Association of Suboptimal Health Status and Cardiovascular Risk Factors in Urban Chinese Workers

Yu X. Yan, Jing Dong, You Q. Liu, Xing H. Yang, Man Li, Gilbert Shia, and Wei Wang

ABSTRACT *Suboptimal health status (SHS) has become a new public health challenge in urban China. Despite indications that SHS may be associated with progression or development of chronic diseases such as cardiovascular and metabolic diseases, there are few reports on SHS investigations. To explore the relationship between SHS and traditional cardiovascular risk factors, a cross-sectional study was conducted in a sample of 4,881 workers employed in 21 companies in urban Beijing. Blood pressure, glucose, lipid levels (total cholesterol, high-density lipoprotein [HDL] cholesterol, low-density lipoprotein [LDL] cholesterol and triglycerides), cortisol, and body mass index were measured. SHS score was derived from data collection in the SHS questionnaire (SHSQ-25). Univariate analysis and linear two-level model were used to analyze the association of SHS with the cardiovascular risk factors. Serum cortisol level was much higher among the SHS high-score group than that among the low SHS score group (204.31 versus 161.33 ng/ml, $P < 0.001$). In a linear two-level model, we found correlation between SHS and systolic blood pressure, diastolic blood pressure, plasma glucose, total cholesterol, and HDL cholesterol among men, and correlation between SHS and systolic blood pressure, diastolic blood pressure, total cholesterol, triglyceride, and HDL cholesterol among women after controlling for age, education background, occupation, smoking, and physical activity. SHS is associated with cardiovascular risk factors and contributes to the development of cardiovascular disease. SHS should be recognized in the health care system, especially in primary care.*

KEYWORDS *Suboptimal health status, Cardiovascular disease, Risk factors*

INTRODUCTION

There has been an increase in the number of people who reported poor health in the absence of a diagnosable condition, which is known as suboptimal health status (SHS).^{1,2} SHS is characterized by ambiguous health complaints, general weakness,

Yan, Yang, Li, Shia, and Wang are with the Department of Epidemiology and Biostatistics, School of Public Health and Family Medicine, Capital Medical University, Beijing, People's Republic of China; Dong and Liu are with the Physical Examination Center, Beijing Xuanwu Hospital, Capital Medical University, Beijing, People's Republic of China; Wang is with the College of Life Sciences, Graduate University, Chinese Academy of Sciences, Beijing, People's Republic of China.

Correspondence: Wei Wang, Department of Epidemiology and Biostatistics, School of Public Health and Family Medicine, Capital Medical University, Beijing, People's Republic of China. (E-mail: wei6014@gucas.ac.cn)

and lack of vitality. It is deemed that SHS may be associated with progression or development of chronic disease.

In the past 30 years, economic growth and associated sociodemographic changes in China have increased the prevalence of the major risk factors for chronic disease, which leads to an increased burden of cardiovascular disease and other chronic diseases.³ Preclinical status of diseases and its early detection have become major issues in the promotion of the basic health service in the reform of health care in China. Despite poor perceived health is a subjective construct lacking in precision, it has been found to hold considerable predictive validity in relation to functional disability, morbidity, and mortality.⁴⁻⁶ We have established a previously proposed instrument (suboptimal health status questionnaire-25, SHSQ-25) for investigating suboptimal health status.² In our recent data analysis, work stress was among the most mentioned factors influencing general health. The multiple linear regression analyses revealed that competition, high job demands, poor relationship with colleagues, and lack of physical activities were the main factors associated with SHS (adjusted $R^2=0.573$), independent of sex, age, education, smoking, and drinking.⁷ There is growing evidence that stress adversely affects cardiovascular health. Melamed et al.⁸ demonstrated that some of the pathways linking psychosocial factors (job stress) and cardiovascular disease incidence are (1) elevation of physiological/hematochemical variables (e.g., blood pressure and serum lipid lipoprotein levels);^{9,10} (2) direct and indirect effects of adverse risk behaviors such as smoking, lack of physical exercise, and poor diet and health care habits;¹¹ and (3) heightened emotional states, such as anger, tension, and anxiety,^{12,13} implicated in cardiovascular disease development through neuroendocrine mediation.

