respondent was an outpatient at a hospital over the past year ('yes' or 'no', 'no' being the reference category). All the variables used in this study are time-varying except gender, highest level of education and marital status.

The psychological distress caseness variable includes 19 items that assess psychological distress, such as: felt unusual in some way, had no appetite, felt depressed and could not be consoled by family or friends, felt I could do anything a normal person could do, could not concentrate on what I was doing, felt depressed, something that is normally effortless was difficult to do, felt the future was bright, felt that my life so far has been a failure, felt frightened, felt happy, felt more taciturn than usual, felt lonely, people around me seemed cold to me, felt fun, cried or felt like crying, felt sad, felt that people around me disliked me, and low in energy. The response modalities are based on weekly frequency.

The models includes four layers of adjustment: (1) The unadjusted model only controls for the variable(s) of interest; (2) The socio-demographic adjusted model controls for the highest level of education obtained, the marital status, whether the household borrowed money from friends or family, whether the household rents or

owns the accommodation; (3) The sleep adjustment controls for weekday sleep hours in the models looking at job quality variables as an outcome. As sleeping hours is not available in sample 1, it is only controlled for in samples 2 and 3; (4) The fully adjusted model additionally controls health variables including self-reported health, whether the respondent reported a health condition, psychological distress and whether the respondent was an outpatient at a hospital over the past year. By using these three layers of adjustment we provide crude estimates that control for basic demographics but also socio-demographic covariates adjusting for potential behavioural confounders (that could be competing exposures) as well as health and mental health variables that may be associated with poor sleep[35]. Model specifications by adjustment level are shown in Supplementary file 3.

Statistical analyses

For the sleep quality variables, the analyses employed a cumulative link mixed model (CLMM), accounting for both individual and temporal variability[36]. The ordered categorical outcome is modelled using the exposures as a fixed effect, while random intercepts are included for both individuals (id) and time (time), reflecting unobserved heterogeneity at these levels. A logit link function is applied, which assumes a logistic distribution of the latent continuous response underlying the ordinal outcome[37]. Odds ratios derived from the logit represent the change in odds of reporting poorer sleep quality for a unit change in the predictor, controlling for the random effects. For weekday sleep hours, we used a linear mixed-effects regression (LMER). In this model, the continuous outcome variable is predicted by the exposures as fixed effects. Random intercepts are included for both time (time) and individual (id), capturing unobserved variability across repeated measures within individuals and across time points. This approach allows for individual-specific deviations from the overall effect, adjusting for potential clustering and time-dependent variability in sleep patterns. The coefficients represent the expected change in weekday sleep hours for a given change in exposure, accounting for individual and temporal heterogeneity. We address data missingness across waves by using multiple imputations to correct sample bias due to attrition. We then meta-analyse the estimates flowing from the subsequent imputed datasets. We also compare results flowing from the non-imputed models with results flowing from the imputed model. Multiple imputations were replicated for each sub-sample (i.e., model 1 and model 2 & 3) separately.

Results

Descriptive statistics for the outcome variables are shown in Table 1 for model 1 and Table 2 for models 2 and 3. Within the full population (model 1), poor self-reported sleep (modalities 2 and 3) concerns about 30 percent of the sample and is stable over time. Same proportions are observed within the working sample (model 2), with between 25 and 30 percent of the sample not reporting a good sleep quality. Sleep duration during weekdays was not asked in wave 2007. Subsequent waves show that sleep duration is, on average, between 6.5 and 7 h per day within the full population (model 1 − sample 2) and between 6.6 and 6.9 h within the working population (model 2 and 3 − sample 2). Finally, sleep quality indicators were only asked in sample 3 (wave 2011 and 2013 − sample 3). 42 percent of the full sample takes less than 10 min to fall asleep − 48 percent in the working sample. About 55 percent of the working sample do not wake up at night against 49 in the full sample. 61 percent of the working sample wake up in the early hours against 56 percent of the full sample. Finally, between 25 and 30 percent of the working sample do not wake up to urinate at night against between 20 and 24 percent of the full sample. Full descriptive statistics are shown in Supplementary file 4. Looking at the employment status within the full population sample, we observe large proportions of full-time employed workers (19 percent in wave 2007), part-time workers (12.9 percent) and housekeepers (21.4 percent). 12.8 percent of the sample reported being retired in 2007. When looking at the working population, we observe that a majority of the 2007 sample works between 31 and 40 h (26.5 percent) and between 41 and 50 h (26.1 percent). Finally, the mean of job satisfaction is between 2 and 2.1 on a scale from 1 to 4 for the self-reported variable and between 60 and 62 on a scale from 49 to 82 for the index.

