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Work environment of Danish shift and day workers

by Henrik Bøggild, PhD,¹ Hermann Burr, PhD,² Finn Tüchsen, MSc,² Hans Jeppe Jeppesen, MSc¹

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Objectives Both shift work and other work environment factors have been shown to be related to heart disease. This study examined whether shift work is associated with other work environment factors related to heart disease in a random sample of the population. If so, shift work could be acting as a proxy for work environment differences.

Methods Data on 5940 employees in the Danish Work Environment Cohort Study from 1990 were reanalyzed. The information included work schedules [permanent day work, irregular workhours (including morning work), 2-shift or fixed evening and 3-shift or fixed night], length of workweek, physical factors (noise, heat, dust, passive smoking, walking, standing and monotonous repetitive tasks), and psychosocial factors (including demands and control dimensions, social support, conflicts and job insecurity).

Results At least 1 group of shift workers had a higher prevalence of nearly every unfavorable work environment factor investigated. Exceptions were dust exposure and quantitative demands. Especially conflicts at work and low decision latitude were higher among all the groups of shift workers, and all-day walking or standing work and part-time jobs were more often found among female shift workers. The 3 different shiftwork groups were exposed to different parts of the work environment, and also men and women in shift work differed in relation to the work environment. Age and social class influenced the relationship, but not in any particular pattern.

Conclusions In a heterogenous population shift work was found to be associated with other work environment factors suspected to cause heart disease.

Key terms cardiovascular diseases, epidemiology, occupational exposure, work, work schedule.

Shift work has been shown to be related to cardiovascular disease (CVD) with a relative risk of approximately 1.4 (1), although other studies have failed to find an association (2–5). In Denmark, one study found no association (2), and another based on aggregated data found a higher risk of hospitalization (6). In addition other work conditions are known or suspected to be risk factors for CVD. Among these are physical factors such as noise and high-paced monotonous work (7, 8), psychosocial factors such as high demands, low control and low social support (7–11), and chemical factors such as passive smoking, dinitroglycol, and carbon disulfide exposure (8, 12). Job insecurity has also been shown to raise blood pressure and lipid levels (13, 14), and dust exposure has recently been proposed to lead to CVD

through inflammation (15, 16). Heat and cold have also been shown to be related to excess CVD mortality (8, 17). Whether long weekly workhours can lead to CVD has been debated (8, 18–20).

Shift work is not randomly distributed among the workforce, being more prevalent among lower civil servants and unskilled workers. As social class is also a well-known risk factor in itself (21–25), it should be taken into account. The nature of the influence of social class on CVD is not known, but it has been related to life-style differences, selection processes, differences in culture, material conditions, and effects in utero or infancy (26). In the first 2 instances, social class can be regarded as a confounder, while the other explanations may suggest that it should be treated as

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a mediating factor. It has also been suggested that social class acts as a proxy for differences in the work environment (27–29); therefore it can be debated whether or not social class should be controlled when the effect of shift work on CVD is examined.

The possibility remains that shift work acts as a proxy for other work-related risk factors for CVD and that the risk of shift work is explained by these other risk factors. Only a few previous studies have controlled for CVD risk factors in the work environment, such as noise (30). Some have described the difference in work conditions between day and shift workers (3, 31), but did not examine the impact of the differences. Overall, shift workers have been shown to be exposed to noise, vibration, and unfavorable climatic conditions more often than day workers (32), and in a recent study (33) offshore workers in 12-hour shifts reported a higher exposure to “physical” factors (eg, noise, vibration, poor air quality, cramped workspaces) than their day-working counterparts on the platform.

This study examines whether shift and day workers differ in a random sample of the working population with regard to other work environment factors that, by themselves, are known or suspected to be related to CVD. The differences are, under other work conditions, this way, not necessarily direct effects of shift work itself, but instead mirror differences in the prevalence of shift work across occupations. If differences are present, future epidemiologic studies using random samples of the working population in examining the relation between shift work and CVD should control for these potential confounders. As social class differences may be present and as it is argued that social class may be regarded as both a mediating factor and a confounder, the effect of controlling for social class is also examined.

