ORIGINAL ARTICLE

A 12 year prospective study of circulatory disease among Danish shift workers

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Background: Previous studies of the risk of heart disease after shift work reached different estimates and review authors disagree about the validity of some of the studies. A cross sectional study showed that shift workers had a higher prevalence of nearly every unfavourable work environment factor investigated. Conflicts at work and low decision latitude were more frequent among shift workers, and all-day walking or standing work and part-time jobs were more often found among female shift workers.
Objectives: To estimate the risk of circulatory disease in a prospective follow up of a representative sample of gainfully employed Danes, considering known or suspected confounding factors.
Methods: A cohort of 5517 people who were gainfully employed in 1990 were followed up for all hospital treatments due to circulatory diseases (390–458, ICD-8; I00–I99, ICD-10) from 1991 to 2002 inclusive. A log linear Poisson regression model was applied to control confounding factors and calculate the relative risk for 927 men and women working nights, evenings, or other non-day shifts compared to 4579 day workers.
Results: Non-day workers compared to day workers had a relative risk (RR) for all circulatory diseases of 1.31 (95% CI 1.06–1.63). Without control for BMI and smoking, the RR estimate was 1.33 (95% CI 1.07–1.65). For a subgroup of workers with at least three years' seniority, the RR was 1.40 (95% CI 1.09–1.81). The population based aetiological fraction of shift work was estimated to 5%.
Conclusion: This study adds to a growing body of evidence suggesting that shift work carries an excess risk of circulatory diseases.

Recent studies estimated that shift work is the most significant source of ischaemic heart disease (IHD) among gainfully employed people, accounting for 10.7% of all male IHD mortality in working age and 5.5% of female IHD mortality.[1] For such estimates to be correct we need to know the relative risk and the prevalence of the exposure.

A major difficulty is the strong selection effect of heart diseases. Long before any clinical diagnoses are established, people tend to change job because they find it difficult to handle the physical demands. Furthermore, shift work often becomes more of a burden by age causing shift workers to choose day work. Therefore the IHD cases are usually found among ex-shift workers as pointed out by Åkerstedt *et al* in 1984.[2] Since then, most review authors have concluded that working shifts including night work carry an excess risk of cardiovascular disease.[2–6] However, Steenland *et al* suggested in 2000 that: ''…the epidemiologic data suggest that a modest association between shift work and heart disease may exist...the epidemiologic studies are still relatively few…and they are not consistent. Therefore a causal relationship between shift-work cannot be inferred''.[7] The method used in that review is interesting because three studies based on aggregated data[8–10] were excluded by the following argument: ''Three studies potentially relevant to rotating shift work are omitted (Alfredsson, *et al*., 1982, Alfredsson, *et al*., 1985 and Tüchsen, 1993 because they are not based on a well-defined population of shift workers''. Those three studies found the highest estimates. Usually one expects ecological studies to produce results biased towards the mean because highly exposed and less exposed are mixed, and in longitudinal studies migration takes place from the index group to the control group and vice versa. It is therefore surprising to find that the ecological record linkage studies came up with the highest estimates.

Bøggild *et al*[11] have shown, however, in a recent cross-sectional study of exposures relevant to cardiovascular disease, that shift work was associated with other work environment factors suspected to cause heart disease such as conflicts at work, low decision latitude, and all-day walking or standing work. The risk estimates from analysis based on aggregated data or other studies with incomplete control of confounding factors may therefore overestimate the true risk.

Since then a recent Swedish cohort study of 2354 shift workers and 3088 day workers showed a standardised rate ratio of 1.24 due to coronary heart mortality among shift workers with at least 30 years' seniority. No excess was, however, found for overall mortality (SRR 1.02, 95% CI 0.93–1.11).[12]

A feasibility study showed that we would have 80% power to find a standardised hospitalisation ratio of 1.30 for circulatory diseases but not for ischaemic heart disease. Taking known and suspected confounders into consideration, the aim of the present prospective study was to estimate the relative risk of hospital treatment due to circulatory diseases among non-day workers compared to day workers.

