Perceived stress in Chinese patients with coronary heart disease: a cross-sectional study

Yifan Gao, Rong Hu, Yinyue Zhang, Menghan Yuan, Yong Xu, Jing Ma

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 disease (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.

Participants A total of 2215 patients with CHD were enrolled and perceived stress was assessed with the Chinese version Perceived Stress Scale (CPSS). Participants were divided into two groups due to CPSS score and binary logistic regression was applied to analyse 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, 95% CI 1.206 to 1.750); this difference was more evident in participants with a master or doctoral degree (OR 1.928, 95% CI 1.290 to 2.882). Also engaging in mental labour (OR 1.389, 95% CI 1.144 to 1.686), having children (OR 2.226, 95% CI 1.098 to 4.515) and having a habit of risky alcohol consumption (OR 1.492, 95% CI 1.146 to 1.944) were associated with perceived stress.

Conclusion Patients who had higher educational attainment, engaged in mental labour, had children, and had a habit of risky alcohol consumption were much easier to perceive the stress.

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. Finding out the potential risk factors of CHD and subsequent targeted treatment is a severe challenge. Recent studies demonstrated that psychological and social factors play an important and independent role in the development of CHD. 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. 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. Stress is believed to be closely linked to the occurrence and development of cardiovascular disease, one of the most important psychosomatic diseases. Acute mental stress caused by sudden accidents or illness may be a trigger for cardiac events such as myocardial ischaemia or Takotsubo cardiomyopathy. The process of seeking medical care for patients with an acute coronary event could be another stressor itself. Meanwhile if certain acute stress becomes persistent, it will change to chronic stress. A meta-analysis suggests that high stress is associated with a moderately increased risk of incident CHD. The current literature suggests that mental 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. A latest study revealed that the amygdala, a stress-sensitive structure, may increase the incidence of cardiovascular diseases by improving the activity of the immune system, which might
be a possible mechanism. Stress-induced platelet bioactivity increase and prolongation may also be involved in this process.\textsuperscript{12}

It was also found that the process by which stressors exert their effects on an organism is not linear; instead, it arises through interactions.\textsuperscript{8} The actual effect of chronic stress on different individuals depends on the stress they perceived. 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 CHD.\textsuperscript{18,19} Therefore, the accurate identification of individuals who are more likely to perceive stress 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, and Impact Scale. The PSS is the most widely used scale to assess chronic stress because it is easy to implement and does not require professional intervention during administration. Developed by Cohen \textit{et al.}, the PSS measures the dimensions of uncontrollability and stressfulness, and assesses the stress levels of individuals based on their subjective perceptions of stressors. It has been translated into many languages and used widely in diverse populations around the world.\textsuperscript{21–27} Blumenthal \textit{et al.}\textsuperscript{28} have used PSS as a tool to assess the chronic stress of patients with CHD. The version most used in Chinese populations is the Chinese PSS (CPSS), which is a simplified-Chinese version translated by Yang \textit{et al.}\textsuperscript{29} The CPSS has demonstrated good validity and reliability in a series of studies in different Chinese populations,\textsuperscript{30–32} especially in cardiac patients.\textsuperscript{33}

Few studies published to date have used the CPSS for the accurate identification of high perceived stress individuals among patients with CHD, and perceived stress detection in the Chinese mainland population with CHD has not yet been reported. We, therefore, analysed the CPSS scores of patients who visited the cardiac rehabilitation clinic at our hospital with the aim of investigating the self-perceived stress levels of Chinese patients with CHD and determining the individual attributes closely associated with perceived stress. The results of this study might help to stratify patients with CHD according to stress perception level and supply the individualised stress management programmes for Chinese populations with CHD.

