Association Between Job Strain Status and Cardiovascular Risk in a Population of Taiwanese White-Collar Workers

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Using data from a survey of a white-collar working population in Taiwan (438 women, 526 men), the relation between job strain status and cardiovascular risk factors (high serum total cholesterol, low serum high-density lipoprotein (HDL) cholesterol, and high plasma fibrinogen) was examined. Job strain indicators, defined by Karasek’s model, included psychological demand and decision latitude. Blood pressure, cholesterol and fibrinogen were analyzed as continuous variables, whereas psychological demand and decision latitude were dichotomized into 2 levels and job strain into 4 exposure categories. Plasma fibrinogen was significantly and positively associated with job strain status in both male and female workers and also with decision latitude in female workers only. No consistent association between job strain status and total serum and HDL cholesterol was detectable. In conclusion, plasma fibrinogen is a possible intermediate factor linking occupational stress to elevated cardiovascular risk. (Jpn Circ J 2001; 65:509–513)

Key Words: Cholesterol; Fibrinogen; Job strain; Occupational stress

Mental stress is considered a risk factor for the development of cardiovascular disease (CVD)1,2 and the role of occupational stress in the etiology of CVD has recently received considerable attention. Occupational stress, in Karasek’s job strain model, is defined by the work environment and the extent to which it allows an individual to modify the stress response. The concept holds that stress is caused by an imbalance between the demands on a worker and the worker’s ability to modify those demands. Low decision-making control coupled with high job demands leads to high strain or to a stressful situation because together these 2 factors have more impact than either factor alone.

Workers reporting a high level of job strain have been found to have elevated risks of psychological distress and psychosomatic and physical health complaints.4–8 Several observational studies have found that occupational stress is associated with an increased risk for CVD.6–8 For example, Haan et al, using 10-year follow-up data from 902 Finnish factory workers, found that those with high job strain had a coronary heart disease odds ratio of 5.0 relative to those with low job strain after adjusting for gender, age, serum cholesterol, systolic blood pressure, smoking, alcohol consumption, and relative body weight? A longitudinal study conducted by Johnson et al found that the incidence ratios were 1.8 for CVD morbidity and 2.0 for mortality among employed Swedish men with high job strain compared with those with low job strain, after adjusting for several risk factors for CVD10

The association between job strain and the prevalence of hypertension has been studied in Western populations as well as among Japanese white-collar workers.19 However, disturbance of thrombogenic processes and lipid metabolism caused by stress might be other possible pathways underlying the observed association between occupational stress and the increased risk for CVD.20–26 Not many studies have examined these potential pathways and most of them have been conducted only in Western populations of male workers. However, there may be differences between genders and culture-related work values in perception of job characteristics or attitudes to the job.27,28 This study examined the associations between job strain status and a number of cardiovascular (CV) risk factors (high serum total and low serum high-density lipoprotein (HDL) cholesterol and high plasma fibrinogen) using data from a representative sample of white-collar workers in Taiwan.

Methods

Subjects
A cross-sectional study was conducted in Taipei City, Taiwan from September 1997 to August 1998. A total of 1,185 white-collar workers aged 18–65 working more than 40 working hours per week in 3 private insurance companies were invited to participate through announcements in the internal newsletters and a personalized e-mail of invitation to each worker; almost all were professionals, technicians, managerial or clerical workers. Non-respondents were contacted by telephone. Among the recruited, those who were pregnant (n=11) or taking medication for hypertension or cardiovascular diseases (n=70), which might lead to modification of regular health behaviors, were excluded. Those missing data on the lipid or fibrinogen profiles (n=6) or on the job strain status (n=8) were also excluded. The final study sample comprised 964 (438 female, 526 male) white-collar workers, an overall participation rate of 79%.

