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Original investigation

A Cross - Sectional Analysis of The Association of Job Strain with Metabolic Syndrome and 10-Year Risk of Coronary Heart Disease

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Abstract

Objective: Beside the well-established biological and behavioral risk factors, psychosocial factors have been accepted as important risk factors for coronary heart diseases (CHD). While there is abundant evidence for the association between job strain and CHD in developed countries, more research needed on this association in developing countries. This study aims to examine the association between job strain and the risk of CHD and metabolic syndrome among the 30–64-year-old employed individuals.

Methods: This is a population-based cross-sectional study. The study sample was derived randomly from the employed individuals aged between 30 and 64 participated in baseline Balcova Heart Study. Karasek's demand-control-support questionnaire was applied to measure job strain. Presence of metabolic syndrome and Framingham risk score were main dependent variables. 191 female and 216 male participants were included in the analyses. Pearson chi-square test, ANCOVA and logistic regression analyses were used.

Results: Women were found to have higher education levels, have more white-collar jobs, and have better economic status perception than men. 20% of men and 18% of women have been working in high-strain jobs. There was significant association of job strain with neither the Framingham risk score nor metabolic syndrome. The adjustments for education, age, and occupation did not alter the results. The interaction between the social support and job strain was also not significant.

Conclusion: Job strain did not have an impact on both the Framingham risk score and metabolic syndrome. Although psychosocial factors are known as important risk factors for CHD in developed countries, the evidence in developing countries is scarce.

Keywords: job strain, coronary heart disease, metabolic syndrome, social support

INTRODUCTION

Although cardiovascular disease (CVD) death rate considerably declined in all high income and some middle-income countries between 1990 and 2015, it remains the leading cause of death globally, causing 17.9 million deaths worldwide in 2015 (1).

In the last 60 years, the trends in the epidemiology of coronary heart disease (CHD) were; the decrease in the mortality of CHD in developed countries, which is in tandem with the increase in the socioeconomic differences of CHD, specifically in developed countries; and the increase of CHD in developing countries (2). In Turkey, there is a declining trend in CVD since 1994. However, despite the decline, Turkish CVD mortality rates are still ranked in the top quartile in Europe both for men and women (3).

Today, beside the well-established biological and behavioral risk factors, psychosocial factors are accepted as important risk factors for CHD (4). Specifically, psychosocial factors at work are considered to be one of the explaining variables of socioeconomic gradient in cardiovascular health, since the traditional risk factors has been able to explain only 50 to 75% of the association between socioeconomic status and cardiovascular health (5).

Research on work-related psychosocial factors differs from traditional biomedical occupational health research because the causative agents cannot be measured directly as objective physical or chemical measures. There is a need for a theoretical model that helps to analyze the nature of the work life to differentiate features from a particular stressful work and to generalize them for different professions (6). Karasek's demand-control model (DCM) is one of the most frequently used theoretical models. According to DCM; the excessive demand at work is interacting with the lack of decision latitude at work in the development of the risk of CHD

(7). The DCM was expanded in the following years by adding an integrated social support component. According to the demand-control and social support model, high job strain and low social support describe the worst psychosocial situation and is defined as "iso-strain" (8).

Job strain, has been shown to be moderately associated with an increased risk of CHD (9), diabetes mellitus (10), stroke (11), and hypertension (12). While there is abundant evidence for the association of job strain with CHD events and its risk factors in developed countries, there has been inadequate research on this association in developing countries (13). Further studies are needed in developing countries to expand the generalizability of the research findings on the association between job strain and CVD (14). In Turkey, there has been very little work on the association of psychosocial factors at work in men (15), and there has been no report in women. The study therefore aims to investigate the associations of psychosocial risks at work with 10-year risk of CHD and metabolic syndrome in middle aged men and women in Balçova District of İzmir, Turkey.

METHODS

This was a population-based cross-sectional study approved by the Ethical Committee for Clinical and Laboratory Research (No: 247/2009). The study was supported by the Scientific and Technological Research Council of Turkey (No: SBAG109S277). Both verbal and written consent was obtained from all the participants.

