Do Circadian Preferences Influence the Sleep Patterns of Night Shift Drivers?

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Introduction

In recent decades, there has been a growing interest in the effects of shift work and night shifts on workers’ health and quality of life [1, 2]. Several studies have reported negative effects of shift work and night shifts on health, as well as possible workplace mistakes and increased accident risk due to fatigue [3–5]. The chronic inversion in sleep patterns caused by shift work can lead to circadian rhythm misalignment or desynchronization, which can cause sleep disorders and significant reductions in sleep duration, architecture and quality [4, 6].

In an evaluation of 613 employees at a Japanese nuclear plant, Smith et al. [7] reported that individuals with morning chronotype showed greater sleepiness at night,
were less tolerant of night work, and ingested stimulants to stay awake. Seo et al. [8] showed that morning-type individuals had increased sleepiness during night work.

Some studies [9, 10] have reported that morning and indifferent preference individuals tend to have a shorter latency to fall asleep than evening chronotype individuals. Morning preference individuals have a higher increase in sleep pressure during extended wakefulness, shorter sleep duration, greater sleep debt, and the presence of sleep and mood disorders.

In addition, Taillard et al. [9] and Mongrain and Dumont [10] have reported that morning preference individuals prefer to perform their daily activities during the morning period because they feel better in terms of performance, attention and alertness. At night, they prefer to rest and sleep.

The hypothesis of this study was that individual circadian preference (chronotype) can influence the sleep patterns of drivers with fixed night work schedules, especially morning drivers, due to the chronic inversion between the endogenous circadian rhythms and sleep time. Thus, the purpose of this study was to analyze the effect of individual circadian preferences of drivers with fixed night work schedules on sleep patterns.

Subjects and Methods

The study included 123 professional male drivers of an intermunicipality and interstate bus transportation company who worked in fixed night shifts (schedule 4 × 2). The sample consisted of 32 indifferent preference drivers and 91 morning preference drivers. The night shift began at 10 p.m. and finished at 6 a.m. (8-hour duration). The study procedures were approved by the Ethics in Research Committee of the Sao Paulo Hospital, Federal University of Sao Paulo, SP, Brazil (ref. 1267/03). The subjects were informed about the study procedures and signed an informed consent for participation. To be included in the study, the drivers must have been hired by the bus company and regularly driven 1 of 32 travel routes. All enrolled drivers underwent a polysomnographic (PSG) examination and completed the administrative questionnaire. They were warned on the use of caffeine or any other substance with possible sedative effects or any other alternatives before the PSG examination.

Experimental Design

After their night shift, drivers immediately went from the company’s central garage situated in the city of Sao Paulo to the Sleep Institute. All evaluated drivers had previously worked for at least 4 consecutive days, with work shifts lasting for 8 h. The PSG evaluations (daytime period) were initiated no more than 120 min after the end of the work shift. The driver was not allowed to nap or fall asleep during the period preceding the PSG examination. The duration of the PSG examination followed the need of each driver.

Upon completion of the PSG recording, each driver filled out a general anamnesis (medical and work history) form and a morningness–eveningness questionnaire.

PSG Examination

The PSG recordings were performed using a digital EMBLA system (EMBLA S7000; Embla Systems Inc., Colo., USA). The electroencephalogram (C3-A2, C4-A1, O1-A2, O2-A1), electrooculogram (LOC-A2, ROC-A1), electromyogram (chin and anterior tibial muscles), electrocardiogram, airflow (thermal sensor), thoracic-abdominal movements, snoring (detected by a microphone placed on the lateral neck), pulse oximetry, and body position were monitored simultaneously and continuously. The sleep stages were scored using Rechtschaffen and Kales criteria [11], and electrode placement was performed according to the international 10–20 system [12]. Thirty-two increments were staged according to standard criteria and were visually inspected by the sleep specialist. The following parameters were analyzed: (a) total sleep time (TST) in minutes, defined as the actual time spent asleep; (b) sleep latency in minutes, defined as the time from lights off to the onset of three consecutive epochs of stage 1 or deeper sleep; (c) sleep efficiency, defined as the percentage of total recording time spent asleep; (d) wake time after sleep onset (WASO) in minutes, defined as the total time scored as wakefulness between sleep onset and final awakening; (e) stages 1–3 and rapid eye movement (REM) sleep, defined as the percentage of TST, and (f) latency to REM, defined as the time from sleep onset until the first epoch of REM sleep.

