Long-Term Psychosocial Work Environment and Cardiovascular Mortality among Swedish Men

ABSTRACT

Objectives. This study examined the effect of cumulative exposure to work organization—psychological demands, work control, and social support—on prospectively measured cardiovascular disease mortality risk.

Methods. The source population was a national sample of 12 517 subjects selected from the Swedish male population by Statistics Sweden in annual surveys between 1977 and 1981. Over a 14-year follow-up period, 521 deaths from cardiovascular disease were identified. A nested case-control design was used. Work environment exposure scores were assigned to cases and controls by linking lifetime job histories with a job exposure matrix.

Results. Conditional logistic regression analysis was used in examining cardiovascular mortality risk in relation to work exposure after adjustment for age, year last employed, smoking, exercise, education, social class, nationality, and physical job demands. In the final multi-variable analysis, workers with low work control had a relative risk of 1.83 (95% confidence interval [CI] = 1.19, 2.82) for cardiovascular mortality. Workers with combined exposure to low control and low support had a relative risk of 2.62 (95% CI = 1.22, 5.61).

Conclusions. These results indicate that long-term exposure to low work control is a risk factor for cardiovascular disease mortality. (*Am J Public Health.* 1996;86:324–331)

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Introduction

Over the past 2 decades, studies have examined the relationship between the organization of work and cardiovascular morbidity and mortality.[1–5] A consistent finding is that the psychosocial factors of high psychological job demands and low control over the work process are associated with excess cardiovascular disease.[6–12] Studies have found that the high demand–low control combination ("job strain") is associated with elevated blood pressure,[13–18] elevations in patterns of neurohormonal arousal,[17,19] left ventricular mass increases,[13] increases in ventricular ectopic activity,[20] coronary heart disease,[6,9,11] myocardial infarction,[7,8,10,12] and cardiovascular disease mortality risk,[6,21] in addition to a number of cardiovascular disease risk factors.[22–24]

Research on the psychosocial work environment has also examined the modifying effects of work social support on the stress and health relationship.[25–27] The absence of coworker social support may interact with job strain to further increase the risk of cardiovascular disease morbidity[28,29] and mortality[24] and total mortality.[30]

However, these findings are contradicted by several studies in which either no association was found between job strain and adverse health outcomes or the directionality of the association was contrary to that hypothesized.[31,32] Methodological differences in design and in measurement of exposure may explain this contradiction. Research has been limited with respect to causal inference because, with few exceptions, the time-dependent nature of the exposure process has not been adequately conceptualized, measured, or investigated.[33–37]

Exposure status has been determined either through self-reported questionnaires[6,10,11,13,17,21,28] or by occupationally representative scores derived from national samples that have been attributed to subjects in another data set.[7,8,12,14,22] In both instances, the exposure score merely reflects the job held at the time of interview. Thus, earlier studies implicitly assumed either that work organization exerts acute, proximal effects on disease risk or that the exposures associated with all past occupations were similar to those associated with the job held at the time of the interview. Job strain has been shown to have acute effects on the cardiovascular system that are mediated by the sympathetic adrenal medullary release of catecholamines and subsequent increase in heart rate and ambulatory blood pressure during the working day. Whether these acute reactions translate into long-term accumulative effects is not yet known, although several recent studies have shown that cumulative exposure is associated with an excess risk of chronic disease.[21,37]

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This paper was accepted October 24, 1995.

Editor's Note. See related editorial by Fine (p301) in this issue.

Assuming that all past exposure conditions are similar to the current occupation is not justified given the degree of job change and career mobility present in modern industrial societies. The present study was specifically designed to address the effect of long-term and cumulative exposure to psychosocial work characteristics on prospective cardiovascular disease mortality risk.

Methods

Study Population

The study group, consisting of 12 517 currently or previously employed Swedish men 25 to 74 years of age, was taken from a random sample of the entire Swedish population obtained by Statistics Sweden from the National Registry of Births. The present group combined four of these annual samples (1977, 1979, 1980, 1981). Statistics Sweden collected information from the men in personal interviews performed by professional interviewers. (The 1978 annual survey did not include information on occupational history and was not used.) The average response rate was 80% over the 4 years. This population has been described extensively elsewhere.[21,23,28,38]

Cardiovascular Outcome Measure

Mortality was obtained by linking study group records to the National Death Registry for the years 1977 through 1990. Cardiovascular mortality was analyzed by combining all deaths for arteriosclerotic heart disease, cerebrovascular disease, and peripheral vascular disease (all years were standardized to *International Classification of Diseases* [8th edition; ICD] codes, 400 through 404, 410 through 414, 427, 430 through 436, and 440 through 445). These ICD codes have been used in previous studies of job strain and cardiovascular disease mortality because the pathophysiological effects of stress exposure have been hypothesized to adversely affect the process of atherosclerosis, the most significant underlying source of both ischemic and cerebrovascular-related mortality.[1] During the follow-up period, there were 521 deaths attributed to cardiovascular disease.