Figure 1 shows the main estimates of the imputed model 1. It exhibits the odds ratios for the sleep quality variables and the linear estimate for weekday sleep time variable as well as the 95% CI. Estimates for the sleep quality variable are derived from sample 1 whilst they come from sample 2 for weekday sleep time and sample 3 for the other outcomes. The figure only shows the unadjusted and full adjusted estimates. Full estimates by levels of adjustment derived from models 1, 2 and 3 are shown in Supplementary file 5 for complete cases analyses and in Supplementary file 6 for the estimates based on the fully imputed datasets. Figures including all the layers of adjustment are shown in Supplementary files 7–9.

Table 1. Descriptive statistics on sleep quality and duration by JSTAR wave (model 1)

		2007 (N=1,837)	2009 (N=1,837)	2009, refreshment (N=695)	2011 (N=2,532)	2011, refreshment (N=1,296)	2013 (N=3,828)	Total (N=12,025)
Sample 1	Sleep quality							
	- 1	1,276 (72.4%)	1,193 (70.5%)	408 (69.3%)	1,709 (72.0%)	801 (65.5%)	2,524 (72.4%)	7,911 (71.1%)
	- 2	351 (19.9%)	347 (20.5%)	131 (22.2%)	503 (21.2%)	315 (25.8%)	715 (20.5%)	2,362 (21.2%)
	- 3	136 (7.7%)	153 (9.0%)	50 (8.5%)	162 (6.8%)	106 (8.7%)	247 (7.1%)	854 (7.7%)
Sample 2	Sleep quality							
	- 1		1,193 (70.5%)	408 (69.3%)	1,709 (72.0%)	801 (65.5%)	2,524 (72.4%)	6,635 (70.9%)
	- 2		347 (20.5%)	131 (22.2%)	503 (21.2%)	315 (25.8%)	715 (20.5%)	2,011 (21.5%)
	- 3		153 (9.0%)	50 (8.5%)	162 (6.8%)	106 (8.7%)	247 (7.1%)	718 (7.7%)
	Weekday sleep hours							
	- Mean (SD)		7.001 (1.260)	6.747 (1.183)	6.950 (1.260)	6.541 (1.154)	6.769 (1.230)	6.826 (1.239)
	- Range		1.000–15.000	1.000–10.000	1.000–13.000	1.000–12.000	1.000–15.000	1.000–15.000
Sample 3	Sleep quality							
	- 1				1,709 (72.0%)		2,524 (72.4%)	4,233 (72.2%)
	- 2				503 (21.2%)		715 (20.5%)	1,218 (20.8%)
	- 3				162 (6.8%)		247 (7.1%)	409 (7.0%)
	Weekday sleep hours							
	- Mean (SD)				6.950 (1.260)		6.769 (1.230)	6.842 (1.245)
	- Range				1.000–13.000		1.000–15.000	1.000–15.000
	Time to fall asleep							
	- 1				1,028 (42.4%)		1,498 (42.2%)	2,526 (42.3%)
	- 2				982 (40.5%)		1,128 (31.8%)	2,110 (35.3%)
	- 3				285 (11.8%)		680 (19.2%)	965 (16.2%)
	- 4				130 (5.4%)		240 (6.8%)	370 (6.2%)
	Waking up at night							
	- 1				1,192 (49.3%)		1,762 (49.8%)	2,954 (49.6%)
	- 2				649 (26.8%)		685 (19.4%)	1,334 (22.4%)
	- 3				323 (13.4%)		625 (17.7%)	948 (15.9%)
	- 4				254 (10.5%)		467 (13.2%)	721 (12.1%)
	Waking up in the early hours							
	- 1				1,357 (56.1%)		2,018 (56.9%)	3,375 (56.6%)
	- 2				555 (22.9%)		582 (16.4%)	1,137 (19.1%)
	- 3				275 (11.4%)		568 (16.0%)	843 (14.1%)
	- 4				232 (9.6%)		192 (5.4%)	424 (7.1%)
	- 5				0 (0.0%)		189 (5.3%)	189 (3.2%)
	Night urination							
	- 1				594 (24.6%)		711 (20.0%)	1,305 (21.9%)
	- 2				1,197 (49.6%)		2,057 (57.9%)	3,254 (54.6%)
	- 3				624 (25.8%)		782 (22.0%)	1,406 (23.6%)