METHODS

In the 1990 round of the Danish Work Environment Cohort Survey (DWECS), a representative random sample was drawn from the Central Population Register of Denmark.[13] The sample contained 9165 residents of Denmark in the age group 20–59 years on 1 October 1990. Of these, 8231 agreed to be interviewed by telephone (response rate 90%); 5837 of the interviewees had been employed for at least one day within two months prior to the interview. A total of 5517

Abbreviations: BMI, body mass index; CHD, coronary heart disease; IHD, ischaemic heart disease; RR, relative risk; SRR, standardised rate ratio

respondents aged 20–59 years on 1 January 1991, who answered a question about their work schedule and who were defined as employees according to register data in the beginning of 1991, are the subjects of the present study. In DWECS, a series of questions about physical and psychosocial work environment, and lifestyle were asked.

The material consisted of person based data obtained through a record linkage between the interview database and three national registers—the central population register, the national patient register, and the employment classification module. The central population register contains information on gender, addresses, dates of birth, death, and migrations for every person who is or has been an inhabitant of Denmark at some time between 1968 and the present. The employment classification module has existed since 1975 and contains annual information on socioeconomic status, occupation, and industry for each Danish inhabitant older than 16 years. The national patient register has existed as a national register since 1978. It is updated each year and contains data on all treatments in Danish hospitals (more than 99% of all discharges). In the time period 1978–93 the diagnoses were coded according to the International Classification of Diseases version 8 (ICD-8). Since 1994 they have been coded according to ICD-10. The basic units of observation in the register are, since 1977, discharges of hospitalised patients. Since 1995 the register also covers the conclusion of outpatient courses and emergency ward visits.

The variable irregular working hours (yes/no) was assigned the value ''no'' if the person answered with the first response category on the question: ''What kind of work schedule do you have? (permanent day duty/two shifts/three shifts/fluctuating according to special schedule or rotation/permanent evening duty/permanent night duty/permanent morning duty/other)''. The work schedule distribution is given in table 1.

The variable passive smoking (yes/no) was based on the question ''Are you exposed to tobacco smoke from other people at your workplace?'', which could be answered with one of six reply categories (almost all the time; approx. ¾ of the time; approx. ½ of the time; approx. ¼ of the time; seldom; and never). The variable was given the value ''yes'' if the person was exposed at least ''approx. ¼ of the time''.

The variable about prolonged standing or walking was based on the question ''Does your work entail that you sit?''. A person was considered to be subject to prolonged standing or walking if his work seldom or never entailed sitting.

The variable cold work environment (yes/no) was based on the question ''Are you exposed to cold (outdoor work in the winter, work in cold rooms, etc)?''. It was given the value ''yes'' if the person was exposed at least ''approx. ¼ of the time''.

The variable hot work environment (yes/no) was based on the question ''Are you exposed to heat so you perspire even though you do not move (more than 28°C)?''. It was given the value ''yes'' if the person was exposed at least ''approx. ¼ of the time''.

Table 1 Number of men and women, by work schedule, in a representative sample of Danish employees in 1990

Work schedule	Men	Women
Permanent day duty	2371	2208
Two shifts	84	64
Three shifts	71	43
Fluctuating according to special schedule or rotation	227	168
Permanent evening duty	34	96
Permanent night duty	46	50
Permanent morning duty	8	23
Other non-day work	12	12
All workers	2853	2664

Of the total 5455 workers, 3657 had at least a seniority of 3 years.

The variable annoying noise (yes/no) was based on the question ''Are you exposed to any other type of annoying noise?''. It was given the value ''yes'' if the person was exposed at least ''approx. ¼ of the time''.

The variable monotonous repetitive tasks (yes/no) was based on the question ''Does your work require that you repeat the same work tasks several times per hour?''. It was given the value ''yes'' if the person was exposed at least ''approx. ½ of the time''.

A scale for conflicts at work was constructed on the basis of four questions: ''Are you involved in conflicts or arguments at your workplace?'', ''Are you exposed to violence or threats of violence at your workplace?'', ''Are you exposed to unpleasant teasing at your workplace?'', and ''Are you exposed to unwanted sexual attention at your workplace?''. Each of the questions could be answered with one of the following reply categories: ''yes, indeed'' (scale score 100); ''to some extent'' (scale score 67); ''not so much'' (scale score 33); or ''no, or very seldom'' (scale score 0). Cronbach's alpha equalled 0.49 and the inter-item correlations ranged from 0.09 to 0.24. The conflict scale was calculated as a mean of at least two non-missing items. In the present study, a person was considered exposed to conflicts at work if he belonged to the highest quartile of the scale.