Study participants

The study sample was derived with stratified random sampling technique from the currently employed individuals aged between 30 and 64 who participated in baseline Balçova Heart Study (BHS). BHS is a prospective cohort study focusing on reducing the CVD risk factors of people over 30 years old living in Balçova District, İzmir, Turkey. The detailed methodologies of the BHS have previously been described (16). Study sample was stratified according to gender, and equal sample size of male and female participants were chosen. The required sample size was calculated to be 724 men and women (362 participants for each strata) using a 95% confidence level, 50% estimated prevalence of MS, and a two-sided alpha error of 0.05. A total of 469 individuals accepted participate to study, resulting a response rate of 65% (59% for females, 70% for males). Due to missing data for demand-control-support scale, 407 (191 females and 216 males) participants were included in the analyses.

Variables

Main dependent variables of the study were metabolic syndrome (MS) and 10-year CHD Risk. MS was defined by the Adult Treatment Panel III (17). Characteristics included in the definition of MS were as follows: increased waist circumference (for men >102 cm, for women >88 cm), raised triglycerides (≥150 mg/dl), reduced HDL cholesterol (for men <40 mg/dl, for women <50 mg/dl), elevated blood pressure (≥130/ ≥85 mm Hg), and raised fasting plasma glucose (≥110 mg/dl). A diagnosis of MS was confirmed when at least three of these five characteristics were present in an individual.

Framingham risk score (FRS) equation was used to estimate 10-year CHD risk, based on the following data: age, sex, presence of diabetes mellitus (DM), smoking status, blood pressure, total plasma cholesterol, and plasma HDL-cholesterol levels. Participants were grouped into two groups, given they presented a risk score of <10% or a risk score of ≥10% (18).

The presence of DM was defined as having a diagnosis of DM or a fasting blood glucose ≥126 mg/dl.

Smoking status was evaluated using a self-reported questionnaire. The participants were grouped into two categories according to their smoking status. Those who smoked at least one cigarette per day were considered as "smokers", whereas those quitted smoking, and those smoked occasionally or never were considered as "non-smokers".

If systolic blood pressure was ≥140 and/or diastolic blood pressure was ≥90, or if the participants stated that they had a diagnosis of HT, then it was considered as HT. When total plasma cholesterol level was ≥200 mg/dl, it was defined as hypercholesterolemia. Obesity was defined as having a BMI of ≥30 kg/m^2.

Job strain and social support, the main independent variables of the study, were determined using Turkish-language version of the Swedish demand-control questionnaire (T-DCQ) (15). The two domains of job strain were work demand and job control (composed by two domains; skill discretion and authority over decision). Social support at work was defined by six items in the T-DCQ. A Likert scale (often/sometimes/seldom/almost never-never for work demand and job control; strongly disagree/disagree/agree/strongly agree for social support) was used for responses scored from 1 to 4. Firstly, job strain, indicating the combination of work demand and job control, was determined by the ratio of job demands to job control. Median values were used as cut-off points to categorize work demand, job control into two groups (low/high). Secondly, job strain was defined in a quaternary structure by using these dichotomized scores. The participants exposed to both high work demand and low job control were considered as high strain group; those exposed to high work demand but also high job control as active group; those with low work demand and low job control as passive work group; those with low work demand and high job control were considered as low strain group.

Occupation was defined as blue collar (as performing bodily work) and white-collar (as performing services or office works).

Education was defined according to answers for the question "What is your educational status?" with possible answers being illiterate, literate, graduated from primary school, and graduated from high school, graduated from university or higher. In the analyses, education was grouped into three groups as primary or lower education, secondary or high school education, and university or higher education.

Income perception of the participants was categorized into three groups as good being first group, fair being the second group, and poor being the last group.

Data collection

The data on blood pressure, physical measurements, and the blood samples obtained previously in the BHS project were used in the present study. Blood pressure was measured two times by skilled nurses using a mercury sphygmomanometer, after at least 5 minutes of resting in the sitting position. Mean value of the two measurements was included in the analyses. Waist circumference was measured using a non-stretchable standard tape by skilled nurses and trained personnel, in the standing position at a level midway between the lowest rib and the iliac crest. Venous blood samples were taken after an 8-hour fasting by a skilled nurse. Triglycerides, total cholesterol, low-density lipoprotein cholesterol, and high-density lipoprotein cholesterol were determined using Abbott Architect c16000 auto-analyzer (Abbott Diagnostics, Abbott Park, IL, USA) (19). Data collection of this study was carried out April 2010 to June 2010. All the households chosen in the sample were visited by trained interviewers, if the participant could not find at home, a second visit was arranged. Demand-control-support questionnaire was applied by face to face interviews.