**METHODS**

**Study participants**

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

**Demographic characteristics and medical history**

The demographic characteristics and medical history of the participants were obtained from the cardiac rehabilitation medical records system and collated by a cardiologist. The demographic characteristics analysed included age, sex, region (south /north, divided along the Qinling Mountains-Huaihe River line), educational level, marital status, family structure (with/without children), nature of work (mental/manual labour), the presence/absence of sleep disorders, and the following lifestyle factors: regular exercise, risky alcohol consumption and smoking. The medical history data analysed included a history of cardiac revascularisation and the presence/absence of other chronic diseases requiring long-term medication. Mental labour was defined as professional, managerial, or administrative work generally performed in an office or other administrative environment. Manual labour was defined as strenuous physical work or other types of work demanding physical exertion. Regular exercise was defined as $\geq 30$ min of low-intensity exercise $>5$ times per week or $\geq 20$ min of moderate-intensity exercise $>3$ times per week. Sleep disorders were defined as the occurrence of at least one of the following $\geq 3$ times per week for at least 1 month: inability to sleep after 30 min in bed, waking up $\geq 2$ times during the night, wake time $>15\%$, dreamful sleep or total sleep time $<6$ hours and waking up $\geq 2$ hours ahead of schedule and subsequently unable to get back to sleep. Risky alcohol consumption was defined as the consumption of $\geq 5$ alcoholic drinks on a single occasion $>12$ times in the past year.\textsuperscript{34}

**Stress assessment**

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

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

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

**Statistical analysis**
Statistical analysis was performed using SPSS V.25.0. Quantitative variables were tested for normality. Normally distributed variables were expressed as mean±SD (x±s); variables not normally distributed were expressed as median and IQR. Qualitative data were expressed as ratios or percentages. Factors associated with the CPSS scores of the study participants were analysed from binary logistic regression.

**Patient and public involvement**
Public and patient involvement was not applicable in this research.

**RESULTS**
**Demographic data of patients with CHD**
Of the 3845 patients referred to the cardiac rehabilitation clinic during the study period, 1630 patients were excluded, of which 1428 did not meet the inclusion criteria, and 202 refused to be evaluated by CPSS. Eventually, 2215 patients with CHD were included in the study (figure 1). The mean age of the study participants was 59.57±10.10 years, and the majority of the participants were male (79.6%), had a university degree or below (94.1%), married (99.1%), had children (98.0%), engaged in mental labour (69.1%), had sleep disorders (74.8%) and did not have a risky drinking habit (86.5%). Of the participants, 77.1% had previously undergone stent insertion, 56.2% had concomitant hypertension, 47.4% had concomitant hyperlipidaemia and 27.0% had concomitant diabetes mellitus (see table 1).

**Comparison of characteristics between groups**
The mean CPSS score of all the patients with CHD was 27.16±6.35. Using the median score of 27 as the cut-off point, the study participants were divided into a low perceived stress group (CPSS score ≤27) and a high perceived stress group (CPSS score >27). Yang et al conducted a CPSS assessment of the Chinese general population (n=3666), with an average score of 24. 22±5. 81. A summary independent-sample t-test proves that the CPSS scores of the two groups are statistically different (p=0.000). Participants who had children, engaged in mental labour, or had a habit of risky alcohol consumption had a higher probability of experiencing higher stress perception levels (see table 2).

**Logistic regression**
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 labour), 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 OR being 2.226 (95% CI 1.098 to 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, 95% CI 1.206 to 1.750); this was more evident in participants with a master or doctoral degree (OR 1.928, 95% CI 1.290 to 2.882). Participants who engaged in mental labour had a higher probability of high perceived stress than those who engaged in manual labour (OR 1.389, 95% CI 1.144 to 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, 95% CI 1.146 to 1.944). Model 2 was adjusted by GAD-7 and PHQ-9 scores, which has no major influence on the conclusion (see table 3).

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

Analysis of the demographic characteristics of high-stress individuals among patients with CHD can support the clinical stratified management of patients according to the perceived stress level, which increases the efficiency of rehabilitation treatment and maximises the clinical benefits to each individual. Previous studies have shown that demographic characteristics such as age, sex, educational level, marital status, family structure (with/without children), nature of work (mental/manual labour), the presence/absence of mental health comorbidities, sleep disorders, other chronic diseases and the following habits: regular exercise, risky alcohol consumption and smoking may have an impact on perceived stress, but the conclusion is not completely consistent. We also observed in the clinic that patients implanted with multiple stents tend to be more stressed.

Our results showed a strong correlation between perceived stress and educational level in Chinese patients with CHD. A higher educational level was associated with higher perceived stress. However, this result is contrary to the findings of studies conducted in other countries, which have indicated that individuals with lower educational attainment generally perceive higher stress. This may be attributed to the long-standing, strong emphasis on educational attainment in Chinese society, which has led to the general view that individuals with higher perceived stress.