Subjects and methods

Subjects

The analyses were conducted in the Danish Work Environment Cohort Study (34). In 1990 a sample of 9653 adults between 18 and 59 years of age was drawn randomly from the Central Population Register of Denmark. Of these, 8664 allowed themselves to be interviewed by telephone (response rate 90%), and 5940 of these persons were working as employees or had been doing so within the last 2 months before the interview. They constituted the basis of our analyses. The interview was structured and included information on different work conditions. All the questions were read aloud, and the categories of possible answers were given before the respondent answered.

Workhours

One question was asked about the work schedule of the respondent. The possible categories were permanent day work, 2 shifts, 3 shifts with either running or alternating schedules, irregular scheduling in day or week, fixed evening or night schedule, early morning or other types of nonday work schedules. No further definitions were given. The workhours, except those labeled permanent day work, were divided into the following 3 categories: night work including 3-shift work, evening work including 2-shift work, and other irregular workhours, including morning work.

The length of the weekly workhours was calculated as the sum of the workhours for the main job and — if necessary — the 2nd job. The length of the weekly workhours was divided into the 3 groups of ≤ 34 hours, 35–40 hours, and ≥ 41 hours. The uniform labor market agreement on weekly workhours was 37 hours per week for day workers and 35 hours for shift workers in 1990. This agreement covered nearly every employee in Denmark. Weekly overtime work was defined as >40 hours per week.

Work environment

A scale describing ergonomic exposures to the musculoskeletal system was constructed from 6 items. Six scales were used describing different psychosocial work factors. They were constructed from 23 questions and covered psychological job demands [on the basis of factor analyses (35) divided into quantitative and cognitive demands], decision latitude, and skill discretion as 2 distinct control dimensions, social support, conflicts at work, and job insecurity (36).

The subjects were classified as carrying out varied or repetitive tasks on the basis of 2 questions (36).

A scale on dust exposure was based on 2 items. Exposure to heat, annoying noise, and walking or standing at work were all measured by 1 question each.

The scales were divided according to quartiles. There were 3 exceptions, however, due to skewed distributions. The scales for conflicts at work and repetitive work were dichotomized, and the scale for ergonomic exposures was divided into 3 parts.

Social class

The respondents were classified into 5 social classes according to employment grade, job title, and education (37). Social class I included executive managers and academics, social class II was made up of middle managers and persons with 3–4 years of higher education. Social class III consisted of other white-collar workers, and social class IV comprised skilled blue-collar work-

ers. Finally social class V covered semiskilled or unskilled workers. People receiving education were classified separately.

The population was divided into 3 equally large age groups, 18–31, 32–45 and 46–59 years.

The distribution of occupations given by the respondents is shown in table 1.

Analyses

The analyses were conducted separately for the men and the women. The crude distributions of all the variables were tabulated according to the types of worktime.

The odds ratios for the occurrence of each variable were calculated from a multiple logistic regression analysis. All the comparisons were done with persons in permanent day work as the reference group. In a 2nd step, social class was entered into the model to examine the impact of controlling for differences in social class.

To examine whether age affected the differences in the work environment, we stratified the material according to age group, and the logistic regression analyses were repeated.

All the analyses were conducted with SPSS (Statistical Package of the Social Sciences) for Windows, version 9.0.

Table 1. Occupation by types of workhours for the men and women. Grouping of occupations based on Borg & Burr (34).

Occupation	Workhours ^a							
	Men				Women			
	Day (N=2484) (%)	Other irregular (N=335) (%)	Evening or 2-shift (N=118) (%)	Night or 3-shift (N=102) (%)	Day (N=2319) (%)	Other irregular (N=263) (%)	Evening or 2-shift (N=163) (%)	Night or 3-shift (N=97) (%)
Academics	7	5	0	0	2	3	0	0
Teachers	4	3	0	1	6	8	1	0
Managers, foremen	13	6	7	3	4	2	1	0
Health and social workers	0	0	0	0	23	36	47	64
Secretaries, bookkeepers and clerks	5	1	2	1	28	4	2	3
Service workers	8	18	12	8	7	26	17	6
Shop and sales assistants	6	6	2	0	4	4	4	0
Manual jobs	38	19	55	64	8	2	15	14
Other	19	43	23	24	18	16	13	12

Table 2. Prevalence of occupational exposures and unskilled workers among the day and shift workers in 1990.

