

Shiftwork and the Length and Quality of Sleep

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Previous investigators have reported that amount and quality of sleep are reduced in the shiftworker. The finding that night and morning shifts lead to shortened sleeping hours is replicated in this study. Overall sleeping time, however, was not found to be different for workers on different shift schedules or for shiftworkers and nonshiftworkers. The correlation between length and quality of sleep was very low. Length of sleep was not predicted well by factors such as stress at work, noisiness of sleeping room, drinking coffee, and smoking cigarettes, although these and similar predictors were strongly related to quality of sleep. Shiftwork was found to have a consistent effect on quality of sleep, even when other variables were controlled.

One of the basic findings in research on shiftwork has been the shortness of sleep after night shifts.¹⁻⁴ Among the few investigators who have examined length before and after other shifts are Rutenfranz and co-workers,⁵ who also have reviewed the recent literature. It is important for the design of shiftwork schedules to learn how length of sleep is related to the patterns of shifts, e.g., whether one sleeps longer if the night shift follows the afternoon shift. The general conclusion in the literature seems to be that shiftworkers sleep less than nonshiftworkers; however, the length of sleep of shiftworkers was not compared directly with that of nonshiftworkers. Rather, it was compared with an assumed norm of adequate sleeping time.⁶ When actual sleeping time is compared with the need for sleep, only a small discrepancy is found.⁷

Furthermore, there are indications in the literature that different shift schedules have different impacts on sleeping time. Loskant⁸ maintains that a quickly rotating shift schedule with 12-hour shifts and with a free day after one or two night shifts is superior to an eight-hour shift schedule that changes after five to seven days.

Typically, the literature on shiftwork describes an association between the shortening of sleep and a reduction of the quality of sleep, as well as general health complaints.^{8,9}

Very few studies, however, examine the issue of quantity of sleep and health complaints in real life.¹⁰ There is some evidence that shiftworkers sleep less during their night shift periods but actually sleep longer during their afternoon and free shift periods, compensating for the sleep deficit.¹¹ Thus, the problems may not lie in the overall length of sleep but in the quality of sleep. This reduced quality may result from sleeping in the daytime⁶ and from the variable length of sleep on different days. It may not be possible to compensate fully for the sleep deficit accumulated in the night shift period.

Other factors that may affect quality of sleep are noise level during sleep, stress level at work, and attempts to cope with the problems of night shiftwork. Noise level in the sleeping room has been repeatedly shown to be an important factor in the quantity and quality of sleep.^{1,6} Stress at work may have a generally activating influence and thus contribute to sleep problems. The major problem one has to cope with in nightwork is overcoming sleepiness. Two frequently used coping strategies that have a physiological effect are smoking more and drinking coffee during the night. Higher consumption of cigarettes and coffee increases physiological activation and thereby helps to keep the worker awake. On the psychological level a coping strategy is to make an extreme effort to keep awake and continue working. Yet another strategy is to keep the time structure of the day constant regardless of the shift one is working. One means is to eat lunch (the main meal in Germany) at the same time each day. Such a strategy could affect sleeping patterns as well.⁶

Thus, this report addresses two questions: First, how do the shifts before and after a given day influence sleeping time? Second, how are length and quality of sleep related and what determines the length and quality?

Sample

A scientific study group for the chemical industry labor union in the Federal Republic of Germany arranged for the distribution of questionnaires in 24 factories. These 24 companies were selected from 69 companies whose union locals had expressed an interest in participating in the study. These companies are representative of the areas in which the union (Industriegewerkschaft Chemie, Papier und

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Keramik) operates. About half of the factories in the sample produce chemical products; the others produce rubber, paper, glass, and ceramics. The *Industriegewerkschaft Chemie, Papier und Keramik* is the only labor union that organizes both blue- and white-collar workers in these areas of production.

Shop stewards distributed consent forms to qualified candidates. They were instructed to make a special effort to approach former shiftworkers and workers who do not belong to the labor union. Furthermore, they were asked to give the consent forms only to native German speakers. Those workers who returned the consent forms received the questionnaire. Each factory was allotted a certain number of consent forms. This amounted to a 15% sample of all the shiftworkers and 5% of the non shiftworkers. The minimum number of consent forms distributed to each factory was 100. Thus, the smaller factories are overrepresented.

