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Psychosocial Stress at Work and Suboptimal Health among Medical Staff: Confirmative Factor Analysis

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Abstract

Objectives To develop and validate a model to measure psychosocial work stress among medical staff in China based on confirmatory factor analysis. The second aim of the current study was to clarify the association between psychosocial work stress and suboptimal health status.

Design The cross-sectional study was conducted by clustered sampling method.

Setting Xuanwu Hospital, a 3A Grade Hospital, in Beijing province.

Participants nine hundred and fourteen medical staff aged over 40 years were sampled. Seven hundred and ninety-seven valid questionnaires were collected and used for further analysis. The sample included 94% of the Han population.

Main outcome measures The Copenhagen Psychosocial Questionnaire (COPSOQ) and Suboptimal Health Status Questionnaires-25 (SHSQ-25) were used to assess the psychosocial factors at work and suboptimal health status, respectively. Confirmative Factor Analysis (CFA) was conducted to establish the evaluating method of COPSOQ. A multivariate logistic regression model was used to estimate the relationship between suboptimal heath status and psychosocial work stress among Chinese medical staff.

Results There was strong correlation among the five dimensions of COPSOQ based on the first-order factor model. And the second-order factor model fit well and then we established two second-order factors, negative and positive psychosocial work factor, to evaluate psychosocial stress at work. The high score of negative (OR (95% CI) = 1.47 (1.34 to 1.62), $p<0.001$) and positive psychosocial work factor (OR (95% CI) = 0.96 (0.94 to 0.98), $p<0.001$) increased and decreased the risk of suboptimal health, respectively. This relationship remained statistically significant after adjusting for confounders and when using different cut-offs of SHS.

Conclusions Among medical staff, the second-order factor model was a suitable method to evaluate psychosocial work stress. The negative and positive psychosocial work stress might be the risk and protective factor of suboptimal health, respectively. Moreover, negative psychosocial work stress was the most associated factors to predict suboptimal health.

Strengths and limitations of this study

- The study had high internal validity, with a good representation of medical staff.
- To assessment psychosocial work stress among medical staff, a more parsimonious, modified second-factor model was finally built to replace the traditional method of calculating the average value of the COPSOQ which ignored the effect of each item.
- The study was conducted in Beijing (a dense city), adding evidence on these issues in a different context than the current literature.
- Although the sample was representative of the diversity of medical staff in one geographical area of the China, the data are not nationally representative and ethnic minority groups are particularly under-represented.
- The study used a cross-sectional design, which is not well suited to assess the direction of causation.

1. Introduction

The impact of psychosocial work conditions on workers' health has been well documented over the past decades. There is accumulating evidence indicted an association between a harsh working environment and a wide range of diseases including mental disorders [1-2], diabetes [3] and cardiovascular disease [4-6] among workers. Exposure to workplace psychosocial risk factors varies according to the types of occupation and job role. Teachers, firefighters and hospital workers have been reported to experience higher level of work-related stress than average level [7-8].

Due to demographic changes, the number of old people and the incidence of chronic diseases are rising in China. Meanwhile, dealing with chronic diseases, incurable or dying patients are emotionally demanding [9]. In addition, there are rapid enhancements on treatment options and therapeutic strategies due to medical advances. These changes may lead to an increased workload and high quantitative demands for Chinese medical staff at hospital. Recent studies have been demonstrated that the prevalence of burnout and stress is relatively high among medical staff [10-11]. Stress fatigue and burnout further have a detrimental influence on the physicians' quality of life and may result in early retirement or reduced quality of patient care and negatively affects health-care systems [12-13]. What is more, studies have shown that medical staff is at increased risk for ill-health, including musculoskeletal disorders [14] and mental health problems [15], caused by adverse workplace factors. Consequently, we need to pay attention to the psychosocial work characteristics of medical staff.

Since the ancient time, traditional Chinese medicine has been identifying a physical status between health and disease which we coined as suboptimal health status (SHS) [16]. SHS is characterized by functional somatic syndromes or symptoms that are medically undiagnosed. Nowadays, much attention has been paid on perceived poor health "somatization" and "medically unexplained symptoms" in community and primary care system located in developed counties [17-18]. Undoubtedly, SHS is becoming a global issue. Recent studies ever reported that 60% of students [19] and 50-60% of occupational population [20-21] suffered from suboptimal health in China. Unfortunately, impaired quality of life, frequent hospital visits and incurrence of significant medical expenses were often accompanied with SHS [22]. Our previous studies have showed that SHS may contribute to the progression or development of chronic diseases, such as cardiovascular disease [23]. Although the aforementioned study has demonstrated the prevalence of SHS and its consequences, few studies that have addressed the issue of psychosocial work stress

and suboptimal health among medical staff in China. This study aimed to evaluate the impact of psychosocial work stress on suboptimal health status and their associations.

2. Participants and Methods

2.1 Ethics Statement

Approval was obtained from the Research Ethics Committee of Capital Medical University prior to the initiation of this project. All study participants provided written informed consent prior to enrollment in the study.

2.2 Participants

This cross-sectional study was conducted by clustered sampling method. The current analysis included 914 medical staff from Xuanwu Hospital who participated in the 2014 annual health medical examination (including physicians, nurses, medical technicians, management staff, et al.). All participants of this study were older than 40 years of age. The data were collected through questionnaires of Suboptimal Health Status Questionnaires-25 (SHSQ-25) and Copenhagen Psychosocial Questionnaire (COPSOQ). The subjects were divided into 'SHS' and 'non-SHS' group by the score of SHSQ-25.

2.3 Instruments

2.3.1 Copenhagen Psychosocial Questionnaire

The Copenhagen Psychosocial Questionnaire (COPSOQ) is a comprehensive instrument for the assessment of psychosocial factors at work, which has been developed and validated by Kristensen and Borg of the Danish National Institute for Occupational Health in Copenhagen [24]. The Chinese translation and adaptation of COPSOQ had been tested in the population with different professions, which had been shown to have good reliability and validity, with Cronbach's alpha coefficients of 0.7 for most scales [25-26]. This instrument includes three versions: a long version for research use, a medium-length version to be used by work environment professionals, and a short version for workplaces. Our study was based on the short Chinese version of COPSOQ, which consists of 44 questions forming 8 scales. We selected 34 questions including 5 psychosocial work characteristics related dimensions from a short version of COPSOQ with namely 'Demands at work', 'Influence and development', 'Interpersonal

relations and leadership', 'Insecurity at work' and 'Job satisfaction' [24]. In this survey, the remaining three health-related dimensions, including 'general health', 'mental health' and 'vitality', in the original short version of COPSOQ were not used. All items of COPSOQ were transformed on a value range from 0 to 100 points with 0 representing the lowest degree of the measured psychosocial factor 'strongly disagree', and 100 representing the highest 'strongly agree'. In most scales, a high score was considered desirable. On the contrary, a low score was considered desirable for 'Demands at work' and 'Insecurity at work'.

As a default generic method, the average scores for each dimension of COPSOQ were calculated and compared. But this method ignored the relationship between each item and corresponding dimension. To explore the association among each dimension of COPSOQ, we conducted confirmative factor analysis (CFA) [27] which could estimate the relationship between each latent variable (i.e. each dimension of COPSOQ) and between observed variables (i.e. items of dimensions) and corresponding latent variable as well.

2.3.2 Suboptimal Health Status Questionnaires-25

Suboptimal Health Status (SHS) was measured by the suboptimal health status questionnaire (SHSQ-25) [16] including 25 items and encompassed five subscales: fatigue, the cardiovascular system, the digestive tract, the immune system and mental status. The SHSQ-25 is short and easy to be completed, and therefore, suitable for use in general population and primary care service [21]. Each individual was asked to rate a specific statement on a 5-point Likert-type scale based on how often they suffered various specific complaints in the preceding 3 months: never or almost never, occasionally, often, very often, and always. The scores on the questionnaire were coded as 0 to 4. SHS scores ranged from 0 to 100 were calculated for each respondent by summing the ratings for the 25 items. A high score represents a high level of SHS) (poor health).

There are no cut-off scores. The sample did not have high levels of suboptimal health (online supplementary table S1); therefore, for an easier interpretation, participants with a SHSQ-25 score higher than 31 (median of the total sample) were classified as 'SHS', and those equal or lower than 31 were classified as 'non-SHS'. The sensitivity of our results to this choice was examined further in sensitivity analyses by classifying the respondents with SHSQ-25 scores in the 75th percentile (P75) and above (a score higher than 43) and in the 90th percentile (P90) and above (a score of 53 and above) as SHS and all others as non-SHS.

2.4 Statistical analysis

Descriptive statistics were used to describe the overall population. Univariate analyses were used to compare variations in demographic characteristics among medical staff with different suboptimal health status; for Binary and categorical variable, chi-square test was used, ordinal variable was analyzed by Kolmogororv-Smirnov Z test. For nonparametic data, Mann-Whitney U test was used to assess psychosocial work stress among medical staff with different health status. Demographic missing data were coded as missing and excluded from relevant analysis. A Cronbach's alpha of >0.70 is considered to be an acceptable reliability coefficient for determining the internal consistency of the scale [28]. Model testing was conducted by confirmatory factor analysis (CFA) and structural equation modeling (SEM) analyses. To assess global fit of the model by total sample, we calculated five goodness-of-fit indices. They were χ^2 and its subsequent ratio with degrees of freedom (χ^2/df), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), standard root mean square residual (SRMR) and root mean square error of approximation (RMSEA). Evaluation standards were described in previous literature [29-30]. The first-order factor model was used to analyze the correlation among the five dimensions of COPSOQ. And, the second-order factor model was to establish the evaluating method of COPSOQ for comparing psychosocial work characteristics among medical staff. A multivariate logistic regression model was used to estimate the relationship between suboptimal heath status and psychosocial work stress. Potential confounders including age, gender, education level, occupation, physical exercise, drinking behavior, and smoking status were adjusted. The two-tailed $p < 0.05$ was considered to be statistically significant. The statistical packages SPSS 22.0 (Chicago, Illinois) and AMOS 22.0 (Chicago, Illinois) were used for statistical analysis.

3. Results

3.1 Baseline Characteristics

Among 914 of the medical staff participated in 2014 annual health medical examination 797 eligible questionnaires were retrieved, with the retrieval rate of 87.20%. Table 1 showed the descriptive analyses of participants according to suboptimal health status. The mean age was approximately 50, More than half of the participants were female (n=554, 69.51%). There were 396 (49.7%) individuals considered as SHS based on the score of SHSQ-25 (median). Among which, 80.6 % was female, nearly half with the

highest record of formal schooling was junior college, 31.8 % careered in nursing, 59.8 % was without the habit of physical exercise and mostly didn't smoking and drinking. The score of SHSQ-25 was significantly different among medical stuff with different age, gender, education level and occupations. Additionally, physical exercise, smoking and drinking also significantly influenced the status of health. In sensitivity analyses of participant according suboptimal health status (P75 and P90) reported the similar results (online supplementary table S2).

3.2 Reliability

The COPSOQ showed a very high overall internal consistency with Cronbach's alpha of 0.849 for the total scale (Items 1-34). The internal consistency characteristics of COPSOQ showed good reliability. The Cronbach's alpha about five dimensions were among 0.791 to 0.891 (online supplementary table S3).

3.3 Confirmatory factor analysis

We performed confirmatory factor analysis (CFA) based on the five theoretical dimensions of COPSOQ. Parameters were estimated for the CFA model based on the maximum likelihood procedure involving fitting the variances and covariances among observed scores. AMOS therefore created a covariance matrix, including the variances and covariances among observed scores. The next step was to illustrate the observed (items) and unobserved (factors) in the hypothesized model (see online supplementary figure S1). The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The structural model consisted of five interrelated constructs, including F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model [31]. The goodness of fit index was unacceptable in M1a (table 2). After modification, the modified first-order factor model (see online supplementary figure S2) for COPSOQ (M1b) had adequate fit of the model to the data (table 2).

However, pearson correlations between first-order factors in M1b model showed that most of the first order factors correlated with

each other (online supplementary table S2). These results supported the notion that the COPSOQ was comprised of five factors subsumed under one or two higher order factors. Based on the theoretical model of COPSOQ, high scores of F1 (Demands at work) and F4 (Insecurity at work) means susceptible to work strain. Conversely, high scores of F2, F3 and F5 may protect people from work strain [25]. According to the theory, the second-order factor model of COPSOQ might be exited. We next conducted CFA to formally test the fit of our hypothesized, second-order factor model (M2a) of COPSOQ. This model, depicted in online supplementary figure S3, didn't have good overall model fit (table 2). This suggested M2a need further modification. M2a was modified in accordance with modification index (Figure 1) and the fit of the modified second-order model (M2b) was acceptable (table 2). The first-order and second-order standardized factor coefficients of this model, displayed in see online supplementary table S4 and S5, were significant, except in the cases where unstandardized coefficients were initially constrained to 1 to scale the latent variables.

We compared modified second-order factor model (M2b) to modified factor first-order model (M1b). The overall fit of this two model were similar. Furthermore, performing a x^2 difference test revealed that modified second-order factor model was significantly better than modified factor first-order model ($\Delta\chi^2$=34.73, P<0.05), which suggested that the more parsimonious, modified second-factor model would be favored for COPSOQ.

3.4 The assessment of psychosocial work strain among medical staff with different work characteristics

We used the two second-order factors (D1 negative psychosocial work factor and D2 positive psychosocial work factor) to assess the psychosocial work stress among medical staff. The factors score was calculated by standardized regression coefficients. In structural equation modeling, the standardized regression coefficients, also called standardized factor loadings, actually are the correlation coefficients between indictors and its latent variables. The form of standardized factor scores of the ith factor in first-order model is:

$$ZFi = \sum_j b_{ij} \left(ZC_j - \overline{ZC_j}\right)$$

Where b_{ij} are standardized regression weights, ZC_j is the standardized scores of the jth questionnaire item, $\overline{ZC_j}$ is average standardized scores. $i = 1,2,3,4,5,\ j = 1,2,3,4,5,6,7,8,9,10$;

The form of standardized factor scores of the ith factor in first-order model is:

$$S = \sum W_i \, (ZF_i - \overline{ZF_i})$$

Where W_i are standardized regression weights, ZF_i is the standardized scores of the ith latent variable, $\overline{ZF_j}$ is average standardized scores of 5 latent variable. $i = 1,2,3,4,5$.

Based on the above 2 formulas, we can get the score of D1 (negative psychosocial work factor) and D2 (positive psychosocial work factor) among medical staff. The two factors score did not meet the normal distribution assumptions, were conducted using the Mann-Whitney U non-parametric test by ranks. The significant difference existed both in negative and positive psychosocial work strain among medical staff with different age, occupation, physical exercise (table 1). According to the result showed in table 3, the scores of negative and positive psychosocial work factor were significantly different between SHS and non-SHS group, and the individuals with SHS were likely to get higher score of negative psychosocial work factor (higher lever of negative psychosocial work stress) and lower score of positive psychosocial work factor (lower lever of negative psychosocial work stress), respectively. This difference remained statistically significant when using SHS cut-offs of either P75 or P90

3.5 The relationship between psychosocial work stress and suboptimal health (P50, P75 and P90)

Multivariate stepwise logistic regression models showed a statistically significant inverse relationship between positive psychosocial work stress and suboptimal health, and a positive relationship between negative psychosocial work stress and suboptimal health. Regarding negative psychosocial work stress in the total sample, those who got higher score of negative psychosocial work factor had higher risk of being suboptimal than low-score individuals (model1: OR (95% CI)=1.47 (1.34 to 1.62), p<0.001). This relationship remained statistically significant in the adjusted models (model2: OR (95% CI)=1.50 (1.36 to 1.66), p<0.001; model3: OR (95% CI)=1.57 (1.42 to 1.75), p<0.01) (table 4) and when using SHS cut-offs of either P75 or P90. Considering the total sample, individuals with higher score of positive psychosocial work factor had a lower risk of being suboptimal health compared with those who got lower score (model1: OR (95% CI) = 0.96 (0.94 to 0.98), p<0.001). This relationship remained statistically significant in the adjusted models (model2: OR (95% CI) = 0.97 (0.95 to 0.99), p=0.003; model3: OR (95% CI) = 0.97 (0.95 to 0.99), p=0.012) and in the majority of SHS sensitivity analyses (using cut-offs of P75 and

P90), with the exception of the first-step adjusted and fully adjusted models using P90 as a SHS cut-off (model2: OR (95% CI) = 0.97 (0.94 to 1.01), p=0.155; model2: OR (95% CI) = 0.98 (0.95 to 1.02), p=0.325).

4. Discussion

As the development of social economy and the rapid pace of life, public have paid more and more attention to the importance of suboptimal health. SHS is regarded as a subclinical, reversible stage of chronic disease, which is characterized by a decline in vitality, in physiological function and in the capacity for adaptation within a period of three months [16]. For measurement of SHS, we developed SHSQ-25 and adopted it as an instrument in this study. SHSQ-25 has good internal consistency, which item-subscale correlations ranged from 0.51 to 0.72, with Cronbach's α of 0.70 or higher for all subscales [21]. The good internal consistency (cronbach's α of 0.943) was also verified in our study (not shown in our study).

Multiple factors which were influential to SHS, including gender, age, physical activities, dietary habits, emotional problems, social adaptation, etc. have been found in recent studies [20, 23]. In corresponded, age, gender, education level, job, physical exercise, smoking and drinking were significant factors that may influence the status of health among medical staff in current study. There was no internationally accepted cutoff value to diagnose SHS. Thus, we further conducted a sensitivity analysis in which the results also valid. Overall, the female nurses without the ways to relieve stress, such as habit of physical exercise, smoke and drink, were higher score of SHSQ-25 (poorer health).

Over the last 20 years, rare longitudinal and many cross-sectional studies have highlighted work organization conditions, including repetitive work [32], decision authority [33], physical and emotional demands [34], irregular schedules and long hours [35-36] and job insecurity [37] were the work factors to explain the emergence or aggravation of mental illness. The relevance of mental work load and health status based on documented measuring instruments which covered all important aspects was undisputedly increased. For enterprises and organizations, the COPSOQ questionnaire is a qualified screening-instrument for psychosocial factors at work [38]. It has good internal consistency with Cronbach's α of 0.79 or higher for all subscales in our study. But scale scores were computed as the average of the values of the single aspects, this method ignored the relationship among each dimension. Previous studies [27] also showed the factor loadings calculated by traditional factor analysis were less

accurate and precise than that calculated by structural equation modeling, due to the traditional method could not control the effects of other variables and caused message loss when extracting common factors. By contrast, structural equation modeling could get factor loadings both of indictors to first-order factors and first-order factors to second-order factors. The standardized regression coefficients, also called standardized factor loadings, estimated the relational degree between indictors and first-order factors, first-order factors and second-order factors under controlling other variables. The other difference with traditional method is that structural equation modeling allows measurement error of indictors.

Based on the above comparison and consideration, we conducted first- and second-order factor model to explore the association among dimensions of COPSOQ. The analyses presented in this article show that the five scales of the short version of COPSOQ had good internal reliability. In this study, a modified second-factor model with better fit indexes was considered to be favored for COPSOQ. Therefore, the psychosocial work stress of medical staff was assessment by modified second-order factor model (M2b). In M2b, the relationship between F4 insecurity at work and D1 negative psychosocial work factor was not significant ($p>0.05$). Thus, demand at work was the largest contributor to the negative psychosocial work factor in current study. This result reflected subjects' job was stable in our study and was accorded with the actual investigation which subjects were on-the-job medical staff (older than 40 years of age) who faced the risk of unemployment was very low, but high pressure during the inservice, so they are high risk groups of SHS. While, positive psychosocial work factor was composed by Influence and development, Interpersonal relations and leadership and Job satisfaction.

