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Perceived Stress in Chinese Patients with Coronary Heart Disease: A cross-sectional study

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Title Page

Perceived Stress in Chinese Patients with Coronary Heart Disease: A cross-sectional study

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ABSTRACT

Objective Studies have shown that stress is closely linked to the occurrence and development of cardiovascular disease. To date, few studies have focused on perceived stress in CHD patients and the identification of high-stress individuals. This study aims to analyse the mental stress of patients with coronary heart diseases(CHD) and determine the individual attributes closely associated it.

Design A cross-sectional study.

Setting This study was conducted at a cardiac rehabilitation clinic of a tertiary hospital in Beijing.

Participants A total of 2215 CHD patients. Participants were categorised as either high stress or low stress (based on the Chinese version Perceived Stress Scale, CPSS-14).

Results The mean CPSS score of Chinese patients with CHD was 27.16 ± 6.35 . Compared with participants who received senior middle school education or below, those with a university degree had a higher probability of high perceived stress (OR: 1.453, CI: 1.206-1.750); this was more evident in participants with a masters or doctoral degree (OR: 1.928, CI: 1.290-2.882). And engaging in mental labor (OR: 1.389, CI: 1.144-1.686), having children (OR: 2.226, CI: 1.098-4.515), and having a habit of risky alcohol consumption (OR:1.492, CI: 1.146-1.944) were associated with perceived stress.

Conclusion: Patients with CHD in China had a relative higher CPSS score. And

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4 patients who had higher educational attainment, engaged in mental labor, had children,
5 and had a habit of risky alcohol consumption may require more stress interventions.
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8 9 **Keywords**

10 Perceived stress, Coronary heart disease, Cardiac rehabilitation
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13 **Word Count** 4369 words
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16 **Strengths and limitations of this study**

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18 Few studies have focused on perceived stress in CHD patients and the identification of
19 high-stress individuals.
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22 Utilize the PSS for the accurate identification of stress-sensitive individuals among
23 patients with coronary heart disease.
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26 Given the cross-sectional nature of the study, we cannot infer causal relationships
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INTRODUCTION

The incidence of coronary heart disease (CHD) has been rising steadily over the past few decades and the resulting burden of disease is an issue faced by developed and developing countries alike ¹. Because the established biological and medical risk factors cannot fully explain the occurrence of CHD-related adverse cardiac events, we propose that psychological and social factors play an important and independent role in the development of coronary heart disease ²⁻³.

Psychological stress (stress) refers to the psychological challenge or threat caused by various triggering events or adverse life factors, and usually manifests as emotional discomfort, pain, or anguish ⁴. Under normal circumstances, a dynamic equilibrium exists between an organism and its external environment, and stress arises when this equilibrium is upset or is self-perceived as upset ⁵. Stress is believed to be closely linked to the occurrence and development of cardiovascular disease, one of the most important psychosomatic diseases ⁶. Although the biological mechanisms remain unclear, the current literature suggests that self-perceived stress may cause over-activation of the autonomic nervous system and elicit a stress response from the endocrine system, thereby inducing endothelial dysfunction, ultimately triggering cardiovascular events ⁷. However, the process by which stressors exert their effects on an organism is not linear; instead, it arises through interactions ⁵. The stress perceived by an individual reflects his/her subjective evaluation of the stressor and will partly depend on individual attributes. Studies have shown that different individuals faced with identical stressors may perceive considerably different levels of stress, with different effects on CHD occurrence and development, resulting in differences in the severity or prognosis of CHD⁸. Therefore, the accurate identification of high-stress individuals is of great significance for the precise assessment and subsequent treatment of CHD.

Assessments of psychological stress are generally performed using standard psychological instruments. Commonly used questionnaires include the Perceived Stress Scale (PSS), Stress Appraisal Measure (SAM), and Impact of Event Scale (IES). The PSS is the most widely used instrument because it is simple to implement and does not require professional intervention during administration. Developed by Cohen et al. in

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4 1983⁹, the PSS measures the dimensions of uncontrollability and stressfulness, and
5 assesses the stress levels of individuals based on their subjective perceptions of
6 stressors. It has been translated into many languages and used widely in diverse
7 populations around the world¹⁰. The version most used in Chinese populations is the
8 Chinese Perceived Stress Scale (CPSS), which is a simplified-Chinese version
9 translated by Yang (2007)¹¹. The CPSS has demonstrated good validity and reliability
10 in a series of studies on general Chinese populations¹².

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17 Few studies published to date have utilized the PSS for the accurate identification
18 of stress-sensitive individuals among patients with CHD, and stress detection in the
19 Chinese population with CHD has not yet been reported.

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23 We, therefore, analyzed the PSS scores of patients who visited the cardiac
24 rehabilitation clinic at our hospital with the aim of investigating the self-perceived
25 stress levels of Chinese patients with CHD and determining the individual attributes
26 closely associated with perceived stress in Chinese society. The results of this study can
27 serve as a scientific basis for the development of stress management programs for
28 Chinese populations in general and for patients with CHD in particular.

29 30 31 32 33 34 35 **METHODS**

36 37 *Study participants*

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39 A cross-sectional study design was adopted. Using the electronic medical records
40 system of our hospital, we screened patients referred to the cardiac rehabilitation clinic
41 between 2015 and 2020. Only those with a definitive diagnosis of CHD were included
42 in the analysis. Based on the criteria of the CHD 2019 ESC Guidelines for the Diagnosis
43 and Management of Chronic Coronary Syndromes, the inclusions were: one or more
44 lesions with $\geq 50\%$ stenosis as shown by coronary angiography; stable angina (SA);
45 unstable angina (USA); old myocardial infarction (OMI); acute myocardial infarction
46 (AMI); post-percutaneous coronary intervention (PCI); post-coronary artery bypass
47 graft (CABG); or ischemic cardiomyopathy (IC).

48 49 50 51 52 53 54 55 56 *Demographic characteristics and medical history*

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58 The demographic characteristics and medical history of the participants were
59 obtained from the cardiac rehabilitation medical records system and collated by a
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4 cardiologist. The demographic characteristics analyzed included age, sex, educational
5 level, marital status, family structure (with/without children), nature of work
6 (mental/manual labor), the presence/absence of sleep disorders, and the following
7 lifestyle factors: regular exercise, risky alcohol consumption, and smoking. The
8 medical history data analyzed included history of cardiac revascularization and the
9 presence/absence of other chronic diseases requiring long-term medication. Mental
10 labor was defined as professional, managerial, or administrative work generally
11 performed in an office or other administrative environment. Manual labor was defined
12 as strenuous physical work or other types of work demanding physical exertion.
13 Regular exercise was defined as ≥ 30 min of low-intensity exercise > 5 times per week
14 or ≥ 20 min of moderate-intensity exercise > 3 times per week. Sleep disorders were
15 defined as the occurrence of at least one of the following ≥ 3 times per week for at
16 least 1 month: inability to sleep after 30 min in bed, waking up ≥ 2 times during the
17 night, wake time $> 15\%$, dreamful sleep or total sleep time < 6 hours, and waking up ≥ 2
18 hours ahead of schedule and subsequently unable to get back to sleep. Risky alcohol
19 consumption was defined as the consumption of ≥ 5 alcoholic drinks on a single
20 occasion > 12 times in the past year¹³.

21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 ***Stress assessment***

38 The perceived stress of the study participants was assessed using the CPSS, which
39 comprises 14 items intended to measure the dimensions of uncontrollability and
40 stressfulness. Each item is rated on a 5-point scale (0 = never, 1 = rarely, 2 = sometimes,
41 3 = fairly often, 4 = very often), with items 4, 5, 6, 7, 9, 10, and 13 scored in the reverse
42 direction. Total scores range from 0 to 56 points, with higher scores indicating higher
43 psychological stress. Study participants were asked to provide responses based on their
44 own perceptions. All patients who visited the cardiac rehabilitation clinic for the first
45 time were requested to complete the CPSS on their own after receiving instructions on
46 questionnaire completion from a nurse. The responses were collected and collated by a
47 cardiologist .

48 49 50 51 52 53 54 55 56 57 58 ***Statistical analysis***

59 Statistical analysis was performed using SPSS 23.0. Quantitative variables were

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4 tested for normality. Normally distributed variables were expressed as mean \pm standard
5 deviation ($x \pm s$); variables not normally distributed were expressed as median and
6 interquartile range (IQR). Qualitative data were expressed as ratios or percentages.
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8 Factors associated with the CPSS scores of the study participants were analyzed from
9
10 binary logistic regression.
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13 ***Patient and public involvement***

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15 Public and patient involvement was not applicable in this research.
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17 **RESULTS**

18 ***Demographic data of patients with CHD***

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21 Of the 3845 patients referred to the cardiac rehabilitation clinic during the study
22 period, 2215 had CHD and were eventually included in the study. The mean age of the
23 study participants was 59.57 ± 10.10 y, and the majority of the participants were male
24 (79.64%), had a university degree or below (94.13%), married (99.05%), had children
25 (97.97%), engaged in mental labor (69.07%), had sleep disorders (74.81%), and did not
26 have a drinking habit (60.18%) Of the participants, 77.1% had previously undergone
27 stent insertion, 56.2% had concomitant hypertension, 47.4% had concomitant
28 hyperlipidemia, and 27% had concomitant diabetes mellitus (see **Table 1**).
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36 ***Comparison of characteristics between groups***

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39 The mean CPSS score of all the patients with CHD was 27.16 ± 6.35 . Using the
40 median score of 27 as the cut-off point, the study participants were divided into a low-
41 stress group (CPSS score ≤ 27) and a high-stress group (CPSS score >27).
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45 Participants who had children, engaged in mental labor, or had a habit of risky
46 alcohol consumption had a higher probability of experiencing higher stress levels. (see
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48 **Table 2**).
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50 ***Logistic regression***

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52 Binary logistic regression analysis was performed by setting the CPSS score as the
53 dependent variable and the following as the independent variables: age, sex, educational
54 level, marital status, family structure (with/without children), nature of work
55 (mental/manual labor), number of stents, and the presence/absence of sleep disorders,
56 other chronic diseases, and the following habits: regular exercise, risky alcohol
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4 consumption, and smoking. Our results indicated that study participants who have
5 children had a higher probability of high perceived stress, with the odds ratio (OR)
6 being 2.226 (confidence interval [CI]: 1.098-4.515). Compared with participants who
7 received middle school education or below, those with a university degree had a higher
8 probability of high perceived stress (OR: 1.453, CI: 1.206-1.750); this was more evident
9 in participants with a masters or doctoral degree (OR: 1.928, CI: 1.290-2.882).
10 Participants who engaged in mental labor had a higher probability of high perceived
11 stress than those who engaged in manual labor (OR: 1.389, CI: 1.144-1.686). Compared
12 with participants who did not have a habit of risky alcohol consumption, those who had
13 this habit had a higher probability of high perceived stress (OR:1.492, CI: 1.146-1.944)
14 (see **Table 3**).

25 **DISCUSSION**

26
27 The relationship between psychological stress and cardiovascular disease has
28 attracted increasing attention in recent years. Considering that psychological stress may
29 play some role in the occurrence and development of CHD, a greater emphasis has been
30 placed on stress management in comprehensive cardiac rehabilitation programs
31 because it may potentially provide benefits, such as improving the long-term prognosis
32 of patients with CHD ¹⁴. Therefore, recent models of comprehensive cardiac
33 rehabilitation require cardiac rehabilitation specialists to accurately assess and identify
34 high-stress individuals for targeted, stratified management. The mean CPSS score of
35 Chinese patients with CHD in our study was 27.16 ± 6.35 , which was slightly higher
36 than that of the normal population ¹¹. In addition, we found that patients who had higher
37 educational attainment, engaged in mental labor, had children, and had a habit of risky
38 alcohol consumption perceived higher levels of stress.

39
40 Analysis of the demographic characteristics of high-stress individuals among
41 patients with CHD can support the clinical stratified management of patients according
42 to stress level, which increases the efficiency of rehabilitation treatment and maximizes
43 the clinical benefits to each individual.