When compared, there were no differences between study subjects and subjects excluded for missing data in gender, job category, levels of serum total cholesterol, HDL cholesterol, plasma fibrinogen, and scores of job strain status.
Cardiovascular Risk Factors

After overnight fasting, blood specimens were collected by venous puncture in the company clinics and handled according to normal clinical practice for analyses of plasma fibrinogen, total and HDL cholesterol. Immediately after specimen collection, vials were stored under appropriate conditions, refrigerated (4–8°C), or frozen (–20°C) until they were shipped to a single analytical laboratory for testing. Serum total cholesterol level was measured using enzymatic procedures on a multianalyzer (Technicon RA-500, Bayer Corp, Tarrytown, NY, USA). Serum HDL cholesterol level was analyzed enzymatically by magnesium chloride-dextran sulfate precipitation of apoprotein B-containing lipoproteins. Plasma fibrinogen was measured by a functional assay29 in an automatic coagulometer autoanalyzer (Instrumentation Laboratory, Lexington, MA, USA).

Job Strain Indicators

A self-administered questionnaire embedded with the Karasek job strain model3 and its measures was used to measure workers' perception of job strain (ie, psychological demands and decision latitude). Psychological demands were measured by a 5-item scale including quantity of work, quality of work, intellectual requirements, conflicting demands, and time constraints. Decision latitude was measured by an 8-item scale including skill discretion factors (learning new things, skill development, skill requirement, task variety, repetition, creativity requirement) and decision authority factors (freedom of making decisions, choice of ways to perform work). All questions were scored on a Likert scale of 1 to 5. Scale reliability was acceptable for ways to perform work). All questions were scored on a Likert scale of 1 to 5. Scale reliability was acceptable for psychological demands (Cronbach's \( \alpha =0.80 \)), and psychological demands (Cronbach's \( \alpha =0.76 \)). The exposure to psychological demand and decision latitude were determined by the median of the distribution of the total score in each gender respectively of the study population. This procedure allowed participants to be classified into 4 categories.

(1) Those exposed to a combination of high psychological demand and low decision latitude had high job strain status (PD+DL+).
(2) Those exposed to high psychological demand but having high decision latitude had active job strain (PD+DL+).
(3) Those exposed to low psychological demand but with low decision latitude had passive job strain status (PD–DL–).
(4) Those with low psychological demand and high decision latitude had low job strain (PD–DL–).

Sociodemographic Variables and Other CV Risk Factors

Demographic information, job category, and health-related behavior data were collected during interviews and used as covariates to control for potential confounding. Demographic variables included gender, number of years of education completed and age at examination. The health-related behaviors included smoking and alcohol consumption. Weight and height were measured during a physical examination before blood specimen collection. The body mass index was calculated from weight and height using the equation: BMI=weight(kg)/height(m)\(^2\). Blood pressure was measured by trained nurses after subjects had been seated for 10min using a mercury manometer and appropriately sized cuffs, according to standard protocols. The mean value of blood pressure was then calculated with the blood pressure measurements.

Statistical Analysis

Descriptive statistics including mean value, standard deviations, and percentages were used to summarize the cardiovascular risk factors, job strain indicators, job categories, sociodemographic variables of the study samples. Gender comparisons were adjusted for age by analysis of covariance for continuous variables and by the Mantel-Haenszel Test for categorical variables.

To test the association of job strain status and cardiovascular risk factors, analyses were conducted separately for male and female workers. Analysis of variance (ANOVA) was employed to compare the mean values of total, HDL cholesterol and plasma fibrinogen between groups with different job strain status. In each comparison, the group with low job strain status was used as the referent group. Multiple linear regression was used to adjust for all covariates of interest in testing the differences in mean values.

All statistical tests were 2-tailed. The significance level was set at a probability of less than 0.05. All data in this study were analyzed by the Statistical Package for Social Sciences version 10.0 (SPSS Inc, Chicago, IL, USA).

Results

The characteristics of the study sample are presented in Table1 and Table2 shows the unadjusted mean value of plasma fibrinogen, serum total and HDL cholesterol as well as sociodemographic variables and other cardiovascular risk factors in the 4 different job strain categories. Table 3 presents the average plasma fibrinogen, adjusted for all covariates of interest, for the referent category of psychological demand, decision latitude, and job strain status and the differences in mean plasma fibrinogen levels for each category. We found plasma fibrinogen was significantly and positively associated with job strain status in both male and female workers and with decision latitude in female workers only. In the comparison of serum total and HDL cholesterol after adjustment for all covariates of interest, we found no significant difference in mean values for psychological demand, decision latitude, or job strain status.

