

## Review Article

# An Epidemiologic Review on Occupational Sleep Research among Japanese Workers

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**Abstract:** Epidemiologic sleep research on Japanese workers has been increasing in recent years. It is timely to give an overview of the sleep issues facing the Japanese working population by reviewing the accumulated epidemiological evidence, which will contribute to the promotion of a sound occupational health policy and the development of occupational sleep research in epidemiology. This paper reviews 24 studies, 13 for non-shift and 11 for shift Japanese workers, identified by using MEDLINE and Japan Cetra Revuo Medicina. The results reviewed are as follows: 1) the prevalence of insomnia and other sleep problems is substantially varied, 5 to 45% for non-shift and 29 to 38% for shift workers, 2) poor sleep quality is related to health, occupational activities and personal relations, 3) the risk or associated factors are identified in pathophysiology (e.g., hypertension), lifestyle behaviors (e.g., diet, alcohol, tobacco), job-related conditions (e.g., job stress, social support, job dissatisfaction, workload, shift schedules) and psychopathology (e.g., depressed mood). The methodological limitations found in the studies and the strategies of future epidemiologic sleep research in workers are discussed.

**Key words:** Epidemiology, Sleep, Sleep problem, Insomnia, Sleepiness, Work, Occupation, Japanese

## Background Introduction

Most epidemiologic studies of adults' insomnia or sleep complaints have come from population-based data. According to recent studies of Japanese adults in general, the estimated 1-month point prevalence of insomnia were 22.3% [95% confidence interval (CI): 20.1–24.5%] and 17.3% (95% CI: 14.6–20.0%) for men and 20.5% (95% CI: 18.4–22.6%) and 21.5% (95% CI: 18.8–24.3%) for women<sup>1-2</sup>. Based on the evidence, “Healthy Japan 21”, a national campaign to promote better health for all in the 21st century of Japan, included sleep as one of the targeted health and behavior issues<sup>3</sup>. In 2003, the labor force of Japan was approximately 66.7 million persons (60.8% of the population aged 15 or older)<sup>4</sup>. It is timely to give an overview of the sleep issues facing the Japanese working population, which may differ from those in community residents.

The aim of this paper is to provide evidence from a

synthesis of epidemiologic studies on deprived or disturbed sleep in the occupational settings of Japanese workers. Specifically, this paper reviews published studies on prevalence and putative risk factors of insomnia and other sleep problems among Japanese workers. Such epidemiological information is an essential component of a sound policy for the provision of occupational health and safety, and will contribute toward the development of occupational sleep research in epidemiology.

## Method of Studies Searched

The primary sources of publications used for this review were two basic health research databases accessed on the Internet. One was MEDLINE for use in search of research paper published in 1966–2004, studying Japanese working subjects, written in either English or Japanese. The other was Igaku Chuo Zasshi CD-ROM database, in which Japan Centra Revuo Medicina covered 2,360 medical, dental and pharmacological periodicals published in Japan between 1987

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and 2004. The following terms combined were searched in article titles and keywords to single out the articles reviewed: sleep AND epidemiology AND Japan\* AND [work\*, employ\* or job]. The superscript word with an asterisk, for example, work\*, indicates work, worker, workers, working and so forth.

## Results of Studies Reviewed

Beginning in the early 1990s, growth of the publications of epidemiologic sleep research for Japanese workers increased rapidly in more recent years. The author identified 24 separate studies, 13 for non-shift and 11 for shift workers, which estimated the prevalence of and examined the correlates of insomnia or sleep status among Japanese workers. Table 1 lists such publications with the brief summaries of reported findings in chronological order of years when the studies were conducted.

The samples of non-shift workers came from the private companies in the industry of information technology, manufacturing and finance. Hospital nurses and factory workers were the main occupations of shift work, with 6 and 5 studies, respectively. Twenty-two of the 24 studies used cross-sectional study design, and the remainder were one cohort and one sequential cross-sectional studies; sample sizes ranged from 95 to 14,509. Nine of the 13 studies on non-shift work analyzed males alone while the combined data of male and female non-shift workers were used for analyses only in 4 studies. On the other hand, over a half of the studies on shift work targeted female nurses. The ages of the subjects varied from 20 to 59 yr in most of the studies, although female hospital nurses and female rotating shift workers were relatively young.

