Original Article

Relationship between Job Stress and Hypo-high-density Lipoproteinemia of Chinese Workers in Shanghai: The Rosai Karoshi Study

Tomohiko Muratsubaki[1], Tomomi Hattori[2], Jue Li[3], Shin Fukudo[1], Masanori Munakata[2,4]

[1]Department of Behavioural Medicine, Tohoku University Graduate School of Medicine, Sendai 980-8575, Japan
[2]Research Centre for Lifestyle-Related Disease, Tohoku Rosai Hospital, Sendai 981-8563, Japan
[3]Heart, Lung and Blood Vessel Research Centre, Tongji University School of Medicine, Shanghai 200092, China
[4]Division of Hypertension, Tohoku Rosai Hospital, Sendai 981-8563, Japan

Abstract

Background: Karoshi, or death due to overwork, has now become a serious social problem in China. Worsening of cardiovascular risks by stress might initiate karoshi. Many studies have examined the relationship between job stress and obesity, hypertension, and type 2 diabetes mellitus, but less evidence exists for dyslipidemia like hypo-high-density lipoproteinemia (hypo-HDL). The aim of this study was to investigate the relationship between job stress and hypo-HDL of Chinese workers in Shanghai.
Methods: We studied 2219 Chinese workers in Shanghai, who participated in the Japan-China cooperative study for the prevention of karoshi. A questionnaire was administered to examine the lifestyle characteristics, job category, weekly working hours, and job stress. Job demand and job control were quantified using the National Institute for Occupational Safety and Health questionnaire. Modified job strain measure was defined by the combination of low job control and high demand. Hypo-HDL was defined as plasma high-density lipoprotein cholesterol concentration of <1.04 mmol/L (40 mg/dl). Multivariate logistic regression analysis was performed for hypo-HDL as a dependent variable.
Results: Modified job strain was not related to hypo-HDL either in men or women. In men, multivariate adjusted odds ratio (*OR*) for having hypo-HDL was significantly higher in the lowest job control tertile compared with the highest job control tertile (*OR* = 1.39, 95% confidence interval [*CI*] 1.03–1.87, *P* = 0.034). In the same model, a similar trend was observed for women, but it did not reach a statistically significant level (*OR* = 1.51, 95% *CI*, 0.88–2.56, *P* = 0.132).
Conclusion: A low level of job control but not modified job strain was significantly related to higher prevalence of hypo-HDL of Chinese workers in Shanghai.

Key words: Chinese Workers; Hypo-high-density Lipoproteinemia; Job Stress

Introduction

Rapid economic growth increases the demand for labor. In most developing countries, legal systems to protect employees from overwork have not been fully established. In such circumstances, long working hours often result in health problems. Japan experienced such a situation in the period of dramatic economic growth following the World War II. In the late 1970s, the incidence of death from brain or heart disease caused by overwork was named “karoshi.”[1]

Karoshi has now become a serious social problem in China, which is achieving rapid economic growth. The Chinese Social Media have reported that nearly 600,000 people die from overwork in the mainland of China.[2] In a survey of the general population in 5 cities in China, 36.8% reported severe stress.[3] The working generation of those aged

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Address for correspondence: Prof. Masanori Munakata, Division of Hypertension, Tohoku Rosai Hospital, 3-21, Dainohara 4, Aoba-ku, Sendai 981-8563, Japan
E-Mail: munakata@tohokuh.rofuku.go.jp

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35–44 years accounted for a considerable degree of this percentage.[3] It is known that obesity, hypertension, type 2 diabetes mellitus, and dyslipidemia are risk factors for the incidence of brain and heart diseases.[4-6] Many studies[7-12] have examined the relationship between job stress and obesity, hypertension, and type 2 diabetes mellitus, but only a few studies have focused on the relationship between job stress and dyslipidemia.

Both hyper-low-density lipoproteinemia and hypo-high-density lipoproteinemia (hypo-HDL) are risk factors for atherosclerotic cardiovascular diseases.[13] However, the influence of each dyslipidemic condition on cardiovascular events might differ between Asian and non-Asian populations. A large cohort study conducted in the Asian-Pacific area has shown that the prevalence of hypo-HDL was higher in Asian than in non-Asian populations.[14] Moreover, isolated hypo-HDL was an independent risk factor for cardiovascular disease in Asian people, including Chinese, but this was not the case in Caucasians in New Zealand and Australia.[14] Recently, we have reported that hypo-HDL is a better predictor for stroke than other lipid measures in the Japanese general population.[15] Therefore, it is important to examine the treatment of isolated hypo-HDL in the prevention of cardiovascular diseases in Asian people.

