

Sleep, sleepiness and need for recovery of industrial employees after a change from an 8- to a 12-hour shift system

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Abstract: Employees often prefer 12-hour work shifts but they can increase sleepiness and injury risk. We assessed whether sleep, sleepiness, satisfaction and need for recovery changed after changing from an 8-hour to a 12-hour shift system. The participants were 178 employees of the paper, pulp and chemical industries. Using a quasi-experimental controlled intervention design, 83 employees, who changed from an 8-hour shift schedule to a 12-hour shift schedule were compared to those who remained in the 8-hour shift schedule (n=95). Participants filled in a survey on sleep, sleepiness, satisfaction and need for recovery at baseline and 9–12 months after the shift schedule change. We used generalized estimation equation models adjusted for age, sex, shift work experience in years and baseline shift system. Sleep length was longer in the 12-hour shift schedule before the first morning shift and between morning shifts. Sleepiness during morning shifts was less frequent and satisfaction with the shift system was more prevalent in the 12-hour shift schedule. Also, perceived negative associations of the current shift system with work-life balance were less common in the 12-hour shift schedule. The differences found between the shift systems were minor and the results did not indicate significant disadvantages of the 12-hour fast forward-rotating shift system.

Key words: Shift work, Shift scheduling, Extended work shift, Controlled study, Work-life balance, Sleep, Sleepiness

Introduction

Shift work, especially night shift work, increases the risk of several diseases including metabolic disorders¹⁾, cardiovascular diseases²⁾, and certain cancers^{3, 4)}. However, the

risks of shift work may depend on several shift characteristics such as the number of consecutive work shifts, the inter-shift recovery time, and the length of shifts⁵⁾.

Extended work shifts (>8 h) have become more popular in Europe^{6, 7)} and despite the digitalizing work life almost 30% of industrial workers still work in shifts⁸⁾. Employees tend to prefer 12-hour shifts as long shifts provide better opportunity for longer time-off periods from work, reduce the commuting time to work and increase the possibilities

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for recovery from fatigue and sleep loss⁹). Our previous study, limited to cross-sectional baseline study design, showed that Finnish industrial employees were more satisfied with 12-hour shifts than 8-hour shifts and perceived their shift system more beneficial to health and work-life balance¹⁰). However, long work shifts (≥ 12 h) can increase the risk of fatigue, compromised sleep and other adverse outcomes¹¹). For example, compared to usual 8-hour work shifts, 12-hour shifts may increase errors¹²) and accident risk¹³) likely via increasing fatigue towards to the end of a long work shift¹⁴). Longer, 12-hour shifts may also affect employee's recovery from work. Shift work including night work has been associated with elevated need for recovery from work compared to day work¹⁵). The association of a change from 8-hour to 12-hour shifts with the need for recovery has, however, not been studied.

Regarding sleep, longer 12-hour shifts have associated with both better¹⁰) and poorer¹⁴) sleep and findings do not provide an unambiguous judgment of the effects of 12-hour shifts. Indeed, the length of a shift as such may not be the main risk predictor of wellbeing among shift workers⁹). Even within a regular shift schedule with long work shifts, significant variations especially in the direction of rotation, shift start and end times, and the number of consecutive work shifts and days-off can occur. Research supports fast-forward rotating shift schedules (e.g., MMEENN-days off) as more ergonomic than slower and/or backward rotating shift schedules¹⁶⁻¹⁸). Overall, the evidence on the effects of 12-hour shifts on wellbeing is equivocal^{9, 19}).

Most studies on 12-hour shifts, sleep and sleepiness have been cross-sectional^{6, 20, 21}). Follow-up studies^{12, 14, 22}), on the other hand, have often lacked control groups, making these "before-after" studies sensitive to comparison bias. Due to practical reasons, no randomized work-life studies on the effects of extended workdays in shift work exist. We were able to find only one study of sleep and sleepiness that utilized a quasi-experimental setting with a control group²³).

The aim of the present study is to examine the impact of changing from an 8-hour shift system to a 12-hour shift system on sleep, sleepiness, satisfaction and need for recovery among Finnish industrial employees before and after they changed from two different regular 8-hour shift systems to a regular 12-hour shift system. In the follow-up, those who stayed in the 8-hour shift systems were compared to those who changed to the 12-hour shift system.

