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ORIGINAL ARTICLE

Effect of psychosocial factors on metabolic syndrome in male and female blue-collar workers

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Abstract

Aim: The purposes of this study were to examine the relationship between psychosocial factors and metabolic syndrome among male and female blue-collar workers, and which factors influence their metabolic syndrome by sex.

Methods: A cross-sectional study was completed of 154 men and 80 women working at small companies in Korea. The data were collected through a structured questionnaire, blood test, and anthropometric and blood pressure measure. Metabolic syndrome was diagnosed from the results of blood test and the measurements of waist circumference and blood pressure.

Results: The prevalence of metabolic syndrome among male and female blue-collar workers was 24.0% and 7.5%, respectively. Multiple logistic regression analysis was performed to examine factors of metabolic syndrome associated with sex. After controlling for age, marital status, smoking, alcohol drinking, shift work, overtime work, and physical exercise, job stress (odds ratio [OR] = 3.10, $P = 0.005$) and risk perception (OR = 1.12, $P = 0.016$) were influencing factors for men, and low job stress (OR = 0.05, $P = 0.04$), low social support (OR = 1.51, $P = 0.009$), and risk perception (OR = 1.27, $P = 0.023$) for women.

Conclusion: Metabolic syndrome among blue-collar workers is closely related to psychosocial factors, such as job stress, social support, and risk perception, with the effect of job stress a point of difference between men and women. Occupational health nurses should be cognizant of the importance of assessing the effect of psychosocial factors on cardiovascular risk for blue-collar workers.

Key words: metabolic syndrome, occupational health, psychosocial factors.

INTRODUCTION

Studies from Europe and the USA found that blue-collar workers had three-times the risk of cardiovascular disease (CVD; Netterstrom, Nielsen, Kristensen, Bach, & Moller, 1999) and ischemic heart disease (Chen, Cheng, Lin, & Hsiao, 2007; Netterstrom, Kristensen, & Sjol, 2006; Tuchsen & Endahl, 1999) compared with white-collar workers. These studies provide evidence that workers from more disadvantaged groups and lower socioeconomic classes are at higher risk of CVD (Hwang, 2011). Social inequality and its relationship to CVD has been documented in studies of Western nations, showing that blue-collar workers have an increased risk of ischemic heart disease as compared with white-collar workers (Tuchsen & Endahl, 1999). Although the relationship between job stress and CVD has been studied extensively, the extent to which the research results apply to Asian or Korean blue-collar workers remains unknown.

The prevalence of metabolic syndrome has recently increased in Korea. Payments from the Korea Labor

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Welfare Corporation for compensation for mortality in workers caused by cardiovascular and cerebrovascular diseases have also increased in Korea in recent years (Yoon, Yi, Oh, & Lee, 2007). The association of metabolic syndrome and job stress has been investigated by several researchers in recent studies (Mikurube *et al.*, 2005; Yoon *et al.*, 2007). Occupational stress studies conducted throughout the world including Japan and Korea provide strong evidence that job stress impacts on metabolic syndrome, which is composed of five CVD risk factors: (i) obesity; (ii) high triglycerides (TG); (iii) low high-density lipoprotein cholesterol (HDL) concentrations; (iv) elevated blood pressure (BP); and (v) impaired glucose tolerance (Ducher, Cerutti, Chatellier, & Fauvel, 2006; Kang *et al.*, 2005; Mikurube *et al.*, 2005; Tobe *et al.*, 2007).

Studies of industrial workers have also suggested that psychosocial work factors independently contribute to CVD (Ducher *et al.*, 2006; Kang *et al.*, 2005). The case–control study by Ducher *et al.* (2006) revealed a significant positive relationship between exposure to job strain and hypertensive status, as measured by ambulatory work BP. As the definition of hypertension became progressively more rigorous, the odds ratio (OR) for exposure to job stress increased correspondingly. Thus, job stress was shown to be positively associated with BP. Job stress was also shown to be associated with metabolic syndrome in a cross-sectional study of law enforcement officers (Ramey, 2003). It was determined that perceived stress was significantly associated with three risk factors (cholesterol, hypertension, physical inactivity) and CVD. Job stress may contribute to CVD development among susceptible individuals as well as contribute to other potential CVD risk factors (Ramey, 2003).

It is clear that both the workplace and the individual bear responsibility for management of CVD risk. Two mechanisms may explain the relationship between job stress and CVD risk. The direct mechanism increases left ventricular mass through physiological variables such as increased BP and serum cholesterol. The indirect mechanism works through behavioral risk factors such as smoking and alcohol consumption. Suspected physiological effects of job stress that could increase BP include sympathetic pathways (Ducher *et al.*, 2006), pituitary adrenocortical hormones (Kunz-Ebrecht, Kirschbaum, Marmot, & Steptoe, 2004), and a highly destructive combination (Niedhammer *et al.*, 1998; Hwang & Hong, 2012).

