J Occup Health 2011; 53: 334–342

Journal of Occupational Health

Association between Job Stress and Newly Detected Combined Dyslipidemia among Chinese Workers: Findings from the SHISO Study

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Abstract: Association between Job Stress and Newly Detected Combined Dyslipidemia among Chinese Workers: Findings from the SHISO Study: Weixian XU, *et al.* Department of Cardiology, Peking University Third Hospital and Key Laboratory of Molecular Cardiovascular Science, Ministry of Education, China—Objectives: Previous studies examining the association between job stress and blood lipids have produced mixed findings. We sought to investigate the association between job stress and blood lipids among Chinese workers. **Methods:** A total of 544 subjects (367 men and 177 women) without known diseases from the Stress and Health in Shenzhen Workers (SHISO) cross-sectional study were analyzed. Job stress was evaluated by the effort-reward imbalance (ERI) model. The associations between job stress and blood lipids, such as for total cholesterol (TCHO), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), were explored by multiple linear regression. The association between job stress and combined dyslipidemia was examined by multiple logistic regression. **Results:** Compared with their corresponding low level groups, groups with high levels of effort, overcommitment and ERI had a significantly increased risk of combined dyslipidemia with adjusted odd ratios (ORs) of 3.5 (95% CI 1.8–6.7), 4.2 (95% CI 2.3–7.7) and 2.7 (95% CI 1.5–5.1), respectively, whereas high rewards significantly reduced the risk of combined dyslipidemia (adjusted OR 0.3, 95% CI 0.2–0.6) compared with low rewards. Effort, overcommitment and ERI were significantly positively related to TG and LDL-C, while rewards were inversely related to them. No significant associations were observed between job stress and TCHO and HDL-C. The results were similar for men and women. **Conclusions:** Effort, overcommitment, low reward and ERI increased the risk of dyslipidemia among Chinese workers, and they were significantly associated with TG and LDL-C rather than TCHO or HDL-C. Increasing blood lipids may be the possible link between job stress and coronary heart disease.
(J Occup Health 2011; 53: 334–342)

Key words: Blood lipids, Dyslipidemia, Effort-reward imbalance, Job stress

Cardiovascular disease (CVD) is the leading cause of death in the world. The CVD epidemic has recently migrated from westernized societies to developing countries[1,2]. Coronary heart disease (CHD) mortality rates have halved in most industrialized countries since the 1980s. However, most developing countries, including China, have experienced substantial increases in CHD mortality in recent decades[3]. In Beijing between 1984 and 1999, the CHD mortality rates rose by 50% in men and 27% in women aged 35–74 yr, and most of these increases could be attributed to dyslipidemia[4]. In Beijing communities, the age- and sex-adjusted standardized prevalences of hypercholesterolemia, high low-density lipoprotein cholesterolemia (LDL-C), low high-density lipoprotein cholesterolemia (HDL-C) and hypertriglyceridemia were 9.3, 2.6, 18.8 and 16.8%, respectively. Prevalence of dyslipidemia was 31.2%[5]. Dyslipidemia is one of the most important independent risk factors for CHD. Aside from a westernized diet and lifestyles, other factors may account for the dramatic increase in the prevalence of dyslipidemia in China; the most common and significant is job stress caused by the

Received Jan 30, 2011; Accepted Jun 17, 2011
Published online in J-STAGE Aug 5, 2011
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huge socioeconomic transition in China.