Measuring Work Environment Exposure

Occupational histories were obtained for each subject by Statistics Sweden. The three-digit international occupation code was used in coding each job held by subjects. Job history was limited to the past five occupations held by the subjects for at least 2 years, beginning with the current or most recent occupation. No information was available during follow-up. In the interview, a distinction was made between a job, or a position with a particular firm, and the more general occupational career. Individuals remaining in the same three-digit job category were considered to have kept the same job, even though they might have changed firms. This study focused on 25 years of history in a group of older men who generally have already achieved career stability. Occupational history information was available for 96% of the total person-years of this 25-year period.

Psychosocial and physical exposure scores were assigned by linking each subject's occupational history with a work organization exposure matrix. The matrix was used to assign scores for work control, psychological job demands, social support, physical demands, and job hazards to each year of the subject's career.[39,40] (Details of the construction and validation of this exposure matrix have been described previously.[39,40]) Use of job exposure matrices was initiated in occupational epidemiology to retrospectively assess exposure intensities over time in studies of chemical agents.[41,42] Although other psychosocial inference systems have been used successfully in Europe,[43] and the United States,[44] they lack an important dimension: exposure time.

The work organization exposure matrix was developed from individual responses about work organization and physical environment in the job held at the time of the Statistics Sweden interviews in 1977 and 1979 (n = 12 084). Mean scores were derived for work control, psychological job demands, work social support, physical job demands, and job hazards for 262 occupations. These scores were calculated separately by sex, age, and duration of employment in each of 262 specific occupations. The scores were linked to each subject's occupational history and assigned to each year of working life corresponding to the variety of specific occupations held. Thus, by linking each subject's three-digit history records with the work organization exposure matrix, sex-, age-, and duration-specific job variables (described below) were assigned to each year of employment in each occupation over the course of the subject's career. As subjects grew older, gained more occupational experience, and/or changed from one occupation to another, different scores were assigned to their exposure record. We were able to successfully link the matrix with 98% of the research subjects. Two hundred eighty-five individuals were removed from the analysis because of errors in the coding of jobs (nonexistent codes were incorrectly assigned).

Five work environment variables from the work organization exposure matrix were used in this study: work control (a 12-item indicator measuring decision authority and skill discretion on the job), psychological job demands (a 2-item indicator measuring time pressure and whether the job is mentally strenuous), work social support (a 4-item indicator measuring the availability of social interaction in the workplace), physical job demands (a 5-item indicator measuring the physical burdensomeness of the job), and job hazards (a 7-item indicator measuring exposure to gas, dust, mist, and temperature extremes). The psychometric properties of these scales have been reported elsewhere,[21,23,28,38,39,45] and the psychosocial measures have been shown to be predictive of cardiovascular disease and other forms of chronic illness.[21,23,37] The items used in the psychological job demand scale and the work control scale were identical to those used in previous studies of job strain and cardiovascular disease morbidity and mortality in Sweden.[6–8,21,28,29]

In a validation study, exposure levels derived from the work organization exposure matrix were found to be strongly correlated (average $r = .60$) with self-reported levels among the same individuals.[40] Matrix scores of these subjects were associated with a stepwise increase in morbidity with a potential stress-related etiology (cardiovascular disease, digestive and muscle skeletal disorders) similar to that observed when using the subject's own self-reported scores.[40] The matrix has also been applied to several epidemiological studies of the psychosocial work environment and cardiovascular disease.[14,46]

Data Analysis

A nested case–control design was used to analyze the data. Of the case subjects, 521 died as a result of cardiovascular disease. Incidence density sampling was used to select 2422 control subjects.[47,48] Five controls were randomly selected for each case subject from the risk set of subjects who were alive in the year that the case patient had died. Given the large number of strata in some cases,