The clinician as a kind of special population, they need possess highly concentrated attention, sensible thinking, exquisite techniques and experiences. Moreover, lasting work and intensive labor intensity make them suffer more stress than other medical specialties. Previous research suggested that individuals with higher levels of education report greater psychological demands [39]. Meanwhile, psychosocial stress also may result from gendered processes [40], such as uneven family responsibilities, gender-specific harassment or discrimination, and unequal levels of poverty which mainly limited the professional influence and development of female. Additionally, age was also a significant factor affecting the stress levels [41-42]. Similarly, we found younger clinical doctors with graduate degree or above who were lack of exercise, on night shift, and longer man-hour (longer than 40 hour per week) reported higher score of negative psychosocial work factor (higher level of psychosocial work strain).

While, older male nonclinical medical staff with habit of physical exercise, smoking and drinking reported higher score of positive psychosocial work factors (lower level of psychosocial work strain). In our study, psychosocial work stress, especially the negative side, was the mentioned factor influencing the risk of suboptimal health among medical staff. This relationship was also found in population of executive employees [43].

The results of this study provided some important insights for supervisors and managers in hospital. Positive effects of work in the medical services should be maximized. And the consequences of the necessary choices and risks such as work-related negative stress, demands and insecurity at work, in this important profession, should be prevented. Moreover, Yan YX, et al [23] indicated that SHS is associated with cardiovascular risk factors and contributes to the development of cardiovascular disease. Therefore, it's less likely to be a question that the above measures are effective to prevent SHS, and further reduce the risks of cardiovascular disease.

5. Conclusion

The modified second-order factor model was a suitable method to evaluate COPSOQ among medical staff. In this population, the negative and positive psychosocial work stress might be the risk and protective factor of suboptimal health, respectively. Negative psychosocial work stress was the most associated factor to predict suboptimal health.

Supplementary Materials

Supplementary Files 1. docx

Supplementary Files 2. pdf

Acknowledgments

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Footnotes

Yingzhi Liang and Shijiao Meng contributed equally to this work.

Contributors

Yuxiang Yan, lead and corresponding author, had full access to the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Yingzhi Liang wrote the majority of the manuscript, provided critical revisions to the manuscript and aided substantially in the preparation of the revised submission. Shijiao Meng provided input into study design, performed many of the data analysis, made substantial critical revisions and aided with interpretation. Jie Zhang aided with interpretation. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

This study and associated protocols were conducted after approval by the Research Ethics Committee of Capital Medical University. All research participants consented to having their anonymous data included in the analyses reported herein.

Provenance and peer review

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Availability of data and materials

The datasets used and/or analyzed during this study are available from the corresponding author on reasonable request.

Table1 Descriptive analyses of participants according to suboptimal health status and of the COPSOQ score as a total sample

Demographics	Total (N=797)	SHSQ-25 (P50)			Second-order factor of COPSOQ			
	n (%)	Non-SHS	SHS	P	D1 negative psychosocial work factor	P	D2 positive psychosocial work factor	P
Age group(years)				0.005*		0.003		0.007
40~	270 (33.9)	118 (29.4)	152 (38.4)		0.21 ± 1.65		-0.80 ± 7.00	
					0.15 (-1.14, 1.32)		0.15 (-5.52, 4.17)	
45~	245 (30.7)	126 (31.4)	119 (30.1)		0.07 ± 1.72		-0.29 ± 6.84	
					-0.1 (-1.28, 1.24)		0.46 (-4.39, 4.76)	
55~68	282 (35.4)	157 (39.2)	125 (31.6)		0.26 ± 1.70		1.01 ± 7.35	
					-0.47 (-1.55, 0.88)		1.08 (-2.93, 6.78)	
Gender				< 0.001		0.292		< 0.001
Male	243 (30.5)	166 (41.4)	77 (19.4)		-0.05 ± 1.88		1.24 ± 7.29	
					-0.17 (-1.67, 1.20)		1.54 (-3.33, 6.82)	
Female	554 (69.5)	235 (58.6)	319 (80.6)		0.02 ± 1.62		-0.54 ± 6.96	
					-0.11 (-1.22, 1.14)		0.24 (-5.02, 4.31)	
Education level				0.003*		< 0.001		0.111
High school and below	122 (15.3)	65 (16.20)	57 (14.4)		-0.41 ± 1.81		0.55 ± 7.79	
					-0.62 (-1.90, 0.64)		1.19 (-3.74, 6.23)	
Junior college	321 (40.3)	130 (32.4)	191 (48.2)		-0.07 ± 1.65		-0.78 ± 7.44	
					-0.21 (-1.39, 1.04)		0.17 (-5.81, 4.35)	
University	182 (22.8)	102 (25.4)	80 (20.2)		-0.15 ± 1.71		0.62 ± 6.68	
					-0.37 (-1.52, 1.01)		1.22 (-3.60, 5.47)	
Graduate students and above	172 (21.6)	104 (25.9)	68 (17.2)		0.57 ± 1.56		0.42 ± 6.30	
					0.70 (-0.65, 1.63)		0.66 (-4.28, 5.17)	
occupation				< 0.001		< 0.001		0.001
Nurses	188 (23.6)	62 (15.5)	126 (31.8)		0.22 ± 1.57		-1.15 ± 7.35	
					0.13 (-0.99, 1.16)		-0.10 (-7.17, 4.10)	
Medical technicians	187 (23.5)	83 (20.7)	104 (26.3)		-0.30 ± 1.59		-0.85 ± 6.75	
					-0.43 (-1.64, 1.02)		-0.20 (-5.48, 3.46)	
Doctors	208 (26.1)	125 (31.2)	83 (21.0)		0.37 ± 1.72		0.70 ± 6.97	
					0.31 (-0.93, 1.53)		0.94 (-4.19, 6.67)	
Others	214 (26.9)	131 (32.7)	83 (21.0)		-0.29 ± 1.78		1.06 ± 7.13	
					-0.60 (-1.77, 0.89)		1.44 (-2.78, 5.51)	
Physical exercise				0.003		0.001		0.022
Yes	363 (45.5)	204 (50.9)	159 (40.2)		-0.19 ± 1.76		0.51 ± 7.30	
					-0.48 (-1.69, 1.14)		1.12 (-4.27, 5.77)	
No	434 (54.5)	197 (49.1)	237 (59.8)		0.16 ± 1.63		-0.43 ± 6.92	
					0.12 (-1.02, 1.18)		0.33 (-5.03, 4.32)	
Smoking				< 0.001		0.082		0.013
Yes	93 (11.7)	63 (15.7)	30 (7.6)		-0.19 ± 2.04		1.58 ± 7.80	
					-0.90 (-1.77, 1.16)		2.16 (-3.16, 7.23)	
No/Quit	704 (88.3)	338 (84.3)	366 (92.4)		0.02 ± 1.65		-0.21 ± 6.99	
					-0.09 (-1.28, 1.16)		0.47 (-4.72, 4.78)	
Drinking				< 0.001		0.081		0.012
Yes	166 (20.8)	105 (26.2)	61 (15.4)		-0.18 ± 1.78		1.18 ± 7.13	
					-0.66 (-1.56, 1.04)		1.39 (-2.83, 6.72)	
No/Abstained	631 (79.2)	296 (73.8)	335 (84.6)		0.05 ± 1.68		-0.31 ± 7.07	
					-0.84 (-1.30, 1.16)		0.37 (-4.93, 4.75)	
Night shift				0.774		< 0.001		0.445
Yes	331 (41.5)	169 (42.1)	162 (40.9)		0.27 ± 1.71		-0.21 ± 7.04	
					0.22 (-1.08, 1.36)		0.46 (-4.42, 4.78)	
No	466 (58.5)	232 (57.9)	234 (59.1)		-0.19 ± 1.67		0.15 ± 7.16	
					-0.39 (-1.53, 0.96)		0.67 (-4.68, 5.22)	
Weekly working hours				0.455		< 0.001		0.827
≤40 hours	270 (33.9)	141 (35.2)	129 (32.6)		-0.49 ± 1.60		0.13 ± 6.92	
					-0.71 (-1.78, 0.56)		0.57 (-4.45, 5.07)	
>40 hours	527 (66.1)	260 (64.8)	267 (67.4)		0.25 ± 1.70		-0.06 ± 7.21	
					0.17 (-1.10, 1.43)		0.70 (-4.62, 5.11)	

Noted: * analyzed by Kolmogorov-Smirnov Z test.

Table 2 Goodness-of-fit indices for the different models

Model	χ^2 (*df*)	χ^2/ *df*	CFI	AGFI	SRMR	RMSEA
M1a	4216.39(517)	8.16	0.737	0.708	0.0802	0.095
M1b	1699.40(503)	3.40	0.915	0.864	0.0696	0.055
M2a	4276.30(521)	8.21	0.733	0.707	0.0852	0.095
M2b	1664.67(508)	3.28	0.918	0.866	0.0659	0.053

Noted: A CFI value of greater than 0.90 showed a psychometrically acceptable fit to the data;

The value of AGFI ranged between 0 and 1. A value of 1 indicated a perfect fit;

For the SRMR, values of 0.08 represented good fit;

The value of RMSEA should be below 0.06 to show good fit.

Table 3. The psychosocial work stress among different health status

groups	Second-order factor of COPSOQ			
	D1 negative psychosocial work factor	P	D2 positive psychosocial work factor	P
suboptimal health status (P50)		<0.001		<0.001
Non-SHS	-0.53 ± 1.60		1.15 ± 6.97	
	-0.77 (-1.83, 0.54)		1.61 (-2.79, 6.34)	
SHS	0.53 ± 1.63		-1.16 ± 7.06	
	0.46 (-0.67, 1.60)		-0.57 (-5.75, 3.94)	
suboptimal health status (P75)		<0.001		<0.001
Non-SHS	-0.24 ± 1.67		0.71 ± 7.08	
	-0.39 (-1.62, 0.91)		1.24 (-3.85, 5.69)	
SHS	0.77 ± 1.57		-2.29 ± 6.73	
	0.70 (-0.44, 1.86)		-1.93 (-7.11, 2.60)	
suboptimal health status (P90)		<0.001		0.005
Non-SHS	-0.09 ± 1.68		0.29 ± 7.13	
	-0.20 (-1.47, 1.08)		0.78 (-4.39, 5.22)	
SHS	0.90 ± 1.68		-2.14 ± 6.57	
	0.57 (-0.44, 2.19)		-1.93 (-7.23, 2.18)	

Table 4 Sensitivity analyses with multivariate models assessing the relationship between psychosocial work stress and suboptimal health (P50, P75 and P90)

Model / variables	suboptimal health status (P50, P75, P90)		
	OR	OR 95%CI	P
suboptimal health status (P50)			
Model1			
D1 negative psychosocial work factor	1.47	1.34-1.62	<0.001
D2 positive psychosocial work factor	0.96	0.94-0.98	<0.001
Model2			
D1 negative psychosocial work factor	1.5	1.36-1.66	<0.001
D2 positive psychosocial work factor	0.97	0.95-0.99	0.003
Model3			
D1 negative psychosocial work factor	1.57	1.42-1.75	<0.001
D2 positive psychosocial work factor	0.97	0.95-0.99	0.012
suboptimal health status (P75)			
Model1			
D1 negative psychosocial work factor	1.39	1.26-1.54	<0.001
D2 positive psychosocial work factor	0.95	0.93-0.97	<0.001
Model2			
D1 negative psychosocial work factor	1.42	1.28-1.58	<0.001
D2 positive psychosocial work factor	0.95	0.93-0.98	<0.001
Model3			
D1 negative psychosocial work factor	1.44	1.29-1.61	<0.001
D2 positive psychosocial work factor	0.96	0.93-0.98	0.001
suboptimal health status (P90)			
Model1			
D1 negative psychosocial work factor	1.36	1.18-1.57	<0.001
D2 positive psychosocial work factor	0.97	0.93-1.00	0.037
Model2			
D1 negative psychosocial work factor	1.43	1.23-1.67	<0.001
D2 positive psychosocial work factor	0.97	0.94-1.01	0.155
Model3			
D1 negative psychosocial work factor	1.46	1.25-1.70	<0.001
D2 positive psychosocial work factor	0.98	0.95-1.02	0.325

Noted: OR: Odds Ratio. Model1: Unadjusted. Model2: Adjusted by age and gender.Model3: Adjusted by age, gender, education level, occupation, physical exercise, drinking behavior, and smoking status.

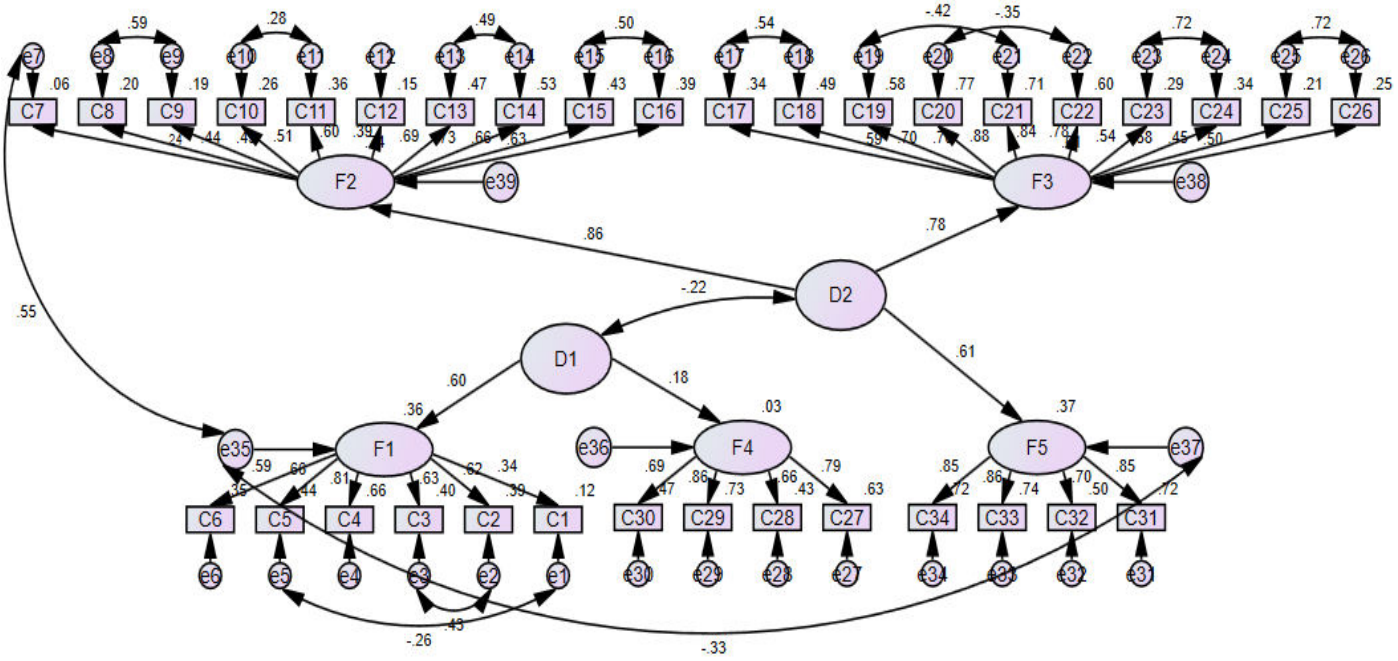

Figure 1 Standardized coefficients for modified second-order confirmatory factor analysis of COPSOQ (M2b). Confirmatory factor analysis (CFA) results indicated good to adequate model fit: $\chi 2$=1664.67; degrees of freedom (df) =508; $\chi 2$/df =3.28; Comparative Fit Index (CFI) =0.918; Root Mean Square Error of Approximation (RMSEA) =0.053; Standardized Root Mean Square Residual (SRMR) =0.066. Standardized factor loadings and residual terms were shown above with directional arrows. F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction.

Table S1. SHSQ-25 score distribution in survey sample

SHSQ-25 score	n	%	Cumulative %
0-10	52.0	6.5	6.5
10-20	128.0	16.1	22.6
20-30	180.0	22.6	45.2
30-40	182.0	22.8	68.0
40-50	140.0	17.6	85.6
50-60	71.0	8.9	94.5
60-70	32.0	4.0	98.5
70-80	8.0	1.0	99.5
80-90	4.0	0.5	100.0
Total	797	100.0	

Table S2. Sensitivity analyses of participant according suboptimal health status

Demographics	Total (N=797)	SHSQ-25 (P75)			SHSQ-25 (P90)		
	n (%)	Non-SHS	SHS	P	Non-SHS	SHS	P
Age group(years)				<0.001			0.005
40~	270 (33.9)	188 (30.9)	82 (43.4)		234 (32.2)	36 (50.7)	
45~	245 (30.7)	188 (30.9)	57 (30.2)		228 (31.4)	17 (23.9)	
55~68	282 (35.4)	232 (38.2)	50 (26.5)		264 (36.40	18 (25.4)	
Gender				<0.001			<0.001
Male	243 (30.5)	213 (35.0)	30 (15.9)		239 (32.9)	4 (5.6)	
Female	554 (69.5)	395 (65.0)	159 (84.1)		487 (67.1)	67 (94.4)	
Education level				0.004			0.007
High school and below	122 (15.3)	970 (16.0)	25 (13.2)		109 (15.0)	13 (18.3)	
Junior college	321 (40.3)	225 (37.0)	96 (50.8)		284 (39.1)	37 (52.1)	
University	182 (22.8)	142 (23.4)	40 (21.2)		167 (23.0)	15 (21.1)	
Graduate students and above	172 (21.6)	144 (23.7)	28 (14.8)		166 (22.9)	6 (8.5)	
occupation				<0.001			<0.001
Nurses	188 (23.6)	117 (19.2)	71 (37.6)		151 (20.8)	37 (52.1)	
Medical technicians	187 (23.5)	137 (22.5)	50 (26.5)		168 (23.1)	19 (26.8)	
Doctors	208 (26.1)	173 (28.5)	35 (18.5)		201 (27.7)	7 (9.9)	
Others	214 (26.9)	181 (29.8)	33 (17.5)		206 (28.4)	8 (11.3)	
Physical exercise				0.012			0.045
Yes	363 (45.5)	292 (48.0)	71 (37.6)		339 (46.7)	24 (33.8)	
No	434 (54.5)	316 (52.0)	118 (62.4)		387 (53.3)	47 (66.2)	
Smoking				<0.001			0.002
Yes	93 (11.7)	87 (14.3)	6 (3.2)		92 (12.7)	1 (1.4)	
No/Quit	704 (88.3)	521 (85.7)	183 (96.8)		634 (87.3)	70 (98.6)	
Drinking				0.001			0.014
Yes	166 (20.8)	142 (23.4)	24 (12.7)		159 (21.9)	7 (9.9)	
No/Abstained	631 (79.2)	466 (76.6)	165 (87.3)		567 (78.1)	64 (90.1)	
Night shift				0.8			0.801
Yes	331 (41.5)	251 (41.3)	80 (42.3)		303 (41.7)	28 (39.4)	
No	466 (58.5)	357 (58.7)	109 (57.7)		423 (58.3)	43 (60.6)	
Weekly working hours				0.022			0.067
≤40 hours	270 (33.9)	219 (36.0)	51 (27.0)		253 (34.8)	17 (23.9)	
>40 hours	527 (66.1)	389 (64.0)	138 (73.0)		473 (65.2)	54 (76.1)	

Noted: *: P<0.01.