The apnea-hypopnea index (AHI) was calculated as the sum of apneas and hypopneas per hour of sleep, and drivers with an AHI ≥5 were classified as having a sleep respiratory disorder. Snoring was measured with a microphone [13, 14].

Anamnesis. The form consisted of sociodemographic and health questions. In addition, body weight in kilograms and height in meters were measured using a digital scale and a stadiometer to calculate the body mass index (BMI).

Individual Circadian Preferences (Chronotype). The Horne and Östberg questionnaire validated for the Brazilian population [15] was used to characterize subjects’ morningness–eveningness preference.

Statistical Analysis

Statistical analysis was performed with the statistical software package (PASW Statistics for Windows, version 18.0; SPSS Inc., Chicago, Ill., USA). Descriptive statistics were used. The data are presented as the mean ± SD and absolute and relative frequency. Nonparametric data were standardized using z-scores.

To evaluate the effect of circadian preference adjusted for age and AHI on the sleep pattern of drivers during a night shift schedule, multiple linear regressions was performed. A p value of <0.05 was considered to be statistically significant.

Multiple regression analyses were used to determine the effect of circadian preference on sleep patterns of drivers during the night shift schedule. An exploratory analysis was conducted to show the effect of years of shift work on BMI and sleep patterns. However, the regression model presented in table 1 does not include these variables, as there has been weighted multicollinearity between the variables, according to the Durbin-Watson test. Based on previous reports [16, 17] on the effect of sleep apnea (assessed by AHI) and age on sleep patterns, the model for the covariate age and AHI was adjusted.
Results

The mean age was 42.54 ± 6.98 years and 82 drivers (66.66%) had worked for ≥15 years. The descriptive data are shown in Table 2. The effect of circadian preference adjusted for age and AHI on the sleep pattern of drivers during a night work schedule is given in Table 1. Morning preference had a significant effect on sleep pattern showing increased REM sleep latency and decreased percentage of REM sleep in the morning preference group. Discussion

In this study, the morning preference of the night shift drivers had a significant effect on REM sleep, with increased REM sleep latency and decreased percentage of REM sleep during daytime sleep (after working hours) in the morning preference group. The morning drivers were more affected in their REM sleep, which has an influence on mental and physical restoration, as compared to indifferent preference drivers. These observations confirmed those of previous studies that REM sleep has a positive effect on mood, learning and memory consolidation [18, 19].

Moreover, the current study confirmed the previous findings by Carrier et al. [20] who reported that morning preference was associated with decreased REM activity and shorter REM sleep stages (measured in minutes and percentages). However, others studies showed different results [3, 21]. Santos et al. [3] reported shorter sleep latency, lower sleep efficiency and a greater number of interruptions in bus drivers who slept during daytime compared to drivers who slept at night. In their study, Fer-

Table 1. Effect of circadian preference adjusted for age on the sleep pattern of drivers during a night work schedule

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>REM latency</th>
<th>Age</th>
<th>Chronotype</th>
<th>AHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>REM latency</td>
<td>97.17 ± 5.58</td>
<td>0.127</td>
<td>0.229</td>
<td>-0.091</td>
</tr>
<tr>
<td>Efficiency</td>
<td>79.24 ± 1.14</td>
<td>0.081</td>
<td>0.069</td>
<td>-0.143</td>
</tr>
<tr>
<td>Awake time</td>
<td>57.84 ± 3.75</td>
<td>0.081</td>
<td>0.069</td>
<td>-0.143</td>
</tr>
<tr>
<td>WASO</td>
<td>80.95 ± 4.20</td>
<td>0.081</td>
<td>0.069</td>
<td>-0.143</td>
</tr>
<tr>
<td>Arousal</td>
<td>14.72 ± 0.66</td>
<td>0.081</td>
<td>0.069</td>
<td>-0.143</td>
</tr>
<tr>
<td>TST</td>
<td>344.51 ± 6.73</td>
<td>0.081</td>
<td>0.069</td>
<td>-0.143</td>
</tr>
<tr>
<td>Latency</td>
<td>12.90 ± 1.23</td>
<td>0.081</td>
<td>0.069</td>
<td>-0.143</td>
</tr>
<tr>
<td>REM</td>
<td>17.50 ± 0.63</td>
<td>0.081</td>
<td>0.069</td>
<td>-0.143</td>
</tr>
</tbody>
</table>