TABLE 1—Proportional Distributions of Study Variables in Case and Control Subjects: 2943 Swedish Men

	Case Subjects (n = 521), %	Control Subjects (n = 2422), %	P
Age, y			.943
25–29	0.19	0.45	
30–34	0.58	0.50	
35–39	1.15	0.87	
40–44	1.34	1.94	
45–49	3.26	3.84	
50–54	6.91	6.65	
55–59	12.28	11.97	
60–64	18.23	19.45	
65–69	25.91	26.30	
70+	30.13	28.03	
Survey year			.926
1977	39.16	40.71	
1979	29.37	28.78	
1980	17.27	16.52	
1981	14.20	14.00	
Social class			.269
Nonmanual	40.19	42.83	
Manual	59.81	57.17	
Education			.507
Higher	14.97	16.14	
Basic	85.03	83.86	
Smoking			.001
No	55.16	68.99	
Yes	44.84	31.01	
Exercise			.002
Yes	77.72	84.34	
No	22.28	15.66	
Parents foreigners			.725
Yes	4.03	4.38	
No	95.97	95.62	
Control			.003
High	14.20	20.48	
Medium high	24.57	21.06	
Medium low	29.75	25.76	
Low	31.48	32.70	
Psychological job demand level			.026
Low	31.67	28.12	
Medium low	29.75	27.91	
Medium high	25.14	25.19	
High	13.44	18.79	
Level of social support			.266
High	19.39	20.77	
Medium high	28.21	31.17	
Medium low	27.45	26.47	
Low	24.95	21.59	
Level of job hazard exposure			.202
Low	22.84	26.88	
Medium low	29.75	29.60	
Medium high	24.38	23.41	
High	23.03	20.11	
Physical job demand level			.103
Low	17.27	21.10	
Medium low	27.83	29.23	
Medium high	37.04	32.54	
High	17.85	17.13	
Years since last worked			.799
0	16.31	17.55	
1	24.57	26.38	
2	7.87	8.30	
3	4.99	4.67	
4	7.49	7.56	
5	6.53	6.85	
6	5.76	5.66	
7	5.37	5.28	
8	5.57	5.53	
9	3.45	3.47	
10	2.30	2.06	
11+	9.79	6.69	

it was possible to obtain only 4 matched controls. The risk sets were also constructed so that each of the controls sampled would be matched to the case subject on the following combination of characteristics: year of survey (1977, 1979, 1980, 1981), chronological age at time of interview (ten 5-year age strata), and last year of employment. The matching variables were selected in order to adjust for varying latency periods that might bias or distort the effect estimates. Since a significant proportion of our sample had ceased working sometime before the beginning of the follow-up period, it was necessary to match case subject and controls on this varying period of time. The incidence density risk set matching method ensured that case subjects were compared with control subjects of the same age who terminated employment at the same time, began their mortality follow-up in the same year, and were followed up for the same period of time. Data were analyzed by means of conditional logistic regression; risk set matching was maintained in the analysis, following the methods suggested by Checkoway et al.[47] The odds ratios estimated with this approach are identical to effect estimates obtained with the proportional hazards model.[47–49]

Each work variable was divided into four quartile groups based on the distribution of that variable in the total study population: a reference category (the theoretically lowest exposure group), a medium low exposure group, a medium high exposure group, and a high exposure group.

Each subject's work history was summarized into cumulative exposure periods beginning with the most recent 5 years and moving backward in 5-year cumulative intervals (10, 15, 20, 25 years). A total exposure period (26+) was constructed by calculating a mean based on complete occupational history. The means of the exposure variables and the quartile assignments were recalculated as each additional interval was included. Although most of the men were constantly employed, the small proportion who were unemployed for one half or more of a cumulative exposure period were assigned a missing value for that entire period. During the total 25-year exposure period, it was possible for case and control subjects to have worked a maximum of 73 575 person-years (25 years × 2943). The actual number of person-years worked was 70 723 (96% of the maximum possible). No proportional differences in person-years worked were found when

TABLE 2—Conditional Logistic Regression Analysis: Adjusted Relative Risk Estimates for Cardiovascular Disease Mortality