Subjects and Methods

The study participants were employees working shifts in

nine paper and pulp or chemical factories in Finland. The decisions to change from 8-hour to 12-hour shifts arose from companies' desire to investigate the suitability and well-being effects of the 12-hour shift system in some factories. A request to participate was sent to 1,023 employees of whom 599 employees answered the questionnaire at baseline (59% response rate) and 351 at follow-up 9 to 12 months later (59% response rate). Two factories that were already working 12-hour shifts at baseline were excluded. The analytical sample consisted of 178 participants who all had an 8-hour shift schedule (MMEENN---- (n=98) or MMMM-EEEE-NNNN----- (n=80)) at baseline. In a quasi-experimental controlled intervention study design, 95 participants of three factories stayed in their 8-hour forward-rotating shift systems (i.e., control group) and 83 participants of four factories changed to the 12-hour forward-rotating shift systems (DDNN----- or DD-NN-----) (i.e., intervention group). Control group and intervention group were working in different factories. Data was collected from both groups at baseline and during the follow-up (Fig. 1). The shift change times were 7:00 and 19:00 in the 12-hour system, 6:00, 14:00 and 22:00 in the slowly forward-rotating 8-hour system, and 6:00, 14:00 and 22:00 or 7:00, 15:00 and 23:00 in the fast forward-rotating 8-hour system.

Demographics

Participants filled in questionnaires on sociodemographics (age, sex, and children under 18 years living in the same household), body mass index (BMI, kg/m²), and shift work experience (years). Chronotype was rated on a five-point scale which was dichotomized to 'morning type' (1=absolutely morning type to 3=neither) and 'evening type' (4=more evening type and 5=absolutely evening type)²⁴). Use of sleep promoting medication or substances during the past three months had four categories: never, less than once a week, several times a week, every day/nearly every day²⁵).

Sleep and sleepiness

Questions on sleep included habitual sleep length (hh:mm), morning and night shift-specific average sleep duration (hh:mm), frequency of morning and night shift-specific sleep difficulties in the past three months (difficulties in initiating and maintaining sleep, difficulties in waking up and excessive daytime sleepiness)²⁵). Occurrence of severe sleepiness during morning and night shifts work was assessed with four categories (never/seldom, quite seldom, quite often, and often/continuously). To as-

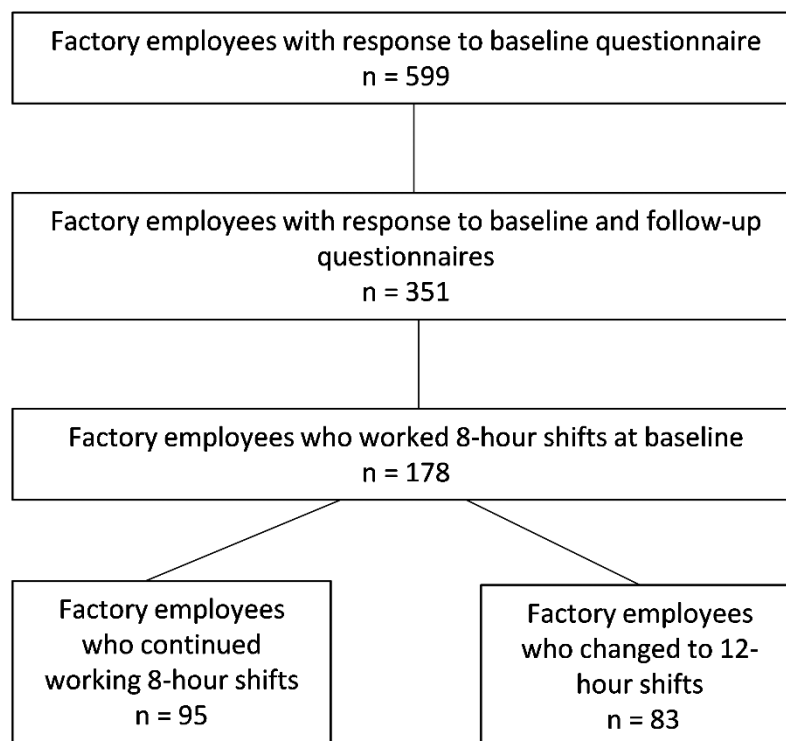


Fig. 1. Flow chart of the study.

sess the level of sleepiness during morning and night shifts, participants retrospectively evaluated their sleepiness during work shifts in 2-hour periods in the previous three months using the nine-grade Karolinska Sleepiness Scale (KSS)²⁶. The ratings were dichotomized as ‘not sleepy (1=extremely alert to 6=some signs of sleepiness) and sleepy (7=sleepy, but no effort to keep awake to 9=very sleepy, great effort to keep awake, fighting sleep) for analyses.