Job stress has been evaluated using the Effort–Reward Imbalance (ERI) model (Bosma, Peter, Siegrist, & Marmot, 1998; Peter, Siegrist, Hallqvist, Reuterwall, & Theorell, 2002). This model claims that stressful experiences at work are elicited by a lack of reciprocity between effort spent for work and rewards received, where rewards include money, promotion prospects, and job security (Siegrist, 2010). Results demonstrate an elevated risk of coronary heart disease among employees exposed to an ERI. In several studies including Koreans, job stress has been associated with an increased risk of CVD in both male and female workers (Ducher *et al.*, 2006; Kang *et al.*, 2005; Peter *et al.*, 2002). However, the effect of job stress on metabolic syndrome is still subject to debate (Fauvel *et al.*, 2003; Ferris, Sinclair, & Kline, 2005). Most, but not all, cross-sectional or short-term studies report that subjects exposed to high job stress have higher BP or heart rate.

Differences about the association of job stress among studies may be caused by population sampling, study design, duration of follow up, or method of metabolic syndrome measurement such as measurements of diastolic, systolic, and/or ambulatory BP (Fauvel *et al.*, 2003; Landsbergis, Schnall, Pickering, Warren, & Schwartz, 2003). One confusing factor may be the intra-individual variability of job stress over time. The effect of job stress on metabolic syndrome is difficult to evaluate because job stress varies with time and sex (Landsbergis *et al.*, 2003). Both factors should be simultaneously studied to determine the independent influence of job stress on metabolic syndrome.

Social support at work could reduce the effects of job stress on metabolic syndrome (Guimont *et al.*, 2006; Steptoe, 2000). In a previous review of the influence of job stress and social support on CVD risk, some evidence indicates that cardiovascular responses to stress are related to the onset of CVD, but did not show how latent stress responses could be reduced by social support (Christenfeld & Gerin, 2000; Hwang & Hong, 2012).

Although industrial manufacturing work is associated with an increased risk of developing CVD (Williams, Mason, & Wold, 2001), there are few studies examining a worker's perception related to metabolic syndrome. Limited information exists in the published work about CVD risk perception in workers. Risk perception is defined as how a person perceives the likelihood of having a CVD event (Frijling *et al.*, 2004), which was included in three studies (Barnhart *et al.*, 2009; Christian, Mochari, & Mosca, 2005; Frijling *et al.*, 2004). Barnhart *et al.* (2009) and Frijling *et al.* (2004) showed an association between CVD risk and CVD risk perception. However, Christian, Mochari, and Mosca (2005) did not find a similar association. In addition, work-related factors such as shift and overtime work have been associated with an increased risk of metabolic syndrome (Munakata *et al*., 2001; Su *et al*., 2008). A recent cohort study explored how metabolic risk factors for CVD differed between shift workers and day workers in a cohort of healthcare providers and factory workers. The results showed that shift work was significantly associated with high TG and abdominal obesity after adjusting for sex, smoking, alcohol consumption, and job seniority (Copertaro *et al*., 2008).

Overall, the influences of job stress and social support on CVD risk are relatively well supported by the published work (Ducher *et al*., 2006; Kang *et al*., 2005; Steptoe, 2000; Tobe *et al*., 2007). This emphasizes the significance of the primary prevention of CVD and the contribution of psychosocial components to metabolic syndrome among workers. However, the association of psychosocial factors, including risk perception on metabolic syndrome, documented in the published work has been inconsistent. The aim of the present study is to clarify whether psychosocial factors, in particular job stress, social support, and risk perception, are associated with increased metabolic syndrome in Korean male and female blue-collar workers.

METHODS

Study design, settings, and procedures

A cross-sectional study was conducted with blue-collar workers who were registered in the occupational health center (OHC) of Inchon, Korea from July to August 2010. Ethical approval was obtained from the institutional review board at the Yonsei University Severance Hospital, Korea. All potential participants were informed about the study and instructed to visit the OHC the morning after a designated 10 h overnight fasting period. They were selected according to the inclusion criteria before they visited the OHC. The participants were asked to complete a survey questionnaire, which was provided by this study, at the OHC or at their workplace, and to have anthropometric and BP measurements taken. Blood was drawn for lipid testing by registered nurses.

