Job strain, social support in the workplace, and haemoglobin A1c in Japanese men

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Abstract

***Objectives*—To examine the association between job strain (defined in the model of job demands and job control) and social support at the workplace with levels of glycosylated haemoglobin A1c (HbA1c)**

***Methods*—All male employees aged 40–60 in a manufacturing firm, Japan, were invited to take part in the study. A blood sample was taken from the participants and HbA1c (%) was measured. Job strain and social support at the workplace were assessed with the job content questionnaire (JCQ). After excluding those who had a history of diabetes mellitus or other chronic diseases, data from 268 male day workers were analyzed.**

***Results*—Age adjusted average concentrations of HbA1c were significantly higher in the highest quartile group of job strain or the lowest quartile group of social support at the workplace ($p<0.05$). Multiple linear regression analysis indicated that job strain was significantly and positively related to HbA1c ($p<0.05$), whereas social support at the workplace was significantly and negatively related to HbA1c ($p<0.05$), both after controlling for other covariates.**

***Conclusions*—Greater job strain and lower social support at the workplace may be associated with increased concentrations of HbA1c. Increased blood glucose may be a physiological mediator between job strain or social support at the workplace and coronary heart disease.**

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Keywords: job strain; social support; glycosylated haemoglobin; Japan

Psychological job strain, which is defined as the combination of greater psychological job demands and lower job control in the job strain model[1 2] has been linked to coronary heart disease (CHD) and its risk factors.[2 3] Recent findings from the Whitehall II study[4 5] have suggested that job control is more important for predicting CHD, although these findings may be attributable to the limited variety in job strain among civil servants. Several biological or physiological mechanisms have been tested—including blood pressure, plasma fibrinogen, and sympathetic nervous functioning—to assess hypotheses proposed about the effects of job strain on CHD.[3] Job strain was also found to be associated with increased blood pressure in a non-Western country, Japan.[6]

Several studies have reported that stressful working conditions were associated with increased concentrations of glycosylated haemoglobin (HbA1c) in non-diabetic populations.[7–9] This is the most abundant minor component of haemoglobin in normal red cells and is formed slowly and continuously throughout the lifespan of the red cell, by the attachment of glucose to the N-terminus of the β-chain followed by the irreversible Amadori rearrangement.[10] The proportion of HbA1c in total haemoglobin (%) is considered to be an integrated measure of blood glucose concentrations during the previous 2–4 months.[10] Concentrations of HbA1c have been used as a measure of glycaemic control among diabetic patients, as well as a possible screening test for undetected diabetes mellitus, as it is not affected by the duration since the last meal.[10] Concentrations of HbA1c are mainly determined by glucose metabolism[11] but are also affected by other factors—such as body fat distribution[12] and smoking.[13] Cesane *et al* reported that concentrations of HbA1c were higher in blue collar workers under stressful working conditions than in clerks.[7] We found that a composite index of job dissatisfaction and poor human relations positively correlated with concentrations of HbA1c in white collar workers.[8] Netterstrom *et al* examined an association between job strain and concentrations of HbA1c in a cross sectional study and found that concentrations of HbA1c were higher in high strain occupations as previously classified on the basis of the model of job demands and job control.[9] The finding is not convincing because the study did not show an association between job strain reported by individual workers and concentrations of HbA1c. A sustained increase in blood glucose, which is reflected in increased concentrations of HbA1c, is considered to be one of the possible mechanisms linking job strain defined in the model of job demands and control to CHD.[3] However, to date, the association between job strain defined in the model of job demands and job control and increased concentrations of HbA1c is not clear.

Epidemiological studies have also suggested that social support at the workplace is inversely associated with the incidence of CHD, either as a main effect or a buffering effect on job strain,[14–16] although some studies failed to show this.[4] Although previous studies reported that lower social support at the workplace was associated with increased blood pressure,[17] plasma fibrinogen,[18] and hyperlipidaemia,[19] findings still conflict and are insufficient to clarify the

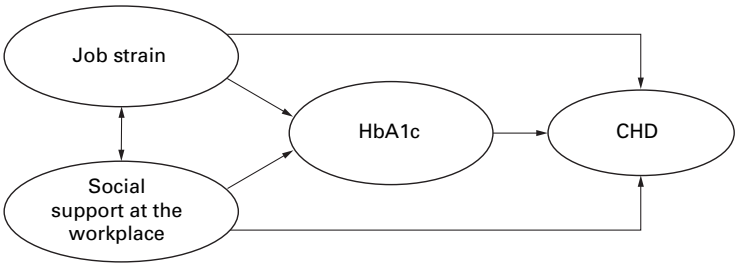

Figure 1 A possible mediating effect of glycosylated haemoglobin (HbA1c) on the relation between job strain or social support at the workplace and coronary heart disease (CHD).

possible underlying mechanism between social support at the workplace and CHD. Increased concentrations of mean blood glucose may again be a possible factor linking social support at the workplace with CHD. But the hypothesis has not yet been tested.