There are several pharmacological choices for the treatment of hyper-low-density lipoproteinemia; however, none of the therapeutic drugs to increase high-density lipoprotein cholesterol (HDL-C) have succeeded in improving cardiovascular prognosis.[16] Thus, nonpharmacological therapy is a more realistic strategy for hypo-HDL. It is well recognized that increases in body weight or smoking reduce HDL-C while regular exercise and alcohol intake increase HDL-C.[17] However, only a few studies have examined the relationship between job stress and HDL-C in Asian people.[18-20]

The aim of this study was to examine the relationship between job stress and hypo-HDL of Chinese workers in Shanghai who participated in the Japan-China cooperative study for the prevention of karoshi.[7,21]

There have been three major job stress models such as effort-reward imbalance model,[22,23] job-demand-control model,[24] and the model of organizational justice.[25] It has been well recognized that these models predict cardiovascular diseases,[26] lipid profiles,[20] and metabolic syndrome.[8-10] In this study, we used job-demand-control model because we have used the questionnaire of the National Institute for Occupational Safety and Health (NIOSH),[27] which quantified job control and job demand, allowing to determine the modified version of job strain condition. We focused not only on job strain but also its individual components because recently we found in the Japanese male workers that lower job control was independently associated with higher diastolic blood pressure.[11]

Methods

Study population

We studied Chinese individuals in Shanghai who underwent health evaluations at the Shanghai Tongji University Medical Hospital or its related institutions. The registration period for this study was from October 2010 to November 2011. During this period, 2994 consecutive Chinese individuals (mean age, 45.5 ± 11.5 years; 60% men) were registered in this study. The participants visited the health check-up centers after overnight fasting. They were initially requested to answer a questionnaire, followed by anthropometric measurements and blood sampling. Blood was collected from the antecubital vein in the morning from 8 to 10 a.m. at least 10 h after fasting.

Questionnaire and measurements

For the questionnaire, the participants were asked about their age, gender, race, marital status, education, medical history, family history, history of present illness, smoking status, drinking status, and exercise habits. Regarding work-related information, the participants were asked about the category of their work (managerial, service, professional, technical, mechanical operation, clerkship, manual labor, and others) and the number of weekly work hours (<25, 25–34, 35–44, 45–54, and ≥55 h). Regarding daily-life information, participants were asked about their usual weekday sleep hours during the previous year, the average hours of walking/day (almost none, <1, 1–2, and >2 h), and their food intake (usually moderate, moderate due to health issues, sometimes small and sometimes large, and mostly until full).

To examine job stress, we used a stress questionnaire that was edited by the NIOSH. The validity of this questionnaire has been reported both in English and Japanese.[27,28] Among 13 scales on job stressors, we selected 2 scales concerning quantitative job requirement and job control. Quantitative job requirement is a 4-item scale that measures how much quantity the respondent has to treat/deal with one's daily job (distribution of scores, 4–20; a higher score indicates higher stress) and, thus, is considered as a measure for "job demand." Job control is a 16-item scale that measures how much the respondent feels one's tasks, workplace setting, and decision at work are controllable (distribution of scores, 16–80; a lower score indicates higher stress).

The Japanese version was translated into Chinese by two independent bilingual translators, and each examined the accuracy of the translation of the other, leading to final agreement. The α-coefficients of job control and job demand in 2219 Chinese workers were 0.99 and 0.96, respectively. The variance ratios explaining the primary comportments of job control and job demand by principal component analysis were 81.9 and 89.2, respectively. These α-coefficients and the variance ratios indicated that the Chinese version of the NIOSH stress questionnaire had a sufficient internal consistency and factorial validity.

We considered modified version of job strain model based on job demand and job control measures examined by the

NIOSH. According to the previous reports,[12] high job demand was defined by the score higher than the median of whole group; similarly, low job control was defined by the score lower than the median. We defined binary variable for job stress: job strain (high demands and low control) versus no job strain (all other combinations).

Height and body weight were measured after the completion of the questionnaire. Next, fasting blood was collected to examine lipid profiles (low-density lipoprotein cholesterol [LDL-C], HDL-C, and triglycerides). Plasma levels of HDL-C and LDL-C were estimated by automated analyzer using commercially available kits (Sekisui Medical, Japan).[29] Triglyceride was measured using assay kit purchased from BioAssay Systems (CA, USA).[30] To ensure the accuracy of measurements, all laboratories in this study successfully completed a standardization and certification program of the Shanghai Quality Control Centre. This study was approved by the Ethics Committees of Tohoku Rosai Hospital and Tongji University Medical Hospital. All cases provided written informed consent.