Table S3. Test of internal consistency and interfactor correlations of the COPSOQ

Factor (Cronbach's α)	N of Items	F_1	F_2	F_3	F_4	F_5
F_1 Demands (0.791)	6	1	—	—	—	—
F_2 Influence and development (0.820)	10	-0.067	1	—	—	—
F_3 Relation and leadership (0.891)	10	-0.094 *	0.606**	1	—	—
F_4 Insecurity at work (0.830)	4	0.037**	0.002	-0.004	1	—
F_5 Job satisfaction (0.881)	4	-0.214**	0.306**	0.366**	-0.027**	1

r correlation *p<0.05; **p<0.01

Table S4 The first-order standardized factor coefficients of model

path	First-order Factor Model (M1a)			Modified First-order Factor Model (M1b)		
	regression coefficients	*P*	standardized regression coefficients	regression coefficients	*P*	standardized regression coefficients
C1<---F1	0.383	***	0.331	0.370	***	0.340
C2<---F1	0.947	***	0.729	0.765	***	0.628
C3<---F1	0.976	***	0.734	0.786	***	0.631
C4<---F1	1.000	—	0.791	1.000	—	0.844
C5<---F1	0.637	***	0.623	0.627	***	0.654
C6<---F1	0.815	***	0.548	0.825	***	0.591
C7<---F2	0.297	***	0.214	0.293	***	0.195
C8<---F2	0.695	***	0.425	0.747	***	0.421
C9<---F2	0.697	***	0.414	0.758	***	0.415
C10<---F2	0.702	***	0.506	0.748	***	0.497
C11<---F2	0.728	***	0.581	0.804	***	0.592
C12<---F2	0.502	***	0.353	0.579	***	0.376
C13<---F2	1.018	***	0.765	1.000	***	0.693
C15<---F2	1.079	—	0.803	1.000	—	0.741
C14<---F2	1.000	***	0.695	1.119	***	0.665
C16<---F2	0.99	***	0.681	1.003	***	0.638
C17<---F3	0.831	***	0.646	0.727	***	0.587
C18<---F3	0.855	***	0.753	0.770	***	0.704
C19<---F3	0.689	***	0.747	0.678	***	0.763
C20<---F3	1.000	—	0.843	1.000	—	0.875
C21<---F3	0.947	***	0.772	0.991	***	0.838
C22<---F3	0.77	***	0.727	0.794	***	0.777
C23<---F3	0.482	***	0.600	0.424	***	0.547
C24<---F3	0.54	***	0.641	0.476	***	0.586
C25<---F3	0.503	***	0.496	0.444	***	0.454
C26<---F3	0.568	***	0.526	0.504	***	0.488
C27<---F4	0.826	***	0.793	0.827	***	0.793
C28<---F4	0.75	***	0.658	0.750	***	0.658
C29<---F4	1.000	—	0.853	1.000	—	0.853
C30<---F4	0.853	***	0.689	0.854	***	0.690
C31<---F5	1.026	***	0.850	1.026	***	0.850
C32<---F5	0.999	***	0.702	1.000	***	0.703
C33<---F5	1.000	—	0.859	1.000	—	0.859
C34<---F5	0.929	***	0.849	0.928	***	0.848

Noted: *** means $P<0.001$

Table S5 The second-order standardized factor coefficients of model

path	Second-order Factor Model (M2a)			Modified First-order Factor Model (M2b)		
	regression coefficients	*P*	standardized regression coefficients	regression coefficients	*P*	standardized regression coefficients
F1<---D1	1.000	—	0.831	1.000	—	0.600
F4<---D1	0.061	0.506	0.144	0.101	0.355	0.177
F2<---D2	1.000	—	0.827	1.000	—	0.859
F3<---D2	1.191	***	0.843	1.226	***	0.783
F5<---D2	0.634	***	0.612	0.670	***	0.609
C1<---F1	0.382	***	0.327	0.392	***	0.343
C2<---F1	0.963	***	0.736	0.796	***	0.625
C3<---F1	0.992	***	0.740	0.827	***	0.635
C4<---F1	1.000	—	0.785	1.000	—	0.812
C5<---F1	0.641	***	0.622	0.663	***	0.662
C6<---F1	0.811	***	0.541	0.865	***	0.592
C7<---F2	0.284	***	0.205	0.365	***	0.238
C8<---F2	0.686	***	0.420	0.799	***	0.443
C9<---F2	0.691	***	0.411	0.807	***	0.434
C10<---F2	0.697	***	0.503	0.779	***	0.509
C11<---F2	0.725	***	0.580	0.829	***	0.600
C12<---F2	0.502	***	0.353	0.612	***	0.390
C13<---F2	1.018	***	0.766	1.008	***	0.687
C14<---F2	1.000	—	0.805	1.000	—	0.729
C15<---F2	1.080	***	0.697	1.124	***	0.657
C16<---F2	0.988	***	0.682	1.003	***	0.627
C17<---F3	0.830	***	0.645	0.723	***	0.586
C18<---F3	0.855	***	0.753	0.764	***	0.702
C19<---F3	0.689	***	0.747	0.671	***	0.759
C20<---F3	1.000	—	0.843	1.000	—	0.879
C21<---F3	0.947	***	0.771	0.990	***	0.841
C22<---F3	0.770	***	0.726	0.790	***	0.777
C23<---F3	0.483	***	0.601	0.418	***	0.543
C24<---F3	0.541	***	0.641	0.469	***	0.581
C25<---F3	0.504	***	0.497	0.442	***	0.455
C26<---F3	0.569	***	0.527	0.521	***	0.504
C27<---F4	0.825	***	0.793	0.824	***	0.793
C28<---F4	0.746	***	0.656	0.745	***	0.655
C29<---F4	1.000	—	0.855	1.000	—	0.856
C30<---F4	0.850	***	0.688	0.850	***	0.688
C31<---F5	1.000	—	0.850	1.000	—	0.850
C32<---F5	0.973	***	0.702	0.976	***	0.704
C33<---F5	0.975	***	0.860	0.974	***	0.859
C34<---F5	0.905	***	0.848	0.904	***	0.848

Noted: *** means $P<0.001$

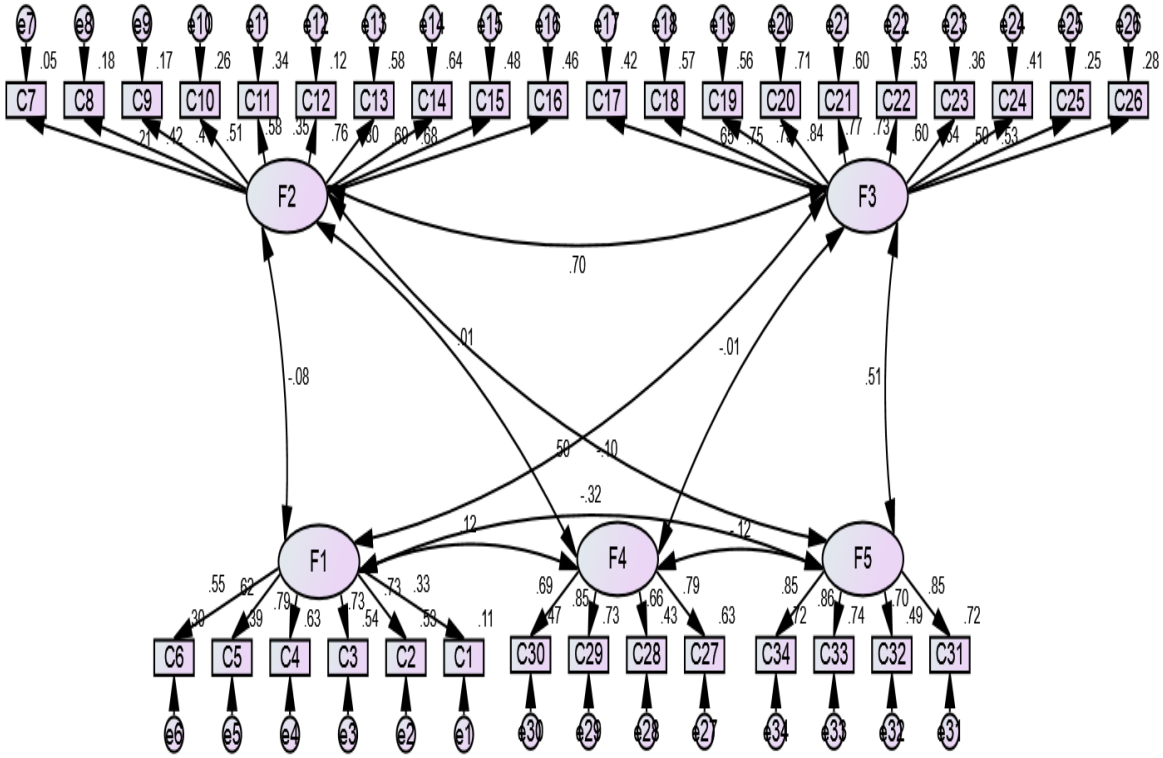

Figure S1 Standardized coefficients for initial first-order confirmatory factor analysis of COPSOQ (M1a). Confirmatory factor analysis (CFA) results didn't indicate good to adequate model fit: x^2=4216.39; degrees of freedom (*df*) =517; x^2/df =8.16; Comparative Fit Index (CFI) =0.737; Root Mean Square Error of Approximation (RMSEA) =0.095; Standardized Root Mean Square Residual (SRMR) =0.080. Standardized factor loadings and residual terms were shown above with directional arrows. F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction.

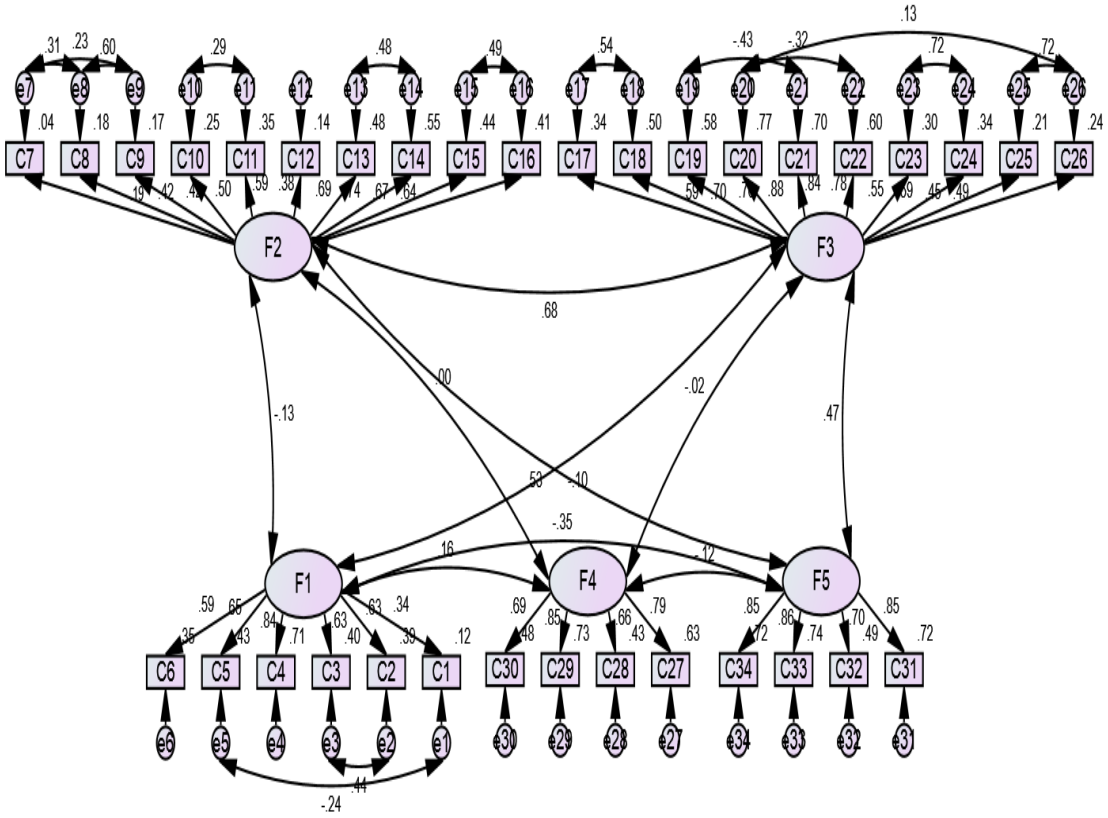

Figure S2 Standardized coefficients for modified first-order confirmatory factor analysis of COPSOQ (M1b). Confirmatory factor analysis (CFA) results indicated good to adequate model fit: x^2=1699.40; degrees of freedom (df)=503; x^2/df=3.40; Comparative Fit Index (CFI)=0.915; Root Mean Square Error of Approximation (RMSEA)=0.055; Standardized Root Mean Square Residual (SRMR)=0.070. Standardized factor loadings and residual terms were shown above with directional arrows. F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction.

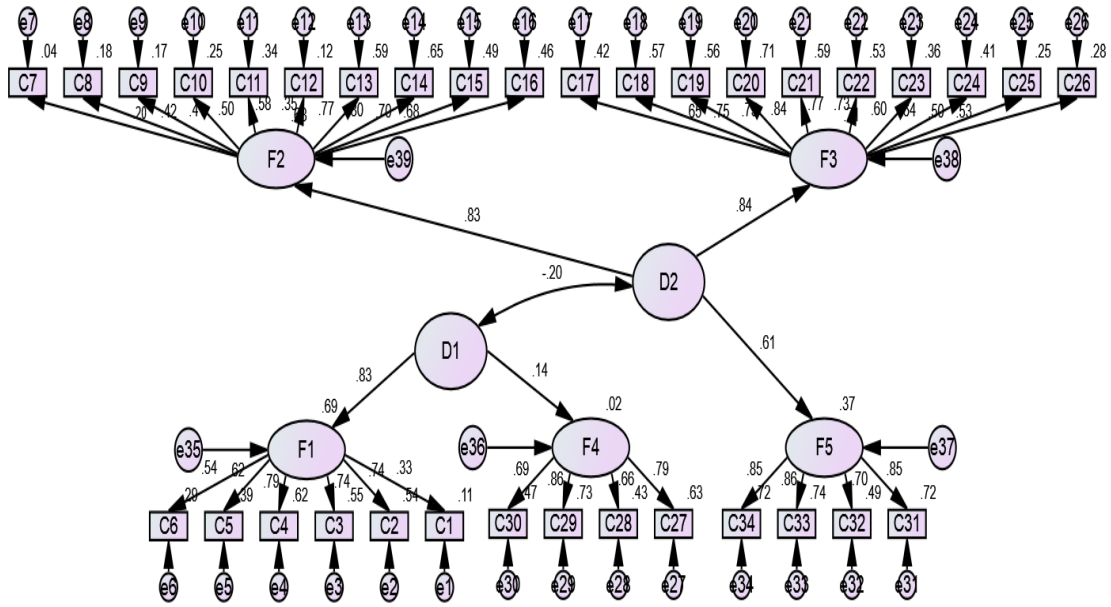

Figure S3 Standardized coefficients for initial second-order confirmatory factor analysis of COPSOQ (M2a). Confirmatory factor analysis (CFA) results didn't indicate good to adequate model fit: x^2=4276.30; degrees of freedom (*df*) =521; x^2/df=8.21; Comparative Fit Index (CFI) =0.733; Root Mean Square Error of Approximation (RMSEA) =0.095; Standardized Root Mean Square Residual (SRMR) =0.085. Standardized factor loadings and residual terms were shown above with directional arrows. F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5, 6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5, 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5, 6
Bias	9	Describe any efforts to address potential sources of bias	*7*

Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N
		(*e*) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7, 8
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	N
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 and 3
		(b) Indicate number of participants with missing data for each variable of interest	N
Outcome data	15*	Report numbers of outcome events or summary measures	Online summary table S1,Table3
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 10 and Table4

		(*b*) Report category boundaries when continuous variables were categorized	8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-10,Table4, Online summary table S2
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	3
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11,12
Generalisability	21	Discuss the generalisability (external validity) of the study results	3
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The relationship between stress-related psychosocial work factors and suboptimal health among Chinese medical staff: a cross-sectional study

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Abstract

Objectives To develop and validate a model to measure psychosocial factors at work among medical staff in China based on confirmatory factor analysis. The second aim of the current study was to clarify the association between stress-related psychosocial work factors and suboptimal health status.

Design The cross-sectional study was conducted by clustered sampling method.

Setting Xuanwu Hospital, a 3A Grade Hospital, in Beijing province.

Participants nine hundred and fourteen medical staff aged over 40 years were sampled. Seven hundred and ninety-seven valid questionnaires were collected and used for further analysis. The sample included 94% of the Han population.

Main outcome measures The Copenhagen Psychosocial Questionnaire (COPSOQ) and Suboptimal Health Status Questionnaires-25 (SHSQ-25) were used to assess the psychosocial factors at work and suboptimal health status, respectively. Confirmative Factor Analysis (CFA) was conducted to establish the evaluating method of COPSOQ. A multivariate logistic regression model was used to estimate the relationship between suboptimal heath status and stress-related psychosocial work factors among Chinese medical staff.

Results There was strong correlation among the five dimensions of COPSOQ based on the first-order factor model. Then, we established two second-order factors including negative and positive psychosocial work stress factor to evaluate psychosocial factors at work and the second-order factor model fit well. The high score of negative (*OR* (*95% CI*) = 1.47 (1.34 to 1.62), $P<0.001$) and positive psychosocial work factor (*OR* (*95% CI*) = 0.96 (0.94 to 0.98), $P<0.001$) increased and decreased the risk of suboptimal health, respectively. This relationship remained statistically significant after adjusting for confounders and when using different cut-offs of SHS.

Conclusions Among medical staff, the second-order factor model was a suitable method to evaluate the COPSOQ. The negative and positive psychosocial work stress factor might be the risk and protective factor of suboptimal health, respectively. Moreover, negative psychosocial work stress was the most associated factor to predict suboptimal health.

Strengths and limitations of this study

- The study had high internal validity, with a good representation of medical staff.
- To assessment psychosocial factors at work among medical staff, a more parsimonious, modified second-factor model was finally built to replace the traditional method of calculating the average value of the COPSOQ which ignored the effect of each item.
- The study was conducted in Beijing (a dense city), adding evidence on these issues in a different context than the current literature.
- Although the sample was representative of the diversity of medical staff in one geographical area of the China, the data are not nationally representative and ethnic minority groups are particularly under-represented.
- The study used a cross-sectional design, which is not well suited to assess the direction of causation.

1. Introduction

Work is viewed as an important aspect of psychosocial stress and the impact of psychosocial work conditions on workers' health has been well documented over the past decades. There is accumulating evidence indicted an association between a harsh working environment and a wide range of diseases including mental disorders [1-2], diabetes [3] and cardiovascular disease [4-6] among workers. So far, several theories have been established that predicted various consequences for the health of workers when exposed to certain psychosocial risk factors at work [7]. Seven influential theories are the job characteristics model, the Michigan organizational stress model, the demand–control–(support) model, the sociotechnical approach, the action–theoretical approach, the effort–reward–imbalance model, and the vitamin model [8]. The Copenhagen Psychosocial Questionnaire (COPSOQ) is a comprehensive and generic instrument based on the integration of the common elements of seven kinds of pattern and development some of the original entry (such as work content) at the same time for the assessment of psychosocial factors at work. Exposure to workplace psychosocial risk factors varies according to the types of occupation and job role. Teachers, firefighters and hospital workers have been reported to experience higher level of work-related stress than average level [9-10].

Due to demographic changes, the number of old people and the incidence of chronic diseases are rising in China. Meanwhile, dealing with chronic diseases, incurable or dying patients are emotionally demanding [11]. In addition, there are rapid enhancements on treatment options and therapeutic strategies due to medical advances. These changes may lead to an increased workload and high quantitative demands for Chinese medical staff at hospital. Recent studies have been demonstrated that the prevalence of burnout and stress is relatively high among medical staff [12-13]. Stress fatigue and burnout further have a detrimental influence on the physicians' quality of life and may result in early retirement or reduced quality of patient care and negatively affects health-care systems [14-15]. What is more, studies have shown that medical staff is at increased risk for ill-health, including musculoskeletal disorders [16] and mental health problems [17], caused by adverse workplace factors. Consequently, we need to pay attention to the psychosocial work characteristics of medical staff.