China has experienced a cardiovascular disease epidemic in recent decades. During the next 20 years, cardiovascular disease morbidity and mortality are predicted to increase in China.¹⁴ Despite SHS may be associated with progression or development of chronic diseases such as cardiovascular and metabolic diseases, few evidences have been shown in any studies so far. The aim of this cross-sectional study is to verify the relationship between the main risk factors of cardiovascular disease and SHS.

METHODS

Study Participants

A cross-sectional study was conducted among workers in urban Beijing. A random third of all the 64 companies whose workers took annual physical examination for at least two consecutive years at the physical examination center of Beijing Xuanwu Hospital, Capital Medical University were selected for cluster sampling. Participants had to meet the following inclusion criteria: (1) no history of somatic or psychiatric abnormalities, as confirmed by their medical records, (2) age from 20 through 60 years; and (3) no history of medication consumption in the previous 2 weeks. All participants attended a standardized examination protocol in Beijing Xuanwu Hospital, including medical history, physical examination, blood hematology and biochemistry analysis, rest electrocardiography, and abdominal ultrasonography. We excluded individuals who met the diagnostic criteria of specific disease concerning cardiovascular system, respiratory system, genitourinary system, digestive system, hematic system, and diabetes. Of the 4,881 workers from 21 companies, 1,476 were excluded from the

study. Finally, a total of 3,405 people were investigated in this study. A self-reported questionnaire was used to assess the respondents' sociodemographics and SHS. Median was used as a cut point in grouping into high versus low of two dimensions of SHS. To assure comparability of the findings, all participants were examined by the physicians who were specially trained for the study. Both the hospital and university research ethical committees approved the study, and written informed consents were obtained from all participants.

Data Collection

Suboptimal Health Status SHS was measured by the suboptimal health questionnaire (SHSQ-25) including 25 items.² Each subject was asked to rate a specific statement on a five-point Likert-type scale, based on how often they suffered various specific complaints in the preceding 3 months: (1) never or almost never, (2) occasionally, (3) often, (4) very often, and (5) always. The raw scores of 1 to 5 on the questionnaire were recoded as 0 to 4. SHS scores were calculated for each respondent by summing the ratings for the 25 items. A high score represents a high level of SHS (poor health). The Cronbach's α coefficient of the SHSQ-25 was 0.91, indicating good internal consistency.

Cardiovascular Risk Factors We included classical risk factors, i.e., blood pressure, glucose, lipid levels, cortisol, and body mass index (BMI) in our analyses. Blood pressure was measured three times consecutively after 5 minutes rest, with each participant seated and using a standard mercury sphygmomanometer. The average of the second and third measurements was used to estimate the systolic and diastolic blood pressures. Overnight fasting blood specimens were obtained for the measurement of plasma glucose, serum lipids, and cortisol. Plasma glucose was measured using a modified hexokinase enzymatic method (Hitachi automatic clinical analyzer, model 7060, Japan). Concentrations of total cholesterol, high-density lipoprotein (HDL) cholesterol, and triglycerides (TG) were assessed enzymatically with commercially available reagents. Lipid measurements were standardized according to the criteria of the Centers for Disease Control and Prevention-National Heart, Lung, and Blood Institute Lipid Standardization Program.¹⁵ Low-density lipoprotein (LDL) cholesterol was computed by the Friedewald formula using the equation $(LDL = \text{total cholesterol} - [HDL + TG/5])$.¹⁶ Fasting cortisol was analyzed by γ radioimmunoassay counter (GC-911) in the Endocrinology Institute. The intra-assay and inter-assay coefficient of variations of this assay were <5.5% and <7.5%, respectively. The reference value was 50–280 ng/ml. Strict quality controls were applied throughout all these assays.

Body weight and height were measured twice during the interview. Weight was measured in light indoor clothing without shoes on electronic scales placed on a firm, level surface to the nearest 0.1 kg. Height was measured without shoes with a wall-mounted stadiometer to the nearest 0.1 cm. BMI was calculated as body weight (in kilograms) divided by height (in meters) squared.