Of those who received the questionnaire, 61% ($N = 5,448$) returned it (shiftworkers and nonshiftworkers had the same return rate). The return rate ranged from 27% to 100% across the different factories. The following groups of blue- and white-collar workers can be distinguished in the sample: night and shiftworkers who have a slowly rotating shift system of eight hours each, with work usually starting at 6, 14, and 22 hours ($N = 1,288$, only male blue-collar workers are allowed to work nights in industry); night and shiftworkers who have a quickly rotating shift system with 12-hour shifts, the work usually starting at six and 18 hours ($N = 1,191$, only males); shiftworkers without night shifts, with work usually starting at six and 14 hours ($N = 263$, 178 males and 85 females); "never-shiftworkers," who have never worked shifts, with work usually starting at 6 or 7 o'clock ($N = 1,117$, 939 males and 178 females); and former shiftworkers who are now working in day shifts ($N = 764$, 679 males and 85 females). This last group can be divided into three subgroups based on reasons for leaving shiftwork: health concerns, other reasons, and a combination of health and other reasons.¹² There were 809 workers who could not be assigned unequivocally to any of the foregoing categories for reasons such as missing data or mixed or unusual shift systems; they are not included in the main analyses. The number of subjects is reduced by missing data in the various analyses reported.

There are two possible problems that can arise from the composition of this sample: First, the sample includes more union members and workers who are actively involved in the union than does the population from which it was drawn. Second, the different return rates of the different factories might have an impact on the results. Both possible influences have been analyzed by us and have been found not to influence the results.

Method and Instruments

All of the measures are self-reported. Two questions with regard to length of sleep were asked. The first was, "How many hours do you usually sleep per night?" To avoid the possible problems of distortion when people are asked to report abstract averages, a second question was asked immediately following the first one, with a short introduction explaining the reason for this second question: "One is particularly well able to remember the sleep/length of the last few days. Therefore, we would like to

know: *How many hours did you sleep yesterday?* Please answer this question, even if you have slept unusually short or unusually long hours yesterday." It is the latter item that is used in the analyses. The correlation between the two items on sleep length is $r = .54$ ($N = 5,298$).

Three scales that had been pretested in pilot studies were used. (The wording of the items and item values are available from the senior author on request.) Environmental stress¹³ is measured by 10 items (e.g., How much are you stressed by noise at your workplace?); its Cronbach's α is .84. Psychological stress¹³ is measured by six items (e.g., How often are you under time pressure in your work?) ($\alpha = .80$). These two scales were validated with observers in another study¹³ and the subjective version of environmental stress showed a correlation of .57 with the ratings of trained observers. The corresponding correlation for psychological stress was .41. The scale on general sleep problems consists of three questions: "Do you show strong signs of fatigue?"; "Do you have sleep disturbances?"; and "Do you feel tired and worn out all day?" (Cronbach's $\alpha = .78$). The other variables are single items regarding the shift worked in the 24 hours before and after filling out the questionnaire, quietness of the sleeping room, putting extreme effort into work, experiencing tiredness, maintaining a regular lunchtime, and drinking more coffee and smoking more cigarettes during night shifts than in the daytime. Wherever possible, the answer format was taken from Rohrman,¹⁴ who empirically determined equidistance between differing answer possibilities.

Since the study is based on a large sample, significance levels of .001 for analyses of the full sample and .01 for analyses of subsamples are used.

Results and Discussion

Length of sleep was analyzed first in relation to the shifts that the subject worked before and after the reported sleeping period. Because of the different types of shift systems, different ANOVAs (regression approach for unequal cell size) had to be performed for the eight-hour shift with night, the 12-hour shift with night, the rotating shift without night, and nonshiftwork. Correspondingly, the levels of the factors are somewhat different, depending on the particular shift system. In the analyses for rotating shifts, sex was included as one factor because women are allowed to work the morning and afternoon shifts but not the night shift. In the analysis of the nonshiftworkers two additional factors were included: sex and level of shiftwork participation (former shiftworkers who had left for health reasons, former shiftworkers/middle group, former shiftworkers who had left for reasons other than health, and never-shiftworkers). The nonshiftworkers work only in the daytime and therefore were asked only whether they had worked before sleeping or had had a free day.