Two hundred and fifty workers who met the study criteria were approached to participate in the study. The participants were from eight different companies. They represented five different sectors: the shipbuilding industry and the print chip, electronic, weaponry, and butane gas manufacturing industries. Most study subjects were involved in direct manufacturing. Two hundred and forty workers (95%) agreed to participate in the study. Ten people declined to participate due to lack of time to complete questionnaires and blood testing. Data from six participants were eliminated from the analysis because they left more than half of one or more of the questions unanswered.

Inclusion and exclusion criteria

Inclusion criteria were: (i) Korean blue-collar workers working for small companies which had less than 300 employees; (ii) aged 18 years or more; (iii) no history of previous myocardial infarction; and (iv) no history of percutaneous transluminal coronary angioplasty. The target population for this study was identified as skilled or non-skilled manual workers based on the Korean standard classification of occupations (Korea National Statistical Office, 2007). Workers were excluded from the study if they failed to meet the inclusion criteria or had cognitive impairment. Eligibility of potential participants was determined by the researcher or the trained research staff, using inclusion and exclusion criteria at the time of initial contact.

Protection of participants

Participants had the right not to answer any questions and to stop the data collection procedure at any point. All subjects were reassured about the confidentiality and anonymity of the information provided. The subject matter in the questionnaires could potentially cause distress. The procedures were designed to be non-coercive. Participants could decline to answer any question they felt uncomfortable answering. Information on how to contact counseling services if desired was provided. Participation in the research study could result in a loss of privacy, but information was handled as confidentially as possible. Study information was coded and kept in locked files at all times. Data collected from all participants were kept in strict confidence and only used for this study.

Data collection instruments

Metabolic syndrome

The definition of metabolic syndrome was based on the presence of three or more of the following signs: (i) waist circumference of 90 cm or more for men or 85 cm or more for women; (ii) hypertension, defined as systolic as BP of 130 mmHg or more, diastolic BP of 85 mmHg or more, or if the subject was under active antihypertensive drug therapy; (iii) fasting blood glucose (FBG) of 100 mg/dL or more, or if the subject was actively using oral antidiabetic medication or insulin; (iv) TG levels of 150 mg/dL or more; and (v) HDL levels of 40 mg/dL or less for men, or 50 mg/dL or less for women. In the present study, metabolic syndrome was defined according to the modified National Cholesterol Education Panel Adult Treatment Panel III (Grundy *et al*., 2005) and the Korean Society for the Study of Obesity guidelines.

Waist circumference was measured in centimeters by placing a non-stretchable measuring tape around the bare abdomen at the top of the iliac crest or just above the hip bone. The reading was taken at the end of expiration, making sure that the tape was secure but not too tight. BP was measured on the right arm with the subject in a supine position after 5 min of rest. It was measured with an electronic monitor using standardized procedures. Measurements were repeated after 2 min and then averaged by the researcher. If the reading was more than 140/90 mmHg, BP was measured again with a conventional sphygmomanometer and stethoscope, and the lower of the two readings was recorded.

Blood was drawn from the venae brachiales by a registered nurse in the OHC, transferred to two tubes, with or without anticoagulants such as sodium citrate/ethylenediamine tetraacetic acid, and delivered to a certified laboratory for analysis. Blood lipids were determined enzymatically, after precipitation by phosphotungstic acid and magnesium chloride. All of the analyses were conducted by medical laboratories certified by the Korean Food and Drug Administration. Laboratory personnel were blinded to participant status. Total serum cholesterol and HDL cholesterol were measured. When TG levels were less than 400 mg/dL, low-density lipoprotein (LDL) cholesterol was calculated using the Friedewald formulation (LDL = total cholesterol – HDL – TG / 5); for TG of 400 mg/dL or higher, the LDL was estimated directly after ultracentrifugation of plasma and cholesterol was measured in the bottom fraction of the tube (Wilson *et al*., 1998).

Demographics and work characteristics

Demographic and work characteristics were obtained by survey. Demographic and work variables included in the study were participants' age, marital status, education level, current smoking, alcohol drinking, physical exercise, type of work (shift work), and time of work (overtime work).

Job stress (ERI)

Job stress was assessed by the validated Korean version of the original ERI questionnaire containing 23 items (Eum *et al*., 2007a; Siegrist *et al*., 2004). The reported internal consistency for the Korean version was satisfactory with 0.71 for effort and 0.86 for reward (Eum *et al*., 2007a). The ratio of effort to reward expresses the amount of perceived ERI at work and will be computed according to the formula (ERI ratio is E [effort score] / R [reward score] × C [correction factor; 0.5454 for six items]), as described by Siegrist *et al*. (2004). A value close to zero indicates relatively low effort and high reward. A value above 1.0 indicates a high amount of effort with little reward (Siegrist *et al*., 2004). Anyone over 1.0 was labeled as having "high job stress" and anyone with a value of 1.0 and lower was labeled as having "low job stress".