To examine HbA1c as a possible mediating variable linking job strain as defined in the model of job demands and job control[1] and social support at the workplace with CHD (figure), we conducted a cross sectional study of middle aged male employees in Japan. In this study, we investigated the association between job strain and social support at the workplace, assessed by a well standardised measure,[20] with HbA1c, after controlling for other relevant factors that may be associated with increased concentrations of HbA1c. We also used two methods of assessing job strain[21] and related each of them to concentrations of HbA1c to see the robustness of the association between job strain and HbA1c.

Subjects and methods

SUBJECTS

Among all male employees aged 40–60 (n=521) working at an electrical equipment manufacturing company, 516 received a medical check up and had a blood sample taken. We did not include women because of the few female employees (n=20) in this age group. At the same time, a posted questionnaire was sent to each subject to collect information on job strain, social support at the workplace, and other covariates. The procedures were fully explained to the subjects before the survey, and written consent was obtained. A total of 447 (90% of subjects who received the medical check up) agreed to participate and returned the questionnaire. Because of the few rotating shift workers (n=31), we limited further analyses to the 416 day workers. We excluded subjects who had a history of diabetes (n=32), heart disease (n=12), cerebrovascular diseases (n=3), any cancer (n=4), hyperlipidaemia (n=11), or hypertension (n=53). Among 301 who had no history of these chronic conditions, 19 had at least one missing response to questions on job strain or social support at the workplace and 14 had a missing response to other covariates. We excluded these 33 subjects. The data of the remaining 268 subjects who had no medical history of chronic conditions and no missing responses in the questionnaire were analyzed. These subjects were younger than those who were excluded because of a medical history of chronic conditions (n=115) and missing responses to relevant questions (n=33): the mean (SD) ages were 46.6 (5.1), 49.1 (5.2), and 48.2 (5.6) years old, respectively.

MEASUREMENT OF HbA1c

HbA1c was measured by an automatic analyzer (Daiichi Kagaku, Kyoto, Japan) by high performance liquid chromatography.[10]

ASSESSMENT OF JOB STRAIN AND SOCIAL SUPPORT AT THE WORKPLACE

The questionnaire included four scales of the job content questionnaire (JCQ)[20 22] to assess job strain and social support at the workplace: job demands, job control, support of supervisors, and support of coworkers. The Japanese version of the scales showed acceptable levels of reliability and validity in previous studies.[23 24] Cronbach's α reliability coefficients for the scales ranged from 0.61 to 0.89 for men and from 0.65 to 0.87 for women; also, the scales showed factor based validity, with distributions of the scale scores across age groups and occupations being in an expected direction. The job strain score was calculated as a ratio of the job demands score to half the job control score. Here, dividing the job control score by 2 was to adjust for the difference in score ranges between the job demands scale (12–48) and the job control scale (24–96). This procedure has been used in seven previous studies which yielded significant associations between job strain with risk factors for myocardial infarction and CHD.[3] An alternative formulation of job strain, job demands score minus half of the job control score,[21] was also used in a subsequent analysis to assess the robustness of the association between job strain and HbA1c. As in previous studies,[21] we used a total score of social support at the workplace by adding the scores from support of the supervisors and the co-worker, because these two scales closely correlated with each other (r=0.44).

OTHER COVARIATES

Other covariates included age, occupation, obesity, alcohol consumption, smoking, total energy intake, physical activity, and family history of diabetes mellitus. Obesity was measured by the body mass index (kg/m^2). Subjects were asked about the number of drinks that they consumed a week, where one drink consisted of about 9 g of pure ethanol. They were also asked to report the number of cigarettes that they usually smoked a day. The total energy intake was estimated with a 31 item food frequency dietary questionnaire[25] and estimated in kcal/day. A single question was used to assess the the subject's usual frequency of leisure time physical exercise a month during the previous year. The subjects were also asked about family history of diabetes mellitus among any first degree relative.

