

Sleep and Sleepiness among Brazilian Shift-Working Bus Drivers

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ABSTRACT

The aim of this study was to evaluate daytime and nighttime sleep, as well as daytime and nighttime sleepiness of professional shift-working bus drivers. Thirty-two licensed bus drivers were assessed by nocturnal and diurnal polysomnography (PSG) recording and multiple sleep latency testing (MSLT) sessions. Sleep length was shorter and sleep efficiency reduced during daytime sleep compared with nighttime sleep. Thirty-eight percent of the drivers had indices of obstructive apnea and hypopnea syndrome ($>5/h$ sleep) during nighttime and daytime sleep; more drivers snored during daytime than nighttime sleep (50% vs. 35%, $p < 0.05$), and 38% of the drivers evidenced periodic leg movements. The MSLT revealed that 42 and 38% of the bus drivers met the criteria for sleepiness when the test was conducted during the day and night, respectively. The daytime as compared to nighttime sleep of shift-working bus drivers was shorter and more fragmented and was associated in many with evidence of excessive sleepiness. Respiratory disorder was a common finding among the professional shift-working bus drivers. All these sleep deficiencies may adversely affect on the job driving performance.

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INTRODUCTION

The remarkable increase in shift and nocturnal work hours over the last decades has been studied with growing concern regarding their effects on health (Rajaratnam and Arendt, 2001; Knutsson, 2004). Among the numerous concerns is the potential negative influence shift and night work might have on the quality of sleep and on increasing or triggering sleep disturbances. Indeed, shift workers routinely report sleep disturbances and sleepiness (see for example in these proceedings Ingre et al., 2004; Nakata et al., 2004; Portela et al., 2004), which have been considered to play an important role in the cause of various types of accidents (Folkard and Lombardi, 2004; Garbarino et al., 2001; George and Smiley, 1999; Hakkanen and Summala, 2000; Lauber and Kayten, 1988; Lyzicki et al., 1998; Mitler et al., 1988; Rajaratnam and Jones, 2004).

The sleep duration and quality are related to when sleep is obtained within the day. Although shift workers try to invert their normal sleep/wake schedule, a misalignment between sleep and appropriate circadian phase commonly leads to a significant reduction in sleep duration and sleep efficiency (Akerstedt, 1998; Dijk and Czeisler, 1995). Moreover, an association between sleep disorders and circadian disruption may further increase the risk of high levels of sleepiness. Obstructive sleep apnea-hypopnea syndrome is a major cause of daytime sleepiness (McNamara et al., 1993). This syndrome has been linked to an increased risk of automobile accidents, and it is frequently observed in professional drivers, since it is directly related to obesity and to the more sedentary lifestyle of this specific population (Findley et al., 1995; George and Smiley, 1999; Horstmann et al., 2000; Teran-Santos et al., 1999; Moreno et al., 2004).

The statistics and operational costs associated with automobile accidents have increased annually and are a significant concern of government institutions. In countries such as the United States, the cost of sleep-related accidents in 1988 was estimated to range from 43 to 56 billion dollars (Leger, 1994). In Brazil, according to data of the 2001 Annual Report of the National Traffic Department (DENATRAN, 2003), there were 394,596 (20,037 fatal and 374,557 nonfatal) federal highway accidents involving 307,287 victims. The importance and contribution of sleepiness to these accidents can be inferred from the findings of Mello et al. (2000) who interviewed 400 interstate bus drivers. These investigators found that 16% of the interstate bus drivers admitted to have dozed off at the wheel, and 55% knew of someone who had dozed off at the wheel.

Present Brazilian regulations allow licensed professional drivers to operate their vehicles for 8 h after a minimum of 12 h of rest, and some passenger transportation companies require day and night shift-work duty of their drivers. We herein compared the nighttime and daytime sleep, the presence of sleep disturbances, and sleepiness as assessed by polysomnographic recordings and the Multiple Sleep Latency Test in a group of long-haul bus drivers working shifts.



METHODS

Thirty-two male licensed long-haul drivers operating on shifts on a randomly selected interstate route were invited to participate in this study (mean age of 42.5 ± 7.1 yrs and body mass index of 26.0 ± 4.9 kg/m²). All were shift workers employed by the same interstate transportation company driving the same 550 Km route between Uberaba City (State of Minas Gerais) and São Paulo City (State of São Paulo). Departures from Uberaba City were at 09:30 and 22:30 h and the respective arrival times in São Paulo City were 17:30 and 06:30 h. The drivers were informed about the study and its procedures and signed an informed consent form to participate in the study. The study, which was approved by the institutional ethical committee, was conducted in accordance with the guidelines set forth by the Declaration of Helsinki and Tokyo and in agreement with the standards expected by the journal (Touitou et al., 2004).