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45 Our results showed a strong correlation between perceived stress and educational
46 level in Chinese patients with CHD. A higher educational level was associated with
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4 higher perceived stress, with the risk of high perceived stress in participants with a
5 university degree being 1.453 times (CI: 1.206-1.750) that of those who received senior
6 middle school education or below, and the OR increased to 1.928 (CI: 1.290-2.882)
7 among participants with a masters or doctoral degree. However, this result is contrary
8 to the findings of studies conducted in other countries¹⁵⁻¹⁶ which have indicated that
9 individuals with lower educational attainment generally perceive higher stress. This
10 may possibly be attributed to the long-standing, strong emphasis on educational
11 attainment in Chinese society, which has led to the general view that individuals with
12 higher educational levels should attain greater personal achievements and bear greater
13 social responsibilities and expectations. However, it is not clear whether this unique
14 sociocultural background has caused the aforementioned difference between Eastern
15 and Western countries in the influence of educational level on perceived stress.
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27 Perceived stress was also found to be strongly related to the nature of work in the
28 Chinese population. Participants who engaged in mental labor had higher perceived
29 stress than did those who engaged in manual labor; in other words, they had a higher
30 probability of a high perceived stress score (OR: 1.389, CI: 1.144-1.686). Such a result
31 is not in complete agreement with the findings of previous studies. A survey by Lesage
32 et al.¹⁷ revealed that differences in perceived stress among administrative, technical,
33 and blue-collar workers were statistically insignificant. However, the 501 participants
34 of Lesage's study were selected from individuals who attended occupational health
35 centers in northern France, whereas the participants of our study had a greater diversity
36 of occupations, including teachers, doctors, taxi drivers and gardeners. The greater
37 diversity of occupations included in our study provides a better reflection of the actual
38 range of perceived stress across occupations, thereby helping the occupational factor to
39 reach significance. Dédèlè et al.¹⁸ performed a cross-sectional study on perceived stress
40 among 571 full-time workers in Lithuania and found that blue-collar workers who spent
41 relatively more time engaging in physical work had a higher risk of high perceived
42 stress than white-collar workers, which appears to contradict our results. However, the
43 distribution of perceived stress across occupations may depend on the social
44 environment. With China's vast population, Chinese workers are often faced with
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4 complicated interpersonal relationships in their workplace. In general, workplace
5 ecology is more complex among individuals engaged in mental labor than among
6 manual workers, which may have partially contributed to the difference in perceived
7 stress we observed between the two occupational categories.
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11 The drinking habit of patients with CHD has also been identified as a potential
12 factor associated with perceived stress. Our results indicated that participants with a
13 habit of risky alcohol consumption had higher perceived stress ($P = 0003$). We also
14 found that the probability that risky alcohol drinkers were assessed as having high stress
15 was 1.492 times that of non-risky alcohol drinkers (CI: 1.146-1.944). These findings
16 are consistent with those reported by Yoon et al.¹⁹, who showed that the proportion of
17 individuals with adverse drinking habits was higher in the population with high
18 perceived stress than in the population with low perceived stress. Although the study
19 by Yoon et al. did not investigate possible causal relationships between high stress and
20 at-risk drinking, there is no doubt that patients with a habit of risky alcohol consumption
21 can have higher perceived stress. Therefore, for such individuals, emphasis should be
22 placed on appropriate stress interventions in the formulation of rehabilitation programs.
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35 Interestingly, we also found that patients with CHD with children were nearly twice
36 as likely to belong to the high stress group as those without children, which is consistent
37 with the findings of Lesage et al.¹⁷
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40 Our results also showed that the perceived stress of patients with CHD was not
41 correlated with age, sex or marital status. Previous studies have disagreed on these
42 aspects. For instance, a study by Andreou et al.²⁰ indicated that younger individuals,
43 women, and single or divorced individuals may have higher perceived stress. Cohen et
44 al.⁹ reported that perceived stress was higher in women, but unrelated to age; similar
45 conclusions were reached in two other studies²¹⁻²². However, Dèdelè et al.¹⁸ asserted
46 that older individuals had higher perceived stress. A study by Leung et al.¹² indicated
47 higher levels of perceived stress in women, but a contrary result was reported by Ojard
48 et al.²³ Although the measurement of the perceived stress of an individual is based on
49 his/her subjective perceptions, it may also be affected by objective environmental
50 stressors. Therefore, differences in the findings of the aforementioned studies may be
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4 related to differences in social background among different countries.

5 **LIMITATIONS**

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7 This study has several limitations. First, some degree of bias may have resulted from
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9 enrolment being limited to a single center. Further multicenter studies with a larger
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11 sample size are therefore warranted to validate the accuracy and clinical value of the
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13 present results. Second, although we were able to screen factors that were possibly
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15 related to perceived stress, we were unable to infer causal relationships given the
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17 cross-sectional nature of the study. To address this limitation, we plan to conduct
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19 further prospective cohort studies to further investigate the effects of the relevant
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21 factors on perceived stress in patients.

22 **CONCLUSIONS**

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24 In conclusion, the results of this study indicate that patients with CHD have a generally
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26 high perceived stress. Individuals who engaged in mental labor, had a habit of risky
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28 alcohol consumption, and had a higher level of educational attainment had a higher
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30 probability of scoring high on perceived stress. These results can provide a scientific
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32 basis for further investigation of the relationship between stress management and
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34 prognosis in patients with CHD. We recommend the formulation of individualized
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36 stress management programs in cardiac rehabilitation to provide additional care to
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38 individuals with the aforementioned characteristics.

39 **Contributors**

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42 The study was initiated by JM and YX. YG performed the statistical analysis and
43
44 drafted the manuscript. RH, YZ and MY were helpful for data collection. JM and YX
45
46 contributed substantially to its revision. JM and YX took responsibility for the
47
48 manuscript as a whole.

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51
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53
54 agency in the public, commercial or not- for- profit sectors.

55 **Competing interests**

56
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58 None declared.
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Patient consent for publication

Not required.

Ethics approval

This study was approved by the ethics committee of the Chinese PLA General Hospital(S2020-382-01)

Data availability statement

Data are available upon reasonable request. Given that the data is in Chinese, complete raw data are not available for sharing. Partial data sets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Table 1 Social Demography Factors of the subjects

social demography factor		n	%
age	<45	160	7.2
	45-64	1317	59.5
	65-84	727	32.8
	≥85	11	0.4
Gender	Male	1764	79.6
	Female	451	20.4
Education level	Senior high school and below	1107	50.0
	College	978	44.2
	Above college	130	5.9
Having children	Yes	2170	98.0
	No	45	2.0
Marital status	Married	2194	99.0
	Other (single, divorced, or widowed)	21	1.0
Occupation	Mental	1530	69.1
	Physical	685	30.9
Regular exercise	Yes	1630	73.6
	No	585	26.4
Risky alcohol drinking	Yes	298	13.5
	No	1917	86.5
Current Smoker	Yes	334	15.1
	No	1881	84.9
Comorbidity			
Number of stent	0	508	22.9
	1	901	40.7
	2	462	20.9
	≥3	344	15.5
Hypertension	Yes	1245	56.2

		No	970	43.8
	Hyperlipemia	Yes	1049	47.4
		No	1166	52.6
	Diabetes	Yes	598	27.0
		No	1617	73.0
	Other disease	Yes	158	7.1
		No	2057	92.9
	Sleep disorder	Yes	1657	74.8
		No	558	25.2

Table 2 comparison of two groups with different CPSS score

Characteristic	Categories	High stress group		Low stress group		X ²	P value
		(n=1190)		(n=1025)			
		n	%	n	%		
age	<45	89	7.5	71	6.9	0.358	0.949
	45-64	709	59.6	608	59.3		
	65-84	386	32.4	341	33.3		
	≥85	6	0.5	5	0.5		
Gender	Male	966	81.2	798	77.9	3.750	0.053
	Female	224	18.8	227	22.1		
Education level	Senior high school and below	526	44.2	581	56.7	36.611	0.000
	College	578	48.6	400	39.0		
	Above college	86	7.2	44	4.3		
Having children	Yes	1173	98.6	997	97.3	4.698	0.030
	No	17	1.4	28	2.7		
Marital status	Married	1182	99.3	1012	98.7	2.083	0.149
	Other (single, divorced, or widowed)	8	0.7	13	1.3		
Occupation	Mental	881	74.0	649	63.3	29.605	0.000
	Physical	309	26.0	376	36.7		
Regular exercise	Yes	901	75.7	729	71.1	5.975	0.015
	No	289	24.3	296	28.9		
Risky alcohol drinking	Yes	188	15.8	110	10.7	12.141	0.000
	No	1002	84.2	915	89.3		

Current	Yes	182	15.3	152	14.8	0.093	0.760
Smoker	No	1008	84.7	873	85.2		
Number of stent	0	280	23.5	228	22.2	0.820	0.845
	1	486	40.8	415	40.5		
	2	243	20.4	219	21.4		
	≥ 3	181	15.2	163	15.9		
Chronic disease	Yes	965	81.1	831	81.1	0.000	0.991
	No	225	18.9	194	18.9		
Sleep disorder	Yes	889	74.7	768	74.9	0.014	0.905
	No	301	25.3	257	25.1		

Table 3 Logistics regression of CPSS score

	OR(95%CI)	P value
Kid		
Yes	1.000	
No	2.226 (1.098-4.515)	0.027
Education level		
Senior high school and below	1.000	
College	1.453 (1.206-1.750)	0.000
Above college	1.928 (1.290-2.882)	0.001
Occupation		
Manual	1.000	
Mental	1.389 (1.144-1.686)	0.001
Risky alcohol drinking		
No	1.000	0.003
Yes	1.492 (1.146-1.944)	

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
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
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	4
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	5
		(d) If applicable, describe analytical methods taking account of sampling strategy	5
		(e) Describe any sensitivity analyses	5
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	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	6
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	6
		(b) Report category boundaries when continuous variables were categorized	6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	
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	7-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	7-10
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	10

*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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Title Page

Perceived Stress in Chinese Patients with Coronary Heart Disease: A cross-sectional study

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ABSTRACT

Objective Studies have shown that chronic stress is closely linked to the occurrence and development of cardiovascular disease. To date, few studies have focused on perceived stress in coronary heart diseases (CHD) patients and the possible factors influencing the stress. This study aims to investigate the mental stress of patients with CHD and determine the individual attributes closely associated it.

Methods A total of 2215 CHD patients were enrolled and chronic stress were assessed with Chinese version Perceived Stress Scale (CPSS). Participants were divided into 2 groups due to CPSS score and binary logistic regression was applied to analyze the factors that affected CPSS.

Results The mean CPSS score of Chinese patients with CHD was 27.16 ± 6.35 which is higher than the mean value in Chinese general population. Compared with participants who received senior middle school education or below, those with a university degree had a higher probability of high perceived stress (OR: 1.453, CI: 1.206-1.750); this difference was more evident in participants with a masters or doctoral degree (OR: 1.928, CI: 1.290-2.882). Also engaging in mental labor (OR: 1.389, CI: 1.144-1.686), having children (OR: 2.226, CI: 1.098-4.515), and having a habit of risky alcohol consumption (OR:1.492, CI: 1.146-1.944) were associated with perceived

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4 33 stress.

5 34 **Conclusion:** Patients with CHD in China had a relative higher CPSS score. Patients
6
7 who had higher educational attainment, engaged in mental labor, had children, and had
8
9 a habit of risky alcohol consumption were much easier to perceive the stress.
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13 **Keywords**

14 Perceived stress, Coronary heart disease, Influencing factor

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16
17 **Word Count** 2992 words

18 42

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21 **Strengths and limitations of this study**

22 44 In this study, we investigated the stress perception level in Chinese CHD population
23 and explored the possible influencing factors associated with them.

24 45
25 46 The Chinese version Perceived Stress Scale (CPSS) was used to evaluate the chronic
26 stress of CHD patients.
27 47

28 48 When screening influencing factors associated with CPSS score, the variables we
29 included might not cover all the possible factors.
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31 50 Our study didn't clarify whether the CPSS score would associate with the clinical
32 outcome of CHD patients, which might be a candidate topic we should investigate
33 further.
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64 INTRODUCTION

65 The incidence of coronary heart disease (CHD) has been rising steadily over the
66 past few decades and the resulting burden of disease is an issue faced by developed and
67 developing countries alike¹. Finding out the potential risk factors of coronary heart
68 disease and subsequent targeted treatment is a severe challenge. Recent studies
69 demonstrated that psychological and social factors play an important and independent
70 role in the development of coronary heart disease.²⁻⁴

71 Psychological stress (stress) refers to the psychological challenge or threat caused
72 by various triggering events or adverse life factors, and usually manifests as emotional
73 discomfort, pain, or anguish⁵. Under normal circumstances, a dynamic equilibrium
74 exists between an organism and its external environment, and stress arises when this
75 equilibrium is upset or is self-perceived as upset⁶. Stress is believed to be closely linked
76 to the occurrence and development of cardiovascular disease, one of the most important
77 psychosomatic diseases⁷. Acute events such as sudden illnesses and car accidents may
78 lead to an increase in acute stress causing Posttraumatic Stress Disorder (PTSD)
79 symptoms. PTSD symptoms were reported to be moderately prevalent among acute
80 coronary syndrome (ACS) patients, which in turn increase risk for recurrent cardiac
81 events and mortality.^{8 9} Meanwhile if certain acute stress becomes persistent, it will
82 change to chronic stress. The current literature suggests that chronic stress may cause
83 over-activation of the autonomic nervous system and elicit a stress response from the
84 endocrine system, thereby inducing endothelial dysfunction, ultimately triggering
85 cardiovascular events.¹⁰ A latest study ¹¹ revealed that amygdala, a stress-sensitive
86 structure, may increase the incidence of cardiovascular diseases by improving the
87 activity of the immune system, which might be a possible mechanism. It was also found
88 that the process by which stressors exert their effects on an organism is not linear;
89 instead, it arises through interactions⁶. The actual effect of chronic stress on different
90 individuals depends on the stress they perceived. The stress perceived by an individual
91 reflects his/her subjective evaluation of the stressor and will partly depend on individual
92 attributes. Studies have shown that different individuals faced with identical stressors
93 may perceive considerably different levels of stress, with different effects on CHD

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4 94 occurrence and development, resulting in differences in the severity or prognosis of
5 95 CHD.¹² Therefore, the accurate identification of individuals who are more likely to
6 96 perceive stress is of great significance for the precise assessment and subsequent
7 97 treatment of CHD.

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11 98 Assessments of psychological stress are generally performed using standard
12 99 psychological instruments. Commonly used questionnaires include the Perceived Stress
13 100 Scale (PSS), Stress Appraisal Measure (SAM), and Impact of Event Scale (IES). The
14 101 PSS is the most widely used scale to assess chronic stress because it is easy to implement
15 102 and does not require professional intervention during administration. Developed by
16 103 Cohen et al. in 1983¹³, the PSS measures the dimensions of uncontrollability and
17 104 stressfulness, and assesses the stress levels of individuals based on their subjective
18 105 perceptions of stressors. It has been translated into many languages and used widely in
19 106 diverse populations around the world¹⁴⁻²⁰. Blumenthal et al.²¹ have used PSS as a tool
20 107 to assess the chronic stress of CHD patients. The version most used in Chinese
21 108 populations is the Chinese Perceived Stress Scale (CPSS), which is a simplified-
22 109 Chinese version translated by Yang (2007)²². The CPSS has demonstrated good validity
23 110 and reliability in a series of studies in different Chinese populations²³⁻²⁵, especially in
24 111 cardiac patients²⁶.