### Prevalence

#### 1) Non-shift workers

Of the 24 studies, 17 studies were prevalence surveys<sup>5-7, 9-13, 17, 20-25, 27, 28</sup>. For non-shift workers, prevalence varied from approximately 5% to almost 29% for a symptom of insomnia defined as any complaints of difficulties in initiating sleep (DIS) and difficulties in maintaining sleep (DMS)<sup>6, 7, 9-13, 17</sup>. Poor sleep quality, more broadly defined sleep conditions including DIS and DMS based on a global score of a standardized sleep quality index, had a prevalence of almost 30 to 45%<sup>5</sup>. These findings are consistent with almost 30% of sleep problems among daytime workers reported from Israel<sup>29</sup> and the USA<sup>30</sup>. The prevalence of excessive daytime sleepiness (EDS) was nearly 7% for male and 13% for female workers<sup>6</sup>. In this study, EDS was assessed using a sleepiness

scale to measure sleep propensities in daily activities. With the same instrument, a prevalence of EDS was 10.9% among Australian workers<sup>31</sup>, which suggests the prevalence was higher in Australian male and Japanese female workers than the respective counterparts. Certainly, the findings aforementioned are not strictly comparable because of the different methods used for study subjects, sample size, case ascertainment and case definition across studies.

#### 2) Shift workers

For shift workers, the prevalence was 29 to 38% for insomniac complaints<sup>20-22, 24, 27, 28</sup> and 4 to 5% for a symptom of EDS<sup>20, 22, 25</sup>. A various kinds of combination in work shift duration, rotation and the direction of rotation formulate so many different forms of shift-work schedule. Especially from the viewpoint of cross-cultural comparability, it is hard to examine the similarities and differences in the prevalence of sleep problems between the studies conducted in and outside Japan. For example, the two-shift system applying to nurses has a different length of consecutive working hours per rota, 12 h in the foreign countries<sup>32</sup> and 16 h including a 2-h recess (from 5:00 in the evening to 9:00 in the next morning) in Japan<sup>33</sup>. As suggested by Smith *et al.*<sup>32</sup>, the situation is not entirely straightforward and consideration has to be given to working conditions and the nature of the job being done as well.

#### 3) Measures and definitions

The proportions were generated by the method of data collection (case ascertainment) based on self-reports using self-administered questionnaires. However, diverse criteria for DIS, DMS and EDS (case definition) were applied to identify cases across studies. Nakata *et al.*<sup>10, 11, 24</sup> developed three sleep questions during the last 1-yr period: (1) How long does it usually take you to fall asleep in bed? (2) how often do you have staying asleep? and (3) how often do you wake up too early and can't fall asleep again? DIS was defined as taking more than 30 min to fall asleep. DMS and early morning awakening (EMA) were defined by an answer of "almost every night" in response to the second and third questions. The presence of insomnia was defined by at least one positive response to questions regarding DIS, DMS or EMA. Kageyama *et al.*<sup>15, 21, 27, 28</sup> adopted the criteria of insomnia as any combinations of the following four symptoms: DIS, DMS, EMA and a feeling of light overnight sleep. These symptoms were considered to be positive when they occurred once or more times per week, and persisted for at least one month. Tachibana *et al.*<sup>13</sup> defined the insomniac group as subjects troubled by any three sleep

problems, DIS, DMS and EMA, in the month preceding survey. Those who answered “always” or “often” to the question “Do you have a symptom of sleep disturbance?” were considered as the symptom-present group in the study of Motohashi *et al.*<sup>17)</sup>. Suka *et al.*<sup>7)</sup> defined DIS and DMS by a answer “always” or “sometimes” to the questions of “falling asleep with difficulty”, “awakening many times in the night” and “awakening once in the night and falling asleep again with difficulty”, respectively. They made the additional definitions of persistent DIS and persistent DMS; the symptoms were reported at every annual health examination during the 5-yr follow-up period. There were found no detailed statement of DIS, DMS or insomnia defined in the studies<sup>9, 12)</sup>. Ohida *et al.*<sup>20, 22)</sup> drew the items from the Pittsburgh Sleep Quality Index (PSQI)<sup>34, 35)</sup>: (1) How often have you not fallen asleep within 30 min? (2) how often have you woken up during the night? and (3) how often have you had trouble staying awake while driving, eating or engaging in social activities? DIS, DMS and EDS were defined when one answered “three or more times a week in the past month” to the corresponding questions.