Previous studies examining the association between job stress and dyslipidemia raise the following important questions for research. First, the studies have been extensively conducted in developed countries and regions, but not in China, where the incidence of CHD, socioeconomic status, labor market and culture may largely differ. Second, job stress is mostly assessed by the job demand-control model (JDCM)[6] developed by Karasek in 1979 according to the characteristics of assembly line production. JDCM does not work as well for service jobs as it does for blue-collar ones[7]. The effort-reward imbalance (ERI) model[8], an alternative job stress model developed by Siegrist in 1996, which focuses on a negative trade-off between experienced "costs" and "gains" at work, has attracted considerable attention in occupational health as a new evaluation method of occupational stress, and it might have more explanatory power, especially from the standpoint of socioeconomic aspects[9, 10]. This model consists of three scales: effort (psychological and physical demands at work), rewards (salary, esteem and career opportunities, including job security) and overcommitment (an individual's exhaustive, work-related and coping style). A mismatch between high effort and low rewards, known as effort-reward imbalance (ERI), is an extrinsic or situational component of the demands of a job, whereas overcommitment is an intrinsic or personal component of the attitudes, behaviors and emotions toward excessive striving combined with a strong desire for approval and esteem. Few studies[11–13] have included ERI in their exposure assessments, and they provide mixed findings. The WOLF study[11] showed that ERI was associated with increased TCHO among men and that overcommitment was related to increased LDL-C levels. However, two other studies[12, 13] showed that neither ERI nor overcommitment was related to blood lipids. Third, total cholesterol (TCHO) has been widely used, while LDL-C, which is regarded as the most important component contributing to atherosclerosis, is seldom included[14]. More importantly, the conflicting results make it difficult to understand the relation between job stress and dyslipidemia. In a recent review[15], among 23 studies examining the association between job stress and TCHO, 9 studies showed positive association, 11 studies provided null findings and 3 studies noted an inverse association. Little is known about the association between job stress and dyslipidemia as evaluated by the ERI model in the Chinese population[16]. For the purpose of prevention and treatment of CHD, clarifying the association between job stress and dyslipidemia in the Chinese population is of great interest.

The goal of the present study was to examine the associations between job stress, as evaluated by the ERI model, and various blood lipid components, such as TCHO, triglycerides (TG), HDL-C and LDL-C, as well as combined dyslipidemia, which is defined as positive according to any of the following conditions: TCHO>200 mg/d*l*, TG>150 mg/d*l*, LDL-C>140 mg/d*l* and/or HDL-C< 40 mg/d*l*[17].

Methods

Subjects

The Stress and Health in Shenzhen Workers (SHISO) study was a cross-sectional study that aimed to evaluate the impact of job stress on physical health in Shenzhen workers. Nine hundred working people from different occupations, including civil servants, managers, teachers, policemen and other white-collar workers, were invited to participate in this study as they underwent their annual medical evaluation at the Peking University Shenzhen Hospital from June 2008 to February 2009. A total of 881 people took part in this SHISO study (with a participation rate of 97.9%). Participants with incomplete questionnaires or missing blood lipids results (n=65) were excluded. We also excluded subjects with a history of or newly detected diseases during this medical checkup, including heart disease (n=64), peripheral arterial or cerebrovascular diseases (n=21), hypertension (n=162) or diabetes mellitus (n=42) (some of them had combined risk factors). To minimize biases in the report of patients who knew their history by overreporting their job stress level, subjects with a known history of dyslipidemia (n=71) were also excluded. The final study population consisted of 544 participants (367 men and 177 women). Subjects were divided into two groups (normolipidemia and dyslipidemia) according to their blood lipid levels. The study was performed in accordance with the Declaration of Helsinki. The procedures were fully explained to the subjects before the survey, and informed consent was obtained.

Measurement of blood lipids

After overnight fasting, blood specimens were collected by venous puncture between 8:00 and 10:00 in the morning and handled according to normal clinical practices for the analysis of blood lipids, including TCHO, TG and HDL-C. All samples were analyzed by a commercial lipid panel analyzer utilizing reflectance photometry. The LDL-C was calculated for specimens having a triglyceride concentration of <400 mg/d*l* using the Friedewald formula[18]. The LDL-C determined by nuclear magnetic resonance spectroscopy was used instead of the calculated LDL-C for subjects with triglyceride concentrations>400 mg/d*l*[19]. Combined dyslipidemia was defined as positive according to any of the following conditions: TCHO>200 mg/d*l*, TG>150 mg/d*l*, LDL-C>140 mg/d*l* and/or HDL-C< 40 mg/d*l*[17].

Questionnaire

A standardized questionnaire, which included information on age, job types, job stress status, past history of chronic diseases regarding primary hypertension, diabetes mellitus, dyslipidemia, heart disease and peripheral or cerebral vascular diseases, was given to the subjects to complete on their own. Trained interviewers gave instructions to complete the questionnaire, and they were on site so that the subjects could ask questions regarding the questionnaire.