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39 112 Few studies published to date have utilized the CPSS for the accurate identification
40 113 of high perceived stress individuals among patients with CHD, and stress detection in
41 114 the Chinese mainland population with CHD has not yet been reported. We, therefore,
42 115 analyzed the CPSS scores of patients who visited the cardiac rehabilitation clinic at our
43 116 hospital with the aim of investigating the self-perceived stress levels of Chinese patients
44 117 with CHD and determining the individual attributes closely associated with perceived
45 118 stress. The results of this study might help to stratify CHD patients according to stress
46 119 perception level and supply the individualized stress management programs for Chinese
47 120 populations with CHD.

48 121 **METHODS**

49 122 *Study participants*

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4 123 A cross-sectional study design was adopted. Using the electronic medical records
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6 124 system of our hospital, we screened patients referred to the cardiac rehabilitation clinic
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8 125 between 2015 and 2020. All patients in the inpatient department of cardiology were
9
10 126 recommended to the rehabilitation clinic regardless of whether they choose to receive
11
12 127 the follow rehabilitation treatment or not. Only those with a definitive diagnosis of
13
14 128 CHD were included in the analysis. Based on the criteria of the CHD 2019 ESC
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16 129 Guidelines for the Diagnosis and Management of Chronic Coronary Syndromes, the
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18 130 inclusions were: one or more lesions with $\geq 50\%$ stenosis as shown by coronary
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20 131 angiography; stable angina (SA); unstable angina (USA); old myocardial infarction
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22 132 (OMI); acute myocardial infarction (AMI); post-percutaneous coronary intervention
23
24 133 (PCI); post-coronary artery bypass graft (CABG); or ischemic cardiomyopathy (IC).
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26 134 Those who are unwilling to take the scale will be excluded.

27 135 ***Demographic characteristics and medical history***

28
29 136 The demographic characteristics and medical history of the participants were
30
31 137 obtained from the cardiac rehabilitation medical records system and collated by a
32
33 138 cardiologist. The demographic characteristics analyzed included age, sex, region (south
34
35 139 /north, divided along the Qinling Mountains-Huaihe River line), educational level,
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37 140 marital status, family structure (with/without children), nature of work (mental/manual
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39 141 labor), the presence/absence of sleep disorders, and the following lifestyle factors:
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41 142 regular exercise, risky alcohol consumption, and smoking. The medical history data
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43 143 analyzed included history of cardiac revascularization and the presence/absence of
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45 144 other chronic diseases requiring long-term medication. Mental labor was defined as
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47 145 professional, managerial, or administrative work generally performed in an office or
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49 146 other administrative environment. Manual labor was defined as strenuous physical
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51 147 work or other types of work demanding physical exertion. Regular exercise was defined
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53 148 as ≥ 30 min of low-intensity exercise >5 times per week or ≥ 20 min of moderate-
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55 149 intensity exercise >3 times per week. Sleep disorders were defined as the occurrence of
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57 150 at least one of the following ≥ 3 times per week for at least 1 month: inability to sleep
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59 151 after 30 min in bed, waking up ≥ 2 times during the night, wake time $>15\%$, dreamful
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152 sleep or total sleep time <6 hours, and waking up ≥ 2 hours ahead of schedule and

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4 153 subsequently unable to get back to sleep. Risky alcohol consumption was defined as
5 154 the consumption of ≥ 5 alcoholic drinks on a single occasion >12 times in the past
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7 155 year.²⁷

156 *Stress assessment*

157 The perceived stress of the study participants was assessed using the CPSS, which
158 comprises 14 items intended to measure the dimensions of uncontrollability and
159 stressfulness. Each item is rated on a 5-point scale (0 = never, 1 = rarely, 2 = sometimes,
160 3 = fairly often, 4 = very often), with items 4, 5, 6, 7, 9, 10, and 13 scored in the reverse
161 direction. Total scores range from 0 to 56 points, with higher scores indicating higher
162 psychological stress.

163 In addition to the CPSS, all the participants were asked to complete the Patient
164 Health Questionnaire (PHQ-9) scale and the Generalized Anxiety Disorder (GAD-7)
165 scale to assess preexisting mental health comorbidities. The PHQ-9 is a self-rating scale
166 consisting of 9 items. A PHQ-9 score greater than 5 indicates that the patient may be in
167 a mild or more depressive state. The GAD-7 is a 7-item self-rating scale indicating a
168 mild or more anxiety state when the score is greater than 5.

169 All the participants were asked to provide responses based on their own perceptions.
170 All patients who visited the cardiac rehabilitation clinic for the first time were requested
171 to complete the scales on their own after receiving instructions on questionnaire
172 completion from a nurse. The responses were collected and collated by a cardiologist.

173 *Statistical analysis*

174 Statistical analysis was performed using SPSS 25.0. Quantitative variables were
175 tested for normality. Normally distributed variables were expressed as mean \pm standard
176 deviation ($x \pm s$); variables not normally distributed were expressed as median and
177 interquartile range (IQR). Qualitative data were expressed as ratios or percentages.
178 Factors associated with the CPSS scores of the study participants were analyzed from
179 binary logistic regression.

180 *Patient and public involvement*

181 Public and patient involvement was not applicable in this research.

182 **RESULTS**

183 ***Demographic data of patients with CHD***

184 Of the 3845 patients referred to the cardiac rehabilitation clinic during the study
185 period, 1630 patients were excluded, of which 1428 did not meet the inclusion criteria,
186 and 202 refused to be evaluated by CPSS. Eventually 2215 CHD patients were
187 included in the study (Figure 1). The mean age of the study participants was $59.57 \pm$
188 10.10 y, and the majority of the participants were male (79.64%), had a university
189 degree or below (94.13%), married (99.05%), had children (97.97%), engaged in
190 mental labor (69.07%), had sleep disorders (74.81%), and did not have a drinking habit
191 (60.18%) Of the participants, 77.1% had previously undergone stent insertion, 56.2%
192 had concomitant hypertension, 47.4% had concomitant hyperlipidemia, and 27% had
193 concomitant diabetes mellitus (see **Table 1**).

194 ***Comparison of characteristics between groups***

195 The mean CPSS score of all the patients with CHD was 27.16 ± 6.35 . Using the
196 median score of 27 as the cut-off point, the study participants were divided into a low-
197 stress group (CPSS score ≤ 27) and a high-stress group (CPSS score > 27).

198 Participants who had children, engaged in mental labor, or had a habit of risky
199 alcohol consumption had a higher probability of experiencing higher stress perception
200 levels. (see **Table 2**).

201 ***Logistic regression***

202 Binary logistic regression analysis was performed in model 1 by setting the CPSS
203 score as the dependent variable and the following as the independent variables: age,
204 sex, educational level, marital status, family structure (with/without children), nature of
205 work (mental/manual labor), number of stents, and the presence/absence of sleep
206 disorders, other chronic diseases, and the following habits: regular exercise, risky
207 alcohol consumption, and smoking. Our results indicated that study participants who
208 have children had a higher probability of high perceived stress, with the odds ratio (OR)
209 being 2.226 (confidence interval [CI]: 1.098-4.515). Compared with participants who
210 received middle school education or below, those with a university degree had a higher
211 probability of high perceived stress (OR: 1.453, CI: 1.206-1.750); this was more evident
212 in participants with a masters or doctoral degree (OR: 1.928, CI: 1.290-2.882).

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4 213 Participants who engaged in mental labor had a higher probability of high perceived
5 214 stress than those who engaged in manual labor (OR: 1.389, CI: 1.144-1.686). Compared
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7 215 with participants who did not have a habit of risky alcohol consumption, those who had
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9 216 this habit had a higher probability of high perceived stress (OR:1.492, CI: 1.146-1.944).
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11 217 Model 2 was adjusted by GAD-7 and PHQ-9 scores, which has no major influence on
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13 218 the conclusion (see **Table 3**).

15 219 **DISCUSSION**

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17 220 The relationship between psychological stress and cardiovascular disease has
18
19 221 attracted increasing attention in recent years. Considering that psychological stress may
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21 222 play some role in the occurrence and development of CHD, a greater emphasis has been
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23 223 placed on stress management in comprehensive cardiac rehabilitation programs
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25 224 because it may potentially provide benefits, such as improving the long-term prognosis
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27 225 of patients with CHD.²¹ In this study, we investigated the stress perception level in
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29 226 Chinese CHD population and explored the possible influencing factors associated with
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31 227 them. Our studied suggested that patients with CHD in China had a relative higher
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33 228 CPSS score. In addition, we found that patients who had higher educational attainment,
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35 229 engaged in mental labor, had children, and had a habit of risky alcohol consumption
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37 230 were much easier to perceive the stress.

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39 231 The mean CPSS score of Chinese patients with CHD in our study was $27.16 \pm$
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41 232 6.35 , which was slightly higher than that of the normal population.²² Yang et al.²²
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43 233 conducted a CPSS assessment of the Chinese general population (n=3666), with an
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45 234 average score of 24.22 ± 5.81 . A summary independent-sample t test proves that the
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47 235 CPSS scores of the two groups are statistically different ($P = 0.000$).

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49 236 Analysis of the demographic characteristics of high-stress individuals among
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51 237 patients with CHD can support the clinical stratified management of patients according
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53 238 to stress level, which increases the efficiency of rehabilitation treatment and maximizes
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55 239 the clinical benefits to each individual. Previous studies have shown that demographic
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57 240 characteristics such as age, sex, educational level, marital status, family structure
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59 241 (with/without children), nature of work (mental/manual labor), the presence/absence of
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242 mental health comorbidities, sleep disorders, other chronic diseases, and the following

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4 243 habits: regular exercise, risky alcohol consumption, and smoking may have an impact
5 244 on mental stress,^{13, 17, 19, 26, 28-30} but the conclusion is not completely consistent. We also
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7 245 observed in the clinic that patients implanted with multiple stents tend to be more
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9 246 stressed.

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11 247 Our results showed a strong correlation between perceived stress and educational
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13 248 level in Chinese patients with CHD. A higher educational level was associated with
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15 249 higher perceived stress, with the risk of high perceived stress in participants with a
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17 250 university degree being 1.453 times (CI: 1.206-1.750) that of those who received senior
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19 251 middle school education or below, and the OR increased to 1.928 (CI: 1.290-2.882)
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21 252 among participants with a masters or doctoral degree. However, this result is contrary
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23 253 to the findings of studies conducted in other countries^{19, 31} which have indicated that
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25 254 individuals with lower educational attainment generally perceive higher stress. This
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27 255 may possibly be attributed to the long-standing, strong emphasis on educational
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29 256 attainment in Chinese society, which has led to the general view that individuals with
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31 257 higher educational levels should attain greater personal achievements and bear greater
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33 258 social responsibilities and expectations. However, it is not clear whether this unique
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35 259 sociocultural background has caused the aforementioned difference between Eastern
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37 260 and Western countries in the influence of educational level on perceived stress.

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39 261 Perceived stress level was also found to be strongly related to the nature of work
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41 262 in the Chinese population. Participants who engaged in mental labor had higher
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43 263 perceived stress than did those who engaged in manual labor; in other words, they had
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45 264 a higher probability of a high perceived stress score (OR: 1.389, CI: 1.144-1.686). Such
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47 265 a result is not in complete agreement with the findings of previous studies. A survey by
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49 266 Lesage et al.¹⁷ revealed that differences in perceived stress among administrative,
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51 267 technical, and blue-collar workers were statistically insignificant. However, the 501
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53 268 participants of Lesage's study were selected from individuals who attended
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55 269 occupational health centers in northern France, whereas the participants of our study
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57 270 had a greater diversity of occupations, including teachers, doctors, taxi drivers and
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59 271 gardeners. The greater diversity of occupations included in our study provides a better
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272 reflection of the actual range of perceived stress across occupations, thereby helping

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4 273 the occupational factor to reach significance. Dèdelè et al.³² performed a cross-sectional
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6 274 study on perceived stress among 571 full-time workers in Lithuania and found that blue-
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8 275 collar workers who spent relatively more time engaging in physical work had a higher
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10 276 risk of high perceived stress than white-collar workers, which appears to contradict our
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12 277 results. However, the distribution of perceived stress across occupations may depend
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14 278 on the social environment. With China's vast population, Chinese workers are often
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16 279 faced with complicated interpersonal relationships in their workplace. In general,
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18 280 workplace ecology is more complex among individuals engaged in mental labor than
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20 281 among manual workers, which may have partially contributed to the difference in
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22 282 perceived stress we observed between the two occupational categories.

23
24 283 The drinking habit of patients with CHD has also been identified as a potential
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26 284 factor associated with perceived stress. Our results indicated that participants with a
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28 285 habit of risky alcohol consumption had higher perceived stress ($P = 0003$). We also
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30 286 found that the probability that risky alcohol drinkers were assessed as having high
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32 287 perceived stress was 1.492 times that of non-risky alcohol drinkers (CI: 1.146-1.944).
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34 288 These findings are consistent with those reported by Yoon et al.²⁹, who showed that the
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36 289 proportion of individuals with adverse drinking habits was higher in the population with
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38 290 high perceived stress than in the population with low perceived stress. Although the
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40 291 study by Yoon et al. did not investigate possible causal relationships between high
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42 292 stress and at-risk drinking, there is no doubt that patients with a habit of risky alcohol
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44 293 consumption can have higher perceived stress. Therefore, for such individuals,
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46 294 emphasis should be placed on appropriate stress interventions in the formulation of
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48 295 rehabilitation programs.