Occupational exposure	Workhours ^a							
	Men				Women			
	Day (N=2503; (%))	Other irregular (N=354) (%)	Evening or 2-shift (N=122) (%)	Night or 3-shift (N=118) (%)	Day (N=2319) (%)	Other irregular (N=263; (%))	Evening or 2-shift (N=163) (%)	Night or 3-shift (N=97) (%)
Length of work week (> 40 hours)	24	33	13	15	7	10	2	3
Annoying noise ($\geq 1/4$ of workhours)	11	16	30	18	11	10	8	14
Heat ($\geq 1/4$ of workhours)	9	20	22	25	8	13	17	14
Dust exposure (high)	18	16	19	21	13	10	16	18
Passive smoking ($\geq 1/4$ of workhours)	27	40	36	42	29	40	35	36
Walking or standing work (all workhours)	25	20	38	44	21	41	44	30
Ergonomic exposures (many)	17	15	20	24	12	16	26	28
Monotonous repetitive tasks ($\geq 1/2$ of workhours)	7	9	27	17	11	9	18	14
Cognitive demands (high)	31	47	33	35	19	31	28	36
Quantitative demands (high)	19	20	17	6	23	27	18	20
Decision authority (low)	19	32	42	42	25	32	40	44
Skill discretion (low)	21	28	35	26	27	32	38	25
Social support (low)	26	38	24	23	23	27	25	25
Conflicts at work (high)	1	5	2	4	4	15	17	15
Job insecurity (high)	21	22	32	23	30	29	34	36
Social class (unskilled worker)	20	24	48	43	19	24	30	24

^a As more exposures could be present, the sum of percentages exceeds 100.

Table 3. Prevalence of occupational exposures by type of worktime for the men and women, stratified for age. (OR = odds ratio, 95%CI