Job stress was evaluated using the Chinese version of the 23-item effort-reward imbalance questionnaire (ERI-Q) developed by Li *et al.*[20] in accordance with Siegrist's ERI-Q. The ERI-Q consists of three scales, including extrinsic effort, representing job demands imposed on the employee (6 items), reward, which consists of income, respect, job security and career opportunities (11 items) and overcommitment, which defines a set of attitudes, behaviors and emotions reflecting excessive striving combined with a strong desire for approval and esteem (6 items). The responses to each item of the effort scale were scored on a 5-point scale, where a higher value means higher stressful effort (1=no stressful experience to 5=very stressful experience). Each item of the reward scale was also scored on a 5-point scale, where a higher value implies a higher level of reward, i.e., a value of 1 indicates a very low level of reward, and 5 indicates a very high level of reward. Each item of the overcommitment scale was scored on a 4-point scale (1=full disagreement to 4=full agreement). The ERI index was calculated using the following formula: ERI=11 × effort / (6 × reward). Cronbach's coefficients of effort, reward and overcommitment were 0.74, 0.82 and 0.83, respectively, in the total sample, 0.73, 0.80 and 0.83, respectively, in men, and 0.77, 0.86 and 0.82, respectively, in women.

Quality control of data

All the data were entered into a computer by two different persons with the use of EpiData software. Consistency tests were performed by the software, and two persons double checked the data to ensure accuracy.

Data analysis

Subjects were categorized into three groups (low, intermediate and high) based on the job stress indicator tertiles defined according to the distribution of scores. The comparison of the means for each blood lipid component between the three groups was analyzed by one-way ANOVA. The association between each job stress variable and dyslipidemia was separately explored by multiple logistic regression analysis in which different confounders were controlled in a stepwise manner. The linear regression model separately explored the associations between each job stress indicator and each blood lipid component (TCHO, TG, HDL-C and LDL-C), and all variables were examined as continuous variables. The linear regression analyses were performed separately for women and men. All tests were two-tailed, and a value of $p<0.05$ was considered statistically significant. Statistical analysis was performed using SPSS 13.0 for Windows.

Results

Ninety-nine of the 544 subjects had dyslipidemia (the prevalence rate was 18.2%). Table 1 shows a comparison of the means for each blood lipid component between the three groups with different job stress levels. Subjects with high effort, or high overcommitment or high ERI had significantly higher means for TG and LDL-C compared with the low level groups. However, the high reward group had significantly lower TG and LDL-C levels than the low reward group.

Table 2 shows a summary of the multiple logistic regression analyses performed to examine the association between job stress and dyslipidemia. Compared with the group with a low level of effort, groups with intermediate and high levels of effort had an increased risk of developing dyslipidemia, with odds ratios (ORs) of 2.4 (95% CI 1.4–3.9) and 4.2 (95% CI 2.2−7.9), respectively. After adjustment for age, sex, length of service and body mass index (BMI), the associations were still robust, with ORs of 1.9 (95% CI 1.1−3.2) and 3.5 (95% CI 1.8−6.7). Similarly, overcommitment and ERI were significantly positively related to the occurrence of dyslipidemia, with adjusted ORs of 3.9 (intermediate overcommitment, 95% CI 2.2−7.0), 4.2 (high overcommitment, 95% CI 2.3−7.7), 2.3 (intermediate ERI, 95% CI 1.3−4.2) and 2.7 (high ERI, 95% CI 1.5−5.1), respectively, compared with the corresponding low level groups. However, the high rewards group showed a significantly reduced risk of dyslipidemia (adjusted OR 0.3, 95% CI 0.2–0.6) compared with the low rewards group.

Tables 3 and 4 summarize the associations between each job stress indicator and blood lipid components, including TCHO, TG, HDL-C and LDL-C, as determined by linear regression analysis, in men and in women, respectively. Effort, overcommitment and ERI were significantly positively related to TG and LDL-C, rewards were inversely related to TG and LDL-C and no significant associations were observed between job stress and TCHO and HDL-C. The results were similar for men and women.