Since the ancient time, traditional Chinese medicine has been identifying a physical status between health and disease which we coined as suboptimal health status (SHS) [18]. SHS is characterized by functional somatic syndromes or symptoms that are medically undiagnosed. Nowadays, much attention has been paid on perceived poor health "somatization" and "medically

unexplained symptoms" in community and primary care system located in developed counties [19-20]. Undoubtedly, SHS is becoming a global issue. Recent studies ever reported that 60% of students [21] and 50-60% of occupational population [22-23] suffered from suboptimal health in China. Unfortunately, impaired quality of life, frequent hospital visits and incurrence of significant medical expenses were often accompanied with SHS [24]. Our previous studies have showed that SHS may contribute to the progression or development of chronic diseases, such as cardiovascular disease [25]. Although the aforementioned study has demonstrated the prevalence of SHS and its consequences, few studies that have addressed the issue of stress-related psychosocial work factors and suboptimal health among medical staff in China. This study aimed to evaluate the impact of stress-related psychosocial work factors on suboptimal health status and their associations.

2. Participants and Methods

2.1 Ethics Statement

Approval was obtained from the Research Ethics Committee of Capital Medical University prior to the initiation of this project. All study participants provided written informed consent prior to enrollment in the study.

2.2 Participants

This cross-sectional study was conducted by clustered sampling method. The current analysis included 914 medical staff from Xuanwu Hospital who participated in the 2014 annual health medical examination (including physicians, nurses, medical technicians, management staff, et al.). All participants of this study were older than 40 years of age. The data were collected through questionnaires of Suboptimal Health Status Questionnaires-25 (SHSQ-25) and Copenhagen Psychosocial Questionnaire (COPSOQ). The subjects were divided into 'SHS' and 'non-SHS' group by the score of SHSQ-25.

2.3 Instruments

2.3.1 Copenhagen Psychosocial Questionnaire

The Copenhagen Psychosocial Questionnaire (COPSOQ) is a comprehensive and generic instrument for the assessment of psychosocial factors at work, which has been developed and validated by Kristensen and Borg of the Danish National Institute for

Occupational Health in Copenhagen [8]. The Chinese translation and adaptation of COPSOQ had been tested in the population with different professions, which had been shown good reliability and validity, with Cronbach's alpha coefficients of 0.7 for most scales [26-27]. This instrument includes three versions: a long version for research use, a medium-length version to be used by work environment professionals, and a short version for workplaces. Our study was based on the short Chinese version of COPSOQ, which consists of 44 questions forming 8 scales. We selected 34 questions including 5 dimensions from a short version of COPSOQ with namely 'Demands at work', 'Influence and development', 'Interpersonal relations and leadership', 'Insecurity at work' and 'Job satisfaction' to assess psychosocial factors at work for stress [8]. In this survey, the remaining three health-related dimensions, including 'general health', 'mental health' and 'vitality', in the original short version of COPSOQ were not used. For most of the questions, we used either intensity (from "to a very small extent" to "to a very large extent") or frequency (from "never/hardly ever" to "always"). All items of COPSOQ were transformed on a value range from 0 to 100 points with 0 representing the lowest degree of the measured psychosocial factor 'never/hardly ever' or 'to a very small extent', and 100 representing the highest 'always' or 'to a very large extent' (online supplementary table S1). In most scales, a high score was considered desirable. On the contrary, a low score was considered desirable for 'Demands at work' and 'Insecurity at work'.

As a default generic method, the average scores for each dimension of COPSOQ were calculated and compared. But this method ignored the relationship between each item and corresponding dimension. To explore the association among each dimension of COPSOQ, we conducted confirmative factor analysis (CFA) [28] which could estimate the relationship between each latent variable (i.e. each dimension of COPSOQ) and between observed variables (i.e. items of dimensions) and corresponding latent variable as well.

2.3.2 Suboptimal Health Status Questionnaires-25

Suboptimal Health Status (SHS) was measured by the suboptimal health status questionnaire (SHSQ-25) [18] including 25 items and encompassed five subscales: fatigue, the cardiovascular system, the digestive tract, the immune system and mental status. The SHSQ-25 is short and easy to be completed, and therefore, suitable for use in general population and primary care service [23]. Each individual was asked to rate a specific statement on a 5-point Likert-type scale based on how often they suffered various specific complaints in the preceding 3 months: never/ hardly ever, occasionally, often, very often, and always. The scores on the

questionnaire were coded as 0 to 4. SHS scores ranged from 0 to 100 were calculated for each respondent by summing the ratings for the 25 items. A high score represents a high level of SHS (poor health).

There are no cut-off scores. The sample did not have high levels of suboptimal health (online supplementary table S2); therefore, for an easier interpretation, participants with a SHSQ-25 score higher than 31 (median of the total sample) were classified as 'SHS', and those equal or lower than 31 were classified as 'non-SHS'. The sensitivity of our results to this choice was examined further in sensitivity analyses by classifying the respondents with SHSQ-25 scores in the 75th percentile (P75) and above (a score higher than 43) and in the 90th percentile (P90) and above (a score of 53 and above) as SHS and all others as non-SHS.

2.4 Statistical analysis

Descriptive statistics were used to describe the overall population. Univariate analyses were used to compare variations in demographic characteristics among medical staff with different suboptimal health status; for Binary and categorical variable, chi-square test was used, ordinal variable was analyzed by *Kolmogororv-Smirnov Z* test. For nonparametic data, *Mann-Whitney U* test was used to assess stress-related working factors among medical staff with different health status. Demographic missing data were coded as missing and excluded from relevant analysis. A Cronbach's alpha of >0.70 is considered to be an acceptable reliability coefficient for determining the internal consistency of the scale [29]. Model testing was conducted by confirmatory factor analysis (CFA) and structural equation modeling (SEM) analyses. To assess global fit of the model by total sample, we calculated five goodness-of-fit indices. They were χ^2 and its subsequent ratio with degrees of freedom (χ^2/df), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), standard root mean square residual (SRMR) and root mean square error of approximation (RMSEA). Evaluation standards were described in previous literature [30-32]. The first-order factor model was used to analyze the correlation among the five dimensions of COPSOQ. And, the second-order factor model was to establish the evaluating method of COPSOQ for comparing psychosocial work characteristics among medical staff. A multivariate logistic regression model was used to estimate the relationship between suboptimal heath status and psychosocial factors at work. Potential confounders including age, gender, education level, occupation, physical exercise, drinking behavior, and smoking status were adjusted. The two-tailed $P < 0.05$ was considered to be statistically significant. The statistical packages SPSS 22.0 (Chicago, Illinois) and AMOS 22.0 (Chicago, Illinois) were used for statistical analysis.

3. Results

3.1 Baseline Characteristics

Among 914 of the medical staff participated in 2014 annual health medical examination 797 eligible questionnaires were retrieved, with the retrieval rate of 87.20%. The mean age was approximately 50, More than half of the participants were female (n=554, 69.5%). Table 1 showed the descriptive analyses of participants according to suboptimal health status. The differences in age, gender, education level, occupation and the status of physical exercise, smoking and drinking between individuals with and without SHS were statistically significant (All $P<0.05$, Table 1). In sensitivity analyses of participant according suboptimal health status (P75 and P90) reported the same results. Moreover, compared with non-SHS individuals, SHS individuals were statistically significantly ($P<0.05$) more likely to be longer weekly working hours when using P75 as a SHS cut-off (online supplementary table S3). There were 396 (49.7%) individuals considered as SHS based on the score of SHSQ-25 (median). Among 396 suboptimal health individuals, 80.6 % was female, nearly half (48.2%) with the highest record of formal schooling was junior college, 31.8 % careered in nursing, 59.8 % was without the habit of physical exercise and mostly (>80%) didn't smoking and drinking (Table 1). This advantage in the proportion of corresponding variables above still existed and became more obvious in sensitivity analyses (online supplementary table S3).

3.2 Reliability

The COPSOQ showed a very high overall internal consistency with Cronbach's alpha of 0.849 for the total scale (Items 1-34). The internal consistency characteristics of COPSOQ showed good reliability. The Cronbach's alpha about five dimensions were among 0.791 to 0.891 (online supplementary table S4).

3.3 Confirmatory factor analysis

We performed confirmatory factor analysis (CFA) based on the five theoretical dimensions of COPSOQ. Parameters were estimated for the CFA model based on the maximum likelihood procedure involving fitting the variances and covariances among observed scores. AMOS therefore created a covariance matrix, including the variances and covariances among observed scores.

The next step was to illustrate the observed (items) and unobserved (factors) in the hypothesized model (see online supplementary figure S1). The goodness of fit index was unacceptable in M1a (Table 2). After modification according to modification index [33], the modified first-order factor model (M1b, see online supplementary figure S2) for COPSOQ had adequate fit of the model to the data (Table 2). However, pearson correlations between first-order factors in M1b model showed that most of the first order factors correlated with each other (online supplementary table S4). These results supported the notion that the COPSOQ was comprised of five factors subsumed under one or two higher order factors. Based on the theoretical model of COPSOQ, high scores of F1 (Demands at work) and F4 (Insecurity at work) means susceptible to work strain. Conversely, high scores of F2 (Influence and development), F3 (Interpersonal relations and leadership) and F5 (Job satisfaction) may protect people from work strain [26]. According to the theory, the second-order factor model of COPSOQ might be exited. We next conducted CFA to formally test the fit of our hypothesized, second-order factor model (M2a) of COPSOQ. This model, depicted in online supplementary figure S3, didn't have good overall model fit (Table 2). This suggested M2a need further modification. M2a was modified (Figure 1) and the fit of the modified second-order model (M2b) was acceptable (Table 2).

The overall fit of modified factor first-order model (M1b) and modified second-order factor model (M2b) were similar. Thus, we further compared these two models. As a result, a χ^2 difference test revealed that modified second-order factor model was significantly better than modified factor first-order model ($\Delta\chi^2$=34.73, P<0.05), which suggested that the more parsimonious, modified second-factor model (M2b) would be favored for COPSOQ. In M2b, D1 which refereed to negative psychosocial work factor included two first-order factors (F1 Demands at work and F4 insecurity at work). And, D2 positive psychosocial work factor was composed by the rest three first-order factors (Influence and development, Interpersonal relations and leadership and Job satisfaction). All standardized factor coefficients of this model were significant (P<0.05, Figure 1). But, the relationship between insecurity at work and D1 negative psychosocial work factor was not significant (r=0.18, P>0.355, Figure 1). Thus, demand at work was the largest contributor to the negative psychosocial work stress in current study.

3.4 The assessment of stress-related psychosocial work factors among medical staff with different individual and work characteristics

We used the two second-order factors (D1 negative psychosocial work stress factor and D2 positive psychosocial work stress

factor) to assess the psychosocial work factors among medical staff. The factors score was calculated by standardized regression coefficients. In structural equation modeling, the standardized regression coefficients, also called standardized factor loadings, actually are the correlation coefficients between indictors and its latent variables. The form of standardized factor scores of the ith factor in first-order model is:

$$ZFi = \sum_j b_{ij} \left(ZC_j - \overline{ZC_j}\right)$$

Where b_{ij} are standardized regression weights, ZC_j is the standardized scores of the jth questionnaire item, $\overline{ZC_j}$ is average standardized scores. $i = 1,2,3,4,5,\ j = 1,2,3,4,5,6,7,8,9,10$;

The form of standardized factor scores of the ith factor in first-order model is:

$$S = \sum W_i \left(ZF_i - \overline{ZF_i}\right)$$

Where W_i are standardized regression weights, ZF_i is the standardized scores of the ith latent variable, $\overline{ZF_j}$ is average standardized scores of 5 latent variable. $i = 1,2,3,4,5$.

Based on the above 2 formulas, we can get the score of D1 (negative psychosocial work factor) and D2 (positive psychosocial work factor) among medical staff. The two factors score did not meet the normal distribution assumptions, were conducted using the *Mann-Whitney U* non-parametric test by ranks. Table 1 showed the score of stress-related psychosocial work factors based on different individual and work characteristics. The score of negative psychosocial work stress factor was significantly different among medical staff with different age, education level, occupation, physical exercise, night shift and weekly working hours (P<0.05). While, the difference between men and women was not significant (P=0.292). In the other hand, the score of positive psychosocial work stress factor was significantly different among medical staff with different age, gender, occupation and the status of physical exercise, smoking and drinking (P<0.05). Then, we explored the score of psychosocial work stress factors between individuals with and without SHS, results shown in Table 3. The scores of negative and positive psychosocial factor were significantly different between SHS and non-SHS group (P<0.05). Briefly, the individuals with SHS were likely to get higher score of negative psychosocial work factor and lower score of positive psychosocial work factor, respectively. This difference stayed statistically significant when using SHS cut-offs of either P75 or P90 (Table 3).

3.5 The relationship between stress-related psychosocial work factors and suboptimal health (P50, P75 and P90)

Multivariate stepwise logistic regression models showed a statistically significant inverse relationship between positive psychosocial work stress factor and suboptimal health, and a positive relationship between negative psychosocial work stress factor and suboptimal health. Regarding negative psychosocial factor in the total sample, those who got higher score of negative psychosocial work stress factor had higher risk of being suboptimal than low-score individuals (model1: *OR* (*95% CI*)=1.47 (1.34 to 1.62), *P*<0.001). This relationship remained statistically significant in the adjusted models (model2: *OR* (*95% CI*)=1.50 (1.36 to 1.66), *P*<0.001; model3: *OR* (*95% CI*)=1.57 (1.42 to 1.75), *P*<0.01) (Table 4) and when using SHS cut-offs of either P75 or P90. Considering the total sample, individuals with higher score of positive psychosocial work stress factor had a lower risk of being suboptimal health compared with those who got lower score (model1: *OR* (*95% CI*) = 0.96 (0.94 to 0.98), *P*<0.001). This relationship remained statistically significant in the adjusted models (model2: *OR* (*95% CI*) = 0.97 (0.95 to 0.99), *P*=0.003; model3: *OR* (*95% CI*) = 0.97 (0.95 to 0.99), *P*=0.012) and in the majority of SHS sensitivity analyses (using cut-offs of P75 and P90), with the exception of the first-step adjusted and fully adjusted models using P90 as a SHS cut-off (model2: *OR* (*95% CI*) = 0.97 (0.94 to 1.01), *P*=0.155; model2: *OR* (*95% CI*) = 0.98 (0.95 to 1.02), *P*=0.325).

4. Discussion

As the development of social economy and the rapid pace of life, public have paid more and more attention to the importance of suboptimal health. SHS is regarded as a subclinical, reversible stage of chronic disease, which is characterized by a decline in vitality, in physiological function and in the capacity for adaptation within a period of three months [18]. For measurement of SHS, we developed SHSQ-25 and adopted it as an instrument in this study. SHSQ-25 has good internal consistency, which item-subscale correlations ranged from 0.51 to 0.72, with Cronbach's α of 0.70 or higher for all subscales [23]. The good internal consistency (cronbach's α of 0.943) was also verified in our study (not shown in our study). Multiple factors which were influential to SHS, including gender, age, physical activities, dietary habits, emotional problems, social adaptation, etc. have been found in recent studies [22, 25]. In corresponded, age, gender, education level, job, physical exercise, smoking and drinking were significant factors that may influence the status of health among medical staff in current study. There was no internationally accepted cutoff value to diagnose SHS. Thus, we further conducted a sensitivity analysis in which the results also valid. Overall,

the female nurses without the ways to relieve stress, such as habit of physical exercise, smoke and drink, were higher score of SHSQ-25 (poorer health).

Over the last 20 years, rare longitudinal and many cross-sectional studies have highlighted work organization conditions, including repetitive work [34], decision authority [35], physical and emotional demands [36], irregular schedules and long hours [37-38], and job insecurity [39] were the stress-related work factors to explain the emergence or aggravation of mental illness. In addition, low job satisfaction that was also found to be important contributors to occupational stress in healthcare settings in different studies [40-41]. The relation of mental work load and health status based on documented measuring instruments which covered all important aspects was undisputedly increased. For enterprises and organizations, the COPSOQ questionnaire is a qualified screening-instrument for psychosocial factors at work [42]. It has good internal consistency with Cronbach's α of 0.79 or even higher for all subscales in our study. But scale scores were computed as the average of the values of the single aspects, this method ignored the relationship among each dimension. Previous studies [28] also showed the factor loadings calculated by traditional factor analysis were less accurate and precise than that calculated by structural equation modeling, due to the traditional method could not control the effects of other variables and caused message loss when extracting common factors. By contrast, structural equation modeling could get factor loadings both of indictors to first-order factors and first-order factors to second-order factors. The standardized regression coefficients estimated the relational degree between indictors and first-order factors, first-order factors and second-order factors under controlling other variables. The other difference with traditional method is that structural equation modeling allows measurement error of indictors.

Based on the above comparison and consideration, we conducted first- and second-order factor model to explore the association among dimensions of COPSOQ. In this study, a modified second-factor model with best fit indexes was considered to be favored for COPSOQ. Therefore, the stress-related psychosocial work factors of medical staff were assessed by modified second-order factor model (M2b). In M2b, the relationship between insecurity at work and negative psychosocial work factor was not significant. This result reflected subjects faced the risk of unemployment was very low in our study. It was accorded with the actual investigation in which subjects were on-the-job medical staff (older than 40 years of age) whose careers have "reached a stable position". The prevalence rate of SHS was 49.7% when using P50 as cutoff value in our study. Although they were low

insecurity at work, they were in high risk of SHS because of the high pressure during the inservice.

The clinician as a kind of special population, they need possess highly concentrated attention, sensible thinking, exquisite techniques and experiences. Moreover, lasting work and intensive labor intensity make them suffer more stress than other medical specialties. Previous research suggested that psychosocial stress may result from gendered processes [43], such as uneven family responsibilities, gender-specific harassment or discrimination, and unequal levels of poverty which mainly limited the professional influence and development of female. In current study, the difference in the score of negative psychosocial work stress factor between men and women was not significant. But, women were lower score of positive psychosocial work stress factor than men (P<0.05). In other word, women were more likely to suffer from stress-related psychosocial work factors than men. The gender gap in suboptimal health status in our study may be explained by the discriminatory impact of gender on the susceptible to stress-related psychosocial work factors and the individuals with high level of psychosocial work stress were high risk group of SHS. Additionally, age was also a significant factor affecting the stress levels [44-45]. Meanwhile, individuals with higher levels of education report greater psychological demands [46]. Similarly, we found older male nonclinical medical staff with habit of physical exercise, smoking and drinking reported higher score of positive psychosocial work factors (less susceptible to work strain). While, younger clinical doctors with graduate degree or above who were lack of exercise, on night shift, and longer man-hour (longer than 40 hour per week) reported higher score of negative psychosocial work factor (more susceptible to work strain). In our study, psychosocial work stress factors, especially the negative side, was the mentioned factor influencing the risk of suboptimal health among medical staff. This relationship was also found in population of executive employees [47].

The results of this study provided some important insights for supervisors and managers in hospital. Positive effects of work in the medical services should be maximized. And the consequences of work-related risk factors, such as demands and insecurity at work, in this important profession, should be prevented. Moreover, Yan YX, et al [25] indicated that SHS is associated with cardiovascular risk factors and contributes to the development of cardiovascular disease. Therefore, it's less likely to be a question that the above measures are effective to prevent SHS, and further reduce the risks of cardiovascular disease.

5. Conclusion

The modified second-order factor model was a suitable method to evaluate COPSOQ among medical staff. In this population, the negative and positive psychosocial work stress factors might be the risk and protective factor of suboptimal health, respectively. Negative psychosocial work stress was the most associated factor to predict suboptimal health.

Supplementary Materials

Supplementary File 1. pdf

Supplementary File 2. pdf

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Footnotes

Yingzhi Liang and Shijiao Meng contributed equally to this work.

Contributors

Yuxiang Yan, lead and corresponding author, had full access to the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Yingzhi Liang wrote the majority of the manuscript, provided critical revisions to the manuscript and aided substantially in the preparation of the revised submission. Shijiao Meng and Lijuan Wu provided input into study design, performed many of the data analysis, made substantial critical revisions and aided with interpretation. Jie Zhang and Xi Chu aided with interpretation. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

This study and associated protocols were conducted after approval by the Research Ethics Committee of Capital Medical University. All research participants consented to having their anonymous data included in the analyses reported herein.

