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Combined effects of shift work and life-style on the prevalence of insomnia, sleep deprivation and daytime sleepiness

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Objectives The combined effects of age, leisure-time physical activity, smoking, alcohol consumption, and different forms of shift work on the prevalence of sleep complaints and daytime sleepiness were studied among workers in industry, transport, and traffic.

Methods Altogether 3020 subjects were studied using a psychosocial questionnaire. The participants were currently employed men, aged 45—60 years, from a postal and telecommunication agency, the railway company, and 5 industrial companies. On the basis of a factor analysis of an 11-item sleep questionnaire, the sleep complaints were grouped into the categories of insomnia, sleep deprivation, daytime sleepiness, and snoring. The importance of the shift schedule, age, and life-style factors as simultaneous predictors of the complaints was studied in a logistic regression analysis and an analysis of covariance.

Results The prevalence of insomnia, sleep deprivation, and daytime sleepiness depended significantly on the shift system. All sleep complaints were more common in 2- and 3-shift work and in irregular shift work than in day work. The prevalence of daytime sleepiness was 20—37%, depending on the shift system. Leisure-time physical activity and alcohol consumption were the most important life-style factors predicting all sleep complaints, except snoring. The effects of physical activity and alcohol consumption differed for different shift schedules.

Conclusions Different shift systems, also 2-shift work and permanent night work, seem to increase the frequency of sleep complaints. Especially 3-shift work seems to interact with life-style factors by increasing the adverse effects and decreasing the beneficial effects on sleep and sleepiness.

Key terms alcohol, physical activity, shift work, sleep, sleepiness.

Disturbed sleep and sleepiness are common among shift workers (1). Sleepiness at work is a considerable problem not only because it affects the shift workers' well-being, but also because of the consequences to safety and performance (2). Sleep complaints are reported especially by shift workers on night shifts. (See, for example, references 3—5.) An averaging survey of 19 separate studies suggested that 10—90% of shift workers on night shifts and about 10% of 2-shift workers and day workers complain about "sleep disturbances" (3).

Epidemiologic studies on the prevalence of sleepiness and specific sleep complaints among workers on different shift schedules are still scarce. Neither is there sufficient information available on the combined effects of shift work and life-style factors on sleep. Most earlier studies have had small samples or have focused on single occupational groups only. In addition, "sleep quality" has often been investigated with rough or inaccurately formulated questions or questions asking only the length of the sleep after different shifts. Since shift workers compensate for the accumulating sleep deficit during their days off and on days with afternoon shifts, the cumulative sleep length does not vary among different categories of shift systems (6). The correlation between sleep length and the quality of sleep is also poor (6).

The prevalence of sleep complaints among shift workers is dependent on the ergonomic factors of the shift system (eg, rotation speed, direction of rotation, starting

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times of the shifts and individual and life-style factors) (7—10). The individual and life-style factors can modify the effects of shift work on sleep in several ways. First, life-style factors can interact with shift schedule factors. For example, the age effect on sleep may depend on the characteristics of the shift schedule. Older shift workers adjust more slowly to consecutive nights shifts (11) and prefer earlier starting times of shifts than do younger shift workers (12).

Second, work times may influence the workers' life-style, or workers with a certain life-style select specific work schedules. Life-style would, in this case, be a pathway for disturbed or improved sleep in a particular shift system. Blue-collar shiftworker populations have a tendency to put on weight, smoke, and increase their use of alcohol, all of which can modify the prevalence of sleep disturbances (13—16). The beneficial effects of physical fitness on the sleep and sleepiness of shift workers, as observed in 1 study (17, 18), could thus depend on the possibilities of the specific rota to allow regular physical training during freetime. Especially long spells of evening and night shifts and weekend shifts in continuous 3-shift work have been found to prevent the optimal use of leisure-time activities (19).

The objective of the present study was to evaluate the combined effects of age, leisure-time physical activity, alcohol consumption, and different forms of shift work on the prevalence of sleep and sleepiness complaints.