Sociodemographic Information and Health-Related Behaviors Data on sociodemographic information and health-related behaviors were collected during interviews. These variables were used as confounders to control for potential confounding. Demographic variables included age, education, occupation, average monthly income, and marital status. The health-related behaviors include current

smoking, alcohol use, and physical activity. Smoking status was dichotomized as current smoker (≥ 1 filter per day) and nonsmoker. Physical activity was assessed by asking to list the average hours of physical activity for each day of the week prior to the questionnaire.

Statistical Analyses

Data were reported as mean $\pm$ SD for continuous variables and frequencies for categorical variables. Univariate and multivariate analyses were performed to estimate the relations of SHS to risk factors for cardiovascular disease. A two-level model was used in multivariate analysis to account for the nested nature of the data,¹⁷ with “sampling company” and “study participant” as the first and second levels, respectively.

Descriptive statistics and univariate analysis were carried out using SAS version 8.2. For multilevel analysis, we used MLwin software (version 2.02, 2005). *P* values for the fixed part of the model were obtained by calculating the chi-square statistics for joint contrasts provided by the MLwin software package. $P < 0.05$ was considered statistically significant.

RESULTS

Our analysis was restricted to 3,019 individuals who had completed the questionnaire and laboratory results. Their mean age was 40.6 years (SD 13.4) and 48.6% were women. The participants were divided into two groups by the median SHS score of 44: high SHS score group (SHS score ≥ 44) and low SHS score group (SHS score < 44). The mean SHS score among the SHS group was 55.73 ± 9.58 and 35.02 ± 6.51 among the control group, respectively. Table 1 presents the participants' characteristics according to the SHS score. The proportion of white-collar workers and those with university/college degree among the high-score group was significantly higher than that among the low-score group ($P < 0.001$). Gender and age distribution were also different between the two groups ($P < 0.001$). Since over half of the individuals aged over 50 years were excluded because of the results of their general medical examination, the number of this age group was significantly lower than the younger age groups. SHS was correlated with current smoking and physical inactivity ($P < 0.001$), whereas monthly income, marital status, and alcohol use were not different between groups.

Table 2 presents the mean values and standard deviation of cardiovascular risk factors of the study groups. Overall, the participants who gave higher SHS score also had a higher risk of cardiovascular disease than those with lower scores. Compared to the low-score group, systolic and diastolic blood pressure, plasma glucose, total cholesterol, triglyceride levels, and BMI were significantly higher among the high-score group ($P < 0.001$). Meanwhile HDL cholesterol levels were higher in low-score group than in high-score group ($P > 0.05$). Serum cortisol level was much higher among the high-score group than that among the low-score group (204.31 versus 161.33 ng/ml, $P < 0.001$). The ranges of cortisol in high-score and low-score group were 122.64–324.17 and 107.12–221.59 ng/ml, respectively. A significant linear correlation between SHS score and serum cortisol was evident ($r = 0.381$, $P < 0.001$).

We further used linear two-level model to analyze the association of SHS with the cardiovascular risk factors, with participants' characteristics showing difference between the high and low SHS score groups (Table 1) as controlling variables and

TABLE 1 Characteristics of study sample

Variables	SHS score ≥44 <i>n</i> (%)	SHS score <44 <i>n</i> (%)	χ^2	<i>P</i>
Gender				
Female	806 (52.10)	660 (44.84)	15.933	<0.001
Male	741 (47.90)	812 (55.16)		
Age (years)				
20–30	167 (10.80)	376 (25.54)	128.978	<0.001
31–40	606 (39.17)	575 (39.06)		
41–50	559 (36.13)	380 (25.82)		
51–60	215 (13.90)	141 (9.58)		
Highest education level				
Compulsory school (through grade 9)	72 (4.65)	171 (11.62)	185.420	<0.001
High school graduate	213 (13.77)	432 (29.35)		
University/college degree	1262 (81.58)	869 (59.04)		
Occupation				
White-collar worker	1431 (92.50)	986 (66.98)	307.665	<0.001
Blue-collar worker	116 (7.50)	486 (33.02)		
Monthly income (RMB)				
<2,000	324 (20.94)	316 (21.47)	3.852	0.146
2,001–5,000	1012 (65.42)	990 (67.26)		
≥5,000	211 (13.64)	166 (11.28)		
Marital status				
Single or divorced	196 (12.67)	168 (11.41)	1.123	0.289
Married	1351 (87.33)	1304 (88.59)		
Current smoking				
Yes	476 (30.77)	187 (12.70)	143.638	<0.001
No	1071 (69.23)	1285 (87.30)		
Alcohol use				
Every day	72 (4.65)	54 (3.67)	2.309	0.511
3–4 × a week	351 (22.69)	348 (23.64)		
1–2 × a week	988 (63.87)	948 (64.40)		
Never	136 (8.79)	122 (8.29)		
Physical activity (h)				
≥5	44 (2.84)	47 (3.19)	31.772	<0.001
3–4	341 (22.04)	437 (29.69)		
1–2	641 (41.44)	486 (33.02)		
<1	521 (33.68)	502 (34.10)		