STATISTICAL ANALYSIS

Age adjusted mean concentrations of HbA1c were compared among four quartiles classified on the basis of scores of job demands, job control, social support at the workplace, or job

Table 1 Age, occupation, job content questionnaire (JCQ) scale scores, other covariates and glycosylated haemoglobin A1c (HbA1c) among 268 employed men aged 40–60 who had no history of diabetes mellitus or other chronic diseases in a manufacturing firm in Japan

Variable	*Mean (SD, range)*	*n (%)*
Age	46.6 (5.1, 40–60)	
Occupation:		
Managers		111 (41)
Professional workers		34 (13)
Technical workers		39 (15)
Clerks		42 (16)
Mechanics		14 (5)
Machine operators		28 (10)
JCQ scales:		
Psychological job demands	33.5 (5.6, 12–48)	
Job control	74.0 (11.3, 30–96)	
Worksite social support	22.5 (3.2, 8–32)	
Job strain*	0.92 (0.18, 0.50–1.82)	
Covariates:		
Body mass index (kg/m^2)	22.7 (2.5, 16.6–29.8)	
Drinks a week (n)	7.7 (8.1, 0–49)	
Cigarettes smoked a day (n)	9.5 (11.5, 0–60)	
Total energy intake (kcal/day)	2897 (682, 1334–5877)	
Leisure time physical exercise (times/month)	2.0 (3.1, 0–26)	
Family history of diabetes mellitus (any first relative)		28 (10)
HbA1c (%)	4.86 (0.32, 3.9–5.8)	

*Job strain was calculated as a ratio of job demands to job control (job demands score divided by half the job control score).[21]

*Table 2 Age adjusted mean concentrations of glycosylated haemoglobin A1c (%) by the groups classified on the basis of job demands, job control, job strain, or worksite social support among 268 employed men aged 40–60 who had no history of diabetes mellitus or other chronic diseases in a manufacturing firm in Japan**

Variable†	*Subjects (n)*	*Age adjusted mean (%)*	*Multivariate adjusted mean (%)*
Job demands:			
Lowest	58	4.81	4.82
Second lowest	61	4.87	4.89
Second highest	96	4.86	4.85
Highest	53	4.86	4.88
p Value for difference (p for trend)		0.747 (0.521)	0.584(0.495)
Job control:			
Lowest	77	4.91	4.89
Second lowest	68	4.80	4.84
Second highest	63	4.89	4.88
Highest	60	4.79	4.81
p Value for difference (p for trend)		0.067 (0.150)	0.058 (0.226)
Job strain:‡			
Lowest	71	4.76	4.78
Second lowest	63	4.83	4.84
Second highest	67	4.91	4.90
Highest	67	4.91	4.91
p Value for difference (p for trend)		0.027 (0.004)	0.006 (0.008)
Worksite social support:			
Lowest	77	4.91	4.92
Second lowest	77	4.86	4.85
Second highest	75	4.81	4.83
Highest	39	4.79	4.80
p Value for difference (p for trend)		0.116 (0.017)	0.040 (0.041)

*Age adjusted mean was estimated with analysis of covariance (ANCOVA) controlling for age as a continuous variable. For multivariate adjusted average, age, body mass index, smoking, alcohol consumption, daily energy intake, leisure time physical exercise, and family history of diabetes were controlled for.
†The subjects were classified into four quartiles on the basis of each variable.
‡Job strain was calculated as a ratio of job demands to job control (job demands score divided by half the job control score).[21]

strain, with an analysis of covariance (ANCOVA) controlled for age as a continuous variable. Multivariate mean concentrations of HbA1c were also compared between the groups with ANCOVA, after controlling for all covariates (age, body mass index, smoking, alcohol consumption, family history of diabetes, daily energy intake, and physical exercise). To assess the buffering effect of social support at the workplace for the relation between job stain and HbA1c, ANCOVA was also used to test for a significant interaction between these two variables. Multiple linear regression analysis of concentrations of HbA1c was conducted with the job strain score, the social support at the workplace score, and the covariates as independent variables. We also calculated Spearman's partial rank correlation between the job strain score or the social support at the workplace score and HbA1c, after controlling for the covariates. We conducted a similar multiple linear regression and calculated Spearman's partial rank correlation coefficients, using an alternative definition of job strain—job demand score minus half the job control score.[21] These analyses were conducted with SAS version 6.12 on a PC (PROC GLM, REG, and CORR).[26]