Subjects and methods

A cross-sectional questionnaire study of 3020 subjects was carried out in connection with a larger clinical trial. The subjects were selected from among the participants in the first screening visit of the Helsinki Heart Study, a 5-year, placebo-controlled coronary prevention trial targeted at middle-aged men (45—60 years at the end of the trial) (20, 21). The participants for the trial were selected via 2 successive screenings from 2 government agencies and 5 industrial companies. The volunteers were eligible for the study if their serum non-high-density-lipoprotein cholesterol was ≥5.2 mmol/l in both pretreatment screenings and if they had no evidence of coronary heart disease or any other major illness. The present study comprises samples both from those who participated only in the first screening and from those in the trial.

A psychosocial questionnaire was mailed to the study population at the end of the double blind trial in 1986—1987. The response rate was 72.5%. Altogether 5885 men responded to the questionnaire. However, the data of only 3020 subjects were used in the analyses of this report, since the following groups of the main sample were omitted from the analysis: those who were retired at the time of the interview (N=1421), all part-time workers (N=82), and those who could not specify their work-retirement situation, occupation, or work schedule (N=371). Workers being treatment with gemfibrozil (N=991) were also excluded. There were some missing values for separate items; for example, about 7% missing values for alcohol consumption and less than 4% for other variables.

Occupation and shift schedule

The industrial cohort comprised men working in oil refinery plants, the forest industry (paper, sawmill, plywood), and heavy engineering. The government agencies were the Finnish Railways and the Post and Telecommunications Agency.

The information on occupation was based on a 3-digit occupational code used in the 1980 census — a Finnish version of the Nordic Classification of Occupations from 1965. This information was obtained by record linkage with Statistics Finland. In this study we used the crude 3-level classification of academic and clerical workers, plant or machine workers, and workers in traffic and transportation. Those in the first group were mostly day workers, while those in the sawmill, plywood, and heavy engineering industries were the majority among the 2-shift workers. About 75% of the 3-shift workers were from the oil refining and paper industries. Those with irregular schedules worked mostly in traffic or transportation.

The shift schedule was recorded in the questionnaire on a 6-point question as follows: (i) permanent day work, (ii) part-time work, (iii) 2-shift work, (iv) 3-shift work, (v) irregular shift work, and (vi) permanent night work.

The shift schedules of the 16 individual plants and 2 large governmental agencies differed widely. In industry, most sites (forest industry) had a continuous rotating shift system (3-shift work with 5 teams with a shift cycle of 20 days), working 4 morning, 4 evening, and 4 night shifts in a row, with 1 day off between successive shifts, and 5 days off after the last episode of shifts. The direction of rotation varied between the sites. Second, a rapidly rotating, continuous shift system (3-shift work with 2 morning, 2 evening, and 2 night shifts with 4 days off at the end) was used in some of the industrial plants. Discontinuous shift systems without night work (2-shift work) were common in heavy engineering.

The railways and the telecommunication agency had a larger variety of shift schedules, including permanent day work, 2-shift work (discontinuous schedules without night work), irregular shift schedules (continuous shift schedules with night work) and regular shift systems (2-shift or 3-shift work).

The shift schedules of the governmental agencies included systems of permanent day work and irregular schedules for traffic and transportation workers.

Age and life-style factors

All the background factors used in the present study were recorded at the first screening visit in 1982. The age range of the subjects was 45—60 (median 52) years. The median was used as cut off when age was dichotomized. Body mass index was calculated as kilograms per cubic meter. Leisure-time physical activity was recorded with the 4-point Gothenburg scale (22), but we used the scale as a dichotomized variable. A modified questionnaire of the Scandinavian drinking survey (23) was used to record alcohol consumption. The reported quantities and the number of drinking occasions were converted into amounts of absolute alcohol (centiliters per year). In these analyses a dichotomized variable was used with a cut off of 250 cl/year, the lower category corresponding to non or occasional users of alcohol and the higher category to moderate and heavy users.