SHS suboptimal health status

sex as a stratifying variable. In the models, SHS score was treated as a continuous variable.

Table 3 shows parameter estimates and standard errors from the two-level model among men. After adjusted for age, education background, occupation, smoking, and physical activity, the diastolic blood pressure, plasma glucose, total cholesterol, and serum cortisol were found to significantly predict SHS score ($P<0.05$). HDL cholesterol level was negatively and significantly associated with SHS score ($P<0.05$). In the fully adjusted multilevel analysis, no significant association was observed between triglyceride, LDL cholesterol, BMI, and SHS score ($P>0.05$). As the major risk factors for most chronic diseases, smoking and lack of physical activity also significantly associated with SHS score among men ($P<0.05$).

TABLE 2 Comparison of the cardiovascular risk factors between high and low SHS score group

	SHS score high	SHS score low	<i>t</i>	<i>P</i> value ^a
	Mean + Std.	Mean + Std.		
SBP (mmHg)	119.43±13.27	115.31±13.19	8.573	<0.001
DBP (mmHg)	77.57±7.38	75.38±7.89	7.880	<0.001
GLU (mmol/L)	5.23±0.57	5.17±0.55	2.941	<0.001
TCH (mmol/L)	4.48±0.76	4.32±0.78	5.708	<0.001
TG (mmol/L)	1.17±0.58	1.08±0.46	4.709	<0.001
HDLc (mmol/L)	1.32±0.32	1.36±0.36	-3.230	<0.001
LDLc (mmol/L)	2.82±0.70	2.78±0.71	1.558	0.119
COR (ng/ml)	204.31±40.06	161.33±27.83	34.076	<0.001
BMI (kg/m ²)	23.24±3.76	22.01±3.52	9.268	<0.001

SHS suboptimal health status; SBP systolic blood pressure; DBP diastolic blood pressure; GLU plasma glucose; TCH total cholesterol; TG triglyceride; HDLc high-density lipoprotein cholesterol; LDLc low-density lipoprotein cholesterol; COR serum cortisol

Table 4 shows parameter estimates and standard errors from the two-level model among women. The results were similar to those among men, with the exception of plasma glucose and HDL cholesterol. After adjusted for age, education background, occupation, smoking, and physical activity, the diastolic blood pressure, total cholesterol, triglyceride, HDL cholesterol, and serum cortisol were found to significantly predict SHS score among woman ($P<0.05$). No significant association was observed between plasma glucose, LDL cholesterol, BMI, and SHS score ($P>0.05$). Smoking and lack of physical activity also significantly associated with SHS score among women ($P<0.05$).

DISCUSSION

This large cross-sectional study addresses the relationship of self-rated ill health with classical cardiovascular risk factors in the primary prevention of cardiovascular disease. This study is conducted in a representative sample of workers in urban Beijing. The response rate was high (88.7%), which therefore limited the potential

TABLE 3 Multilevel estimates for SHS score in relation to cardiovascular risk factors among male participants

	Estimate (<i>b</i>)	SE	<i>P</i> value
Systolic blood pressure	0.601	0.211	0.004
Diastolic blood pressure	0.486	0.230	0.035
Plasma glucose	0.636	0.302	0.035
Total cholesterol	1.003	0.333	0.003
Triglyceride	0.477	0.293	0.104
HDL cholesterol	-0.986	0.400	0.014
LDL cholesterol	0.160	0.116	0.168
Serum cortisol	0.231	0.004	<0.001
Body mass index	0.180	0.214	0.400
Level 2 (person) intercept variance (SE)		6.903 (1.369)	
Level 2 (company) intercept variance (SE)		3.418 (1.192)	