JSTAR: Japanese Study of Aging and Retirement.

Looking at sleep time during the week, we observe that all categories sleep longer than full-time employed workers. This is particularly true for those receiving medical care (unadjusted estimate: 0.46, 95% CI: 0.38;0.55; adjusted estimate: 0.37, 95% CI: 0.30;0.44) and those who are retired (unadjusted: 0.31, 95% CI: 0.27;0.36), although adjusting the model significantly reduces the coefficient (adjusted: 0.14, 95% CI: 0.09;0.20).

Self-reported overall sleep quality shows broad confidence intervals and odds ratios (ORs) near 1, indicating small differences across subgroups. Nevertheless, several trends emerge. First, the odds of poor sleep quality for company executives are lower compared to full-time employed respondents (unadjusted OR: 0.37, 95% CI:

Table 2. Descriptive statistics on sleep quality and duration by JSTAR wave (models 2 & 3)

		2007 (N=1,097)	2009 (N=979)	2009, refreshment (N=374)	2011 (N=1,992)	2011, refreshment (N=669)	2013 (N=1,691)	Total (N=5,975)
Sample 1	Sleep quality							
	- 1	792 (75.1%)	638 (70.7%)	215 (72.6%)	847 (75.4%)	414 (66.2%)	1,185 (75.0%)	4,091 (73.3%)
	- 2	201 (19.1%)	193 (21.4%)	60 (20.3%)	207 (18.4%)	151 (24.2%)	297 (18.8%)	1,109 (19.9%)
	- 3	62 (5.9%)	72 (8.0%)	21 (7.1%)	70 (6.2%)	60 (9.6%)	97 (6.1%)	382 (6.8%)
Sample 2	Sleep quality							
	- 1		638 (70.7%)	215 (72.6%)	847 (75.4%)	414 (66.2%)	1,185 (75.0%)	3,299 (72.9%)
	- 2		193 (21.4%)	60 (20.3%)	207 (18.4%)	151 (24.2%)	297 (18.8%)	908 (20.1%)
	- 3		72 (8.0%)	21 (7.1%)	70 (6.2%)	60 (9.6%)	97 (6.1%)	320 (7.1%)
	Weekday sleep hours							
	- Mean (SD)		6.928 (1.225)	6.698 (1.206)	6.841 (1.210)	6.509 (1.087)	6.683 (1.166)	6.749 (1.189)
	- Range		1.000–15.000	1.000–10.000	3.000–13.000	3.000–10.000	1.000–12.000	1.000–15.000
Sample 3	Sleep quality							
	- 1				847 (75.4%)		1,185 (75.0%)	2,032 (75.2%)
	- 2				207 (18.4%)		297 (18.8%)	504 (18.6%)
	- 3				70 (6.2%)		97 (6.1%)	167 (6.2%)
	Weekday sleep hours							
	- Mean (SD)				6.841 (1.210)		6.683 (1.166)	6.750 (1.187)
	- Range				3.000–13.000		1.000–12.000	1.000–13.000
	Time to fall asleep							
	- 1				556 (48.9%)		778 (48.7%)	1,334 (48.7%)
	- 2				441 (38.8%)		482 (30.1%)	923 (33.7%)
	- 3				101 (8.9%)		263 (16.4%)	364 (13.3%)
	- 4				40 (3.5%)		76 (4.8%)	116 (4.2%)
	Waking up at night							
	- 1				623 (55.0%)		893 (56.1%)	1,516 (55.7%)
	- 2				296 (26.1%)		270 (17.0%)	566 (20.8%)
	- 3				128 (11.3%)		255 (16.0%)	383 (14.1%)
	- 4				86 (7.6%)		173 (10.9%)	259 (9.5%)
	Waking up in the early hours							
	- 1				697 (61.4%)		987 (61.9%)	1,684 (61.7%)
	- 2				247 (21.7%)		230 (14.4%)	477 (17.5%)
	- 3				112 (9.9%)		234 (14.7%)	346 (12.7%)
	- 4				80 (7.0%)		69 (4.3%)	149 (5.5%)
	- 5				0 (0.0%)		74 (4.6%)	74 (2.7%)
	Night urination							
	- 1				344 (30.3%)		402 (25.2%)	746 (27.3%)
	- 2				572 (50.4%)		878 (55.0%)	1,450 (53.1%)
	- 3				219 (19.3%)		315 (19.7%)	534 (19.6%)