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50 296 Interestingly, we also found that patients with CHD with children were nearly twice
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52 297 as likely to perceive the stress as those without children, which is consistent with the
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54 298 findings of Lesage et al.¹⁷

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56 299 Our results also showed that the perceived stress of patients with CHD was not
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58 300 correlated with age, sex or marital status. There is no study to investigate the effect of
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60 301 this 3 factors on perceived stress level especially in CHD patients. For the general
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303 302 population, there is some inconsistent findings. A study by Andreou et al.²⁸ indicated

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4 303 that younger individuals, women, and single or divorced individuals may have higher
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6 304 perceived stress. Cohen et al.¹³ reported that perceived stress was higher in women, but
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8 305 unrelated to age; similar conclusions were reached in two other studies.^{33,34} However,
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10 306 Dèdelè et al.³² asserted that older individuals had higher perceived stress. A study by
11
12 307 Leung et al.²⁶ indicated higher levels of perceived stress in women, but a contrary result
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14 308 was reported by Ojard et al.³⁵ In summary, we have to say research on this matter is far
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16 309 from conclusive. And the inconsistency of our study with other precious ones might
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18 310 attribute to the disease type, difference environmental and social background.

311 **LIMITATIONS**

312 This study has several limitations. First, we conducted the study in CHD patients
313 referred to the cardiac rehabilitation center in our hospital, which might bring
314 selection bias. Also, multi-center study to further evaluate the CPSS score in CHD
315 patients all over China is ongoing. Second, when screening influencing factors
316 associated with CPSS score, the variables we included might not cover all the possible
317 factors. The effect size should be interpreted with caution due to the low variation of
318 marital status and other potential missing covariates. Third, our study didn't clarify
319 whether the CPSS score would associate with the clinical outcome of CHD patients,
320 which might be a candidate topic we should investigate further.

321 **CONCLUSIONS**

322 In conclusion, the results of this study indicate that patients with CHD have a relative
323 higher perceived stress level. Individuals who had higher educational attainment,
324 engaged in mental labor, had children, and had a habit of risky alcohol consumption
325 were much easier to perceive the stress. The results of this study might help to stratify
326 CHD patients according to stress perception level and supply the individualized stress
327 management programs for Chinese populations with CHD..

328 329 **Contributors**

330 The study was initiated by JM and YX. YG performed the statistical analysis and
331 drafted the manuscript. RH, YZ and MY were helpful for data collection. JM and YX
332 contributed substantially to its revision. JM and YX took responsibility for the

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4 333 manuscript as a whole.

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11 339 **Competing interests**

12
13
14 340 None declared.

15 341 **Patient consent for publication**

16
17 342 Not required.

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19 343 **Ethics approval**

20 344 This study was approved by the ethics committee of the Chinese PLA General
21 345 Hospital(S2020-382-01)

22 346 **Data availability statement**

23 347 Data are available upon reasonable request. Given that the data is in Chinese,
24 348 complete raw data are not available for sharing. Partial data sets used and/or analysed
25 349 during the current study are available from the corresponding author on reasonable
26 350 request.

27 351

28 352 **REFERENCE:**

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502 Table 1 Social Demography Factors of the subjects

social demography factor		n	%
age	<45	160	7.2
	45-64	1317	59.5
	65-84	727	32.8
	≥85	11	0.4
Gender	Male	1764	79.6
	Female	451	20.4
Region	North	1388	62.7
	South	827	37.3
Education level	Senior high school and below	1107	50.0
	College	978	44.2
	Above college	130	5.9
Having children	Yes	2170	98.0
	No	45	2.0
Marital status	Married	2194	99.0
	Other (single, divorced, or widowed)	21	1.0
Occupation	Mental	1530	69.1
	Physical	685	30.9
Regular exercise	Yes	1630	73.6
	No	585	26.4
Risky alcohol drinking	Yes	298	13.5
	No	1917	86.5
Current Smoker	Yes	334	15.1
	No	1881	84.9
Comorbidity			
Number of stent	0	508	22.9
	1	901	40.7
	2	462	20.9

	≥ 3		344	15.5
Hypertension	Yes		1245	56.2
	No		970	43.8
Hyperlipemia	Yes		1049	47.4
	No		1166	52.6
Diabetes	Yes		598	27.0
	No		1617	73.0
Cerebrovascular disease	Yes		39	1.8
	No		2176	98.2
Other disease	Yes		119	7.1
	No		2096	92.9
Sleep disorder	Yes		1657	74.8
	No		558	25.2
Depressive state	Yes		817	36.9
	No		1398	63.1
Anxiety state	Yes		1113	50.2
	No		1102	49.8

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516 Table 2 comparison of two groups with different CPSS score

Characteristic	Categories	High stress group		Low stress group		X ²	P value
		(n=1190)		(n=1025)			
		n	%	n	%		
age	<45	89	7.5	71	6.9	0.358	0.949
	45-64	709	59.6	608	59.3		
	65-84	386	32.4	341	33.3		
	≥85	6	0.5	5	0.5		
Gender	Male	966	81.2	798	77.9	3.750	0.053
	Female	224	18.8	227	22.1		
Education level	Senior high school and below	526	44.2	581	56.7	36.611	0.000
	College	578	48.6	400	39.0		
	Above college	86	7.2	44	4.3		
Having children	Yes	1173	98.6	997	97.3	4.698	0.030
	No	17	1.4	28	2.7		
Marital status	Married	1182	99.3	1012	98.7	2.083	0.149
	Other (single, divorced, or widowed)	8	0.7	13	1.3		
Occupation	Mental	881	74.0	649	63.3	29.605	0.000
	Physical	309	26.0	376	36.7		
Regular exercise	Yes	901	75.7	729	71.1	5.975	0.015
	No	289	24.3	296	28.9		
Risky alcohol drinking	Yes	188	15.8	110	10.7	12.141	0.000
	No	1002	84.2	915	89.3		

Current	Yes	182	15.3	152	14.8	0.093	0.760
Smoker	No	1008	84.7	873	85.2		
Number of stent	0	280	23.5	228	22.2	0.820	0.845
	1	486	40.8	415	40.5		
	2	243	20.4	219	21.4		
	≥3	181	15.2	163	15.9		
Chronic disease	Yes	965	81.1	831	81.1	0.000	0.991
	No	225	18.9	194	18.9		
Sleep disorder	Yes	889	74.7	768	74.9	0.014	0.905
	No	301	25.3	257	25.1		

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537 Table 3 Logistics regression of CPSS score

	Model 1*		Model 2**	
	OR(95%CI)	P value	OR(95%CI)	P value
Kid				
Yes	1.000		1.000	
No	2.226(1.098-4.515)	0.027	2.338(1.258-4.345)	0.007
Education level				
Senior high school and below	1.000		1.000	
College	1.453(1.206-1.750)	0.000	1.478(1.231-1.776)	0.000
Above college	1.928(1.290-2.882)	0.001	1.936(1.306-2.870)	0.001
Occupation				
Manual	1.000		1.000	
Mental	1.389(1.144-1.686)	0.001	1.394(1.149-1.690)	0.001
Risky alcohol drinking				
No	1.000	0.003	1.000	0.001
Yes	1.492 (1.146-1.944)		1.516(1.175-1.958)	

538 *Adjusted by age, sex, educational level, marital status, family structure (with/without
 539 children), nature of work (mental/manual labor), number of stents, and the
 540 presence/absence of sleep disorders, other chronic diseases, and the following habits:
 541 regular exercise, risky alcohol consumption, and smoking.

542 *Adjusted by age, sex, educational level, marital status, family structure (with/without
 543 children), nature of work (mental/manual labor), number of stents, and the
 544 presence/absence of sleep disorders, other chronic diseases, the following habits:
 545 regular exercise, risky alcohol consumption, and smoking, PHQ9 scores and GAD7
 546 scores.

547 OR: Odds Ratio

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5 550 Figure 1 Flow diagram of the participants
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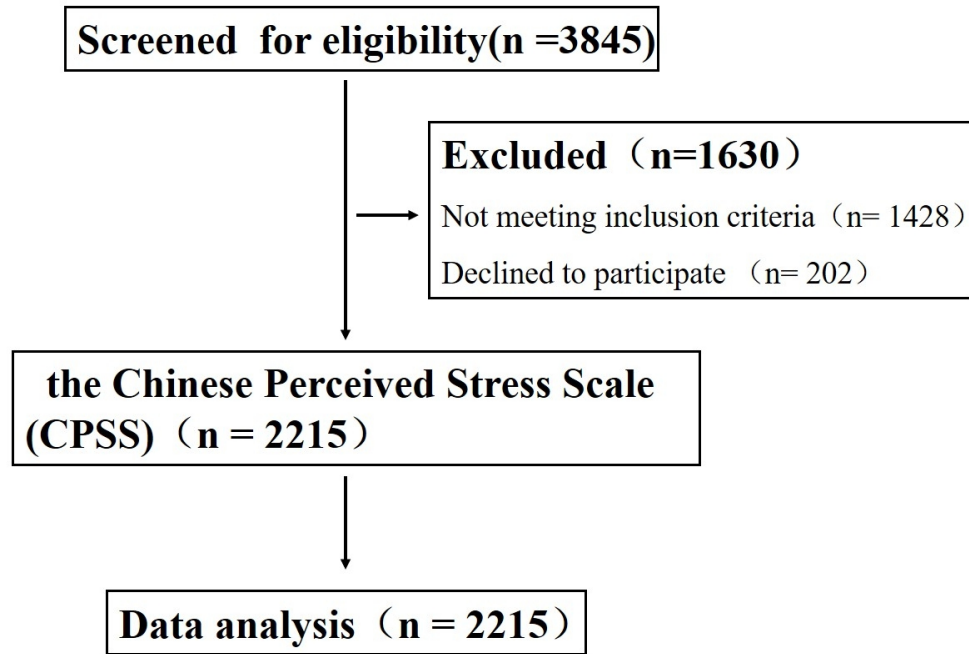


Figure 1 Flow diagram of the participants

203x136mm (150 x 150 DPI)

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
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
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	4
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	5
		(d) If applicable, describe analytical methods taking account of sampling strategy	5
		(e) Describe any sensitivity analyses	5
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	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	6
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	6
		(b) Report category boundaries when continuous variables were categorized	6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	
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	7-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	7-10
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	10

*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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Perceived Stress in Chinese Patients with Coronary Heart Disease: A cross-sectional study

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Title Page

Perceived Stress in Chinese Patients with Coronary Heart Disease: A cross-sectional study

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ABSTRACT

Objective Studies have shown that chronic stress is closely linked to the occurrence and development of cardiovascular disease. To date, few studies have focused on perceived stress in coronary heart diseases (CHD) patients and the possible factors influencing the stress. This study aims to investigate the mental stress of patients with CHD and determine the individual attributes closely associated with it.

Design A cross-sectional study.

Participates A total of 2215 CHD patients were enrolled and chronic stress was assessed with the Chinese version Perceived Stress Scale (CPSS). Participants were divided into 2 groups due to CPSS score and binary logistic regression was applied to analyze the factors that affected CPSS.

Results The mean CPSS score of Chinese patients with CHD was 27.16 ± 6.35 . Compared with participants who received senior middle school education or below, those with a university degree had a higher probability of high perceived stress (OR: 1.453, CI: 1.206-1.750); this difference was more evident in participants with a master or doctoral degree (OR: 1.928, CI: 1.290-2.882). Also engaging in mental labor (OR: 1.389, CI: 1.144-1.686), having children (OR: 2.226, CI: 1.098-4.515), and having a habit of risky alcohol consumption (OR:1.492, CI: 1.146-1.944) were associated with

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4 33 perceived stress.

5 34 **Conclusion:** Patients who had higher educational attainment, engaged in mental labor,
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7 35 had children, and had a habit of risky alcohol consumption were much easier to perceive
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9 36 the stress.

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13 38 **Keywords**

14 39 Perceived stress, Coronary heart disease, Influencing factor

15 40
16 41 **Word Count** 3081 words

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20 43 **Strengths and limitations of this study**

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22 44 Few studies have focused on perceived stress in CHD patients and the identification of
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24 45 high-stress individuals.

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26 46 Utilize the PSS for the accurate identification of stress-sensitive individuals among
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28 47 patients with coronary heart disease.

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30 48 Given the cross-sectional nature of the study, we cannot infer causal relationships

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50 INTRODUCTION

51 The incidence of coronary heart disease (CHD) has been rising steadily over the
52 past few decades and the resulting burden of disease is an issue faced by developed and
53 developing countries alike¹. Finding out the potential risk factors of coronary heart
54 disease and subsequent targeted treatment is a severe challenge. Recent studies
55 demonstrated that psychological and social factors play an important and independent
56 role in the development of coronary heart disease.²⁻⁴

57 Psychological stress (stress) refers to the psychological challenge or threat caused
58 by various triggering events or adverse life factors and usually manifests as emotional
59 discomfort, pain, or anguish⁵. Under normal circumstances, a dynamic equilibrium
60 exists between an organism and its external environment, and stress arises when this
61 equilibrium is upset or is self-perceived as upset⁶. Stress is believed to be closely linked
62 to the occurrence and development of cardiovascular disease, one of the most important
63 psychosomatic diseases⁷⁻⁸. Acute mental stress caused by sudden accidents or illness
64 may be a trigger for cardiac events such as myocardial ischemia or Takotsubo
65 cardiomyopathy.⁹⁻¹⁰ The process of seeking medical care for patients with an acute
66 coronary event could be another stressor itself.¹¹ Meanwhile if certain acute stress
67 becomes persistent, it will change to chronic stress. A meta-analysis¹² suggests that high
68 stress is associated with a moderately increased risk of incident CHD. The current
69 literature suggests that mental stress may cause over-activation of the autonomic
70 nervous system and elicit a stress response from the endocrine system, thereby inducing
71 endothelial dysfunction, ultimately triggering cardiovascular events.¹³⁻¹⁵ A latest
72 study¹⁶ revealed that the amygdala, a stress-sensitive structure, may increase the
73 incidence of cardiovascular diseases by improving the activity of the immune system,
74 which might be a possible mechanism. Stress-induced platelet bioactivity increase and
75 prolongation may also be involved in this process.¹⁷

76 It was also found that the process by which stressors exert their effects on an
77 organism is not linear; instead, it arises through interactions⁶. The actual effect of
78 chronic stress on different individuals depends on the stress they perceived. The stress
79 perceived by an individual reflects his/her subjective evaluation of the stressor and will

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4 80 partly depend on individual attributes. Studies have shown that different individuals
5
6 81 faced with identical stressors may perceive considerably different levels of stress, with
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8 82 different effects on CHD occurrence and development, resulting in differences in the
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10 83 severity or prognosis of CHD.¹⁸⁻¹⁹ Therefore, the accurate identification of individuals
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12 84 who are more likely to perceive stress is of great significance for the precise assessment
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14 85 and subsequent treatment of CHD.