The drivers were invited to come to the Sleep Laboratory (located in São Paulo City) on three occasions. During the first visit subjects were familiarized to the laboratory setting and PSG procedures, but no recording was done out on this occasion. The following night the subjects reported to the same Sleep Laboratory for a scheduled nocturnal PSG commencing at the usual bedtime. A second PSG recording was done in the same way after a night trip, also commencing as close as possible to the usual bedtime. The bus drivers were submitted to the Multiple Sleep Latency Test (MSLT) 2 h after the end of PSG recordings, when the drivers normally would be working/driving.

The drivers work for 8 h after a minimum of 12 h of rest, with one or 2 days off following 4 or 5 working days. Although desired, the number of night shifts that preceded the PSG recordings could not be controlled. However, it was possible to conduct the MSLT on work days; that is, instead of starting a new trip after awakening in the Sleep Laboratory, the bus drivers were submitted to the MSLTs.

POLYSOMNOGRAPHIC RECORDS

PSG was performed according to Rechtschaffen and Kale (1968), and electrode placement was carried out according to the 10–20 system. PSG records were conducted by a trained sleep technician using a sleep analyzer computer (SAC, version 9.3, Oxford Instruments, Abingdon, UK). The following channels were included: EEG (C3-A2, C4-A1, O2-A1), EOG chin and tibial EMG, ECG, airflow (thermal sensor), thoracic-abdominal movements, microphone to the lateral neck to detect snoring, pulse oxymetry, and body position (Jasper, 1958). Thirty-second epochs were staged according to standard criteria and visually inspected by the sleep specialist, who was blind to the study conditions. The following parameters were analyzed: (a) Total Sleep Time (TST, in min), defined as the actual time spent asleep; (b) sleep latency (in min), defined as the time from lights out until the onset of 3 consecutive epochs of Stage 1 or deeper sleep; (c) sleep efficiency, defined as the percentage of total recording time spent asleep; (d) Wake After Sleep Onset (WASO, in min), defined as the total time scored as wakefulness between sleep onset and final



awakening; (e) stages 1, 2, 3, 4, and REM sleep, as the percentage of TST; (f) latency to REM, defined as the time from sleep onset until the first epoch of REM sleep.

Periodic leg movements (PLM) were scored according to standard criteria (The Atlas Task Force of the American Sleep Disorders Association, 1993)—i.e., they were scored if they occur in series of four or more consecutive movements lasting for at least 0.5 s and separated by intervals of 4–90 s. The presence of periodic limb movement was defined as a PLM index (number of PLM per hour of sleep) of five or greater. Apnea was defined as a complete cessation of airflow during sleep lasting 10 s or longer, and hypopnea as either a reduction by more than 50% of the basal ventilatory value or a reduction by less than 50% and associated reduction of oxy-haemoglobin saturation above 3% or to an arousal. The apnea-hypopnea index (AHI) was calculated as the sum of apneas and hypopneas per hour of sleep, and bus drivers were classified as having sleep respiratory disorder if the $AHI \geq 5$. Snoring was measured with a microphone. The sleep specialist classified snoring according to the output of the microphone. All volunteers presenting some type of sleep disturbance were advised to seek the company's doctor for necessary treatment.

MULTIPLE SLEEP LATENCY TEST (MSLT)

Participants were submitted to the MSLT (Richardson et al., 1978) 2 h after awakening from their nighttime or daytime sleep. They were provided five opportunities to sleep while they lay on a bed in a dark and quiet room for 20 min at 2 h intervals. Standard EEG, EMG, and EOG were recorded during naps. Subjects were invited to leave the room at the end of each test. During the intervals in between the MSLTs, the subjects were free to perform normal activities, such as reading, watching TV, chatting, walking around, and eating, but they were not allowed to ingest caffeinated beverages or sleep. Sleepiness was defined as a sleep latency of less than 5 min.

Statistical analysis

Polysomnographic variables were compared by Student *t*-test, and periodic leg movements (PLM), apnea-hypopnea index, snoring, and sleepiness were analyzed by the McNemar χ^2 test using the Statistica program, with the level of significance set at $p \leq 0.05$.

RESULTS

As shown in Table 1, the average length of the diurnal sleep was shorter than the nocturnal sleep. The diurnal sleep was also characterized by shorter latency to sleep, lower sleep efficiency, and a greater number of interruptions. Daytime sleeping was associated with significantly decreased stage 1 sleep, but no modification of the duration of the other sleep stages.



Table 1. Characteristics of nighttime and daytime sleep (Mean \pm SD) in shift working bus drivers ($N=32$).

