Insomnia in shift work

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Abstract

Background: Shift work disorder involves insomnia and/or excessive sleepiness associated with the work schedule. The present study examined the impact of insomnia on the perceived physical and psychological health of adults working on night and rotating shift schedules compared to day workers.

Methods: A total of 418 adults (51% women, mean age 41.4 years), including 51 night workers, 158 rotating shift workers, and 209 day workers were selected from an epidemiological study. An algorithm was used to classify each participant of the two groups (working night or rotating shifts) according to the presence or absence of insomnia symptoms. Each of these individuals was paired with a day worker according to gender, age, and income. Participants completed several questionnaires measuring sleep, health, and psychological variables.

Results: Night and rotating shift workers with insomnia presented a sleep profile similar to that of day workers with insomnia. Sleep time was more strongly related to insomnia than to shift work per se. Participants with insomnia in the three groups complained of anxiety, depression, and fatigue, and reported consuming equal amounts of sleep-aid medication. Insomnia also contributed to chronic pain and otorhinolaryngology problems, especially among rotating shift workers. Work productivity and absenteeism were more strongly related to insomnia.

Conclusion: The present study highlights insomnia as an important component of the sleep difficulties experienced by shift workers. Insomnia may exacerbate certain physical and mental health problems of shift workers, and impair their quality of life.

1. Introduction

Shift work is highly prevalent in industrialized societies, representing about 30% of the Canadian workforce [1]. This work schedule characterizes a wide variety of professions such as police officers, truck drivers, air traffic controllers, airline pilots, nuclear power plant operators, and nurses [2]. These professionals expose themselves and their society to significant risks that endanger human lives, as they are more likely to experience sleepiness and reduced alertness that negatively affect their work performance [3-5]. It is estimated that about 32% of night workers [6-8], 10% of dayworkers [8], and 8-26% of rotating shift workers [6] suffer from shift work disorder (SWD). The International Classification of Sleep Disorders-II (ICSD-II) [9] defines SWD as the presence of insomnia and/or excessive sleepiness temporally associated with a habitual work schedule that overlaps usual sleep time. Both insomnia and excessive sleepiness are likely to occur among night shift workers and to interfere with their quality of life. These sleep difficulties are closely related to the sleep regulation system, and are explained mainly by the fact that the work schedule is out of phase with, and often in direct opposition to, the endogenous circadian rhythms [10,11].

Several negative consequences attributed to shift work schedules have been reported for workers, their employers, and society in general. Many studies on shift work populations have shown that shift and permanent night work may cause various problems for employees [12-15]. For instance, physical and mental health can be severely affected by stress and sleep deprivation [14]. Knutsson [13] reported that night work is strongly linked to disorders such as gastrointestinal and cardiovascular diseases, diabetes and metabolic disturbances, cancer, and complications in pregnancy. Other studies [12,15] have associated night work with a higher risk of developing breast and endometrial cancers, because exposure to light at night suppresses melatonin biosynthesis and deregulates circadian genes involved in cancer-related pathways [16].

Shift workers can experience difficulties in falling asleep, and report diminished sleep time and sleepiness during work hours [3,17]. Night workers often complain of family and social difficulties, as they are out of phase with activities that follow the diurnal rhythm of the general population [4,18]. Shift work seems to increase the risk of marital separations by 7-11% [19]. Further difficulties appear within the workplace: shift workers show chronic fatigue and anxiety that lead to work dissatisfaction [20]. Both productivity and safety may also be compromised, especially over successive night shifts [21]. These results all show that the negative consequences of shift work are far-reaching and widespread.

It is unclear whether shift work per se explains the consequences attributed to the work schedule, or whether they are the result of SWD. Most authors consider that the sleep difficulties are simply part of the overall negative consequences attributed to shift work. However, it is also well documented that sleep disorders such as insomnia have specific consequences that are independent of the context in which they appear. In the context of shift work, therefore, it may not be easy to parcel out the contributions of shift work per se and SWD (including insomnia), as these variables can be expected to produce similar symptoms, such as depression and anxiety [22], higher risk of motor vehicle accidents [4], work absenteeism, impaired work performance, and increased risk of work-related accidents [23-26]. Insomnia might also aggravate symptoms associated with the work schedule.

Some studies have attempted to more clearly identify the impact of SWD on the health of shift workers [4,6-8,27-29].Workers with SWD seem to maintain a circadian phase similar to that of day workers [29]. SWD was shown to be related to an increased risk of depression, sleepiness, hypertension, anxiety, absenteeism, and road accidents, as well as decreased work performance. Workers with SWD also showed a severely impaired quality of life [7,8,28]. Which of these negative consequences of SWD can be

attributed to the insomnia symptoms included in SWD? In order to tease out the negative impact of insomnia symptoms on shift workers, a two-by- two comparison needs to be made: shift workers with or without insomnia versus day workers with or without insomnia. Several studies have compared shift workers with day workers [6-8,11,27,30-32] but only two seem to have distinguished day workers according to presence or absence of insomnia [6,11]. In one of these studies [11], the authors concluded that shift workers without SWD are similar to day workers. The other study showed that rotating shift workers with both insomnia and sleepiness had more absenteeism, whereas rotating shift workers with only insomnia were absent more from family and social activities [6]. It would appear that the negative consequences attributed to shift work may be confounded with those related more specifically to insomnia.

The present study specifically addresses the negative impacts of insomnia on the perceived physical and psychological health of shift workers by comparing them to day workers. Second, the study investigates the impact of insomnia on the quality of life, work, and lifestyle habits of shift workers.

2. Method

2.1. Study context

Data analyzed in this study were derived from a larger epidemiological study conducted in Canada. The goals of the original study were to estimate the prevalence of insomnia symptoms and insomnia syndrome in the general population, and to describe the types of consultation initiated for insomnia and products and strategies used to promote sleep. Furthermore, the initial study aimed at evaluating incidence rate and risk factor for insomnia. The first step was a telephone survey to document the prevalence of insomnia [33]. Inclusion criteria yielded a sample composed of English and French speaking residents of Canada, aged ≥18 years. Two sampling procedures were employed: the random digit dialing method, which generates geographically stratified

phone numbers, and the Kish method [34], which designates the person to be interviewed in the household. At the conclusion of the telephone interview, participants were asked if they would agree to take part in the longitudinal phase of the study. Seven mail-in evaluations were scheduled over the 5-year longitudinal phase, the first evaluation to be sent 1 month after the telephone interview, the second evaluation at 6 months, and the remaining evaluations scheduled every 12 months. This research was approved by the ethical committee of the Université Laval.