		Men ^a			
Occupational exposure		Unadjusted OR	95%CI ^b	Adjusted OR ^c	95%CI ^d
Length of work week, >40 hours	Day	1	..	1	..
	Other irregular	<i>1.61</i>	<i>1.3—2.1</i>	<i>1.64</i>	<i>1.3—2.1</i>
	Evening/2-shift	<i>0.49</i>	<i>0.3—0.8</i>	<i>0.66</i>	<i>0.4—1.1</i>
	Night/3-shift	<i>0.56</i>	<i>0.3—0.9</i>	<i>0.79</i>	<i>0.5—1.3</i>
Annoying noise, ≥1/4 of workhours	Day	1	..	1	..
	Other irregular	<i>1.39</i>	<i>1.0—1.9</i>	<i>1.51</i>	<i>1.1—2.1</i>
	Evening/2-shift	<i>3.27</i>	<i>2.2—4.9</i>	<i>3.02</i>	<i>2.0—4.6</i>
	Night/3-shift	<i>1.71</i>	<i>1.0—2.8</i>	<i>1.54</i>	<i>0.9—2.5</i>
Heat, ≥1/4 of workhours	Day	1	..	1	..
	Other irregular	<i>2.15</i>	<i>1.7—2.8</i>	<i>2.42</i>	<i>1.9—3.1</i>
	Evening/2-shift	<i>2.07</i>	<i>1.4—3.1</i>	<i>1.91</i>	<i>1.3—2.9</i>
	Night/3-shift	<i>2.75</i>	<i>1.9—4.0</i>	<i>2.47</i>	<i>1.7—3.7</i>
Dust exposure, high	Day	1	..	1	..
	Other irregular	<i>0.88</i>	<i>0.6—1.2</i>	<i>0.95</i>	<i>0.7—1.3</i>
	Evening/2-shift	<i>1.02</i>	<i>0.6—1.6</i>	<i>0.78</i>	<i>0.5—1.3</i>
	Night/3-shift	<i>1.20</i>	<i>0.8—1.9</i>	<i>0.90</i>	<i>0.6—1.4</i>
Passive smoking, ≥1/4 of workhours	Day	1	..	1	..
	Other irregular	<i>1.73</i>	<i>1.4—2.2</i>	<i>1.72</i>	<i>1.4—2.2</i>
	Evening/2-shift	<i>1.49</i>	<i>1.0—2.2</i>	<i>1.65</i>	<i>1.1—2.4</i>
	Night/3-shift	<i>1.90</i>	<i>1.3—2.8</i>	<i>2.06</i>	<i>1.4—3.0</i>
Walking or standing, all workhours	Day	1	..	1	..
	Other irregular	<i>0.72</i>	<i>0.5—1.0</i>	<i>0.80</i>	<i>0.6—1.1</i>
	Evening/2-shift	<i>1.86</i>	<i>1.3—2.7</i>	<i>1.21</i>	<i>0.8—1.8</i>
	Night/3-shift	<i>2.34</i>	<i>1.6—3.4</i>	<i>1.53</i>	<i>1.0—2.3</i>
Ergonomic exposures, many	Day	1	..	1	..
	Other irregular	<i>0.88</i>	<i>0.6—1.2</i>	<i>0.98</i>	<i>0.7—1.4</i>
	Evening/2-shift	<i>1.27</i>	<i>0.8—2.0</i>	<i>0.80</i>	<i>0.5—1.3</i>
	Night/3-shift	<i>1.55</i>	<i>1.0—2.4</i>	<i>0.98</i>	<i>0.6—1.5</i>
Monotonous repetitive tasks, ≥ ½ of workhours	Day	1	..	1	..
	Other irregular	<i>1.52</i>	<i>1.0—2.2</i>	<i>1.41</i>	<i>0.9—2.1</i>
	Evening/2-shift	<i>5.20</i>	<i>3.4—8.0</i>	<i>3.18</i>	<i>2.0—5.0</i>
	Night/3-shift	<i>2.85</i>	<i>1.7—4.8</i>	<i>1.76</i>	<i>1.0—3.0</i>
Quantitative demands, high	Day	1	..	1	..
	Other irregular	<i>1.12</i>	<i>0.8—1.5</i>	<i>1.12</i>	<i>0.8—1.5</i>
	Evening/2-shift	<i>0.91</i>	<i>0.6—1.5</i>	<i>1.24</i>	<i>0.8—2.0</i>
	Night/3-shift	<i>0.28</i>	<i>0.1—0.6</i>	<i>0.38</i>	<i>0.2—0.8</i>
Cognitive demands, high	Day	1	..	1	..
	Other irregular	<i>2.06</i>	<i>1.6—2.6</i>	<i>2.15</i>	<i>1.7—2.7</i>
	Evening/2-shift	<i>1.09</i>	<i>0.7—1.6</i>	<i>1.15</i>	<i>0.8—1.7</i>
	Night/3-shift	<i>1.20</i>	<i>0.8—1.8</i>	<i>1.29</i>	<i>0.9—1.9</i>
Decision authority, low	Day	1	..	1	..
	Other irregular	<i>1.90</i>	<i>1.5—2.5</i>	<i>1.96</i>	<i>1.5—2.6</i>
	Evening/2-shift	<i>3.08</i>	<i>2.1—4.5</i>	<i>2.19</i>	<i>1.5—3.2</i>
	Night/3-shift	<i>3.09</i>	<i>2.1—4.5</i>	<i>2.21</i>	<i>1.5—3.3</i>
Skill discretion, low	Day	1	..	1	..
	Other irregular	<i>1.43</i>	<i>1.1—1.9</i>	<i>1.34</i>	<i>1.0—1.8</i>
	Evening/2-shift	<i>2.06</i>	<i>1.4—3.0</i>	<i>1.25</i>	<i>0.8—1.9</i>
	Night/3-shift	<i>1.36</i>	<i>0.9—2.1</i>	<i>0.84</i>	<i>0.5—1.3</i>
Social support, low	Day	1	..	1	..
	Other irregular	<i>1.65</i>	<i>1.3—2.1</i>	<i>1.54</i>	<i>1.2—2.0</i>
	Evening/2-shift	<i>0.88</i>	<i>0.6—1.3</i>	<i>0.82</i>	<i>0.5—1.3</i>
	Night/3-shift	<i>0.84</i>	<i>0.5—1.3</i>	<i>0.80</i>	<i>0.5—1.2</i>
Conflicts at work, high	Day	1	..	1	..
	Other irregular	<i>4.44</i>	<i>2.3—8.7</i>	<i>4.64</i>	<i>2.3—9.2</i>
	evening/2-shift	<i>1.71</i>	<i>0.4—7.3</i>	<i>2.00</i>	<i>0.5—8.7</i>
	Night/3-shift	<i>4.59</i>	<i>1.7—12.2</i>	<i>5.22</i>	<i>1.9—14.3</i>
Job insecurity, high	Day	1	..	1	..
	Other irregular	<i>1.09</i>	<i>0.8—1.4</i>	<i>1.05</i>	<i>0.8—1.4</i>
	Evening/2-shift	<i>1.77</i>	<i>1.2—2.6</i>	<i>1.53</i>	<i>1.0—2.3</i>
	Night/3-shift	<i>1.13</i>	<i>0.7—1.8</i>	<i>0.98</i>	<i>0.6—1.5</i>

^a Significant results are shown in italics.^b 95% CI for unadjusted OR.^c Adjusted for social class.^d 95% CI for OR adjusted for social class.