Work Environment Variable	Exposure Quartile	5 RR	5 95% CI	10 RR	10 95% CI	15 RR	15 95% CI	20 RR	20 95% CI	25 RR	25 95% CI	26+ RR	26+ 95% CI
		Cumulative Exposure Period,[a] y											
Control	High	1.00		1.00		1.00		1.00		1.00		1.00	
	Medium high	1.68	1.14, 2.49	1.77	1.20, 2.62	1.74	1.17, 2.57	1.58	1.05, 2.38	1.56	1.04, 2.37	1.17	0.78, 1.77
	Medium low	1.56	0.99, 2.44	1.79	1.14, 2.81	1.65	1.07, 2.54	1.76	1.12, 2.76	1.82	1.16, 2.86	1.23	0.78, 1.93
	Low	1.46	0.95, 2.25	1.64	1.07, 2.52	1.51	0.98, 2.32	1.48	0.94, 2.32	1.53	0.97, 2.39	1.09	0.68, 1.74
Psychological demands	Low	1.00		1.00		1.00		1.00		1.00		1.00	
	Medium low	0.90	0.66, 1.24	1.01	0.74, 1.38	0.90	0.66, 1.51	1.00	0.73, 1.37	0.99	0.74, 1.33	0.79	0.58, 1.37
	Medium high	0.93	0.67, 1.26	0.88	0.64, 1.20	0.91	0.81, 1.24	1.04	0.76, 1.42	0.85	0.60, 1.88	0.73	0.51, 1.04
	High	0.76	0.52, 1.13	0.71	0.48, 1.05	0.66	0.44, 1.00	0.59	0.38, 0.91	0.61	0.39, 0.93	0.55	0.34, 0.88
Social support	High	1.00		1.00		1.00		1.00		1.00		1.00	
	Medium high	0.98	0.72, 1.34	1.14	0.83, 1.56	1.04	0.76, 1.42	0.90	0.66, 1.23	1.14	0.82, 1.59	1.09	0.78, 1.52
	Medium low	0.89	0.64, 1.25	0.86	0.62, 1.20	0.86	0.62, 1.21	0.84	0.60, 1.17	0.99	0.71, 1.38	1.11	0.80, 1.55
	Low	0.96	0.68, 1.37	1.08	0.76, 1.54	1.10	0.72, 1.56	1.03	0.72, 1.47	1.16	0.81, 1.64	1.06	0.74, 1.51
Hazards	Low	1.00		1.00		1.00		1.00		1.00		1.00	
	Medium low	1.16	0.83, 1.62	1.14	0.82, 1.62	1.04	0.74, 1.51	1.12	0.79, 1.59	1.14	0.82, 1.67	1.27	0.86, 1.88
	Medium high	1.42	0.96, 2.10	1.31	0.89, 1.94	0.86	0.83, 1.83	1.39	0.94, 2.06	0.99	0.88, 1.92	1.16	0.75, 1.79
	High	1.39	0.94, 2.06	1.28	0.85, 1.93	1.10	0.83, 1.90	1.33	0.88, 2.01	1.16	0.92, 2.08	1.37	0.87, 2.15
Physical demands	Low	1.00		1.00		1.00		1.00		1.00		1.00	
	Medium low	1.06	0.72, 1.57	1.08	0.73, 1.60	0.96	0.65, 1.42	0.96	0.65, 1.42	1.11	0.75, 1.64	1.00	0.65, 1.54
	Medium high	1.18	0.79, 1.74	1.19	0.80, 1.76	1.25	0.84, 1.88	1.22	0.81, 1.84	1.26	0.82, 1.94	1.18	0.75, 1.85
	High	1.24	0.76, 1.57	1.15	0.70, 1.88	1.05	0.64, 1.72	1.14	0.70, 1.86	1.22	0.76, 1.96	1.03	0.63, 1.68

Note. The conditional logistic regression analysis encompassed each work environment exposure variable across all of the 5-year exposure intervals. Relative risk estimates were adjusted for age, year last worked, survey year, smoking, exercise, education, social class, and nationality. RR = relative risk; CI = confidence interval.
[a]Duration of exposure period before the date of the survey or most recent occupation.