Provenance and peer review

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Availability of data and materials

The datasets used and/or analyzed during this study are available from the corresponding author on reasonable request.

Table1 Descriptive analyses of participants according to suboptimal health status and the stress-related psychosocial work factors as a total sample

Demographics	Total (N=797)	SHSQ-25 (P50)			Second-order factor of COPSOQ			
	n (%)	Non-SHS	SHS	*P*	D1 negative psychosocial work stress factor	*P*	D2 positive psychosocial work stress factor	*P*
Age group(years)				0.005*		0.003		0.007
40~	270 (33.9)	118 (29.4)	152 (38.4)		0.21 ± 1.65		-0.80 ± 7.00	
					0.15 (-1.14, 1.32)		0.15 (-5.52, 4.17)	
45~	245 (30.7)	126 (31.4)	119 (30.1)		0.07 ± 1.72		-0.29 ± 6.84	
					-0.1 (-1.28, 1.24)		0.46 (-4.39, 4.76)	
55~68	282 (35.4)	157 (39.2)	125 (31.6)		0.26 ± 1.70		1.01 ± 7.35	
					-0.47 (-1.55, 0.88)		1.08 (-2.93, 6.78)	
Gender				< 0.001		0.292		< 0.001
Male	243 (30.5)	166 (41.4)	77 (19.4)		-0.05 ± 1.88		1.24 ± 7.29	
					-0.17 (-1.67, 1.20)		1.54 (-3.33, 6.82)	
Female	554 (69.5)	235 (58.6)	319 (80.6)		0.02 ± 1.62		-0.54 ± 6.96	
					-0.11 (-1.22, 1.14)		0.24 (-5.02, 4.31)	
Education level				0.003*		< 0.001		0.111
High school and below	122 (15.3)	65 (16.20)	57 (14.4)		-0.41 ± 1.81		0.55 ± 7.79	
					-0.62 (-1.90, 0.64)		1.19 (-3.74, 6.23)	
Junior college	321 (40.3)	130 (32.4)	191 (48.2)		-0.07 ± 1.65		-0.78 ± 7.44	
					-0.21 (-1.39, 1.04)		0.17 (-5.81, 4.35)	
University	182 (22.8)	102 (25.4)	80 (20.2)		-0.15 ± 1.71		0.62 ± 6.68	
					-0.37 (-1.52, 1.01)		1.22 (-3.60, 5.47)	
Graduate students and above	172 (21.6)	104 (25.9)	68 (17.2)		0.57 ± 1.56		0.42 ± 6.30	
					0.70 (-0.65, 1.63)		0.66 (-4.28, 5.17)	
occunation				< 0.001		< 0.001		0.001
Nurses	188 (23.6)	62 (15.5)	126 (31.8)		0.22 ± 1.57		-1.15 ± 7.35	
					0.13 (-0.99, 1.16)		-0.10 (-7.17, 4.10)	
Medical technicians	187 (23.5)	83 (20.7)	104 (26.3)		-0.30 ± 1.59		-0.85 ± 6.75	
					-0.43 (-1.64, 1.02)		-0.20 (-5.48, 3.46)	
Doctors	208 (26.1)	125 (31.2)	83 (21.0)		0.37 ± 1.72		0.70 ± 6.97	
					0.31 (-0.93, 1.53)		0.94 (-4.19, 6.67)	
Others	214 (26.9)	131 (32.7)	83 (21.0)		-0.29 ± 1.78		1.06 ± 7.13	
					-0.60 (-1.77, 0.89)		1.44 (-2.78, 5.51)	
Physical exercise				0.003		0.001		0.022
Yes	363 (45.5)	204 (50.9)	159 (40.2)		-0.19 ± 1.76		0.51 ± 7.30	
					-0.48 (-1.69, 1.14)		1.12 (-4.27, 5.77)	
No	434 (54.5)	197 (49.1)	237 (59.8)		0.16 ± 1.63		-0.43 ± 6.92	
					0.12 (-1.02, 1.18)		0.33 (-5.03, 4.32)	
Smoking				< 0.001		0.082		0.013
Yes	93 (11.7)	63 (15.7)	30 (7.6)		-0.19 ± 2.04		1.58 ± 7.80	
					-0.90 (-1.77, 1.16)		2.16 (-3.16, 7.23)	
No/Quit	704 (88.3)	338 (84.3)	366 (92.4)		0.02 ± 1.65		-0.21 ± 6.99	
					-0.09 (-1.28, 1.16)		0.47 (-4.72, 4.78)	
Drinking				< 0.001		0.081		0.012
Yes	166 (20.8)	105 (26.2)	61 (15.4)		-0.18 ± 1.78		1.18 ± 7.13	
					-0.66 (-1.56, 1.04)		1.39 (-2.83, 6.72)	
No/Abstained	631 (79.2)	296 (73.8)	335 (84.6)		0.05 ± 1.68		-0.31 ± 7.07	
					-0.84 (-1.30, 1.16)		0.37 (-4.93, 4.75)	
Night shift				0.774		< 0.001		0.445
Yes	331 (41.5)	169 (42.1)	162 (40.9)		0.27 ± 1.71		-0.21 ± 7.04	
					0.22 (-1.08, 1.36)		0.46 (-4.42, 4.78)	
No	466 (58.5)	232 (57.9)	234 (59.1)		-0.19 ± 1.67		0.15 ± 7.16	
					-0.39 (-1.53, 0.96)		0.67 (-4.68, 5.22)	
Weekly working hours				0.455		< 0.001		0.827
≤40 hours	270 (33.9)	141 (35.2)	129 (32.6)		-0.49 ± 1.60		0.13 ± 6.92	
					-0.71 (-1.78, 0.56)		0.57 (-4.45, 5.07)	
>40 hours	527 (66.1)	260 (64.8)	267 (67.4)		0.25 ± 1.70		-0.06 ± 7.21	
					0.17 (-1.10, 1.43)		0.70 (-4.62, 5.11)	

Noted: * analyzed by Kolmogororv-Smirnov Z test.

Table 2 Goodness-of-fit indices for the different models

Model	χ^2 (*df*)	χ^2/ *df*	CFI	AGFI	SRMR	RMSEA
M1a	4216.39(517)	8.16	0.737	0.708	0.0802	0.095
M1b	1699.40(503)	3.40	0.915	0.864	0.0696	0.055
M2a	4276.30(521)	8.21	0.733	0.707	0.0852	0.095
M2b	1664.67(508)	3.28	0.918	0.866	0.0659	0.053

Noted: M1a: the first-order factor model; M1b: the modified first-order factor model; M2a: the second-order factor model; M2b: the modified second-order factor model. Model fitting criteria were as followed: A CFI value of greater than 0.90 showed a psychometrically acceptable fit to the data; The value of AGFI ranged between 0 and 1, a value of 1 indicated a perfect fit; For the SRMR, values of 0.08 or lower represented good fit; The value of RMSEA should be below 0.06 to show good fit.

Table 3. The assessment of stress-related psychosocial work factors between individuals with and without SHS

groups	Second-order factor of COPSOQ			
	D1 negative psychosocial work stress factor	*P*	D2 positive psychosocial work stress factor	*P*
suboptimal health status (P50)		<0.001		<0.001
Non-SHS	-0.53 ± 1.60 -0.77 (-1.83, 0.54)		1.15 ± 6.97 1.61 (-2.79, 6.34)	
SHS	0.53 ± 1.63 0.46 (-0.67, 1.60)		-1.16 ± 7.06 -0.57 (-5.75, 3.94)	
suboptimal health status (P75)		<0.001		<0.001
Non-SHS	-0.24 ± 1.67 -0.39 (-1.62, 0.91)		0.71 ± 7.08 1.24 (-3.85, 5.69)	
SHS	0.77 ± 1.57 0.70 (-0.44, 1.86)		-2.29 ± 6.73 -1.93 (-7.11, 2.60)	
suboptimal health status (P90)		<0.001		0.005
Non-SHS	-0.09 ± 1.68 -0.20 (-1.47, 1.08)		0.29 ± 7.13 0.78 (-4.39, 5.22)	
SHS	0.90 ± 1.68 0.57 (-0.44, 2.19)		-2.14 ± 6.57 -1.93 (-7.23, 2.18)	

Table 4 Sensitivity analyses with multivariate models assessing the relationship between stress-related psychosocial work factors and suboptimal health (P50, P75 and P90)

Model / variables	suboptimal health status (P50, P75, P90)		
	OR	*OR 95%CI*	*P*
suboptimal health status (P50)			
Model1			
D1 negative psychosocial work stress factor	1.47	1.34-1.62	<0.001
D2 positive psychosocial work stress factor	0.96	0.94-0.98	<0.001
Model2			
D1 negative psychosocial work stress factor	1.50	1.36-1.66	<0.001
D2 positive psychosocial work stress factor	0.97	0.95-0.99	0.003
Model3			
D1 negative psychosocial work stress factor	1.57	1.42-1.75	<0.001
D2 positive psychosocial work stress factor	0.97	0.95-0.99	0.012
suboptimal health status (P75)			
Model1			
D1 negative psychosocial work stress factor	1.39	1.26-1.54	<0.001
D2 positive psychosocial work stress factor	0.95	0.93-0.97	<0.001
Model2			
D1 negative psychosocial work stress factor	1.42	1.28-1.58	<0.001
D2 positive psychosocial work stress factor	0.95	0.93-0.98	<0.001
Model3			
D1 negative psychosocial work stress factor	1.44	1.29-1.61	<0.001
D2 positive psychosocial work stress factor	0.96	0.93-0.98	0.001
suboptimal health status (P90)			
Model1			
D1 negative psychosocial work stress factor	1.36	1.18-1.57	<0.001
D2 positive psychosocial work stress factor	0.97	0.93-1.00	0.037
Model2			
D1 negative psychosocial work stress factor	1.43	1.23-1.67	<0.001
D2 positive psychosocial work stress factor	0.97	0.94-1.01	0.155
Model3			
D1 negative psychosocial work stress factor	1.46	1.25-1.70	<0.001
D2 positive psychosocial work stress factor	0.98	0.95-1.02	0.325

Noted: OR: Odds Ratio. Model1: Unadjusted. Model2: Adjusted by age and gender.Model3: Adjusted by age, gender, education level, occupation, physical exercise, drinking behavior, and smoking status.

Figure legends

Figure 1 Standardized coefficients for modified second-order confirmatory factor analysis of COPSOQ (M2b). The structural model consisted of seven interrelated constructs, F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction; D1, negative psychosocial work stress factor; D2, positive psychosocial work stress factor. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results indicated good to adequate model fit: $\chi 2$=1664.67; degrees of freedom (df) =508; $\chi 2$/df =3.28; Comparative Fit Index (CFI) =0.918; Root Mean Square Error of Approximation (RMSEA) =0.053; Standardized Root Mean Square Residual (SRMR) =0.066.

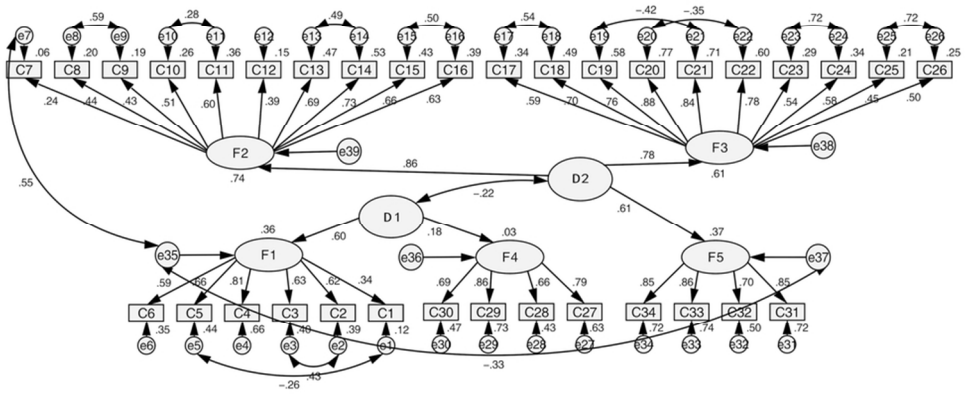

Figure 1 Standardized coefficients for modified second-order confirmatory factor analysis of COPSOQ (M2b). The structural model consisted of seven interrelated constructs, F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction; D1, negative psychosocial work stress factor; D2, positive psychosocial work stress factor. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results indicated good to adequate model fit: $\chi 2=1664.67$; degrees of freedom (df) =508; $\chi 2/df$ =3.28; Comparative Fit Index (CFI) =0.918; Root Mean Square Error of Approximation (RMSEA) =0.053; Standardized Root Mean Square Residual (SRMR) =0.066.

85x42mm (300 x 300 DPI)

Table S1. COPSOQ questions used in stress-related psychosocial work factors survey

Demands at work:		never/hardly ever	occasionally	often	very often	always
C1	Do you have to work very fast?					
C2	Is your workload unevenly distributed, so that it piles up?					
C3	How often do you not have time to complete all your work tasks?					
C4	Does your work put you in emotionally disturbing situations?					
C5	Do you get emotionally involved in your work?					
C6	Does your work require that you hide your feelings?					
Influence and development:		never/hardly ever	occasionally	often	very often	always
C7	Do you have a large degree of influence on the decisions concerning your work?					
C8	Can you influence the amount of work assigned to you?					
C9	Do you have any influence on what you do at work?					
C10	Can you play a leading role in the work?					
C11	Do you have the possibility of learning new things through your work?					
C12	Can you decide when to take a break?					
C13	Is your work meaningful?					
C14	Do you feel that the work you do is important?					
C15	Would you like to stay at your current place of work for the rest of your worklife?					
C16	Do you think your work is extremely important to yourself?					
Interpersonal relations and leadership:		never/hardly ever	occasionally	often	very often	always
C17	At your place of work, are you informed well in advance about, for example, important decisions, changes, or plans for the future?					
C18	Do you receive all the information that you need in order to do your work well?					
C19	How often do you get help and support from your colleagues?					
C20	How often do you get help and support from your nearest superior?					
C21	How often do you talk with your superior about how well you carry out					

	your work?					
C22	How often do you talk with your colleagues about how well you carry out your work?					
C23	Is there good co-operation between your colleagues at work?					
C24	Do you feel you are part of work team?					

Quality of leadership		to a very small extent	to a small extent	general	to a large extent	to a very large extent
C25	Is your immediate superior good at work-planning?					
C26	Is your immediate superior good at solving conflicts?					

Job insecurity		No	Yes
C27	Are you worried about becoming unemployed?		
C28	Do you worry about that new technology making you / your work redundant?		
C29	Are you worried about being difficult for you to find another job if you became unemployed?		
C30	Are you worried about being transferred to another job against your will?		

Job satisfaction		strongly dissatisfied	dissatisfied	general	satisfied	strongly satisfied
C31	Are you satisfied with your job prospects?					
C32	Are you satisfied with the hardware facilities in your work place?					
C33	Are you satisfied with the way you play an ability at your work?					
C34	Taken together, are you satisfied with your work?					

Table S2. SHSQ-25 score distribution in survey sample

SHSQ-25 score	*n*	%	Cumulative %
0-10	52.0	6.5	6.5
10-20	128.0	16.1	22.6
20-30	180.0	22.6	45.2
30-40	182.0	22.8	68.0
40-50	140.0	17.6	85.6
50-60	71.0	8.9	94.5
60-70	32.0	4.0	98.5
70-80	8.0	1.0	99.5
80-90	4.0	0.5	100.0
Total	797	100.0	

Table S3. Sensitivity analyses of participant according suboptimal health status

Demographics	Total (*N*=797)	SHSQ-25 (P75)			SHSQ-25 (P90)		
	n (%)	Non-SHS	SHS	*P*	Non-SHS	SHS	*P*
Age group(years)				<0.001			0.005
40~	270 (33.9)	188 (30.9)	82 (43.4)		234 (32.2)	36 (50.7)	
45~	245 (30.7)	188 (30.9)	57 (30.2)		228 (31.4)	17 (23.9)	
55~68	282 (35.4)	232 (38.2)	50 (26.5)		264 (36.40	18 (25.4)	
Gender				<0.001			<0.001
Male	243 (30.5)	213 (35.0)	30 (15.9)		239 (32.9)	4 (5.6)	
Female	554 (69.5)	395 (65.0)	159 (84.1)		487 (67.1)	67 (94.4)	
Education level				0.004			0.007
High school and below	122 (15.3)	970 (16.0)	25 (13.2)		109 (15.0)	13 (18.3)	
Junior college	321 (40.3)	225 (37.0)	96 (50.8)		284 (39.1)	37 (52.1)	
University	182 (22.8)	142 (23.4)	40 (21.2)		167 (23.0)	15 (21.1)	
Graduate students and above	172 (21.6)	144 (23.7)	28 (14.8)		166 (22.9)	6 (8.5)	
occupation				<0.001			<0.001
Nurses	188 (23.6)	117 (19.2)	71 (37.6)		151 (20.8)	37 (52.1)	
Medical technicians	187 (23.5)	137 (22.5)	50 (26.5)		168 (23.1)	19 (26.8)	
Doctors	208 (26.1)	173 (28.5)	35 (18.5)		201 (27.7)	7 (9.9)	
Others	214 (26.9)	181 (29.8)	33 (17.5)		206 (28.4)	8 (11.3)	
Physical exercise				0.012			0.045
Yes	363 (45.5)	292 (48.0)	71 (37.6)		339 (46.7)	24 (33.8)	
No	434 (54.5)	316 (52.0)	118 (62.4)		387 (53.3)	47 (66.2)	
Smoking				<0.001			0.002
Yes	93 (11.7)	87 (14.3)	6 (3.2)		92 (12.7)	1 (1.4)	
No/Quit	704 (88.3)	521 (85.7)	183 (96.8)		634 (87.3)	70 (98.6)	
Drinking				0.001			0.014
Yes	166 (20.8)	142 (23.4)	24 (12.7)		159 (21.9)	7 (9.9)	
No/Abstained	631 (79.2)	466 (76.6)	165 (87.3)		567 (78.1)	64 (90.1)	
Night shift				0.800			0.801
Yes	331 (41.5)	251 (41.3)	80 (42.3)		303 (41.7)	28 (39.4)	
No	466 (58.5)	357 (58.7)	109 (57.7)		423 (58.3)	43 (60.6)	
Weekly working hours				0.022			0.067
≤40 hours	270 (33.9)	219 (36.0)	51 (27.0)		253 (34.8)	17 (23.9)	
>40 hours	527 (66.1)	389 (64.0)	138 (73.0)		473 (65.2)	54 (76.1)	

Noted: *: P<0.01.