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16 86 Assessments of psychological stress are generally performed using standard
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18 87 psychological instruments. Commonly used questionnaires include the Perceived Stress
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20 88 Scale (PSS), Stress Appraisal Measure (SAM), and Impact of Event Scale (IES). The
21
22 89 PSS is the most widely used scale to assess chronic stress because it is easy to
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24 90 implement and does not require professional intervention during administration.
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26 91 Developed by Cohen et al. in 1983²⁰, the PSS measures the dimensions of
27
28 92 uncontrollability and stressfulness, and assesses the stress levels of individuals based
29
30 93 on their subjective perceptions of stressors. It has been translated into many languages
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32 94 and used widely in diverse populations around the world²¹⁻²⁷. Blumenthal et al.²⁸ have
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34 95 used PSS as a tool to assess the chronic stress of CHD patients. The version most used
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36 96 in Chinese populations is the Chinese Perceived Stress Scale (CPSS), which is a
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38 97 simplified-Chinese version translated by Yang (2007)²⁹. The CPSS has demonstrated
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40 98 good validity and reliability in a series of studies in different Chinese populations³⁰⁻³²,
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42 99 especially in cardiac patients³³.

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44 100 Few studies published to date have utilized the CPSS for the accurate identification
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46 101 of high perceived stress individuals among patients with CHD, and stress detection in
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48 102 the Chinese mainland population with CHD has not yet been reported. We, therefore,
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50 103 analyzed the CPSS scores of patients who visited the cardiac rehabilitation clinic at our
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52 104 hospital with the aim of investigating the self-perceived stress levels of Chinese patients
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54 105 with CHD and determining the individual attributes closely associated with perceived
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56 106 stress. The results of this study might help to stratify CHD patients according to stress
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58 107 perception level and supply the individualized stress management programs for Chinese
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60 108 populations with CHD.

109 **METHODS**

110 *Study participants*

111 A cross-sectional study design was adopted. Using the electronic medical records
112 system of our hospital, we screened patients referred to the cardiac rehabilitation clinic
113 between 2015 and 2020. All patients in the inpatient department of cardiology were
114 recommended to the rehabilitation clinic regardless of whether they choose to receive
115 the following rehabilitation treatment or not. Only those with a definitive diagnosis of
116 CHD were included in the analysis. Based on the criteria of the CHD 2019 ESC
117 Guidelines for the Diagnosis and Management of Chronic Coronary Syndromes, the
118 inclusions were: one or more lesions with $\geq 50\%$ stenosis as shown by coronary
119 angiography; stable angina (SA); unstable angina (USA); old myocardial infarction
120 (OMI); acute myocardial infarction (AMI); post-percutaneous coronary intervention
121 (PCI); post-coronary artery bypass graft (CABG); or ischemic cardiomyopathy (IC).
122 Those who are unwilling to take the scale will be excluded.

123 *Demographic characteristics and medical history*

124 The demographic characteristics and medical history of the participants were
125 obtained from the cardiac rehabilitation medical records system and collated by a
126 cardiologist. The demographic characteristics analyzed included age, sex, region (south
127 /north, divided along the Qinling Mountains-Huaihe River line), educational level,
128 marital status, family structure (with/without children), nature of work (mental/manual
129 labor), the presence/absence of sleep disorders, and the following lifestyle factors:
130 regular exercise, risky alcohol consumption, and smoking. The medical history data
131 analyzed included a history of cardiac revascularization and the presence/absence of
132 other chronic diseases requiring long-term medication. Mental labor was defined as
133 professional, managerial, or administrative work generally performed in an office or
134 other administrative environment. Manual labor was defined as strenuous physical
135 work or other types of work demanding physical exertion. Regular exercise was defined
136 as ≥ 30 min of low-intensity exercise >5 times per week or ≥ 20 min of moderate-
137 intensity exercise >3 times per week. Sleep disorders were defined as the occurrence of

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4 138 at least one of the following ≥ 3 times per week for at least 1 month: inability to sleep
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6 139 after 30 min in bed, waking up ≥ 2 times during the night, wake time $>15\%$, dreamful
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8 140 sleep or total sleep time <6 hours, and waking up ≥ 2 hours ahead of schedule and
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10 141 subsequently unable to get back to sleep. Risky alcohol consumption was defined as
11
12 142 the consumption of ≥ 5 alcoholic drinks on a single occasion >12 times in the past
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14 143 year.³⁴

144 ***Stress assessment***

145 The perceived stress of the study participants was assessed using the CPSS, which
146 comprises 14 items intended to measure the dimensions of uncontrollability and
147 stressfulness. Each item is rated on a 5-point scale (0 = never, 1 = rarely, 2 = sometimes,
148 3 = fairly often, 4 = very often), with items 4, 5, 6, 7, 9, 10, and 13 scored in the reverse
149 direction. Total scores range from 0 to 56 points, with higher scores indicating higher
150 psychological stress.

151 In addition to the CPSS, all the participants were asked to complete the Patient
152 Health Questionnaire (PHQ-9) scale and the Generalized Anxiety Disorder (GAD-7)
153 scale to assess preexisting mental health comorbidities. The PHQ-9 is a self-rating scale
154 consisting of 9 items. A PHQ9 score greater than 5 indicates that the patient may be in
155 a mild or more depressive state. The GAD-7 is a 7-item self-rating scale indicating a
156 mild or more anxiety state when the score is greater than 5.

157 All the participants were asked to provide responses based on their own perceptions.
158 All patients who visited the cardiac rehabilitation clinic for the first time were requested
159 to complete the scales on their own after receiving instructions on questionnaire
160 completion from a nurse. The responses were collected and collated by a cardiologist.

161 ***Statistical analysis***

162 Statistical analysis was performed using SPSS 25.0. Quantitative variables were
163 tested for normality. Normally distributed variables were expressed as mean \pm standard
164 deviation ($x \pm s$); variables not normally distributed were expressed as median and
165 interquartile range (IQR). Qualitative data were expressed as ratios or percentages.
166 Factors associated with the CPSS scores of the study participants were analyzed from
167 binary logistic regression.

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4 168 ***Patient and public involvement***

5 169 Public and patient involvement was not applicable in this research.

6
7 170 **RESULTS**

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9 171 ***Demographic data of patients with CHD***

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11 172 Of the 3845 patients referred to the cardiac rehabilitation clinic during the study
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13 173 period, 1630 patients were excluded, of which 1428 did not meet the inclusion criteria,
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15 174 and 202 refused to be evaluated by CPSS. Eventually, 2215 CHD patients were
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17 175 included in the study (Figure 1). The mean age of the study participants was $59.57 \pm$
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19 176 10.10 y, and the majority of the participants were male (79.64%), had a university
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21 177 degree or below (94.13%), married (99.05%), had children (97.97%), engaged in
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23 178 mental labor (69.07%), had sleep disorders (74.81%), and did not have a drinking habit
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25 179 (60.18%) Of the participants, 77.1% had previously undergone stent insertion, 56.2%
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27 180 had concomitant hypertension, 47.4% had concomitant hyperlipidemia, and 27% had
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29 181 concomitant diabetes mellitus (see **Table 1**).

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31 182 ***Comparison of characteristics between groups***

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33 183 The mean CPSS score of all the patients with CHD was 27.16 ± 6.35 . Using the
34
35 184 median score of 27 as the cut-off point, the study participants were divided into a low-
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37 185 stress group (CPSS score ≤ 27) and a high-stress group (CPSS score > 27).

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39 186 Participants who had children, engaged in mental labor, or had a habit of risky
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41 187 alcohol consumption had a higher probability of experiencing higher stress perception
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43 188 levels. (see **Table 2**).

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45 189 ***Logistic regression***

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47 190 Binary logistic regression analysis was performed in model 1 by setting the CPSS
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49 191 score as the dependent variable and the following as the independent variables: age,
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51 192 sex, educational level, marital status, family structure (with/without children), nature of
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53 193 work (mental/manual labor), number of stents, and the presence/absence of sleep
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55 194 disorders, other chronic diseases, and the following habits: regular exercise, risky
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57 195 alcohol consumption, and smoking. Our results indicated that study participants who
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59 196 have children had a higher probability of high perceived stress, with the odds ratio (OR)
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197 being 2.226 (confidence interval [CI]: 1.098-4.515). Compared with participants who

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4 198 received middle school education or below, those with a university degree had a higher
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6 199 probability of high perceived stress (OR: 1.453, CI: 1.206-1.750); this was more evident
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8 200 in participants with a master or doctoral degree (OR: 1.928, CI: 1.290-2.882).
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10 201 Participants who engaged in mental labor had a higher probability of high perceived
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12 202 stress than those who engaged in manual labor (OR: 1.389, CI: 1.144-1.686). Compared
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14 203 with participants who did not have a habit of risky alcohol consumption, those who had
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16 204 this habit had a higher probability of high perceived stress (OR: 1.492, CI: 1.146-1.944).
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18 205 Model 2 was adjusted by GAD-7 and PHQ-9 scores, which has no major influence on
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20 206 the conclusion (see **Table 3**).

21 207 **DISCUSSION**

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23 208 The relationship between psychological stress and cardiovascular disease has
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25 209 attracted increasing attention in recent years. Considering that psychological stress may
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27 210 play some role in the occurrence and development of CHD, a greater emphasis has been
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29 211 placed on stress management in comprehensive cardiac rehabilitation programs
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31 212 because it may potentially provide benefits, such as improving the long-term prognosis
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33 213 of patients with CHD.²⁸ In this study, we investigated the stress perception level in the
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35 214 Chinese CHD population and explored the possible influencing factors associated with
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37 215 them. Our study suggested that patients with CHD in China had a relatively higher
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39 216 CPSS score. In addition, we found that patients who had higher educational attainment,
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41 217 engaged in mental labor, had children, and had a habit of risky alcohol consumption
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43 218 were much easier to perceive the stress.

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45 219 The mean CPSS score of Chinese patients with CHD in our study was $27.16 \pm$
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47 220 6.35 . Yang et al.²⁹ conducted a CPSS assessment of the Chinese general population
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49 221 ($n=3666$), with an average score of 24.22 ± 5.811 . A summary independent-sample t-
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51 222 test proves that the CPSS scores of the two groups are statistically different ($P = 0.000$).

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53 223 Analysis of the demographic characteristics of high-stress individuals among
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55 224 patients with CHD can support the clinical stratified management of patients according
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57 225 to the stress level, which increases the efficiency of rehabilitation treatment and
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59 226 maximizes the clinical benefits to each individual. Previous studies have shown that
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227 demographic characteristics such as age, sex, educational level, marital status, family

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4 228 structure (with/without children), nature of work (mental/manual labor), the
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6 229 presence/absence of mental health comorbidities, sleep disorders, other chronic
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8 230 diseases, and the following habits: regular exercise, risky alcohol consumption, and
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10 231 smoking may have an impact on mental stress,^{20, 24, 26, 33, 35-37} but the conclusion is not
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12 232 completely consistent. We also observed in the clinic that patients implanted with
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14 233 multiple stents tend to be more stressed. Our results showed a strong correlation
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16 234 between perceived stress and educational level in Chinese patients with CHD. A higher
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18 235 educational level was associated with higher perceived stress, with the risk of high
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20 236 perceived stress in participants with a university degree being 1.453 times (CI: 1.206-
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22 237 1.750) that of those who received senior middle school education or below, and the OR
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24 238 increased to 1.928 (CI: 1.290-2.882) among participants with a master or doctoral
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26 239 degree. However, this result is contrary to the findings of studies conducted in other
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28 240 countries^{26, 38} which have indicated that individuals with lower educational attainment
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30 241 generally perceive higher stress. This may be attributed to the long-standing, strong
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32 242 emphasis on educational attainment in Chinese society, which has led to the general
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34 243 view that individuals with higher educational levels should attain greater personal
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36 244 achievements and bear greater social responsibilities and expectations. However, it is
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38 245 not clear whether this unique socio-cultural background has caused the aforementioned
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40 246 difference between Eastern and Western countries in the influence of educational level
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42 247 on perceived stress.