Statistical analysis

After excluding cases with missing data for lipid profiles (n = 775), 2219 cases (mean age, 44.0 ± 10.6 years; 1412 men; response rate, 74.1%) were included in the statistical analysis. All data are expressed as mean and standard deviation (SD). Cases were divided into two groups according to the presence or absence of hypo-HDL; hypo-HDL was defined as a plasma HDL-C concentration of <1.04 mmol/L (40 mg/dl).[31,32] Unpaired t-test and Chi-squared tests were used to compare the groups.

Job stress condition was categorized as job strain and nonjob strain. Job strain components, or job control and job demand scores also were divided into tertiles. The number of weekly working hours was categorized as <45, 45–54, and ≥55 h, and the group working <45 h served as the reference because the legal number of working hours per week in China is <45 h. Multivariate logistic regression analysis was conducted using hypo-HDL as the dependent variable. Both crude and adjusted odds ratios (*OR*s) and 95% confidence intervals (*CI*s) were calculated to examine the association between job strain or its components and hypo-HDL. Data were analyzed according to gender because a previous study reported that men and women experienced different stressors at work.[33]

We examined two logistic regression models. The first model was crude and the second model was fully adjusted. In the analysis for hypo-HDL as dependent variables, the model was adjusted for age, body mass index (BMI), smoking, heavy drinking (over 40 ml/day for men and over 20 ml/day for women in terms of alcohol conversion), exercise habits, the number of hours of walking in a day, weekday sleep hours, the quantity of food intake, use of dyslipidemic agents, and occupational categories. Recent Chinese survey has shown that age- and gender-adjusted standardized prevalence of low HDL-C was 18.8% in Beijing communities.[18] The minimum sample size needed, therefore, would be nearly 585 for each gender. Hence, our sample size seems to be fully satisfied with this level. The lowest tertile group served as the reference for weekly working hours and job demand, and the highest tertile group served as the reference for job control. Statistical analyses were performed using IBM SPSS Statistics (version 20.0; IBM, Somers, NY, USA). $P < 0.05$ was considered statistically significant.

Results

Table 1 compares the clinical characteristics between hypo-HDL and nonhypo-HDL groups by gender. BMI and triglyceride concentration were significantly higher in the hypo-HDL group than in the nonhypo-HDL group in men. LDL-C concentration was lower and LDL/HDL-C ratio was higher in the hypo-HDL group than in the nonhypo-HDL group in both genders. Frequency of the cases with job strain did not differ between hypo-HDL and nonhypo-HDL groups in either gender. Scores for job control was lower in the hypo-HDL group than in the nonhypo-HDL group in women while no job stress scores differed between the hypo-HDL group and the nonhypo-HDL group in men. Lifestyle characteristics such as the smoking status, frequency of heavy drinking, and hours of daily walking did not differ between the hypo-HDL group and the nonhypo-HDL group in either men or women. The distribution of occupational categories differed between the hypo-HDL group and the nonhypo-HDL group in women but not in men. The frequency of weekly working hours was similar between the hypo-HDL group and the nonhypo-HDL group in both genders. Frequency of dyslipidemic agents was significantly lower in the hypo-HDL group than in the nonhypo-HDL group in men.

Table 2 shows the results of logistic regression analysis for hypo-HDL, as dependent variables. On crude analysis, intermediate and low levels of job control were associated with a significantly higher *OR* for having hypo-HDL compared with a high level of job control in male workers (*OR* = 1.40, 95% *CI*, 1.06–1.85, P = 0.018; and *OR* = 1.42, 95% *CI*, 1.07–1.89, P = 0.015, respectively). Those associations were hardly affected by adjustments for age, BMI, lifestyle, dietary factors, use of dyslipidemic agents, and occupational categories (*OR* = 1.39, 95% *CI*, 1.04–1.86, P = 0.028; and *OR* = 1.39, 95% *CI*, 1.03–1.87, P = 0.034, respectively). In female workers, on crude analysis, low level of job control was associated with a significantly higher *OR* for having hypo-HDL compared with a high level of job control (*OR* = 1.75, 95% *CI*, 1.08–2.83, P = 0.023). This significance disappeared after adjustments for multiple covariates (*OR* = 1.51, 95% *CI*, 0.88–2.56, P = 0.132). In binary model of job strain, high job strain was not related to hypo-HDL in either gender.