Statistical Analyses

Mean and standard deviation values for continuous variables, count (n) and percentages (%) for categorical variables were used to present the baseline characteristics of the participants. Pearson chi-square test was used for univariate analyses of categorical variables. Linear regression or ANCOVA analyses were used for age adjusted comparisons of two or more groups of continuous variables. Logistic regression models were created to assess the associations of job strain and its domains with MS and FRS. Age (continuous), sex (dichotomous), occupation (dichotomous), and educational status (categorical) were considered as potential confounders in the models. FRS included age and sex in its equation, therefore the models for FRS was not adjusted with age and sex. All variables were entered simultaneously into the models using "enter" method. The level of significance was defined as $p<0.05$. All analyses were performed with SPSS for Windows (version 21.0, SPSS Inc.; Chicago IL, USA).

RESULTS

191 female and 216 male participants were included in the analyses. % 46.9 of the study participants were women. Mean age was 41.9±6.3 and 39.4±6.3 for men and women respectively. Male participants were significantly older than female participants ($p<0.001$). Women were more likely to be white-collar workers, well-educated and more likely to have better economic status perception than male participants (p values were 0.001, 0.001, and 0.047 respectively). 25.1% of men was working at low strain jobs, whereas 33.3% of women were working at low strain jobs. Nearly 20% of both men and women were experiencing high strain at work. Men tend to have more work demand than women, but the association was not significant. The other domains of job strain were similar between men and women (Table 1). Table 2 represents the traditional CHD risk factor levels of men and women. All the traditional risk factor levels and the prevalence of FRS of ≥10%, except LDL-cholesterol, smoking, and obesity, were significantly higher in men. 19.9% of men and 11.5% of women had MS, and there was not any statistical significant difference between men and women for MS.

Table 1. The distribution of socioeconomic and psychosocial factors according to sex

	Men		Women		p value*
	n	%	n	%	
Education					
Primary school or lower	54	25.0	44	23.0	
Secondary or high school	115	53.2	74	38.7	**0.001**
University or higher	47	21.8	73	38.3	
Occupation					
White collar	76	35.2	113	59.2	**<0.001**
Blue collar	140	64.8	78	40.8	
Income perception					
Good	29	13.4	43	22.5	
Fair	174	80.6	135	70.7	**0.047**
Poor	13	6.0	13	6.8	
Work demand					
Low	109	50.7	114	60.3	0.052
High	106	49.3	75	39.7	
Job control					
Low	98	45.6	85	45.0	0.903
High	117	54.4	104	55.0	
Social support					
Low	111	52.9	88	47.8	0.319
High	99	47.1	96	52.2	
Job strain					
Low strain jobs	54	25.1	63	33.3	
Passive jobs	55	25.6	51	27.0	0.180
Active jobs	63	29.3	41	21.7	
High strain jobs	43	20.0	34	18.0	

* Pearson chi-square test

Table 2. Traditional coronary heart disease risk factor levels of participants according to sex