The PSQI assesses subjective sleep during the previous month and generates 7 component scores (range of a component score, 0–3): sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. The sum of these 7 component scores yields 1 global score of subjective sleep quality (range, 0–21); high scores represent more sleep complaints. A global PSQI score greater than 5 distinguishes healthy control from sleep-disordered patients with high sensitivity and high specificity<sup>34, 36)</sup>. Thus, Doi *et al.*<sup>5)</sup> defined those with a global score of greater than 5 in the PSQI as poor sleepers. Similarly, they used to assess EDS with the Epworth Sleepiness Scale (ESS)<sup>6)</sup>, and defined those with an ESS global score of 11 or more as being impaired in their daily activities by their extraordinary sleepiness<sup>37, 38)</sup>.

### Impact

Workers with sleep problems may intuitively recognize that their work productivity decreases due to their disturbed sleep (e.g., absenteeism and reduction of labor efficiency). Doi *et al.*<sup>5)</sup> presented that daytime white-collar employees with poor sleep quality were more likely to take sick leave (odds ratios, OR=1.9, 95% CI: 1.6–2.2), suffer from poor physical (OR=4.3, 95% CI: 3.6–5.1) and psychological health (OR=5.0, 95% CI: 4.2–6.0), have problems in occupational activities (OR=2.4, 95% CI: 1.6–3.6), and personal relationships (OR=2.4, 95% CI: 1.6–3.8) than those with good sleep quality. However, traffic or any other accidents

did not produce statistical significance in relation to poor sleep quality (OR=1.48, 95% CI: 0.95–2.32), because of a small number of accidents actually occurred for a 1-month period and a possibility of some accidents unreported.

Further investigation is needed to confirm the causal effects of poor sleep quality to health, safety, and quality of professional and personal life among workers over a long period of time.

### Correlates

#### 1) Non-shift workers

Most of the studies reviewed here tried to detect risk or associated factors of sleep problems (e.g., DIS, DMS, EMA, insomnia, poor sleep quality, EDS)<sup>5–7, 9–14, 16–25, 27, 28)</sup> and sleep length<sup>8, 15, 26)</sup>. Main research topics on sleep correlates in the studies for non-shift workers could be categorized into four: (1) pathophysiology<sup>5–7, 9)</sup>; (2) life-style behaviors<sup>5, 8, 14, 17)</sup>; (3) job-related conditions<sup>5, 6, 10–13, 15)</sup>; and (4) psychopathology<sup>5, 6, 10, 16, 17)</sup>.

Kawaguchi *et al.*<sup>5)</sup> reported the association of DMS with a multifaceted syndrome<sup>39, 40)</sup>, a clustering of metabolic disorders including hypertension, obesity, lipid abnormalities, non-insulin-dependent diabetes mellitus and atherosclerotic cardiovascular disease, and implied the possibility that a specific higher activity of metabolic status might cause sleep disorders. On the contrary to their assumption, however, Suka *et al.*<sup>7)</sup> suggested that persistent insomnia may predict of occurring or developing hypertension, as a major risk factor of cardiovascular diseases, in Japanese male workers followed for the 5-yr period. They also suggested that the three-way relationships among insomnia, hypertension and cardiovascular diseases should be fully examined in future because the potential interaction between insomnia and hypertension may lead to excessive cardiovascular morbidity and mortality. Doi *et al.*<sup>5)</sup> also found the significant relationship between hypertension and poor sleep quality, but reserved the conclusion on causal or interaction effects among poor sleep quality, hypertension itself and the side effect of antihypertensives, because of its nature of a cross-sectional study.