Health, need for recovery and perceived effects of shift work

Subjective health compared with age peers, was rated on a five-point scale from 1=very bad to 5=very good²⁷ and self-rated work ability on an 11-point scale (0 to 10)²⁸. Need for recovery from work (NFR) was assessed using an 11-item questionnaire with a dichotomic scale (0=no and 1=yes) and ratings were dichotomized to ‘not so strong’ (≤ 5) and ‘strong’ (> 5)²⁹. Satisfaction with working time arrangements was rated on a five-point scale which was dichotomized to satisfied (1=extremely satisfied to 2=rather satisfied) and not satisfied (3=not satisfied or dissatisfied to 5=extremely dissatisfied). Perceived effects of working time arrangements on a) sleep and alertness, b) work-life

balance, c) fluency of work and d) commuting were assessed using items from Standard Shiftwork Index (SSI)³⁰. Each item was rated on a five-point scale and was dichotomized to disturbs (1=disturbs/compromises a lot or 2=disturbs/compromises to some extent) and do not disturb (3=do not disturb/compromise or improve to 5=improves a lot).

Ethical issues

Ethical approval for the study was obtained from the Ethical Committee of the Finnish Institute of Occupational Health. Before participation the employees were informed about the study and answering to surveys was considered as consent to participate in the study.

Statistical Analysis

Statistical analyses were conducted using IBM SPSS 25.0 (Chicago, IL, USA). The Pearson Chi-square test and Student’s t-test were used to compare baseline variables in those who continued to work in an 8-hour shift system and those who changed to a 12-hour shift system. Generalized estimating equations (GEE) estimates population average effects and allows modeling of correlated longitudinal data³¹. We used GEE with independent correlation struc-

ture to study the differences in changes in subjective health, sleep, sleepiness, and effects of shift arrangements between those who continued in an 8-hour shift system and those who changed to a 12-hour shift system. Age, sex, and shift work experience were used as covariates in the GEE analyses. For the binary response data (e.g., Need for recovery from work), the variance function for binomial probability distribution and logit link function were specified as the model type. For the ordinal response data (e.g., work ability) the variance function for multinomial link and cumlogit link function were specified and for continuous variable analysis (e.g., habitual sleep length), the variance function for normal link and identity link function was used. The GEE analysis results were presented in odds ratios (OR) with confidence intervals (CI) of 95%. A *p*-value of <0.05 indicated a statistical significance.

Results

Demographics

Participants were 24 to 61 years old and 90% of them were men. The duration of shift work experience ranged between one to 43 years with an average of 19 years. The individual differences between the working time groups were small and statistically non-significant at baseline (see Table 1).

Sleep and sleepiness

Self-rated sleep length before the 1st morning shift (OR

2.33, 95%CI, 1.60–3.40) and between successive morning shifts (OR 1.89, 95%CI, 1.42–2.52) was longer in the group who changed to a 12-hour shifts compared to those who remained in an 8-hour schedules. Reported habitual sleep length or sleep length in connection with night shifts or days off sleep did not differ between the groups (Table 2). The same applied for sleepiness and insomnia while working morning or night shifts. However, the odds of reporting sleepiness (often or always during a shift) were lower during morning (OR 0.48, 95%CI 0.29–0.80) and night shifts (OR 0.55, 95%CI 0.32–0.98) in the 12-hour group.

Whether the results obtained during morning shifts were affected by the differences in the start times was tested in additional analyses. After adding shift start time (6:00 vs. 7:00) to the model all results remained significant (data not shown).

Health, need for recovery, and perceived effects of shift work

Satisfaction with the current shift system was more common in the 12-hour group (OR 2.64, 95%CI 1.49–4.69). This group also reported fewer negative effects of their shift system on sleep and alertness (OR 0.42, 95%CI 0.25–0.69) and work-life balance (OR 0.30, 95%CI 0.18–0.50) than the 8-hour group. Analysis of subjective health, work ability and need for recovery from work, or perceived effect of the current shift system on fluency of work or commuting did not reveal significant group differences (Table 3).