2.2. Measures

Participants completed French versions of the validated self-report measures at each assessment period. Measures retained for the present study covered four general domains: sleep, psychological symptoms, physical health, and work and lifestyle habits.

2.2.1. Sleep measures

2.2.1.1. Insomnia Severity Index (ISI). This seven-item questionnaire assesses the severity of problems related to sleep onset, sleep maintenance, and early-morning awakening, as well as satisfaction with sleep, perceived interference of sleep problems with daytime functioning, noticeability of sleep problems by others, and stress [35]. A five-point Likert scale, where 0 represents ‘not at all’ and 4 represents ‘extreme’, is used to rate each of these items, yielding a total score ranging from 0 to 28; higher scores indicate more severe insomnia. Guidelines for scoring were classified into four categories: no clinically significant insomnia (0-7); subthreshold insomnia (8-14); moderately severe clinical insomnia (15-21); severe clinical insomnia (22-28) [36]. The ISI has been shown to have adequate psychometric properties for day workers [36].

2.2.1.2. Pittsburgh Sleep Quality Index (PSQI). This 19-item questionnaire evaluates sleep quality and disturbances over a 1-month period [37]. The first four items are open questions, whereas items 5-19 are rated on a four-point Likert scale. Component scores include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency,

sleep disturbances, use of sleep-promoting medication, and daytime dysfunction. A total score, ranging from 0 to 21, is obtained by adding the seven component scores. A score >5 indicates poor quality of sleep. The psychometric properties of the PSQI are adequate, especially with respect to diagnostic sensitivity (89.6%) and specificity (86.5%). The French-Canadian version has been validated and has adequate psychometric properties [38].

2.2.1.3. Epworth Sleepiness Scale (ESS). This scale comprises eight items evaluating sleepiness on a Likert scale from 0 to 3; total scores vary between 0 and 24, a higher score indicating substantial sleepiness, which increases the risk of unexpectedly falling asleep [39]. This questionnaire is widely used with shift workers.

2.2.1.4. Pre-Sleep Arousal Scale (PSAS). This 16-item questionnaire measures the intensity of somatic (eight items) and cognitive (eight items) arousal [40]. Participants rate each item on a 1-5 Likert scale. Scores indicate the intensity of arousal experienced while going to sleep the previous night. The PSAS has adequate psychometric properties, notably high internal consistency and an adequate stability [40].

2.2.1.5. Dysfunctional Beliefs and Attitudes about Sleep Scale, 30- item version (DBAS-30). This scale measures sleep-related cognitions: participants rate each item on a 0-10 Likert scale, where 0indicates strong agreement and 10 expresses strong disagreement [35]. The total score is the mean of the 30 items, higher scores indicating strong endorsement of dysfunctional beliefs and attitudes concerning sleep. The DBAS has adequate psychometric properties with day workers [41-43].

2.2.1.6. Multidimensional Fatigue Inventory (MFI). This measure is composed of 20 statements for which the participant indicates, on a five-point Likert scale, the extent to which the item currently applies to him or her [44]. The questionnaire measures five dimensions of fatigue: general fatigue, mental fatigue, physical fatigue, reduced activity, and reduced motivation. Scores vary between 4 and 20 for each scale, higher scores

indicating greater fatigue. The internal consistency and construct validity of this scale are both adequate.

2.2.2. Psychological measures

2.2.2.1. Health-related quality of life (SF-12 Health Survery Version 2). This measure is a short version of the SF-36, the most widely-used health survey [45]. The 12 items are rated on a five-point Likert scale, and eight subscores are derived from the answers (physical functioning, physical role, body pain, general health, vitality, social functioning, emotional role, and mental health). The psychometric properties of the SF-12v2 are adequate, with reliability coefficients for the eight subscales ranging from 0.73 to 0.87 in the general population [46]. A French-Canadian version was used.

2.2.2.2. Beck Depression Inventory (BDI-II). This measure is widely used to assess symptoms of depression, containing 21 items rating symptoms experienced during the preceding week on a four-point Likert scale (0-3) [47]. Total scores range from 0 to 63, with higher scores suggesting more severe depression symptoms. The psychometric properties of the French version are well documented and equivalent to those of the original English version [47].

2.2.2.3. State–Trait Anxiety Inventory (STAI–State and STAI–Trait). This inventory assesses anxiety as both a state and a trait [48]. Each subscale has 20 items rated on a four-point Likert scale, where 1 indicates ‘not at all’ and 4 signifies ‘a lot’. Total scores range from 20 to 80. The psychometric properties of the STAI are excellent [48], as are those of the French-Canadian adaptation used in this study [49].

2.2.2.4. Perceived Stress Scale (PSS). This 14-item scale measures the frequency of stressful events and situations experienced during the previous month [50]. Participants rate the frequency of each item on a five-point Likert scale, where 0 indicates ‘never’ and 4 signifies ‘very often’. Higher scores indicate that the person experiences life as unpredictable and uncontrollable. The PSS has adequate test-retest reliability (0.85) and

internal consistency (0.80), and is correlated with a range of self-report and behavioral criteria [50]. A French-Canadian version of the questionnaire was used in the present study.

2.2.3. Health and lifestyle measures

Several questions assessed use of sleep-promoting products (prescribed and over-the-counter medication), medical conditions, use of alcohol, coffee, and cigarettes, and physical activity. The specific questions were: 'During the past month, how many nights per week have you taken prescribed medication to help you sleep?' and 'During the past month, how many nights per week have you taken over the- counter medication to help you sleep?' For medical conditions: 'Presently do you suffer from one or more of the following medical conditions?' Participants ticked pertinent items from a list; for alcohol and coffee consumption: 'How many items do you consume a day?' for cigarette consumption: 'Do you smoke cigarettes, cigars or a pipe?' Participants chose an answer from 'yes, everyday', 'yes, occasionally' and 'no'. For physical activity: 'How many times during the week do you exercise for more than thirty minutes?' Participants chose an answer from 'every day' to 'never'.

The Work Productivity and Activity Impairment questionnaire (WPAI) [51] measures work time missed and work activity impairment over the previous week as a consequence of a health problem, in this case insomnia. The WPAI-insomnia is composed of eight questions that specify: work hours missed due to the health problem; work hours missed for any other reason such as holidays; hours actually worked; extent to which health problems affected work productivity; extent to which insomnia affected work productivity; extent to which health problems affected daily activities; and relation between insomnia and decreased productivity. The last four questions are answered on a Likert scale from 1 to 10. Scores are expressed as percentage of impairment, with higher scores indicating greater impairment. A French version of the measure was used.