Sleep duration less than 6 h was significantly associated with unhealthy dietary habit in male industry workers<sup>8)</sup>. The other study also found unhealthy dietary habit as a male characteristic feature of life-style behaviors associated with insomnia, while that study did not detect it but sleep length and smoking as the associated factors in female counterparts<sup>14)</sup>. Mental stress, exercise and working hours were the significant correlates commonly found for both male and female workers in that study. Unhealthy sleep/

**Table 1. Epidemiologic studies on sleep of Japanese workers**

Study Conducted year, Author	Subject	Prevalence	Impact/Correlate
<b>NON-SHIFT WORKER (13 studies)</b>			
2000, Doi Y <i>et al.</i> <sup>5)</sup>	4,003 male and 865 female white-collar workers aged 20–59 yr, working at a telecommunications company	32.6–43.9% in men and 41.8–44.6% in women of poor sleep quality including DIS and DMS	Poor sleep quality significantly impacts on perceived health, sick leave, occupational performance and personal relationships. Perceived stress, job dissatisfaction, hypertension, poor bedroom conditions, being single and younger age are the correlates of poor sleep quality.
1999, Doi Y <i>et al.</i> <sup>6)</sup>	3,909 male and 813 female white-collar workers aged 20–59 yr, working at a telecommunications company	7.2% and 13.3% of EDS, 24.0% and 28.6% of DIS or DMS, 17.8% and 13.9% of daily sleep/wake variability, and 4.1% and 4.6% of less than 5 h of sleep in men and women, respectively	Deprived sleep, an irregular sleep-wake schedule, depression are the associated factors of EDS for both genders. Being married works as a protective factor of EDS for men alone.
1994–1998, Suka M <i>et al.</i> <sup>7)</sup>	8,333 male office workers aged 40–55 yr	4.0% of persistent DIS and 6.4% of persistent DMS	Persistent complaints of DIS and DMS are the risk factors of hypertension.
1992–1998, Imaki M <i>et al.</i> <sup>8)</sup>	1,652–1,860 male industrial workers aged 20–59 yr, working at a chemical plant between 1992 and 1998	16%, 83% and 1% of less than 6, 6–9, and 9 and more hours of sleep, respectively, through the years	Those with less than 6 h of sleep are more likely to take unhealthy dietary habit than those who sleep 6–9 h nightly. The associations of sleep duration with other lifestyle behaviors (tobacco, alcohol, exercise) are not identified.
1998, Kawaguchi H <i>et al.</i> <sup>9)</sup>	14,509 male workers aged 30–59 yr, working at a telecommunications company	2.7% of DIS, 3.6% of DMS, and 5.2% of DIS or DMS	Multiple risk factor syndrome is associated with DMS alone.
1997, Nakata A <i>et al.</i> <sup>10)</sup>	1,161 male white-collar workers aged 23–59 yr, working at an electronic equipment manufacturing company	23.6% of insomnia (DIS, DMS or EMA): 11.3% of DIS, 14.2% of DMS, and 1.9% of EMA	Psychological job stress factors (e.g., inter-group conflict, job dissatisfaction, low social support, and depression) are associated with insomnia complaints.
1997, Nakata A <i>et al.</i> <sup>11)</sup>	1,161 male white-collar workers aged 23–59 yr, working at an electronic equipment manufacturing company	26.0% of insomnia (DIS, DMS or EMA): 11.3% of DIS, 14.1% of DMS, and 2.0% of EMA	EMA and EDS are prevalent for older and younger workers, respectively. Insufficient sleep is more remarkable in professional, technical and managerial workers than clerks.
1994, Minowa N <sup>12)</sup>	2,171 male IT engineers aged 21–60 yr, working at a telecommunications company	20.3% of a complaint of insomnia	Insomnia is correlated to quantitative and qualitative workload, difficulty in job, inter-personal problems, and younger age.
1992, Tachibana H <i>et al.</i> <sup>13)</sup>	271 male white-collar workers aged 18–64 yr, working at a manufacturing company	10.0% of DIS, 22.8% of DMS, 13.3% of EMA, and 27.7% of DIS or DMS	Visual display terminal work is associated with all types of sleep complaints, while over-involvement in job with DIS and EMA.
1989, Ezoe S <i>et al.</i> <sup>14)</sup>	2,132 male and 668 female workers aged 20–59 yr, working at a camera manufacturing company	N/A	Anxiety-insomnia in the GHQ-28 is associated with mental stress, nutritional balance, eating breakfast, exercise and working hours for men and mental stress, exercise, working hours, sleeping hours and smoking for women.
N/A, Kageyama T <i>et al.</i> <sup>15)</sup>	232 male and 28 female workers aged 20–59 yr, working at a publishing company	436 min, 391min and 461 min of sleep length required everyday (RSL), on weekdays (SLW), and on weekends (SLH), respectively	The associated factors are younger age, recent life event for RLS, overtime work, commuting time and workload for SLW. SLH is inversely correlated to commuting time and workload.
N/A, Fukunishi I <i>et al.</i> <sup>16)</sup>	171 male workers aged 46.4 (± 6.3) yr, working at an electronic company	N/A	Non-restorative sleep and EDS are associated with depression and confusion in alexithymic men.
N/A, Motohashi Y <i>et al.</i> <sup>17)</sup>	140 male and 64 female bank workers	7.1% of sleep always disturbed, 24% of dailysleep/wake variability, 15% of less than 5 h of sleep, 24% of dissatisfied sleep, and 34% of non-refreshment on rising in the morning	Psychosomatic health complaints of sleep disturbances, fatigue, digestive troubles and depressive mood are associated with sleep habits and perceived mental stress.