Table S4. Test of internal consistency and interfactor correlations of the COPSOQ

Factor (Cronbach's α)	N of Items	F_1	F_2	F_3	F_4	F_5
F_1 Demands (0.791)	6	1	—	—	—	—
F_2 Influence and development (0.820)	10	-0.067	1	—	—	—
F_3 Relation and leadership (0.891)	10	-0.094 *	0.606 **	1	—	—
F_4 Insecurity at work (0.830)	4	0.037 **	0.002	-0.004	1	—
F_5 Job satisfaction (0.881)	4	-0.214 **	0.306 **	0.366 **	-0.027 **	1

r correlation *p<0.05; **p<0.01

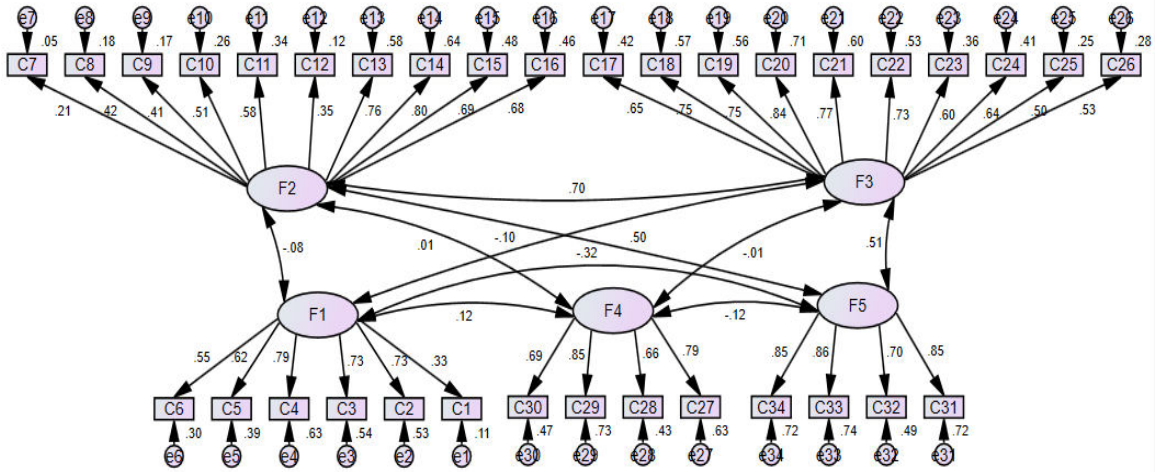

Figure S1 Standardized coefficients for initial first-order confirmatory factor analysis of COPSOQ (M1a). The structural model consisted of five interrelated constructs, including F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results didn't indicate good to adequate model fit: $\chi 2=4216.39$; degrees of freedom (df) =517; $\chi 2/df$ =8.16; Comparative Fit Index (CFI) =0.737; Root Mean Square Error of Approximation (RMSEA) =0.095; Standardized Root Mean Square Residual (SRMR) =0.080.

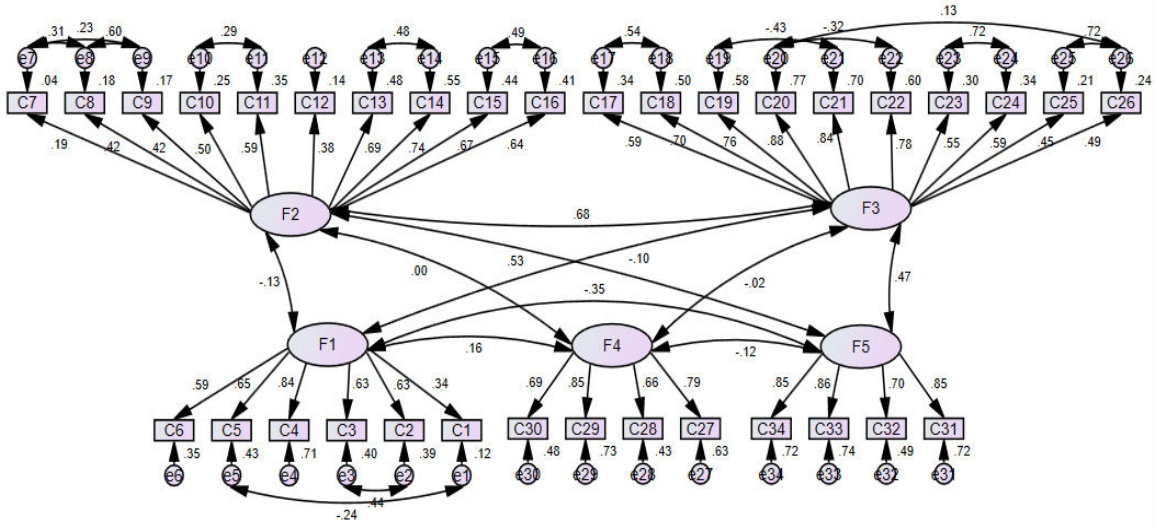

Figure S2 Standardized coefficients for modified first-order confirmatory factor analysis of COPSOQ (M1b). The structural model consisted of five interrelated constructs, F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results indicated good to adequate model fit: χ^2=1699.40; degrees of freedom (*df*)=503; χ^2/df=3.40; Comparative Fit Index (CFI)=0.915; Root Mean Square Error of Approximation (RMSEA)=0.055; Standardized Root Mean Square Residual(SRMR)=0.070.

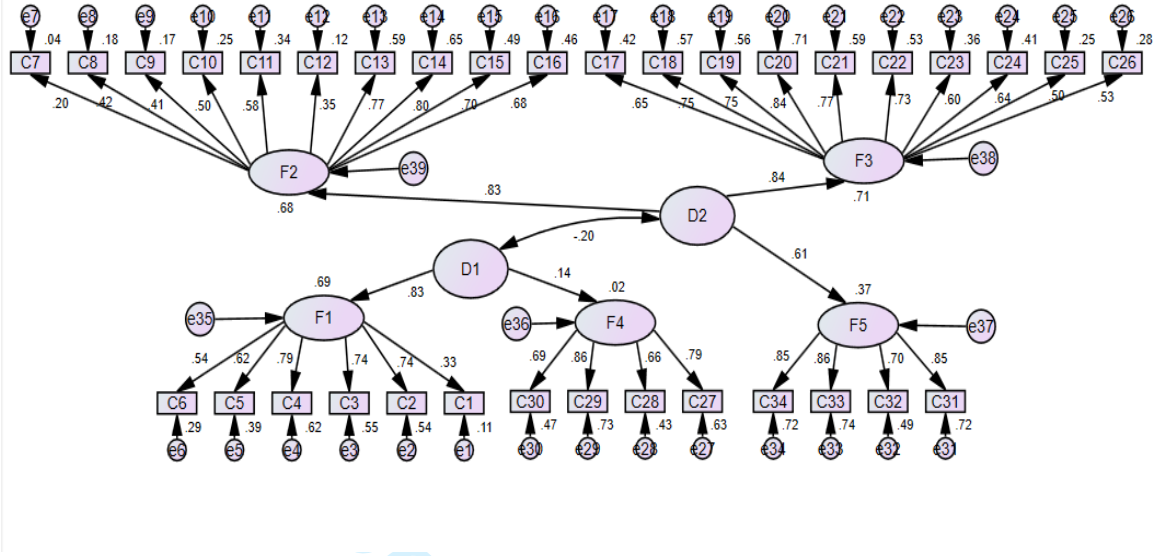

Figure S3 Standardized coefficients for initial second-order confirmatory factor analysis of COPSOQ (M2a). The structural model consisted of seven interrelated constructs, F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction; D1, negative psychosocial work stress factor; D2, positive psychosocial work stress factor. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results didn't indicate good to adequate model fit: $\chi 2$=4276.30; degrees of freedom (*df*) =521; $\chi 2/df$=8.21; Comparative Fit Index (CFI) =0.733; Root Mean Square Error of Approximation (RMSEA) =0.095; Standardized Root Mean Square Residual (SRMR) =0.085.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5, 6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5, 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5, 6
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N
		(*e*) Describe any sensitivity analyses	7
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	N
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 and 3
		(b) Indicate number of participants with missing data for each variable of interest	N
Outcome data	15*	Report numbers of outcome events or summary measures	Online summary table S2,Table3
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 11 and Table4
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-11,Table4, Online summary table S3
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	3
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12, 13
Generalisability	21	Discuss the generalisability (external validity) of the study results	3
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The relationship between stress-related psychosocial work factors and suboptimal health among Chinese medical staff: a cross-sectional study

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Abstract

Objectives To develop and validate a model to measure psychosocial factors at work among medical staff in China based on confirmatory factor analysis. The second aim of the current study was to clarify the association between stress-related psychosocial work factors and suboptimal health status.

Design The cross-sectional study was conducted by clustered sampling method.

Setting Xuanwu Hospital, a 3A Grade Hospital, in Beijing province.

Participants nine hundred and fourteen medical staff aged over 40 years were sampled. Seven hundred and ninety-seven valid questionnaires were collected and used for further analysis. The sample included 94% of the Han population.

Main outcome measures The Copenhagen Psychosocial Questionnaire (COPSOQ) and Suboptimal Health Status Questionnaires-25 (SHSQ-25) were used to assess the psychosocial factors at work and suboptimal health status, respectively. Confirmative Factor Analysis (CFA) was conducted to establish the evaluating method of COPSOQ. A multivariate logistic regression model was used to estimate the relationship between suboptimal heath status and stress-related psychosocial work factors among Chinese medical staff.

Results There was strong correlation among the five dimensions of COPSOQ based on the first-order factor model. Then, we established two second-order factors including negative and positive psychosocial work stress factor to evaluate psychosocial factors at work and the second-order factor model fit well. The high score of negative (*OR* (*95% CI*) = 1.47 (1.34 to 1.62), *P*<0.001) and positive psychosocial work factor (*OR* (*95% CI*) = 0.96 (0.94 to 0.98), *P*<0.001) increased and decreased the risk of suboptimal health, respectively. This relationship remained statistically significant after adjusting for confounders and when using different cut-offs of SHS.

Conclusions Among medical staff, the second-order factor model was a suitable method to evaluate the COPSOQ. The negative and positive psychosocial work stress factor might be the risk and protective factor of suboptimal health, respectively. Moreover, negative psychosocial work stress was the most associated factor to predict suboptimal health.

Strengths and limitations of this study

- The study had high internal validity, with a good representation of medical staff.
- To assessment psychosocial factors at work among medical staff, a more parsimonious, modified second-factor model was finally built to replace the traditional method of calculating the average value of the COPSOQ which ignored the effect of each item.
- The study was conducted in Beijing (a dense city), adding evidence on these issues in a different context than the current literature.
- Although the sample was representative of the diversity of medical staff in one geographical area of the China, the data are not nationally representative and ethnic minority groups are particularly under-represented.
- The study used a cross-sectional design, which is not well suited to assess the direction of causation.

1. Introduction

Work is viewed as an important aspect of psychosocial stress and the impact of psychosocial work conditions on workers' health has been well documented over the past decades. There is accumulating evidence indicted an association between a harsh working environment and a wide range of diseases including mental disorders [1-2], diabetes [3] and cardiovascular disease [4-6] among workers. So far, several theories have been established that predicted various consequences for the health of workers when exposed to certain psychosocial risk factors at work [7]. Seven influential theories are the job characteristics model, the Michigan organizational stress model, the demand–control–(support) model, the sociotechnical approach, the action–theoretical approach, the effort–reward–imbalance model, and the vitamin model [8]. The Copenhagen Psychosocial Questionnaire (COPSOQ) is a comprehensive and generic instrument based on the integration of the common elements of seven kinds of pattern and development some of the original entry (such as work content) at the same time for the assessment of psychosocial factors at work. Exposure to workplace psychosocial risk factors varies according to the types of occupation and job role. Teachers, firefighters and hospital workers have been reported to experience higher level of work-related stress than average level [9-10].

Due to demographic changes, the number of old people and the incidence of chronic diseases are rising in China. Meanwhile, dealing with chronic diseases, incurable or dying patients are emotionally demanding [11]. In addition, there are rapid enhancements on treatment options and therapeutic strategies due to medical advances. These changes may lead to an increased workload and high quantitative demands for Chinese medical staff at hospital. Recent studies have been demonstrated that the prevalence of burnout and stress is relatively high among medical staff [12-13]. Stress fatigue and burnout further have a detrimental influence on the physicians' quality of life and may result in early retirement or reduced quality of patient care and negatively affects health-care systems [14-15]. What is more, studies have shown that medical staff is at increased risk for ill-health, including musculoskeletal disorders [16] and mental health problems [17], caused by adverse workplace factors. Consequently, we need to pay attention to the psychosocial work characteristics of medical staff.

Since the ancient time, traditional Chinese medicine has been identifying a physical status between health and disease which we coined as suboptimal health status (SHS) [18]. SHS is characterized by functional somatic syndromes or symptoms that are medically undiagnosed. Nowadays, much attention has been paid on perceived poor health "somatization" and "medically

unexplained symptoms" in community and primary care system located in developed counties [19-20]. Undoubtedly, SHS is becoming a global issue. Recent studies ever reported that 60% of students [21] and 50-60% of occupational population [22-23] suffered from suboptimal health in China. Unfortunately, impaired quality of life, frequent hospital visits and incurrence of significant medical expenses were often accompanied with SHS [24]. Our previous studies have showed that SHS may contribute to the progression or development of chronic diseases, such as cardiovascular disease [25]. Although the aforementioned study has demonstrated the prevalence of SHS and its consequences, few studies that have addressed the issue of stress-related psychosocial work factors and suboptimal health among medical staff in China. This study aimed to evaluate the impact of stress-related psychosocial work factors on suboptimal health status and their associations.

2. Participants and Methods

2.1 Ethics Statement

Approval was obtained from the Research Ethics Committee of Capital Medical University prior to the initiation of this project. All study participants provided written informed consent prior to enrollment in the study.

2.2 Participants

This cross-sectional study was conducted by clustered sampling method. The current analysis included 914 medical staff from Xuanwu Hospital who participated in the 2014 annual health medical examination (including physicians, nurses, medical technicians, management staff, et al.). All participants of this study were older than 40 years of age. The data were collected through questionnaires of Suboptimal Health Status Questionnaires-25 (SHSQ-25) and Copenhagen Psychosocial Questionnaire (COPSOQ). The subjects were divided into 'SHS' and 'non-SHS' group by the score of SHSQ-25.

2.3 Instruments

2.3.1 Copenhagen Psychosocial Questionnaire

The Copenhagen Psychosocial Questionnaire (COPSOQ) is a comprehensive and generic instrument for the assessment of psychosocial factors at work. The Chinese translation and adaptation of COPSOQ had been tested in the population with different

professions, which had been shown good reliability and validity, with Cronbach's alpha coefficients of 0.7 for most scales [26-27]. This instrument includes three versions: a long version for research use, a medium-length version to be used by work environment professionals, and a short version for workplaces. Our study was based on the short Chinese version of COPSOQ, which consists of 44 questions forming 8 scales. We selected 34 questions including 5 dimensions from a short version of COPSOQ with namely 'Demands at work', 'Influence and development', 'Interpersonal relations and leadership', 'Insecurity at work' and 'Job satisfaction' to assess psychosocial factors at work for stress [8]. In this survey, the remaining three health-related dimensions, including 'general health', 'mental health' and 'vitality', in the original short version of COPSOQ were not used. For most of the questions, we used either intensity (from "to a very small extent" to "to a very large extent") or frequency (from "never/hardly ever" to "always"). All items of COPSOQ were transformed on a value range from 0 to 100 points with 0 representing the lowest degree of the measured psychosocial factor 'never/hardly ever' or 'to a very small extent', and 100 representing the highest 'always' or 'to a very large extent' (online supplementary table S1). In most scales, a high score was considered desirable. On the contrary, a low score was considered desirable for 'Demands at work' and 'Insecurity at work'.

As a default generic method, the average scores for each dimension of COPSOQ were calculated and compared. But this method ignored the relationship between each item and corresponding dimension. To explore the association among each dimension of COPSOQ, we conducted confirmative factor analysis (CFA) [28] which could estimate the relationship between each latent variable (i.e. each dimension of COPSOQ) and between observed variables (i.e. items of dimensions) and corresponding latent variable as well.

2.3.2 Suboptimal Health Status Questionnaires-25

Prior to survey, participants had attended a hospital annual health examination, comprising a medical history, physical examination, blood biochemical examination, routine urinalysis, rest ECG, chest radiography and so on. According to medical history and physical examination results, participants diagnosed with clinical diseases by associate chief physician or more professional clinical doctors were excluded. Then, the SHS of the other participants was measured by the suboptimal health status questionnaire (SHSQ-25) [18] including 25 items and encompassed five subscales: fatigue, the cardiovascular system, the digestive tract, the immune system and mental status. The SHSQ-25 is short and easy to be completed, and therefore, suitable for

use in general population and primary care service [23]. Each individual was asked to rate a specific statement on a 5-point Likert-type scale based on how often they suffered various specific complaints in the preceding 3 months: never/ hardly ever, occasionally, often, very often, and always. The scores on the questionnaire were coded as 0 to 4. SHS scores ranged from 0 to 100 were calculated for each respondent by summing the ratings for the 25 items. A high score represents a high level of SHS (poor health).

There are no cut-off scores. The sample did not have high levels of suboptimal health (online supplementary table S2); therefore, for an easier interpretation, participants with a SHSQ-25 score higher than 31 (median of the total sample) were classified as 'SHS', and those equal or lower than 31 were classified as 'non-SHS'. The sensitivity of our results to this choice was examined further in sensitivity analyses by classifying the respondents with SHSQ-25 scores in the 75th percentile (P75) and above (a score higher than 43) and in the 90th percentile (P90) and above (a score of 53 and above) as SHS and all others as non-SHS.

2.4 Statistical analysis

Descriptive statistics were used to describe the overall population. Univariate analyses were used to compare variations in demographic characteristics among medical staff with different suboptimal health status; for Binary and categorical variable, chi-square test was used, ordinal variable was analyzed by *Kolmogororv-Smirnov Z* test. For nonparametic data, *Mann-Whitney U* test was used to assess stress-related working factors among medical staff with different health status. Demographic missing data were coded as missing and excluded from relevant analysis. A Cronbach's alpha of >0.70 is considered to be an acceptable reliability coefficient for determining the internal consistency of the scale [29]. Model testing was conducted by confirmatory factor analysis (CFA) and structural equation modeling (SEM) analyses. To assess global fit of the model by total sample, we calculated five goodness-of-fit indices. They were χ^2 and its subsequent ratio with degrees of freedom (χ^2/df), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), standard root mean square residual (SRMR) and root mean square error of approximation (RMSEA). Evaluation standards were described in previous literature [30-32]. The first-order factor model was used to analyze the correlation among the five dimensions of COPSOQ. And, the second-order factor model was to establish the evaluating method of COPSOQ for comparing psychosocial work characteristics among medical staff. A multivariate logistic regression model was used to estimate the relationship between suboptimal heath status and psychosocial factors at work.

Potential confounders including age, gender, education level, occupation, physical exercise, drinking behavior, and smoking status were adjusted. The two-tailed $P < 0.05$ was considered to be statistically significant. The statistical packages SPSS 22.0 (Chicago, Illinois) and AMOS 22.0 (Chicago, Illinois) were used for statistical analysis.

3. Results

3.1 Baseline Characteristics

Among 914 of the medical staff participated in 2014 annual health medical examination 797 eligible questionnaires were retrieved, with the retrieval rate of 87.20%. The mean age was approximately 50, More than half of the participants were female (n=554, 69.5%). Table 1 showed the descriptive analyses of participants according to suboptimal health status. The differences in age, gender, education level, occupation and the status of physical exercise, smoking and drinking between individuals with and without SHS were statistically significant (All $P<0.05$, Table 1). In sensitivity analyses of participant according suboptimal health status (P75 and P90) reported the same results. Moreover, compared with non-SHS individuals, SHS individuals were statistically significantly ($P<0.05$) more likely to be longer weekly working hours when using P75 as a SHS cut-off (online supplementary table S3). There were 396 (49.7%) individuals considered as SHS based on the score of SHSQ-25 (median). Among 396 suboptimal health individuals, 80.6 % was female, nearly half (48.2%) with the highest record of formal schooling was junior college, 31.8 % careered in nursing, 59.8 % was without the habit of physical exercise and mostly (>80%) didn't smoking and drinking (Table 1). This advantage in the proportion of corresponding variables above still existed and became more obvious in sensitivity analyses (online supplementary table S3).

3.2 Reliability

The COPSOQ showed a very high overall internal consistency with Cronbach's alpha of 0.849 for the total scale (Items 1-34). The internal consistency characteristics of COPSOQ showed good reliability. The Cronbach's alpha about five dimensions were among 0.791 to 0.891 (online supplementary table S4).