43 248 The perceived stress level was also found to be strongly related to the nature of
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45 249 work in the Chinese population. Participants who engaged in mental labor had higher
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47 250 perceived stress than did those who engaged in manual labor; in other words, they had
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49 251 a higher probability of a high perceived stress score (OR: 1.389, CI: 1.144-1.686). Such
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51 252 a result is not in complete agreement with the findings of previous studies. A survey by
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53 253 Lesage et al.²⁴ revealed that differences in perceived stress among administrative,
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55 254 technical, and blue-collar workers were statistically insignificant. However, the 501
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57 255 participants of Lesage's study were selected from individuals who attended
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59 256 occupational health centers in northern France, whereas the participants of our study
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257 had a greater diversity of occupations, including teachers, doctors, taxi drivers, and

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4 258 gardeners. The greater diversity of occupations included in our study provides a better
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6 259 reflection of the actual range of perceived stress across occupations, thereby helping
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8 260 the occupational factor to reach significance. Dèdelè et al.³⁹ performed a cross-sectional
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10 261 study on perceived stress among 571 full-time workers in Lithuania and found that blue-
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12 262 collar workers who spent relatively more time engaging in physical work had a higher
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14 263 risk of high perceived stress than white-collar workers, which appears to contradict our
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16 264 results. However, the distribution of perceived stress across occupations may depend
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18 265 on the social environment. With China's vast population, Chinese workers are often
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20 266 faced with complicated interpersonal relationships in their workplace. In general,
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22 267 workplace ecology is more complex among individuals engaged in mental labor than
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24 268 among manual workers, which may have partially contributed to the difference in
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26 269 perceived stress we observed between the two occupational categories.

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28 270 The drinking habit of patients with CHD has also been identified as a potential
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30 271 factor associated with perceived stress. Our results indicated that participants with a
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32 272 habit of risky alcohol consumption had higher perceived stress ($P = 0003$). We also
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34 273 found that the probability that risky alcohol drinkers were assessed as having high
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36 274 perceived stress was 1.492 times that of non-risky alcohol drinkers (CI: 1.146-1.944).
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38 275 These findings are consistent with those reported by Yoon et al.³⁶, who showed that the
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40 276 proportion of individuals with adverse drinking habits was higher in the population with
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42 277 high perceived stress than in the population with low perceived stress. Although the
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44 278 study by Yoon et al. did not investigate possible causal relationships between high
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46 279 stress and at-risk drinking, there is no doubt that patients with a habit of risky alcohol
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48 280 consumption can have higher perceived stress. Therefore, for such individuals,
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50 281 emphasis should be placed on appropriate stress interventions in the formulation of
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52 282 rehabilitation programs.

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54 283 Interestingly, we also found that patients with CHD with children were nearly twice
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56 284 as likely to perceive the stress as those without children, which is consistent with the
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58 285 findings of Lesage et al.²⁴

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60 286 Our results also showed that the perceived stress of patients with CHD was not
287 correlated with age, sex, or marital status. There is no study to investigate the effect of

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4 288 these 3 factors on perceived stress levels, especially in CHD patients. For the general
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6 289 population, there are some inconsistent findings. A study by Andreou et al.³⁵ indicated
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8 290 that younger individuals, women, and single or divorced individuals may have higher
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10 291 perceived stress. Cohen et al.²⁰ reported that perceived stress was higher in women but
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12 292 unrelated to age; similar conclusions were reached in two other studies.⁴⁰⁻⁴¹ However,
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14 293 Dèdelè et al.³⁹ asserted that older individuals had higher perceived stress. A study by
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16 294 Leung et al.³³ indicated higher levels of perceived stress in women, but a contrary result
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18 295 was reported by Ojard et al.⁴² In summary, we have to say research on this matter is far
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20 296 from conclusive. And the inconsistency of our study with other precious ones might
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22 297 attribute to the disease type, difference in environmental and social background.

23 298 **LIMITATIONS**

24 299 This study has several limitations. First, we conducted the study in CHD patients
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26 300 referred to the cardiac rehabilitation center in our hospital, which might bring
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28 301 selection bias and the stress levels in the general population only had historical
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30 302 control. Also, a multi-center study to further evaluate the CPSS score in CHD patients
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32 303 and the general population all over China is ongoing. Second, when screening
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34 304 influencing factors associated with the CPSS score, the variables we included might
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36 305 not cover all the possible factors. The effect size should be interpreted with caution
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38 306 due to the low variation of marital status and other potential missing covariates. Third,
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40 307 our study didn't clarify whether the CPSS score would associate with the clinical
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42 308 outcome of CHD patients, which might be a candidate topic we should investigate
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44 309 further.

45 310 **CONCLUSIONS**

46
47 311 In conclusion, individuals who had higher educational attainment, engaged in mental
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49 312 labor, had children and had a habit of risky alcohol consumption were much easier to
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51 313 perceive the stress. The results of this study might help to stratify CHD patients
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53 314 according to stress perception level and supply the individualized stress management
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55 315 programs for Chinese populations with CHD.

56 316 57 317 **Contributors**

58
59 318 The study was initiated by JM and YX. YG performed the statistical analysis and
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4 319 drafted the manuscript. RH, YZ, and MY were helpful for data collection. JM and YX
5
6 320 contributed substantially to its revision. JM and YX took responsibility for the
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8 321 manuscript as a whole.

9 322

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14 327 **Competing interests**

15 328 None declared.

16 329 **Patient consent for publication**

17 330 Not required.

18 331 **Ethics approval**

19 332 This study was approved by the ethics committee of the Chinese PLA General
20 333 Hospital(S2020-382-01)

21 334 **Data availability statement**

22 335 Data are available upon reasonable request. Given that the data is in Chinese,
23 336 complete raw data are not available for sharing. Partial data sets used and/or analyzed
24 337 during the current study are available from the corresponding author on reasonable
25 338 request.

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485 Table 1 Social Demography Factors of the subjects

social demography factor		n	%
age	<45	160	7.2
	45-64	1317	59.5
	65-84	727	32.8
	≥85	11	0.4
Gender	Male	1764	79.6
	Female	451	20.4
Region	North	1388	62.7
	South	827	37.3
Education level	Senior high school and below	1107	50.0
	College	978	44.2
	Above college	130	5.9
Having children	Yes	2170	98.0
	No	45	2.0
Marital status	Married	2194	99.0
	Other (single, divorced, or widowed)	21	1.0
Occupation	Mental	1530	69.1
	Physical	685	30.9
Regular exercise	Yes	1630	73.6
	No	585	26.4
Risky alcohol drinking	Yes	298	13.5
	No	1917	86.5
Current Smoker	Yes	334	15.1
	No	1881	84.9
Comorbidity			
Number of stent	0	508	22.9
	1	901	40.7
	2	462	20.9

		≥3	344	15.5
	Hypertension	Yes	1245	56.2
		No	970	43.8
	Hyperlipemia	Yes	1049	47.4
		No	1166	52.6
	Diabetes	Yes	598	27.0
		No	1617	73.0
	Cerebrovascular	Yes	39	1.8
	disease	No	2176	98.2
	Other diseases	Yes	119	7.1
		No	2096	92.9
	Sleep disorder	Yes	1657	74.8
		No	558	25.2
	Depressive state	Yes	817	36.9
		No	1398	63.1
	Anxiety state	Yes	1113	50.2
		No	1102	49.8

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487 Table 2 Comparison of two groups with different CPSS scores

Characteristic	Categories	High-stress group (n=1190)		Low stress group (n=1025)		X ²	P value
		n	%	n	%		
		age	<45	89	7.5		
	45-64	709	59.6	608	59.3		
	65-84	386	32.4	341	33.3		
	≥85	6	0.5	5	0.5		
Gender	Male	966	81.2	798	77.9	3.750	0.053
	Female	224	18.8	227	22.1		
Education level	Senior high school and below	526	44.2	581	56.7	36.611	0.000
	College	578	48.6	400	39.0		
	Above college	86	7.2	44	4.3		
Having children	Yes	1173	98.6	997	97.3	4.698	0.030
	No	17	1.4	28	2.7		
Marital status	Married	1182	99.3	1012	98.7	2.083	0.149
	Other (single, divorced, or widowed)	8	0.7	13	1.3		
Occupation	Mental	881	74.0	649	63.3	29.605	0.000
	Physical	309	26.0	376	36.7		
Regular exercise	Yes	901	75.7	729	71.1	5.975	0.015
	No	289	24.3	296	28.9		
Risky alcohol drinking	Yes	188	15.8	110	10.7	12.141	0.000
	No	1002	84.2	915	89.3		

Current	Yes	182	15.3	152	14.8	0.093	0.760
Smoker	No	1008	84.7	873	85.2		
Number of stent	0	280	23.5	228	22.2	0.820	0.845
	1	486	40.8	415	40.5		
	2	243	20.4	219	21.4		
	≥ 3	181	15.2	163	15.9		
Chronic disease	Yes	965	81.1	831	81.1	0.000	0.991
	No	225	18.9	194	18.9		
Sleep disorder	Yes	889	74.7	768	74.9	0.014	0.905
	No	301	25.3	257	25.1		
Depressive state	Yes	626	52.6	487	47.5	5.713	0.017
	No	564	47.4	538	52.5		
Anxiety state	Yes	470	39.5	347	33.9	7.530	0.006
	No	720	60.5	678	66.1		

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489 Table 3 Logistics regression of CPSS score

	Model 1*		Model 2**	
	OR(95%CI)	P value	OR(95%CI)	P value
Kid				
Yes	1.000		1.000	
No	2.226(1.098-4.515)	0.027	2.338(1.258-4.345)	0.007
Education level				
Senior high school and below	1.000		1.000	
College	1.453(1.206-1.750)	0.000	1.478(1.231-1.776)	0.000
Above college	1.928(1.290-2.882)	0.001	1.936(1.306-2.870)	0.001
Occupation				
Manual	1.000		1.000	
Mental	1.389(1.144-1.686)	0.001	1.394(1.149-1.690)	0.001
Risky alcohol drinking				
No	1.000	0.003	1.000	0.001
Yes	1.492 (1.146-1.944)		1.516(1.175-1.958)	

490 *Adjusted by age, sex, educational level, marital status, family structure (with/without
 491 children), nature of work (mental/manual labor), number of stents, and the
 492 presence/absence of sleep disorders, other chronic diseases, and the following habits:
 493 regular exercise, risky alcohol consumption, and smoking.

494 *Adjusted by age, sex, educational level, marital status, family structure (with/without
 495 children), nature of work (mental/manual labor), number of stents, and the
 496 presence/absence of sleep disorders, other chronic diseases, the following habits:
 497 regular exercise, risky alcohol consumption, and smoking, PHQ9 scores and GAD7
 498 scores. OR: Odds Ratio

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3 499 Figure 1 Flow diagram of the participants
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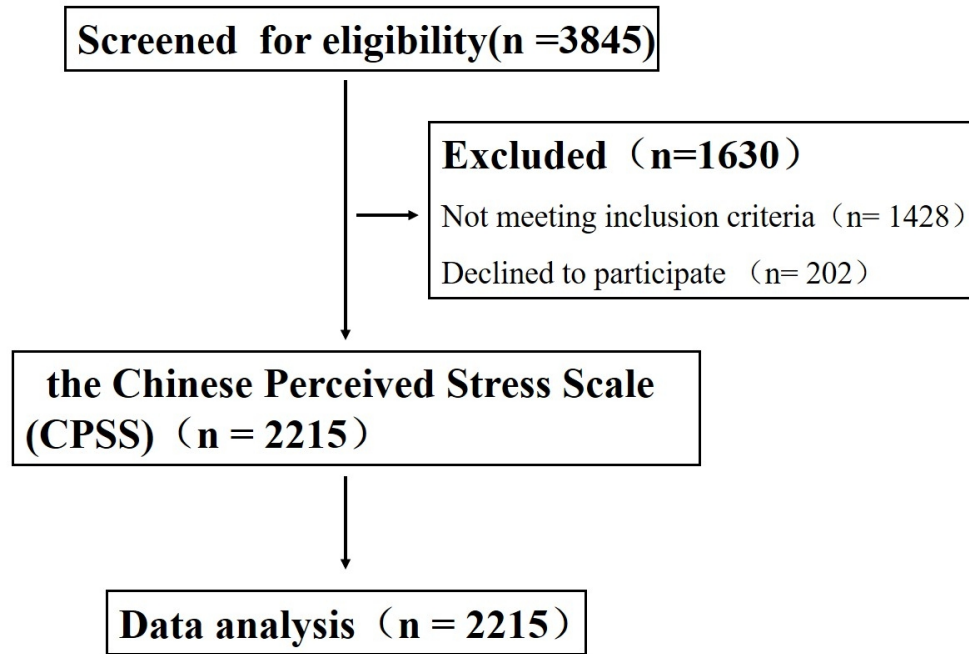


Figure 1 Flow diagram of the participants

203x136mm (150 x 150 DPI)

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
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
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	4
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	5
		(d) If applicable, describe analytical methods taking account of sampling strategy	5
		(e) Describe any sensitivity analyses	5
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	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	6
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	6
		(b) Report category boundaries when continuous variables were categorized	6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	
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	7-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	7-10
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	10

*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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Title Page

Perceived Stress in Chinese Patients with Coronary Heart Disease: A cross-sectional study

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ABSTRACT

Objective Studies have shown that chronic stress is closely linked to the occurrence and development of cardiovascular disease. To date, few studies have focused on perceived stress in coronary heart diseases (CHD) patients and the possible factors influencing the stress. This study aims to investigate the perceived stress of patients with CHD and determine the individual attributes closely associated with it.

Design A cross-sectional study.

Participates A total of 2215 CHD patients were enrolled and perceived stress was assessed with the Chinese version Perceived Stress Scale (CPSS). Participants were divided into 2 groups due to CPSS score and binary logistic regression was applied to analyze the factors that affected perceived stress level.

Results The mean CPSS score of Chinese patients with CHD was 27.16 ± 6.35 . Compared with participants who received senior middle school education or below, those with a university degree had a higher probability of high perceived stress (OR: 1.453, CI: 1.206-1.750); this difference was more evident in participants with a master or doctoral degree (OR: 1.928, CI: 1.290-2.882). Also engaging in mental labor (OR: 1.389, CI: 1.144-1.686), having children (OR: 2.226, CI: 1.098-4.515), and having a habit of risky alcohol consumption (OR:1.492, CI: 1.146-1.944) were associated with

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4 33 perceived stress.

