



# The influence of perceived stress and income on mental health in China and Germany

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## ABSTRACT

**Background:** Mental health issues affect rich and poor, young and old, and are widespread in Asia as well as in Europe. However, few studies have investigated the influence of perceived stress and income on mental health among general population in China and in Germany.

**Methods:** We conducted an online survey from December 2021 to February 2022 to investigate how perceived stress and income affect mental health among the general population in China (N = 1123) and in Germany (N = 1018). Accordingly, we used the 10-item Perceived Stress Scale (PSS-10) and the 12-item General Health Questionnaire (GHQ-12). We ran a multiple linear regression model to investigate the relationship between perceived stress, income, and mental health.

**Results:** Overall, we found that 53.4% participants reported mental health issues (GHQ-12 score  $\geq 12$ ). The proportion of our sample who reported mental health issues was higher in Germany (60.3%) than in China (44.8%). The regression model revealed that a higher perceived stress score was associated with more mental health issues in both countries ( $b = 0.60, p < 0.01$ ). Individuals with a low income reported poorer mental health in Germany than those in China. Interestingly, the situation was reversed when incomes were high: individuals with a high income reported worse mental health in China than in Germany ( $b = -0.40, p < 0.01$ ).

**Conclusion:** Perceived stress has a negative impact on mental health, while income has differential effects. Mental health promotion programmes may involve teaching stress management, while considering differences in mental health outcomes in developed and developing countries.

## 1. Introduction

There is no health without mental health especially during the era of the Coronavirus disease 2019 (COVID-19) [1]. Countries

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worldwide have turned their attention toward mental health. Characteristics of mental health vary from developing to developed country [2]. China and Germany represent developing and developed countries: China is the largest developing country with a population of more than 1.4 billion, while Germany is one of the most developed countries in Europe. According to a cross-sectional epidemiological study of mental disorders in China, the 12-month prevalence of mental disorders was 9.3%, and lifetime prevalence was 16.6% [3]. The treatment rates of mental disorders in China are low, only 9.5% of participants in a survey with 12-month depressive disorders were treated in any treatment sector [4]. There is a lack of access to mental health services [5]. China has attached great importance to caring for mental disorders in recent years. During COVID-19, research and policies on mental health in China kept emerging [6–9]. In Germany, the 12-month prevalence of mental disorders was around 30%, while lifetime prevalence was even higher [10–12]. Despite community-based mental health care [13], many people in Germany still need mental health care as 26% of people seek help for their mental health [14]. Both China and Germany are facing these challenges and looking for ways to promote mental health [15,16]. Cross-cultural studies can reveal new perspectives of mental health service. Previous cross-cultural studies between China and Germany have investigated happiness, obesity, vegetarian diet and mental health [17–19]. They found that obesity was significantly associated with later depression and anxiety only in male participants in China but not in Germany, which highlights the cross-cultural differences in mental health outcome [18].

According to the World Health Organization's definition, mental health is a state of well-being, rather than the mere absence of mental disorders [20]. Although other definitions of mental health exist [21], there is no doubt that mental health is a comprehensive concept. For informative assessments of mental health in the general population, medical practitioners or researchers usually use screening tools. For example, the 12-item General Health Questionnaire (GHQ-12) is widely used all over the world [22,23]. The assessment using the GHQ-12 contains multiple aspects, such as sleep, feeling strained, concentration, overcoming difficulties, feeling unhappy etc. Such a non-specific tool comprehensively reflects the mental health status.

Our mental health is impacted by a number of factors, such as lifestyle, coping strategies, stress, social support, socioeconomic status and so on [24–26]. Among them, stress may play a key role and interact with other factors [24,27,28]. Stress contributes to a series of physiological diseases like cardiovascular disease and cancer [29]. Several studies have investigated the positive correlation between stress and depression and anxiety [28–30]. Previous studies on stress and mental health have mainly focused on university students, young adults or specific populations like health care workers [24,27,31]. As mental health is a comprehensive concept, the influence of stress on mental health, rather than on any single disease, is probably widely disseminated among general population. Besides, stress is considered as a universal key factor related to mental health throughout developing countries like China and developed countries like Germany [32,33].