3.3 Confirmatory factor analysis

We performed confirmatory factor analysis (CFA) based on the five theoretical dimensions of COPSOQ. Parameters were estimated for the CFA model based on the maximum likelihood procedure involving fitting the variances and covariances among observed scores. AMOS therefore created a covariance matrix, including the variances and covariances among observed scores. The next step was to illustrate the observed (items) and unobserved (factors) in the hypothesized model (see online supplementary figure S1). The goodness of fit index was unacceptable in M1a (Table 2). After modification according to modification index [33], the modified first-order factor model (M1b, see online supplementary figure S2) for COPSOQ had adequate fit of the model to the data (Table 2). However, pearson correlations between first-order factors in M1b model showed that most of the first order factors correlated with each other (online supplementary table S4). These results supported the notion that the COPSOQ was comprised of five factors subsumed under one or two higher order factors. Based on the theoretical model of COPSOQ, high scores of F1 (Demands at work) and F4 (Insecurity at work) means susceptible to work strain. Conversely, high scores of F2 (Influence and development), F3 (Interpersonal relations and leadership) and F5 (Job satisfaction) may protect people from work strain [26]. According to the theory, the second-order factor model of COPSOQ might be exited. We next conducted CFA to formally test the fit of our hypothesized, second-order factor model (M2a) of COPSOQ. This model, depicted in online supplementary figure S3, didn't have good overall model fit (Table 2). This suggested M2a need further modification. M2a was modified (Figure 1) and the fit of the modified second-order model (M2b) was acceptable (Table 2).

The overall fit of modified factor first-order model (M1b) and modified second-order factor model (M2b) were similar. Thus, we further compared these two models. As a result, a χ^2 difference test revealed that modified second-order factor model was significantly better than modified factor first-order model ($\Delta\chi^2$=34.73, P<0.05), which suggested that the more parsimonious, modified second-factor model (M2b) would be favored for COPSOQ. In M2b, D1 which refereed to negative psychosocial work factor included two first-order factors (F1 Demands at work and F4 insecurity at work). And, D2 positive psychosocial work factor was composed by the rest three first-order factors (Influence and development, Interpersonal relations and leadership and Job satisfaction). All standardized factor coefficients of this model were significant (P<0.05, Figure 1). But, the relationship between insecurity at work and D1 negative psychosocial work factor was not significant (r=0.18, P>0.355, Figure 1). Thus, demand at work was the largest contributor to the negative psychosocial work stress in current study.

3.4 The assessment of stress-related psychosocial work factors among medical staff with different individual and work characteristics

We used the two second-order factors (D1 negative psychosocial work stress factor and D2 positive psychosocial work stress factor) to assess the psychosocial work factors among medical staff. The factors score was calculated by standardized regression coefficients. In structural equation modeling, the standardized regression coefficients, also called standardized factor loadings, actually are the correlation coefficients between indictors and its latent variables. The form of standardized factor scores of the ith factor in first-order model is:

$$ZFi = \sum_j b_{ij} \left(ZC_j - \overline{ZC_j}\right)$$

Where b_{ij} are standardized regression weights, ZC_j is the standardized scores of the jth questionnaire item, $\overline{ZC_j}$ is average standardized scores. $i = 1,2,3,4,5,\ j = 1,2,3,4,5,6,7,8,9,10$;

The form of standardized factor scores of the ith factor in first-order model is:

$$S = \sum W_i \left(ZF_i - \overline{ZF_i}\right)$$

Where W_i are standardized regression weights, ZF_i is the standardized scores of the ith latent variable, $\overline{ZF_j}$ is average standardized scores of 5 latent variable. $i = 1,2,3,4,5$.

Based on the above 2 formulas, we can get the score of D1 (negative psychosocial work factor) and D2 (positive psychosocial work factor) among medical staff. The two factors score did not meet the normal distribution assumptions, were conducted using the *Mann-Whitney U* non-parametric test by ranks. Table 1 showed the score of stress-related psychosocial work factors based on different individual and work characteristics. The score of negative psychosocial work stress factor was significantly different among medical staff with different age, education level, occupation, physical exercise, night shift and weekly working hours (P<0.05). While, the difference between men and women was not significant (P=0.292). In the other hand, the score of positive psychosocial work stress factor was significantly different among medical staff with different age, gender, occupation and the status of physical exercise, smoking and drinking (P<0.05). Then, we explored the score of psychosocial work stress factors between individuals with and without SHS, results shown in Table 3. The scores of negative and positive psychosocial factor were

significantly different between SHS and non-SHS group (P<0.05). Briefly, the individuals with SHS were likely to get higher score of negative psychosocial work factor and lower score of positive psychosocial work factor, respectively. This difference stayed statistically significant when using SHS cut-offs of either P75 or P90 (Table 3).

3.5 The relationship between stress-related psychosocial work factors and suboptimal health (P50, P75 and P90)

Multivariate stepwise logistic regression models showed a statistically significant inverse relationship between positive psychosocial work stress factor and suboptimal health, and a positive relationship between negative psychosocial work stress factor and suboptimal health. Regarding negative psychosocial factor in the total sample, those who got higher score of negative psychosocial work stress factor had higher risk of being suboptimal than low-score individuals (model1: *OR* (*95% CI*)=1.47 (1.34 to 1.62), P<0.001). This relationship remained statistically significant in the adjusted models (model2: *OR* (*95% CI*)=1.50 (1.36 to 1.66), P<0.001; model3: *OR* (*95% CI*)=1.57 (1.42 to 1.75), P<0.01) (Table 4) and when using SHS cut-offs of either P75 or P90. Considering the total sample, individuals with higher score of positive psychosocial work stress factor had a lower risk of being suboptimal health compared with those who got lower score (model1: *OR* (*95% CI*) = 0.96 (0.94 to 0.98), P<0.001). This relationship remained statistically significant in the adjusted models (model2: *OR* (*95% CI*) = 0.97 (0.95 to 0.99), P=0.003; model3: *OR* (*95% CI*) = 0.97 (0.95 to 0.99), P=0.012) and in the majority of SHS sensitivity analyses (using cut-offs of P75 and P90), with the exception of the first-step adjusted and fully adjusted models using P90 as a SHS cut-off (model2: *OR* (*95% CI*) = 0.97 (0.94 to 1.01), P=0.155; model2: *OR* (*95% CI*) = 0.98 (0.95 to 1.02), P=0.325).

4. Discussion

As the development of social economy and the rapid pace of life, public have paid more and more attention to the importance of suboptimal health. SHS is regarded as a subclinical, reversible stage of chronic disease, which is characterized by a decline in vitality, in physiological function and in the capacity for adaptation within a period of three months [18]. For measurement of SHS, we developed SHSQ-25 and adopted it as an instrument in this study. SHSQ-25 has good internal consistency, which item-subscale correlations ranged from 0.51 to 0.72, with Cronbach's α of 0.70 or higher for all subscales [23]. The good internal consistency (cronbach's α of 0.943) was also verified in our study (not shown in our study). However, there were other SHS

questionnaires in China, such as Sub-Health Measurement Scale V1.0 (SHMS V1.0) and Multidimensional Subhealth Questionnaire of Adolescents (MSQA). MSQA is aimed at adolescents. SHMS V1.0 is a 39-items questionnaire and includes physiological, psychological and social dimensions. Previous research has shown SHMS V1.0 has good internal consistency in population of Southern Chinese medical staff [34]. However, the SHSQ-25 was reliable and valid in a large sample health status survey in Beijing [23]. On the other hand, the content and function of social symptoms dimension of SHMS V1.0 were repeated with COPSOQ which used to assess the social-psychological factors at work in our study. In comparison, SHSQ-25 is shorter and easier to complete, and therefore suitable for use in studies of the medical staff in our study. Multiple factors which were influential to SHS, including gender, age, physical activities, dietary habits, emotional problems, social adaptation, etc. have been found in recent studies [22, 25]. In corresponded, age, gender, education level, job, physical exercise, smoking and drinking were significant factors that may influence the status of health among medical staff in current study. There was no internationally accepted cutoff value to diagnose SHS. Thus, we further conducted a sensitivity analysis in which the results also valid. Overall, the female nurses without the ways to relieve stress, such as habit of physical exercise, smoke and drink, were higher score of SHSQ-25 (poorer health).

Over the last 20 years, rare longitudinal and many cross-sectional studies have highlighted work organization conditions, including repetitive work [35], decision authority [36], physical and emotional demands [37], irregular schedules and long hours [38-39], and job insecurity [40] were the stress-related work factors to explain the emergence or aggravation of mental illness. In addition, low job satisfaction that was also found to be important contributors to occupational stress in healthcare settings in different studies [41-42]. The relation of mental work load and health status based on documented measuring instruments which covered all important aspects was undisputedly increased. For enterprises and organizations, the COPSOQ questionnaire is a qualified screening-instrument for psychosocial factors at work [43]. It has good internal consistency with Cronbach's α of 0.79 or even higher for all subscales in our study. But scale scores were computed as the average of the values of the single aspects, this method ignored the relationship among each dimension. Previous studies [28] also showed the factor loadings calculated by traditional factor analysis were less accurate and precise than that calculated by structural equation modeling, due to the traditional method could not control the effects of other variables and caused message loss when extracting common factors. By contrast,

structural equation modeling could get factor loadings both of indictors to first-order factors and first-order factors to second-order factors. The standardized regression coefficients estimated the relational degree between indictors and first-order factors, first-order factors and second-order factors under controlling other variables. The other difference with traditional method is that structural equation modeling allows measurement error of indictors.

Based on the above comparison and consideration, we conducted first- and second-order factor model to explore the association among dimensions of COPSOQ. In this study, a modified second-factor model with best fit indexes was considered to be favored for COPSOQ. Therefore, the stress-related psychosocial work factors of medical staff were assessed by modified second-order factor model (M2b). In M2b, the relationship between insecurity at work and negative psychosocial work factor was not significant. This result reflected subjects faced the risk of unemployment was very low in our study. It was accorded with the actual investigation in which subjects were on-the-job medical staff (older than 40 years of age) whose careers have "reached a stable position". The prevalence rate of SHS was 49.7% when using P50 as cutoff value in our study. Although they were low insecurity at work, they were in high risk of SHS because of the high pressure during the inservice.

The clinician as a kind of special population, they need possess highly concentrated attention, sensible thinking, exquisite techniques and experiences. Moreover, lasting work and intensive labor intensity make them suffer more stress than other medical specialties. Previous research suggested that psychosocial stress may result from gendered processes [44], such as uneven family responsibilities, gender-specific harassment or discrimination, and unequal levels of poverty which mainly limited the professional influence and development of female. In current study, the difference in the score of negative psychosocial work stress factor between men and women was not significant. But, women were lower score of positive psychosocial work stress factor than men ($P<0.05$). In other word, women were more likely to suffer from stress-related psychosocial work factors than men. The gender gap in suboptimal health status in our study may be explained by the discriminatory impact of gender on the susceptible to stress-related psychosocial work factors and the individuals with high level of psychosocial work stress were high risk group of SHS. Additionally, age was also a significant factor affecting the stress levels [45-46]. Meanwhile, individuals with higher levels of education report greater psychological demands [47]. Similarly, we found older male nonclinical medical staff with habit of physical exercise, smoking and drinking reported higher score of positive psychosocial work factors (less susceptible to work

strain). While, younger clinical doctors with graduate degree or above who were lack of exercise, on night shift, and longer man-hour (longer than 40 hour per week) reported higher score of negative psychosocial work factor (more susceptible to work strain). In our study, psychosocial work stress factors, especially the negative side, was the mentioned factor influencing the risk of suboptimal health among medical staff. This relationship was also found in population of executive employees [48].

The results of this study provided some important insights for supervisors and managers in hospital. Positive effects of work in the medical services should be maximized. And the consequences of work-related risk factors, such as demands and insecurity at work, in this important profession, should be prevented. Moreover, Yan YX, et al [25] indicated that SHS is associated with cardiovascular risk factors and contributes to the development of cardiovascular disease. Therefore, it's less likely to be a question that the above measures are effective to prevent SHS, and further reduce the risks of cardiovascular disease.

5. Conclusion

The modified second-order factor model was a suitable method to evaluate COPSOQ among medical staff. In this population, the negative and positive psychosocial work stress factors might be the risk and protective factor of suboptimal health, respectively. Negative psychosocial work stress was the most associated factor to predict suboptimal health.

Supplementary Materials

Supplementary File 1. pdf

Supplementary File 2. pdf

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Footnotes

Yingzhi Liang and Xi Chu contributed equally to this work.

Contributors

Yuxiang Yan, lead and corresponding author, had full access to the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Yingzhi Liang wrote the majority of the manuscript, provided critical revisions to the manuscript and aided substantially in the preparation of the revised submission. Xi Chu participated in study design, performed data analysis and aided with interpretation. Shijiao Meng, Lijuan Wu and Jie Zhang collected and inputted questionnaires. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

This study and associated protocols were conducted after approval by the Research Ethics Committee of Capital Medical University. All research participants consented to having their anonymous data included in the analyses reported herein.

Provenance and peer review

Not commissioned; externally peer reviewed.

Availability of data and materials

The datasets used and/or analyzed during this study are available from the corresponding author on reasonable request.

Table1 Descriptive analyses of participants according to suboptimal health status and the stress-related psychosocial work factors as a total sample

Demographics	Total (N=797)	SHSQ-25 (P50)			Second-order factor of COPSOQ			
	n (%)	Non-SHS	SHS	*P*	D1 negative psychosocial work stress factor	*P*	D2 positive psychosocial work stress factor	*P*
Age group(years)				0.005*		0.003		0.007
40~	270 (33.9)	118 (29.4)	152 (38.4)		0.21 ± 1.65		-0.80 ± 7.00	
					0.15 (-1.14, 1.32)		0.15 (-5.52, 4.17)	
45~	245 (30.7)	126 (31.4)	119 (30.1)		0.07 ± 1.72		-0.29 ± 6.84	
					-0.1 (-1.28, 1.24)		0.46 (-4.39, 4.76)	
55~68	282 (35.4)	157 (39.2)	125 (31.6)		0.26 ± 1.70		1.01 ± 7.35	
					-0.47 (-1.55, 0.88)		1.08 (-2.93, 6.78)	
Gender				< 0.001		0.292		< 0.001
Male	243 (30.5)	166 (41.4)	77 (19.4)		-0.05 ± 1.88		1.24 ± 7.29	
					-0.17 (-1.67, 1.20)		1.54 (-3.33, 6.82)	
Female	554 (69.5)	235 (58.6)	319 (80.6)		0.02 ± 1.62		-0.54 ± 6.96	
					-0.11 (-1.22, 1.14)		0.24 (-5.02, 4.31)	
Education level				0.003*		< 0.001		0.111
High school and below	122 (15.3)	65 (16.20)	57 (14.4)		-0.41 ± 1.81		0.55 ± 7.79	
					-0.62 (-1.90, 0.64)		1.19 (-3.74, 6.23)	
Junior college	321 (40.3)	130 (32.4)	191 (48.2)		-0.07 ± 1.65		-0.78 ± 7.44	
					-0.21 (-1.39, 1.04)		0.17 (-5.81, 4.35)	
University	182 (22.8)	102 (25.4)	80 (20.2)		-0.15 ± 1.71		0.62 ± 6.68	
					-0.37 (-1.52, 1.01)		1.22 (-3.60, 5.47)	
Graduate students and above	172 (21.6)	104 (25.9)	68 (17.2)		0.57 ± 1.56		0.42 ± 6.30	
					0.70 (-0.65, 1.63)		0.66 (-4.28, 5.17)	
occunation				< 0.001		< 0.001		0.001
Nurses	188 (23.6)	62 (15.5)	126 (31.8)		0.22 ± 1.57		-1.15 ± 7.35	
					0.13 (-0.99, 1.16)		-0.10 (-7.17, 4.10)	
Medical technicians	187 (23.5)	83 (20.7)	104 (26.3)		-0.30 ± 1.59		-0.85 ± 6.75	
					-0.43 (-1.64, 1.02)		-0.20 (-5.48, 3.46)	
Doctors	208 (26.1)	125 (31.2)	83 (21.0)		0.37 ± 1.72		0.70 ± 6.97	
					0.31 (-0.93, 1.53)		0.94 (-4.19, 6.67)	
Others	214 (26.9)	131 (32.7)	83 (21.0)		-0.29 ± 1.78		1.06 ± 7.13	
					-0.60 (-1.77, 0.89)		1.44 (-2.78, 5.51)	
Physical exercise				0.003		0.001		0.022
Yes	363 (45.5)	204 (50.9)	159 (40.2)		-0.19 ± 1.76		0.51 ± 7.30	
					-0.48 (-1.69, 1.14)		1.12 (-4.27, 5.77)	
No	434 (54.5)	197 (49.1)	237 (59.8)		0.16 ± 1.63		-0.43 ± 6.92	
					0.12 (-1.02, 1.18)		0.33 (-5.03, 4.32)	
Smoking				< 0.001		0.082		0.013
Yes	93 (11.7)	63 (15.7)	30 (7.6)		-0.19 ± 2.04		1.58 ± 7.80	
					-0.90 (-1.77, 1.16)		2.16 (-3.16, 7.23)	
No/Quit	704 (88.3)	338 (84.3)	366 (92.4)		0.02 ± 1.65		-0.21 ± 6.99	
					-0.09 (-1.28, 1.16)		0.47 (-4.72, 4.78)	
Drinking				< 0.001		0.081		0.012
Yes	166 (20.8)	105 (26.2)	61 (15.4)		-0.18 ± 1.78		1.18 ± 7.13	
					-0.66 (-1.56, 1.04)		1.39 (-2.83, 6.72)	
No/Abstained	631 (79.2)	296 (73.8)	335 (84.6)		0.05 ± 1.68		-0.31 ± 7.07	
					-0.84 (-1.30, 1.16)		0.37 (-4.93, 4.75)	
Night shift				0.774		< 0.001		0.445
Yes	331 (41.5)	169 (42.1)	162 (40.9)		0.27 ± 1.71		-0.21 ± 7.04	
					0.22 (-1.08, 1.36)		0.46 (-4.42, 4.78)	
No	466 (58.5)	232 (57.9)	234 (59.1)		-0.19 ± 1.67		0.15 ± 7.16	
					-0.39 (-1.53, 0.96)		0.67 (-4.68, 5.22)	
Weekly working hours				0.455		< 0.001		0.827
≤40 hours	270 (33.9)	141 (35.2)	129 (32.6)		-0.49 ± 1.60		0.13 ± 6.92	
					-0.71 (-1.78, 0.56)		0.57 (-4.45, 5.07)	
>40 hours	527 (66.1)	260 (64.8)	267 (67.4)		0.25 ± 1.70		-0.06 ± 7.21	
					0.17 (-1.10, 1.43)		0.70 (-4.62, 5.11)	

Noted: * analyzed by Kolmogororv-Smirnov Z test.

Table 2 Goodness-of-fit indices for the different models

Model	χ^2 (*df*)	χ^2/ *df*	CFI	AGFI	SRMR	RMSEA
M1a	4216.39(517)	8.16	0.737	0.708	0.0802	0.095
M1b	1699.40(503)	3.40	0.915	0.864	0.0696	0.055
M2a	4276.30(521)	8.21	0.733	0.707	0.0852	0.095
M2b	1664.67(508)	3.28	0.918	0.866	0.0659	0.053

Noted: M1a: the first-order factor model; M1b: the modified first-order factor model; M2a: the second-order factor model; M2b: the modified second-order factor model. Model fitting criteria were as followed: A CFI value of greater than 0.90 showed a psychometrically acceptable fit to the data; The value of AGFI ranged between 0 and 1, a value of 1 indicated a perfect fit; For the SRMR, values of 0.08 or lower represented good fit; The value of RMSEA should be below 0.06 to show good fit.