5 34 **Conclusion:** Patients who had higher educational attainment, engaged in mental labor,
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7 had children, and had a habit of risky alcohol consumption were much easier to perceive
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9 the stress.
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13 38 **Keywords**

14 39 Perceived stress, Coronary heart disease, Influencing factor

15 40
16 41 **Word Count** 2979 words

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19 43 **Strengths and limitations of this study**

20 44 Few studies have focused on perceived stress in CHD patients and the identification of
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22 high perceived stress individuals.
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25 45 Utilize the PSS for the accurate identification of stress-sensitive individuals among
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27 patients with coronary heart disease.
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30 48 Given the cross-sectional nature of the study, we cannot infer causal relationships.
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51 INTRODUCTION

52 The incidence of coronary heart disease (CHD) has been rising steadily over the
53 past few decades and the resulting burden of disease is an issue faced by developed and
54 developing countries alike¹. Finding out the potential risk factors of coronary heart
55 disease and subsequent targeted treatment is a severe challenge. Recent studies
56 demonstrated that psychological and social factors play an important and independent
57 role in the development of coronary heart disease.²⁻⁴

58 Psychological stress (stress) refers to the psychological challenge or threat caused
59 by various triggering events or adverse life factors and usually manifests as emotional
60 discomfort, pain, or anguish⁵. Under normal circumstances, a dynamic equilibrium
61 exists between an organism and its external environment, and stress arises when this
62 equilibrium is upset or is self-perceived as upset⁶. Stress is believed to be closely linked
63 to the occurrence and development of cardiovascular disease, one of the most important
64 psychosomatic diseases⁷⁻⁸. Acute mental stress caused by sudden accidents or illness
65 may be a trigger for cardiac events such as myocardial ischemia or Takotsubo
66 cardiomyopathy.⁹⁻¹⁰ The process of seeking medical care for patients with an acute
67 coronary event could be another stressor itself.¹¹ Meanwhile if certain acute stress
68 becomes persistent, it will change to chronic stress. A meta-analysis¹² suggests that high
69 stress is associated with a moderately increased risk of incident CHD. The current
70 literature suggests that mental stress may cause over-activation of the autonomic
71 nervous system and elicit a stress response from the endocrine system, thereby inducing
72 endothelial dysfunction, ultimately triggering cardiovascular events.¹³⁻¹⁵ A latest
73 study¹⁶ revealed that the amygdala, a stress-sensitive structure, may increase the
74 incidence of cardiovascular diseases by improving the activity of the immune system,
75 which might be a possible mechanism. Stress-induced platelet bioactivity increase and
76 prolongation may also be involved in this process.¹⁷

77 It was also found that the process by which stressors exert their effects on an
78 organism is not linear; instead, it arises through interactions⁶. The actual effect of
79 chronic stress on different individuals depends on the stress they perceived. The stress
80 perceived by an individual reflects his/her subjective evaluation of the stressor and will

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4 81 partly depend on individual attributes. Studies have shown that different individuals
5 82 faced with identical stressors may perceive considerably different levels of stress, with
6 83 different effects on CHD occurrence and development, resulting in differences in the
7 84 severity or prognosis of CHD.¹⁸⁻¹⁹ Therefore, the accurate identification of individuals
8 85 who are more likely to perceive stress is of great significance for the precise assessment
9 86 and subsequent treatment of CHD.

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15 87 Assessments of psychological stress are generally performed using standard
16 88 psychological instruments. Commonly used questionnaires include the Perceived Stress
17 89 Scale (PSS), Stress Appraisal Measure (SAM), and Impact of Event Scale (IES). The
18 90 PSS is the most widely used scale to assess chronic stress because it is easy to
19 91 implement and does not require professional intervention during administration.
20 92 Developed by Cohen et al. in 1983²⁰, the PSS measures the dimensions of
21 93 uncontrollability and stressfulness, and assesses the stress levels of individuals based
22 94 on their subjective perceptions of stressors. It has been translated into many languages
23 95 and used widely in diverse populations around the world²¹⁻²⁷. Blumenthal et al.²⁸ have
24 96 used PSS as a tool to assess the chronic stress of CHD patients. The version most used
25 97 in Chinese populations is the Chinese Perceived Stress Scale (CPSS), which is a
26 98 simplified-Chinese version translated by Yang (2007)²⁹. The CPSS has demonstrated
27 99 good validity and reliability in a series of studies in different Chinese populations³⁰⁻³²,
28 100 especially in cardiac patients³³.

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43 101 Few studies published to date have utilized the CPSS for the accurate identification
44 102 of high perceived stress individuals among patients with CHD, and perceived stress
45 103 detection in the Chinese mainland population with CHD has not yet been reported. We,
46 104 therefore, analyzed the CPSS scores of patients who visited the cardiac rehabilitation
47 105 clinic at our hospital with the aim of investigating the self-perceived stress levels of
48 106 Chinese patients with CHD and determining the individual attributes closely associated
49 107 with perceived stress. The results of this study might help to stratify CHD patients
50 108 according to stress perception level and supply the individualized stress management
51 109 programs for Chinese populations with CHD.
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110 **METHODS**

111 *Study participants*

112 A cross-sectional study design was adopted. Using the electronic medical records
113 system of our hospital, we screened patients referred to the cardiac rehabilitation clinic
114 between 2015 and 2020. All patients in the inpatient department of cardiology were
115 recommended to the rehabilitation clinic regardless of whether they choose to receive
116 the following rehabilitation treatment or not. Only those with a definitive diagnosis of
117 CHD were included in the analysis. Based on the criteria of the CHD 2019 ESC
118 Guidelines for the Diagnosis and Management of Chronic Coronary Syndromes, the
119 inclusions were: one or more lesions with $\geq 50\%$ stenosis as shown by coronary
120 angiography; stable angina (SA); unstable angina (USA); old myocardial infarction
121 (OMI); acute myocardial infarction (AMI); post-percutaneous coronary intervention
122 (PCI); post-coronary artery bypass graft (CABG); or ischemic cardiomyopathy (IC).
123 Those who are unwilling to take the scale will be excluded.

124 *Demographic characteristics and medical history*

125 The demographic characteristics and medical history of the participants were
126 obtained from the cardiac rehabilitation medical records system and collated by a
127 cardiologist. The demographic characteristics analyzed included age, sex, region (south
128 /north, divided along the Qinling Mountains-Huaihe River line), educational level,
129 marital status, family structure (with/without children), nature of work (mental/manual
130 labor), the presence/absence of sleep disorders, and the following lifestyle factors:
131 regular exercise, risky alcohol consumption, and smoking. The medical history data
132 analyzed included a history of cardiac revascularization and the presence/absence of
133 other chronic diseases requiring long-term medication. Mental labor was defined as
134 professional, managerial, or administrative work generally performed in an office or
135 other administrative environment. Manual labor was defined as strenuous physical
136 work or other types of work demanding physical exertion. Regular exercise was defined
137 as ≥ 30 min of low-intensity exercise >5 times per week or ≥ 20 min of moderate-
138 intensity exercise >3 times per week. Sleep disorders were defined as the occurrence of

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4 139 at least one of the following ≥ 3 times per week for at least 1 month: inability to sleep
5 140 after 30 min in bed, waking up ≥ 2 times during the night, wake time $>15\%$, dreamful
6 141 sleep or total sleep time <6 hours, and waking up ≥ 2 hours ahead of schedule and
7 142 subsequently unable to get back to sleep. Risky alcohol consumption was defined as
8 143 the consumption of ≥ 5 alcoholic drinks on a single occasion >12 times in the past
9 144 year.³⁴

145 ***Stress assessment***

146 The perceived stress of the study participants was assessed using the CPSS, which
147 comprises 14 items intended to measure the dimensions of uncontrollability and
148 stressfulness. Each item is rated on a 5-point scale (0 = never, 1 = rarely, 2 = sometimes,
149 3 = fairly often, 4 = very often), with items 4, 5, 6, 7, 9, 10, and 13 scored in the reverse
150 direction. Total scores range from 0 to 56 points, with higher scores indicating higher
151 psychological stress.

152 In addition to the CPSS, all the participants were asked to complete the Patient
153 Health Questionnaire (PHQ-9) scale and the Generalized Anxiety Disorder (GAD-7)
154 scale to assess preexisting mental health comorbidities. The PHQ-9 is a self-rating scale
155 consisting of 9 items. A PHQ9 score greater than 5 indicates that the patient may be in
156 a mild or more depressive state. The GAD-7 is a 7-item self-rating scale indicating a
157 mild or more anxiety state when the score is greater than 5.

158 All the participants were asked to provide responses based on their own perceptions.
159 All patients who visited the cardiac rehabilitation clinic for the first time were requested
160 to complete the scales on their own after receiving instructions on questionnaire
161 completion from a nurse. The responses were collected and collated by a cardiologist.

162 ***Statistical analysis***

163 Statistical analysis was performed using SPSS 25.0. Quantitative variables were
164 tested for normality. Normally distributed variables were expressed as mean \pm standard
165 deviation ($x \pm s$); variables not normally distributed were expressed as median and
166 interquartile range (IQR). Qualitative data were expressed as ratios or percentages.
167 Factors associated with the CPSS scores of the study participants were analyzed from
168 binary logistic regression.

169 ***Patient and public involvement***

170 Public and patient involvement was not applicable in this research.

171 **RESULTS**

172 ***Demographic data of patients with CHD***

173 Of the 3845 patients referred to the cardiac rehabilitation clinic during the study
 174 period, 1630 patients were excluded, of which 1428 did not meet the inclusion criteria,
 175 and 202 refused to be evaluated by CPSS. Eventually, 2215 CHD patients were
 176 included in the study (**Figure 1**). The mean age of the study participants was $59.57 \pm$
 177 10.10 y, and the majority of the participants were male (79.64%), had a university
 178 degree or below (94.13%), married (99.05%), had children (97.97%), engaged in
 179 mental labor (69.07%), had sleep disorders (74.81%), and did not have a drinking habit
 180 (60.18%) Of the participants, 77.1% had previously undergone stent insertion, 56.2%
 181 had concomitant hypertension, 47.4% had concomitant hyperlipidemia, and 27% had
 182 concomitant diabetes mellitus (see **Table 1**).

183 Table 1 Social Demography Factors of the subjects

Social demography factor		n	%
age	<45	160	7.2
	45-64	1317	59.5
	65-84	727	32.8
	≥ 85	11	0.4
Gender	Male	1764	79.6
	Female	451	20.4
Region	North	1388	62.7
	South	827	37.3
Education level	Senior high school and below	1107	50.0
	College	978	44.2
	Above college	130	5.9
Having children	Yes	2170	98.0
	No	45	2.0

1				
2				
3				
4	Marital status	Married	2194	99.0
5				
6		Other (single, divorced, or widowed)	21	1.0
7	Occupation	Mental	1530	69.1
8				
9		Physical	685	30.9
10				
11	Regular exercise	Yes	1630	73.6
12				
13		No	585	26.4
14				
15	Risky alcohol drinking	Yes	298	13.5
16				
17		No	1917	86.5
18				
19	Current Smoker	Yes	334	15.1
20				
21		No	1881	84.9
22				
23	Comorbidity			
24				
25	Number of stent	0	508	22.9
26				
27		1	901	40.7
28				
29		2	462	20.9
30				
31		≥3	344	15.5
32				
33	Hypertension	Yes	1245	56.2
34				
35		No	970	43.8
36				
37	Hyperlipemia	Yes	1049	47.4
38				
39		No	1166	52.6
40				
41	Diabetes	Yes	598	27.0
42				
43		No	1617	73.0
44				
45	Cerebrovascular	Yes	39	1.8
46				
47	disease	No	2176	98.2
48				
49	Other diseases	Yes	119	7.1
50				
51		No	2096	92.9
52				
53	Sleep disorder	Yes	1657	74.8
54				
55		No	558	25.2
56				
57	Depressive state	Yes	817	36.9
58				
59		No	1398	63.1
60				

Anxiety state	Yes	1113	50.2
	No	1102	49.8

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185 ***Comparison of characteristics between groups***

186 The mean CPSS score of all the patients with CHD was 27.16 ± 6.35 . Using the
 187 median score of 27 as the cut-off point, the study participants were divided into a low
 188 perceived stress group (CPSS score ≤ 27) and a high perceived stress group (CPSS
 189 score >27). Yang et al.²⁹ conducted a CPSS assessment of the Chinese general
 190 population (n=3666), with an average score of 24.22 ± 5.811 . A summary independent-
 191 sample t-test proves that the CPSS scores of the two groups are statistically different (P
 192 = 0.000). Participants who had children, engaged in mental labor, or had a habit of risky
 193 alcohol consumption had a higher probability of experiencing higher stress perception
 194 levels. (see **Table 2**).