HDL high-density lipoprotein cholesterol, LDL low-density lipoprotein cholesterol

TABLE 4 Multilevel estimates for SHS score in relation to cardiovascular risk factors among female participants

	Estimate (<i>b</i>)	SE	<i>P</i> value
Systolic blood pressure	0.388	0.181	0.032
Diastolic blood pressure	0.751	0.280	0.007
Plasma glucose	0.151	0.116	0.193
Total cholesterol	1.353	0.423	0.001
Triglyceride	1.245	0.407	0.002
HDL cholesterol	−1.516	0.669	0.024
LDL cholesterol	0.420	0.365	0.250
Serum cortisol	0.225	0.005	<0.001
Body mass index	0.250	0.197	0.205
Level 2 (person) intercept variance (SE)		4.152 (1.530)	
Level 2 (company) intercept variance (SE)		2.414 (1.116)	

HDL high-density lipoprotein cholesterol, *LDL* low-density lipoprotein cholesterol

selection bias. We found correlation between SHS and systolic blood pressure, diastolic blood pressure, plasma glucose, total cholesterol, and HDL cholesterol among men and correlation between SHS and systolic blood pressure, diastolic blood pressure, total cholesterol, triglyceride, and HDL cholesterol among women.

In our study, a newly created instrument, SHSQ-25, was used for measurement of SHS.² The SHSQ-25 is a self-rated questionnaire of perceived health complaints. SHS is more prevalent in women than in men and more in white-collar workers than in blue-collar workers. In addition, the prevalence of SHS increases with age. This trend is consistent with the prevalence of metabolic syndrome and cardiovascular disease in urban China.^{18–20} The similarity could partially be accounted by sharing common risk factors.

Significant higher level of serum cortisol among high SHS score group compared to low-score group ($t=34.076$, $P<0.001$) and significant linear correlation between SHS score and serum cortisol ($r=0.381$, $P<0.001$) strengthen the evidence that stress is an important related factor for SHS. With the rapid economic progress across China, employees have been becoming more exposed to stressful situations such as excessive workload, competition, and perceived loneliness.²¹ Continuous psychosocial stress seems to be a part of the everyday life in Chinese, especially among white-collar workers.²² Endocrine measures of stress and self-rated health (SRH) were also proved in a longitudinal study: poorer SRH at each point in time was associated with higher levels of serum cortisol and prolactin.²³ SRH may capture subclinical or undiagnosed disease.²⁴ In addition, the measures of perceived health modified the effects of biomedical risk factors both in the prediction of myocardial infarction and stroke.^{25,26} A possible pathway for observed effects is that SRH reflects the presence or absence of psychosocial risk factors or resources.²⁴ Psychological stress can affect health not only directly through neuroendocrine responses, but also indirectly through changes in health behaviors.¹¹ Current smoking was significantly more common in individuals giving higher SHS score. They also reported significantly less physical activity.

A growing body of research has documented that jobs or organizational roles which are associated with overload, excessive demands, and many responsibilities lead to a high risk of adverse health outcomes, especially cardiovascular.^{27–31} The largest INTERHEART study covering 11,119 cases and 13,648 controls from 52

different countries all over the world confirmed this association with regard to work, home, financial, and major life stress.²⁹ A higher occupational stress index was directly associated with higher systolic and diastolic blood pressures and higher level of plasma triglyceride in Taiwan white-collar male workers.³⁰ Smolin et al. reported that there was a significant elevation in plasma glucose and HDL cholesterol under academic stress.³¹ In this study, we also found high SHS score associated with increased risk of cardiovascular disease, including blood pressure, plasma glucose, lipid, and BMI. The results of linear two-level model showed that the correlation of SHS and plasma glucose and triglyceride are inconsistent among men and women. After confounding variables were adjusted, BMI was shown to be not associated with SHS.