The perceived stress level was also found to be strongly correlated with the nature of work in the Chinese population. Participants who engaged in mental labour had higher perceived stress than did those who engaged in manual labour. Such a result is not in complete agreement with the findings of previous studies. A survey by Lesage et al. revealed that differences in perceived stress among administrative, technical and blue-collar workers were statistically insignificant. However, the 501 participants of Lesage’s study were selected from individuals who attended occupational health centres in northern France, whereas the participants of our study had a greater diversity of occupations, including teachers, doctors, taxi drivers and gardeners. The greater diversity of occupations included in our study provides a better reflection of the actual range of perceived stress across occupations, thereby helping the occupational factor to reach

### 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| 99.1|
| Other (single, divorced or widowed) | 21 | 0.9|
| **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**          |    |     |
| No 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|
| Hyperlipaemia            |    |     |
| 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 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|
significance. Dėdelė et al performed a cross-sectional study on perceived stress among 571 full-time workers in Lithuania and found that blue-collar workers who spent relatively more time engaging in physical work had a higher risk of high perceived stress than white-collar workers, which appears to contradict our results. However, the distribution of perceived stress across occupations may depend on the social environment. With China’s vast population, Chinese workers are often faced with complicated interpersonal relationships in their workplace. In general, workplace ecology is more complex among individuals engaged in mental labour than among manual workers, which may have partially contributed to the difference in perceived stress we observed between the two occupational categories.

The drinking habit of patients with CHD has also been identified as a potential factor associated with perceived stress. Our results indicated that participants with a habit of risky alcohol consumption had higher perceived stress. These findings are consistent with those reported by Yoon

| Characteristics | Categories | High-stress group (n=1190) | Low stress group (n=1025) | X²  | P value |
|-----------------|------------|-----------------------------|---------------------------|-----|---------|
| Age             | <45        | 89 7.5                      | 71 6.9                    | 0.358 | 0.949   |
| Age             | 45–64      | 709 59.6                    | 608 59.3                  | 3.750 | 0.053   |
| Age             | 65–84      | 386 32.4                    | 341 33.3                  | 36.611 | 0.000   |
| Age             | ≥85        | 6 0.5                       | 5 0.5                     |       |         |
| Gender          | Male       | 966 81.2                    | 798 77.9                  | 3.750 | 0.053   |
| Gender          | Female     | 224 18.8                    | 227 22.1                  |       |         |
| Education level | Senior high school and below | 526 44.2                   | 581 56.7                  | 39.611 | 0.000   |
| Education level | College    | 578 48.6                    | 400 39.0                  |       |         |
| Education level | Above college | 86 7.2                     | 44 4.3                    |       |         |
| Having children | Yes        | 1173 98.6                   | 997 97.3                  | 4.698 | 0.030   |
| Having children | No         | 17 1.4                      | 28 2.7                    |       |         |
| Marital status  | Married    | 1182 99.3                   | 1012 98.7                 | 2.083 | 0.149   |
| Marital status  | Other (single, divorced or widowed) | 8 0.7                     | 13 1.3                    |       |         |
| Occupation      | Mental     | 881 74.0                    | 649 63.3                  | 29.605 | 0.000   |
| Occupation      | Physical   | 309 26.0                    | 376 36.7                  |       |         |
| Regular exercise| Yes        | 901 75.7                    | 729 71.1                  | 5.975 | 0.015   |
| Regular exercise| No         | 289 24.3                    | 296 28.9                  |       |         |
| Risky alcohol drinking | Yes   | 188 15.8                    | 110 10.7                  | 12.141 | 0.000   |
| Risky alcohol drinking | No   | 1002 84.2                   | 915 89.3                  |       |         |
| Current smoker  | Yes        | 182 15.3                    | 152 14.8                  | 0.093 | 0.760   |
| Current smoker  | No         | 1008 84.7                   | 873 85.2                  |       |         |
| No of stent     | 0          | 280 23.5                    | 228 22.2                  | 0.820 | 0.845   |
| No of stent     | 1          | 486 40.8                    | 415 40.5                  |       |         |
| No of stent     | 2          | 243 20.4                    | 219 21.4                  |       |         |
| No of stent     | ≥3         | 181 15.2                    | 163 15.9                  |       |         |
| Chronic disease | Yes        | 965 81.1                    | 831 81.1                  | 0.000 | 0.991   |
| Chronic disease | No         | 225 18.9                    | 194 18.9                  |       |         |
| Sleep disorder  | Yes        | 889 74.7                    | 768 74.9                  | 0.014 | 0.905   |
| Sleep disorder  | No         | 301 25.3                    | 257 25.1                  |       |         |
| Depressive state| Yes        | 626 52.6                    | 487 47.5                  | 5.713 | 0.017   |
| Depressive state| No         | 564 47.4                    | 538 52.5                  |       |         |
| Anxiety state   | Yes        | 470 39.5                    | 347 33.9                  | 7.530 | 0.006   |
| Anxiety state   | No         | 720 60.5                    | 678 66.1                  |       |         |