Table 1. (continuation)

Study Conducted year, Author	Subject	Prevalence	Impact/Correlate
SHIFT WORKER (11 studies)			
2001, Masuda Y <sup>18)</sup>	172 general (35.2 ± 9.6 yr old) and 232 psychiatric (42.6 ± 10.4 yr old) hospital nurses	N/A	The score of sleep disturbance in the GHQ-30 is higher (2.9 ± 1.7) in general than psychiatric (2.4 ± 1.8) hospital nurses.
2001, Masuda Y <i>et al.</i> <sup>19)</sup>	403 general hospital nurses and 245 female white-collar workers	N/A	The score of sleep disturbance in the GHQ-30 is higher in general hospital nurses (2.8 ± 1.7) than in female white-collar workers (2.5 ± 1.7).
2000, Ohida T <i>et al.</i> <sup>20)</sup>	2,496 nurses aged 20–59 yr, being engaged in three × 8-h rotating shift work at a university hospital in Tokyo, 2 public hospitals in Mie and 2 public hospitals in Fukui	12% and 19% of DIS, 27% and 25% of DMS, 6% and 6% of EMA, 4% and 5% of EDS in daytime and night shift work, respectively	The correlates of sleep disorders are night shift work, anxiety or stress, less than 6 h of sleep, a university hospital in Tokyo, and having children.
1999, Kobayashi T <i>et al.</i> <sup>21)</sup>	293 male engineers aged 25–56 yr, working at an electronic equipment manufacturing company	10.4%, 15.9% and 34.5% of insomnia, 3.9%, 11.4%, and 19.3% of DIS, 4.5%, 9.1% and 17.2% of DMS, 2.6%, 9.1% and 13.8% of EMA in daytime, fixed night shift and two-rotating-shift work, respectively	Two-rotating-shift work is the worst in sleep as well as depressed mood among the three types of work schedules.
1999, Ohida T <i>et al.</i> <sup>22)</sup>	600 female university and national hospital nurses (23.9 ± 1.6 yr old), being engaged in two-shift including 16-h night shifts and three shift systems	12% and 23% of DIS, 18% and 20% of DMS, 3% and 6% of EMA, 0% and 4% of EDS in daytime and night shift work, respectively	There are the associations of night shift-work with alcohol use to induce sleep, and of less than 6 h of sleep with DIS and EDS. There is significant difference in subjective sleep quality between the two- and three-shift works.
1998, Sudo N <i>et al.</i> <sup>23)</sup>	129 female workers working at a computer factory: 45 daytime (27.3 yr old), 40 early-shift (26.2 yr old), and 44 late-shift (24.8 yr old) workers	4.4–22.2%, 9.1–27.3% and 20.0–62.5% of DIS, 13.3–24.4%, 4.5–11.4%, 17.5–37.5% of DMS, and 2.2–11.5%, 2.3–18.2%, 2.5–15.0% of EMA in daytime, late-shift and early-shift workers, respectively	The sleep problem scores are the highest in the early-shift workers through weekdays and weekends.
1997, Nakata A <i>et al.</i> <sup>24)</sup>	530 male shift workers aged 18–59 yr, working at an electronic equipment manufacturing company	37.8% of insomnia (DIS, DMS or EMA)	Insomnia is associated with social support, while it is not associated with job demand or job control.
1997, Inoue Y <i>et al.</i> <sup>25)</sup>	332 rotating-shift and 332 daytime workers (37.9 ± 10.2 yr old), working at industrial companies	7.2% and 5.4% of dozing off while driving or working in daytime and shift workers, respectively	Those with a disordered condition due to shift work (DCSW) are engaged in shift work for a shorter period and drink alcohol more habitually than those without DCSW.
N/A, Kawada T <i>et al.</i> <sup>26)</sup>	95 male shift workers aged 19–59 yr, being engaged in three rotating shift schedules	6.0–6.9, 7.1–7.4 and 7.7–7.9 h of sleep in morning, night and evening shift work, respectively	Sleep length is affected by rotating shift work and age. No errors were recognized during the 3-wk survey period.
N/A, Kageyama T <i>et al.</i> <sup>27)</sup>	149 female general hospital nurses (27.6 ± 6.8 yr old), being engaged in three × 8-h rotating shift work	31.7% of DIS, 16.2% of DMS, 9.9% of EMA, 22.2% of light overnight sleep, 37.3% of any sleep complaints (insomnia)	Insomnia is associated with hypnotic use, younger age, 6 or less non-working days per month, 5 or more night shifts per month, smoking and difficulty in relationships with patients.
N/A, Kageyama T <i>et al.</i> <sup>28)</sup>	555 female hospital nurses aged 59 yr or younger, being engaged in two- and three-rotating shift work	23.5% of DIS, 11.9% of DMS, 9.8% of EMA, 15.8% of light overnight sleep, 29.2% of any sleep complaints (insomnia), 23% of hypnotic medication use among insomniacs	The associated factors with insomnia are younger age, 6 or less non-working days per month, less social support and taking care of severely ill patients.