Discussion

A key finding of this study was that the low job control

Table 1: Clinical characteristics of nonhypo-HDL and hypo-HDL groups by gender

Variables	Men (n = 1412)				Women (n = 807)			
	Nonhypo-HDL (n = 998)	Hypo-HDL (n = 414)	Statistics	P	Nonhypo-HDL (n = 655)	Hypo-HDL (n = 152)	Statistics	P
Age (years)	46.0 ± 10.5	45.5 ± 10.2	0.80*	0.424	40.8 ± 10.2	40.3 ± 9.3	0.53*	0.595
Weight (kg)	72.2 ± 9.8	74.1 ± 9.7	3.32*	0.001	57.4 ± 8.7	59.1 ± 9.5	2.06*	0.040
BMI (kg/m^2)	24.5 ± 2.9	25.1 ± 2.8	3.28*	0.001	22.2 ± 3.1	22.7 ± 3.5	1.93*	0.055
Triglyceride (mmol/L)	1.7 ± 1.6	2.1 ± 1.6	3.96*	<0.001	1.1 ± 1.2	1.2 ± 1.0	1.42*	0.158
HDL-C (mmol/L)	1.3 ± 0.4	0.9 ± 0.1	30.98*	<0.001	1.5 ± 0.3	0.9 ± 0.1	37.15*	<0.001
LDL-C (mmol/L)	3.1 ± 0.8	2.7 ± 0.6	11.06*	<0.001	2.8 ± 0.7	2.5 ± 0.5	6.55*	<0.001
LDL-C/HDL-C	2.3 ± 0.7	2.9 ± 0.6	11.26*	<0.001	2.0 ± 0.7	2.7 ± 0.4	16.08*	<0.001
Job control	49.9 ± 13.4	48.5 ± 12.9	1.77*	0.077	46.0 ± 13.6	43.5 ± 10.0	2.60*	0.010
Job demand	10.2 ± 3.8	10.4 ± 4.0	0.98*	0.327	10.0 ± 3.7	10.2 ± 3.7	0.53*	0.594
Binary job strain category			0.01†	0.908			0.24†	0.621
No job strain	791 (79.3)	327 (79.0)			491 (75.0)	111 (73.0)		
Job strain	207 (20.7)	87 (21.0)			164 (25.0)	41 (27.0)		
Smoking status			0.12†	0.941			1.48†	0.478
Never	487 (48.8)	204 (49.3)			641 (97.9)	150 (98.7)		0.423
Previous	52 (5.2)	23 (5.6)			2 (0.3)	1 (0.7)		
Current	459 (46.0)	187 (45.2)			12 (1.8)	1 (0.7)		
Heavy drinking			2.78†	0.096			0.02†	0.982
No	881 (88.3)	378 (91.3)			650 (99.2)	151 (99.3)		
Yes	117 (11.7)	36 (6.0)			5 (0.8)	1 (0.7)		
Exercise habits			1.67†	0.198			1.00†	0.317
No	582 (58.3)	226 (54.6)			483 (73.7)	106 (69.7)		
Yes	416 (41.7)	188 (45.4)			172 (26.3)	46 (30.3)		
Walking in a day (h)			0.58†	0.901			1.69†	0.640
Almost none	241 (24.4)	103 (25.1)			159 (24.5)	40 (26.3)		
<1	541 (54.7)	223 (54.3)			337 (51.9)	80 (52.6)		
1–2	166 (16.8)	65 (15.8)			115 (17.7)	27 (17.8)		
>2	41 (4.1)	20 (4.9)			38 (5.9)	5 (3.3)		
Weekday sleep (h)			0.85†	0.624			3.64†	0.162
<5	45 (4.5)	23 (5.6)			16 (2.5)	4 (2.6)		
5–6	633 (63.4)	264 (63.8)			363 (55.6)	97 (63.8)		
>6	320 (32.1)	127 (30.7)			274 (42.0)	51 (33.6)		
Quantity of food intake			0.45†	0.930			5.40†	0.145
Usually moderate	438 (44.2)	178 (43.1)			276 (42.3)	77 (50.7)		
Moderate due to health issues	158 (15.9)	63 (15.3)			100 (15.3)	14 (9.2)		
Sometimes small or large	138 (13.9)	62 (15.0)			122 (18.7)	26 (17.1)		
Mostly until full	258 (26.0)	110 (26.6)			154 (23.6)	35 (23.0)		
Occupational categories			4.61†	0.595			13.24†	0.039
Clerkship	102 (10.2)	43 (10.4)			95 (14.5)	22 (14.5)		
Managerial	467 (46.8)	176 (42.5)			197 (30.1)	31 (20.4)		
Service	52 (5.2)	19 (4.6)			75 (11.5)	11 (7.2)		
Professional	198 (19.8)	97 (23.4)			227 (34.7)	71 (46.7)		
Technical	130 (13.0)	61 (14.7)			50 (7.6)	16 (10.5)		
Mechanical operation	27 (2.7)	8 (1.9)			2 (0.3)	0		
Manual labor	22 (2.2)	10 (2.4)			9 (1.4)	1 (0.7)		
Weekly work (h)			0.04†	0.982			1.22†	0.542
<45	697 (69.8)	291 (70.3)			492 (75.1)	110 (72.4)		
45–54	192 (19.2)	79 (19.1)			135 (20.6)	37 (24.3)		
≥55	109 (10.9)	44 (10.6)			28 (4.3)	5 (3.3)		
Use of dyslipidemic agents			5.87†	0.015			1.17†	0.280
No	984 (98.6)	414 (100.0)			650 (99.2)	152 (100.0)		
Yes	14 (1.4)	0			5 (0.8)	0		