A scale for ergonomic exposures was constructed on the basis of six questions: ''Does your work entail that you do the same twists and bending many times per hour?'', ''Is your work so physically hard that it makes you breathe faster?'', ''Does your work entail that you kneel?'', ''Do you work with your hands lifted to shoulder height or higher?'', ''Do you work with you back heavily bent without supporting it with your hands or arms?'', and ''In your everyday work, do you lift loads weighing more than 20 kg?''. Each of the questions could be answered with one of the following reply categories: ''almost all the time'' (scale score 100); ''approx. ¾ of the time'' (scale score 75); ''approx. ½ of the time'' (scale score 50); ''approx. ¼ of the time'' (scale score 25); ''seldom'' (scale score 6); and ''never'' (scale score 0). The ergonomic exposure scale was calculated as a mean of at least three non-missing items. Cronbach's alpha equalled 0.72 and the inter-item correlations ranged from 0.24 to 0.40. In the present study, a person was considered to have many ergonomic exposures if he belonged to the highest quartile of the scale.

A job insecurity scale was constructed on the basis of four questions: ''Are you worried about becoming unemployed?'', ''Do you worry about being involuntarily transferred to another job?'', ''Do you worry that implementation of new technology will make you redundant?'', and ''Do you worry about difficulty finding a new job with your present qualifications?''. Each of the questions could be answered with ''yes'' (scale score 100) or ''no'' (scale score 0). The job insecurity scale was calculated as a mean of at least two non-missing items. Cronbach's alpha equalled 0.62 and the inter-item correlations ranged from 0.19 to 0.35. In the present study, a person was considered to be subject to job insecurity if he belonged to the highest quartile of the scale.

A decision authority scale was constructed on the basis of three questions: ''Can you decide you own rate of working?'', ''Do you participate in planning your own work (e.g. what to do, how to do it, or who to work with)?'', and ''Are you informed about decisions that concern your workplace?''. The first of the questions could be answered with one of the following reply categories: ''almost all the time'' (scale score 100); ''approx. ¾ of the time'' (scale score 75); ''approx. ½ of the time'' (scale score 50); ''approx. ¼ of the time'' (scale score 25); ''seldom'' (scale score 6); and ''never'' (scale score

0). The reply categories of the other two questions were ''always'' (scale score 100), ''mostly'' (scale score 67), ''not very often'' (scale score 33), and ''never'' (scale score 0). The decision authority scale was calculated as a mean of at least two non-missing items. Cronbach's alpha equalled 0.53 and the inter-item correlations ranged from 0.15 to 0.37. In the present study, a person was considered to have low decision authority if he belonged to the lowest quartile of the scale.

The scale ''social support'' was based on five questions: ''Do you work isolated from your colleagues?'', ''Is it possible to get advice and help if it is required?'', ''Does your superior support and encourage you?'', ''Do your colleagues support and encourage you?'', and ''Is it possible for you to talk with colleagues when you are working?''. The last of the questions could be answered with one of the following reply categories: ''almost all the time'' (scale score 100); ''approx. ¾ of the time'' (scale score 75); ''approx. ½ of the time'' (scale score 50); ''approx. ¼ of the time'' (scale score 25); ''seldom'' (scale score 6); and ''never'' (scale score 0). The reply categories of the other questions were ''always'' (scale score 100), ''mostly'' (scale score 67), ''not very often'' (scale score 33), ''never'' (scale score 0), and ''not applicable'' (scale score 0). The social support scale was calculated as a mean of at least three non-missing items. Cronbach's alpha equalled 0.64 and the inter-item correlations ranged from 0.06 to 0.59. In the present study, a person was considered to have low social support if he belonged to the lowest quartile of the scale.