CPSS, Chinese version Perceived Stress Scale.
et al. who showed that the proportion of individuals with adverse drinking habits was higher in the population with high perceived stress than in the population with low perceived stress. Although the study by Yoon et al. did not investigate possible causal relationships between high stress and at-risk drinking, there is no doubt that patients with a habit of risky alcohol consumption can have higher perceived stress. Therefore, for such individuals, emphasis should be placed on appropriate stress interventions in the formulation of rehabilitation programmes.

Interestingly, we also found that patients with CHD with children were nearly twice as likely to perceive the stress as those without children, which is consistent with the findings of Lesage et al.24 Our results also showed that the perceived stress of patients with CHD was not correlated with age, sex or marital status. There is no study to investigate the effect of these three factors on perceived stress levels, especially in patients with CHD. For the general population, there are some inconsistent findings. A study by Andreou et al.35 indicated that younger individuals, women, and single or divorced individuals may have higher perceived stress. Cohen et al.20 reported that perceived stress was higher in women but unrelated to age; similar conclusions were reached in two other studies.40 41 However, Dédélé et al.89 asserted that older individuals had higher perceived stress. A study by Leung et al.43 indicated higher levels of perceived stress in women, but a contrary result was reported by Ojard et al.42 In summary, we have to say research on this matter is far from conclusive. And the inconsistency of our study with other previous ones might attribute to the disease type, difference in environmental and social background.

**LIMITATIONS**

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

**CONCLUSIONS**

In conclusion, individuals who had higher educational attainment, engaged in mental labour, had children and had a habit of risky alcohol consumption were much easier to perceive the stress. The results of this study might help to stratify patients with CHD according to stress perception level and supply the individualised stress intervention.

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**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 to 4.515) | 0.027 | 2.338 (1.258 to 4.345) | 0.007 |
| Education level          |          |          |
| Senior high school and below | 1.000   |          | 1.000       |          |
| College                  | 1.453 (1.206 to 1.750) | 0.000 | 1.478 (1.231 to 1.776) | 0.000 |
| Above college            | 1.928 (1.290 to 2.882) | 0.001 | 1.936 (1.306 to 2.870) | 0.001 |
| Occupation               |          |          |
| Manual                   | 1.000    |          | 1.000       |          |
| Mental                   | 1.389 (1.144 to 1.686) | 0.001 | 1.394 (1.149 to 1.690) | 0.001 |
| Risky alcohol drinking   |          |          |
| No                       | 1.000    | 0.003    | 1.000       | 0.001   |
| Yes                      | 1.492 (1.146 to 1.944) |          | 1.516 (1.175 to 1.958) |          |

*Adjusted by age, sex, educational level, marital status, family structure (with/without children), nature of work (mental/manual labour), number of stents and the presence/absence of sleep disorders, other chronic diseases and the following habits: regular exercise, risky alcohol consumption and smoking.
†Adjusted by age, sex, educational level, marital status, family structure (with/without children), nature of work (mental/manual labour), number of stents and the presence/absence of sleep disorders, other chronic diseases, the following habits: regular exercise, risky alcohol consumption, and smoking, PHQ-9 scores and GAD-7 scores.

CPSS, Chinese version Perceived Stress Scale; GAD-7, Generalised Anxiety Disorder 7; PHQ9, Patient Health Questionnaire 9.
management programmes for Chinese populations with CHD.