= 95% confidence interval)

			Women ^a						
OR, stratified (age) and adjusted ^c							OR, stratified (age) and adjusted ^c		
18—31 years	32—45 years	46—59 years	Unadjusted OR	95%CI ^b	Adjusted OR ^c	95%CI ^d	18—31 years	32—45 years	46—59 years
1	1	1	1	..	1	..	1	1	1
1.85	1.37	1.74	1.36	0.9—2.1	1.42	0.9—2.2	0.85	1.96	1.57
0.77	0.68	0.44	0.33	0.1—0.9	0.37	0.1—1.0	0.91	0.15	.
0.60	0.91	0.82	0.42	0.1—1.3	0.46	0.1—1.4	.	0.54	0.78
1	1	1	1	..	1	..	1	1	1
1.34	1.61	1.79	0.94	0.6—1.4	0.94	0.6—1.4	0.63	1.25	0.90
2.58	2.61	4.96	0.75	0.4—1.3	0.78	0.4—1.4	0.70	0.85	0.57
1.15	2.26	1.07	1.37	0.8—2.5	1.41	0.8—2.6	0.70	2.26	1.11
1	1	1	1	..	1	..	1	1	11
2.64	2.37	2.10	1.73	1.3—2.4	1.67	1.2—2.3	2.19	1.54	1.10
2.30	1.42	2.16	1.74	1.2—1.6	1.62	1.1—2.4	2.11	1.38	1.22
3.16	2.30	1.23	1.46	0.9—2.4	1.40	0.8—2.4	2.01	3.38	0.88
1	1	1	1	..	1	..	1	1	1
1.11	1.01	0.58	0.75	0.5—1.7	0.72	0.5—1.1	0.99	0.61	0.62
1.20	0.56	0.47	1.20	0.8—1.9	1.10	0.7—1.7	0.69	1.91	0.54
0.74	0.94	1.26	1.42	0.8—2.4	1.35	0.8—2.3	1.63	1.07	1.43
1	1	1	1	..	1	..	1	1	1
2.00	1.38	2.11	1.65	1.3—2.1	1.68	1.3—2.2	2.19	1.54	1.09
1.70	1.43	2.01	1.27	0.9—2.1	1.29	0.9—1.8	1.54	1.36	0.69
2.34	1.95	1.51	1.37	0.9—2.1	1.39	0.9—2.4	1.32	1.83	0.95
1	1	1	1	..	1	..	1	1	1
0.99	0.88	0.44	2.63	2.0—3.4	2.85	2.1—3.8	2.74	3.54	2.56
1.56	1.52	0.54	3.02	2.2—4.2	2.68	1.9—3.8	2.71	3.42	2.15
1.66	1.50	1.33	1.68	1.1—2.6	1.54	1.0—2.5	0.95	2.86	0.91
1	1	1	1	..	1	..	1	1	1
1.44	1.08	0.22	1.36	1.0—1.9	1.36	0.9—1.9	1.11	1.49	1.80
0.95	1.12	0.23	2.52	1.7—3.7	2.20	1.5—3.2	1.52	2.84	2.43
1.36	0.56	1.05	2.69	1.7—4.3	2.51	1.6—4.1	1.63	3.56	2.19
1	1	1	1	..	1	..	1	1	1
1.82	1.77	0.38	0.84	0.5—1.3	0.74	0.5—1.2	0.69	0.51	1.16
2.03	7.08	1.80	1.83	1.2—2.8	1.43	0.9—2.3	1.37	1.06	2.64
1.77	1.22	2.96	1.44	0.8—2.6	1.25	0.7—2.3	2.67	0.38	1.48
1	1	1	1	..	1	..	1	1	1
1.02	0.97	1.58	1.23	0.9—1.6	1.24	0.9—1.7	2.10	1.14	0.70
0.78	0.88	2.74	0.74	0.5—1.1	0.87	0.6—1.3	0.64	0.88	1.22
0.88	0.12	.	0.79	0.5—1.3	0.88	0.5—1.5	2.82	0.61	0.39
1	1	1	1	..	1	..	1	1	1
1.22	2.32	3.77	1.87	1.4—2.5	1.86	1.4—2.5	2.83	1.75	0.83
0.76	0.91	2.61	1.70	1.2—2.4	1.97	1.4—2.8	2.47	1.59	2.20
1.28	1.17	1.37	2.26	1.5—3.5	2.49	1.6—3.9	5.22	2.22	1.40
1	1	1	1	..	1	..	1	1	1
1.87	2.45	1.56	1.44	1.1—1.9	1.44	1.1—1.9	1.36	2.13	0.86
1.46	2.89	3.30	1.97	1.4—2.7	1.77	1.3—2.5	1.29	1.95	2.60
1.85	2.34	3.56	2.43	1.6—3.7	2.41	1.6—3.7	4.71	2.00	2.05
1	1	1	1	..	1	..	1	1	1
1.47	1.19	1.48	1.33	1.0—1.7	1.29	1.0—1.7	1.16	1.30	1.51
1.28	1.67	0.84	1.64	1.2—2.3	1.48	1.0—2.0	2.10	0.91	1.69
1.20	0.70	0.52	0.93	0.6—1.5	0.82	0.5—1.3	2.09	0.44	0.60
1	1	1	1	..	1	..	1	1	1
1.41	1.74	1.39	1.23	0.9—1.6	1.18	0.9—1.6	0.90	1.39	1.48
1.12	0.76	0.57	1.13	0.8—1.6	1.08	0.7—1.6	0.84	1.23	1.14
0.77	0.81	1.04	1.12	0.7—1.8	1.08	0.7—1.7	1.47	0.72	1.22
1	1	1	1	..	1	..	1	1	1
5.95	4.27	3.24	4.01	2.7—6.0	4.00	2.7—6.0	6.87	3.35	0.90
5.36	.	.	4.62	2.9—7.3	4.60	2.9—7.3	6.13	3.83	3.21
4.87	5.10	6.09	3.96	2.2—7.2	3.87	2.1—7.1	3.11	3.63	4.86
1	1	1	1	..	1	..	1	1	1
1.46	1.05	0.69	0.95	0.7—1.3	0.97	0.7—1.3	0.93	0.97	1.04
1.25	1.71	1.74	1.26	0.9—1.8	1.13	0.8—1.6	0.63	1.81	1.04
1.22	0.98	0.70	1.32	0.9—2.0	1.22	0.8—1.9	1.21	1.38	1.04