Data are presented as mean ± SD or n (%). *t value; †χ^2 value. Hypo-HDL: Hypo-high-density lipoproteinemia; BMI: Body mass index; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; SD: Standard deviation.

Table 2: Association between hypo-HDL and job stress by multivariate logistic regression analysis

Variables	Number with hypo-HDL/group, *n/N*	Crude		Fully adjusted*	
		OR (95% *CI*)	*P*	*OR* (95% *CI*)	*P*
Male					
Weekly work (h)					
<45	291/988	1		1	
45–54	79/271	0.98 (0.73–1.32)	0.900	0.93 (0.68–1.26)	0.625
≥55	44/153	0.96 (0.66–1.40)	0.830	0.94 (0.63–1.39)	0.745
P-for trend			0.851		
Job control					
High	142/559	1		1	
Middle	139/440	1.40 (1.06–1.85)	0.018	1.39 (1.04–1.86)	0.028
Low	132/412	1.42 (1.07–1.89)	0.015	1.39 (1.03–1.87)	0.034
P-for trend			0.019		
Job demand					
Low	139/482	1		1	
Middle	119/425	0.93 (0.73–1.30)	0.851	0.95 (0.68–1.25)	0.615
High	156/504	1.14 (0.87–1.50)	0.353	1.04 (0.78–1.40)	0.782
P-for trend			0.461		
Job strain					
No job strain	327/1118	1		1	
Job strain	84/294	1.05 (0.79–1.40)	0.716	0.97 (0.72–1.31)	0.830
P-for trend			0.908		
Female					
Weekly work (h)					
<45	110/602	1		1	
45–54	37/172	1.23 (0.81–1.87)	0.339	1.21 (0.79–1.87)	0.383
≥55	5/33	0.79 (0.30–2.09)	0.630	0.96 (0.34–2.65)	0.929
P-for trend			0.716		
Job control					
High	27/198	1		1	
Middle	51/266	1.51 (0.91–2.52)	0.111	1.26 (0.71–2.24)	0.427
Low	74/342	1.75 (1.08–2.83)	0.023	1.51 (0.88–2.56)	0.132
P-for trend			0.025		
Job demand					
Low	53/277	1		1	
Middle	60/311	1.01 (0.67–1.53)	0.949	0.99 (0.64–1.52)	0.965
High	39/218	0.93 (0.59–1.48)	0.769	0.91 (0.56–1.49)	0.714
P-for trend			0.740		
Job strain					
No job strain	111/602	1		1	
Job strain	41/205	1.10 (0.74–1.65)	0.629	1.01 (0.66–1.54)	0.953
P-for trend			0.621		

*Adjusted for age, BMI, smoking, heavy drinking, exercise habits, the number of hours of walking in a day, weekday sleep hours, the quantity of food intake, use of dyslipidemic agents and occupational categories. Hypo-HDL: Hypo-high-density lipoproteinemia; *OR*: Odds ratio; 95% *CI*: 95% confidence interval; LDL: Low-density lipoproteinemia; BMI: Body mass index.