The results for the shiftworkers with night shifts (Table 1) show that the shift worked before sleeping had a significant effect and the shift worked after sleeping had a small effect on length of sleep. All interaction effects are non-significant. Apparently, the main determinant of length of sleep is the time of the preceding shift and not the amount of time allowed for sleeping by the shift worked afterward. Shiftworkers slept longest when they had a free day (with means of 7.1 hours for the eight-hour shift and 7.3 hours

Table 1 – Effect of Shift Before and After on Length of Sleep (Analysis of Variance)*

Source of Variation	F	p Level	Mean Hours of Sleep (N)
8-Hour shift system with night shifts			6.5 (1,264)
24hr before:	11.90	.001	
Free of work			7.1 (191)
Early shift			6.1 (385)
Afternoon shift			6.9 (342)
Night shift			6.2 (346)
24hr afterward:	3.26	.02	
Free of work			6.6 (179)
Early shift/day shift			6.1 (365)
Afternoon shift			7.0 (353)
Night shift			6.4 (367)
12-Hour shift system with night shifts			6.6 (1,071)
24hr before:	17.88	.001	
Free of work			7.3 (212)
Early shift/day shift			6.6 (417)
Night shift			6.3 (442)
24hr afterward:	3.08	.047	
Free of work			6.8 (232)
Early shift/day shift			6.4 (391)
Night shift			6.6 (448)
Rotating shift system without night shift			6.5 (251)
24hr before:	2.76	NS	
Free of work			7.6 (17)
Early/day shift			6.2 (134)
Afternoon shift			7.7 (100)
24hr afterward:	4.101	.018	
Free of work			6.2 (23)
Early/day shift			6.3 (139)
Afternoon shift			6.8 (89)
Sex:	7.23	NS	
Female			6.7 (78)
Male			6.4 (173)
Nonshift workers			6.7 (1,715)
Sex:	.50	NS	
Female			6.9 (235)
Male			6.7 (1,480)
Shiftwork:	2.58	NS	
Former shiftworker/ other reasons for leaving			6.7 (280)
Former shiftworker/ middle group			6.5 (82)
Former shiftworker/ health reasons			6.6 (248)
Never shiftworker			6.7 (1,105)
Work before:	4.23	.039	
Yes			6.6 (1,259)
No			7.0 (456)

* All interactions not significant

for the 12-hour shift) or when they worked the afternoon shift before they went to bed (with a mean of 6.9 hours for the eight-hour shift with night). The sleeping time was shortest when they had night shifts (means of 6.2 hours for the eight-hour shift system, 6.3 hours for the 12-hour shift) and morning shifts (6.1 hours for the eight-hour shift). In accord with the findings of nearly all studies on shiftwork, workers slept least after working a night shift. It is interesting to note, however, that sleeping time after the morning shift does not differ from that after the night shift. No differences were found between the eight-hour and 12-hour shift schedules in the length of sleep after the night and day shifts.

No significant effects were observed among shiftworkers who rotate without night shifts or among nonshiftworkers. The shift afterward was found to have a marginally significant effect ($p = .018$) on length of sleep in the rotating shift systems, with afternoon shifts allowing longer sleep. Also, a marginally significant effect ($p = .039$) of having worked ν having had a free day before was observed among nonshiftworkers. No significant effects of sex and no interactions were found, with men and women reporting similar periods of sleep.

In view of previous reports, it is surprising to note that shiftworkers on the different shiftwork schedules and non-shiftworkers sleep the same length of time on the average. According to our criterion of $.001$, there are no significant differences between the groups (mean lengths of sleep: eight-hour shift with night shifts, 6.5 hours; 12-hour shift with night, 6.6 hours; rotating shift without night shifts, 6.5 hours; never-shiftworkers, 6.7 hours; and all groups of former shiftworkers, 6.6 hours). According to our criterion, the one-way ANOVA is nonsignificant across these groups ($F[4,4609] = 3.9, p = .004$). Apparently, the shiftworkers are compensating during their free time and during the afternoon shift for the sleep deficit accumulated during the night and morning shift periods. This agrees with the data reported by Tune¹¹ and his conclusion is here underscored with a much larger sample. Although the average lengths of sleep for these different groups are similar, the standard deviations (SDs) are quite different (SD = 1.58 for the eight-hour shift with night, SD = 1.88 for the 12-hour shift schedule with night, SD = 1.50 for the men of the rotating shift without night, SD = 1.36 for the former shiftworkers, and SD = 1.35 for the never-shiftworkers). These differences were tested with Bartlett's box test and proved to be significant ($F = 40.7, p < .001$). This greater variation in amount of sleep may in itself be an indicator of lower quality and it may be difficult for shiftworkers to really compensate for the little sleep they get in the night and morning shift periods since daytime sleep seems to be of poorer quality.⁶

The correlation between length of sleep and general sleep problems is very small ($r = -.10, N = 5,050, p < .001$). The correlation is a little higher if one includes only shiftworkers with night shift, but not significantly so ($r = -.12, N = 2,399, p < .001$ for the night shift workers; $r = -.02, N = 1,778, p$, not significant for the nonshiftworkers; and $r = -.07, N = 261, p$, not significant for the rotating shift without night shift). These small although partly significant correlations clearly contradict the view that sleeping problems and length of sleep are strongly

associated. A differentiation between these two aspects of sleep seems warranted.