Sleep quality and sleepiness

Sleep complaints were studied by an 11-item sleep questionnaire (4) including separate questions on difficulties in falling asleep, difficulties of waking up, waking up in the middle of sleep or difficulties to fall asleep again, nightmares, a feeling of insufficient sleep when waking up, waking up too early, disturbed or restless night sleep, tiredness and sleepiness during work and leisure time, irritated and tired eyes, a "heavy feeling" in the head, and, finally, heavy snoring. All the items were asked by the same structure: "Have you felt some of the following symptoms during the past 3 months (never or very rarely, rarely or sometimes, rather often or repeatedly, always or very often)?

Shiftwork sleep disorder has been clinically defined as a disorder consisting of symptoms if insomnia or excessive sleepiness occurs as transient phenomena in relation to work schedules (Diagnostic Classification Steering Committee 1990). It is thus not a disease but a disorder defined as an occurrence of symptoms. Since the current study is a cross-sectional epidemiologic study interested in the prevalence of sleep complaints, we had to decide what should be considered a meaningful disturbance, in other words, we attempted to dichotomize the output items.

With the use of a factor analysis, the individual sleep complaints were first classified into the 4 groups of insomnia (questions 1, 3—7), sleep deprivation (questions 2, 5, 6), daytime sleepiness (questions 8—10), and snoring (questions 4, 11). The details of the factor analysis have been described elsewhere (Kalimo R, Tenkanen L, Härmä M, Poppius E, Heinsalmi P. Job stress and sleep disorders: findings from the Helsinki Heart Study, unpublished manuscript). Three- or even the 2-factor solutions could have been advocated in the factor analysis. Our choice of 4 factors was directed by pragmatic considerations. The 4 groups formed clearly defined and easily interpreted accumulations of symptoms, even if not quite independently of each other. Due to the multiple and varying etiologic background of the complaints, they have to be considered as mere accumulations of symptoms and not as expressions of some latent factors.

The items were dichotomized as 1 = rather often or very often and 0 = otherwise and then summed groupwise. The dichotomization was considered necessary since the differentiation between the responses 1 = never or very rarely and 2 = rarely or sometimes may mirror more individual ways of responding rather than a real disorder. Similarly, the scales 3 = rather often or repeatedly and 4 = always or very often may both be considered to indicate a real disorder. Along with this sum variable a dichotomized variable was used to study the overall prevalence of the complaints. This variable equaled 1, if at least 1 of the symptoms in the group occurred often or very often, and equaled 0 otherwise.

Statistical methods

To get an overview of the factors related to different sleep complaints, we used logistic regression analysis with shift schedule, age, and the life-style factors as simultaneous predictors of the overall prevalence of the 4 different kinds of sleep complaints. The impact of the interaction was shown by giving the prevalences of the complaints in the combined categories for shift schedule and the life-style factors in question.

Since the dichotomized sleep complaint variable could lose some information on severity of the complaint, we also used the original sum variable of sleep symptom items as the response variables. In this case, the analysis of covariance was used to study the importance of shift work, life-style factors, and age as the predictors of the sleep complaints. As the variable describing occupational category had several missing values, we repeated the preceding analysis for the restricted group with the occupational variable included.

Results

Both life-style factors and the number of ageing workers (subjects over 52 years) differed across the shift schedule groups (table 1). The small group on permanent nights were more frequently smokers, consumed more alcohol, and had a more sedentary life-style than the other groups. Due to the small size of the group it still had to be excluded from further analysis. Three-shift workers and irregular shift workers were, on the contrary, physically active and did not consume any more alcohol than permanent day workers or 2-shift workers. Day workers smoked less than the various groups of shift workers.

When analyzed together with the life-style factors, shift work (2-shift, 3-shift or irregular shift work) emerged as the most important predictor of all sleep complaints except snoring (table 2). The amount of insomnia, sleep deprivation, and daytime sleepiness depended significantly on the shift system. The prevalence of insomnia was 39—53%, depending on the shift system (figure 1). The proportions of complaints related to sleep deprivation, snoring, and daytime sleepiness were 30—45%, 38—50% and 20—37%, respectively. All the sleep complaints were the most common for permanent night work and the least common for permanent day work. The overall differences in the prevalence between the 2-shift, 3-shift, and irregular shift systems were minor.