group demonstrated a significantly higher *OR* for having hypo-HDL compared with the high job control group in male Chinese workers. This association was significant even after adjustments for age, BMI, smoking, drinking, exercise habits, daily walking hours, sleep hours, the quantity of food intake, use of dyslipidemic agents, and occupational categories. These data suggest that job control could be related to HDL-C metabolism independent of known factors affecting HDL-C concentration. When we compared the data of fully adjusted model, the *OR* for having hypo-HDL in the low job control group was reduced from 1.42 to 1.39 for men, and the significant association between low job control and hypo-HDL was no longer observed in women. These data suggest that the relationship between low job control and hypo-HDL might be mediated in part through lifestyle factors and/or job categories. In fact, the distribution of job categories significantly differed between the hypo-HDL and nonhypo-HDL groups in women, and the frequency of hypo-HDL tended to be higher in professional and technical occupations compared with others. Of note, neither job demand nor job strain was related to hypo-HDL either in men or women. These data suggest that job control could be an independent modulator for HDL metabolism.

Our data are consistent with the previous report showing that job strain was not related to HDL-C in Taiwanese white-collar workers.[19] In the Stress and Health in Shenzhen Workers Study, high effort, over-commitment, low reward, and effort-reward imbalance at work did not relate to the HDL-C level in white-collar workers such as civil servants, management level workers, and teachers.[18] None of the two studies, however, examined the association of job control and HDL-C. In other words, our study might be a rare study to examine the relationship between job control and hypo-HDL in a Chinese population including various kinds of occupations. We have recently shown in the same Chinese cohort that the *OR* for having diabetes mellitus was significantly higher in men who work ≥55 h per week compared with those who work <45 h per week.[7] Those relationships were not observed for women. In this study, we could not find a significant relationship between weekly working hours and the prevalence of hypo-HDL in either gender. These data suggest that HDL and glucose metabolisms are differently related to quantitative and qualitative job stress, respectively. A study conducted in Western population showed a link with job strain and hypo-HDL.[34] In this study, however, we failed to demonstrate such relationship. The reason of the discrepancy between our data and previous studies is unclear, but difference in ethnics of studied population, used questionnaire might be involved. Moreover, it is also possible that job demand score of this population might be generally low, reducing the power to establish true strain group.

Regarding the mechanism linking with job stress and hypo-HDL, an activation of the hypothalamic–pituitary–adrenal axis and/or sympathetic nervous system might be involved. It has been suggested that high job stress activates the sympathetic nervous system and increases the production of cortisol,[35,36] leading to hyperinsulinemia.[37] As a result, the production of HDL-C might be reduced by the suppression of lipoprotein lipase activity by insulin.[38] Recently, we found in Japanese male workers that lower job control is associated with higher diastolic blood pressure independent of sympathetic nervous system or hypothalamo-pituitary-adrenocortical system activities.[11] Thus, other mechanisms linking with low job control and physiologic stress response might exist.

There are several limitations in this study. First, this is a cross-sectional study and thus cannot discuss the causal relationship between job stress and hypo-HDL. To clarify this point, we need a prospective study. Second, this study examined only Chinese cases. Therefore, it is unclear if the results would be applicable to other Asian population. Third, we studied workers only in Shanghai; hence, it might be difficult to apply the present results to rural workers. Finally, we failed to obtain information on menopause, which might be an important confounding factor in women.

In conclusion, low job control but not job strain was significantly related to hypo-HDL in male Chinese workers. To further confirm our results, prospective longitudinal studies are required in the general Asian population. Alternatively, another way to examine the hypothesis might be to examine whether stress management for workers with low job control increases HDL-C concentration.

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Conflicts of interest

There are no conflicts of interest.