A number of studies indicate that people with a higher income have better mental health outcomes [34,35]. Given that wealth is unevenly distributed around the world, the relationship between income and mental health is not the same everywhere. In developing countries, the relationship between income and mental health can be complicated. As China is a developing country, the economy is undergoing a period of growth and people's incomes are rising. On the one hand, the increase of income may lead to better mental health outcomes. On the other hand, the work overload and the pressure behind economic growth might be associated with psychological distress [36]. In developed countries with advanced economies, the average income is higher. The Gutenberg Health Study in Germany revealed that lower household net-income predicts the occurrence of depressive symptoms [37]. However, another longitudinal study in Germany showed no significant association between income and morbidity, which included mental illness [38].

Thus, from one society to another, mental health and its influence factors have common characteristics (e.g., stress) and differing features (e.g., income). Here, we carried out a cross-cultural survey among the general population in China and Germany to capture the characteristics of mental health and its impact factors. In this study, we used the GHQ-12 as a measure for mental health issues. We hypothesize that perceived stress and income will influence mental health. Perceived stress will have a negative impact on mental health in China and Germany. However, income will have different impacts on mental health in China compared to Germany, due to differing features of developing and developed countries.

## 2. Materials and methods

### 2.1. Participants and procedure

We conducted a cross-sectional Sino-German study to assess mental health in general and perceived stress among general population in China and Germany. The study was implemented through an online survey with a Chinese version on the Wenjuanxing platform (<https://www.wjx.cn>) and a Germany version on the Unipark platform (<https://www.unipark.com/en/>). Social media, advertisements, newsletters, and Prolific (<https://www.prolific.co>) were used to recruit participants. Participants aged 18 and above from China and Germany were eligible to take part in the survey with no other inclusion criteria. After giving informed consent online, participants filled in the online survey anonymously. The online survey was carried out from December 2021 to February 2022. Participants only took part in the survey once. In the end, 1123 participants from China and 1018 participants from Germany completed the online survey.

The study was approved by the ethics committees from both China and Germany, i.e., Ethics Committee of Shanghai Mental Health Center (ref: 2021ky-15), Ethics Committee of Charité – Universitätsmedizin Berlin (ref: EA2/143/20), and Ethics Committee of Freie Universität Berlin (ref: 030/2022). The investigation was carried out in accordance with the latest version of the Declaration of Helsinki.

## 2.2. Measurement

In the online survey, we asked for socio-demographic information (i.e., sex, age, marital status, years of education, employment status, and income). Marital status was classified according to five categories: single, in a relationship, married/civil partnership, separated/divorced/dissolution, and widowed. Employment status was categorized into two categories: employed and unemployed. Respondents reported their annual net income based on 6 income levels in China (¥0-¥7,000; ¥7,001-¥16,000; ¥16,001-¥25,000; ¥25,001-¥39,000; ¥39,000-¥76,000; >¥76,000) according to China Statistic Year Book 2020 [39] and in Germany (€0-€9,999; €10,000-€24,999; €25,000-€74,999; €75,000-€124,999; €125,000-€174,999; and > €175,000) according to a previous study [40].

Moreover, we assessed participants' perceived stress and mental health by using the 10-item Perceived Stress Scale (PSS-10) [41] in Chinese [42] and in German [43], and the GHQ-12 [22] in Chinese [44] and in German [45], respectively. The PSS-10 consists of 10 items, generating a total score ranging from 10 to 50, with higher scores indicating higher levels of perceived stress [41]. The GHQ-12 consists of 12 items, each of which is scored using the Likert scoring method (0-1-2-3). Total scores range from 0 to 36 with a higher score indicating worse mental health [46]. In this study, we used GHQ-12  $\geq$  12 as a threshold score to identify participants with mental health issues according to previous studies [27,47].