Table 1. Baseline sample characteristics

	Stayed in 8-hour shift system (n=95)	Changed from 8-hour to 12-hour shift system (n=83)	<i>p</i> -value ¹
Age (Mean, SD)	44.2, ± 10.0	41.4, ± 9.9	0.069
Years of shift work experience (Mean, SD)	20.0, ± 11.6	17.2, ± 10.9	0.109
BMI (kg/m ²) (Mean, SD)	26.7, ± 4.1	26.8, ± 3.6	0.916
Sex (males) (%)	89.5	91.6	0.636
Children under 18 years (%) ²	49.5	59.0	0.202
Evening Chronotype (%) ³	60.0	66.1	0.388
Use of hypnotics or other sleep promoting substances (%) ⁴	20.0	16.9	0.592
Habitual sleep length (hh:mm) (Mean, SD)	07:16, ± 0.82	07:20, ± 0.99	0.646
Subjective health (%) ⁵	61.4	70.1	0.201
Need for recovery from work (NFR) (%) ⁶	72.2	70.0	0.795

¹*t*-test or Pearson Chi-square. ²Living in the same household. ³More evening type or absolutely evening type.

⁴Weekly or more often. ⁵Good subjective health (good or very good). ⁶Increased need for recovery (6≥ points).

Discussion

We aimed to study whether industrial employees' perceptions of their sleep, sleepiness, satisfaction and need for

recovery were affected by a change from an 8-hour forward-rotating shift system to a 12-hour forward-rotating system. The results did not show any negative associations following the change. Instead, we found some positive, al-

Table 2. Change from 8-hour shift system to 12-hour shift system and sleep, sleepiness and insomnia. Odds ratios (OR) with 95% confidence intervals in the GEE models with those who stayed in 8-hour shift system as the reference group

	OR	95%CI	<i>p</i> -value
Habitual sleep length (h)	0.971	0.740–1.273	0.831
Sleep length before 1st morning shift	2.330	1.599–3.395	<0.001
Sleep length between morning shifts	1.890	1.419–2.518	<0.001
Sleep length before night shift	1.009	0.874–1.165	0.906
Sleep length after night shift (day sleep)	0.817	0.563–1.563	0.286
Sleep length after last night shift	1.203	0.875–1.653	0.256
Sleep length between days off	0.968	0.749–1.250	0.801
Sleepiness in morning shifts (often or always)	0.479	0.286–0.804	0.005
Sleepiness in night shifts (often or always)	0.554	0.315–0.975	0.040
Insomnia in relation to morning shifts (often or always)	0.941	0.551–1.607	0.824
Insomnia in relation to night shifts (often or always)	0.628	0.356–1.109	0.109
Sleepiness in morning shift (KSS 7 or more) ¹	0.749	0.443–1.268	0.282
Sleepiness in night shift (KSS 7 or more) ¹	1.113	0.649–1.909	0.697

GEE analyses adjusted with age, sex and baseline 8-hour shift system (fast forward vs. slow forward). ¹ Retrospectively rated sleepiness, KSS = Karolinska Sleepiness Scale.

Table 3. Change from 8-hour shift system to 12-hour shift system and wellbeing and perceived effects of shift work arrangements. Odds ratios (OR) with 95% confidence intervals in the GEE models with those who stayed in 8-hour shift system as the reference group

	OR	95%CI	<i>p</i> -value
Subjective health	1.297	0.757–2.223	0.343
Work ability	1.073	0.646–1.782	0.785
Need for Recovery from Work (NFR)	0.748	0.412–1.359	0.341
Satisfied with current shift system	2.640	1.486–4.689	0.001
Perceived negative effects of current shift system on:			
Sleep and alertness	0.417	0.252–0.689	0.001
Work-life balance	0.299	0.178–0.504	<0.001
Fluency of work	0.723	0.391–1.338	0.302
Commuting	0.804	0.435–1.794	0.734

*Disturbs to some extent or a lot. GEE analyses adjusted with age, sex and baseline 8-hour shift system (fast vs. slow forward-rotating)

beit rather modest association with self-rated sleep length and sleepiness and a clear positive association with satisfaction with the current shift system among the employees who changed to a 12-hour shift system.