In China, chronic noncommunicable diseases accounts for about 80% of deaths and 70% of disability-adjusted life-years.³ As a developing country with huge population, it is imperative that an economical and valid instrument is developed for screening major chronic diseases. The SHSQ-25 is short and easy to be completed, and therefore, suitable for use in general population and primary care service.² In many developed counties, much attention has been paid on perceived poor health “somatization” and “medically unexplained symptoms” in community and primary care system.^{32,33} Somatic symptom is one of the main reasons for patients seeking health care.^{34,35} SHS cannot be fully understood from the conventional disease-oriented biomedical point of view. Instead, it requires a holistic biopsychosocial perspective in which complaints are viewed as the result of complex interactions of physiology, psychology, and social environment. Primary care providers must be able to detect and manage SHS. The SHSQ-25 is a valid instrument for such purpose. Effective intervention on SHS may be a cost-effective way for preventing cardiovascular disease.

It could be argued that our participants were not representative of the general urban Chinese workers because they were recruited at the physical examination center of Beijing Xuanwu Hospital, Capital Medical University. The sample had different demographic distributions compared with urban Chinese workers.³⁶ This could affect the generalization of the results.

ACKNOWLEDGMENTS

This study was funded by the National High Technology Research and Development Grant (863 Program; 2006AA02Z434), the National Science Foundation (81102208), the National Science and Technology Support Program (2012BAI37B03), the Beijing Municipal Project for Developing Advanced Human Resources (20081D0501800211), and the Capital Medical University Grant (10JL16).

REFERENCES

1. Yan YX, Wang W. Advances in research of suboptimal health status. *Chin J Pub Health (in Chin)*. 2008; 24(9): 1037–1038.
2. Yan YX, Liu YQ, Li M, et al. Development and evaluation of a questionnaire for measuring suboptimal health status in urban Chinese. *J Epidemiol*. 2009; 19(6): 333–341.
3. Wang L, Kong LZ, Wu F, Bai YM, Burton R. Preventing chronic diseases in China. *Lancet*. 2005; 366(9499): 1821–1824.

4. Idler EL, Kasl SV. Self-ratings of health: do they also predict change in functional ability? *J Gerontol B Psychol Sci Soc Sci*. 1995; 50(6): S344–S353.
5. Kaplan GA, Goldberg DE, Everson SA, et al. Perceived health status and morbidity and mortality: evidence from the Kuopio ischemic heart disease risk factor study. *Int J Epidemiol*. 1996; 25(2): 259–265.
6. Burström B, Fredlund P. Self rated health: is it as good a predictor of subsequent mortality among adults in lower as well as in higher social classes? *J Epidemiol Community Health*. 2001; 55(11): 836–840.
7. Yan YX, Wang W. *Analysis of the risk factors and estimation of the cut point for sub-optimal health status*. Hong Kong: Asia Conference on Emerging Issues in Public Health; 2009.
8. Melamed S, Kushnir T, Strauss E, Vigiser D. Negative association between reported life events and cardiovascular disease risk factors in employed men: the CORDIS study. *J Psychosom Res*. 1997; 43(3): 247–258.
9. Jenkins CD. Epidemiology of cardiovascular diseases. *J Psychosom Res*. 1987; 31(6): 661–671.
10. Krantz DS, Contrada RJ, Hill DR, Friedler E. Environmental stress biobehavioral antecedents of coronary heart disease. *J Consult Clin Psychol*. 1988; 56(3): 333–341.
11. Adler N, Matthews K. Health psychology: why do some people get sick and some stay well? *Annu Rev Psychol*. 1994; 45: 229–259.
12. Goldstein MG, Niaura R. Psychological factors affecting physical condition: cardiovascular disease literature review (part I). *Psychosomatics*. 1992; 33(2): 134–155.
13. Friedman HS, Booth-Kewley S. The disease-prone personality Q: a meta-analytic view of the construct. *Am Psychol*. 1987; 42(6): 539–555.
14. Wu Z, Yao C, Zhao D, et al. Sino-MONICA project: a collaborative study on trends and determinants in cardiovascular diseases in China, Part I: morbidity and mortality monitoring. *Circulation*. 2001; 103(3): 462–468.
15. Myers GL, Cooper GR, Winn CL, et al. The Centers for Disease Control-National Heart, Lung and Blood Institute Lipid Standardization Program. An approach to accurate and precise lipid measurements. *Clin Lab Med*. 1989; 9(1): 105–135.
16. Friedewald WT, Levy N, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem*. 1972; 18(6): 499–502.
17. Raudenbush SW, Bryk AS. *Hierarchical linear models*. London, England: Sage; 2002.
18. Ministry of Health of the Peoples Republic of China. *Chinese health statistics yearbook (2009)*. Beijing, China: Beijing Union Medical College Press; 2009.
19. Gu D, Reynolds K, Wu X, et al. Prevalence of the metabolic syndrome and overweight among adults in China. *Lancet*. 2005; 365(9548): 1398–1405.
20. Further Study of Risk Factors for Stroke and Coronary Heart Disease Cooperation group. The prevalence of metabolic syndrome in a 11 provinces cohort in China. *Zhonghua Yu Fang Yi Xue Za Zhi (Chin)*. 2002; 36(5): 298–300.
21. Siu OL, Spector PE, Cooper CL, Lu C. Work stress, self-efficacy, Chinese work values, and work well-being in Hong Kong and Beijing. *Int J Stress Manag*. 2005; 12(3): 274–288.
22. Zhou Y, You LM, Zhang JB, Guan NH. Causes and prevention of sub-health. *Chin J Health Educ (in Chin)*. 2002; 18(6): 714–715.
23. Halford C, Anderzén I, Arnetz B. Endocrine measures of stress and self-rated health: a longitudinal study. *J Psychosom Res*. 2003; 55(4): 317–332.
24. Kristenson M, Olsson AG, Kucinskiene Z. Good self-rated health is related to psychosocial resources and a strong cortisol response to acute stress: the LiVicordia study of middle-aged men. *Int J Behav Med*. 2005; 12(2): 153–160.
25. Weinehall L, Johnson O, Jansson JH, et al. Perceived health modifies the effect of biomedical risk factors in the prediction of acute myocardial infarction. An incident case-control study from northern Sweden. *J Intern Med*. 1998; 243(2): 99–107.