Leisure-time physical activity was the most important life-style factor predicting all the sleep complaints except snoring (table 2). It was followed by alcohol consumption and smoking. As a stimulant, smoking decreased daytime sleepiness, but, interestingly, it also decreased insomnia. Smoking, obesity, and a sedentary life-style, but not shift work, were the best predictors of snoring, showing that this dimension of complaints has a different etiology. The analyses further showed that, although shift work, sedentary life-style, alcohol consumption, and smoking were significant predictors of daytime sleepiness, the fit of the model was poor without the inclusion of the interaction between shift work and sedentary life-style. In addition, the inclusion of the interaction between shift work and alcohol consumption improved the fit of the model considerably in the case of both daytime sleepiness and insomnia, although the latter interaction term did not reach statistical significance. This result indicates that the effects of a sedentary life-style and alcohol consumption were different in the different shift systems.

Table 1. Prevalence (%) of some life-style factors and subjects above 52 years of age[a] by shiftwork status. (BMI = body mass index)

Time schedule for work	N	Smoking	Use of alcohol	Sedentary life-style	BMI ≥28 kg/m²	Age ≥52 years
Day work	1985	30	53	60	22	46
2-shift work	195	33	55	58	22	37
3-shift work	397	36	50	55	26	41
Irregular shift work	417	36	50	51	27	38
Night work	38	40	69	69	29	50
Chi square test		P=0.05	P=0.19	P=0.01	P=0.14	P=0.007

[a] Median age 52 years.

Table 3 illustrates the joint effect of shift work and the life-style factors. While leisure-time physical activity was associated with decreased daytime sleepiness and insomnia among the day workers, 2-shift workers and irregular shift workers, this was not the case for the 3-shift workers. Alcohol consumption did not essentially increase daytime sleepiness or insomnia among the day workers, but it definitely did among the 3-shift workers, and it increased insomnia also among the irregular shift workers.

If the prevalent cases of sleep complaints were further divided into those with few simultaneous symptoms of the same kind and those with several (eg, in the case of insomnia, those with 1—2, and those with 3—6 symptoms), we see that among 3-shift workers adverse life-style factors increased especially the latter, multisymptom forms of complaints (figure 2).

In the prediction of the overall prevalence of different sleep complaints, age was not statistically significant, neither as a dichotomized nor as a continuous variable.

Table 2. Importance of shift work, age, and some life-style factors as simultaneous predictors of sleep complaints — results from stepwise logistic regression analyses. (BMI = body mass index)

Predictor	Insomnia		Sleep deprivation		Snoring		Daytime sleepiness	
	Chi -square[a]	P-value[b]	Chi- square	P-value[b]	Chi -square	P-value[b]	Chi -square	P-value[b]
Shift schedule[a]	15.3	0.002	20.6	0.000	-	-	11.9	0.008
Sedentary life-style	10.1	0.001	5.7	0.017	3.7	0.056	8.7	0.003
Alcohol consumption	5.7	0.017	-	-	-	-	4.9	0.026
Smoking	3.9	0.049	-	-	22.1	0.000	6.8	0.009
Obesity (BMI ≥28 kg/m²)		-	-	-	38.9	0.000	-	-
Age (≥2 years)	-	-	-	-	-	-	-	-
Shift schedule × sedentary life-style		0.13						0.07
Goodness of fit, Chi square[c]								
Without interaction		0.41		0.43		0.28		0.007
With interaction		0.76						0.72

[a] Chi square of improving the fit by including the variable.
[b] High P-values indicate good fit.
[c] A measure of how well the model derived expected values for the observed values.