The scale for psychological demands was constructed on the basis of four questions: ''Is you workload so extensive that you have no time to talk about or think of anything but the work?'', ''Does your work require that you concentrate all your attention on the work?'', ''Do you carry out work tasks which may be of risk to other people's or your own health or result in a substantial loss of profit if you make a mistake?'', and ''Do you think that your work is associated with a large enough field of responsibility?''. The first three of the questions could be answered with one of the following reply categories: ''almost all the time'' (scale score 100); ''approx. ¾ of the time'' (scale score 75); ''approx. ½ of the time'' (scale score 50); ''approx. ¼ of the time'' (scale score 25); ''seldom'' (scale score 6); and ''never'' (scale score 0). The reply categories of the last question were ''yes'' (scale score 0), ''no'' (scale score 0), and ''too much responsibility'' (scale score 100). The psychological demands scale was calculated as a mean of at least three non-missing items. Cronbach's alpha equalled 0.40 and the inter-item correlations ranged from 0.07 to 0.28. In the present study, a person was considered to have high psychological demands if he belonged to the highest quartile of the scale.

Seniority within the actual workplace was measured with the question: ''How many years have you been working at the company you are at now?''.

The study subjects were followed up for their first hospital contact with a circulatory disease (390–458, ICD-8; I00–I99, ICD-10) as the principal diagnosis in the time period 1991–2002. Dates of deaths, emigrations, and hospital contacts were used to calculate person-years at risk for each individual. Indirect standardisation was used to calculate an expected number of cases for each individual, which was adjusted for gender and five year age group, with all employees in the total population of Denmark as standard population.

Statistical analysis

We used log linear Poisson regression with the expected number of cases as an offset to estimate relative risks for circulatory disease as a function of irregular work hours (yes/no) and a series of background variables. As such we included smoking status (never smoker, ex-smoker, current smoker (<15 g/day), current smoker (⩾15 g/)), baseline body mass index (BMI) in kg/m^2 (<20, 20–24, 25–29, ⩾30), passive smoking (yes/no), and the occupational factors: conflicts at work, ergonomic exposures, job insecurity, decision authority, social support, psychological demands, prolonged standing or walking, cold work environment, hot work environment, annoying noise, and monotonous repetitive tasks. All independent variables mentioned by Bøggild *et al*[11] were forced into the model as recommended by Raab[14] and Budtz-Jørgensen.[15] The model was also calculated for the subgroup which had at least three years' seniority.

We also calculated the aetiological fraction of shift work for circulatory disease. The proportion of exposed in this cohort was used to estimate the proportion of exposed in the Danish working population.

Sixty two of the observations were deleted due to missing values in at least one of the independent variables.

RESULTS

In total we observed 113 cases of circulatory disease among people with irregular work hours and 449 among those with a fixed day schedule. Details about the cohort was published in 2001.[11] Before adjusting for the occupational factors, the relative risk (RR) among people with irregular work hours compared to those with a fixed day schedule was 1.36 (95% CI 1.10–1.68). After the adjustment it decreased to 1.31 (95% CI 1.06–1.63) (table 2).

Table 2 also shows the fully adjusted estimated relative risk (RR) and 95% CI for each of the confounding factors in the fully adjusted model. Only three of the confounders reached statistical significance: ''many ergonomic exposures,'' ''job insecurity'', and ''body mass index''. There was no significant difference in the relative risk ratio between men (RR = 1.25; 95% CI 0.92–1.71) and women (RR = 1.33; 95% CI 0.98–1.81), nor was there any significant interaction between gender and the control variables (p = 0.12).

It may well be argued that the risk factors obesity and smoking are not confounders but rather steps in the causal chain. If so, they should not be controlled for. Leaving out control for BMI and smoking we found that the RR among those with irregular work hours was 1.33 (95% CI 1.07–1.65).

We did not control for socioeconomic status because it is an overall measure of all the exposures in the various status groups. When controlling for confounding factors one have to ensure that the factors are not overlapping (measure partly the same thing). With the many specific exposures included in our study we believe that by also including social status we would control some of the same factors twice. For a subgroup of workers with at least three years' seniority, the RR was 1.40 (95% CI 1.09–1.81) with control for all of the factors given in table 2. In order to make comparisons with former studies possible we also calculated the standardised incidence ratio for the 29 cases of IHD among the shift workers. It was 1.40 (95% CI 0.90–2.12) compared to day workers. The aetiological fraction of circulatory disease due to shift work was estimated to be 5%.