Social support

Social support was defined as instrumental and emotional support from co-workers and supervisors. The perception of social support was measured by the subscale of the Job Contents Questionnaire (JCQ). The JCQ consists of 22 items that include psychological demands, skill discretion, decision authority, and social support, and is measured on a 4 point Likert scale (1 = strongly agree, 4 = strongly disagree; Karasek *et al*., 1998). The social support score was obtained by adding the scores for supervisor support and co-worker support. Supervisor support was measured by four items: (i) concern about the welfare of those under him/her; (ii) pays attention to what others are saying; (iii) helpful in getting the job performed; and (iv) successful in getting people to work together. Co-worker support was measured by four items: (i) competent co-workers; (ii) co-workers' interest in me; (iii) friendly co-workers; and (iv) helpful co-workers. High *versus* low social support was divided by a median split. Cronbach's alpha coefficients were 0.87 for supervisor support and 0.77 for co-worker support in this study, which were slightly higher than those (0.71) in the Korean version of the JCQ of 157 Korean healthcare workers (nurses and pharmacists; Eum *et al*., 2007b).

Risk perception of CVD

Risk perception of CVD was measured by an index of relative risk perception developed and tested by Becker and Levine (1987) in a study of a high-risk population. This index has demonstrated good internal consistency with Cronbach's alpha of 0.80 in a US sample (Becker & Levine, 1987) and 0.78 in a Korean immigrant sample (Choi, Rankin, Stewart, & Oka, 2008). Cronbach's alpha was 0.86 in the current study. The index is comprised of four items that address a person's: (i) frequency of concern over having CVD; (ii) his/her estimate of the likelihood of having such an event in the next 10 years;

(iii) the likelihood of having an event in his/her lifetime; and (iv) his/her estimated CVD risk compared with people of similar age and sex in the general population. Items were measured on a 5 point Likert scale (1 = very low probability, 5 = extremely high probability). The potential range for the risk perception score was between 4 and 20, with higher scores indicating a higher level of concern and a higher probability for having a CVD. High and low risk perception was also dichotomized by the median.

Shift work and overtime work

A participant was asked to indicate by marking "yes" or "no" whether they were working on shifts, including night shift. Overtime work was measured by self-report of working more than 60 h/week (Liu & Tanaka, 2002).

Data analysis

Data analysis was conducted using the Statistical Package for Social Sciences, recently renamed PASW ver. 18 (SPSS, Chicago, IL, USA). The χ^2-test or Student's *t*-test was used to test for differences between categorical data and continuous data, and the Pearson and Spearman's rho correlation were used to examine associations between psychosocial factors and the components of metabolic syndrome. Multiple logistic regression analysis was performed to examine the determinants of metabolic syndrome by sex among demographic variables, work-related factors, and psychosocial factors. Adjustments were carried out for all interested independent variables. All reported *P*-values were two-tailed, and confidence intervals (CI) were calculated at the 95% level. A *P*-value of less than 0.05 was considered significant.

RESULTS

Comparison of characteristics by sex

The final 234 employees included 154 men and 80 women, with mean ages of 33.68 (standard deviation [SD] = 7.71) and 42.10 (SD = 7.04) years, respectively. The demographic, work-related, and psychosocial factors of the Korean workers by sex are presented in Table 1. The majority of the participants finished high school (81.7%), but 43 (18.4%) workers had middle school education or less. Male workers were younger, better educated, had a higher percentage of shift work, and did more overtime work (≥60 h/week) than female workers. Also, the men drank more alcohol and smoked more frequently than women. More of the female workers were married than male. The male workers (74.0%) showed higher perceived job stress than female workers.

Prevalence of metabolic syndrome

The prevalence of each component of metabolic syndrome and the clustering of metabolic syndrome is shown in Table 2. According to these criteria, 104 (44.4%) of the workers had high BP and approximately one-third of workers had high blood glucose (30.9%). Low HDL prevalence was found in 11.2% of workers. Overall, the prevalence of metabolic syndrome among blue-collar workers was 18.4%. Of note, metabolic syndrome was more common among male blue-collar workers (24.0%) than among female blue-collar workers (7.5%). Male workers had a higher prevalence of abdominal obesity, high BP, higher TG levels, and a clustering of three or more components of metabolic syndrome, whereas female workers had higher prevalence of low HDL.