TABLE 3—Dichotomous Multivariable Conditional Logistic Regression Analysis: Adjusted Relative Risk Estimates for Cardiovascular Disease Mortality

Cumulative Exposure Period,[a] y	Control[b] RR	Control[b] 95% CI	Psychological Demands[c] RR	Psychological Demands[c] 95% CI	Social Support[b] RR	Social Support[b] 95% CI	Hazards[d] RR	Hazards[d] 95% CI	Physical Demands[d] RR	Physical Demands[d] 95% CI
	Work Environment Variable									
5	1.60	1.06, 2.41	0.95	0.71, 1.24	1.00	0.75, 1.34	1.14	0.79, 1.65	0.84	0.55, 1.45
10	1.83	1.19, 2.82	0.93	0.71, 1.22	1.09	0.81, 1.46	1.07	0.74, 1.46	0.82	0.52, 1.29
15	1.83	1.19, 2.82	0.88	0.67, 1.16	1.05	0.78, 1.41	1.03	0.70, 1.52	0.76	0.47, 1.22
20	1.71	1.11, 2.63	1.01	0.75, 1.36	0.93	0.69, 1.25	1.16	0.78, 1.72	0.75	0.47, 1.20
25	1.68	1.04, 2.69	0.88	0.66, 1.18	1.16	0.86, 1.56	1.15	0.76, 1.74	0.79	0.47, 1.32
26+	1.10	0.67, 1.80	0.76	0.47, 1.02	1.10	0.79, 1.53	1.32	0.79, 2.20	0.82	0.46, 1.45

Note. All five work exposures were considered simultaneously. Relative risk estimates were adjusted for age, year last worked, survey year, smoking, exercise, education, social class, and nationality. RR = relative risk; CI = confidence interval.
[a]Duration of exposure period before the date of the survey or most recent occupation.
[b]The low, medium low, and medium high quartile groups were combined and compared with the high quartile group.
[c]The medium low, medium high, and high quartile groups were combined and compared with the low quartile group.
[d]The medium low, medium high, and high quartile groups were combined and compared with the low quartile group.

case subjects were compared with controls. Although 19% of case subjects and controls had been unemployed on at least one occasion during the previous 25 years, more than 90% had worked at least 23 years out of 25. Periods of unemployment, for the most part, occurred during transitions from one occupation to another.

As a data reduction step for the final multivariable analysis, work variables were dichotomized such that the reference category for each variable was compared with the combination of the other three exposure quartiles. The effect estimates for these three quartiles demonstrated an approximate homogeneity of effect across strata. The contrasts for the variables are indicated in the footnotes of Table 3.

These dichotomous exposure variables were introduced into a multivariable model to consider the effect of all five work exposures simultaneously.

Interactions were examined by including the following two-way interaction terms in the model: high psychological job demands and low work control, high psychological job demands and low social support, and low social support and low work control. These interaction terms were selected a priori on the basis of the theoretical predictions of the demand–control and demand–control–support models.[6,28]

All of the conditional logistic models at each stage of the analysis were stratified on age, survey year, and years since last worked. In addition, five variables were introduced in all models as covariates: social class (nonmanual vs manual), education (basic vs higher), smoking (smoker vs nonsmoker), physical exercise (sedentary vs fitness-promoting exercise at least twice a week), and nationality (parents non-Swedish nationals or otherwise). The measurement of these variables has been described in detail elsewhere.[45,46]

Results

The proportional distributions and differences in the baseline characteristics between case and control subjects are shown in Table 1. There were no statistically significant differences between the case and control subjects in age distribution, survey year, social class, education level, nationality, or years since last worked. Case subjects were significantly more likely to be daily smokers and were less likely to engage in fitness-promoting exercise. In terms of work exposure characteristics, Table 1 shows a comparison of the proportions of case and control subjects falling into the four quartiles of 25-year cumulative exposure variables. Statistically significant differences were found for the work control and psychological job demand variables.

The adjusted odds ratios and 95% confidence intervals (CIs) for each exposure variable by 5-year cumulative exposure intervals are shown in Table 2. The relative risk for work control and cardiovascular disease mortality was consistently and significantly elevated. The general pattern of the findings suggests that high levels of work control are protective relative to all other quartiles. In particular, the relative risks for the two middle quartiles relative to the high control quartile were found to range from 1.56 to 1.82. While the relative risk for the lowest control quartile was also found to be elevated, it was not consistently significant across all exposure periods.

Significant elevations in risk for lower levels of work control were found in each 5-year cumulative exposure interval except the 26+ category. (This variable, based on the total number of years of exposure information available on each subject, was not found to be significantly associated with elevated cardiovascular disease risk.) Furthermore, the relative risks for work control were largely homogeneous across cumulative exposure intervals.