2.3. Participants and procedure

Participants selected the category that best described their present work schedule from the following choices: ‘day work’, ‘evening work’, ‘night work’ and ‘rotating work’. A total of 209 participants reported either night work (51) or rotating work (158). These participants were selected from a group of 3962 individuals who participated in a larger epidemiological study. Each participant was classified according to the presence or absence of insomnia as a function of a specific algorithm [33,52]. The algorithm is based on the DSM-IV [53] and ICD-10 [54] diagnostic criteria and the use of sleep-promoting medication. For each assessment, the algorithm used responses to selected items of the ISI and PSQI, and to questions addressing sleep-promoting medication usage. The algorithm resulted in the classification of participants into three groups: good sleepers, insomnia symptoms, and insomnia syndrome. For the purpose of the present study, the insomnia symptoms and syndrome groups were combined. Therefore, our insomnia group included participants who were dissatisfied with their sleep, reported a sleep onset latency or time awake during the night >30 min, and distress or daytime consequences related to their sleep problems. Insomnia had to be present at least three nights per week for more than 1 month. All participants in the insomnia group were dissatisfied with their sleep and met at least one other criterion. None of them were short sleepers and satisfied with their sleep. Only one participant reported using medication to promote sleep three times a week and did not report any other insomnia symptoms. Finally, participants reporting symptoms of another sleep disorder, such as sleep apnea or periodic limb movement disorder, were excluded from our sample. Good sleepers satisfied with their sleep (score of ≥2 on ISI item 2) did not report insomnia symptoms, and had not used prescribed or over-the-counter medication as a sleep promoting agent in the previous month. Furthermore, day workers reported a time for going to bed ranging from 20 h 00 min to 23 h 59 min whereas for night workers the time for going to

bed varied mainly from 7 h 00 min to 18 h 00 min, and from 7 h 30 min to 2 h 00 min for rotating workers.

When night and rotating shift workers had been classified either into the insomnia or into the good sleepers group, they were paired with a day worker (n = 209) in the same group classification (insomnia or good sleepers), age, gender, and reported income. Thus, participants were paired according to presence or absence of insomnia, age, gender, and reported income. Participant characteristics are presented in Table 1. No significant differences were found between groups on the matching variables, thus confirming the adequacy of the matching procedure. The 209 day workers paired with night or rotating shift workers were used as control group. There were 2019 day workers for whom data on age, gender, and sleep were available in the whole cohort of 3962 participants. From these day workers, 42.3% (n = 855) were classified into the insomnia group with a mean age of 44.3 years (standard deviation, 11.1). Therefore, the 209 paired day workers were representative of the overall day worker participants.

The total sample used in the present study included 418 adults (214 women) with a mean age of 41.4 years (range, 19-68 years). Two-thirds of the participants (64.6%) were married or in common law relationships, and marital status varied significantly across groups [$\chi^2(8) = 18.7$, $P = 0.016$]. Night and rotating shift workers were predominantly married. The majority of workers in all groups finished high school or more. Overall, 91.1% of workers reported having a full-time job, although there were significant differences between groups, from 100% of day workers to 76% of night workers.

2.4. Data analysis

Raw data were entered by two independent research assistants and compared to insure accuracy. Distributions for main outcomes were checked for normality and outliers. Outliers were examined according to an alpha level of 0.001 and treated as

missing values when exceeding the criterion. All statistical analyses were conducted using the SPSS statistical software package (version 13.0; SPSS Inc., Chicago, IL, USA). Descriptive statistics were compiled for sociodemographic variables. Continuous dependent variables were analyzed with randomized factorial analysis of variance using a 3 (work group) × 2 (sleep group) design. Interactions were investigated by a-posteriori multiple comparisons with Bonferroni correction (family-wise alpha: two-tailed 5%). For dichotomous variables, standard logistic regression was conducted to examine the contribution of work schedule, insomnia, and their interaction with dichotomous health variables.

3. Results

3.1. Sleep measures according to work schedule and sleep status

Table 2 shows the means and standard deviations for sleep variables according to work schedule and sleep status. Across work schedule groups, there were significant differences in sleep quality only. Night and rotating shift workers had poorer sleep quality than day workers [$F(2, 412) = 6.24$, $P = 0.029$]. In addition, night workers had a nearly significant ($P = 0.06$) tendency towards higher pre-sleep arousal and to take longer to fall asleep ($P = 0.08$). Apart from sleep quality, most differences found were between good sleepers and individuals with insomnia (INS) independent of work schedules. INS had significantly more severe insomnia and poorer sleep quality than did good sleepers as measured by ISI and PSQI [$F(1, 412) = 251.29$ and $F(1, 410) = 48.03$, both $P < 0.001$, respectively]. SOL and WASO were significantly longer for INS [$F(1, 408) = 49.08$; $F(1, 401) = 81.48$, $P < 0.001$]. Furthermore, INS showed significantly less TST than good sleepers [$F(1, 407) = 27.66$, $P < 0.001$]. Finally, INS endorsed significantly more dysfunctional beliefs about sleep than did good sleepers, independently of work schedule [$F(1, 411) = 25.36$, $P < 0.001$]. For sleepiness, the difference between good sleepers and INS was marginally significant ($P = 0.08$). There was no interaction

between sleep status and work schedule except for sleepiness (P = 0.02). Insomnia symptoms were associated with increased sleepiness only in rotating shift workers.

3.2. Perceived health

Stepwise logistic regression analysis was used to examine the contribution of insomnia and work schedule to the presence of health problems and medication use. There was no significant overall association, with Nagelkerke R2 ranging from 8% to 28%. However, as shown by the Wald χ2-value, there was a significant contribution of specific factors to prescribed medication, natural products for sleep, over-the-counter products, presence of chronic pain, and presence of otorhinolaryngology (ORL) problems. Figure 1 presents medication intake as a function of work schedules and sleep status. Overall, 29.7% of the sample took sleep-aid medication. Night work contributed significantly to the use of natural products for sleep, although the use of natural products decreased with insomnia, and to ORL problems [Wald χ^2 = 6.72, P = 0.01; Wald χ^2 = 4.15, P = 0.04, respectively], while a rotating work schedule contributed significantly to ORL problems [Wald χ^2 = 4.93, P = 0.03]. Insomnia symptoms contributed significantly to the use of prescribed medication, natural products for sleep, and over-the-counter products for sleep [Wald χ^2 = 11.8, 10.07; Wald χ^2 = 5.85, all P < 0.02, respectively]. In addition, insomnia symptoms contributed significantly to the presence of chronic pain and to ORL problems [Wald χ^2 = 9.17, P = 0.002;Waldχ2 = 6.64, P = 0.01, respectively]. Furthermore, the interaction between ‘sleep status’ and ‘work schedule’ contributed to ORL problems [Wald χ^2 = 7.54, P = 0.02]. The interaction indicates that working on a rotating work schedule and having insomnia symptoms contributed more significantly to ORL problems.

