Sleep and napping in young shiftworkers: A 5-year follow-up

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The present study examined sleep characteristics in young workers who entered rapidly rotating shiftwork for the first time and stayed on shifts for 5 years. Data were collected when the subjects had shiftwork experience of approximately 1.5, 3.5 and 5.5 years and a mean age of 22, 24 and 26 years. Data are presented showing significant differences in the main sleep durations between situations within the shift cycle and a small reduction in overall sleep over the observed period, primarily due to a sleep reduction on afternoon shift days. Data on sleep quality did not show any change over this early period of shiftwork exposure. In addition, napping strategies did not change, with the exception of a small increase in those taking naps on night-shift days between 1.5 years and 3.5 years of shiftwork exposure. At all the observed phases there were more young shiftworkers taking a nap on the morning shift days than on the night-shift days. The data suggested that reduced sleeps on morning and night-shift days were not compensated by taking a nap, but rather with an increase in main sleep duration on afternoon shift days and days off. A weak tendency for individuals to be relatively long or short sleepers irrespective of sleep conditions could be seen.

1. Introduction

The impact of shiftwork, especially if it involves night-shift, on the sleep of shiftworkers has been widely investigated. The numerous papers addressing this issue document sleep characteristics in shiftwork conditions, such as timing, duration, quality and structure of the main sleep, frequency and duration of naps, as well as their relationships (Åkerstedt 1984, Brown 1990, Douchon and Karen 1990, Folkard and Barton 1993, Knauth et al. 1980, Kogi 1982, Maesen et al. 1980, Oginska and Oginski 1990, Radošević-Vidaček et al. 1991, Tepas 1982, Tepas and Carvalhais 1990, Tepas and Mahan 1989, Tepas et al. 1993).

However, the number of follow-up studies of sleep in shiftworkers, usually involving one re-examination, is limited. There is one follow-up after eighteen months of 282 shiftworkers who either quit shiftwork, changed the type of shiftwork, or stayed in the same shift system (Åkerstedt and Torsvall 1978, 1985), one follow-up after 3 years of 46 rotating-shift shiftworkers (Tepas et al. 1984), one follow-up after 5 years of 91 shiftworkers (Kundi et al. 1986), one follow-up after 8 years of 17 rotating-shift shiftworkers who changed the order of shift rotation (Verhaegen et al. 1987), and one follow-up after 7 years of 69 shiftworkers on irregular working hours (de Vries and de Vries-Griever 1990).

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In this study young subjects who started work for the first time after having finished school and entered a continuous rapidly rotating shiftwork system were examined before starting shiftwork and after having 1.5, 3.5 and 5.5 years of shiftwork experience. The rapidly rotating shiftwork system that they were working on all the time, put them interchangeably, for a few days, into conditions that were unfavourable (morning and especially night-shift days) or favourable (afternoon shift days and days off) for sleep. Thus the study made it possible to determine the sleep characteristics in favourable and unfavourable shiftwork conditions of an age- and shiftwork-experience homogeneous group over the first years of exposure to shiftwork.

2. Method
The present investigation is part of a larger study designed to evaluate the validity of some individual difference measures for prediction of tolerance to shiftwork. The subjects in this study were young male oil refinery shiftworkers recruited by the company from a 4-year training school. At the beginning of the study 204 final-year students with a mean age of 19.0 years (SD = 0.6 years) were examined. Of these, 51 either did not start work in the company (n = 30) or were transferred to a non-shiftwork position (n = 21). The remaining 153 subjects started to work in shifts after a mean period of 14 months (SD = 7 months) following the initial examination. They worked in a rapidly rotating three-shift system with shift changes at 06:00, 14:00 and 22:00 h. The shifts rotated in the order mornings—afternoons—nights, followed by days off.

The subjects were followed up three times, after approximately 1.5, 3.5 and 5.5 years of shiftwork experience. They were administered a battery of questionnaires scored for various individual difference and tolerance to shiftwork measures. At the first follow-up there were 142 subjects, at the second 117 and at the third 101. Fifty-two (34%) subjects were missing at the third follow-up because they had left the company: for unknown reasons (n = 29); because of shiftwork (n = 6); as their home was too far away or they changed home (n = 5); because they got a better paid job (n = 3); because they continued education (n = 2); as they were not satisfied with interpersonal relations (n = 1); because they had been dismissed (n = 1); because they were transferred by company management to a non-shiftwork position (n = 3); or, because they were no longer willing to take part in the study (n = 2).

In this paper only the sleep characteristics of workers who reached 5.5 years of shiftwork experience are presented (n = 101). At the first follow-up their mean shiftwork experience was 17 months (SD = 7 months) and mean age 21.7 years (SD = 1.1 years). At the second follow-up their mean shiftwork experience was 39 months (SD = 7 months) and mean age 23.7 years (SD = 0.9 years). At the third follow-up their mean shiftwork experience was 66 months (SD = 7 months) and mean age 26.0 years (SD = 0.9 years).

