

Original article

Effect of age on sleep onset time in rotating shift workers

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Abstract

Background: To determine the relationship between sleep onset time and age in rotating shift workers.

Methods: Sleep diaries were used to record the sleeping onset time in rotating shift workers. Work shifts were rotated on a weekly basis and fell into three periods: morning (06:00–14:00 h), evening (14:00–22:00 h), and night (22:00–06:00 h). Work shifts were rotated in the following order: night, evening, and morning. One working week consisted of 5 days. The mean age of the male shift workers was 40.3 years.

Results: A significantly earlier sleep onset time was observed in older workers working morning and evening shifts ($r = -0.42$ and $r = -0.66$, respectively), but not when working night shifts ($r = -0.10$). Regardless of age, night-shift workers usually go to sleep after their shift ends at 06:00 h. After the evening shift ends at 22:00 h, older workers tend to go to sleep earlier than younger workers.

Conclusions: Sleep onset time becomes earlier with age in morning- and evening-shift workers. The morning shift starts very early, at 06:00 h, so workers must go to sleep very early to obtain an adequate amount of sleep. Older workers may go to sleep earlier because of physiological (circadian) and/or social factors associated with shift work. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Sleep onset time; Aging; Sleep diary; Shift worker; Rotating shifts

1. Introduction

Modern companies often require continuous industrial output for economic reasons. Consequently, quantitative information on the health effects of shift work is needed. Previous investigations have shown that shift work has an adverse effect on sleep [1]. Shift work is considered to present a potential health risk to those who work at different times of the day and night. In rotating shift work, workers experience the most sleep-related problems while working the night shift and are most adaptable when working the evening shift [2].

Since one-third of Japanese manufacturers have work schedules that include night shifts, the sleep quality of shift workers should be monitored to determine quality of life, given that adequate sleep, in addition to nutrition and exercise, is an important element of health.

A self-administered questionnaire survey is a simple and cost-effective method, previously validated [3,4]. In our report, changes in the sleep onset time of male shift workers performing a rotating three-shift schedule were evaluated with regard to age by using questionnaires.

2. Materials and methods

Ninety-five male workers, between the ages of 19 and 59 years, were enrolled in our study in September 2000. The sleep onset time and sleep hours of these rotating shift workers were measured using a sleep diary. Workplace categories were divided according to the type of product being manufactured: synthetic rubber boots, sheets, or walls. A working week consisted of 5 days. Three work shifts were established: morning (06:00–14:00 h), evening (14:00–22:00 h), and night (22:00–06:00 h). The work shifts were rotated in a counter-clockwise manner. All workers participated in each shift, and no special considerations were made regarding age. Each shift was performed for 5 consecutive days. Weekend data were not obtained or included in the analysis. Each worker completed a sleep diary entry once a day for the 3 weeks of the study period.

Pearson's moment correlation coefficients between age and sleep onset time or sleep hours were calculated with no separation according to workplace, since the workload of the three workplaces did not differ. Each worker remained in the same workplace throughout the study. This study was approved by the public health committee on human research, and appropriate informed consents were obtained from the subjects. The statistical analysis

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was performed using the SPSS 10.0J software package for Windows.

3. Results

The analysis of sleep onset time in relation to the day of the week, stratified by age group, revealed a significant difference of sleep onset time in morning- and evening-shift workers in their 20s and morning-shift workers in their 30s and 40s, and a significant delay of sleep onset time in morning-shift workers on Friday. In contrast, there was no significant increase of sleep onset time among those in their 50s, indicating no phase adjustment effect. Those younger than 30 years of age showed a delay of sleep onset time before the weekend.

The median sleep onset time after the morning, evening, and night shifts was 22:00, 01:00, and 8:48 h, respectively. A significantly earlier sleep onset time was observed in older workers working morning and evening shifts ($r = -0.42$ and $r = -0.66$, respectively, $P < 0.01$, Fig. 1). In contrast, there was no association between sleep onset time and age in night-shift workers.