Hence, the second question of this article – What conditions contribute to length of sleep and to general sleep problems? – will address both amount and quality of sleep.

The correlations of the main variables are presented in Table 2. The multiple regression analyses are reported in Table 3. (Since the N is reduced in these analyses, there are slight differences between the correlations reported here and the ones shown in Table 2.) The regression analyses involved the following variables as theoretical predictors of length and quality of sleep: shift, including night shift *v* nonshift; environmental stress at work; psychological stress at work; quietness of sleeping room; and age. Females, workers with a rotating shift system without night shift, and former shiftworkers are not included in these analyses. In the second regression analysis two concrete attempts to cope with night shift also are included as predictors. Only workers who also work nights are included. In the third regression analysis, items on higher coffee and cigarette consumption during the night are included as predictors. Therefore, this analysis includes only those individuals who generally smoke cigarettes and drink coffee.

Length of sleep is not predicted well by any of the potential predictors, although some multiple correlations are significant. (One could argue that it is not warranted to use an index of yesterday's length of sleep here because this index is influenced by the particular shift one worked in the day before. Therefore, the same analyses reported in Table 3 were made with the answers to the question on *average* sleep length. The same results prevail as the ones

shown in Table 3.) On the other hand, the potential predictors correlate highly with sleep problems, the highest predictors being psychological stress at work ($\beta = .27$), a quiet sleeping room ($\beta = -.20$), shiftwork rather than never-shiftwork ($\beta = -.15$), and drinking more coffee during the night shift ($\beta = .15$). The predictors explain 30% of the variance of sleep problems. With the exception of smoking, all of the β values contribute significantly to an explanation of sleep problems. Thus, it appears that shiftwork, a noisy sleeping room, stress at work, and attempts to cope with sleepiness at night (such as drinking more coffee or making an extra effort) contribute to sleeping problems.

Summary and Conclusion

The analysis of this large sample of shiftworkers shows that overall length of sleep is not different for shift and non-shiftworkers, but that shiftworkers show a greater variability across different shifts and sleep least after night and morning shifts. Apparently, night and morning shifts have a similar impact on length of sleep. This finding is not surprising, since a morning shift starting at 6 o'clock often means that the worker has to get up at 3 or 4 o'clock – an “ungodly” hour from the standpoint of the circadian rhythm.

On the other hand, length of sleep is related only weakly to quality of sleep. This finding is in contrast to the common assumption in the literature on shiftwork that shiftwork has a similar impact on length and quality of sleep. The most important predictors of quality of sleep are shift *v* nonshiftwork, psychological stress, a noisy sleeping room, and drinking more coffee during the night than during the daytime. Overall, general sleep problems are well predicted

Table 2 – Product Moment Intercorrelations of the Main Variables

Variables*	1	2	3	4	5	6	7	8	9	10	Mean	SD
1 Shift <i>v</i> nevershift [†]	X									
2 Environmental stress at work	-.16 [‡]	X									2.66	0.79
3 Psychological stress at work	-.22 [‡]	.43 [‡]	X								3.59	0.67
4 Quiet sleeping room	.26 [‡]	-.14 [‡]	-.16 [‡]	X							3.62	1.17
5 Eat lunch at normal time during night shift period	§	-.12 [‡]	-.07 [‡]	-.14 [‡]	X						2.83	1.51
6 When tired at night, I make an extreme effort	§	.05	.15 [‡]	-.05	-.04	X					4.14	1.01
7 More coffee during night shift	§	.11 [‡]	.15 [‡]	-.10 [‡]	-.12 [‡]	.15 [‡]	X				2.90	1.48
8 More smoking during night shift	§	.09 [‡]	.13 [‡]	-.11 [‡]	-.11 [‡]	.18 [‡]	.44 [‡]	X			2.84	1.49
9 Age, yr	-.15 [‡]	-.05 [‡]	.13 [‡]	-.07 [‡]	.13 [#]	.06 [‡]	-.02	-.11 [‡]	X		40.17	10.39
10 Sleep problems	-.29 [‡]	.28 [‡]	.38 [‡]	-.27 [‡]	-.17 [‡]	.29 [‡]	.24	.22 [‡]	.14 [‡]	X	8.93	3.63
11 Length of sleep [¶]	.06 [‡]	-.06 [‡]	-.03	.07 [‡]	.00	-.03	-.06	-.10 [‡]	.04	-.10 [‡]	6.6	1.60