Contributors The study was initiated by JM and YX. YG performed the statistical analysis and drafted the manuscript. RH, YZ and MY were helpful for data collection. JM and YX contributed substantially to its revision. JM is the guarantor of this work.

Funding The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article. This work was supported by the National Key R&D Program of China (2018YFC0906000).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

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

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on 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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ORCID iD Yitan Gao http://orcid.org/0000-0001-9922-0107

REFERENCES

1. H, Much AA, Maor E. Global, regional, and national burden of ischemic heart disease and its attributable risk factors, 1990-2017: results from the global burden of disease study 2017. Euro Heart J 2020.
2. Rosengren A, Hawken S, Ounpuu S, et al. Association of psychosocial risk factors with risk of acute myocardial infarction in 11119 cases and 13648 controls from 52 countries (the INTERHEART study): case-control study. Lancet 2004;364:953–62.
3. Iso H, Date C, Yamamoto A, et al. Perceived mental stress and mortality from cardiovascular disease among Japanese men and women: the Japan collaborative cohort study for evaluation of cancer risk sponsored by Mombusho (JACC study). Circulation 2002;106:1229–36.
4. Rozanski A, Blumenthal JA, Davidson KW, et al. The epidemiology, pathophysiology, and management of psychosocial risk factors in cardiac practice: the emerging field of behavioral cardiology. J Am Coll Cardiol 2005;45:637–51.
5. Chauvet-Gelinier J-C, Bonin B. Stress, anxiety and depression in heart disease patients: a major challenge for cardiac rehabilitation. Ann Phys Rehabil Med 2017;60:5–12.
6. Chrousos GP. Stress and disorders of the stress system. Nat Rev Endocrinol 2009;5:374–81.
7. Guillete EC, Blumenthal JA, Babayik M, et al. Effects of mental stress on myocardial ischemia during daily life. JAMA 1997;277:1521–6.
8. Esler M. Mental stress and human cardiovascular disease. Neurosci Biobehav Rev 2017;74:269–76.
9. Pelliccia F, Kaski JC, Crea F, et al. Pathophysiology of takotsubo syndrome. Circulation 2017;135:2426–41.
10. Hammadah M, Sullivan S, Pearce B, et al. Inflammatory response to mental stress and mental stress induced myocardial ischemia. Brain Behav Immun 2018;68:90–7.
11. Liyanage-Del NA, Edelman DS, Chang BP, et al. Associations between emergency department crowding and perceptions of interpersonal care in patients presenting with suspected acute coronary syndrome. Emerg Med J 2022;39:210493.
12. Richardson S, Shaffer JA, Falzon L, et al. Meta-analysis of perceived stress and its association with incident coronary heart disease. Am J Cardiol 2012;110:1711–6.
13. Golbold S, Fritsche JC, Oliviier L. Chronic stress impacts the cardiovascular system: animal models and clinical outcomes. Am J Physiol Heart Circ Physiol 2015;308:H1476–98.
14. Aschbacher K, Milush JM, Gilbert A, et al. Chronic stress is associated with reduced circulating hematopoietic progenitor cell number: a maternal caregiving model. Brain Behav Immun 2017;59:245–52.
15. Sugar LD, Geddie H, Olivier L, et al. Chronic stress and endothelial dysfunction: mechanisms, experimental challenges, and the way ahead. Am J Physiol Heart Circ Physiol 2020;319:H488–506.
16. Tawakol A, Ishai A, Takx RA, et al. Relation between resting amygdalar activity and cardiovascular events: a longitudinal and aromt study. Lancet 2017;389:834–45.
17. Koudouvoth-Tripp P, Hübner K, Egeter J, et al. Stress enhances proinflammatory platelet activity: the impact of acute and chronic mental stress. J Neuroimmune Pharmacol 2021;16:500–12.
18. Godoy LD, Rossignoli MT, Delfino-Pereira P, et al. A comprehensive overview on stress neurobiology: basic concepts and clinical implications. Front Behav Neurosci 2018;12:127.