The few longitudinal studies of sleep and sleepiness among industry employees with a 12-hour shift system largely accord with the present findings, suggesting little or no negative associations between 12-hour shift systems and sleep or sleepiness. For example, a study of petrochemical employees showed improved sleep quality, including less awakenings and feeling more refreshed after sleep in a 12-hour shift system¹²⁾. A few older studies on computer operators and mine employees showed mixed results of tiredness/fatigue and some improvements in sleep quality following a change from an 8-hour to a 12-hour shifts system³²⁾. In another study on nuclear power plant employees, a change from a forward rotating 8-hour system to a 12-hour fast rotating system did not result in an increase in sleepiness or in other negative outcomes³³⁾. There is also some evidence suggesting that sleep length may increase, and sleepiness decrease while working a 12-hour fast rotating shifts compared to 8-hour fast forward-rotating shifts³⁴⁾. Instead, a study of control room operators reported increments in sleepiness and reduced sleep amount at 7-month follow up after changing from an 8-hour system to a 12-hour system³⁵⁾. Another follow-up study of the same group showed no association for sleep quality but a negative association for sleep length and alertness after changing from an 8-hour shift system to a 12-hour shift system among natural gas utility employees¹⁴⁾.

There is paucity of controlled intervention studies examining the result of a change from an 8-hour system to a 12-hour system. We were able to find only one such study where 32 control room operators changed from a slowly backward rotating 8-hour system to a faster 12-hour shift system (2 or 3 consecutive night or day shifts) and day workers served as a reference group²³⁾. In line with our findings, the change increased satisfaction with working hours and sleep. Also, sleepiness decreased and perceived recovery after a night shift was enhanced.

A single group follow-up study of control room operators reported less sleep and alertness decrements in a slow rotating 12-hour shift system compared to previously worked 8-hour shift system³⁵⁾. The 12-hour shift system of the present study was fast forward-rotating with two consecutive morning and night shifts followed by 5 or 6 successive days off. It is possible that the differences between these studies relate to less cumulative fatigue and better possibilities to recuperate in a fast forward-rotating shift

system³⁶⁾. Even if the work shifts of a fast forward 12-hour shift system are long, the shift system does not include many other negative shift characteristics such as short shift intervals (<11 hours) and several successive night shifts that have proven to have major impact on shift workers' sleep and health⁵⁾.

A strength of our quasi-experimental controlled panel study was that we had a control group of workers who stayed in an 8-hour shift system. We were able to study the combined role of longer work shifts and shorter spells of consecutive working days, and the results were not confounded by shift starting times, changes in the direction and or speed of shift rotation. The GEE analyses accounted for correlated observations that longitudinal data generate, which may lead to incorrect estimation of standard errors, resulting in incorrect inferences of parameters. However, it is possible that some unaccounted differences between the working time groups may have influenced the results. At baseline the factories differed in speed of rotation of the 8-hour shift systems. We included this factor as a covariate in the analyses, but it had no influence on the results. This suggests that speed of rotation did not significantly impact main findings and their interpretation. A limitation of the study design was the relatively short follow-up time to evaluate the possible long-term health risks of working in 12-hour shifts. Nevertheless, the 9- to 12-month period may be long enough for adjusting work routines and personal life habits to the new system. A study with a longer follow up to 3–5 years suggests that the initial changes during the first year after change to a 12-hour shift system are likely to endure. Sleep and sleepiness measures of our study were retrospective and thus potentially subject to memory bias. We assume that should this kind of bias occur it likely would be similar in both experienced shift worker groups and thus would have little effect on our longitudinal findings. Some ordinal variables were used as dichotomous variables with previously used cut-off points which may have decreased analysis power.

This study included industrial employees with physically relatively light operator and control room work and the participants were predominantly males. This may have contributed to the positive view of a 12-hour shift system and the findings may not generalize to female employees and other groups with, e.g., a higher physical or mental workload. The response rate was relatively low (<60%), and our study sample was relatively small, similarly to the referenced studies. This may decrease the reliability of our results and their generalizability. In the future, additional longitudinal studies with larger samples and objective

measures of sleep, sleepiness and recovery are needed.

Conclusions

A change from an 8- to a 12-hour shift system among industrial employees showed positive results in most respects but the differences between the groups were minor. The results indicated no downsides of a 12-hour forward-rotating shift system for rated sleep, sleepiness, satisfaction or need for recovery from work compared to an 8-hour shift system.

Conflict of Interest

None.

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