Results

Altogether 3.6% of the subjects did night work, 4.8% had evening work, and 10.4% were in other types of work with irregular workhours. The age distribution was very alike in the 4 groups. The mean age was 37 (SD 11) years for the male day workers, 38 (SD 11) for the female day workers, and 36–37 years for both the male and female shift workers, except for the male and female nightwork group, which had a mean age of 34 (SD 11) years and 38 (SD 10) years, respectively. Table 2 (on page 99) shows the distribution of work environment risk factors according to the type of shift work in this random sample of employees. The mean weekly workhours were 37 (SD 8) for the day workers, 37 (SD 12) for the group with irregular workhours, and 34 (SD 10) and 36 (SD 8) for the evening and night shift workers, respectively. All the risk factors except dust and quantitative demands were more prevalent among the male shift-working population, while female shift workers had smaller differences from the day workers. There were differences among the 3 groups of work schedules, and overall the evening work and night work groups had the same work environment, while the group with irregular workhours shared work environment with the daywork group in some instances, especially with respect to physical (noise, dust) and ergonomic variables. The differences between the female groups did not follow any particular pattern.

Among the men, all the shiftwork groups had a statistically significant higher odds of being exposed to noise, heat, and passive smoking than the day workers did (table 3 on pages 100 and 101). All the groups also had higher odds ratios for monotonous repetitive tasks and low decision latitude. The odds for walking and standing were higher among the evening and night work group, whereas ergonomic exposures were higher and quantitative demands lower among the night work group than among the day workers. The odds ratio for job insecurity was higher among the evening work group, whereas weekly overtime work, cognitive demands, and low social support were higher among the “other irregular” work group and skill discretion was higher among the groups of other irregular and evening workers. There were no statistically significant differences among the 4 groups for dust exposure. Among the women a slightly different situation existed. As for the men, the odds ratios for exposure to dust and quantitative demands were not higher for the shift workers. In addition, the pattern for skill discretion also resembled that of the men. Contrary to the situation for the men, noise was not associated with shiftwork type among the women, and walking or standing postures, high ergonomic exposure, high cognitive demands, and conflicts at work

were associated with all 3 groups of shift work among the women. Passive smoking was higher only for the group with other irregular workhours, and the odds of long weekly workhours was lower in the groups with evening or night work when compared with the odds of the day work group.