19. Xu X, Bao H, Strat KM, et al. Perceived stress after acute myocardial infarction: a comparison between young and middle-aged women versus men. Psychosom Med 2017;79:50–8.
20. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav 1983;24:385.
21. Mimura G, Griffiths P A Japanese version of the perceived stress scale: translation and preliminary test. Int J Nurs Stud 2004;41:379–85.
22. Katsarou A, Panagiotakos D, Zafeiropoulou A, et al. Validation of a Greek version of PSS-14: a global measure of perceived stress. Cent Eur J Public Health 2012;20:104–9.
23. Almadi T, Cathers I, Hamdan Mansour AM, et al. An Arabic version of the perceived stress scale: translation and validation study. Int J Nurs Stud 2012;49:84–9.
24. Lesage F-X, Benjot S, Deschamps F. Psychometric properties of the French versions of the perceived stress scale. Int J Occup Med Environ Health 2012;25:178–84.
25. Lee E-H, Chung BY, Suh C-H, et al. Korean versions of the perceived stress scale (PSS-14, 10 and 4): psychometric evaluation in patients with chronic disease. Scand J Caring Sci 2015;29:183–92.
26. Klein EM, Brähler E, Dreier M, et al. The German version of the perceived stress scale – psychometric characteristics in a representative German community sample. BMC Psychiatry 2016;16:169.
27. Kaya C, Tansey TN, Melekgolu M, et al. Psychometric evaluation of Turkish version of the perceived stress scale with Turkish college students. J Ment Health 2019;28:161–7.
28. Blumenthal JA, Sherwood A, Smith PJ, et al. Enhancing cardiac rehabilitation with stress management training: a randomized, clinical efficacy study. Circulation 2016;133:1341–50.
29. Yang TZ, Huang JJ, XJ W. An epidemiologic study among urban residents in social transition period. Chinese J Behav Med Brain Sci 2007;16:331–47.
30. Huang F, Wang H, Wang Z, et al. Psychometric properties of the perceived stress scale in a community sample of Chinese. BMC Psychiatry 2020;20:130.
31. She Z, Li D, Zhang W, et al. Three versions of the perceived stress scale: psychometric evaluation in a nationally representative sample of Chinese adults during the COVID-19 pandemic. Int J Environ Res Public Health 2021;18:8312.
32. Lu W, Bian Q, Wang W, et al. Chinese version of the perceived stress scale-10: a psychometric study in Chinese university students. PLoS One 2017;12:e0189543.
33. Leung DYP, Lam T-hing, Chan SSC. Three versions of perceived stress scale: validation in a sample of Chinese cardiac patients who smoke. BMC Public Health 2010;10:513.
34. Coups EJ, Ostroff JS. A population-based estimate of the prevalence of behavioral risk factors among adult cancer survivors and noncancer controls. Prev Med 2005;40:702–11.
35. Andreou E, Alexopoulos EC, Lions C, et al. Perceived stress scale: reliability and validity study in Greece. Int J Environ Res Public Health 2011;8:3287–98.
36. Yoon S-J, Kim H-J, Doo M. Association between perceived stress, alcohol consumption and obesity in Koreans. Asia Pac J Clin Nutr 2016;25:316–25.
37. Malik AO, Peri-Okonny P, Gosch K, et al. Association of perceived stress levels with long-term mortality in patients with peripheral artery disease. JAMA Netw Open 2020;3:e208741.
38. Hernandez R, Allen NB, Liu K, et al. Association of depressive symptoms, trait anxiety, and perceived stress with subclinical atherosclerosis: results from the Chicago healthy aging study (CHAS). Prev Med 2014;61:54–60.
39. Didek A, Milkinsky A, Andružkaitytė S, et al. Perceived stress among different occupational groups and the interaction with sedentary behaviour. Int J Environ Res Public Health 2019;16:1625.
40 Avila-Palencia I, de Nazelle A, Cole-Hunter T, et al. The relationship between bicycle commuting and perceived stress: a cross-sectional study. BMJ Open 2017;7:e13542.

41 Nitsch KP, Miskovic A, Rodichok B. Measurement characteristics of the perceived stress scale in individuals with spinal cord injury. Arch Phys Med Rehabil 2016;97:1219–20.

42 Ojard C, Donnelly JP, Safford MM, et al. Psychosocial stress as a risk factor for sepsis: a population-based cohort study. Psychosom Med 2015;77:93–100.