26. Emmelin M, Weinehall L, Stegmayr B, Dahlgren L, Stenlund H, Wall S. Self-rated ill-health strengthens the effect of biomedical risk factors in predicting stroke, especially for men—an incident case referent study. *J Hypertens*. 2003; 21(5): 887–896.
27. Kang MG, Koh SB, Cha BS, Park JK, Baik SK, Chang SJ. Job stress and cardiovascular risk factors in male workers. *Prev Med*. 2005; 40(5): 583–588.
28. Bugajska J, Widderszal-Bazyl M, Radkiewicz P, et al. Perceived work-related stress and early atherosclerotic changes in healthy employees. *Int Arch Occup Environ Health*. 2008; 81(8): 1037–1043.
29. Rosengren A, Hawken S, Ounpuu S, et al. Association of psychosocial risk factors with risk of acute myocardial infarction in 11119 cases and 13648 controls from 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004; 364(9437): 953–962.
30. Su CT, Yang HJ, Lin CF, Tsai MC, Shieh YH, Chiu WT. Arterial blood pressure and blood lipids as cardiovascular risk factors and occupational stress in Taiwan. *Int J Cardiol*. 2001; 81(2–3): 181–187.
31. Smolin B, Leiba R, Levy Y. The effect of stress on markers of cardiovascular health. *Nutr Metab Cardiovasc Dis*. 2007; 17(6): e15–e17.
32. Woolfolk RL, Allen LA. *Treating somatization: a cognitive-behavioural approach*. New York, NY: Guilford; 2007.
33. Brown RJ. Introduction to the special issue on medically unexplained symptoms: background and future directions. *Clin Psychol Rev*. 2007; 27(7): 769–780.
34. al-Windi A, Elmfeldt D, Tibblin G, Svärdsudd K. The influence of sociodemographic characteristics on well-being and symptoms in a Swedish community. Results from a postal questionnaire survey. *Scand J Prim Health Care*. 1999; 17(4): 201–209.
35. Hagen KB, Bjørndal A, Uhlig T, Kvien TK. A population study of factors associated with general practitioner consultation for non-inflammatory musculoskeletal pain. *Ann Rheum Dis*. 2000; 59(10): 788–793.
36. Fifth National Population Census. Beijing, China: National Bureau of Statistics of China; 2000.