## 2.3. Patient and public involvement

Patients and the public were not involved in the design, conduction or reporting of this research. And the dissemination of the results also did not involve them.

## 2.4. Data analysis

We performed statistical analysis using R Statistical Software (version 4.1.0; R Foundation for Statistical Computing, Vienna, Austria, [www.r-project.org](http://www.r-project.org)). To describe participant characteristics, we reported quartiles (i.e., median, the first and the third quartiles) for non-normally distributed continuous variables (i.e., age and years of education) and we reported frequency and percentage for discrete variables (i.e., sex, marital status, employment status, income level, GHQ-12  $\geq$  12). To compare participants' characteristics between China and Germany, we used non-parametric test (the Wilcoxon rank-sum test) for continuous variables with nonnormal distribution and the chi-square test for discrete variables. To test the effects of perceived stress and income on mental health, we built a multiple linear regression model. In this model, we used GHQ-12 scores as the outcome, and "PSS-10 scores", "income", "country" as well as the interactions between "income" and "country" as predictors by controlling for "age", "sex", "years of education" "marital status", and "employment status". For marital status, we transformed into two categories: married (i.e., the status

**Table 1**  
Comparison of participant characteristics between China and Germany.

	[ALL] N = 2141	China N = 1123	Germany N = 1018	W/ $\chi^2$	p
<b>Sex</b>				27.667	<0.01*
Male	918 (43.1%)	423 (37.7%)	495 (49.1%)		
Female	1214 (56.9%)	700 (62.3%)	514 (50.9%)		
<b>Age</b>	26.0 [22.0; 33.0]	24.0 [21.0; 33.0]	26.0 [22.0; 32.0]	514637	<0.01*
<b>Years of education</b>	16.0 [13.0; 18.0]	16.0 [13.0; 18.0]	16.0 [13.0; 18.0]	565450	0.67
<b>Marital status</b>					
Single	1105 (51.6%)	566 (50.4%)	539 (52.9%)		
In a relationship	520 (24.3%)	198 (17.6%)	322 (31.6%)		
Married/civil partnership	478 (22.3%)	335 (29.8%)	143 (14.0%)		
Separated/divorced/dissolution	33 (1.54%)	19 (1.69%)	14 (1.38%)		
Widowed	5 (0.23%)	5 (0.45%)	0 (0.00%)		
<b>Employment status</b>				54.924	<0.01*
Employed	2052 (95.8%)	1111 (98.9%)	941 (92.4%)		
Unemployed	89 (4.2%)	12 (1.1%)	77 (7.6%)		
<b>Income level<sup>a</sup></b>					
1	932 (43.5%)	505 (45.0%)	427 (41.9%)		
2	319 (14.9%)	77 (6.86%)	242 (23.8%)		
3	375 (17.5%)	52 (4.63%)	323 (31.7%)		
4	72 (3.36%)	50 (4.45%)	22 (2.16%)		
5	141 (6.59%)	139 (12.4%)	2 (0.20%)		
6	302 (14.1%)	300 (26.7%)	2 (0.20%)		
<b>PSS-10 score</b>	30.0 [25.0; 33.0]	30.0 [26.0; 32.0]	29.0 [23.0; 35.0]	592452	0.14
<b>GHQ-12 score</b>	12.0 [9.00; 16.0]	11.0 [9.00; 13.0]	14.0 [10.0; 18.0]	409260	<0.01*
<b>GHQ-12 <math>\geq</math> 12</b>	1144 (53.4%)	503 (44.8%)	641 (63.0%)	70.166	<0.01*

<sup>a</sup> Income level: China: 1. ¥0-¥7,000; 2. ¥7,001-¥16,000; 3. ¥16,001-¥25,000; 4. ¥25,001-¥39,000; 5. ¥39,000-¥76,000; 6. >¥76,000. Germany: 1. €0-€9,999; 2. €10,000-€24,999; 3. €25,000-€74,999; 4. €75,000-€124,999; 5. €125,000-€174,999; 6. > €175,000.