Relationship between psychosocial factors and the components of metabolic syndrome

Correlations between psychosocial factors (job stress and social support) and the components of metabolic syndrome are presented in Table 3. A significant correlation was found between co-worker support and HDL in women ($r = -0.23$, $P < 0.05$), indicating that women with higher levels of co-worker support demonstrated decreased HDL. Women were also negatively correlated with BP, FBG, and TG ($r = -0.22$, $r = -0.23$, $r = -0.33$, $P < 0.05$, respectively). Therefore, women with high effort have lower BP, FBG, and TG than women with less effort, contrasting the hypothesis that high effort is associated with higher BP, FBG, and higher TG. The strongest negative correlation was found between job stress and BP in women ($r = -0.33$, $P < 0.05$), indicating that higher job stress is related to decreased BP, from which it was hypothesized that job stress is associated with lower BP (Table 3).

Metabolic syndrome and the independent variables

Among psychosocial factors, metabolic syndrome was significantly associated with risk perception. Compared with workers with low risk perception, high risk perception for CVD correlated with a higher metabolic rate ($t = 11.96$, $P < 0.001$). None of the work-related factors were significantly associated with metabolic syndrome. Workers doing physical exercise tended to report a lower metabolic syndrome rate than workers not doing

Table 1 Demographic, work-related, and psychosocial characteristics of blue-collar workers by sex

Characteristics	Categories	Total (n = 234)	Men (n = 154) N (%)	Women (n = 80) N (%)	χ^2/t-test†	P-value
Age (years)	20–35	108 (46.2)	97 (63.0)	11 (13.7)	51.46	<0.001
	35–49	107 (45.7)	49 (31.8)	58 (72.6)		
	≥50	19 (8.1)	8 (5.2)	11 (13.7)		
		36.86 ± 8.66	33.68 ± 7.71	42.10 ± 7.04		
Education	Middle school or less	17 (7.3)	6 (3.9)	11 (13.7)	19.65	<0.001
	High school	174 (74.4)	109 (70.8)	65 (81.3)		
	College or over	43 (18.4)	39 (25.3)	4 (5.0)		
Marital status	Unmarried	80 (34.2)	71 (46.1)	9 (11.2)	24.43	<0.001
	Married	154 (65.8)	83 (53.9)	71 (88.8)		
Current smoking	No	129 (55.1)	53 (34.4)	76 (95.0)	78.12	<0.001
	Yes	105 (44.9)	101 (65.6)	4 (5.0)		
Alcohol drinking	No	52 (22.2)	24 (15.6)	28 (35.0)	11.48	0.001
	Yes	182 (77.8)	130 (84.4)	52 (65.0)		
Shift work	No	148 (63.2)	81 (52.6)	67 (83.8)	21.98	<0.001
	Yes	86 (36.8)	73 (47.4)	13 (16.3)		
Overtime work (≥60 h/week)	No	146 (62.4)	82 (53.3)	64 (80.0)	19.10	<0.001
	Yes	88 (37.6)	72 (47.7)	16 (20.0)		
Social support	High	138 (59.0)	95 (61.7)	43 (53.8)	1.37	0.151
	Low	96 (41.0)	59 (38.3)	37 (46.3)		
Job stress	Low	74 (22.3)	40 (26.0)	34 (42.5)	6.65	0.012
	High	160 (68.4)	114 (74.0)	46 (57.5)		
Risk perception	Low	154 (65.8)	101 (65.6)	53 (66.3)	0.01	0.519
	High	80 (34.2)	53 (34.4)	27 (33.8)		
Physical exercise (≥30 min, ≥3/week)	No	209 (89.3)	135 (87.7)	74 (92.5)	1.29	0.372
	Yes	25 (10.7)	19 (12.3)	6 (7.5)		

†Fisher's exact test was performed. Continuous variable expressed as mean (± standard deviation).

Table 2 Prevalence of metabolic syndrome and its clustering of components among blue-collar workers by sex

Components of MS		Total (n = 234) N (%)	Men (n = 154) N (%)	Women (n = 80) N (%)	χ^2	P-value
WC ≥90 cm (men), ≥85 cm (women)		24 (10.3)	18 (11.7)	6 (7.5)	3.96	0.001
BP ≥130/85 mmHg		104 (44.4)	80 (51.9)	24 (30.4)	9.82	0.002
FBG ≥100 mg/dL		72 (30.9)	49 (31.8)	23 (29.1)	0.18	0.672
TG ≥150 mg/dL		48 (20.6)	43 (27.9)	5 (6.3)	14.90	<0.001
HDL <40 mg/dL (men), <50 mg/dL (women)		26 (11.2)	12 (7.8)	14 (17.7)	10.87	0.001
No. of MS components	0	68 (29.1)	31 (20.1)	37 (46.3)	17.43	<0.001
	1	78 (33.3)	52 (33.8)	26 (32.5)	0.04	0.483
	2	45 (19.2)	34 (22.1)	11 (13.8)	2.35	0.082
	3	25 (10.7)	22 (14.3)	3 (3.8)	6.12	0.009
	4	14 (6.0)	11 (7.1)	3 (3.8)	1.08	0.232
	5	4 (1.7)	4 (2.6)	0 (0.0)	2.11	0.285
Diagnosis of MS	≥3	43 (18.4)	37(24.0)	6 (7.5)	9.59	0.002