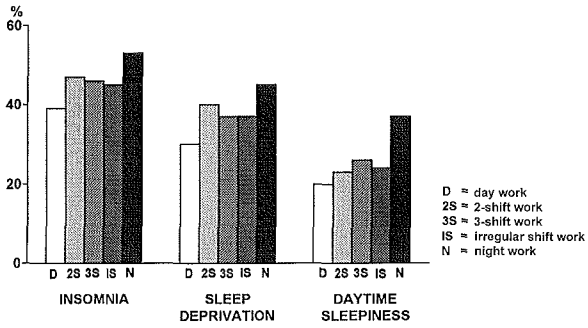

Figure 1. Prevalence of sleep complaints related to insomnia, sleep deprivation, and daytime sleepiness for different shift schedules. Each sleep complaint was regarded as prevalent if at least one of the individual symptoms of each group occurred often or very often. The 4 groups of sleep complaints were formed according to a factor analysis of an 11-item sleep questionnaire.

Table 3. Prevalence of sleep complaints by shift schedule and some life-style factors.

Shift work status	N	Prevalence[a] (%)		
		Insomnia	Sleep deprivation	Daytime sleepiness
Day work				
Sedentary life-style	1163	41	32	23
Active life-style	771	35	27	16
2-shift work				
Sedentary life-style	107	52	44	25
Active life-style	79	42	37	22
3-shift work				
Sedentary life-style	214	45	36	25
Active life-style	177	47	39	29
Irregular shift work				
Sedentary life-style	206	48	39	27
Active life-style	194	43	35	22
Day work				
No or light user of alcohol	878	37	30	19
User of alcohol	1002	40	30	21
2-shift work				
No or light user of alcohol	84	46	37	20
User of alcohol	102	48	42	26
3-shift work				
No or light user of alcohol	193	42	34	22
User of alcohol	190	51	42	33
Irregular shift work				
No or light user of alcohol	191	40	35	24
User of alcohol	192	52	41	25
Day work				
Nonsmoker	1388	40	31	21
Smoker	589	37	29	19
2-shift work				
Nonsmoker	129	48	39	23
Smoker	64	45	42	22
3-shift work				
Nonsmoker	255	44	37	27
Smoker	140	48	38	25
Irregular shift work				
Nonsmoker	268	46	38	27
Smoker	147	43	35	20

[a] Percentage of subjects having at least one symptom often or very often.

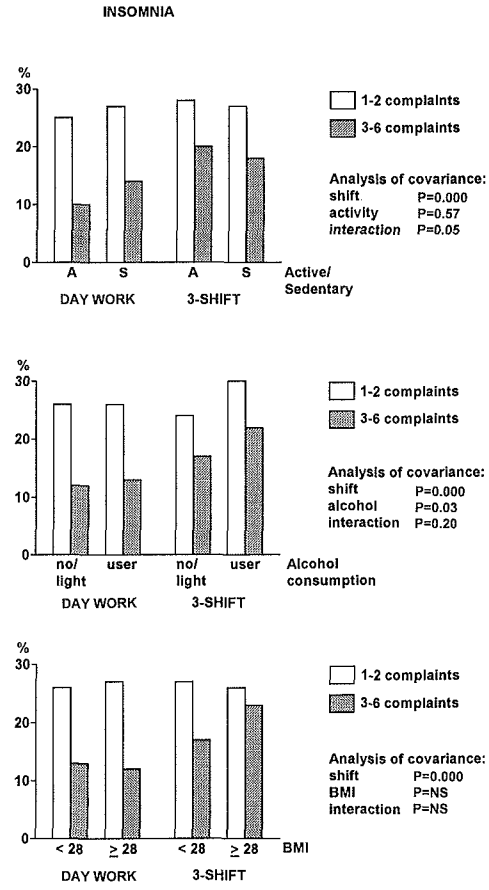

Figure 2. Prevalence of insomnia by shift schedule (day or 3-shift work) and leisure-time physical activity, alcohol consumption, and body mass index (BMI).

Figure 3 shows that for day workers age has no impact on the prevalence of insomnia or daytime sleepiness, but the younger shift workers had a higher prevalence of 1- or 2-symptom complaints, while the older shift workers had a higher prevalence of multisymptom complaints.

When the association between occupational category and sleep complaints was analyzed simultaneously with shift work and life-style factors, occupation emerged as a significant predictor ($P<0.02$) only for daytime sleepiness. Those working in transport and traffic complained less frequently of daytime sleepiness than did clerical workers or factory workers or machine operators (tables 4 and 5).