3.3. Quality of life and psychological functioning

Table 3 presents means and standard deviations for the quality of life and psychological functioning measures. No significant differences were found between work schedules for these variables. Marginally significant results (P = 0.06, 0.05) suggest that night workers have a poorer quality of life (pain and social dimensions) than did other workers. Significant differences were found between good sleepers and INS for all the measured variables related to quality of life and psychological functioning. Quality-of-life scores were higher for good sleepers. In fact, good sleepers on any work schedule had a significantly better quality of life for the all eight domains of the SF-12 [general health, $F(1, 411) = 22.34$, $P < 0.001$; physical functioning, $F(1, 411) = 14.36$, $P < 0.001$; physical role, $F(1, 411) = 23.59$, $P < 0.001$; pain, $F(1, 410) = 31.80$, $P < 0.001$; social life, $F(1, 410) = 55.25$, $P < 0.001$; mental health, $F(1, 410) = 71.85$, $P < 0.001$; emotional role, $F(1, 410) = 28.46$, $P < 0.001$; and superior energy, $F(1, 410) = 56.36$, $P < 0.001$]. Moreover, INS reported significantly more fatigue than good sleepers, independent of work schedule [$F(1, 411) = 68.60$, $P < 0.001$]. Finally, INS had significantly more stress, more state and trait anxiety, and more depressive symptoms than did good sleepers [$F(1, 412) = 33.29$; $F(1, 407) = 48.29$; $F(1, 406) = 35.77$; $F(1, 410) = 52.57$, $P < 0.001$, respectively]. There were significant interactions between ‘sleep status’ and ‘work schedule’ for quality of life (social dimension) and for pain (P = 0.04 and 0.002, respectively). These interactions showed that shift workers with insomnia had a lower quality of life (social dimension) than did other workers, and that having insomnia in the context of shift work further diminishes the quality of life (pain dimension).

3.4. Lifestyle habits

Very few differences were seen across sleep or work-schedule groups for the measured health and lifestyle habit variables (Table 4). For weekly alcohol use, day, night, and rotating shift workers show significant differences [$F(2, 348) = 5.67$, $P < 0.001$], day workers showing greater consumption than night and rotating shift workers.

In all, 70.1% of the sample were non-smokers. Several significant results were found concerning cigarette consumption among smokers. More night workers than day or rotating shift workers were regular smokers [$F(2, 409) = 5.25$, $P = 0.006$]. Good sleepers were more occasional smokers than INS [$F(1, 409) = 12.07$, $P = 0.001$]. The interaction between 'sleep status' and 'work schedule' was significant [$F(2, 409) = 4.98$, $P = 0.007$], indicating that night workers with insomnia were more regular smokers than good sleepers working day or rotated shifts. There was no significant difference in the level of physical activity.

3.5. Productivity according to work schedule and sleep status

Table 5 presents means and standard deviations for work productivity as a function of work schedule and sleep status. Day workers reported a greater number of hours missed because of insomnia: there were significant differences between day, night, and rotating shift workers [$F(2, 237) = 4.75$, $P = 0.01$]. Good sleepers were significantly different from INS on all variables. Individuals with insomnia experienced more absenteeism as a consequence of insomnia and complained of decreased productivity both at work [$F(1, 247) = 20.22$, $P < 0.001$], and outside work [$F(1, 295) = 62.92$, $P < 0.001$], because of insomnia. Missed hours at work due to health problems (WPAI-2) was also higher in SIS [$F(1, 274) = 7.20$, $P = 0.008$]. Compared with the performance of good sleepers, the performance of INS both at work (WPAI-5) and outside work (WPAI-6) was diminished because of health problems [$F(1, 248) = 16.66$ and $F(1, 295) = 56.34$, $P < 0.001$, respectively].

4. Discussion

The present study investigates the impact of insomnia on the perceived physical and psychological health of shift workers. The results suggest that insomnia has similar effects on night, day, and rotating shift workers despite the presence of sleepiness. All three groups present similar profiles, complaining of symptoms of anxiety, depression,

and fatigue, and consuming equal amounts of sleep-aiding medication. Insomnia seems also to contribute to chronic pain and ORL problems, especially for rotating shift workers. Diminished work productivity and increased absenteeism seem more related to symptoms of insomnia than to the work schedule per se. Furthermore, sleepiness seems to be associated with insomnia for rotating shift workers and quality of life (pain and social dimensions) for both rotated and night workers. Only a few effects on sleep and lifestyle habits are specifically linked to the work schedule. Working at night, on a fixed or rotating schedule, negatively affects sleep quality and leads to an increase in weekly alcohol intake. Night workers seem to have a lower quality of life (social), take more natural sleep-aid products, and smoke more cigarettes, especially when they have insomnia.

What do these results tell us about the impact of insomnia on shift workers? First, our study indicates that insomnia is an important component of sleep difficulties among shift workers, given that a significant proportion of shift workers (45%) do suffer from insomnia. With its epidemiological design, this study identified a higher proportion of shift workers with insomnia than did previous studies [6,11,30]. Multiple measures of insomnia were used to classify study participants according to a standard diagnostic algorithm [33,52]. It is likely that insomnia symptoms were reliably identified; however, it cannot be determined whether these appeared before or after beginning shift work. On the other hand, questions related to work schedule might have been less specific, less accurately identifying shift workers and therefore resulting in more within-group heterogeneity. Consequently, the overall percentage of shift workers in the sample is likely lower than expected. Percentages of shift workers suffering from insomnia might also vary in the type of night work and specific work schedule used. For instance, Waage et al. [30] had a more homogeneous sample in their investigation of oil rig workers in the North Sea, and found a lower percentage of shift workers with insomnia.