Statistically significant associations were found for psychological job demands. The directionality of this association was repeatedly found to be opposite that predicted by the demand–control formulation: higher levels of psychological job demands were found to be inversely associated with cardiovascular disease risk. In four of the six cumulative exposure intervals examined, the highest level of psychological job demands was found to involve the lowest level of cardiovascular disease mortality risk. These statistically significant relative risks ranged in magnitude from 0.55 to 0.66. As distinct from the findings for work control, the exposure variable for the total measured life course was associated with the lowest risk. No significant associations between work social support, physical job demands, job hazards, and cardiovascular disease mortality were observed.

The results of the full conditional logistic regression model with the five dichotomous work characteristics (considered simultaneously after adjustment for the five covariates and stratification on age, year last worked, and survey year) are shown in Table 3. The effect of work control on cardiovascular disease risk remained significantly elevated above 1.00 when other work variables were included. The relative risk for work control defined as a dichotomous variable ranged from 1.60 to 1.83. As in the earlier stage of the analysis (Table 2), no significant effects were found in the total measured exposure period (26+ years). Psychological job demands were not found to be statistically significant in the multivariable model. Social support, job hazards, and physical job demands were also found not to be associated with cardiovascular disease mortality risk.

After the three two-way interaction terms had been introduced into the combined main effects model, the only statistically significant interaction was that between social support and work control. Workers exposed to both low control and low support for 25 years had relative risk of 2.62 (95% CI = 1.22, 5.61) for cardiovascular disease mortality relative to those exposed to comparable durations of high control and high support. The excess risk for the low support and low control combination was 78% greater than the multiplicative estimate derived from the main effects logistic regression model.[50] No significant interaction effects were found for any combination that included psychological job demands.

Discussion and Conclusions

This study was designed to address several methodological and conceptual problems in the work stress field that House and colleagues[36] and we[40] had previously suggested: (1) most studies are cross sectional with no prospective component; (2) both outcome variables and measures of job characteristics are often based on self-reports, and therefore associations between the two could be due to methodological similarity; (3) valid health outcome data are often lacking; (4) small samples have been studied that are not representative of larger populations and are often restricted to male workers; (5) research has been restricted to relatively healthy employed workers, and thus those who might have already left the labor force as a result of the adverse health effects of work-related exposures would not be sampled; and (6) long-term exposure data are lacking in most studies.

The current study addressed a number of these limitations. The study sample was representative of the working and nonworking Swedish male population. It involved a prospective design with 14 years of follow-up for cardiovascular disease mortality. Exposure status was not based on self-report but was estimated and assigned with objective data derived from the work organization exposure matrix. Subjects did report individual occupational history, which, in validation studies performed by Statistics Sweden,[51] has been found to be quite accurate. Although the current study was restricted to men, we have also examined the effects of work exposure on Swedish women in other investigations.[52–54]

The clearest finding of this study is that men exposed to lower control jobs have a substantial and statistically significant elevated risk for cardiovascular disease mortality relative to men with a work history of high control jobs. Excess cardiovascular disease mortality risk associated with exposure to lower levels of work control persisted after adjustment for social class, education, smoking, exercise, nationality, age, and other adverse psychosocial and physical work organization characteristics. To our knowledge, this is the strongest evidence to date supporting the hypothesis that low work control is a risk factor for cardiovascular disease mortality. Indeed, the relative risks for low control reported here may be underestimates of true risk in that we adjusted for smoking and exercise, which may be part of the causal pathway leading to cardiovascular disease (as suggested by several recent studies[22,24]). Other biomedical risk factors, such as elevated blood pressure, were not adjusted; however, since research has strongly suggested that elevated blood pressure is in the causal pathway between job strain (or low work control) and cardiovascular disease, controlling for it would represent overcontrol and an underestimation of risk.

It is unlikely that this association is merely due to social class position because occupational class and educational level were introduced as covariates in all logistic models. Moreover, when physical job demands and hazardous exposures (variables that are strongly associated with occupational class position) were introduced into the multivariable model, the relative risk estimates for work control were not affected. Adjustments for major cardiovascular disease risk factors that vary by class, such as smoking and exercise, did not explain away the excess risk associated with low work control.