Discussion

The present cross-sectional analyses of the data from a representative sample of the white-collar working population in Taiwan support the existence of a significant relation between job strain status and plasma fibrinogen. No association between job strain status and serum total or HDL cholesterol was detectable.

The observed association is supported by the stress–response pathophysiologic link. The stress response involves 2 neuroendocrine systems: the sympathoadrenal medullary system, which secretes the catecholamines, and the pituitary–adrenal cortical system, which secretes corticosteroids such as cortisol. Under demanding conditions where the organism can exert control in the face of controllable and predictable stressors (analogous to the PD+DL+ group), the level of catecholamines increases, but cortisol decreases.30–32 In low demand–low control situations (analogous to the PD–DL group), cortisol elevates whereas the level of catecholamines is only mildly elevated.30 However, in demanding low control situations (analogous to the PD+DL group), both catecholamines and cortisol are elevated.30–32 Elevated levels of both catecholamines and cortisol have
Table 1 Characteristics of the Study Subjects

<table>
<thead>
<tr>
<th>Heart Disease Risk Factors</th>
<th>Men (n=526)</th>
<th>Women (n=438)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibrinogen (mg/dl)</td>
<td>242.4 (1.5)</td>
<td>237.5 (1.4)</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>194.6 (34.2)</td>
<td>189.2 (35.8)</td>
</tr>
<tr>
<td>HDL cholesterol (mg/dl)</td>
<td>46.5 (1.4)</td>
<td>49.8 (1.2)</td>
</tr>
</tbody>
</table>

Job strain indicator (%)
- High (PD+DL–): 21.7 vs. 20.4
- Active (PD+DL+): 28.7 vs. 26.3
- Passive (PD–DL–): 30.4 vs. 32.9
- Low (PD–DL+): 19.2 vs. 20.4

Table 2 Unadjusted Mean Values of Health Characteristics by Job Strain Status

<table>
<thead>
<tr>
<th>Job strain status</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low PD–DL+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibrinogen (mg/dl)</td>
<td>242.5 (1.2)</td>
<td>192.7 (34.7)</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>244.6 (1.3)</td>
<td>195.9 (38.4)</td>
</tr>
<tr>
<td>HDL cholesterol (mg/dl)</td>
<td>46.1 (1.2)</td>
<td>40.3 (1.8)</td>
</tr>
</tbody>
</table>

Sociodemographic variables and other cardiovascular risk factors
- Age (years): 44.6 (8.2) vs. 42.3 (9.0)
- No. years of schooling: 14.4 (3.1) vs. 12.6 (2.4)*
- Body mass index (kg/m²): 24.7 (1.6) vs. 24.5 (1.2)
- Alcohol use (drinks/day): 1.2 (0.7) vs. 0.5 (0.5)*
- No. cigarettes smoked per day: 9.4 (5.6) vs. 2.1 (1.3)*
- Mean blood pressure (mmHg): 115.2 (5.2) vs. 93.4 (7.8)*

* p value <0.05 for comparison with men. † Mean; numbers in parentheses, standard deviation. HDL, high-density lipoprotein; PD, psychological demand; DL, decision latitude.

Table 3 Difference in Mean Values for Plasma Fibrinogen (mg/dl) Adjusted by All Covariates in Interest Among Groups Defined by Psychological Demand, Decision Latitude, and Job Strain Status

<table>
<thead>
<tr>
<th>Psychological Demand (PD)</th>
<th>Men (n=256)</th>
<th>Women (n=438)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size (no.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean¹</td>
<td></td>
<td></td>
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<tr>
<td>Difference±SE</td>
<td></td>
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</tr>
</tbody>
</table>

* p value <0.05. † Age, education, body mass index, smoking, alcohol use, job category, and mean blood pressure were adjusted for using multiple linear regression. Mean fibrinogen was calculated for the regressions using mean values of all covariates. ‡ Reference group in comparison of differences in mean values; § SE, standard error.
severe consequences for cardiovascular pathology, and this link is consistent with the association between catecholamine levels and coagulation possibly through the stimulation of thrombocyte adhesion by catecholamines.