DISCUSSION

In this prospective study we found an increased risk of hospital treatment due to circulatory diseases among non-day workers compared to day workers.

A main strength of our prospective design is that exposure data are collected independently of the memory of the investigated people. The follow up time may be long enough to reduce healthy worker effect and short enough to avoid too much dilution of the contrast between the exposed subgroup

Table 2 Exposures in 1990 and relative risk (RR) and 95% confidence intervals (CI) for hospitalisation due to circulatory diseases (390–458, ICD-8; I00–I99, ICD-10), 1991–2002

Variable and level	n	RR	95% CI
Shift work			
Yes	927	1.31	1.06–1.63
No	4528	1.00	–
Annoying noise (⩾¼ of working hours)			
Yes	646	0.95	0.73–1.25
No	4809	1.00	–
Coldness (⩾¼ of working hours)			
Yes	1058	0.98	0.79–1.23
No	4397	1.00	–
Conflicts at work			
Yes	2166	1.16	0.97–1.38
No	3289	1.00	–
High cognitive demands			
Yes	1271	1.11	0.92–1.34
No	4184	1.00	–
Many ergonomic exposures			
Yes	1299	1.25	1.00–1.56
No	4156	1.00	–
Job insecurity			
Yes	1428	1.25	1.05–1.50
No	4027	1.00	–
Passive smoking (⩾¼ of working hours)			
Yes	1656	1.03	0.86–1.25
No	3799	1.00	–
Monotonous repetitive tasks (⩾½ of working hours)			
Yes	1992	0.92	0.76–1.11
No	3463	1.00	–
Low decision authority			
Yes	1268	0.90	0.72–1.11
No	4187	1.00	–
Heat (⩾¼ of working hours)			
Yes	562	0.89	0.67–1.19
No	4893	1.00	–
Walking or standing at work (almost all the time)			
Yes	2029	1.14	0.94–1.38
No	3426	1.00	–
Low social support			
Yes	1429	0.99	0.82–1.19
No	4026	1.00	–
Baseline BMI			
BMI<20	690	0.63	0.41–0.96
20⩽BMI<25	3261	0.70	0.50–0.97
25⩽BMI<30	1262	0.77	0.55–1.09
BMI⩾30	242	1.00	–
Smoking status			
Never smoker	1940	0.97	0.78–1.21
Ex-smoker	966	0.92	0.71–1.17
Current smoker (<15 g/day)	1114	1.08	0.85–1.37
Current smoker (⩾15 g/day)	1435	1.00	–

of the cohort and the unexposed segment. Another strength is that the reference group is respondents with day work only. Analysis based on the Nurses Health Study cohort indicated the importance of length of exposure time.[16] It showed an adjusted relative risk of 1.21 (95% CI 0.92–1.59) among women reporting less that six years and 1.51 (95% CI 1.12–2.03) among women reporting six or more years of rotating shift work. It is a weakness that we have no information about length of employment on shift. This shortcoming tends to bias the result towards unity. However, we had information about how many years respondents had worked in their present workplace, and analysis of the subgroup with at least three years seniority in the workplace resulted in a higher estimate than for the whole group. This finding supports the thesis that the excess risk is due to shift work exposure.

We had no information regarding prevalent circulatory diseases or treatment relevant for circulatory diseases. Instead we used first treatment in the follow up period, so prevalent cases were not excluded at baseline unless they were indirectly excluded due to death or non-response. Furthermore, this restriction tends to bias the results towards unity. The eldest members of our cohort are most likely to be hospitalised due to a circulatory disease, but those workers may already have left shift work at baseline because of maladaptation. Finally we used circulatory diseases as the end point rather than ischaemic heart disease or myocardial infarction. This is likely to have diluted the result because some of the included diagnosis may have risk factors other than ischaemic heart disease.

As it is often assumed that smoking and weight gain are a result of shift work, we reanalysed our data leaving those two variables out. Only a very small increase in the risk estimate was seen. It may be that the assumption that shift work is associated with an increase in weight is mostly based on cross-sectional analysis. The few prospective studies in the field tell a more complicated story. Van Amelsvoort *et al*[17] found an increase in smoking but no increase in BMI after one year of shift work. In a former study based on the same cohort as the present study, Hannerz *et al* found no significant increase in BMI over a five year period which could be attributed to shift work.[18] Furthermore, the study showed that job insecurity and suboptimal psychological demands will increase the likelihood of weight gain among obese employees, whereas they will increase the likelihood of weight loss among employees with low BMI.