	Men (n=216)	Women (n=191)	
	Mean ± SD	Mean ± SD	p value**
Age (years)	41.9±6.3	39.4±6.3	**<0.001**
SBP* (mmHg)	115.6±14.0	106.4±13.0	**<0.001**
DBP* (mmHg)	77.3±9.5	71.5±8.6	**0.011**
T. cholesterol (mg/gl)	210.1±38.6	197.3±36.4	**<0.001**
Triglycerides (mg/dl)	183.3±122.3	110.5±58.1	0.051
LDL-chol. * (mg/dl)	132.1±33.0	123.0±31.5	**<0.001**
HDL-chol. * (mg/dl)	41.7±10.0	53.2±16.6	**0.030**
BMI* (kg/m^2)	27.7±3.6	26.4±4.5	**0.003**
	n (%)	**n (%)**	**OR (95% CI)*** **
Hypertension	43 (19.9)	15 (7.9)	**2.46 (1.29–4.61)**
Hypercholesterolemia	53 (24.5)	24 (12.6)	**2.05 (1.20–3.51)**
Smoking status	91 (42.1)	82 (42.9)	0.96 (0.66–1.48)
Obesity	51 (23.6)	40 (20.9)	1.03 (0.64–1.67)
DM*	13 (6.0)	3 (1.6)	**3.47 (1.06–12.52)**
FRS* ≥10	51 (23.6)	5 (2.6)	**10.38 (3.9–27.6)**
Metabolic syndrome	43 (19.9)	22 (11.5)	1.70 (0.96–2.98)

***SBP:** Systolic blood pressure; **DBP:** Diastolic blood pressure; **LDL-chol:** Low density lipoprotein cholesterol; **HDL-chol:** High density lipoprotein cholesterol;
BMI: Body mass index; **DM:** Diabetes mellitus; **FRS:** Framingham risk score.
****Age adjusted linear regression analyses
*****Age adjusted logistic regression analyses (women is the reference group)

Table 3. The associations of socioeconomic characteristics with job demand and control stratified by gender#

	Male		Female	
	Job control	**Work demand**	**Job control**	**Work demand**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Occupation				
White collar	16.2 (3.4)	8.9 (2.3)	16.5 (2.8)	8.2 (2.2)
Blue collar	14.8 (3.5)**	9.5 (2.6)*	13.9 (3.1)***	9.9 (2.4)***
Education				
Primary school or lower	14.9 (3.4)*	9.7 (2.5)	13.8 (3.2)***	10.2 (2.3)***
Secondary or high school	15.1 (3.6)*	9.3 (2.6)	15.0 (3.2)***	8.9 (2.5)*
University or higher	16.3 (3.4)	9.0 (2.2)	16.8 (2.5)	8.1 (2.1)
Income perception				
Poor	14.1 (3.5)**	9.5 (2.6)	14.2 (3.2)	9.7 (2.6)
Fair	15.0 (3.5)**	9.3 (2.5)	15.7 (3.1)	8.9 (2.5)
Good	17.4 (2.6)	9.3 (2.6)	15.3 (3.3)	8.7 (2.3)
Job control				
Low	-	9.1 (2.5)	-	8.8 (2.6)
High	-	9.5 (2.5)	-	9.0 (2.3)
Work demand				
Low	15.2 (3.4)	-	15.5 (3.1)	-
High	15.5 (3.7)	-	15.5 (3.3)	-
Social support				
Low	15.1 (3.7)	9.6 (2.2)	15.0 (3.2)	9.2 (2.2)
High	15.6 (3.4)	9.1 (2.7)	15.9 (3.1)	8.6 (2.6)

Age adjusted ANCOVA
***** p<0.05, ****** p<0.01, ******* p<0.001
SD: Standard deviation

Table 3 shows the age adjusted associations of socioeconomic characteristics with job demand and job control stratified by gender. Blue collar workers were more likely to have lower job control and higher work demand than white collar workers both in men and women [p values for job control in men and women respectively, p=0.004, p<0.001; p values for work demand in men and women respectively; p=0.01, p<0.001]. Significant associations of both job control and work demand with educational level were found in men and women. As expected, there was a positive association between education and job control; whereas the

Table 4. Age and sex adjusted associations of job strain with Framingham risk score and metabolic syndrome

	Framingham Risk Score	Metabolic Syndrome	
	OR[a] (CI 95%)	OR[b] (CI 95%)	OR[c] (CI 95%)
	56/407*	65/407**	
Job strain			
High	0.67 (0.31–1.49)	0.76 (0.37–1.56)	0.73 (0.35–1.52)
Low	1.00	1.00	1.00
Work demand			
High	0.91 (0.52–1.61)	0.70 (0.40–1.21)	0.65 (0.37–1.14)
Low	1.00	1.00	1.00
Job control			
Low	1.05 (0.60–1.86)	1.08 (0.63–1.84)	0.99 (0.57–1.71)
High	1.00	1.00	1.00
Social support			
Low	0.94 (0.52–1.67)	1.18 (0.69–2.03)	1.13 (0.65–1.96)
High	1.00	1.00	1.00