Results

Mean age, distribution of age, occupation, JCQ scores, and other covariates among the 268 subjects are shown in table 1. Significant differences in mean concentrations of HbA1c were found among the groups classified on the basis of job strain score after controlling for age and all the covariates (table 2). Subjects in the highest quartile of job strain had higher concentrations of HbA1; a significant dose-response relation between job strain and HbA1c was found. Multivariate adjusted mean concentrations of HbA1c were significantly different between the groups classified on the basis of social support at the workplace. Subjects in the highest quartile of social support at the workplace had lower concentrations of HbA1c; a significant negative dose-response relation was found between social support at the workplace and HbA1c after controlling for age and all the covariates. Mean concentrations of HbA1c were slightly different among the groups classified on the basis of job control, but the trend was not significant.

The interaction between job strain (four quartiles) and social support at the workplace (four quartiles) by ANCOVA was not significant (df=9, p=0.503), after controlling for all covariates. When we used dichotomous categorisations—that is, highest versus others for job strain and lowest versus others for social support at the workplace—a marginally significant interaction between job strain and social support at the workplace (df=1, p=0.079) was found with a significant main effect of social support at the workplace (df=1, p=0.031) and a marginally significant main effect of job strain (df=1, p=0.091), after controlling for all covariates: the adjusted mean concentrations of HbA1c were 5.01% for a group with highest job strain and lowest social support at the workplace and 4.83%–4.85% for other combinations.

Multiple linear regression analysis indicated that job strain was significantly and positively related to concentrations of HbA1c after controlling for other covariates (table 3). Social support at the workplace was significantly and negatively related to concentrations of HbA1c. Age, body mass index, alcohol consumption, smoking, and frequency of physical activity during leisure time were significantly correlated with concentrations of HbA1c. Spear-

Table 3 Association between job strain or worksite social support and concentrations of glycosylated haemoglobin A1c (%) among 268 male employees aged 40–60 who had no medical history of diabetes mellitus or other chronic diseases in a manufacturing firm in Japan: multiple linear regression analysis

Variable	Regression coefficient (standard error)	Standardised regression coefficient	p Value
Age (y)	0.015 (0.004)	0.237	0.000
Job strain*	0.424 (0.206)	0.118	0.041
Worksite social support*	−0.012 (0.006)	−0.122	0.033
Body mass index (kg/m^2)	0.030 (0.007)	0.227	0.000
Alcohol consumption (drinks/week)	−0.006 (0.002)	−0.146	0.010
Smoking (cigarettes/day)	0.003 (0.002)	0.117	0.044
Daily energy intake (kcal/day)	−0.019 (0.027)†	−0.040	0.484
Leisure time physical activity (times/month)	−0.013 (0.006)	−0.126	0.027
Family history of diabetes mellitus‡	0.109 (0.059)	0.104	0.067
Multiple R^2	0.210		

*Scores were entered as a continuous variable. Job strain was calculated as a ratio of job demands to job control (job demands score divided by half the job control score).[21]
†Regression coefficient for a change of 1000 kcal/day was shown.
‡Coded as 1 for any first degree relative; 0 for none.

man's partial rank correlation between job strain score and HbA1c was 0.163 (p=0.009) after controlling for the social support at the workplace score and the covariates (age, body mass index, alcohol consumption, smoking, daily energy intake, physical activity, and family history of diabetes). Spearman's partial rank correlation between the score for social support at the workplace and HbA1c was –0.119 (p=0.056) after controlling for job strain and the covariates. When a multiplication term of job strain and social support at the workplace was added to the equation in table 3, it was not significant (p=0.675).

When we used an alternative formula for job strain, job demands score minus half job control score, multiple linear regression analysis indicated that job strain was significantly and positively related to HbA1c (R=0.006; SEM 0.003; p=0.045), whereas social support at the workplace was significantly and negatively related to HbA1c (R=–0.013; SEM 0.006; p=0.028). Spearman's partial rank correlation coefficients with HbA1c were 0.160 (p=0.010) and –0.119 (p=0.056) for this definition of job strain and social support at the workplace, respectively, after controlling for other covariates. When a multiplication term for this assessment of job strain and social support at the workplace was added to the multiple linear regression equation, it was not significant (p=0.669).