All in all, none of these shortcomings are likely to explain away our finding of an excess risk among the shift workers.

Former studies are inhomogeneous in their conclusions. How do we explain the different results? Case referent studies are often subject to recall bias when they rely on self-reported exposures, especially when dealing with heart disease, because workers may find it difficult to continue with hard labour for a long time before a circulatory disease is diagnosed. Case control studies regarding shift work and heart diseases have, however, avoided the pitfall of recall bias by using personnel records and other files instead of self reported exposures.[7 19] The lowest relative risk estimate was found by Steenland *et al* in 1996 in a nested case control study labelled a pilot study by the authors.[20] The most likely explanation for the unexpected result is lack of power. Another study showing a low risk was based on data from the Copenhagen Male Study established in 1970–71. At 14 companies in Copenhagen covering the railway, public road construction, military, post, telephone, customs, national bank, and medical industries, all men between 40 and 59 years of age were invited. At baseline, those workers who had difficulties with adaptation to shift work were therefore unlikely to be found among the active shift workers. All participants worked in the Danish capital. The study was thus far from representative for the working age population of Denmark. A different risk estimate in the two studies will, however, only occur if the composition of work tasks is so different that it influences the risk of ischaemic heart disease. The authors have not found any dilution effect of the 22 years of follow up.[21] A possible explanation for the relatively low risk is that have, for many years, participated in a study cohort of fitness and risk of cardiovascular disease in which they have been subject to clinical measurements and exercise tests. The population may therefore be more aware of any early signs of CHD and risk factors for CHD and the importance of a healthy lifestyle.

Three of the four studies reporting the highest risk estimates used a design with aggregated data.[7–9] The known weaknesses of the studies with aggregated data are that the

Main message

- Shift work may carry an excess risk of circulatory diseases.

Policy implications

- Shift work should be limited and scheduled in such a way that the circadian rhythms are disturbed as little as possible.

exposure contrast is reduced because the shift work groups include unexposed workers and workers with little exposure. We should therefore expect results biased towards unity. Another weakness is that only a few confounders could be controlled, i.e. age and gender. As we have seen, some relevant confounders like job insecurity account for some of the apparent risk, but uncontrolled confounding is unlikely to explain all the difference in risk estimates.

Tenkanen *et al* reanalysed data from Helsinki Heart Study.[22] Comparing all the shift workers with all the day workers and adjusting for age, they found an RR of 1.5 (95% CI 1.1–2.1). In line with our findings they saw a small decrease to 1.4 in RR when adjusting for lifestyle factors, Thirty one per cent of the study population was receiving treatment with gemfibrozil. Analysis showed that the treatment had a better effect on the shift workers than on the day workers. Therefore the risk estimates for all workers may underestimate the true risk. Further analysis on the same database showed that shift work seems to trigger the effects of lifestyle risk factors like smoking, obesity, and sedentary work.[23]

Behavioural variables like BMI and smoking are possible links in the causal chain. BMI is strongly related to circulatory diseases but weakly related to the work environment.[18] Therefore we have also calculated the risk of leaving BMI and smoking out of the model.

Shift work is becoming more common in many countries, but that does not mean that prevention is impossible. For instance, an intervention study including 101 nurses and nurses' aides showed that better ergonomic scheduling of shift work in hospital wards was followed, after six months, by a higher high-density lipoprotein cholesterol level and a decrease in total cholesterol level and in the total:HDL cholesterol ratio.[24]

In conclusion, we found that this study adds to a growing body of evidence suggesting that shift work carries an excess risk of circulatory diseases.