*Number of participants with 10% and higher Framingham risk score/all the participants
**Number of participants with metabolic syndrome/all the participants
OR: Odds ratio; **CI:** Confidence interval
Model a: No adjustment
Model b: No adjustment
Model c: Adjusted with age and sex

Table 5. The associations of job strain with metabolic syndrome and Framingham risk score stratified by social support

		Framingham Risk Score	Metabolic Syndrome
		OR[a] (95% CI)	OR[b] (95% CI)
Job strain	**Social support**	56/407*	65/407**
Low	High	1.00	1.00
Low	Low	0.90 (0.48–1.69)	1.12 (0.61–2.04)
High	High	0.44 (0.10–1.96)	0.64 (0.18–2.31)
High	Low	0.69 (0.25–1.92)	0.91 (0.36–2.28)

*Number of participants with 10% and higher Framingham risk score/all the participants
**Number of participants with metabolic syndrome/all the participants
OR: Odds ratio; **CI:** Confidence interval
Model a: No adjustment
Model b: Adjusted with age and sex

Table 6. The adjusted associations of job strain with metabolic syndrome and Framingham Risk Score

	Framingham Risk Score		Metabolic Syndrome	
	OR[a] (CI 95%)	OR[b] (CI 95%)	OR[c] (CI 95%)	OR[d] (CI 95%)
Job strain	56/407*		65/407**	
Low	1.00	1.00	1.00	1.00
Passive	1.50 (0.71–3.20)	0.74 (0.30–1.84)	0.94 (0.46–1.91)	0.81 (0.39–1.69)
Active	1.34 (0.62–2.89)	0.83 (0.34–2.06)	0.64 (0.30–1.37)	0.56 (0.26–1.22)
High	0.85 (0.34–2.14)	0.38 (0.12–1.14)	0.62 (0.27–1.44)	0.48 (0.20–1.17)

*Number of participants with 10% and higher Framingham risk score/all the participants
**Number of participants with metabolic syndrome/all the participants
OR: Odds ratio; **CI:** Confidence interval
Model a: No adjustment
Model b: Adjusted with education and occupational status
Model c: Adjusted with age, and sex
Model d: Adjusted with education and occupational status

association between education and work demand was negative. Only in men, there was a positive significant association between job control and income perception (Table 3).

Table 4 shows age and sex adjusted associations of job strain with FRS and MS. Neither job strain nor each of its domains was found to be significantly associated with FRS and MS (Table 4). The stratification by social support or doing the analyses with the quaternary job strain model did not alter the results (Table 5 and Table 6).

DISCUSSION

In this population-based cross-sectional study, psychosocial factors at work were not significantly associated with FRS and MS. Our study did not support the hypothesis that psychosocial risk factors at work is one of the risk factors for cardiovascular disease risk measured by FRS and MS.

FRS and MS, the main dependent variables in our study, are commonly used tools to predict CHD risk of individuals. The risk factors that are included in the FRS equation (20) (age, gender, blood pressure, total cholesterol, HDL-cholesterol, smoking status, and diagnosis of diabetes) and in the definition of metabolic syndrome (waist circumference, plasma triglycerides, HDL cholesterol, blood pressure, and fasting plasma glucose levels) approximately explain 75% to 90% of CHD events (21). Thus, in this study, it was considered that FRS and metabolic syndrome might be used as indexes to predict the incidence of CHD with a cross-sectional data.

In one of the recent meta-analysis study, investigating the association between job strain and CHD risk factors, the high overall CHD risk was defined as a FRS of 20% or higher, and a significant association between job strain and FRS, with an OR of 1.13 (95% CI; 1.03–1.25), was found. The individuals with high job strain were more likely to have diabetes [OR (95% CI): 1.29 (1.11–1.51)], to smoke [OR (95% CI): 1.14 (1.08–1.20)], to be physically inactive [OR (95% CI): 1.34 (1.26–1.41)], and to be obese [OR (95% CI): 1.12 (1.04–1.20)], compared to those without job strain (22). In our study, no significant association was found between FRS and job strain. The "high risk" category, in our study, was defined as those with a FRS of 10% or higher, and the insignificant results for this association might arise from different cut-off points used for "high risk" category due to the relatively small sample size.