References

1. Iwasaki K, Takahashi M, Nakata A. Health problems due to long working hours in Japan: Working hours, workers' compensation (karoshi), and preventive measures. Ind Health 2006;44:537-40. doi: 10.2486/indhealth.44.537.
2. About 600,000 Chinese a Year Die from Over Working. The China Youth Daily; 2012. Available from: http://www.news.xinhuanet.com/politics/2012-10/28/c_123879087.htm. [Last accessed on 2014 Nov 01].
3. Yang T, Wu D, Zhang W, Cottrell RR, Rockett IR. Comparative stress levels among residents in three Chinese provincial capitals, 2001 and 2008. PLoS One 2012;7:e48971. doi: 10.1371/journal.pone.0048971.
4. Lloyd-Jones D, Adams R, Carnethon M, De Simone G, Ferguson TB, Flegal K, *et al.* Heart disease and stroke statistics-2009 update: A report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Circulation 2009;119:e21-181. doi: 10.1161/CIRCULATIONAHA.108.191261.
5. Gu K, Cowie CC, Harris MI. Diabetes and decline in heart disease mortality in US adults. JAMA 1999;281:1291-7. doi: 10.1001/jama.281.14.1291.
6. Pöss J, Custodis F, Werner C, Weingärtner O, Böhm M, Laufs U. Cardiovascular disease and dyslipidemia: Beyond LDL. Curr Pharm Des 2011;17:861-70. doi: 10.2174/138161211795428858.
7. Tayama J, Li J, Munakata M. Working long hours is associated with higher prevalence of diabetes in urban male Chinese workers: The rosai karoshi study. Stress Health 2016;32:84-7. doi: 10.1002/smi.2580.
8. Magnavita N, Fileni A. Work stress and metabolic syndrome in radiologists: First evidence. Radiol Med 2014;119:142-8. doi: 10.1007/s11547-013-0329-0.
9. Loerbroks A, Shang L, Angerer P, Li J. Effort-reward imbalance at work increases the risk of the metabolic syndrome: A prospective study in Chinese university staff. Int J Cardiol 2015;182:390-1. doi: 10.1016/j.ijcard.2015.01.030.
10. Gimeno D, Tabák AG, Ferrie JE, Shipley MJ, De Vogli R, Elovainio M, *et al.* Justice at work and metabolic syndrome: The Whitehall II study. Occup Environ Med 2010;67:256-62. doi: 10.1136/oem.2009.047324.
11. Hattori T, Munakata M. Low job control is associated with higher diastolic blood pressure in men with mildly elevated blood pressure: The rosai karoshi study. Ind Health 2015;53:480-8. doi: 10.2486/indhealth.2014-0205.
12. Nyberg ST, Fransson EI, Heikkilä K, Ahola K, Alfredsson L, Bjorner JB, *et al.* Job strain as a risk factor for type 2 diabetes: A pooled analysis of 124,808 men and women. Diabetes Care 2014;37:2268-75. doi: 10.2337/dc13-2936.
13. Rader DJ, Hovingh GK. HDL and cardiovascular disease. Lancet 2014;384:618-25. doi: 10.1016/S0140-6736(14)61217-4.
14. Huxley RR, Lopez FL, Folsom AR, Agarwal SK, Loehr LR, Soliman EZ, *et al.* Absolute and attributable risks of atrial fibrillation