JSTAR: Japanese Study of Aging and Retirement.

0.14;0.98; adjusted OR: 0.38, 95% CI: 0.16;0.91). Second, there are higher odds of poor sleep quality among temporary workers, although the OR is not statistically significant (adjusted OR: 1.45, 95% CI: 0.50;4.19). Third, we observe conflicting results for the retired population, with a positive but not significant OR in the unadjusted model (1.22, 95% CI: 0.30;4.85) and a slightly negative, though still not significant OR in the adjusted model (0.98, 95% CI: 0.26;3.68). This suggests that socio-demographic and health variables may contribute to explain differences in the relationship between sleep quality and retirement.

Patterns are clearer among the other measures of job quality. First, we observe longer time to fall asleep among contract (adjusted OR: 3.20, 95% CI: 2.28;4.48) and tem-

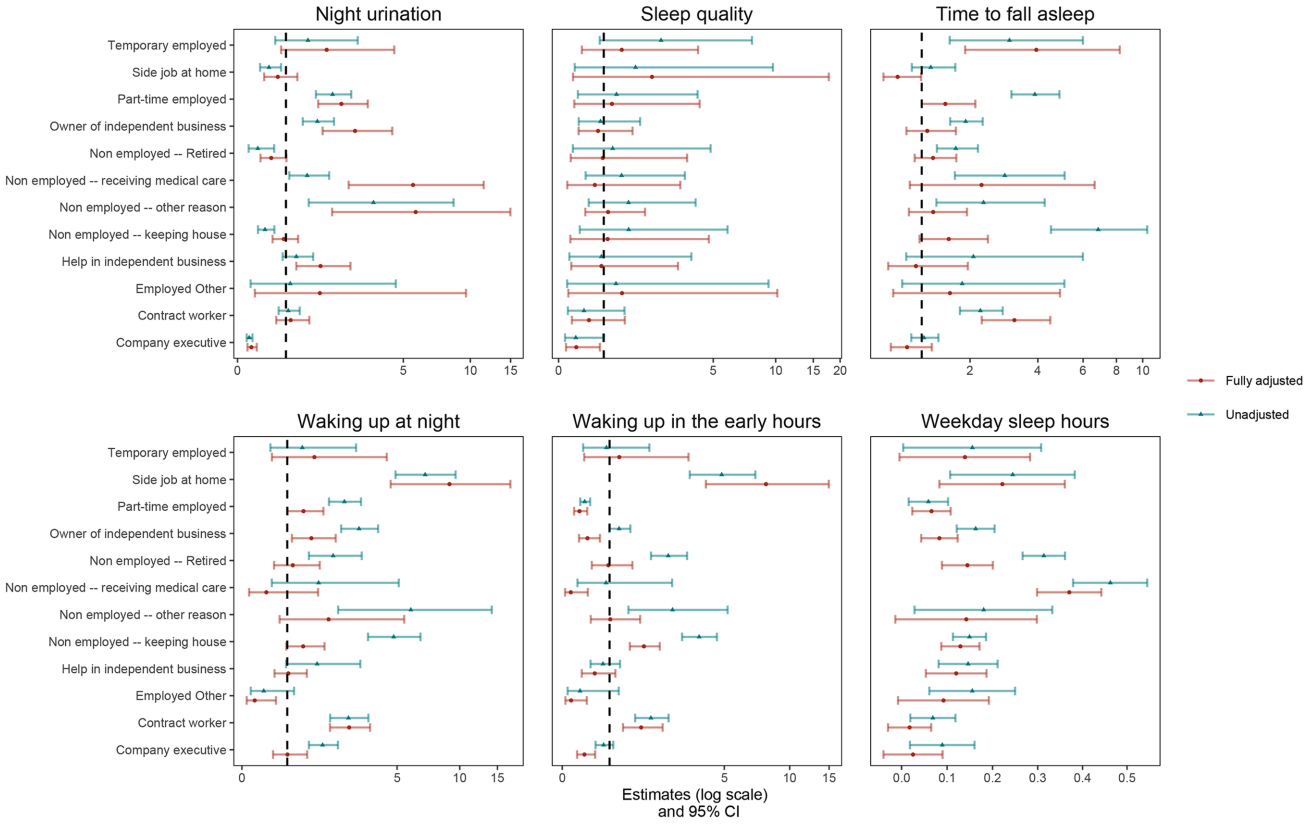

Fig. 1. Association between employment category and sleep duration and quality (model 1 with multiple imputations).

porary workers (3.94, 95% CI: 1.89;8.23). This is also the case among pensioners and housekeepers but only in the unadjusted model. Similarly, we observe that the odds of waking up at night are higher for contract workers (adjusted OR: 2.80, 95% CI: 2.16–3.64). They are also higher for temporary workers but not statistically significant (adjusted OR: 1.70, 95% CI: 0.65;4.44). Again, odds are higher among pensioners in the unadjusted model (2.25, 95% CI: 1.55;3.29) but not in the adjusted model (1.13, 95% CI: 0.70;1.85). A large part of the reduction in OR for this category come from the socio-demographic adjustment (OR:1.03). Waking up in the early hours follows more or less the same pattern with higher odds for contract workers (adjusted OR:1.78, 95% CI: 1.32;2.41) and for pensioners (only in the unadjusted model: 2.60, 95% CI: 2.06;3.28) but no significant association is observed for temporary workers (adjusted OR: 1.23, 95% CI: 0.45;3.33).

The main results for the imputed model 2 are shown in Fig. 2.

We observe no straightforward association between working time and sleep hours during the week as both those working less than 20 h and those working more than 51 h report higher sleeping time compared to the reference group (31 to 40 h a week). This is due to the fact that job satisfaction absorb most of the relationship between working time and sleep duration. In Supplementary file 7, we replicated model 2 (only the imputed fully adjusted model) excluding job satisfaction. We find a negative and statistically significant association between high working time and sleep duration (>51 h a week) (−0.08, 95% CI: −0.13;−0.04) and slightly positive but no significant difference between the reference category (31 to 49 h) and working less than 20 h a week (0.02, 95% CI: −0.01;0.06). This suggests that when job satisfaction is included in the model, it mediates or attenuates the relationship between working time and sleep duration.

We find no association between working time and sleep quality as all the CIs overlap the null (=1). This is also the case when looking at the odds of waking up at night and in the early hours when the model is fully adjusted. However, we observe that respondents reporting working 51 h or more a week report a higher time to fall asleep compared to those working 31 to 40 h (adjusted OR: 4.02, 95% CI: 2.21;7.29) but this is also the case of those working 21 to 30 h (2.00, 95% CI: 1.34;2.99). The same type of pattern is observed for night urination odds.