Table 2. Participant characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Values</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>42.54 ± 6.98</td>
<td>0.907</td>
</tr>
<tr>
<td>BMI</td>
<td>27.52 ± 3.88</td>
<td>0.000*</td>
</tr>
<tr>
<td>AHI, events/h</td>
<td>6.66 ± 6.31</td>
<td>0.055</td>
</tr>
<tr>
<td>Indifferent preference drivers</td>
<td>32 (26.00)</td>
<td>0.000*</td>
</tr>
<tr>
<td>Morning preference drivers</td>
<td>91 (74.00)</td>
<td>0.000*</td>
</tr>
<tr>
<td>Overweight defined as BMI ≥25</td>
<td>50 (40.65)</td>
<td>0.000*</td>
</tr>
<tr>
<td>Work time ≥15 years</td>
<td>82 (66.66)</td>
<td>0.000*</td>
</tr>
<tr>
<td>Men</td>
<td>123 (100)</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SD.

* p ≤ 0.05 multiple linear regression.

1 Data are presented as mean ± SD.
A number of individual factors may be associated with sleep quality, sleep deprivation and sleep disorders. The circadian preference, for example, can affect tolerance to work, alertness, performance and sleep architecture [22, 23].

Several publications have reported that morning-type individuals have a stronger increase in homeostatic sleep pressure with prolonged periods of wakefulness (work) [9, 10]. The night workers’ sleep period mostly occurs during the day and is considered an inappropriate circadian time to sleep because in the morning an endogenously decrease of melatonin occurs. Furthermore, increased core body temperature and peak cortisol secretion may impair daytime sleep [24, 25].

In addition, the literature shows that the morning-type individuals prefer sleep at night and perform their activities of leisure and daily living during the day [9, 15, 20] such as physical activity, social and domestic work. Therefore, these endogenous characteristics and social’s life preference can modify the sleep parameters and lead to insufficient sleep recovery during daytime. Takahashi et al. [26] revealed a cycle of dissatisfaction with shift work, physical and psychosocial disorders, fatigue, sleep disorders, and decreased task performance.

This study has several limitations. First of all, it had a cross-sectional design and only employed one subjective method to evaluate the circadian preference; however, we could not compare another group of circadian preference (i.e. evening subjects) because evening-type subjects could not be found in the sample. Maybe we could have discovered different sleep parameters between the three samples of bus drivers (morning, indifferent and evening preference) and identify their (evening preference) sleep patterns. In addition, we could not perform the PSG habituation due to work schedule. All evaluated drivers had previously worked for at least 4 consecutive days, with the work shifts lasting 8 h. The fact that morning preference is associated with REM sleep during daytime sleep does not necessarily mean that it has a negative effect on sleep quality. This can influence the findings concerning REM sleep in this sample. Therefore, it was an important limitation of this study, once the average values of circadian preference assessed by our questionnaire were utilized.

Furthermore, the study did not have a control group and drivers’ data were not compared with normative values of literature or with each other, especially for the PSG examination. However, this study facilitates further research on shift work sleep and its relation to life habits and overall workers’ health.

Moreover, the focus of the present study was not to report the implementation of intervention programs; however, several studies have shown that implementation of intervention programs to prevent adverse consequences for workers’ physical and mental health is important. Naps [27], physical exercise [28], sleep hygiene [29], sleep disorder treatment [30] and anchor sleep are often reported to be good preventive and therapeutic strategies for improving rest and restorative sleep and promoting workers’ health [27, 29].

Conclusion

In night shift workers of the morning preference group with decreased REM percentage and increased REM sleep latency, morning preference had a significant effect on the pattern of sleep, especially REM sleep. Thus, it is important to evaluate interactions between individual aspects of health and other parameters, such as sleep quality and work organizational factors, to promote night shift workers’ health and well-being.

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References


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