* Five-point answer scale, except where otherwise noted

† Eight and 12 shiftworkers with night shift *v* never-shiftworkers (dichotomous variable; therefore no mean and SD given)

‡ $p < .001$

§ No value computed because only shiftworkers answered this question

|| Scale from 5 to 15

¶ Number of hours

Table 3 — Prediction of Length of sleep and Sleep Problems (Regression Analyses)

Variable	Length of sleep				Sleep Problems			
	1st Analysis		2nd Analysis		1st Analysis		2nd Analysis	
	β	r	β	r	β	r	β	r
No shiftwork*	.03	.05	†	†	-.15‡	-.30‡	†	†
Environmental stress at work	-.07‡	-.08‡	-.06	-.06	.13‡	.30‡	.10‡	.25‡
Quiet sleeping room	.07‡	.09‡	.09‡	.08‡	-.20‡	-.32‡	-.21‡	-.29‡
Psychological stress at work	.01	-.04	.02	-.02	.27‡	.41‡	.29‡	.39‡
Age	.03	.02	.01	.01	.07‡	.15‡	.08‡	.10‡
	R = .12‡ R ² = .01 N = 3,041				R = .52‡ R ² = .27 N = 3,041			
When I get tired at night, I make an extreme effort			-.02	-.02			.13‡	.20‡
During the night shift I eat my lunch period at normal lunchtime			-.04	-.02			-.11‡	-.17‡
			R = .11‡ R ² = .01 N = 1,990				R = .50‡ R ² = .25 N = 1,990	
Additional variables in 3rd analysis								
I drink more coffee on the night shift [§]			.01	-.04			.15‡	.27‡
I smoke more on the night shift [§]			-.08	-.09‡			.05	.20‡
			R = .12 R ² = .02 N = 1,244				R = .55‡ R ² = .30 N = 1,244	

* Eight- and 12-hour shift system *v* never-shiftworkers

† The second regression was done only with shiftworkers, because concrete coping with night shift is included

‡ $p < .001$

§ Including these additional variables slightly changes the β values of the other variable above and drastically reduces the N, because only smokers and coffee drinkers are included in the analysis (for the sake of clarity these slightly changed β values are not reported in this Table)

by the theoretically derived predictors; however, the causal relationship is not quite clear. Although it is plausible that drinking coffee produces a general activation that influences quality of sleep, the relationship may be the reverse. It is conceivable that people with a lower quality of sleep will be more tired and therefore drink more coffee (or smoke more cigarettes), make a stronger effort in their work, hear more noise in their sleeping room, or feel greater stress in their workplace. In the present study the causal path cannot be confirmed. There is, however, at least one predictor for which one causal hypothesis is more plausible than the other: shiftwork *v* never-shiftwork. According to the literature, people leave shiftwork because of health problems rather than seek shiftwork because of health problems¹⁵; therefore, it is more plausible that shiftwork in fact leads to sleep disturbances and not the reverse. This influence holds when all the other factors are held constant with a significant β of $-.15$ in Table 3. The results for the predictors of sleep problems are in accord with most of the reports in the shiftwork literature, although only a few of the studies have included rigorous controls (compare the overviews).^{5,16,17} Thus, we can conclude that amount of sleep is not predicted well by the theoretically relevant factors and also that it has little relationship to quality of

sleep. The more serious problem of quality of sleep is predicted quite well by the factors included in this study, underscoring the previously reported conclusion that shiftwork contributes to sleep problems.

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Missing Commitment

My generation of feminists insisted that men change, but we were not always directive — or patient — enough to say how. We applauded every sign of male sensitivity or growth as if it were an evolutionary advance. We even welcomed the feminization of male tastes, expecting that the man who was a good cook and a tasteful decorator at 25 would be a devoted father and partner in midlife. We did not understand that men were changing along a trajectory of their own and that they might end up being less like what we *are* than like what we were once expected to be — vain and shallow and status-conscious. . . .

So it is not enough, anymore, to ask that men become more like women; we should ask instead that they become more like what both men and women *might* be. My new man, if I could design one, would be capable of appreciation, sensitivity, intimacy — values that have been, for too long, feminine. But he would also be capable of commitment, to use that much-abused word, and I mean by that commitment not only to friends and family but to a broad and generous vision of how we might all live together. As a feminist, I would say that vision includes equality between men and women and also — to mention a social goal that seems almost to have been forgotten — equality among men.

—From "A Feminist's View of the New Man" by Barbara Ehrenreich in *The New York Times Magazine*, May 20, 1984.