Table 3. The assessment of stress-related psychosocial work factors between individuals with and without SHS

groups	Second-order factor of COPSOQ			
	D1 negative psychosocial work stress factor	*P*	D2 positive psychosocial work stress factor	*P*
suboptimal health status (P50)		<0.001		<0.001
Non-SHS	-0.53 ± 1.60 -0.77 (-1.83, 0.54)		1.15 ± 6.97 1.61 (-2.79, 6.34)	
SHS	0.53 ± 1.63 0.46 (-0.67, 1.60)		-1.16 ± 7.06 -0.57 (-5.75, 3.94)	
suboptimal health status (P75)		<0.001		<0.001
Non-SHS	-0.24 ± 1.67 -0.39 (-1.62, 0.91)		0.71 ± 7.08 1.24 (-3.85, 5.69)	
SHS	0.77 ± 1.57 0.70 (-0.44, 1.86)		-2.29 ± 6.73 -1.93 (-7.11, 2.60)	
suboptimal health status (P90)		<0.001		0.005
Non-SHS	-0.09 ± 1.68 -0.20 (-1.47, 1.08)		0.29 ± 7.13 0.78 (-4.39, 5.22)	
SHS	0.90 ± 1.68 0.57 (-0.44, 2.19)		-2.14 ± 6.57 -1.93 (-7.23, 2.18)	

Table 4 Sensitivity analyses with multivariate models assessing the relationship between stress-related psychosocial work factors and suboptimal health (P50, P75 and P90)

Model / variables	suboptimal health status (P50, P75, P90)		
	OR	*OR 95%CI*	*P*
suboptimal health status (P50)			
Model1			
D1 negative psychosocial work stress factor	1.47	1.34-1.62	<0.001
D2 positive psychosocial work stress factor	0.96	0.94-0.98	<0.001
Model2			
D1 negative psychosocial work stress factor	1.50	1.36-1.66	<0.001
D2 positive psychosocial work stress factor	0.97	0.95-0.99	0.003
Model3			
D1 negative psychosocial work stress factor	1.57	1.42-1.75	<0.001
D2 positive psychosocial work stress factor	0.97	0.95-0.99	0.012
suboptimal health status (P75)			
Model1			
D1 negative psychosocial work stress factor	1.39	1.26-1.54	<0.001
D2 positive psychosocial work stress factor	0.95	0.93-0.97	<0.001
Model2			
D1 negative psychosocial work stress factor	1.42	1.28-1.58	<0.001
D2 positive psychosocial work stress factor	0.95	0.93-0.98	<0.001
Model3			
D1 negative psychosocial work stress factor	1.44	1.29-1.61	<0.001
D2 positive psychosocial work stress factor	0.96	0.93-0.98	0.001
suboptimal health status (P90)			
Model1			
D1 negative psychosocial work stress factor	1.36	1.18-1.57	<0.001
D2 positive psychosocial work stress factor	0.97	0.93-1.00	0.037
Model2			
D1 negative psychosocial work stress factor	1.43	1.23-1.67	<0.001
D2 positive psychosocial work stress factor	0.97	0.94-1.01	0.155
Model3			
D1 negative psychosocial work stress factor	1.46	1.25-1.70	<0.001
D2 positive psychosocial work stress factor	0.98	0.95-1.02	0.325

Noted: OR: Odds Ratio. Model1: Unadjusted. Model2: Adjusted by age and gender.Model3: Adjusted by age, gender, education level, occupation, physical exercise, drinking behavior, and smoking status.

Figure legends

Figure 1 Standardized coefficients for modified second-order confirmatory factor analysis of COPSOQ (M2b). The structural model consisted of seven interrelated constructs, F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction; D1, negative psychosocial work stress factor; D2, positive psychosocial work stress factor. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results indicated the goodness of fit index is fairly good: χ^2=1664.67; degrees of freedom (*df*) =508; χ^2/df =3.28; Comparative Fit Index (CFI) =0.918; Root Mean Square Error of Approximation (RMSEA) =0.053; Standardized Root Mean Square Residual (SRMR) =0.066.

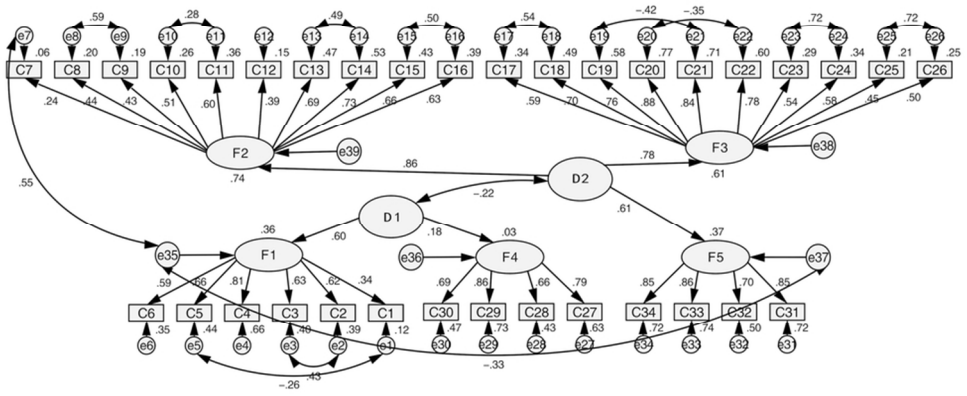

Figure 1 Standardized coefficients for modified second-order confirmatory factor analysis of COPSOQ (M2b). The structural model consisted of seven interrelated constructs, F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction; D1, negative psychosocial work stress factor; D2, positive psychosocial work stress factor. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results indicated good to adequate model fit: $\chi 2=1664.67$; degrees of freedom (df) =508; $\chi 2/df$ =3.28; Comparative Fit Index (CFI) =0.918; Root Mean Square Error of Approximation (RMSEA) =0.053; Standardized Root Mean Square Residual (SRMR) =0.066.

85x42mm (300 x 300 DPI)

Table S1. COPSOQ questions used in stress-related psychosocial work factors survey

Demands at work:		never/hardly ever	occasionally	often	very often	always
C1	Do you have to work very fast?					
C2	Is your workload unevenly distributed, so that it piles up?					
C3	How often do you not have time to complete all your work tasks?					
C4	Does your work put you in emotionally disturbing situations?					
C5	Do you get emotionally involved in your work?					
C6	Does your work require that you hide your feelings?					
Influence and development:		never/hardly ever	occasionally	often	very often	always
C7	Do you have a large degree of influence on the decisions concerning your work?					
C8	Can you influence the amount of work assigned to you?					
C9	Do you have any influence on what you do at work?					
C10	Can you play a leading role in the work?					
C11	Do you have the possibility of learning new things through your work?					
C12	Can you decide when to take a break?					
C13	Is your work meaningful?					
C14	Do you feel that the work you do is important?					
C15	Would you like to stay at your current place of work for the rest of your worklife?					
C16	Do you think your work is extremely important to yourself?					
Interpersonal relations and leadership:		never/hardly ever	occasionally	often	very often	always
C17	At your place of work, are you informed well in advance about, for example, important decisions, changes, or plans for the future?					
C18	Do you receive all the information that you need in order to do your work well?					
C19	How often do you get help and support from your colleagues?					
C20	How often do you get help and support from your nearest superior?					
C21	How often do you talk with your superior about how well you carry out					

	your work?					
C22	How often do you talk with your colleagues about how well you carry out your work?					
C23	Is there good co-operation between your colleagues at work?					
C24	Do you feel you are part of work team?					

Quality of leadership		to a very small extent	to a small extent	general	to a large extent	to a very large extent
C25	Is your immediate superior good at work-planning?					
C26	Is your immediate superior good at solving conflicts?					

Job insecurity		No	Yes
C27	Are you worried about becoming unemployed?		
C28	Do you worry about that new technology making you / your work redundant?		
C29	Are you worried about being difficult for you to find another job if you became unemployed?		
C30	Are you worried about being transferred to another job against your will?		

Job satisfaction		strongly dissatisfied	dissatisfied	general	satisfied	strongly satisfied
C31	Are you satisfied with your job prospects?					
C32	Are you satisfied with the hardware facilities in your work place?					
C33	Are you satisfied with the way you play an ability at your work?					
C34	Taken together, are you satisfied with your work?					

Table S2. SHSQ-25 score distribution in survey sample

SHSQ-25 score	*n*	%	Cumulative %
0-10	52.0	6.5	6.5
10-20	128.0	16.1	22.6
20-30	180.0	22.6	45.2
30-40	182.0	22.8	68.0
40-50	140.0	17.6	85.6
50-60	71.0	8.9	94.5
60-70	32.0	4.0	98.5
70-80	8.0	1.0	99.5
80-90	4.0	0.5	100.0
Total	797	100.0	

Table S3. Sensitivity analyses of participant according suboptimal health status

Demographics	Total (*N*=797)	SHSQ-25 (P75)			SHSQ-25 (P90)		
	n (%)	Non-SHS	SHS	*P*	Non-SHS	SHS	*P*
Age group(years)				<0.001			0.005
40~	270 (33.9)	188 (30.9)	82 (43.4)		234 (32.2)	36 (50.7)	
45~	245 (30.7)	188 (30.9)	57 (30.2)		228 (31.4)	17 (23.9)	
55~68	282 (35.4)	232 (38.2)	50 (26.5)		264 (36.40	18 (25.4)	
Gender				<0.001			<0.001
Male	243 (30.5)	213 (35.0)	30 (15.9)		239 (32.9)	4 (5.6)	
Female	554 (69.5)	395 (65.0)	159 (84.1)		487 (67.1)	67 (94.4)	
Education level				0.004			0.007
High school and below	122 (15.3)	970 (16.0)	25 (13.2)		109 (15.0)	13 (18.3)	
Junior college	321 (40.3)	225 (37.0)	96 (50.8)		284 (39.1)	37 (52.1)	
University	182 (22.8)	142 (23.4)	40 (21.2)		167 (23.0)	15 (21.1)	
Graduate students and above	172 (21.6)	144 (23.7)	28 (14.8)		166 (22.9)	6 (8.5)	
occupation				<0.001			<0.001
Nurses	188 (23.6)	117 (19.2)	71 (37.6)		151 (20.8)	37 (52.1)	
Medical technicians	187 (23.5)	137 (22.5)	50 (26.5)		168 (23.1)	19 (26.8)	
Doctors	208 (26.1)	173 (28.5)	35 (18.5)		201 (27.7)	7 (9.9)	
Others	214 (26.9)	181 (29.8)	33 (17.5)		206 (28.4)	8 (11.3)	
Physical exercise				0.012			0.045
Yes	363 (45.5)	292 (48.0)	71 (37.6)		339 (46.7)	24 (33.8)	
No	434 (54.5)	316 (52.0)	118 (62.4)		387 (53.3)	47 (66.2)	
Smoking				<0.001			0.002
Yes	93 (11.7)	87 (14.3)	6 (3.2)		92 (12.7)	1 (1.4)	
No/Quit	704 (88.3)	521 (85.7)	183 (96.8)		634 (87.3)	70 (98.6)	
Drinking				0.001			0.014
Yes	166 (20.8)	142 (23.4)	24 (12.7)		159 (21.9)	7 (9.9)	
No/Abstained	631 (79.2)	466 (76.6)	165 (87.3)		567 (78.1)	64 (90.1)	
Night shift				0.800			0.801
Yes	331 (41.5)	251 (41.3)	80 (42.3)		303 (41.7)	28 (39.4)	
No	466 (58.5)	357 (58.7)	109 (57.7)		423 (58.3)	43 (60.6)	
Weekly working hours				0.022			0.067
≤40 hours	270 (33.9)	219 (36.0)	51 (27.0)		253 (34.8)	17 (23.9)	
>40 hours	527 (66.1)	389 (64.0)	138 (73.0)		473 (65.2)	54 (76.1)	

Noted: *: P<0.01.

Table S4. Test of internal consistency and interfactor correlations of the COPSOQ

Factor (Cronbach's α)	N of Items	F_1	F_2	F_3	F_4	F_5
F_1 Demands (0.791)	6	1	—	—	—	—
F_2 Influence and development (0.820)	10	-0.067	1	—	—	—
F_3 Relation and leadership (0.891)	10	-0.094 *	0.606 **	1	—	—
F_4 Insecurity at work (0.830)	4	0.037 **	0.002	-0.004	1	—
F_5 Job satisfaction (0.881)	4	-0.214 **	0.306 **	0.366 **	-0.027 **	1

r correlation *p<0.05; **p<0.01

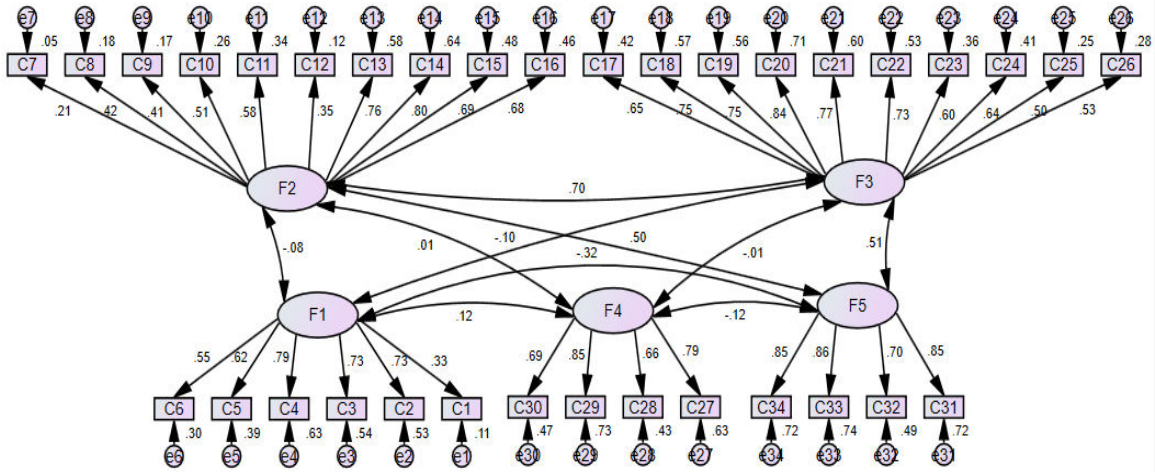

Figure S1 Standardized coefficients for initial first-order confirmatory factor analysis of COPSOQ (M1a). The structural model consisted of five interrelated constructs, including F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results didn't indicate good to adequate model fit: $\chi 2=4216.39$; degrees of freedom (df) =517; $\chi 2/df$ =8.16; Comparative Fit Index (CFI) =0.737; Root Mean Square Error of Approximation (RMSEA) =0.095; Standardized Root Mean Square Residual (SRMR) =0.080.

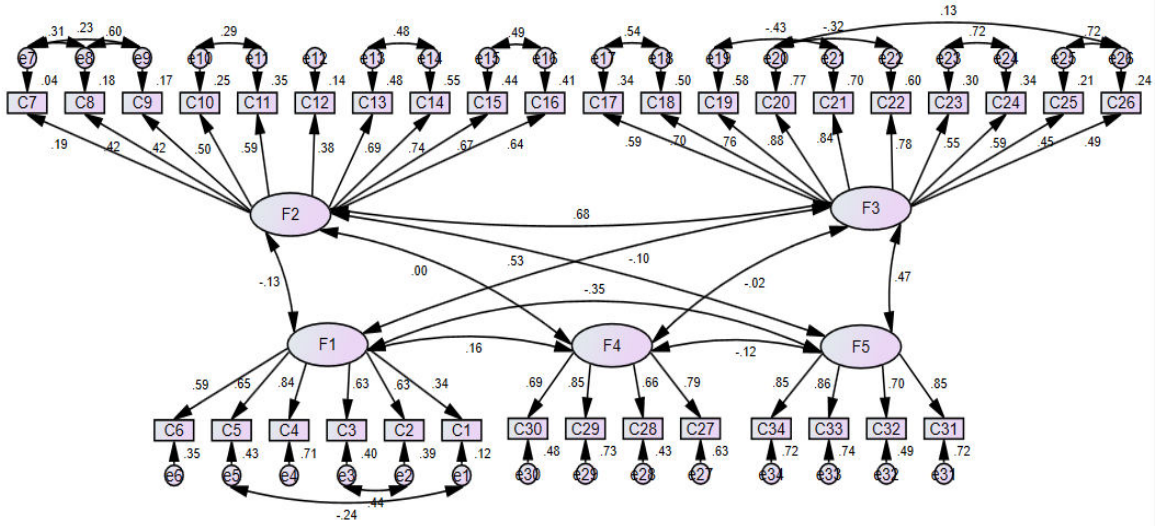

Figure S2 Standardized coefficients for modified first-order confirmatory factor analysis of COPSOQ (M1b). The structural model consisted of five interrelated constructs, F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results indicated good to adequate model fit: χ^2=1699.40; degrees of freedom (*df*)=503; χ^2/df=3.40; Comparative Fit Index (CFI)=0.915; Root Mean Square Error of Approximation (RMSEA)=0.055; Standardized Root Mean Square Residual(SRMR)=0.070.

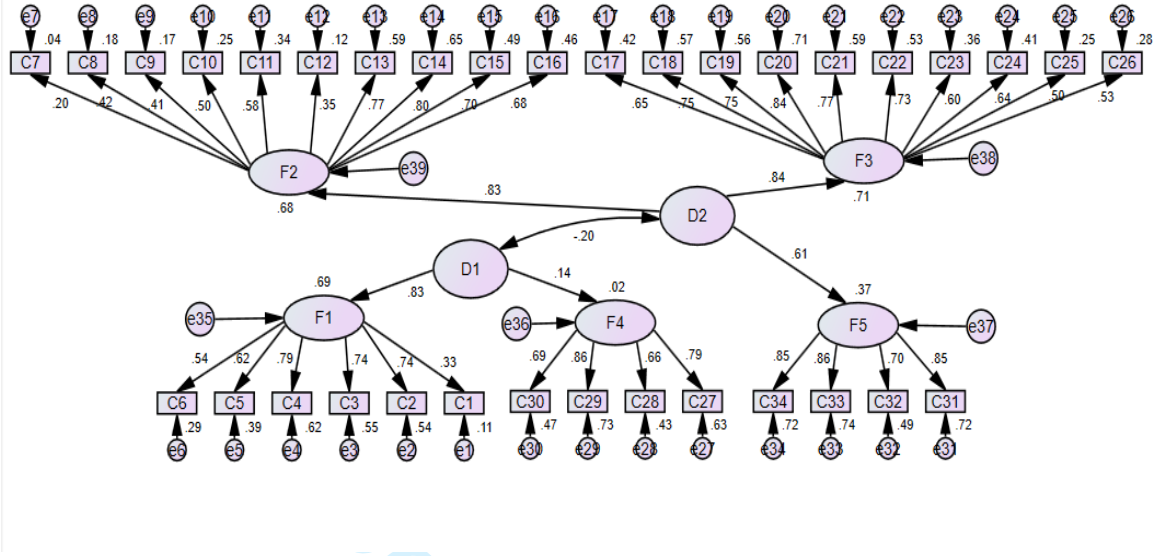

Figure S3 Standardized coefficients for initial second-order confirmatory factor analysis of COPSOQ (M2a). The structural model consisted of seven interrelated constructs, F1 refers to Demands at work; F2, Influence and development; F3, Interpersonal relations and leadership; F4, Insecurity at work; F5, Job satisfaction; D1, negative psychosocial work stress factor; D2, positive psychosocial work stress factor. The observed variables, unobserved variables and measurement error were represented as rectangles, ellipses and circles respectively. The arrow between the unobserved variable and the observed variable represented a regression path and its number represented the standardized regression weight. The arrow between a small circle and the observed variable represented a measurement error term. The double-headed arrows represented the correlation between two unobserved variables (factor covariances) of the model. Confirmatory factor analysis (CFA) results didn't indicate good to adequate model fit: $\chi 2$=4276.30; degrees of freedom (*df*) =521; $\chi 2/df$=8.21; Comparative Fit Index (CFI) =0.733; Root Mean Square Error of Approximation (RMSEA) =0.095; Standardized Root Mean Square Residual (SRMR) =0.085.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5, 6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5, 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5, 6
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N
		(*e*) Describe any sensitivity analyses	7
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	N
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 and 3
		(b) Indicate number of participants with missing data for each variable of interest	N
Outcome data	15*	Report numbers of outcome events or summary measures	Online summary table S2,Table3
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 11 and Table4
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-11,Table4, Online summary table S3
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	3
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12, 13
Generalisability	21	Discuss the generalisability (external validity) of the study results	3
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.