The results show that insomnia seen in shift workers seems to be a sign of an aggravated overall clinical picture. It does seem that insomnia negatively affects perceived physical and psychological health, and negatively impacts rotating shift workers by increasing sleepiness and the risk of ORL problems. Insomnia also seems to amplify the negative effect of shift work on the quality of life (social and pain). With respect to pain, Waage et al. [30]. Reported similar results, showing that shift workers with SWD had more complaints of musculoskeletal pain than those without SWD. Insomnia contributes negatively to work productivity and absenteeism for both day workers and shift workers. These results concord with Ohayon and Smirne [55] who showed a link between insomnia and sick leave in the context of shift work. However, day workers are more likely to report that insomnia and its consequences are responsible for work absenteeism compared to night and rotating shift workers with insomnia: night and rotating shift workers might expect having to work while sleep-deprived, and therefore attribute absenteeism to some other cause (e.g. illness, work schedule). Finally, medication intake profiles vary greatly with the presence of insomnia symptoms and with work schedule. Indeed, whereas prescribed medication intake seems to be high among workers with insomnia, natural product and over-the-counter product intake seems to vary with the work schedule. The latter two product types might be taken to improve sleep quality or to better cope with transitional insomnia. Further investigation of sleeping-aid agents should be undertaken in other studies.

Working on shift seems to have a direct impact on only a few variables. For instance, it clearly impairs sleep quality compared to day workers independently of insomnia. This impairment can likely be attributed to the desynchronization of the circadian system, since shift workers try to get their sleep during the day. Other effects specifically attributable to night work are: increases in natural sleep aids, alcohol consumption, cigarette consumption, and a lower quality social life. It is likely that night

workers are taking more natural sleep aids in an attempt to improve their sleep quality. Alcohol consumption might be related to an impoverished social life whereas cigarette consumption might serve to increase vigilance.

A surprising result of our study is the finding that total sleep time reported is equivalent across groups, decreasing only when insomnia is present. This result diverges from that of most previous studies comparing night and day workers [4,6,8,11,32,56]. In our study, however, day workers were selected as a control group based on age, gender, income, and reported insomnia. The proportion of day workers with insomnia as well as their other characteristics is comparable to those of shift workers. Furthermore, day workers were divided into two groups according to insomnia symptoms. These particularities strengthened the design, possibly producing more accurate findings relating to insomnia. Nevertheless, Drake et al. [6], who also divided the dayworker group, still found that night workers slept less than day workers. Our definition of work schedule might have led to inclusion of varying work schedules, thereby creating noise in the results obtained. In addition, it is impossible in our study, as in Drake et al. [6], to know whether insomnia appeared before or after beginning shift work. Therefore, it would appear necessary at least to compare shift workers with and without SWD to a divided group of dayworkers. Specific criteria for insomnia and work schedule should be used as well as diagnostic interviews to determine when insomnia appears in the context of shift work. As such, further studies could determine whether shift workers with SWD have insomnia prior to working on shifts, and whether they develop maladaptive sleep habits in reaction to insomnia symptoms after beginning shift work. Sleep duration should be further investigated in other studies based on this design.

Another surprising result regards levels of sleepiness. Sleepiness might have been expected to be higher in night or rotating shift workers, but was found to be

equivalent across insomnia-free groups. Furthermore, our results showed that insomnia seems to be related to sleepiness for rotating shift workers with insomnia. These results seem awkward, as sleepiness is not known to be an essential feature of insomnia. However, they are linked in some other studies. For instance, Ohayon et al. [27] found that sleepiness is associated with short sleep duration (≤6 h) rather than with work schedule. Our results for sleepiness might thus be explained by sleep duration >6 h for all groups. At least one other study [6] using the same questionnaire reports that 32.7% of day workers have moderate levels of sleepiness. We now believe that sleepiness might be more importantly related to insomnia than the literature suggests. Another explanation of these results on sleepiness might be that the Epworth Sleepiness Scale used does not represent sleepiness as experienced by our participants, since it does not address the frequency and duration of sleepiness. Our participants might have experienced sleepiness at a time of day at which it was not a problem. Nevertheless, our results show that insomnia seems to be related to sleepiness, especially for rotating shift workers, thus demonstrating at least the importance of addressing insomnia in this population in order to decrease sleepiness.

The present study possesses some methodological limitations since the data came from an epidemiological study of insomnia in the general population. In that study, most of the questions focused on difficulties while sleeping at night. Therefore, the questions did not permit discrimination between insomnia occurring at night on days off, during the day after returning from a night shift, or simply during nap time. It can be postulated that shift workers experience insomnia at each sleeping period related to their work schedule. In addition, self-report questionnaires for insomnia such as the ISI have not been validated in a shift work population, and items are phrased to focus on sleep occurring at night. Although their validity might be weak, these results are first attempts, along with other studies using similar insomnia questionnaires [7,11,30], to assess

insomnia in a population of shift workers. Another limitation is the heterogeneity of the sample for night and rotating shift workers. In fact, the number and length of shifts were not available for objective verification, and group membership was determined by participant self-report. In addition, neither the nature of work nor occupation was available. This limit seems to be present in previous studies [6,11] that compare shift and day workers using a similar survey methodology, so at least the results of those studies are mutually comparable.

In spite of these limitations, this study is one of the few [6-8,11] that address insomnia symptoms in the context of shift work, comparing these workers to day workers with and without insomnia. It is clear that insomnia is an important component of sleep difficulties among shift workers and contributes to an aggravation of the clinical picture for these workers. It is therefore important to directly address insomnia in affected workers, and to use measures that provide a more global picture of insomnia. Future studies should replicate our research in a shift worker population, using direct individual interviews to differentiate between the consequences of insomnia as opposed to sleepiness in that context. The presence and impact of insomnia as a function of the type of work and work schedule also needs to be investigated. Insomnia with and without sleepiness can also be compared among workers in further studies. Moreover, future studies should identify the sleep episodes during which insomnia appears, to adapt interventions accordingly. Finally, the numerous similarities found across worker groups suggest that the circadian rhythm misalignment in the context of shift work provides ideal conditions for the development of several factors that contribute to the chronicity of insomnia.

Table 1
Demographics characteristics of participants according to work schedule.