GHQ-12: The 12-item Goldberg General Health Questionnaire; PSS-10: The 10-item Perceived stress scale.

\* $p < 0.05$ .

of married/civil partnership) and unmarried (other marital status). We have mean-centered the continuous independent variables in the model for testing a potential interaction effect. The variance inflation factor (VIF) for each variable is reported to show the interdependency. The Lindeman, Merenda, and Gold (LMG) metric calculated in the R package “relaimpo” is reported to show the relative importance of variables [48,49]. LMG is the contribution of ordered predictors to  $R^2$  [48,49]. Differences are considered statistically significant at  $p < 0.05$  and  $p$ -values are two-tailed.

### 3. Results

#### 3.1. Group description

A total of 2141 participants took part in the survey, with 1123 participants from China and 1018 participants from Germany. The median age of the participants was 26.0 years old, with a statistical difference between China and Germany (Median age: 24 years old versus 26 years old,  $p < 0.01$ ). Female participants accounted for 56.9% ( $n = 1241$ ) of the sample. There were more female participants in China (62.3%,  $n = 700$ ) than in Germany (50.9%,  $n = 514$ ,  $\chi^2 = 27.667$ ,  $p < 0.01$ ). The median years of education was 16 years among participants from both China and Germany ( $p = 0.67$ ). For marital status, 51.6% ( $n = 1105$ ) of participants were single. There were more participants being employed in China than in Germany (98.9% versus 92.4%,  $\chi^2 = 54.924$ ,  $p < 0.01$ ). For income, 43.5% ( $n = 932$ ) of participants were in the first income level (i.e., ¥0-¥7,000 in China or €0-€9,999 in Germany) and 14.1% were in the sixth level (i.e., > ¥76,000 in China or > €175 000 in Germany). Table 1 shows socio-demographic characteristics among participants in China and Germany.

The median score of the PSS-10 was 30.0 reflecting a high level of perceived stress in our sample as the maximum possible score of the PSS-10 was 50. There was no statistically significant difference in the PSS-10 score between participants from China (Median = 30) and Germany (Median = 29,  $p = 0.14$ ). Regarding mental health issues, 53.4% ( $n = 1144$ ) of participants reporting mental health issues (GHQ-12  $\geq 12$ ) and the median GHQ-12 score for all participants was 12. Participants in China reported a lower GHQ-12 score (Median = 11) than participants in Germany (Median = 14,  $p < 0.01$ ). The percentage of participants with mental health issues (GHQ-12  $\geq 12$ ) was lower in China than in Germany (44.8% versus 63.0%,  $\chi^2 = 70.166$ ,  $p < 0.01$ ).

#### 3.2. The influence of perceived stress and income on mental health

The multiple linear regression model ( $F = 262$ ,  $p < 0.01$ , adjusted R squared = 0.52) revealed the following main effects: “PSS-10 score” ( $b = 0.60$ ,  $p < 0.01$ , LMG = 0.8224), “income” ( $b = 0.23$ ,  $p < 0.01$ , LMG = 0.0075), “country” ( $b = 3.11$ ,  $p < 0.01$ , LMG = 0.1273), and the interaction effect of income and country ( $b = -0.40$ ,  $p < 0.01$ , LMG = 0.0120) on the GHQ-12 score by controlling for age, sex, years of education, marital status, and employment status (Table 2). In this model, all VIF values of variables were less than 5. Fig. 1 shows that higher PSS-10 scores were associated with higher GHQ-12 scores, indicating high perceived stress was associated with poor mental health in both countries. Fig. 2 depicts the interaction effect of income and country on GHQ-12 scores. Participants with a low income level reported higher GHQ-12 scores in Germany than participants in China, while participants with high income levels in China reported higher GHQ-12 scores than participants in Germany (Fig. 2).

### 4. Discussion

We conducted a cross-cultural study to explore the influence of perceived stress and income on mental health among general population in China and Germany. We found that the prevalence of mental health issues was higher among participants in Germany than in China. Moreover, perceived stress had a significantly negative impact on mental health, while income had differential effects.