As expected, there was a social gradient for shift work, mostly for the men, with day work accounting for 91% of the persons in social class I; for 80%, 81% and 84% of the persons in social class II, III and IV, respectively; and for 74% of the persons in social class V. Within the different types of shift work, social class I especially had irregular workhours and no night work, while both evening work and especially night work was more prevalent in the low social classes. Controlling for social class in general lowered the risk estimates, except for cognitive demands for both genders and conflicts at work for the men. There was a tendency for the estimates to be increased by adjustment in the group of other irregular workhours in contrast to the other 2 groups.

The modifying effect of age was investigated by stratifying the associations between the work environment factors and the shiftwork groups by age. There were no distinct patterns found between either the shift work groups, the work environment groups, or gender.

Discussion

The prevalence of nonday work schedules in this study was 19%, which is of the same magnitude as found in other sources from industrialized western countries (38, 39).

The grouping of shift work was based on the idea that it is the placement of work in the evening and night rather than the shifts themselves that are related to heart disease (40–42). The group with irregular workhours seemed to be very heterogeneous, and it resembled the daywork group both with regard to weekly workhours and type of occupation (table 1). We grouped 2-shift and evening work together although 2-shift work may include alternating between 2 12-hour shifts, covering the night period as well. In 1990 12-hour shifts were not very common in Denmark, and this misclassification is negligible.

The CVD risk factors of the work environment differed both between the day and shift workers and between the genders. Apart from the shift workers in evening and night work having shorter weekly workhours, even when hours in an extra job are allowed for, the shiftwork population had more prevalent exposure to most of the disadvantageous work-environment risk factors analyzed in this study. The only exception

was exposure to dust and quantitative demands. For physical exposures, the odds ratios for walking or standing, exposure to heat, and passive smoking was higher in all 3 groups when compared with those of day work, and those for ergonomic exposures and noise were higher for the evening and night work groups. For passive smoking (43) and noise (30, 32), this finding is in accord with the results of previous studies.

Demands and decision latitude have been used in the context of work-related stress, the findings showing workers in stressful jobs with high demands and low control to have a higher risk of CVD (11). In this manner stress is both theoretical and, in questionnaire wording, related to the organization of work contents rather than to the organization of worktime, although this distinction is not always made (44). One study has previously examined stress among day and shift workers without finding differences (44), in another study on oil workers shift work was associated with lower skill discretion, but unrelated to demands and social support (33), and, from a Finnish study of a more homogeneous group of industrial workers (45), it can be calculated that shift workers experience lower control, while their demands do not differ from those of day workers. Our study suggests that especially the cognitive aspect of demands and the decision latitude aspects of control differ between day and shift workers and that especially the quantitative demands are equally distributed across the different work schedules, except for a lower prevalence for male night workers.

Thus far no studies have examined the prevalence of conflicts at work or job insecurity among day and shift workers. Especially conflicts were much more common among both the male and female shift workers in our study.

Not all of the selected environmental factors have been shown to the same degree to be risk factors for CVD (8). However, even restricting the focus to the factors with the most uniform elevated risk, such as demands, control and social support, the shift workers had a higher prevalence of work environment factors.

The differences in work environment between the shift and day workers may, in some instances, be related to the work contents, as evening and night work often encompasses more surveillance work or more simple production than day work does, while, in other instances, certain occupations may only encompass certain work schedules, as bakers work nights only and schoolteachers work days only. Therefore the relations between occupation, work environment, and shift work are mere associations.

The National Work Environment Cohort Study only included questions on broad categories of chemicals, and therefore we were not able to explore differences between shift and day workers with respect to chemi-

cals related to CVD in the workplace (12), as the validity of the questions may have been questionable. It has, however, been estimated that only a few percent of the Danish workforce is exposed (46).