The findings for psychological job demands were not consistent. This variable was found to be protective when considered by itself in the quartile analysis; when the other work exposure variables were introduced in the final multivariable model, however, the relative risk became nonsignificant. No statistically significant interactions between psychological demand and work control or social support were found. These findings are not consistent with earlier studies that have used the identical demand indicator. Other studies have found both significant cardiovascular disease risks associated with elevated levels of psychological job demands and significant interactions of this variable with social support and work control.[6,10,21,28] Earlier studies that have used imputed occupational averages of this demand measure have found associations with cardiovascular disease, but of a lower magnitude than those studies that have used the self-reported version.[7,8] It should be noted, too, that frequently demands are combined with control, making it difficult to ascertain the degree to which psychological demands, in and of themselves, contribute to the excess risk for cardiovascular disease.

These earlier studies also were confined to the demands associated with the subject's most current occupational experience, whereas the present study examined the impact of exposure over a working life. The disparity in findings may be due to differences in exposure measurement. More generally, the relative differences in the degree of exposure misclassification may have affected the extent to which each variable emerged as a cardiovascular disease risk factor in this study. Since misclassification is likely to be nondifferential, relative risk estimates are likely to be underestimated. Our earlier analysis does suggest, however, that misclassification may be more severe for psychological job demands and social support than it is for work control, physical job demands, and job hazards.[40]

In our view, the initial psychometric properties of the 2-item psychological job demand scale make this instrument a less robust one than our study's 12-item work control scale. Because the demands indicator is subjectively worded ("Is your job psychologically demanding?" and "Is your job hectic?"), it may be less amendable to use in an exposure imputation system designed to measure environmental differences. Recently, a study that used the US imputed demand and control scores also found a pattern similar to that reported here: an excess cardiovascular disease risk associated with low control but not with high demands.[55] Clearly, one practical conclusion of this study is that the basic measurement of the demand construct should be improved.

Although the findings of this study do not support all of the specific theoretical predictions of the job strain model, the central importance of work control as a significant risk factor for cardiovascular disease is underscored. Previous studies indicate that approximately 15% to 25% of the working population can be characterized as being in the high strain risk group.[3,21] The etiological fraction for job strain in Swedish men has previously been estimated to be from 7% to 16% for cardiovascular disease, depending on the age group investigated.[3(p152)] In contrast, in this study 75% of the Swedish male population may be seen to be at some risk for cardiovascular disease mortality relative to the "protected" 25% in high control occupations. The etiological fraction[56,57] for low work control in this study was substantially greater: 35%. Thirty-five percent of cardiovascular deaths in those working from the 1950s to the early 1980s may have been attributable to cumulative exposure to low control working conditions.[56] The magnitude of this attributable risk and the consistently elevated relative risks for low control indicate that previous studies may have underestimated the health effects of adverse work organization. The strong main effects of control may have been more apparent in this study because of the long-term cumulative measure of exposure and the sustained period of follow-up.

The concept of work control has been of central importance in a number of theoretical formulations in the occupational stress field.[58–64] It is an essential dimension linking research on social inequalities in health to occupational epidemiology.[65,66] Social and psychobiological researchers such as Gardell and Frankenhaeuser suggested, nearly 2 decades ago, that work control is a fundamental component of the stress process.[62,63] The results of this study support the view that control over the work process is an important, if not critical, component of a healthy work environment. □

Acknowledgments

This research is part of a collaboration involving the Johns Hopkins School of Hygiene and Public Health, Statistics Sweden, and the Swedish National Institute for Psychosocial Factors and Health. It has been jointly funded by the Swedish Work Environment Fund, project number 88-0416 (grant 89-0303), and the US National Heart, Lung and Blood Institute (grant HL39633).

We gratefully acknowledge the methodological and programming contributions of Tsung-Shan Tsou, PhD, of the Department of Biostatistics and Hsin-Chieh Yeh of the Department of Epidemiology, Johns Hopkins School of Hygiene and Public Health.

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Errata

In: Weisner C, Greenfield T, Room R. Trends in the treatment of alcohol problems in the US general population, 1979 through 1990. *Am J Public Health.* 1995:85:55–60.

In Table 1, ".0" was incorrectly added to integer-rounded percentages in the "Total Sample" column.

Regarding the results for married subjects, those results reported in Table 4 are correct; however, the abstract and text should have read "*Unmarried* persons were twice as likely as *married* persons to have been treated."

In: Warbasse JP. What is the matter with the medical profession? *Am J Public Health.* 1996;86:108–109. Voices from the Past.

The academic degree listed for Donald W. Light, who submitted the Warbasse essay for publication, should have been PhD, not MD.