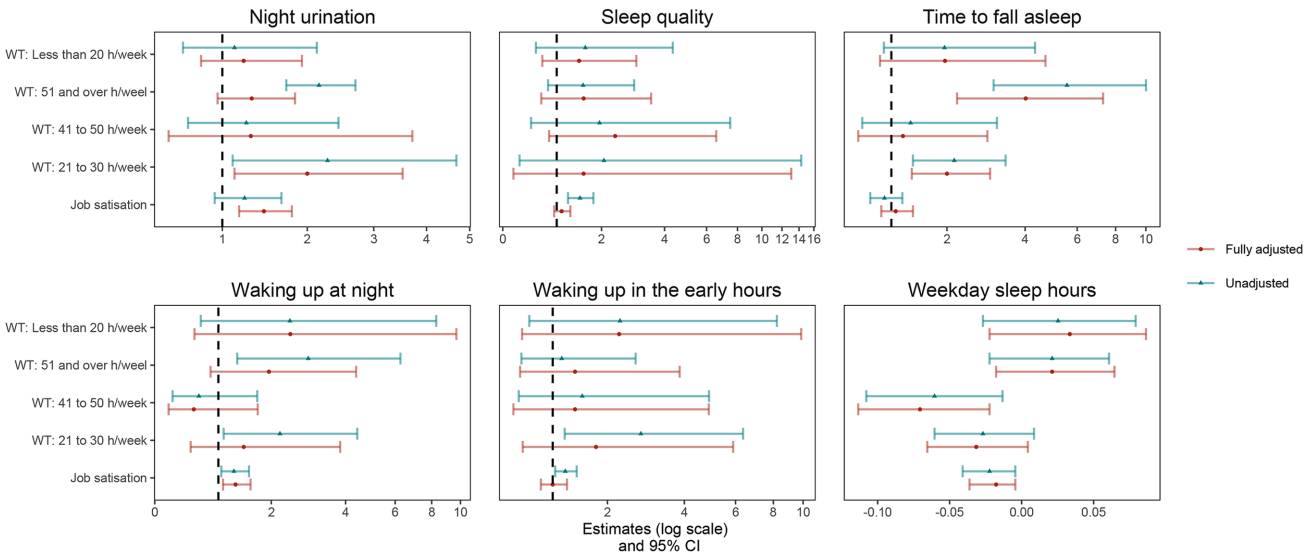

Fig. 2. Association between working time and job satisfaction and sleep duration and quality (model 2 with multiple imputations).

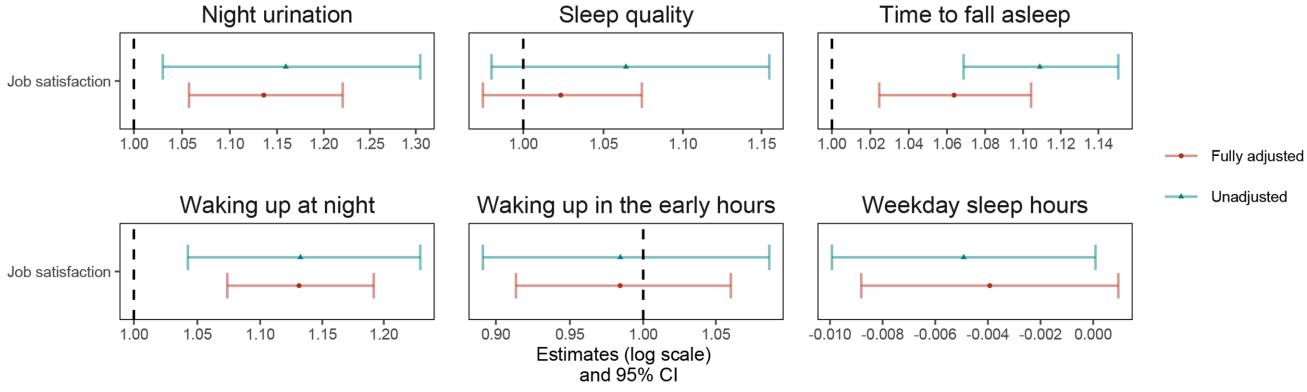

Fig. 3. Association between job satisfaction index and sleep quality and duration (model 3 with multiple interaction).