Discussion

In the present study, job stress indicators, such as high effort, overcommitment and ERI indicated a 3- to 4-fold increased risk of combined dyslipidemia, while high reward reduced the risk of combined dyslipidemia by 70% compared with the low level groups after adjustment for age, sex, length of service and BMI. Dose-response relationships were observed for each association. Effort, overcommitment and ERI were positively associated with TG and LDL-C, whereas reward was inversely related to

Table 1. Comparison of the mean blood lipid values among the low, intermediate and high level groups of each job stress variable by one-way ANOVA

Variable	TCHO (mg/d*l*)	TG (mg/d*l*)	HDL-C (mg/d*l*)	LDL-C (mg/d*l*)
Effort				
Low	160.8 ± 14.0	132.4 ± 44.1	34.6 ± 3.8	103.8 ± 15.4
Intermediate	167.8 ± 21.0	167.6 ± 61.8	34.6 ± 3.8	107.7 ± 15.4
High	195.8 ± 31.5	167.6 ± 79.4	38.5 ± 23.1	115.4 ± 19.2
p	0.006	<0.001	0.006	<0.001
Reward				
Low	171.3 ± 10.5	167.6 ± 70.6	34.6 ± 15.4	107.7 ± 15.4
Intermediate	167.8 ± 17.5	141.2 ± 52.9	38.5 ± 3.8	103.8 ± 23.1
High	164.3 ± 14.0	141.2 ± 44.1	34.6 ± 3.8	107.7 ± 15.4
p	0.426	<0.001	0.534	0.003
OVC				
Low	164.3 ± 17.5	132.4 ± 44.1	34.6 ± 3.8	103.8 ± 15.4
Intermediate	164.3 ± 17.5	158.8 ± 61.8	34.6 ± 3.8	107.7 ± 15.4
High	185.3 ± 24.5	176.5 ± 70.6	38.5 ± 19.2	111.5 ± 19.2
p	0.055	<0.001	0.154	0.001
ERI				
Low	167.8 ± 14.0	132.4 ± 35.3	34.6 ± 3.8	103.8 ± 15.4
Intermediate	164.3 ± 21.0	167.6 ± 61.8	34.6 ± 3.8	107.7 ± 19.2
High	181.8 ± 14.0	167.6 ± 61.8	38.5 ± 19.2	111.5 ± 15.4
p	0.112	<0.001	0.082	0.001

TCHO: total cholesterol. TG: triglycerides. HDL-C: high-density lipoprotein cholesterol. LDL-C: low-density lipoprotein cholesterol. OVC: overcommitment. ERI: effort-reward imbalance.

Table 2. Associations between each job stress indicator and combined dyslipidemia by multiple logistic regression analysis among the total sample

Variable	Step 1	Step 2	Step 3	Step 4	Step 5
Effort					
Low	1.0	1.0	1.0	1.0	1.0
Intermediate	2.4 (1.4–3.9)	2.4 (1.4–3.9)	2.3 (1.4–3.8)	2.0 (1.2–3.3)	1.9 (1.1–3.2)
High	4.2 (2.2–7.9)	4.1 (2.2–7.9)	4.1 (2.1–7.8)	3.6 (1.9–6.9)	3.5 (1.8–3.7)
Reward					
Low	1.0	1.0	1.0	1.0	1.0
Intermediate	0.7 (0.4–1.1)	0.7 (0.4–1.1)	0.7 (0.4–1.2)	0.7 (0.4–1.3)	0.8 (0.5–1.3)
High	0.3 (0.2–0.5)	0.2 (0.1–0.4)	0.3 (0.1–0.5)	0.3 (0.2–0.6)	0.3 (0.2–0.6)
OVC					
Low	1.0	1.0	1.0	1.0	1.0
Intermediate	3.8 (2.2–6.6)	4.3 (2.4–7.7)	3.9 (2.2–7.0)	3.9 (2.1–6.9)	3.9 (2.2–7.0)
High	4.9 (2.7–8.9)	5.1 (2.8–9.3)	4.8 (2.6–8.7)	4.4 (2.4–8.0)	4.2 (2.3–7.7)
ERI					
Low	1.0	1.0	1.0	1.0	1.0
Intermediate	3.1 (1.8–5.5)	3.3 (1.9–5.8)	2.9 (1.7–5.2)	2.4 (1.3–4.3)	2.3 (1.3–4.2)
High	3.2 (1.8–5.9)	3.5 (1.9–6.4)	3.3 (1.8–6.1)	2.9 (1.6–5.4)	2.7 (1.5–5.1)