	Shift work			Total
	Night work ($n = 51$)	Rotating work ($n = 158$)	Day work ($n = 209$)	(N = 418)
Insomnia, % (n)	46.0 (23)	45.4 (74)	45.5 (97)	46.6 (194)
Women, % (n)	58.0 (29)	48.5 (79)	50.7 (108)	51.7 (216)
Age, years M (SD)	43.2 (11.9)	40.8 (10.9)	41.5 (10.9)	41.4 (11.0)
Married*, % (n)	63.3 (31)	70.6 (115)	58.2 (124)	64.6 (270)
Education*, % (n)				
High school	56.0 (28)	48.8 (75)	36.5 (76)	26.3 (179)
College	26.0 (13)	32.5 (51)	27.0 (54)	7.2 (118)
University	32.0 (9)	19.7 (31)	37.6 (78)	19.3 (118)
Full time occupation*, % (n)	76.0 (38)	82.2 (134)	100.0 (209)	91.1 (381)
Reported annual familial income, % (n)				
Less than 20,000$	7.0 (4)	5.0 (8)	6.0 (13)	6.0 (25)
Between 20,001$ and 40,000$	23.5 (12)	13.2 (21)	15.3 (32)	15.5 (65)
Between 40,001 and 60,000$	21.6 (11)	22.2 (35)	23.4 (49)	22.7 (95)
Between 60,000$ and 80,000$	25.5 (13)	19.0 (30)	19.6 (41)	20.1 (84)
Over 80,001$	11.8 (6)	34.8 (55)	29.2 (61)	29.2 (122)
Don't know	9.8 (5)	6.0 (9)	6.0 (13)	6.5 (27)

SD, standard deviation.
The matching procedure yielded an 'n' in the day work column equal to the sum of 'n' values for night work and rotating work for each variable (row).
*Significant difference between groups at $P < 0.05$.

Table 2
Sleep of participants according to work schedule and sleep.

	Shift work								
	Night work ($n = 51$)			Rotating work ($n = 158$)			Day work ($n = 209$)		
	GS ($n = 28$) *M* (*SD*)	INS ($n = 23$) *M* (*SD*)	total ($n = 51$) *M* (*SD*)	GS ($n = 87$) *M* (*SD*)	INS ($n = 71$) *M* (*SD*)	Total ($n = 158$) *M* (*SD*)	GS ($n = 115$) *M* (*SD*)	INS ($n = 94$) *M* (*SD*)	Total ($n = 209$) *M* (*SD*)
PSQI	4.6[a] (2.8)	9.2[b] (2.9)	6.7[†] (3.6)	4.0[a] (1.9)	9.1[b] (3.7)	6.3[†] (3.9)	3.6[a] (1.8)	7.8[b] (3.3)	5.5[‡] (3.3)
ISI	5.5[a] (4.2)	13.2[b] (4.7)	9.0 (5.8)	4.5[a] (3.2)	12.5[b] (5.2)	8.1 (5.8)	4.7[a] (3.7)	12.3[b] (4.5)	8.1 (5.5)
TST (h)	7.2[a] (1.6)	6.5[b] (1.8)	6.9 (1.7)	7.5[a] (1.2)	6.5[b] (1.3)	7.0 (1.3)	7.4[a] (0.8)	6.8[b] (1.3)	7.1 (1.1)
SOL (min)	13.8[a] (10.1)	26.1[b] (17.3)	19.3 (14.9)	14.5[a] (10.2)	30.8[b] (21.7)	21.7 (18.1)	13.5[a] (12.7)	24.2[b] (18.8)	18.9 (16.5)
WASO (min)	17.3[a] (20.2)	42.9[b] (39.5)	29.1 (32.9)	12.3[a] (13.1)	44.3[b] (32.3)	26.6 (28.5)	10.7[a] (18.2)	46.2[b] (43.3)	26.8 (36.6)
PSAS	28.4[a] (6.9)	32.8[b] (8.7)	30.4 (8.0)	26.1[a] (7.1)	31.3[b] (7.7)	28.5 (7.8)	28.8[a] (6.8)	32.2[b] (7.1)	30.3 (8.0)
DBAS-16	3.7[a] (1.1)	5.0[b] (1.8)	4.3 (1.6)	3.8[a] (2.1)	4.9[b] (1.8)	4.3 (1.6)	4.0[a] (1.5)	4.6[b] (1.4)	4.2 (1.5)
ESS*	9.3 (4.4)	10.1 (3.9)	9.7 (4.2)	7.7 (3.7)	10.0 (4.8)	8.9 (4.3)	9.3 (4.0)	9.0 (4.9)	9.1 (4.4)
ESS<10 (%)	46.2	52.4	48.9	71.8	51.5	62.9	52.7	60.0	56.0
ESS≥10 (%)	53.8	47.6	51.1	28.2	48.5	37.1	47.3	40.0	44.0

GS, good sleepers; INS, individuals with insomnia symptoms; PSQI, Pittsburgh Sleep Quality Index; ISI, Insomnia Severity Index; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; PSAS, Pre-Sleep Arousal Scale; DBAS-16, Dysfunctional Beliefs and Attitudes About Sleep; ESS, Epworth Sleepiness Scale.
Values are mean (standard deviation) unless indicated otherwise.
*Interaction between the simple effects (work schedule and sleep) is significantly different at $P < 0.05$. There is no significant difference between groups in the proportion of participants with an ESS score >10.
[a,b]Values with different letters represent significant difference between GS and INS of specific work schedule at $P < 0.05$.
[†,‡]Values with different symbols in the same row represent significant difference between day, night, or rotating work at $P < 0.05$.

Table 3
Quality of life and psychological functioning of participants according to work schedule and sleep.