Self-reported job satisfaction is not significantly associated with time to fall asleep or waking up in the early hours. However, we observe a significant association with sleep quality (unadjusted OR: 1.49, 95% CI: 1.23;1.80) that fades away when adjusting the model (adjusted OR: 1.10, 95% CI: 0.95;1.28) as well as positive odds ratios when looking at night urination (adjusted OR: 1.46, 95% CI: 1.18;1.80) and waking up at night (adjusted OR: 1.30, 95% CI: 1.08;1.58).

Model 3 replicates model 2, but it uses a job satisfaction index instead of self-reported job satisfaction. The estimates are shown in Fig. 3. These estimates are similar to those from Model 2, with positive odds of night urination (adjusted OR: 1.14, 95% CI: 1.06;1.22) and waking up at night (adjusted OR: 1.13, 95% CI: 1.07;1.19). However, we observe a significant association with time to fall asleep (adjusted OR: 1.06, 95% CI: 1.02;1.10), which was not present in Model 2. Finally, the association with sleep quality follows a similar pattern to that of model 2, but with wider confidence intervals (unadjusted OR: 1.06, 95% CI: 0.98;1.15; adjusted OR: 1.02, 95% CI: 0.98;1.07).

The original analyses included different levels of adjustment, as shown in Supplementary files 8–10. We observe no major differences across adjustment levels, except for the following. First, the odds of a longer time to fall asleep for part-time workers, housekeepers, and those helping in an independent business are significantly higher in the unadjusted model compared to the model adjusting for socio-demographic variables, indicating that most of these effects are attributable to individuals' characteristics. A similar pattern is observed for waking up at night, waking up early, and total sleep time. Second, we observe minor differences in the models examining sleep characteristics when controlling for total sleep duration, suggesting

that most of the associations observed for the different measures of sleep quality are independent of sleep duration. Third, most differences across adjustment levels are observed within model 1; however, models examining working time and job satisfaction do not show significant differences across adjustment levels, indicating that the relationship between employment status and sleep is more sensitive to respondents' socio-demographic characteristics and health. We also conducted analyses on different subsamples (restricting the sample to four, three, and two waves, i.e., sample 1, 2, and 3), with no major differences in the estimates.

Discussion

Individual characteristics are often pointed out as the cause of poor sleep and low sleep duration. Alcohol consumption, cigarette smoking or unhealthy dietary habits[38] as well as being unmarried[39] indeed play a role in explaining sleep problems within the Japanese population. Policy interventions have long tried to address sleep issues in Japan with interventions targeting individual behaviours or sleep patterns (e.g. napping)[40]. Whilst these are fruitful to some extent, improving sleep among the Japanese 50+ population would also require addressing the social determinants of sleep among which work and employment play a key role.

This study identifies several work-related factors that affect sleep quality and duration—including employment status, working time and job satisfaction—among the older Japanese population but not without limitations. A first limitation concerns the dataset itself. JSTAR contains only four waves with questions on sleep quality not systematically replicated across waves. That is why we have utilised three specific sub-samples. Associations for the main exposure variables (sleep duration and overall sleep quality) were replicated across these sub-samples, showing no fundamental differences across estimates. This also explains broader confidence intervals for the variables not replicated in the first two waves. A second limitation pertains to causation. We used a directed acyclic graph (DAG) (Supplementary file 2) to illustrate how adjustment levels control for confounders and competing exposures. However, sample sizes did not allow for stratification, limiting our ability to infer causal pathways. It has been evidenced that there is a reciprocal relationship between work stress and poor sleep[41] and that low sleep quality is associated with an increase in work-related stress[42]. Similarly, poor sleep leads to fatigue, which may in turn affect work[43, 44]. By contrast, job satisfaction is recognised to be influenced by workplace determinants more than by workers' characteristics[45], thus limiting the risk of bidirectionality. Similarly, employment status and working time cannot be considered as the product of poor sleep. Nevertheless, we refrained from using causal language to avoid misleading interpretations of our findings. Finally, the use of random effects instead of a fixed effect is justified by the small number of respondents transitioning from one status (or working time pattern or job satisfaction category) to another over time.

Nevertheless, the study contributes to the current knowledge in four different ways.