DIS, DMS, EMA and EDS mean difficulty in initiating sleep, difficulty in maintaining sleep, early morning wakening, and excessive daytime sleepiness, respectively. GHQ is the abbreviation of General Health Questionnaire. N/A means not available for information on a year of study conducted or a prevalence of sleep problems. Study design is cross-sectional, except for cohort<sup>7)</sup> and sequential cross-sectional<sup>8)</sup> studies. The numerical superscripts correspond to the reference numbers of studies listed in references.

wake practice (e.g., short sleep duration, and daily irregular variability of rising time and bedtime) was related to EDS<sup>6</sup> and sleep disturbances<sup>17</sup>.

Various job-related factors were identified with insomnia, poor sleep quality and deprived sleep: heavy work load or overwork<sup>12, 15</sup>; difficulty in job<sup>12</sup>; over commitment in job<sup>13</sup>; intra-group conflict or interpersonal problems<sup>12, 15</sup>; low social support<sup>10</sup>; and job dissatisfaction<sup>5, 10</sup>. Perceived job stress was associated with poor sleep quality<sup>5</sup> and sleep disturbed<sup>17</sup>, and so was depressed mood with insomnia<sup>10</sup>, disturbed sleep<sup>17</sup> and EDS<sup>6, 16</sup>. The younger was a risk group for either poor sleep quality<sup>5</sup>, excessive sleepiness<sup>6</sup>, sleep loss<sup>15</sup> or insomnia<sup>12</sup>.