	Shift work								
	Night work ($n = 51$)			Rotating work ($n = 158$)			Day work ($n = 209$)		
	GS ($n = 28$) *M* (*SD*)	INS ($n = 23$) *M* (*SD*)	Total ($n = 51$) *M* (*SD*)	GS ($n = 87$) *M* (*SD*)	INS ($n = 71$) *M* (*SD*)	Total ($n = 158$) *M* (*SD*)	GS ($n = 115$) *M* (*SD*)	INS ($n = 94$) *M* (*SD*)	Total ($n = 209$) *M* (*SD*)
SF-12v2 (%)									
General health	64.5[a] (29.3)	58.2[b] (18.7)	61.7 (25.0)	74.3[a] (17.1)	57.2[b] (27.1)	61.7 (25.0)	73.7[a] (18.3)	61.1[b] (22.2)	68.0 (21.1)
Physical functioning	89.3[a] (19.7)	80.4[b] (27.1)	85.3 (23.5)	92.1[a] (15.5)	81.7[b] (22.3)	87.4 (19.5)	91.3[a] (17.2)	83.2[b] (24.7)	87.7 (21.2)
Physical role	78.1[a] (21.4)	67.9[b] (22.9)	73.5 (22.5)	84.9[a] (17.6)	71.3[b] (21.9)	78.7 (20.7)	81.8[a] (17.6)	71.9[b] (20.7)	77.4 (19.7)
Pain*	83.0[a] (23.6)	69.6[b] (30.1)	77.0 (27.3)	93.3[a] (13.0)	70.1[b] (26.9)	82.8 (23.5)	87.8[a] (19.7)	80.9[b] (24.0)	84.7 (21.9)
Energy	68.7[a] (20.0)	50.0[b] (27.2)	60.3 (25.1)	70.6[a] (14.4)	51.4[b] (24.2)	61.9 (21.7)	69.3[a] (15.9)	56.2[b] (20.4)	63.5 (19.2)
Social life*	81.2[a] (22.2)	62.0[b] (26.0)	72.6 (25.6)	90.7[a] (14.9)	68.0[b] (24.0)	80.4 (22.5)	85.0[a] (9.2)	73.1[b] (21.9)	79.7 (21.3)
Emotional role	80.8[a] (17.8)	66.3[b] (22.4)	74.3 (21.1)	87.9[a] (15.4)	72.2[b] (21.6)	80.8 (20.0)	79.8[a] (18.3)	74.5[b] (19.7)	77.4 (19.1)
Mental health	73.2[a] (16.6)	53.3[b] (25.6)	64.2 (23.2)	76.9[a] (13.3)	58.1[b] (20.3)	68.4 (19.2)	73.8[a] (13.6)	61.6[b] (18.8)	68.3 (17.2)
MFI	41.8[a] (16.8)	55.0[b] (16.9)	47.8 (17.9)	39.4[a] (11.5)	53.6[b] (15.3)	47.7 (11.1)	40.5[a] (11.1)	51.8[b] (13.1)	45.6 (13.3)
PSS	20.6[a] (7.9)	25.8[b] (9.9)	23.0 (9.1)	19.2[a] (7.7)	25.5[b] (9.1)	22.0 (8.9)	20.1[a] (6.7)	24.3[b] (7.4)	22.0 (7.3)
STAI									
trait	35.9[a] (10.6)	42.1[b] (13.2)	38.7 (12.1)	32.0[a] (8.1)	41.4[b] (11.6)	36.3 (10.9)	35.3[a] (9.0)	40.9[b] (10.2)	37.7 (9.9)
state	29.1[a] (9.8)	40.3[b] (14.9)	34.2 (13.4)	27.8[a] (7.0)	37.0[b] (14.0)	32.0 (11.6)	29.8[a] (9.4)	35.6[b] (11.1)	32.4 (10.5)
BDI-II	5.7[a] (5.8)	12.9[b] (9.8)	9.0 (8.6)	4.3[a] (4.8)	11.6[b] (10.7)	7.6 (8.7)	5.4[a] (5.7)	10.6[b] (9.0)	7.7 (7.8)

GS, good sleepers; INS, individual with insomnia symptoms; SF-12v2, Health-Related Quality of Life version 2 (high scores indicate a better quality of life); MFI, Multidimensional Fatigue Inventory; PSS, Perceived Stress Scale; STAI, State–Trait Anxiety Inventory; BDI-II, Beck Depression Inventory-II.
Values are mean (standard deviation) unless indicated otherwise.
*The interaction between the simple effects (work schedule and sleep) is significantly different at $P < 0.05$.
[a,b]Values with different letters represent significant difference between GS and INS of specific work schedule at $P < 0.05$.

Table 4
Health functioning of participants according to work schedule and sleep.

	Shift work								
	Night work ($n = 51$)			Rotating work ($n = 158$)			Day work ($n = 209$)		
	GS ($n = 28$) *M* (*SD*)	INS ($n = 23$) *M* (*SD*)	Total ($n = 51$) *M* (*SD*)	GS ($n = 87$) *M* (*SD*)	INS ($n = 71$) *M* (*SD*)	Total ($n = 158$) *M* (*SD*)	GS ($n = 115$) *M* (*SD*)	INS ($n = 94$) *M* (*SD*)	Total ($n = 209$) *M* (*SD*)
BMI (kg²/m)	27.5 (3.9)	25.6 (5.6)	26.6 (4.8)	27.2 (5.3)	27.4 (5.3)	27.3 (5.3)	26.4 (4.8)	26.4 (5.3)	26.4 (5.0)
Alcohol use/ day	0.3 (1.2)	0.3 (1.3)	0.3 (1.2)	0.2 (0.8)	0.5 (1.5)	0.3 (1.2)	0.4 (1.0)	0.2 (0.7)	0.3 (0.9)
Alcohol use/ week	2.2 (3.6)	1.9 (2.0)	2.1[†] (3.0)	2.8 (3.4)	3.5 (6.0)	3.1[†] (4.7)	4.6 (5.3)	4.2 (4.3)	4.4[‡] (4.9)
Coffee use/ day	1.9 (1.7)	2.4 (2.4)	2.1 (2.1)	1.9 (1.8)	2.0 (1.8)	2.0 (1.8)	1.9 (1.4)	2.0 (1.5)	2.0 (1.5)
Cigarette user*	2.5[a] (0.9)	1.8[b] (0.9)	2.2[†] (0.9)	2.7[a] (0.7)	2.4[b] (0.9)	2.6[‡] (0.8)	2.5[a] (0.8)	2.5[b] (0.8)	2.5[‡] (0.8)

GS, good sleepers; INS, individual with insomnia symptoms; BMI, body mass index.
Cigarette user is an ordinal variable where 1 = regular smoker; 2 = occasional smoker; 3 = non-smoker.
*The interaction between the simple effects (work schedule and sleep) is significantly different at $P < 0.05$.
[a,b]Values with different letters represent significant difference between GS and INS of specific work schedule at $P < 0.05$.
[†,‡]Values with different symbols in the same row represent significant difference between day, night, or rotating work at $P < 0.05$.

Table 5
Productivity of participants according to work schedule and sleep.