First, our analyses reveal that the association between employment status and sleep is multifaceted. While overall self-reported sleep quality does not vary significantly across employment statuses, specific aspects of sleep—such as time taken to fall asleep and nighttime awakenings—show notable differences[46]. For instance, contract workers (and, to a lesser extent, temporary workers) report higher odds of sleep disturbances, including longer sleep latency and more frequent nighttime awakenings[47]. This suggests that focusing solely on overall self-reported sleep quality may obscure important variations in specific sleep dimensions that are influenced by employment conditions. These findings highlight the limitations of relying on single-item or self-reported measures of sleep quality in population-based studies, underscoring the need for more robust and multidimensional sleep assessment tools to capture the full spectrum of sleep-related outcomes.

Second, the study emphasizes the role of employment quality in shaping sleep outcomes, particularly in the context of non-standard work arrangements. Consistent with prior research linking job insecurity and precarious employment to poorer sleep[48], we find that contract and temporary workers are more likely to experience sleep disturbances[47]. This is particularly relevant in the Japanese context, where such employment arrangements are prevalent among older workers. These findings suggest that employment stability and job security are critical factors influencing sleep health, and policies aimed at improving job quality may have downstream benefits for sleep outcomes.

Third, our findings shed light on the nuanced relationship between working hours, job satisfaction, and sleep. While longer working hours are associated with shorter sleep duration and greater difficulty falling asleep[49], this relationship is largely mediated by job satisfaction. Specifically, job satisfaction absorbs much of the negative

association between extended working hours and sleep duration[50]. Additionally, we find that individuals working fewer than 20 h per week report longer sleep duration, but the relationship between part-time work and sleep quality is less clear, reflecting the heterogeneity in working conditions within this group[26]. These results underscore the need to consider both objective working conditions and subjective work experiences when examining the impact of work on sleep.

Finally, our study offers novel insights into the relationship between job satisfaction and specific aspects of sleep. While previous research has established a link between job dissatisfaction and poor sleep quality[50], our findings suggest that this relationship is attenuated when accounting for socio-demographic and health-related factors. However, job satisfaction remains a significant predictor of specific sleep disturbances, such as nighttime awakenings. We find no major differences in trends between using a single-item measure of job satisfaction and a more comprehensive job satisfaction index (although the job satisfaction index shows small confidence intervals), suggesting that both approaches capture meaningful aspects of the job satisfaction-sleep relationship. This finding has practical implications for future research, as it indicates that simpler measures of job satisfaction may suffice in certain contexts.

This study highlights several critical areas for future research. While we have established associations between non-standard employment and specific sleep disturbances, the underlying mechanisms remain underexplored. Future research should investigate potential factors, such as financial insecurity or irregular work schedules, to better understand how precarious employment impacts sleep. Additionally, the relationship between long working hours and job satisfaction requires further scrutiny. Our analyses show that controlling for job satisfaction attenuates the association between working hours and sleep duration, suggesting that job satisfaction may play an important role in this relationship. However, the nature of this relationship remains unclear and clarifying these dynamics could provide valuable insights into how work conditions affect both job satisfaction and sleep outcomes. Finally, comparative studies across diverse cultural and socio-economic contexts are needed to explore how perceptions of sleep quality and the impact of employment conditions vary globally.

Author Contribution

Conceptualisation: JW; Supervision: JW, RF; Project Administration: JW; Investigation: JW; Formal Analysis: JW; Software: JW; Methodology: JW, RF; Validation: RF; Data Curation: JW; Resources: JW; Funding Acquisition: JW; Writing − Original Draft Preparation: JW; Writing − Review & Editing: RF; Visualization: JW.

Data Access and Ethical Statement

JSTAR data can be accessed upon request to the Research Institute of Economic, Trade & Industry (RIETI): https://www.rieti.go.jp/en/projects/jstar/. JW was granted access. This study utilized fully anonymized secondary data, and in accordance with national ethical guidelines and institutional regulations, no ethical approval was required.

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Conflict of Interest

The authors report no conflict of interest. JW is a member of the Belgian Health Data Agency (HDA) user committee.

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