The sleep variables analysed were: main sleep duration on morning shift days (SDMS), afternoon shift days (SDAS), night-shift days (SDNS), and days off (SDDO); sleep quality (SQ6); frequency of napping on morning shift days (NAPMS), and night-shift days (NAPNS); increase in sleep duration from morning shift days to afternoon shift days (SDAS—SDMS); and, increase in sleep duration from night shift days to days off (SDDO—SDNS).

The main sleep durations were determined by means of questions about usual time of going to bed and time of waking up. The sleep quality scale was a 6-item version of an originally 7-item scale (Vidaček et al. 1987). The questions concerned falling asleep easily
and quickly, frequent awakenings, unpleasant dreams, feeling of having slept enough and well, being treated for, or told they had, insomnia, and taking sleeping pills. The possible range of results on this scale was from 6 to 20 and Cronbach’s alpha was computed to be .71 for a group of 604 shiftworkers. Higher scores on this scale indicated better sleep quality and lower scores a more disturbed sleep. The questions about napping on morning shift and night-shift days enabled classification of workers into three categories: those who usually napped, those who napped occasionally, and those who usually did not nap.

The SQ6 scores were obtained before shiftwork and at three follow-ups. All other variables were, owing to their nature, measured only at follow-ups.

All statistical analyses were performed by means of SPSS/PC+ statistical software.

3. Results

3.1. Main sleep duration

The differences between main sleep durations (figure 1) were tested by means of MANOVA with two within-subjects factors: shiftwork experience (1.5, 3.5 and 5.5 years), and different days within a shift cycle (morning shift, afternoon shift, night-shift and days off). Of the multivariate test statistics that SPSS calculates, Pillai’s Trace will be reported here.

The well-known differences between sleep durations on different days within the shiftwork cycle were confirmed in the young shiftworkers (Pillai’s Trace $V = .94709$, approx. $F(3,98) = 584.75, p < .001$). Thus, the workers slept on average 6.0 h on morning shift days when the early start of work restrained them from sleeping as long as they would have wanted to. On subsequent afternoon shift days, when conditions for sleep were very favourable because workers did not have to wake up early in the morning, they usually slept for 9.7 h. On the night-shift days that followed (the least favourable sleep conditions),

![Figure 1. Mean sleep durations in young shiftworkers (n = 101).](image-url)
the workers' sleep was the shortest (on average 5.4 h). Finally, on days off, without working time to restrain workers from sleeping when and as long as they wanted to, they slept the longest (on average 9.8 h).

In addition, the analysis proved a small, but reliable, reduction in average sleep duration over years spent in shiftwork (Pillai's Trace $V = .09857$, approx. $F(2,99) = 5.41, p < .01$). The workers' mean sleep duration was 7.9 h at 1.5 years, 7.8 h at 3.5 years, and 7.6 h at 5.5 years shiftwork experience.

Finally, there was a significant interaction between shiftwork experience and the day within the shift cycle when sleep was taken (Pillai's Trace $V = .19424$, approx. $F(6,95) = 3.82, p < .01$). This interaction was examined further by analysing the differences between sleep durations for each of the five types of day separately. The analyses revealed a reliable reduction of sleep only for afternoon shift days (Pillai's Trace $V = .1599$, approx. $F(2,99) = 9.42, p < .001$) and an almost significant reduction for days off (Pillai’s Trace $V = .05471$, approx. $F(2,99) = 2.86, p = .06$), while the sleep durations for morning and night-shift days did not show a significant change (Pillai’s Trace $V = .01915$, approx. $F(2,99) < 1$, and Pillai's Trace $V = .0866$, approx. $F(2,99) < 1$, respectively).

The obtained correlation coefficients, indicating temporal stability of the reported main sleep durations (table 1), ranged from .28 to .64 and were all highly significant. The highest stability was found for sleep durations on days of the morning shift and the lowest for sleep on days off.

### 3.2. Napping

The percentage of workers usually taking a nap on the morning shift days fluctuated with shiftwork experience: 13% (1.5 years), 8% (3.5 years) and 10% (5.5 years). Those taking a nap occasionally also varied (52, 59, 64% respectively), as did those usually not taking a nap (36, 33, 26%). The percentage of workers usually taking naps on the night-shift days (7, 9, 12%) taking naps occasionally (30, 43, 49%) and of those usually not taking naps (63, 48, 48%) also varied with shiftwork experience.