There are few studies investigating the association between MS and job strain in the literature. In a longitudinal US study, men in active jobs and women in high strain jobs had significantly increased risk of MS over 5 years, compared to those in low strain jobs, after adjustment for sociodemographic factors, health behaviors, and depressive symptoms (23). In another prospective cohort study with a 14-year follow-up, job strain was measured in four different point in time, and chronic job stress was defined as three or more exposures to job strain. A dose-response association was found between chronic job stress and MS after adjustment for age and employment grade, with a OR of 2.25 (95% CI: 1.31–3.85). It was concluded that job strain is a modifiable risk factor for metabolic syndrome, and the study provides evidence for the biological plausibility for the association (24).

There is only one previous study that investigates the relationship between MS and job strain in Turkey. In that cross-sectional work place based study, conducted among 450 municipal garbage collection workers, there was no significant association of MS with both job strain, and its domains, separately. The results were not altered after the adjustments for age, educational status, income, duration of employment, contract type and smoking cessation (15). Differently, our study was the first population based study investigating the association between job strain and CHD risk in Turkey, and included both blue-collar and white-collar workers. However, similar results were obtained in the findings.

To date, many studies have been carried out on the effects of psychosocial factors and job strain on CHD, especially in developed countries (9, 25). In the studies, that conducted mostly in US and northern European countries, it has been concluded that there is a consistent evidence of association between job strain and CHD, specifically in men (26). Nevertheless, the research regarding job strain in developing countries is scarce, and most of them are based on relatively small samples of cross-sectional data (15, 27). Although many investigations to date have found that psychosocial factors were positively related to CHD events, there were also studies in which there was no significant association. In a systematic review for the association of job strain with CHD, a significant positive association were found in 8 out of 17 prospective surveys, 6 out of 9 case-control surveys, and 4 out of 8 cross-sectional surveys (26).

There might be several possible explanations for the insignificant and inconsistent results. Firstly, the demand-control scale does not include the psychosocial risk factors such as job insecurity, continuity at the same work, and equality at work and role ambiguity, which might be crucial factors, specifically for developing countries. Thus, the DCQ scales used may be inadequate to measure psychosocial risks due to work causes CHD in different cultural settings. Furthermore, there are evidences that psychosocial work conditions predict the occurrence of sick leave and early exit from work life independently of occupational status (28). Thus, non-participation of the people with higher psychosocial risks is likely to be a source of bias in our study.

Second possible explanation might be the long latent period of stress before the onset of CHD and its risk factors. In a study, analyzing the 5-year follow-up results of the data obtained from Whitehall-II study, a significant relationship was found only with job control, but not with job strain (29). However, in another study, this time analyzing the 11-year follow-up results of Whitehall-II data, a significant increase in the risk of CHD among those with high job strain was determined (30). The different findings of the studies might be due to the long latent period. Additionally, in another meta-analysis, it was found that the risk of CHD was higher in high-strain [1.26 (95% CI: 1.12–1.41)] and passive jobs [1.14 (95% CI: 1.02–1.29)] compared with low-strain jobs, specifically in studies with long follow-up durations (9).

Thirdly, some of the studies confirmed that there was a temporal dose-response association between job strain and CHD events. In a study, it was concluded that the participants who did not change their occupation for more than five years had a higher risk of CHD than the whole cohort with a hazard ratio of 2.9 (95% CI: 1.25–6.71) (13, 26). In our study, the job stress was measured only one point in time, furthermore current occupation was taken into account when examining the association with stress. In cross-sectional studies on psychosocial factors, it may be a much more precise approach to assess the long-term occupation across lifespan, at least to be able to take the cumulative effect into account.

In conclusion, although psychosocial factors are known as important risk factors for CHD in developed countries, the evidence in developing countries is limited. Further longitudinal large population based studies with comprehensive psychosocial risk measures, in accordance with diverse cultural aspects of working conditions might be essential for developing countries.

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