## 2) Shift workers

How does the shift work system affect sleep, health and well-being of people? Previous research well documented the adverse effects of shiftworking<sup>41</sup>. As shown in the studies of this review, for example, insomnia was more prevalent among shift workers than among non-shift ones (38% versus 26%); both groups were employed at the same company and assessed using the same instrument and definition of sleep complaints<sup>11, 24</sup>. The other study also showed that two-rotating shift, fixed night shift and daytime works were in order of prevalence of sleep complaints and depression in male manual workers<sup>21</sup>. A disordered condition due to shift work or a shift work sleep disorder correlated with the length of being engaged in work and habitual alcohol drinking<sup>25</sup>. Regarding work shift rotation, early or morning shift was the worst in insomnia and the shortest in sleep length for female and male three-rotating shift workers, respectively<sup>23, 26</sup>. Concerning work shift duration, the system commonly comprises two categories of three × 8-h shifts and two × 12-h shifts. According to a review comparing these two systems<sup>32</sup>, much of the evidence suggests few differences between eight and 12 h shifts in sleep, health and well-being. In recent years, the two shift systems have been introduced to nurses at an increasing number of general hospitals in Japan, from 25.1% in 1995 to 33.9% in 1999<sup>33</sup>. Significant differences were observed in subjective sleep quality between the two shift systems including 16-h night shifts and the traditional three shift systems in young female nurses<sup>22</sup>. However, job performance, errors and accidents, absenteeism and turnover have not been examined for the nurses being engaged in extraordinarily extended work of consecutive 16 h per rota in this study<sup>22</sup>. The effects of long-term exposure to extended workdays and compressed working weeks yet remains to be known. Short sleep duration, stress, younger age, having children, alcohol or medication use to aid induce sleep,

smoking, the frequency of non-working days and night shifts, social support, patient-nurse communications and the severity of patient's health conditions were suggested as putative risk factors for insomnia and sleepiness in some nurse studies<sup>20, 22, 27, 28</sup>.

## Future Perspectives for Occupational Sleep Research

This paper reviewed the current state of epidemiologic sleep research on Japanese workers conducted for nearly these ten years. In summary, the results reviewed are as follows. Firstly, the prevalences of sleep problems were substantially varied among Japanese workers. Being rounded, the proportions were 5 to 29% and 29 to 38% of a symptom of insomnia for non-shift and shift workers, respectively. For non-shift workers, poor sleep quality was 33 to 44% and 42 to 45% for men and women, and excessive daytime sleepiness was 7% and 13% for men and women, respectively. Secondly, poor sleep quality was related to perceived health, sick absence, occupational activities and personal relations. Lastly, risk or associated factors of sleep problems were identified in pathophysiology (e.g., hypertension), life-style behaviors (e.g., diet, alcohol, tobacco), job-related conditions (e.g., job stress, social support, job dissatisfaction, workload, shift schedules) and psychopathology (e.g., depressed mood).

As seen in the preceding section, the research is very much in progress, even with several limitations inherently found in cross-sectional studies depending on self-reports using non-standardized case ascertainties and definitions. Now the next stage has come, when occupational sleep epidemiologists should challengingly resolve these methodological issues to provide more informative evidence for occupational health policy, litigations and services. In addition, the author would like to stress the following three points for future occupational sleep research in epidemiology.

Firstly, most of the studies reviewed targeted a very limited sample of study subjects, such as full-time male workers employed at large-scale private companies as daytime workers and female nurses working at public or university hospitals as shift workers. More evidence on contingent workers, owners or employees in medium- to small-size business, and female workers is needed because they comprise the bulk of Japanese workforce and may be more adversely affected by deprived or disturbed sleep connecting to their working and living conditions.

Secondly, hard outcomes on safety should be more rigorously evaluated and investigated, linking with sleep/

wake status and time management at workplace. The number of traffic accidents on highways, explosions or fires at factories, and medical errors in hospitals or clinics may not be caused solely by individual unskilled performance and inexperience in profession, rather, partly due to the working conditions tightly scheduled.

Finally, the well-designed occupational interventions for ensuring good sleep should be planned, put into action, and judged the extent to which the interventional effects consequently have on health, safety, productivity and well-being of workers and our society as a whole.

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