After the workers were grouped into two categories, of those who usually napped or napped occasionally, and those who usually did not nap (figure 2), a difference in the number of workers nappping between the morning shift and night-shift days was tested for each follow-up period using the McNemar test. The McNemar test showed that there were more subjects napping usually or occasionally on the days of the morning shift than on the night-shift days at all three follow-ups ($\chi^2 = 16.6; p < .001, \chi^2 = 5.4; p < .05$, and $\chi^2 = 11.3; p < .001$, respectively).

<table>
<thead>
<tr>
<th>SDMS</th>
<th>SDAS</th>
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<tr>
<td>1.5</td>
<td>-</td>
<td>-</td>
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<tr>
<td>3.5</td>
<td>.54***</td>
<td>.46***</td>
<td>.60***</td>
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<tr>
<td>5.5</td>
<td>.40***</td>
<td>.64***</td>
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The differences in the number of workers napping between the pairs of successive follow-ups were tested for morning shift days and night-shift days separately using the binomial test. Napping on the morning shift days did not change significantly either from the 1.5-year to the 3.5-year follow-up, or from the 3.5-year to the 5.5-year follow-up. Thus, 20.8% of the workers neither napped at the 1.5-year nor at the 3.5-year follow-up, 52.5% napped at both follow-ups, 11.9% napped only at the 1.5-year, and 14.9% napped only at the 3.5-year follow-up. Further, 15.8% of the workers neither napped at the 3.5-year nor at the 5.5-year follow-up, 57.4% napped at both follow-ups, 9.9% napped only at the 3.5-year, and 16.8% only at the 5.5-year follow-up.

On the night-shift days, 41.6% of the workers napped either at the 1.5-year or at the 3.5-year follow-up, 29.7% napped both at the 1.5-year and 3.5-year follow-up, 6.9% only napped at the 1.5-year, and 21.8% only at the 3.5-year follow-up. The binomial test showed that significantly more subjects napped at the 3.5-year than at the 1.5-year follow-up (2-tailed $p < .01$). There was no further significant change in the number of shiftworkers napping on night-shift days from the 3.5-year to the 5.5-year follow-up. Namely, 34.7% of the workers did not nap at either follow-up, 37.6% napped at both, 13.9% napped only at the 3.5-year, and 13.9% only at the 5.5-year follow-up.

3.3 Sleep quality
The sleep quality scores (SQ6) are presented in figure 3. Owing to some technical problems, only 27 out of 101 subjects had SQ6 scores for the 1.5-year follow-up and 75 had scores obtained before entering shiftwork, and both at the 3.5-year and 5.5-year follow-ups. MANOVA was performed without the results for the 1.5-year follow-up because of the very small number of subjects having these results. It indicated no change in sleep quality over the observed period (Pillai’s Trace $V = 0.05364$, approx. $F(2,73) = 2.07$).
Figure 3. Mean sleep quality scores (± SE) before entering shiftwork (n = 75), at 1.5 years (n = 27), 3.5 years (n = 75) and 5.5 years (n = 75) of shiftwork experience.

The correlation coefficients indicating temporal stability of the SQ6 for the 75 workers were: \( r = .23 \) (\( p > .05 \)) between the scores obtained before they entered shifts and the scores at 3.5-year follow-up, \( r = .30 \) (\( p < .01 \)) between the scores obtained before they entered shiftwork and those at the 5.5-year follow-up, and \( r = .65 \) (\( p < .001 \)) between the scores obtained at the 3.5-year and 5.5-year follow-ups. Thus, sleep quality seems to have been fairly stable between two follow-ups, after the subjects spent some time working in shifts, but rather unstable in relation to sleep quality reported before they had entered shiftwork.

3.4. Reduced sleep compensation
In order to find out whether reduced sleep on the morning shift and night-shift days was compensated for with naps, differences in the main sleep duration between the workers usually napping, those napping occasionally and those usually not napping were tested by means of a one-way analysis of variance. There was no statistically significant difference in the main sleep duration for workers who differed in napping on the morning shift days (\( F(2,98) = 2.33 \) for the 1.5-year experience, \( F(2,98) < 1 \) for the 3.5-year experience, and \( F(2,98) < 1 \) for the 5.5-year experience). Workers differing in napping on the night-shift

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<tr>
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<tr>
<td>SDMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>.16</td>
<td>-.35***</td>
</tr>
<tr>
<td>3.5</td>
<td>.28**</td>
<td>-.39***</td>
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<td>5.5</td>
<td>.26**</td>
<td>-.41***</td>
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\(* *p < .01; \ ***p < .001.\)
Table 3. Pearson correlation coefficients between sleep duration on night-shift days (SDNS) on the one hand, and sleep duration on days off (SDDO) and increase in sleep duration from night-shift days to days off (SDDO-SDNS) on the other hand. Results obtained at 1.5, 3.5 and 5.5 years of shiftwork experience.