The numbers in the table are ORs (95% CI). Combined dyslipidemia is defined as positive according to any of the following conditions: TCHO>200 mg/d*l*, TG>150 mg/d*l*, LDL-C>140 mg/d*l* and/or HDL-C<40 mg/d*l*. OVC: overcommitment. ERI: effort-reward imbalance. Step 1: no confounder was included. Step 2: adjusted for age. Step 3: adjusted for age and sex. Step 4: adjusted for age, sex and length of service. Step 5: adjusted for age, gender, length of service and body mass index.

Table 3. Association between each job stress variable and blood lipids by multiple linear regression analysis for men

Variable	Step 1			Step 2		
	B	Beta	*p*	B	Beta	*p*
TCHO						
Effort	0.05	0.076	0.156	0.037	0.054	0.326
Reward	–0.039	–0.091	0.081	–0.031	–0.071	0.206
OVC	0.053	0.08	0.125	0.036	0.054	0.315
ERI	1.222	0.111	0.033	0.899	0.08	0.14
TG						
Effort	0.059	0.316	<0.001	0.046	0.244	<0.001
Reward	–0.031	–0.261	<0.001	–0.027	–0.219	<0.001
OVC	0.066	0.352	<0.001	0.056	0.299	<0.001
ERI	0.966	0.312	<0.001	0.775	0.246	<0.001
HDL-C						
Effort	0.005	0.062	0.236	0.007	0.096	0.081
Reward	0.001	0.02	0.697	–0.002	–0.032	0.569
OVC	0.003	0.046	0.278	0.005	0.071	0.18
ERI	0.057	0.046	0.382	0.017	0.084	0.119
LDL-C						
Effort	0.024	0.203	<0.001	0.02	0.165	0.002
Reward	–0.003	–0.038	0.468	–0.004	–0.055	0.321
OVC	0.033	0.278	<0.001	0.03	0.255	<0.001
ERI	1.222	0.111	0.033	0.899	0.08	0.14

Step 1: no confounder was included. Step 2: adjusted for age, sex, length of service and body mass index. TCHO: total cholesterol. TG: triglyceride. HDL-C: high-density lipoprotein cholesterol. LDL-C: low-density lipoprotein cholesterol. OVC: overcommitment. ERI: effort-reward imbalance.

Table 4. Association between each job stress variable and blood lipids by multiple linear regression analysis for women

Variable	Step 1			Step 2		
	B	Beta	*p*	B	Beta	*p*
TCHO						
Effort	0.003	0.028	0.716	–0.005	–0.036	0.633
Reward	0.003	0.049	0.518	–0.004	–0.064	0.475
OVC	–0.022	–0.158	0.036	–0.013	–0.096	0.231
ERI	–0.066	–0.034	0.65	–0.071	–0.036	0.645
TG						
Effort*	0.025	0.205	0.006	0.024	0.181	0.011
Reward	–0.002	–0.027	0.722	–0.017	–0.247	0.003
OVC*	0.017	0.125	0.098	0.036	0.26	0.001
ERI*	0.329	0.173	0.022	0.463	0.234	0.001
HDL-C						
Effort	0	0.01	0.898	0	0.018	0.807
Reward	–0.001	–0.104	0.169	0	–0.019	0.832
OVC*	0.002	0.082	0.279	–0.005	–0.004	0.963
ERI	0.013	0.037	0.624	0.003	0.008	0.916
LDL-C						
Effort	0.02	0.186	0.013	0.017	0.151	0.035
Reward	0.002	0.026	0.729	–0.011	–0.182	0.031
OVC*	0.027	0.23	0.002	0.039	0.323	0
ERI	0.176	0.105	0.166	0.27	0.154	0.034

Step 1: no confounder was included. Step 2: adjusted for age, sex, length of service and body mass index. TCHO: total cholesterol. TG: triglyceride. HDL-C: high-density lipoprotein cholesterol. LDL-C: low-density lipoprotein cholesterol. OVC: overcommitment. ERI: effort-reward imbalance. *: $p<0.05$.