The effect of controlling for social class (table 3) lowered the odds for ergonomic exposures, monotonous tasks, and decision latitude and raised the odds for cognitive demands and conflicts among the men in the evening and night work group. Therefore, even within the social class groups, there were large differences between the day and (especially) evening and night work groups in regard to demand, control, and conflicts, shift workers having the most unfavorable conditions.

As CVD is primarily a disease affecting older age groups, the work environment of these groups would be especially interesting. It has been shown that the psychosocial work environment in general relates to age in a U-formed curve for demands and a nonlinear rise for control (47). Stratification was thus done for age, and it showed large differences with regard to the association between work schedules and both physical and psychosocial factors, but the patterns were not clear. The work environment of the group with irregular workhours seemed to approach that of the day work group in the older age groups, which even had a more favorable work environment in some models. After age stratification the shiftwork groups tended to be rather small, however. The cross-sectional data make it important not to judge the age stratification as a trend, as the younger subjects in this study had probably not been in the same work environment as the older workers when they were younger.

Surprisingly large differences were observed among the 3 groups of nonday workers. These differences were probably related to different types of work, using different types of worktime schedules. Thus, although shift work often merely covers work outside normal day work in the literature, it seems to be too simplistic to maintain this broad group as uniform exposure with regard to CVD, especially for the group working "other irregular" hours, which in some instances resembled the day work group more than the evening and night shift groups. The situation may be the result of the group probably being very inhomogeneous and made up of employees not finding themselves only working in the day hours, but not fitting very well in other categories. They may have only a few of their workhours outside day work, for instance, being senior staff with occasional evening work, but not regarding themselves as 2-shift workers.

This reanalysis was based on cross-sectional baseline data, and evaluating any direction of causation is thus not possible. In describing work environment differences between groups, the approach is valid. The random sample approach in this study does not imply

selection bias regarding exposures, as exposure status is not an effect of selection. The study did not permit an analysis of whether shift workers are a selected group. As selection processes may have been present, shift workers could have left for day work (48). Such an occurrence would have caused the age distribution of this random sample to differ between the shift and day workers, the shift-working groups being younger. This was in fact not so. Neither the mean nor the standard deviation differed between the groups.

The data collection was carried out through interviews, and the data were thus self-reported. People may judge the same environment in different ways. If so, there would be a problem if shift workers were to judge their environment worse than day workers consistently. Evaluating the impact of this information bias is impossible. Differences may have also been present between different age groups, younger people probably being more critical toward poor work conditions. We have therefore only made comparisons within the same age groups, and the tendency, for instance, for experiencing less dust, heat, and passive smoking among the older age group did not result from a comparison of different age groups.

The measurement of the work environment was based on the use of scales, which, in most circumstances, had been used elsewhere. The scales on demands and control (9) had previously given unclear results and were thus divided on the basis of the results of a factor analysis (35). The division into 4 groups was also externally valid, as the groups can be thought of as covering distinct parts of control and demands. It may have also helped to give better results in a study covering a broad span of work, as the demand-control model has previously been shown to work only fairly well for groups of white-collar workers (49, 50). The results suggest that the differences in the work environment are especially related to two of the dimensions, one on each of the original demand and control dimensions.

Two strengths of the study deserve attention. The study comprised a large random sample of subjects actually working as employees and was thus representative of Danish employees in 1990. The results may also be valid for other Western countries with the same mixture of occupations as Denmark. The study also had a participation rate of 90%, which is unusually high.

It should be stressed that we did not include any information regarding outcome measures related to CVD. Thus it is impossible to judge the magnitude of the risk of CVD related to the differences in the work environment. In the literature, the risks related to the examined factors are modest, ranging from 1.3 to 2.0 (51), but, as they are more widespread among shift workers than day workers, the attributable risk might be high. Estimating whether these differences in the work environment be-

tween shift and day workers would explain away the risk connected to shift work itself was also not possible.

In conclusion, this study found that, in a random sample of employees, shift workers more often than day workers report higher exposure to work environment factors related to heart disease. In our study social class interfered with the estimates for weekly overtime, decision latitude, skill discretion, job insecurity, repetitive tasks, cognitive demands, and conflicts at work. Thus studies of CVD among shift and day workers, especially in population samples, should ask about and control for differences in the work environment, as they may act as confounders. It may be that shift work has merely been acting as a proxy for differences in other work environment factors between shift and day workers and that these differences were responsible for the findings.

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