195 Table 2 Comparison of two groups with different CPSS scores

Characteristic	Categories	High-stress group (n=1190)		Low stress group (n=1025)		X ²	P value
		n	%	n	%		
		age	<45	89	7.5		
	45-64	709	59.6	608	59.3		
	65-84	386	32.4	341	33.3		
	≥ 85	6	0.5	5	0.5		
Gender	Male	966	81.2	798	77.9	3.750	0.053
	Female	224	18.8	227	22.1		
Education level	Senior high school and below	526	44.2	581	56.7	36.611	0.000
	College	578	48.6	400	39.0		
	Above college	86	7.2	44	4.3		

Having children	Yes	1173	98.6	997	97.3	4.698	0.030
	No	17	1.4	28	2.7		
Marital status	Married	1182	99.3	1012	98.7	2.083	0.149
	Other (single, divorced, or widowed)	8	0.7	13	1.3		
Occupation	Mental	881	74.0	649	63.3	29.605	0.000
	Physical	309	26.0	376	36.7		
Regular exercise	Yes	901	75.7	729	71.1	5.975	0.015
	No	289	24.3	296	28.9		
Risky alcohol drinking	Yes	188	15.8	110	10.7	12.141	0.000
	No	1002	84.2	915	89.3		
Current Smoker	Yes	182	15.3	152	14.8	0.093	0.760
	No	1008	84.7	873	85.2		
Number of stent	0	280	23.5	228	22.2	0.820	0.845
	1	486	40.8	415	40.5		
	2	243	20.4	219	21.4		
	≥ 3	181	15.2	163	15.9		
Chronic disease	Yes	965	81.1	831	81.1	0.000	0.991
	No	225	18.9	194	18.9		
Sleep disorder	Yes	889	74.7	768	74.9	0.014	0.905
	No	301	25.3	257	25.1		
Depressive state	Yes	626	52.6	487	47.5	5.713	0.017
	No	564	47.4	538	52.5		
Anxiety state	Yes	470	39.5	347	33.9	7.530	0.006
	No	720	60.5	678	66.1		

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197 ***Logistic regression***

198 Binary logistic regression analysis was performed in model 1 by setting the CPSS

score as the dependent variable and the following as the independent variables: age, sex, educational level, marital status, family structure (with/without children), nature of work (mental/manual labor), number of stents, and the presence/absence of sleep disorders, other chronic diseases, and the following habits: regular exercise, risky alcohol consumption, and smoking. Our results indicated that study participants who have children had a higher probability of high perceived stress, with the odds ratio (OR) being 2.226 (confidence interval [CI]: 1.098-4.515). Compared with participants who received middle school education or below, those with a university degree had a higher probability of high perceived stress (OR: 1.453, CI: 1.206-1.750); this was more evident in participants with a master or doctoral degree (OR: 1.928, CI: 1.290-2.882). Participants who engaged in mental labor had a higher probability of high perceived stress than those who engaged in manual labor (OR: 1.389, CI: 1.144-1.686). Compared with participants who did not have a habit of risky alcohol consumption, those who had this habit had a higher probability of high perceived stress (OR: 1.492, CI: 1.146-1.944). Model 2 was adjusted by GAD-7 and PHQ-9 scores, which has no major influence on the conclusion (see **Table 3**).

Table 3 Logistics regression of CPSS score

	Model 1*		Model 2**	
	OR(95%CI)	P value	OR(95%CI)	P value
Kid				
Yes	1.000		1.000	
No	2.226(1.098-4.515)	0.027	2.338(1.258-4.345)	0.007
Education level				
Senior high school and below	1.000		1.000	
College	1.453(1.206-1.750)	0.000	1.478(1.231-1.776)	0.000
Above college	1.928(1.290-2.882)	0.001	1.936(1.306-2.870)	0.001
Occupation				
Manual	1.000		1.000	

Mental	1.389(1.144-1.686)	0.001	1.394(1.149-1.690)	0.001
Risky alcohol drinking				
No	1.000	0.003	1.000	0.001
Yes	1.492 (1.146-1.944)		1.516(1.175-1.958)	

216 *Adjusted by age, sex, educational level, marital status, family structure (with/without
 217 children), nature of work (mental/manual labor), number of stents, and the
 218 presence/absence of sleep disorders, other chronic diseases, and the following habits:
 219 regular exercise, risky alcohol consumption, and smoking.

220 *Adjusted by age, sex, educational level, marital status, family structure
 221 (with/without children), nature of work (mental/manual labor), number of stents, and
 222 the presence/absence of sleep disorders, other chronic diseases, the following habits:
 223 regular exercise, risky alcohol consumption, and smoking, PHQ9 scores and GAD7
 224 scores. OR: Odds Ratio

226 DISCUSSION

227 The relationship between psychological stress and cardiovascular disease has
 228 attracted increasing attention in recent years. Considering that perceived stress may
 229 play some role in the occurrence and development of CHD, a greater emphasis has been
 230 placed on stress management in comprehensive cardiac rehabilitation programs
 231 because it may potentially provide benefits, such as improving the long-term prognosis
 232 of patients with CHD.²⁸ In this study, we investigated the stress perception level in the
 233 Chinese CHD population and explored the possible influencing factors associated with
 234 them. Our study suggested that patients with CHD in China had a relatively higher
 235 perceived stress level. In addition, we found that patients who had higher educational
 236 attainment, engaged in mental labor, had children, and had a habit of risky alcohol
 237 consumption were much easier to perceive the stress.

238 Analysis of the demographic characteristics of high-stress individuals among
 239 patients with CHD can support the clinical stratified management of patients according

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4 240 to the perceived stress level, which increases the efficiency of rehabilitation treatment
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6 241 and maximizes the clinical benefits to each individual. Previous studies have shown
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8 242 that demographic characteristics such as age, sex, educational level, marital status,
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10 243 family structure (with/without children), nature of work (mental/manual labor), the
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12 244 presence/absence of mental health comorbidities, sleep disorders, other chronic
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14 245 diseases, and the following habits: regular exercise, risky alcohol consumption, and
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16 246 smoking may have an impact on perceived stress,^{20, 24, 26, 33, 35-37} but the conclusion is
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18 247 not completely consistent. We also observed in the clinic that patients implanted with
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20 248 multiple stents tend to be more stressed.

21 249 Our results showed a strong correlation between perceived stress and educational
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23 250 level in Chinese patients with CHD. A higher educational level was associated with
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25 251 higher perceived stress. However, this result is contrary to the findings of studies
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27 252 conducted in other countries^{26, 38} which have indicated that individuals with lower
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29 253 educational attainment generally perceive higher stress. This may be attributed to the
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31 254 long-standing, strong emphasis on educational attainment in Chinese society, which has
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33 255 led to the general view that individuals with higher educational levels should attain
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35 256 greater personal achievements and bear greater social responsibilities and expectations.
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37 257 However, it is not clear whether this unique socio-cultural background has caused the
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39 258 aforementioned difference between Eastern and Western countries in the influence of
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41 259 educational level on perceived stress.

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43 260 The perceived stress level was also found to be strongly related to the nature of
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45 261 work in the Chinese population. Participants who engaged in mental labor had higher
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47 262 perceived stress than did those who engaged in manual labor. Such a result is not in
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49 263 complete agreement with the findings of previous studies. A survey by Lesage et al.²⁴
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51 264 revealed that differences in perceived stress among administrative, technical, and blue-
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53 265 collar workers were statistically insignificant. However, the 501 participants of
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55 266 Lesage's study were selected from individuals who attended occupational health
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57 267 centers in northern France, whereas the participants of our study had a greater diversity
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59 268 of occupations, including teachers, doctors, taxi drivers, and gardeners. The greater
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4 269 diversity of occupations included in our study provides a better reflection of the actual
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6 270 range of perceived stress across occupations, thereby helping the occupational factor to
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8 271 reach significance. Dédèlè et al.³⁹ performed a cross-sectional study on perceived stress
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10 272 among 571 full-time workers in Lithuania and found that blue-collar workers who spent
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12 273 relatively more time engaging in physical work had a higher risk of high perceived
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14 274 stress than white-collar workers, which appears to contradict our results. However, the
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16 275 distribution of perceived stress across occupations may depend on the social
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18 276 environment. With China's vast population, Chinese workers are often faced with
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20 277 complicated interpersonal relationships in their workplace. In general, workplace
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22 278 ecology is more complex among individuals engaged in mental labor than among
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24 279 manual workers, which may have partially contributed to the difference in perceived
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26 280 stress we observed between the two occupational categories.

27 281 The drinking habit of patients with CHD has also been identified as a potential
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29 282 factor associated with perceived stress. Our results indicated that participants with a
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31 283 habit of risky alcohol consumption had higher perceived stress. . These findings are
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33 284 consistent with those reported by Yoon et al.³⁶, who showed that the proportion of
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35 285 individuals with adverse drinking habits was higher in the population with high
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37 286 perceived stress than in the population with low perceived stress. Although the study
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39 287 by Yoon et al. did not investigate possible causal relationships between high stress and
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41 288 at-risk drinking, there is no doubt that patients with a habit of risky alcohol consumption
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43 289 can have higher perceived stress. Therefore, for such individuals, emphasis should be
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45 290 placed on appropriate stress interventions in the formulation of rehabilitation programs.

46 291 Interestingly, we also found that patients with CHD with children were nearly twice
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48 292 as likely to perceive the stress as those without children, which is consistent with the
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50 293 findings of Lesage et al.²⁴

51
52 294 Our results also showed that the perceived stress of patients with CHD was not
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54 295 correlated with age, sex, or marital status. There is no study to investigate the effect of
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56 296 these 3 factors on perceived stress levels, especially in CHD patients. For the general
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58 297 population, there are some inconsistent findings. A study by Andreou et al.³⁵ indicated
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60 298 that younger individuals, women, and single or divorced individuals may have higher

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4 299 perceived stress. Cohen et al.²⁰ reported that perceived stress was higher in women but
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6 300 unrelated to age; similar conclusions were reached in two other studies.⁴⁰⁻⁴¹ However,
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8 301 Dèdelè et al.³⁹ asserted that older individuals had higher perceived stress. A study by
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10 302 Leung et al.³³ indicated higher levels of perceived stress in women, but a contrary result
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12 303 was reported by Ojard et al.⁴² In summary, we have to say research on this matter is far
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14 304 from conclusive. And the inconsistency of our study with other precious ones might
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16 305 attribute to the disease type, difference in environmental and social background.

306 **LIMITATIONS**

307 This study has several limitations. First, we conducted the study in CHD patients
308 referred to the cardiac rehabilitation center in our hospital, which might bring
309 selection bias and the stress levels in the general population only had historical
310 control. Also, a multi-center study to further evaluate the CPSS score in CHD patients
311 and the general population all over China is ongoing. Second, when screening
312 influencing factors associated with the CPSS score, the variables we included might
313 not cover all the possible factors. The effect size should be interpreted with caution
314 due to the low variation of marital status and other potential missing covariates. Third,
315 our study didn't clarify whether the CPSS score would associate with the clinical
316 outcome of CHD patients, which might be a candidate topic we should investigate
317 further.

318 **CONCLUSIONS**

319 In conclusion, individuals who had higher educational attainment, engaged in mental
320 labor, had children and had a habit of risky alcohol consumption were much easier to
321 perceive the stress. The results of this study might help to stratify CHD patients
322 according to stress perception level and supply the individualized stress management
323 programs for Chinese populations with CHD.

324 **Contributors**

325
326 The study was initiated by JM and YX. YG performed the statistical analysis and
327 drafted the manuscript. RH, YZ, and MY were helpful for data collection. JM and YX
328 contributed substantially to its revision. JM and YX took responsibility for the
329 manuscript as a whole.

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Competing interests

None declared.

Patient consent for publication

Not required.

Ethics approval

This study was approved by the ethics committee of the Chinese PLA General Hospital(S2020-382-01)

Data availability statement

Data are available upon reasonable request. Given that the data is in Chinese, complete raw data are not available for sharing. Partial data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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492 Figure 1 Flow diagram of the participants

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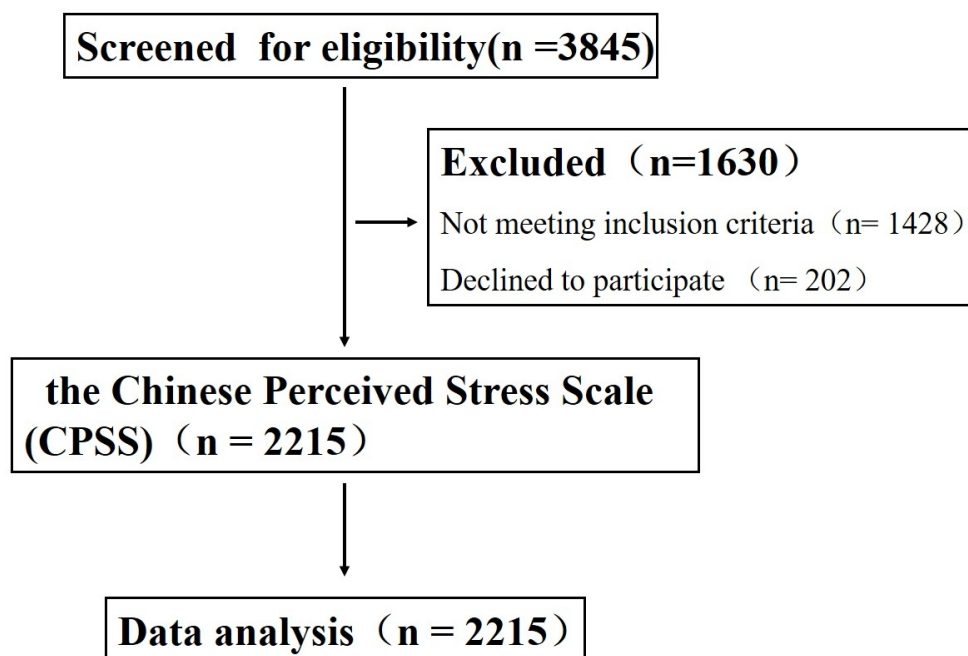


Figure 1 Flow diagram of the participants

203x136mm (150 x 150 DPI)

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
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
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	4
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	5
		(d) If applicable, describe analytical methods taking account of sampling strategy	5
		(e) Describe any sensitivity analyses	5
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	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	6
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	6
		(b) Report category boundaries when continuous variables were categorized	6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	
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	7-10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	7-10
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	10

*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.