in relation to optimal and borderline risk factors: The Atherosclerosis Risk in Communities (ARIC) study. Circulation 2011;123:1501-8. doi: 10.1161/CIRCULATIONAHA.110.009035.
15. Konno S, Munakata M. High-density lipoprotein cholesterol might be a better predictor of stroke than other lipid measures in the general Japanese population: The Watari study. Int J Cardiol 2016;203:874-6. doi: 10.1016/j.ijcard.2015.11.080.
16. Keene D, Price C, Shun-Shin MJ, Francis DP. Effect on cardiovascular risk of high density lipoprotein targeted drug treatments niacin, fibrates, and CETP inhibitors: Meta-analysis of randomised controlled trials including 117,411 patients. BMJ 2014;349:g4379. doi: 10.1136/bmj.g4379.
17. Hubert HB, Eaker ED, Garrison RJ, Castelli WP. Life-style correlates of risk factor change in young adults: An eight-year study of coronary heart disease risk factors in the Framingham offspring. Am J Epidemiol 1987;125:812-31.
18. Xu W, Hang J, Gao W, Zhao Y, Cao T, Guo L. Association between job stress and newly detected combined dyslipidemia among Chinese workers: Findings from the SHISO study. J Occup Health 2011;53:334-42. doi: 10.1539/joh.11-0023-OA.
19. Su CT. Association between job strain status and cardiovascular risk in a population of Taiwanese white-collar workers. Jpn Circ J 2001;65:509-13. doi: 10.1253/jcj.65.509.
20. Tsutsumi A, Kayaba K, Ishikawa S, Gotoh T, Nago N, Yamada S, *et al.* Job characteristics and serum lipid profile in Japanese rural workers: The Jichi Medical School Cohort Study. J Epidemiol 2003;13:63-71. doi: 10.2188/jea.13.63.
21. Munakata M, Httori T, Konno S, Tayama J, Li J. Job stress and health conditions of Japanese workers in Shanghai: Japan-China cooperative study for the prevention of karoshi. Jpn J Occup Med Traumatol 2013;62:138-43.
22. Siegrist J. Adverse health effects of high-effort/low-reward conditions. J Occup Health Psychol 1996;1:27-41. doi: 10.1037/1076-8998.1.1.27.
23. Siegrist J, Siegrist K, Weber I. Sociological concepts in the etiology of chronic disease: The case of ischemic heart disease. Soc Sci Med 1986;22:247-53. doi: 10.1016/0277-9536(86)90073-0.
24. Karasek RA. Job demands, job decision latitude and mental strain: Implications for job redesign. Adm Sci Q 1979;24:285-307. doi: 10.2307/2392498.
25. Greenberg J. A taxonomy of organizational justice theories. Acad Manage Rev 1987;12:9-22. doi: 10.5465/AMR.1987.4306437.
26. Glozier N, Tofler GH, Colquhoun DM, Bunker SJ, Clarke DM, Hare DL, *et al.* Psychosocial risk factors for coronary heart disease. Med J Aust 2013;199:179-80. doi: 10.5694/mja13.10440.
27. Hurrell JJ Jr., McLaney MA. Exposure to job stress – A new psychometric instrument. Scand J Work Environ Health 1988;14 Suppl 1:27-8.
28. Haratani T, Kawakami N, Araki S, Hurrell JJ, Sauter SL, Swanson NG. Psychometric Properties and Stability of the Japanese Version of the NIOSH Job Stress Questionnaire. Vol. 2. The 25th International Congress on Occupational Health Book of Abstracts; 1996. p. 393.
29. Tsubakio-Yamamoto K, Sugimoto T, Nishida M, Okano R, Monden Y, Kitazume-Taneike R, *et al.* Serum adiponectin level is correlated with the size of HDL and LDL particles determined by high performance liquid chromatography. Metabolism 2012;61:1763-70. doi: 10.1016/j.metabol.2012.05.011.
30. Tam J, Vemuri VK, Liu J, Bátkai S, Mukhopadhyay B, Godlewski G, *et al.* Peripheral CB1 cannabinoid receptor blockade improves cardiometabolic risk in mouse models of obesity. J Clin Invest 2010;120:2953-66. doi: 10.1172/JCI42551.
31. Joint Committee for Developing Chinese guidelines on Prevention and Treatment of Dyslipidemia in Adults. Chinese guidelines on prevention and treatment of dyslipidemia in adults (In Chinese). Chin J Cardiol 2007;35:390-419. doi: 10.3760/j.issn:0253-3758.2007.05.003.
32. Yang W, Xiao J, Yang Z, Ji L, Jia W, Weng J, *et al.* Serum lipids and lipoproteins in Chinese men and women. Circulation 2012;125:2212-21. doi: 10.1161/CIRCULATIONAHA.111.065904.
33. Liu C, Spector PE, Shi L. Use of both qualitative and quantitative approaches to study job stress in different gender and occupational groups. J Occup Health Psychol 2008;13:357-70. doi: 10.1037/1076-8998.13.4.357.
34. Alfredsson L, Hammar N, Fransson E, de Faire U, Hallqvist J, Knutsson A, *et al.* Job strain and major risk factors for coronary heart disease among employed males and females in a Swedish study on work, lipids and fibrinogen. Scand J Work Environ Health 2002;28:238-48. doi: 10.5271/sjweh.671.
35. Andrews RC, Walker BR. Glucocorticoids and insulin resistance: Old hormones, new targets. Clin Sci (Lond) 1999;96:513-23. doi: 10.1042/cs0960513.
36. Borggreve SE, De Vries R, Dullaart RP. Alterations in high-density lipoprotein metabolism and reverse cholesterol transport in insulin resistance and type 2 diabetes mellitus: Role of lipolytic enzymes, lecithin: Cholesterol acyltransferase and lipid transfer proteins. Eur J Clin Invest 2003;33:1051-69. doi: 10.1111/j.1365-2362.2003.01263.x.
37. Cheng C, Cheung SF, Chio JH, Chan MP. Cultural meaning of perceived control: A meta-analysis of locus of control and psychological symptoms across 18 cultural regions. Psychol Bull 2013;139:152-88. doi: 10.1037/a0028596.
38. Al-Mashaan OS. Job stress and job satisfaction and their relation to neuroticism, type a behavior, and locus of control among Kuwaiti personnel. Psychol Rep 2001;88:1145-52. doi: 10.2466/pr0.2001.88.3c.1145.