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<tr>
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<th>SDDO</th>
<th>SDDO-SDNS</th>
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<tbody>
<tr>
<td>SDNS</td>
<td>1.5</td>
<td>0.24*</td>
</tr>
<tr>
<td></td>
<td>3.5</td>
<td>0.20*</td>
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<tr>
<td></td>
<td>5.5</td>
<td>0.24*</td>
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</table>

*p < .05; ***p < .001.

days similarly did not show a statistically significant difference in the main sleep duration at 1.5 and 5.5 years of experience (\(F(2,98) < 1\), and \(F(2,98) < 1\), respectively). However, the difference at 3.5 years of experience was statistically significant (\(F(2,98) = 5.27, p < .01\)). Pairwise comparisons of main sleep durations for 3.5 years of experience (sleep duration mean = 6.4 h for those usually napping, 5.0 h for those napping occasionally and 5.7 h for those usually not napping) showed the only significant difference to be between the workers who usually napped and those napping occasionally (Scheffe, \(p < .05\)).

The notion that an increase in sleep duration in favourable conditions compensates for reduced sleep in unfavourable conditions was investigated using two groups of correlation coefficients. The first were the correlations between sleep durations on morning and afternoon shift days, and between sleep durations on night-shift days and days off, i.e. between sleep durations in favourable and unfavourable conditions (tables 2 and 3). The second group of correlations were those between sleep duration on morning shift days and the increase in sleep duration from morning to afternoon shift days, and between sleep duration on night-shift days and the increase in sleep duration from night-shift days to days off, i.e. between sleep durations in unfavourable conditions and the increase in sleep duration from unfavourable to favourable conditions (tables 2 and 3).

The correlations between sleep durations in favourable and unfavourable conditions were all positive, small (not exceeding .28), and all but one were statistically significant. To the contrary, all the correlations between sleep durations in unfavourable conditions and the increase in sleep from unfavourable to favourable conditions were negative and highly statistically significant. They were moderate for morning/afternoon shift conditions and high for night-shift/days off conditions.

4. Discussion

In this study young shiftworkers generally reduced their overall sleep duration, and specifically sleep duration on the afternoon shift days, over the first 5 years of shiftwork. The question is: why? It may be that they learn to sleep less on the morning shift days and the need to compensate for short sleep is not as strong as it used to be, or that they generally learn to sleep less (Verhaegen et al. 1987). Alternatively, it could be that their sleep is influenced by some changes in their social life. They are at an age when young people start their own family life and their responsibilities increase substantially, which may not permit a long sleep in the morning. Both explanations may be correct. Without additional data it is difficult to tell.

While sleep duration shows some changes over the time spent in shifts sleep quality does not seem to change at this early phase of exposure to shiftwork.
A study of rotating-shift shiftworkers (Åkerstedt and Torsvall 1985) indicates that there is a relationship between napping and sleep loss. That study involved older workers with many years of exposure to shiftwork and analysed differences between those who usually napped and those who did not. In an earlier study of 604 experienced shiftworkers (mean age 32.1 years, range 21–57 years) working in the same company and the same shift system as the subjects in this study (Radošević-Vidaček et al. 1991), differences between workers who usually napped, those who napped occasionally and those who usually did not nap were analysed. Two opposite tendencies could be detected. On morning shift days the workers who napped usually or occasionally slept longer than the workers who did not nap, while on the night-shift days those who napped usually or occasionally slept less than those who did not nap. However, on both the morning and night-shift days napping was more common in older workers (Radošević-Vidaček 1986). Such results would indicate a need to control for the effect of age when napping is analysed. In this study, which deals with an age-homogeneous group of workers, there is no evidence that a nap might serve as a replacement for a short main sleep. Moreover, more young shiftworkers napped on morning shift days than on night-shift days when sleep was on average shorter than on morning shift days.

The present study shows that young shiftworkers who sleep less on morning shift days prolong their sleep on the afternoon shift more while those who sleep longer increase it less. Even greater negative correlations between sleep duration on the night-shift days, when there is a greater sleep reduction, and the increase in sleep from night-shift days to days off indicate that the compensation of reduced sleep is more pronounced when the sleep reduction is greater. A similar tendency was found also between sleep in the night-shift week and increase in sleep from the night-shift week to week off for young shiftworkers in a weekly rotating shift system (Maasen et al. 1980). Thus, the data strongly support the notion that sleep in more favourable conditions makes up for reduced sleep in less favourable conditions. Similar tendencies were found in some other groups of shiftworkers (Radošević-Vidaček and Vidaček 1994).

At the same time it is possible for a worker to show a tendency, although a rather weak one, to be a relatively long or short sleeper irrespective of sleep conditions. Thus, if a sleep in more favourable conditions makes up for reduced sleep in less favourable conditions it does not mean that there should necessarily be a negative correlation between sleep in unfavourable and favourable conditions.

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