**Table 2**  
Multiple linear regression model for all participants.

	b	p	LMG	Model
Intercept	11.34	<0.01*	/	F = 262 p < 0.01
PSS-10 score	0.60	<0.01*	0.8224	Adjusted R squared = 0.52
Income level	0.23	<0.01*	0.0075	
<sup>a</sup> Country	3.11	<0.01*	0.1273	
<sup>b</sup> Age	-0.001	0.96	0.0028	
<sup>b</sup> Sex	0.08	0.67	0.0065	
Years of education	0.08	<0.01*	0.0021	
<sup>c</sup> Marital status	-0.42	0.12	0.0055	
<sup>d</sup> Employment status	-0.20	0.66	0.0137	
Income × Country	-0.40	<0.01*	0.0120	

GHQ-12: The 12-item Goldberg General Health Questionnaire; PSS-10: The 10-item Perceived stress scale.

\* $p < 0.05$ .

<sup>a</sup> Country: China = 0, Germany = 1.

<sup>b</sup> Sex: Male = 0, Female = 1.

<sup>c</sup> Marital status: Unmarried = 0, Married = 1.

<sup>d</sup> Employment: Unemployment = 0, Employment = 1.

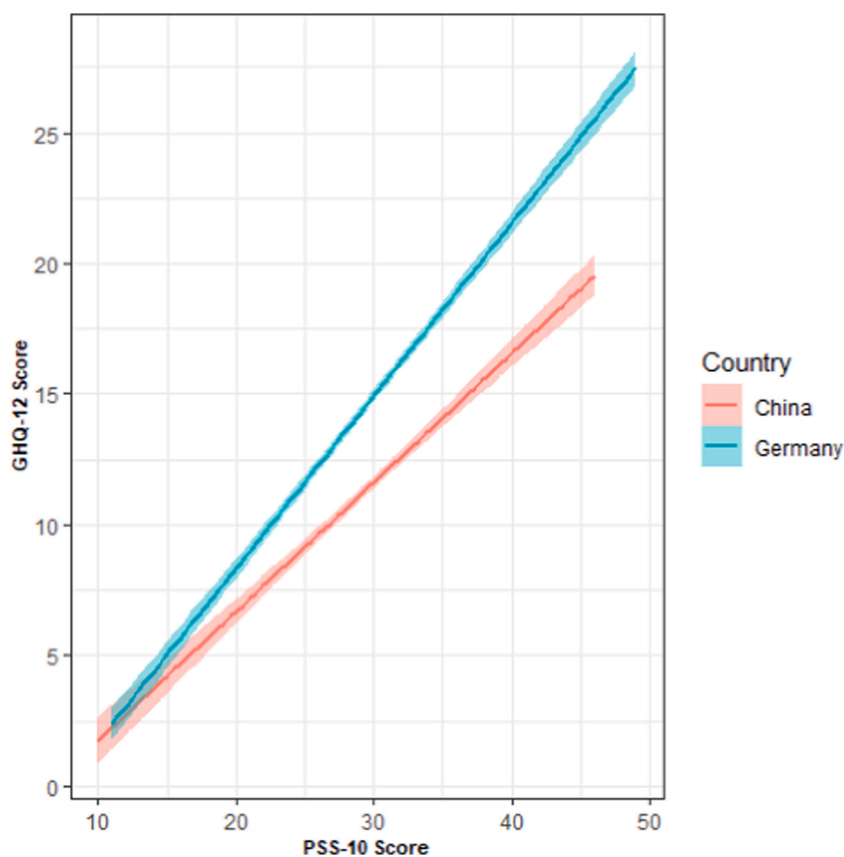


Fig. 1. The impact of PSS-10 scores on GHQ-12 scores in both countries.

At low income levels, participants in Germany reported poorer mental health than those in China, while at high income levels, participants in China reported poorer mental health than those in Germany.