Discussion

We studied the combined effects of shift work, age, and some typical life-style factors on the prevalence of sleep and sleepiness complaints. Although shift work interacted with life-style factors, all forms of shift work were related to a greater amount of insomnia, sleep

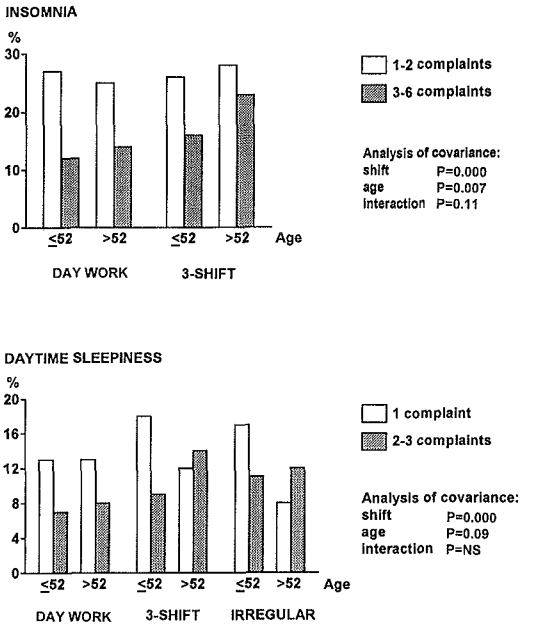

Figure 3. Prevalence of insomnia and daytime sleepiness by shift schedule and age.

deprivation, and daytime sleepiness. The 46—47% prevalence of insomnia and 37—40% prevalence of sleep deprivation are high among 2- and 3-shift workers, considering that over 20% of the total work force are shift workers and the number is still rising (24).

Rotating 2-shift workers (without night shifts) had roughly the same number of sleep complaints as did 3-shift workers and irregular shift workers. Rotating 2-shift work is common only in Europe, while permanent day, afternoon, and night shifts are more common in the United States. (See, eg, reference 5.) There are only a few earlier studies on the prevalence of sleep complaints among workers doing rotating 2-shift work. Graf et al (25) has reported a prevalence of only 8% for 2-shift workers' "sleep problems". Kecklund et al (26) showed that matched 2-shift workers in a car factory had a lower frequency of sleep complaints than night workers. However, the study did not give the actual prevalences of the complaints. Sleep length before morning shifts in a 2-shift system of the German automobile industry suggested a sleep reduction of about 2 hours when compared with that of the evening shifts of the same workers (27). In 3-shift work, morning shifts have been found to be as detrimental to sleep as night shifts (28, 12) — the same may thus concern early morning shifts in 2-shift work. Our results suggest that the prevalence of sleep disturbances related to shift work among 2-shift workers should not be underestimated.

The combined analysis indicated that the greater amount of sleep disturbances among the 2-shift, 3-shift, and irregular shift workers in comparison with day workers was not due to differences in the life-style of the groups. The 2- and 3-shift workers even tended to drink less alcohol and were physically more active than the day workers. Neither did the main differences between the day and shift workers depend on occupation. Only the transport and traffic workers reported less daytime sleepiness, and this difference may partly cause an underestimation of the prevalence of sleepiness in irregular shift work. The relatively small differences between the day and shift workers can still partly be due to the "healthy shiftworker effect" (29) since the selection of shift workers underestimates the health consequences of shift work (30).

Table 4. Prevalence of different sleep complaints[a] by shift schedule and occupational group.

Shift schedule	N	Insomnia	Sleep deprivation	Snoring	Daytime sleepiness
Day work					
Clerical	613	40	34	37	23
Transport & traffic	602	38	28	36	18
Industry	661	39	28	42	21
Two-shift work					
Transport & traffic	68	49	43	38	19
Industry	112	50	43	36	28
Three-shift work					
Transport & traffic	119	40	34	42	19
Industry	235	48	40	35	30
Irregular shift work					
Transport & traffic	381	44	36	37	24

[a] The sleep complaints were grouped according to the results obtained by a factor analysis, dichotomized (1 if the disorder occurred often or rather often, 0 otherwise) and summed. If the sum >0, the disorder was considered present.