Discussion

The present study showed that the levels of job strain defined in the model of job demands and job control[1 2] were positively associated with concentrations of HbA1c in Japanese middle aged male employees. This is consistent with previous findings that concentrations of HbA1c were higher in high strain occupations[9] and other findings about the association between general job stress and HbA1c.[7 8] Netterstrom *et al*, on the other hand, did not show an association between job strain and HbA1c in individual people.[9] This may be attributable to the fact that their study sample was selected from both sexes, as the effects of job strain on risk factors for CHD were less clear in a sample of women.[27] In our study, as predicted by the model of job demands and control, the ratio of job demands to job control showed a significant positive association with HbA1c. A similar association was consistently found when an alternative definition of job strain (job demands minus half job control)[21] was used, which shows the robustness of the association between job strain and HbA1c, as previously reported for blood pressure.[21] It is suggested that job strain is associated with increased HbA1c or mean concentrations of blood glucose. Job control was slightly more but not significantly associated with HbA1c than was job demands. Job control may be the more important of these two factors. Although it is thought that increased concentrations of HbA1c predict the onset of CHD among diabetic patients,[28 29] there is still no direct evidence linking HbA1c with CHD in a non-diabetic population. However, it has been suggested that HbA1c is associated with the development of arteriosclerosis.[30] Glucose intolerance is considered to have a central role in increasing the risk of cardiovascular disease.[31] Our findings suggest that increased HbA1c or blood glucose concentration is a possible mediating factor for the relation between job strain and CHD.[3]

Social support in the workplace was significantly and negatively related to concentrations of HbA1c. The present study also suggested that social support in the workplace is associated with decreased concentrations of HbA1c. Despite the previous published negative association between social support in the workplace and CHD,[11–13] previous studies reported no clear association between social support in the workplace and blood pressure or serum total cholesterol.[6 21 32] Increased concentrations of HbA1c or blood glucose might be a possible factor accounting for the relation between social support in the workplace and CHD. We, as in previous studies, did not show a significant buffering effect of social support in the workplace on job strain, with the quartile categorisations or the continuum scores.[14–16 21] We found a marginally significant interaction between job strain and social support at the workplace and HbA1c, with dichotomous categorisations focusing on the highest quartile of job strain and the lowest quartile of social support at the workplace. The buffering effect of social support at the workplace may be more obvious for extreme categories of job strain or social support. Our research should be replicated by research with more subjects.

Concentrations of HbA1c in our study sample were within the normal range (<6.0%), and we excluded known cases of diabetes mellitus. The finding is thus unlikely to be attributable to symptoms or disability due to diabetes. We found that the association between job strain or social support in the workplace and HbA1c was independent of personal life habits, such as obesity, alcohol consumption, smoking, total energy intake, and physical activity. Psychological distress stimulates release of catecholamines and cortisol, which, in turn, increase blood glucose.[33] There is evidence that anger and hostility are associated with increased concentrations of HbA1c in non-diabetic working men.[34] Job strain and lower social support in

the workplace have been associated with affective and psychosomatic symptoms,[2 3 35] whereas job strain (or lower job control) and a poor social network have been linked to increased concentrations of catecholamines in plasma and urine.[36–38] The association between job strain or social support at the workplace and increased concentrations of HbA1c might be explained by such a pathway linking mood changes, counterregulatory hormones, and increased blood glucose.

From the comparison of standardised regression coefficients in table 3, job strain and social support at the workplace seem to have an equal contribution to concentrations of HbA1c, which is equal to that of leisure time physical activity and about half of the contribution of body mass index. On the other hand, a difference in mean HbA1c among the groups classified on the basis of job strain or social support at the workplace was not large, 0.11% or 0.13%, respectively, even between the two extreme categories. Previous studies reported that the 10 year risk of mortality from CHD increased by 10% for every 1% increase in HbA1c among diabetic patients.[28] If this were applicable to a non-diabetic population, the difference in HbA1c in our study might explain only a small increase (about 1%) in mortality from CHD. However, the small difference found may also be attributable to measurement errors and time dependent variability of job strain, social support at the workplace, or HbA1c. The degree of contribution of HbA1c to the risk of CHD associated with job strain or social support at the workplace should be examined in future research with more reliable, repeated measurements of job strain, social support at the workplace, and HbA1c.

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