BP, blood pressure; FBG, fasting blood glucose; HDL, high-density lipoprotein; MS, metabolic syndrome; TG, triglyceride; WC, waist circumference.

Table 3 Correlations between the psychosocial factors and components of metabolic syndrome by sex

	Men (n = 154)					Women (n = 80)				
	WC	BP	FBG	TG	HDL	WC	BP	FBG	TG	HDL
Social support	0.049	0.045	0.006	0.015	–0.006	–0.059	–0.163	–0.148	0.189	–0.130
Co-worker support	0.042	0.022	0.005	0.052	–0.028	–0.120	–0.147	–0.166	0.171	–0.225*
Supervisor support	0.036	0.051	–0.014	–0.014	–0.028	–0.035	–0.135	–0.101	0.169	–0.020
Job stress (effort–reward imbalance)	0.147	0.064	0.086	0.102	–0.165	0.170	–0.325*	–0.122	–0.115	–0.030
Effort	0.125	0.109	–0.017	0.052	–0.082	–0.088	–0.224*	–0.233*	–0.329*	–0.128
Reward	–0.046	0.052	–0.148	–0.050	0.090	0.040	0.006	–0.171	–0.255*	0.094

*$P < 0.05$, two-tailed. BP, blood pressure; FBG, fasting blood glucose; HDL, high-density lipoprotein; TG, triglyceride; WC, waist circumference.

Table 4 Metabolic syndrome and the independent variables (N = 234)

Characteristics	Categories	Metabolic syndrome	$\chi^{2\dagger}$	P-value
Age (years)	20–35	21 (25.4)	0.21	0.903
	35–49	18 (28.1)		
	≥50	4 (26.3)		
Education	High school or less	35 (26.9)	0.07	0.792
	College or over	8 (25.0)		
Marital status	Unmarried	14 (26.3)	0.02	0.912
	Married	29 (26.9)		
Current smoking	No	21 (23.3)	1.09	0.297
	Yes	22 (28.9)		
Alcohol drinking	No	7 (19.2)	1.85	0.174
	Yes	36 (28.6)		
Shift work	No	28 (26.4)	0.01	0.969
	Yes	15 (26.6)		
Overtime work (≥60 h/week)	No	31 (27.2)	0.26	0.607
	Yes	12 (23.9)		
Social support	High	22 (25.2)	0.27	0.604
	Low	21 (28.2)		
Job stress	Low	11 (21.9)	0.91	0.330
	High	32 (28.0)		
Risk perception	Low	19 (18.9)	11.96	<0.001
	High	24 (39.3)		
Physical exercise (≥30 min, ≥3/week)	No	40 (33.9)	5.61	0.019
	Yes	3 (20.3)		

†Fisher's exact test was performed. Metabolic syndrome was defined as having more than three among five cardiovascular disease risk factors: (i) obesity; (ii) high triglyceride level; (iii) low high-density lipoprotein levels; (iv) elevated blood pressure; and (v) impaired glucose tolerance.

physical exercise (t = 5.61, P = 0.019). Metabolic syndrome rate tended to be higher in workers with high job stress compared to workers with low job stress, but the differences were not significant (t = 0.91, P = 0.330; Table 4).

Influencing factors for metabolic syndrome

Table 5 summarizes the adjusted OR for associations between demographic, work-related factors, and psychosocial factors and the risk of metabolic syndrome in male and female blue-collar workers, respectively. The adjusted OR results suggested that middle age (35–49 years; OR = 2.79, 95% CI = 1.15–6.77; data not shown), high job stress (OR = 3.10, 95% CI = 1.40–6.88), and high risk perception (OR = 1.12, 95% CI = 1.02–1.23) predicted increased risk of metabolic syndrome in male workers. In women, low job stress (OR = 0.05, 95% CI = 0.01–0.87), high risk perception

Table 5 Association of metabolic syndrome in (a) male blue-collar workers† (n = 154) and (b) female blue-collar workers† (n = 80)