The effect of poor job strain status on the well-established CV risk factors may explain, at least in part, the association between occupational stress and increased CVD risk observed in previous studies. Plasma fibrinogen is a well-established CV risk factor that promotes early plaque formation through damaging the endothelial cells of artery linings, stimulating the proliferation of vascular muscle cells, and activating inflammatory cell. Fibrinogen also plays an important role in thrombosis by influencing platelet adhesion and aggregation. Thus, it is possible that plasma fibrinogen serves as an intermediate variable linking occupational stress and elevated CVD risk.

This study has several important characteristics. First, it was conducted in a representative sample of white-collar working men and women. The response rate was reasonably high (78%), which therefore limited the potential of selection bias. Participants having conditions that could lead to modification of health behaviors were excluded, which limited the potential of information bias. Second, statistical analyses were performed with adjustment for a number of potential confounders. Covariates such as age, mean blood pressure, educational attainment, job category, cigarette smoking, alcohol use and body mass index were included, which limited confounding bias.

It also needs to be kept in mind that this study may be subject to several limitations. The observed association between job strain status and plasma fibrinogen generally supports the existence of a possible pathway that links occupational stress to CVD. However, differences in genetic predisposition for variations in plasma fibrinogen concentrations could not be taken into account. The cross-sectional design could result in information bias and selection bias, which could lead to either over- or underestimation of the true association. Lack of evaluation of the effect of job strain duration due to cross-sectional data used could lead to an underestimation of the true association. The use of a self-administered questionnaire to measure job strain may subject to response bias. However, no reliable objective measurement of occupational stress is available. Perceptual measure of job strain may be a better indicator than some external stressors that might not be perceived or felt like stressors by workers. Objective formulation of the questionnaires used in this study is also an appropriate way to focus.

In this study, psychological demand, decision latitude and job strain levels were not found to be associated with serum total and HDL cholesterol, which is consistent with previous studies that used Karasek's job strain measure or other measures of psychosocial factors at work.

In this study, plasma fibrinogen was found to be associated with job strain status and decision latitude in female workers and job strain status in male workers. The highest mean values for men and women were found in the category with high job strain. This is consistent with previous studies in Western populations, which have reported that job strain is related to high plasma fibrinogen levels and that low perceived job control is associated with higher concentrations of plasma fibrinogen in women. Lack of reward has also been shown to be associated with high plasma fibrinogen levels among middle managers when using boredom and lack of reward as measures of occupational stress. However, job strain has not been associated with fibrinogen in other studies in Western populations, nor in a recent study performed in a Japanese population. The differences in results could be attributed to differences in the questionnaires and to racial factors. The finding of an association with low decision latitude and not psychological demand is also consistent with a previous study which proposed that the association between decision latitude and plasma fibrinogen was more consistent than the association between psychological demands and plasma fibrinogen, and those that argued that psychological demands did not necessarily predict CVD.

Gender seemed to play a role in the association between job strain and plasma fibrinogen in the present study, which accords with a previous study. In male subjects, when decision latitude was defined by the highest quartile and this group was compared with the other 3 quartiles, decision latitude was significantly associated with plasma fibrinogen after adjustment of covariates of interest. Difference of cut off points between men and women for discriminating an increased risk may be responsible. Job category discrepancy may be another reason. An inversely graded association was observed between occupational class and coronary heart disease risk in a Swedish study. It could also be due to demographic difference because the education level attained by women is lower when compared with men. Previous studies found an association between job strain and physical conditions in lower social classes. Unpaid work at home as well as paid employment imply longer working hours for women and a previous study indicated that home stress may be more important than job stress.

Some unknown physiological mechanisms may also result in a biological gender difference in response to job strain.

It is also noteworthy that the results cannot be generalized. Our sample was small and not representative of the general population. The difference in plasma fibrinogen mean values was small and some associations may have appeared by chance in our analyses. This finding requires deeper analysis and replication in other designs and settings to establish its validity. Not many cohort studies so far have evaluated the relation between occupational stress and CV risk factors and even fewer among Asian populations. Further data will be collected on a longitudinal basis for this study population of white-collar workers to evaluate the long-term effect of job strain exposure.

In conclusion, this study suggests that poor job strain status is associated with elevated plasma fibrinogen, which may explain the link between occupational stress and increased CVD risk.

References

Job Strain and Cardiovascular Risk Factors

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