Consistent with previous studies, we found a higher percentage of people having mental health issues in Germany than in China: previous results showed that the 12-month prevalence of mental disorders was approximately 30% in Germany and 9% in China [3, 11]. Longitudinal studies also showed that higher positive mental health and less depression among students in China compared to those in Germany [50,51]. It has been reported that the burden of mental disorders is increasing in Europe, above the world average [52]. The current study demonstrates the challenges of mental health in Germany. Although we found that a smaller proportion of participants reported mental health issues in China than in Germany, promoting mental health has still become an important issue over the past few years in China [15].

We found that both in China and in Germany, people with a higher PSS-10 score tended to have a higher GHQ-12 score, indicating that high perceived stress is associated with poor mental health. Consistent with previous studies from China and Germany, higher perceived stress was correlated with higher psychological distress among specific populations (i.e., health care workers, refugees, university students, and perimenopausal women) [27,53–55]. Furthermore, we evaluated the relative importance of mental health influence factors in a multiple linear model using the LMG metric. We showed that PSS-10 scores had a significant effect, which reflects the significant impact of perceived stress on mental health. This finding has crucial implications for programs promoting mental health, i.e., mental health practitioners should pay attention to encouraging stress reduction or stress regulation. Different methods, such as mindfulness technique, stress optimization, and internet and app-based intervention, could be considered [56–59]. Mental health services should be provided to the public to cope with stress and maintain mental health.

Moreover, we found that the impact of income on mental health varies depending on developing and developed countries. When individual incomes were low, participants in Germany reported higher GHQ-12 scores than participants in China, and the situation was reversed when individual incomes were high. Different basic national conditions may be one of the main reasons for this phenomenon. China is experiencing a period of rapid economic development, while Germany is a high-income country with an advanced economy. Individuals with high income in China have longer working hours and a higher workload than in Germany. According to data from the Organization for Economic Cooperation and Development (OECD), Germany has the least working hours among over 40 representative countries [60]. It is reported that the working hours of people in Germany was 34.8 h per week ([https://www.destatis.de/EN/Themes/Labour/Labour-Market/Quality-Employment/Dimension3/3.1\\_WeeklyHoursWorked.html](https://www.destatis.de/EN/Themes/Labour/Labour-Market/Quality-Employment/Dimension3/3.1_WeeklyHoursWorked.html)). In China, working overtime is reported frequently and there is a tendency of a work culture that includes long working hours [61,62]. Longer working hours can