Variables	Categories	Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
(a)					
Overtime work (≥60 h/ week)	No	Ref		Ref	
	Yes	0.58 (0.29–1.14)	0.114	0.56 (0.24–1.30)	0.178
Social support	High	Ref		Ref	
	Low	1.25 (0.63–2.45)	0.528	1.04 (0.95–1.14)	0.428
Job stress	Low	Ref		Ref	
	High	2.10 (0.94–4.72)	0.071	3.10 (1.40–6.88)	0.005
Risk perception	Low	Ref		Ref	
	High	2.46 (1.24–4.89)	0.010	1.12 (1.02–1.23)	0.016
Physical exercise (≥30 min, ≥3/week)	No	Ref		Ref	
	Yes	0.78 (0.30–2.08)	0.624	0.98 (0.31–3.17)	0.978
(b)					
Overtime work (≥60 h/ week)	No	Ref		Ref	
	Yes	0.21 (0.03–1.75)	0.028	0.40 (0.76–6.86)	0.502
Social support	High	Ref		Ref	
	Low	1.52 (0.49–4.67)	0.470	1.51 (1.11–2.06)	0.009
Job stress	Low	Ref		Ref	
	High	0.19 (0.16–1.45)	0.012	0.05 (0.01–0.87)	0.040
Risk perception	Low	Ref		Ref	
	High	6.46 (1.97–21.45)	0.002	1.27 (1.04–1.55)	0.020
Physical exercise (≥30 min, ≥3/week)	No	Ref		Ref	
	Yes	1.29 (0.14–11.92)	0.821	0.66 (0.04–12.35)	0.781

†Logistic regression was performed adjusted for age, education, marital status, alcohol drinking, smoking, and type of work (shift work or not). CI, confidence intervals; OR, odds ratio; Ref, reference.

(OR = 1.27, 95% CI = 1.04–1.55), and low social support (OR = 1.51, 95% CI = 1.11–2.06) were significantly associated with risk of metabolic syndrome. With the exception of social support and risk perception, other variables were labeled as dummy variables for analysis. If the metabolic syndrome component was more than three, it was entered as the dependent variable with "1" signifying that metabolic syndrome component has more than three factors.

DISCUSSION

This research was undertaken to identify which work-related and psychosocial factors were associated with the development of CVD risk, defined as metabolic syndrome. In this study, the percentage of people with metabolic syndrome was significantly higher than the 21% of the Korean general working population who participated in the 2008 KNHANS study and the 11.7% of male white-collar workers who worked in a laboratory (Yoon *et al*., 2007). Such a high rate of metabolic syndrome in this study's population of male blue-collar workers is of serious concern. Work-related CVD risk factors such as shift work, overtime work, and job stress affected the workers' productivity and their quality of life and increased the CVD-related costs. These findings demonstrate the urgent need to improve the management of CVD risk factors in Korean blue-collar workers.

This study found that metabolic syndrome in Korean blue-collar workers was associated with job stress, risk perception, and social support, not shift and overtime work. The relationship between job stress and CVD risk has been examined extensively. Several studies have shown that job stress is related to CVD risk (Cho, Lee, & Kim, 2005; Yap, Yang, Wang, Bacon, & Campbell, 2006). Furthermore, Korea has adopted a regulation that requires a worker's compensation related to CVD death (Yoon *et al*., 2007). Job stress has been shown to be associated with coronary heart disease in a meta-analysis (Kivimaki, 2006) and is emerging as an effective measurement to assess the risk of CVD (Schulze *et al*., 2006). In Asian populations, job stress is positively associated with metabolic syndrome and CVD risk factors (Sakurai *et al*., 2006; Yang *et al*., 2007). Thus, workers who have higher job stress may have a higher risk of a CVD event.

Job stress was found to be the strongest association with metabolic syndrome in Korean blue-collar workers as postulated by the Job Stress Model. However, it is interesting to find the opposite association of job stress with metabolic syndrome in female workers. Male blue-collar workers with higher levels of job stress had an increased risk of metabolic syndrome. In contrast, women with lower job stress were at increased risk of metabolic syndrome. Job stress is the high risk condition for imbalance between effort and reward (Siegrist *et al.*, 2004). The Job Stress Model is based on a model which focuses on failed reciprocity between efforts spent at work and rewards received (Godefroi *et al.*, 2005; Griffin, Fuhrer, Stansfeld, & Marmot, 2002).