Table 5. Shift work, occupation, and some life-style factors as simultaneous predictors of the relative risk (odds ratio) of daytime sleepiness. Results from a stepwise logistic regression analysis. (95% CI = 95% confidence interval)

Predictors	Odds ratio	95 % CI
Shift work		
Day work	1	
Two-shift work	1.31	0.90—1.90
Three-shift work	1.51	1.15—1.99
Irregular shift work	1.64	1.21—2.21
Occupation		
Academic & clerical	1	
Traffic & transportation	0.73	0.56—0.96
Plant & machine	0.98	0.76—1.26
Alcohol consumption		
<250 g/year	1	
≥250 g /year	1.30	1.08—1.52
Physical activity		
Active	1	
Sedentary	1.35	1.11—1.63
Smoking		
Non and past	1	
Current	0.78	0.64—0.96

The main finding of our study was that life-style factors, especially physical inactivity, had a different relationship on sleep and sleepiness among the 3-shift workers than among the other studied groups. In a follow-up study with a matched-pair design, moderate physical training was shown to increase sleep length and alertness among middle-aged women (17, 18). It is noteworthy that regular training was possible in that particular group because the shift schedule was rapidly rotating, each week allowing possibilities for physical exercise during the days off or on days with morning shifts. Exercise before evening shifts has been found to decrease alertness (18).

In our study, a sedentary life-style was the most important life-style factor that increased sleep complaints and daytime sleepiness in most groups. Although it is not possible to draw any conclusions on causality, the results seem to suggest that physical activity may decrease insomnia and daytime sleepiness among day workers, 2-shift workers, and irregular shift workers, but increase complaints among 3-shift workers. It would be tempting to speculate that the slowly rotating continuous shift systems in industry may hinder efficient physical training when compared with other schedules.

The use of alcohol also had a detrimental effect on the sleep of 3-shift workers and irregular shift workers, while no such effect was observed for the day workers. Although the 3-shift workers did not consume alcohol more often than the day workers, "heavy drinking" may have been more frequent in this group. A hangover with its related consequences on sleep and fatigue naturally depends on the amount of alcohol consumed.

Another explanation for the unfavorable relationship between leisure-time physical activity and alcohol consumption in regard to 3-shift workers' sleep and sleepiness is the hypothesis that among 3-shift workers the disturbance of sleep-wakefulness and other circadian rhythms may biologically interact with the life-style factors, hindering the positive effects of leisure-time exercise and exaggerating the negative effects of alcohol.

Age was not related to the prevalence of overall sleep complaints, but, when the multisymptom complaints were investigated, aging seemed to increase insomnia, the effect being clearest among the 3-shift workers. In the study of the effect of aging, the design had some apparent limitations. The design was cross-sectional, and the studied age range was narrow, only 45—60 years. Although aging is known to have a detrimental effect on shift workers' day sleep (after night shifts), the relationship on daytime sleepiness has not been so clear (31, 12). The shortened day sleep may not necessarily lead to daytime sleepiness due to the lower sleep need of elderly people (32). Laboratory studies have also shown that older subjects are less sensitive to an acute sleep debt (33, 34) when compared with younger subjects. Our results seem to support these findings, since the increased insomnia of the elderly workers did not result in a similar difference in sleepiness.

As a stimulant, smoking was related to increased daytime alertness. However, the positive effect on insomnia is more difficult to explain, especially when the result does not support earlier findings (6).

In summary, the study suggests that sleep and sleepiness complaints are the most frequent in industry, among 2- and 3-shift workers and especially among workers with a sedentary life-style and high alcohol consumption. Second, continuous 3-shift work seemed to interact with life-style factors, especially leisure-time physical activity, by decreasing the beneficial effects and increasing the adverse effects on sleep and sleepiness. The results seem to suggest that slowly rotating shift schedules hinder the positive effects of leisure-time physical activity on sleep and sleepiness.

Acknowledgments

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