In view of the difference in sleep duration according to age, the correlation coefficient between age and sleep duration was also calculated. A significant association between age and the number of sleep hours was observed in morning workers ($r = 0.36$, $P < 0.01$, Fig. 2). In evening- and night-shift workers, a significant relationship between age and sleep duration was not observed.

To eliminate the potential effect of the previous shift work schedule, sleep onset time for Mondays was removed from our analysis, but the correlation coefficient did not change (-0.67 and -0.43 for the evening and morning

shifts, respectively, $P < 0.01$). Because the work shifts were rotated in a counter-clockwise manner with no exceptions, the effect of the shift order was not evaluated in this study. Data on shifts rotated in a clockwise manner should be gathered to determine the health effects of the shift order. Regarding the validity of the subjective data, the author relied on previous validations of the sleep diary method [5–7].

4. Discussion

The ability of workers to cope with shift work is influenced by circadian, sleep and domestic factors [8]. Circadian (rhythm) factors are directly related to the biological clock. In data obtained from daytime workers older people have been shown to go to sleep earlier than younger people. If sleep disorders and social or domestic issues are involved, as in the case of shift workers, the above trend may not hold true. The present study shows that the sleep onset time of morning- and evening-shift workers, but not of night-shift workers, becomes earlier with aging.

Unlike night-shift workers, morning- and evening-shift workers exhibited a correlation between sleep onset time and aging, wherein older workers had an earlier sleep onset time. The sleep onset time in morning- and evening-shift workers may be influenced by physiological factors, and the time at which a worker goes to bed is probably regulated by the worker's physical capacity to endure his workload.

The number of sleep hours obtained by workers engaged in rotating shift work was also evaluated. Older morning-shift workers slept significantly longer than younger workers. This result agrees with the trend in sleep onset time, as

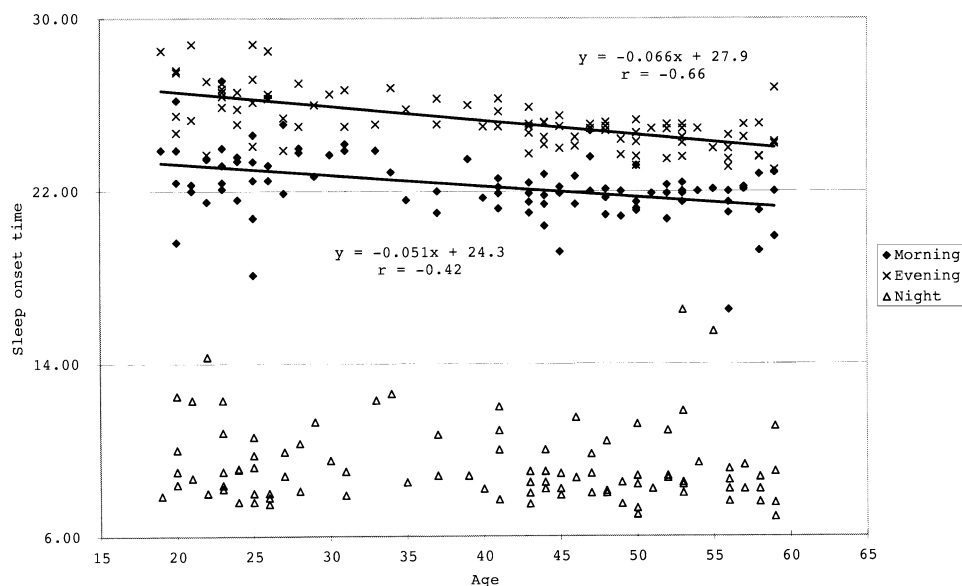


Fig. 1. Association between age and sleep onset time according to work shift. The horizontal lines at 06:00, 14:00 and 22:00 h show the times at which the three shifts ended.