In previous studies, the most consistent work organization feature associated with CVD was job stress (Kang *et al.*, 2005; Malik & Wong, 2009). However, the present study shows that job stress has an opposite effect on the prevalence of metabolic syndrome in male and female blue-collar workers. Effort (one component of ERI) also is negatively correlated with BP in women. The healthy worker effect (HWE), a phenomenon observed in occupational disease studies, is often prevalent in this type of cross-sectional study in which female workers who have high BP may leave the workplace. Thus, a decrease of BP in female workers is a result of this effect. Similarly, female workers have less reward (lower salary, fewer career opportunities, less job security, and less respect at work) than their male counterparts (Kang *et al.*, 2005). This results in workers with low wages, particularly those who are female blue-collar workers. Consequently, male workers may experience additional job stress at the workplace. These findings show that male and female blue-collar workers are different from each other in their relationship between job stress and metabolic syndrome. For this reason, future longitudinal research should be conducted in exploring the relationship between metabolic syndrome and various psychosocial factors by sex.

In this study, risk perception of CVD also emerged as significantly associated with metabolic syndrome, considering psychosocial and work-related factors in the model. This finding is consistent with other studies, which have reported an association between risk perception and CVD risk factors (Barnhart *et al.*, 2009; Frijling *et al.*, 2004). Because of the high prevalence of CVD risk factors and low risk perception, any strategy to prevent the risk of CVD should begin by explaining the severity of CVD and an individual's susceptibility to it. It should include personalized information about risk perception to dispel misconceptions and encouraging talks about real risks. Nevertheless, more insight is needed about what kinds of risk communication are the most effective.

Low social support has been significantly associated with metabolic syndrome for women enrolled in this study. Female blue-collar workers with lower social support have a higher rate of metabolic syndrome. This finding suggests that female blue-collar workers need social support to decrease metabolic syndrome in the workplace and strategies to lower their risk of metabolic syndrome. Thus, the role of occupational health professionals is pivotal in providing female blue-collar workers with social support and skills to participate in risk reduction behavior to prevent CVD. However, no relationship was demonstrated between social support and metabolic syndrome among male workers, which is consistent with a recent study that explored the effect of social support on CVD risk (Fan *et al.*, 2012). It is worth noting that job stress has a greater effect on a women's metabolic syndrome than social support.

As a result, although not significant, the OR of overtime suggested that overtime work decreases metabolic syndrome in both male and female blue-collar workers. This could be a HWE, in which blue-collar workers who overwork with metabolic syndrome withdraw from the workplace.

This is the first study examining the relationship between psychosocial factors and metabolic syndrome in Korean blue-collar workers, including female blue-collar workers. Specifically, the findings of this study can provide a baseline for future studies for the improvement of metabolic syndrome in this population. This study, however, has several limitations. First, because it used a cross-sectional design, the research cannot determine if the relationship between risk perception and metabolic syndrome was due to recent changes in health habits. For that analysis, a prospective study is required. Longitudinal research or experimental designs are more likely to provide better insight into causal relationships than cross-sectional studies, which identify descriptive data or associations (Hulley, Cummings, Browner, Grady, & Newman, 2007).

Second, although the study attempted to use comprehensive measures (objective and subjective measures), the self-report survey limits the findings by under- and over-reporting the variables related to affectivity or social desirability. Specifically, self-report of overtime work may not represent actual overwork, may contain error, and may under- or overestimate actual overwork. In addition, activity levels such as housekeeping, leisure activities, commute to work, and physical demand of the job were not measured. Furthermore, in terms of social support, only social support at work was measured. Networking with friends and relatives, which may serve as mediating factors, were not accounted for.

Third, only 7.5% of female blue-collar workers were classified as having metabolic syndrome in this study. A small portion of the dependent variable provides different results (Pallant, 2007). For example, high co-worker support was related to lower HDL among female workers. However, it was in accordance with the bivariate relationship. Further study on metabolic syndrome in female blue-collar workers is warranted.

CONCLUSION

This research concludes that metabolic syndrome of blue-collar workers is closely linked to psychosocial factors such as job stress, risk perception, and social support. Both job stress and risk perception influenced or interfered with male and female blue-collar workers' metabolic syndrome. The effects of job stress were especially different between men and women. Hence, effective healthcare management for job stress and risk perception should be considered in future research.

Careful consideration of workers' job stress must be taken into account by sex, as well as teaching male blue-collar workers to reduce job stress and to therefore lower their rate of metabolic syndrome. It also focuses on the need for organizational change and management's commitment to align efforts at work with solid rewards. During workers' health checkups, the assessment of job stress and risk perception of CVD should be considered. For female workers, increasing social support, as well as reducing exposure to hazardous working conditions, would be useful goals for intervention. Management could use strategies aimed at increasing individual and group support, as well as communication, to enhance supervisor and co-worker support.

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