	Nighttime sleep	Daytime sleep	$t_{(df=31)}$	p
Bedtime (hh:mm)	22:33 \pm 00:42 (range: 20:54–00:22)	10:25 \pm 00:42 range (09:06–11:31)		
Awakening time (hh:mm)	06:24 \pm 01:18	18:24 \pm 00:36		
TST (min)	404 \pm 52	361 \pm 92	2.9	<0.01
Sleep latency (min)	14.9 \pm 17.5	3.9 \pm 3.3	3.7	<0.01
Sleep efficiency (%)	86.2 \pm 7.7	76.5 \pm 17.5	3.4	<0.01
WASO (min)	43.6 \pm 22.7	76.7 \pm 51.5	3.9	<0.01
Stage 1 (%)	7.4 \pm 4.6	10.1 \pm 6.8	2.3	<0.05
Stage 2 (%)	49.3 \pm 10.2	50.8 \pm 9.3	0.6	NS
Stage 3 (%)	8.5 \pm 4.8	7.2 \pm 3.8	1.2	NS
Stage 4 (%)	12.8 \pm 7.5	12.2 \pm 7.8	0.5	NS
Stage REM (%)	21.1 \pm 4.8	19.7 \pm 8.5	0.9	NS
REM latency (min)	80.6 \pm 46.3	74.2 \pm 45.9	0.6	NS

The percentage of drivers with 5 or more events/h of PLM was significantly higher during diurnal than nocturnal sleep (28% vs. 18%, $p < 0.05$). One half of the professional bus drivers snored during diurnal sleep, a proportion significantly higher than those who snored during nocturnal sleep (35%; $p < 0.05$). Thirty-eight percent of the drivers had an apnea-hypopnea index of 5 or more events/h during daytime and nighttime sleep.

Diurnal MSLT began at 08:28 \pm 00:42 h, ranging from 07:00 to 09:40 h and the nocturnal MSLT began at 20:24 \pm 00:36 h, ranging from 19:00 to 21:30 h. The MSLT revealed that 42 and 38% of the bus drivers met the criteria for excessive sleepiness (mean latency <5 min) when the test was conducted during the day and during the night, respectively.

DISCUSSION

Our study revealed that the sleep of shift-working bus drivers was shorter and more fragmented when it occurred during the day than night. The bus drivers fell asleep quicker during the daytime studies probably because of the higher sleep debt and fatigue that accumulated during nighttime work. However, because drivers were attempting to sleep during an inappropriate phase of the circadian cycle, that is, during their “biological” day, they commonly experienced difficulties in attaining good sleep. The notion that these drivers were not getting sufficient sleep can also be inferred from the finding that many of them showed objective evidence of sleepiness, even after nocturnal sleep. This is highly relevant since the sleepiness measures were obtained after a period of approximately 7 h of sleep, during a time when they were expected to be alert. The lack of difference between shifts was also reported by Fischer et al. (2000), whose findings among petrochemical workers showed comparable sleep quality after day and night work. These authors suggested that the physical and mental overburdens were strong enough to negatively affect sleep regardless of its timing.



Sleep loss and circadian rhythm disruption are not the only factors that induce sleepiness and fatigue in shift workers (Arkerstedt, 1998). Sleep disorders, such as periodic leg movements and sleep-disordered breathing, also play an important role and as previously reported by Hui et al. (2002); a considerable proportion of bus drivers in our study met the criteria for apnea-hypopnea syndrome.

Interestingly, a greater proportion of bus drivers snored and met the criteria for PLM when the sleep took place during the day as opposed to the night. However, some studies have shown a worsening of the restless legs syndrome symptoms intensity (leg discomfort and PLM or motor restlessness) in the evening and during the night, with peak times (circadian acrophases) between 00:00 and 04:00 h and a nadir during the early portion of the wake period (Garcia-Borreguero et al., 2002). A circadian variation in the number of PLM has also been found in control subjects with the peak occurring at 06:00 h (Michaud et al., 2004). On the other hand, motor symptoms are known to be worsened by sleep deprivation or excessive tiredness, suggesting the existence of a “homeostatic drive” as a contributing factor (Garcia-Borreguero et al., 2002). Therefore, it is likely that the increase in PLM seen during daytime sleep was due to a greater level of tiredness accumulated following nighttime compared with daytime work. The shortened latency to sleep onset observed during daytime sleep is consistent with this hypothesis. Similarly, the increased snoring found during daytime sleep may be explained by augmented upper airway collapsibility due to increased muscle fatigue.

Our study has limitations that deserve comment. Firstly, the number of shifts that preceded the diurnal PSG recordings was not controlled. One can wonder if this could account for the finding that the bus drivers fell asleep quicker during the day than night. Secondly, the first PSG was always conducted at night; thus, an order effect could not be estimated. Finally, the drivers slept in a laboratory setting. Although efforts were done to familiarize the drivers to the Sleep Laboratory environment, it is possible that they slept poorer in this setting than usual at home. However, the average duration of the night sleep was almost 7 h, making us confident that some level of familiarization was obtained. Nevertheless, a “real world study,” a field study conducted in normal accommodations, would probably be more informative.

Even though with these shortcomings, we have found evidence that the day sleep of this group of shift-working bus drivers was short and fragmented. As measured by the MSLT, the ability of this group of shift workers to obtain restorative sleep appears to be reduced. Sleep loss, circadian rhythm disruption, and sleep disorders will clearly act synergistically, with deleterious consequences for public and individual health and safety. Consequently, it is important that shift workers and their employers be aware of the importance of sleep for health and safety, and of the dangers of inverted working and rest periods.

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