TG and LDL-C. No significant associations were found between job stress indicators and TCHO and HDL-C. The results were similar for men and women.

Our findings support the ERI model, which indicates that the mismatch between efforts provided and rewards gained in the workplace would have an adverse effect on health. Effort, reward and overcommitment also had significant effects on combined dyslipidemia. Our results are in line with those of previous studies in which job stress was evaluated by the JDC model in both cross-sectional[21–26] and longitudinal designs[27–30]. Few studies have used the ERI model to assess the association between job stress and blood lipids. Our results are consistent with the baseline results from the WOLF study[11], which showed that ERI was associated with increased TCHO (prevalence odds ratio, POR=1.24) and TCHO/HDL-C ratios (POR=1.26–1.30) among men and that overcommitment was related to increased LDL-C (POR=1.37–1.39). Analyses of variance showed increasing mean values of LDL-C with increasing degrees of ERI among men, as well as increased LDL-C among women with high levels of overcommitment. However, two other studies[12, 13] showed that neither ERI nor overcommitment was related to blood lipids. Some factors may account for the null results in these studies. First, selection bias must be considered. The population[13] in a recently downsized corporation was characterized by job insecurity. More than 10% of the workers who had been laid off one year before the study may have developed serious health impairments. In Vrijkotte's study[12], the response rate was low (57%). Workers may have hesitated to respond to the questionnaire because they felt uncomfortable appraising themselves in the workplace, and selection bias from healthy worker effects may have led to null results. Second, people with diseases such as hypertension and diabetes mellitus, which are confounding factors, may have overreported their job stress. This reporting bias may have resulted in the attenuation of the association between job stress and blood lipids after adjustment for these confounding factors. Third, as previously mentioned, job stress was assessed at only one point in time, causing underestimations of its association with various blood lipid components, especially when the job was very unstable[31].

Our findings are similar to the results from other Chinese samples. Su[26, 32] reported that job strain evaluated by JDCM was significantly associated with TG, but not TCHO and HDL, among white-collar workers in Taiwan. A study[16] among the university staff in Yunnan Province showed that high ERI increased the risk of hypertriglyceridemia 3.5-fold and that high overcommitment increased the risk of increased LDL-C (OR=2.86) compared with the low level groups. Why are there strong associations between job stress and dyslipidemia, as observed in our study? First, the study population is unique and completely represents Chinese workers during a time of great socioeconomic transition; the working conditions of the Chinese are significantly different from those in Western societies. China, with its huge manufacturing sector, is often referred to as the factory of the world. The work is hard, facilities are poor and the wages are low. The average monthly wage of China's factory worker was $234 in 2007, and the hourly labor costs in China ($0.60) are dramatically lower than that in Western societies (Britain $19.50; and the United States $21.60; http://factsanddetails.com). However, Chinese workers are hard-working and obedient due to the culture of nationalism, stability and harmony. This, in combination with a fear of past poverty and the opportunities of the present, has created a uniquely motivated population. During China's transition from a planned-economy to a market economy, the labor market has undergone significant changes over the last three decades. Trade liberalization, deregulation, privatization and reduced welfare programs have resulted in increased job demands, work hours and control, while reduced rewards and social support make work more precarious. The conflicts between employers and employees have sharply increased, but workers are inadequately protected by the current laws and regulations. Shenzhen is one of the earliest cities in which the economic policy changed, and the transition has spread throughout the entire country. The effect of job stress on dyslipidemia, as determined in our study, may differ from that in other populations in developed countries and regions because of variations in the labor market, economic policy, culture and race. Second, job stress was evaluated by the ERI model, which may have more explanatory power, especially from the standpoint of socioeconomic aspects[9, 10]. In our previous studies, ERI was found to be related to coronary artery disease and carotid intima-media thickness in Chinese workers[33, 34]. Third, the study had good quality control. We used a standard questionnaire and standard procedures. All the researchers were trained before the procedure, and they were on hand during the survey to provide key instructions for completing the questionnaires and answer relevant questions asked by the participants. After the survey, all data were double checked by both software and hand. In the analysis, we excluded subjects with a history of hypertension, diabetes or cardiovascular disease, as well as the subjects with a known history of dyslipidemia, to limit the reporting bias. We used different methods to explore the association between job stress and blood lipids by multiple logistic regression and multiple linear regression to ensure the accuracy of the results. However, the criteria for dyslipidemia in our study[17] were lower than those of the Third Report of the National Cholesterol Educational Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults[35]. Furthermore, we not only focused on each blood lipid component, but also on the combined effect of blood lipids given that any kind of dyslipidemia was a risk factor for cardiovascular disease. The use of lower criteria and combined dyslipidemia could cause the results to differ from those of previous studies. To the best of our knowledge, this is the first study to observe the dose-response relationship between job stress and combined dyslipidemia.