	Shift work								
	Night work ($n = 51$)			Rotating work ($n = 158$)			Day work ($n = 209$)		
	GS ($n = 28$) *M* (*SD*)	INS ($n = 23$) *M* (*SD*)	Total ($n = 51$) *M* (*SD*)	GS ($n = 87$) *M* (*SD*)	INS ($n = 71$) *M* (*SD*)	Total ($n = 158$) *M* (*SD*)	GS ($n = 115$) *M* (*SD*)	INS ($n = 94$) *M* (*SD*)	Total ($n = 209$) *M* (*SD*)
Acti/ins	0.9[a] (2.0)	4.7[b] (3.0)	2.5 (3.1)	1.1[a] (1.6)	3.0[b] (2.7)	2.0 (2.4)	1.2[a] (2.0)	3.7[b] (2.9)	2.5 (2.7)
Work/ins	0.9[a] (2.1)	2.3[b] (1.9)	1.4 (2.1)	0.9[a] (1.5)	2.8[b] (2.9)	1.7 (2.4)	1.4[a] (2.2)	3.6[b] (3.3)	2.5 (3.0)
WS/ins	1.2[a] (0.8)	1.0[b] (0.0)	1.1[†] (0.6)	1.0[a] (0.2)	1.9[b] (2.2)	1.1[†] (0.6)	1.4[a] (1.2)	2.7[b] (2.8)	2.0[‡] (2.2)
WPAI-2	0.0[a] (0.0)	3.5[b] (8.7)	1.4 (5.7)	0.6[a] (4.7)	1.5[b] (5.9)	1.0 (5.3)	0.3[a] (1.4)	1.5[b] (4.9)	0.9 (3.6)
WPAI-5	0.4[a] (1.6)	1.3[b] (1.3)	0.8 (1.5)	0.6[a] (1.4)	2.3[b] (2.6)	1.3 (2.2)	0.9[a] (1.7)	2.5[b] (2.6)	1.7 (2.3)
WPAI-6	0.8[a] (2.0)	4.7[b] (3.0)	2.4 (3.1)	1.0[a] (1.8)	3.3[b] (2.7)	2.0 (2.5)	1.2[a] (1.9)	2.7[b] (2.6)	2.0 (2.4)

GS, good sleepers; INS, individual with insomnia symptoms; Acti/ins, relationship between insomnia and productivity in daily activities; Work/ins, relationship between insomnia and work productivity; WS/ins: insomnia and its consequences responsible for missed hours at work; WPAI-2, mean number of hours of missed work due to health problems during the last 7 days; WPAI-5, health problems affected work productivity in the last 7 days; WPAI-6, health problems affected capacity to do daily activities outside work.
[a,b]Values with different letters represent significant difference between GS and INS of specific work schedule at $P < 0.05$.
[†,‡]Values with different symbols in the same row represent significant difference between day, night, or rotating work at $P < 0.05$.

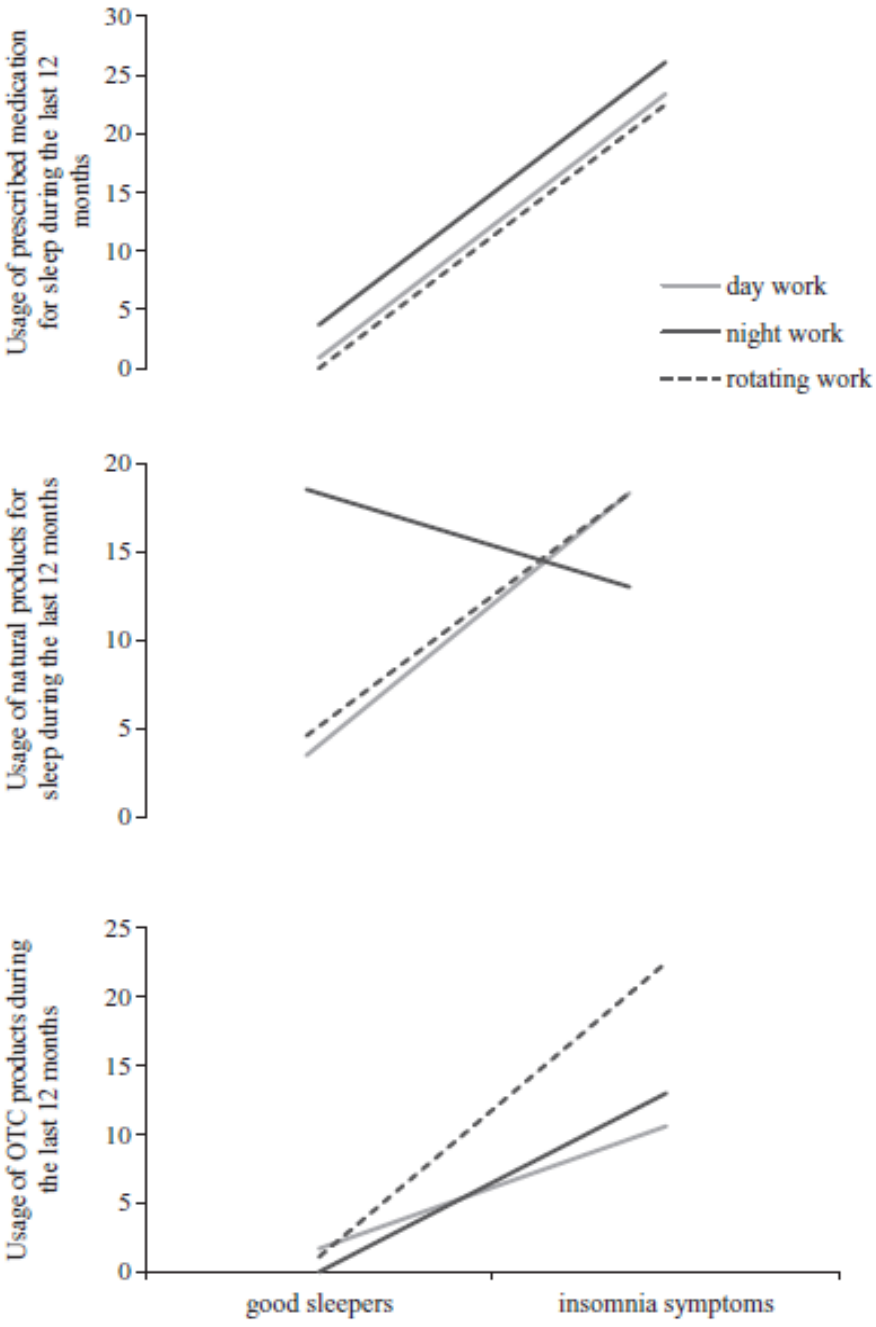

Fig. 1. Medication intake by work and sleep groups. OTC, over-the-counter.

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