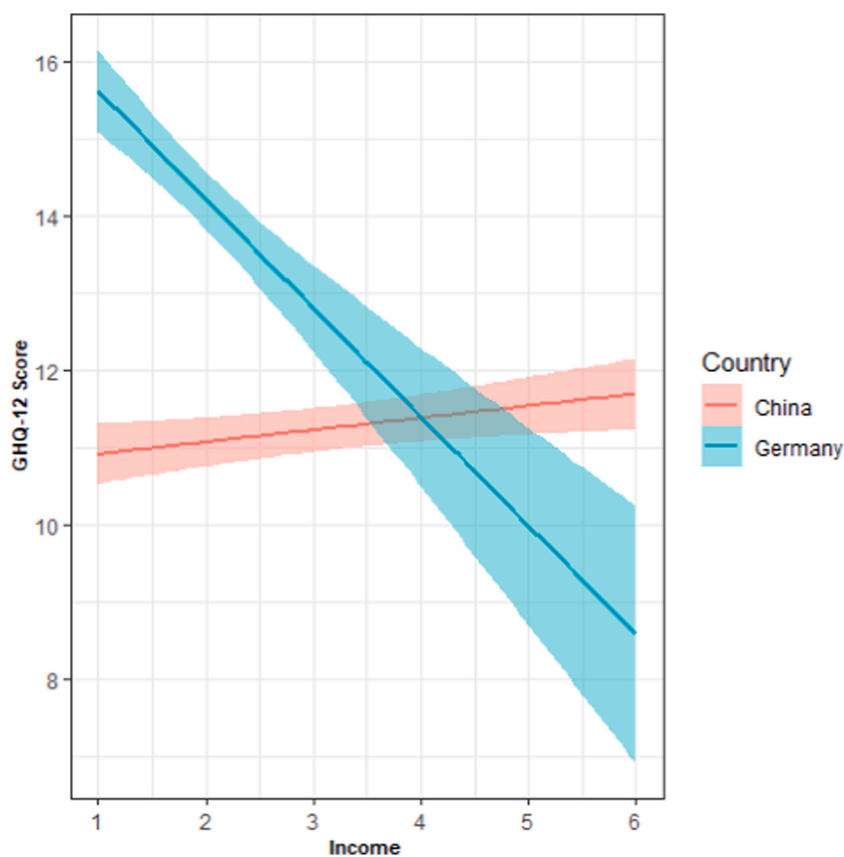


Fig. 2. The interaction of country and income with GHQ-12 scores.

reduce or eliminate positive factors associated with better mental health, such as relaxation, leisure, family time, good sleep etc [63–66]. A meta-analysis showed the negative effect of long working hours and working overtime on occupational health, including mental health [67]. Our findings suggest that China and Germany might approach enhancing mental health differently. In Germany, policies should pay more attention to mental health in the low income population. Whereas in China, promoting a good work-life balance can boost well-being.

Overall, we found that perceived stress, income and country could explain 52% of the variance of mental health issues, which was calculated by the adjusted R squared. On the one hand, the adjusted R squared reflected at least a medium-level effectiveness of our model. Prior studies showed the adjusted R squared varied from 0.05 to 0.86 [68–71]. On the other hand, the adjusted R squared in our model reflected the complexity of the mental health, which may contribute to other factors that affect mental health.

Our study has several limitations. First, the variables in our study were assessed through questionnaires. However, mental health and stress are complex and can be reported from numerous aspects. Future studies could investigate other indicators of mental health and stress, such as well-being and life events stressors [72,73]. Secondly, the cross-sectional study cannot reveal a causal relationship between stress, income, and mental health. Other studies have found that poor mental health could lead to lower income, which indicates an interrelation [74–76]. Thirdly, our web-based survey limits to generalizability and representativeness [77], which means that our findings need to be interpreted cautiously. To be noticed, the employment rates in 2019 in China and Germany were 64% and 58% respectively [78], and the proportions of employed participants in this study were 98.9% and 92.4%. In 2021, the marriage rates were 7.3 per 1000 residents and 4.3 per 1000 residents in China and Germany accordingly [79,80], and the proportions were 2.98% and 1.40% in this study. For income, the survey question was designed according to the whole population's income data in China [39]. In Germany, 20% of the population had an annual net income of less than 16,300 euros in 2021 [81]. There were more participants with low income in this study compared to the whole population in China and Germany. Our participants may not have been representative of the total populations in terms of age distribution and level of education. To balance this limitation, we implemented the survey on a national wide scale which covers participants across 34 provinces in China and 16 states across Germany. Participants from eastern provinces of China accounted for 56.19% with no significant difference of mental distress between eastern and non-eastern provinces in this study. Participants from East Germany accounts for 10.51% with no significant difference of mental distress between East and West Germany in this study. Fourthly, other socioeconomic factors (e.g., financial loans, price level in specific area) might have influence on mental health. Future studies could take these factors into consideration by integrating qualitative methods. Despite the above-mentioned limitations, our study provides insights into understanding how perceived stress and

income influence our mental health across cultures. Our findings suggest that programs promoting mental health should focus on stress management, in accordance with the differences in developing and developed countries.

### Author contribution Statement

Ruihua Li: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Shuyan Liu: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Chuanning Huang: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Debora Darabi: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Min Zhao: Conceived and designed the experiments; Wrote the paper.

Stephan Heinzel: Analyzed and interpreted the data; Wrote the paper.

### Data sharing

Data will be made available on request.

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### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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