Several limitations of this study need to be addressed. First, as our study was cross-sectional, we could not draw a cause-effect conclusion. Second, residual confounding due to deficient and/or incomplete adjustment is an important limitation. The association between job stress and dyslipidemia should be adjusted by well-known confounding factors, such as drinking, smoking and eating habits and physical activity, among others. The type of job held by participants also affects dyslipidemia. Unfortunately, our study did not include these confounders in the analysis. Although the smoking rate was high among Chinese men, the smoking and alcohol drinking rates among Chinese women were very low[36]. Thus, the effect of smoking negligibly affects the results in women. BMI is associated with eating habits and physical activity. We adjusted for BMI as an indicator of them, given that we failed to collect information on diets, which varied every day, and obtaining accurate data was relatively difficult. In our study, many employers provided lunch to their employees as a benefit. Thus, the eating habits of the employees may be similar. The exact mechanism that links job stress and blood lipids remains incompletely elucidated. There are two hypotheses for this mechanism: the direct neuroendocrine pathway and the indirect behavioral pathway. ERI has been associated with an increased risk of sedentary lifestyle[7]. In a cross-sectional survey of a sample of 36,127 public sector employees, ERI was found to be related to the co-occurrence of lifestyle risk factors, such as smoking, drinking, obesity and physical inactivity[37]. An unhealthy lifestyle may also contribute to the dyslipidemia. Socioeconomic status, as indicated by income, educational level and occupation, is another important confounder that may affect the risk of CHD. While a higher social status in a developed country is related to a lower risk for CHD, there is a greater risk for CHD among higher socioeconomic groups in developing countries[38]. Recent research conducted in Japan—an industrialized, non-Western country—did not find an association between socioeconomic status and cardiovascular disease[39, 40]; therefore, the findings for socioeconomic status and CHD are contradictory. Furthermore, patient information was confidential in this study, and gaining accurate information on the socioeconomic status of participants was difficult; thus, this factor was excluded in our analysis. Third, our assessment of job stress was limited by the fact that the results were based on a single measurement. It did not consider the duration of job stress, a participant's job status in previous jobs or the possible effect of periods of unemployment. Longitudinal studies in large samples, from which more information can be collected, are necessary to investigate the effect of job stress on CHD risk factors.

In summary, job stress indicators, such as high effort, overcommitment and ERI, showed an increased risk of dyslipidemia, mainly due to increased levels of TG and LDL, in both Chinese men and women. Reducing job stress may decrease TCHO and TG levels and the LDL/HDL ratio[41]. In our study, the awareness rate of dyslipidemia was very low in the Chinese population (42%). The high prevalence, low awareness and low treatment rate of dyslipidemia will definitely exaggerate the CHD burden in China. Clarification of the association between job stress and health in the Chinese population may potentially assist Chinese policy makers in developing new policies for reducing job stress. This is of great interest for the prevention of CHD, particularly since the incidence and mortality of CHD is dramatically increasing in China. Taking measures to improve the job stress status of Chinese workers with respect to CHD prevention is crucial and of utmost importance.

Acknowledgments: The authors thank Rong Shi, Wenshuang Zeng, Yuanfei Deng, Haiou Yang, Jian Li, Paul Landsbergis and Peter Schnall for their help. This study was supported by the Major National Basic Research Program of the P.R. China (No. 2007CB512107 to W. G.).

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