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REFERENCES

1 **Nurminen M**, Karjalainen A. Epidemiologic estimate of the proportion of fatalities related to occupational factors in Finland. *Scand J Work Environ Health* 2001;**27**:161–213.
2 **Åkerstedt T**, Knutsson A, Alfredsson L, *et al*. Shift work and cardiovascular disease. *Scand J Work Environ Health* 1984;**10**:409–14.
3 **Kristensen TS**. Cardiovascular diseases and the work environment: a critical review of the epidemiologic literature on nonchemical factors. *Scand J Work Environ Health* 1989;**15**:165–79.
4 **Kristensen TS**. Cardiovascular diseases and the work environment. An update. In: Cheremisinoff P, ed. *Encyclopedia of environmental control technology*. New York: Gulf Publishing. 1994:217–43.
5 **Harrington JM**. Shift work and health—a critical review of the literature on working hours. *Ann Acad Med Singapore* 1994;**23**:699–705.
6 **Bøggild H**, Knutsson A. Shift work and cardiovascular disease—evidence and risk factors: an overview. *Scand J Work Environ Health* 1998;**25**:85–99.
7 **Steenland K**, Fine L, Belkic K, *et al*. Research findings linking workplace factors to CVD outcomes. *Occup Med* 2000;**15**:7–68.
8 **Alfredsson L**, Karasek RA, Theorell T. Myocardial infarction risk and psychosocial work environment: an analysis of the male Swedish working force. *Soc Sci Med* 1982;**16**:463–7.
9 **Alfredsson L**. Myocardial infarction and environment. Use of registers in epidemiology. *Acta Med Scand Suppl* 1985;**698**:1–24.
10 **Tüchsen F**. Working hours and ischaemic heart diseases in Danish men. A 4-year cohort study of hospitalization. *Int J Epidemiol* 1993;**22**:215–21.
11 **Bøggild H**, Burr H, Tüchsen F, *et al*. Work environment of Danish shift and day workers. *Scand J Work Environ Health* 2001;**27**:97–105.
12 **Karlsson B**, Alfredsson L, Knutsson A, *et al*. Total mortality and cause-specific mortality of Swedish shift- and dayworkers in the pulp and paper industry in 1952–2001. *Scand J Work Environ Health* 2005;**31**:4–10.
13 **Burr H**, Bjorner JB, Kristensen TS, *et al*. Trends in the Danish work environment and their associations with labor-force changes. *Scand J Work Environ Health* 2003;**29**:270–9.
14 **Raab GM**. Selecting confounders from covariates. *Journal of the Royal Statistical Society Series A – Statistics in Society* 1994;**157**:271–83.
15 **Budtz-Jørgensen E**, Keiding N, Grandjean P, *et al*. Consequences of exposure measurement error for confounder identification in environmental epidemiology. *Stat Med* 2003;**22**:3089–100.
16 **Kawachi I**, Colditz GA, Stampfer MJ, *et al*. Prospective study of shift work and risk of coronary heart disease in women. *Circulation* 1995;**92**:3178–82.
17 **van Amelsvoort LG**, Schouten EG, Kok FJ. Impact of one year of shift work on cardiovascular disease risk factors. *J Occup Environ Med* 2004;**46**:699–706.
18 **Hannerz H**, Albertsen K, Nielsen ML, *et al*. Occupational factors and five-year weight change among men in a Danish national cohort. *Health Psychol* 2004;**23**:283–8.
19 **McNamee R**, Binks K, Jones S, *et al*. Shiftwork and mortality from ischaemic heart disease. *Occup Environ Med* 1996;**53**:367–73.
20 **Steenland K**, Fine L. Shift work, shift change, and risk of death from heart disease at work. *Am J Ind Med* 1996;**29**:278–81.
21 **Bøggild H**, Suadicani P, Hein HO, *et al*. Shift work, social class, and ischaemic heart disease in middle aged and elderly men; a 22 year follow up in the Copenhagen Male Study. *Occup Environ Med* 1999;**56**:640–5.
22 **Tenkanen L**, Sjöblom T, Kalimo R, *et al*. Shift work, occupation and coronary heart disease over a 6-year period. *Scand J Work Environ Health* 1997;**23**:257–65.
23 **Tenkanen L**, Sjöblom T, Härmä M. Joint effect of shift work and adverse life-style factors on the risk of coronary heart disease. *Scand J Work Environ Health* 1998;**24**:351–7.
24 **Bøggild H**, Jeppesen HJ. Intervention in shift scheduling and changes in biomarkers of heart disease in hospital wards. *Scand J Work Environ Health* 2001;**27**:87–96.