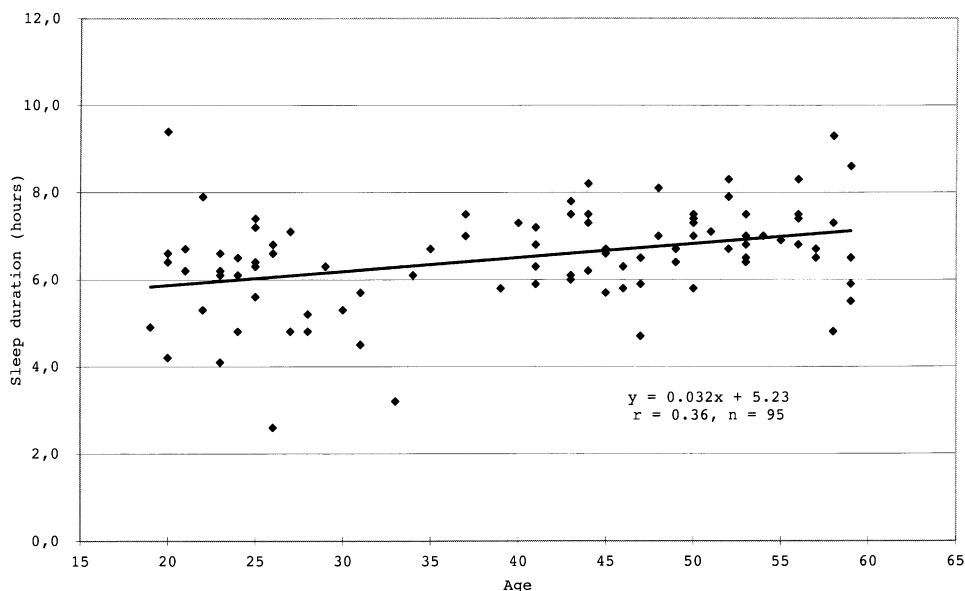


Fig. 2. Association between age and sleep duration in morning-shift workers. The Pearson's moment correlation coefficients between age and sleep duration in evening- and night-shift workers were not significant (0.13 and 0.12, respectively).

the time of awakening does not differ in general. In evening-shift workers, however, the number of sleep hours obtained by older and younger workers did not differ significantly. The author speculates that the time of awakening may be delayed in the younger generation.

Pilcher et al. [9] found that morning and evening shifts performed according to a rotating schedule resulted in shorter and longer periods of sleep, respectively, when compared to the sleep periods of workers with permanent daily shifts. These results agree with data reported by Kecklund et al. [10]. In general, younger workers do not go to bed earlier, even when they have to wake-up early in the morning [3]. This fact is also related to the difference in sleep onset times of shift workers.

Harma et al. [11] reported that age was significantly related to self-rated sleepiness in workers adjusted to a night shift: young subjects had lower levels of self-rated sleepiness than older subjects. This finding reflects a physiological capacity to remain awake for a longer period of time. This capacity is also related to the negative association between age and sleep onset time. Care must be taken to preserve the quality of daytime sleep in older workers. Workers with rotating work schedules obtain less sleep, overall, than their counterparts with permanent schedules. Increasing experience with shift work does not result in the sleep adaptations experienced by permanent daytime workers, and the amount of daytime sleep may decrease in older shift workers [12].

The author previously reported the effects of shift work on sleep duration [13]. The mean period of sleep duration in morning-, evening-, and night-shift workers was 6.5, 7.8, and 7.3 h, respectively. Thus, evening-shift workers sleep longer than night-shift workers, who in turn sleep longer than morning-shift workers. When the correlation between

age and sleep duration according to shift work was calculated (a calculation that was not included in the previous paper), a significant correlation was observed only in morning-shift workers (Fig. 2).

In conclusion, the sleep onset time in morning- and evening-shift workers becomes earlier with aging. The longer periods of sleep observed in older workers correspond to the shortening of the sleep onset time with aging observed in morning-shift workers.

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