

# More Positive Emotion, Less Stress Perception?

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**Purpose:** Shanghai, a mega-city with a population of 25 million, was becoming the first city in mainland China to erupt in the Omicron pandemic. The pandemic and the quarantine measures of whole city static management brought out big challenges for the population. This study sought to examine the psychological impact of such quarantine measures.

**Methods:** A cross-sectional study was conducted in China between April 8 to April 14, 2022. The survey contained inventories of stress perception, emotion states, duration of quarantine, and demographic characteristics. A total of 1,051 participants in Shanghai who were quarantined at home were included by random sampling.

**Results:** We found moderate-to-mild perceived stress ( $3.248 \pm 1.936$ ) and emotion states ( $3.453 \pm 2.094$ ). Individuals with high negative emotions had high levels of perceived stress. Specifically, the population aged 30–49, female, with higher household income, staying with the elderly or children, were more likely to report high stress and negative emotion. Hierarchical regression and the further path analysis indicated that emotion states partially mediated the relationship between quarantined days at home and perceived stress.

**Conclusion:** There was a moderate-to-mild level of perceived stress and emotion when quarantined at home for an average of 20 days in Shanghai. The present findings implicated more positive emotion than less stress perception at the same duration of quarantine. It was suggested to consider the measures taken to construct positive emotions for the public to overcome negativity and bring out a virtuous circle to thrive, if the quarantine has to be continued for preventing the pandemic.

**Keywords:** omicron pandemic, zero-COVID policy, perceived stress, emotion states, quarantine at home

## Introduction

The increasing menace of the epidemic led to an international public health emergency for the world with the evolution of COVID-19 variants. Shanghai, a mega-city with a resident population of about 25 million, ushered in the impact of the Omicron variants in early March 2022. In terms of the basic reproductive number  $R_0$  (the average number of people infected by one infectious person during the infection period), Omicron was the environmental stability with high infectiousness,<sup>1</sup> compared with the SARS-CoV-2de and the Delta variety. As a result of this pandemic in Shanghai, the number of new infections cases in a single day reached as high as 27,605. As of May 4, the cumulative infections in the whole city were 601,942, including 547,056 cases without pulmonary symptoms, and a total of 503 deaths.<sup>2</sup> In order to stop the spread of the epidemic as soon as possible, with the zero-COVID policy,<sup>3</sup> “whole city static management” was announced on March 28 in Shanghai. By April 1, 25 million people began to quarantine at home. The city locked down with traffic stoppage, markets closure, production suspension, logistics shutdown, online learning, and so on.

In this situation, people were facing huge challenges not only physically but also mentally both cross-sectionally<sup>4,5</sup> and longitudinally.<sup>6</sup> Most studies reported a negative psychological impact of quarantine, such as fear,<sup>7</sup> anxiety and anger,<sup>8,9</sup> emotional distress,<sup>10</sup> symptoms of depression,<sup>11</sup> symptoms of acute stress disorder,<sup>12,13</sup> and post-traumatic stress symptoms.<sup>14</sup> In quarantine, health care workers were more likely to suffer psychological consequences such as Post-Traumatic Stress Disorder (PTSD) than the general population.<sup>15</sup> Frontline workers reported higher scores for stress,

emotional exhaustion, and depersonalization as compared to colleagues working in units not directly serving patients with COVID-19.<sup>16</sup> A few studies have discussed the effect of policy stringency on public mental health during quarantine. A recent one reviewed the data of the COVID-19 pandemic in 15 countries from April 2020 to June 2021, indicating that more stringent policies were associated with poorer mental health, and maintaining social distance was more closely associated with poor mental health than closing schools, workplaces, public transport, canceling public events, and restricting domestic travel.<sup>17</sup> Consequently, the present study was concerned with the psychological impact of such quarantine measures which inevitably affected people's daily life and social distance.

The mental health of the public during the quarantine may be caused by COVID-19, the pandemic itself, or by the measures of quarantine, or the result of the combination of both factors. Risk factors related to the pandemic itself (eg, contact history of COVID-19, risk perception, exposure to COVID-19 at work) had been identified as related to public mental health in China.<sup>18–20</sup> Several characteristics of participants associated with negative psychological impacts were reported, such as younger age (16–24 years), female, lower levels of formal educational qualifications, lower household income, and having one child as opposed to no children.<sup>18,21</sup> Analysis on effect of lockdown in Australia found that the lockdown was associated with a modest negative change in overall population mental health, and women were more likely to have adverse mental health outcomes, especially those aged 20–29 years old.<sup>22</sup> Government and staff should pay special attention to the mental health of those susceptible populations during the outbreak of COVID-19.

Studies on stressors during quarantine showed what was associated with poorer mental health were duration of quarantine,<sup>9,23</sup> fears of infection and concerns about its effects on family,<sup>24–26</sup> inadequate basic supplies (eg, food, water, clothes, or accommodation),<sup>27</sup> insufficient clear guidelines about actions to take and confusion about the purpose of quarantine from public health authorities,<sup>13,28</sup> economic uncertainty, especially in vulnerable groups,<sup>29</sup> etc. Whether it has a psychological impact or not, the social effects of lockdown measures such as concerns over availability of food and household goods and social isolation were present as important stressors.<sup>24,29</sup> In addition, emotion states and stress were related and often discussed, especially in special circumstances. One study confirmed the efficacy of a brief online form of Emotional Freedom Techniques in the prevention of stress, anxiety, and burnout in nurses involved in the treatment of COVID patients.<sup>30</sup> In order to reduce the stress of the masses during the quarantine period, it was necessary to understand related risk factors and underlying mechanisms.

Although emotion and stress were discussed as the public psychological impact of quarantine in previous studies, it seems little known about the psychological mechanisms underlying the mental health problems related to the COVID-19 pandemic.<sup>31</sup> To our knowledge, few studies have explored the relationship between emotion states and stress perception in quarantine. Therefore, the present study would like to explore what and how this citywide, involving 25 million people, long-term quarantine in Shanghai affects public psychology in a pandemic. It was hypothesized that emotion states might play a moderating role on the relations between quarantine measures and stress perception. Based on the results of the present study, further measures can be taken to mitigate the negative consequences of the quarantine on public mental health.

## Methods

### Participants and Procedure

An online survey was conducted in Chinese by the Questionnaire Star platform (<https://www.wjx.cn>) to recruit participants between April 8 and April 14, 2022. At that time, it had been nearly 2 weeks since March 28 when the city started lockdown, and before that there were a considerable number of buildings and communities already in quarantine at home during the pandemic spreading. The survey was mainly distributed to the society through daily broadcasting on WeChat groups and psychological service institutions. On opening the link of the survey, there was an announcement to clarify the purpose of the study and then all the items for the study for those who volunteered to respond. This design was to make the participants clear about what private information needed to be provided before they decided to join in. Therefore, all participants were entirely voluntary and informed consent was obtained from the study participants prior to study commencement. This study was approved by the ethics committee of the Naval Medical University. All procedures were in accordance with the Helsinki Declaration.

We received responses from 1,320 participants and finally a total of 1,051 were included (626 males and 425 females). The inclusion criteria involved 1) willing to accept the investigation; 2) located in Shanghai; 3) normal levels of speech, comprehension, and expression. Then 219 were deleted because of not meeting the inclusion criterion, and 50 more were deleted for too many missing values (38 removed) or spending more than 30 minutes or less than 2 minutes to respond to the survey (12 removed). Supplementary [Figure S1](#) is a flow diagram showing the selection process.

## Measures

### Demographic Characteristics

Age, gender, occupation, education, annual household income, stay with elderly or not, and stay with children or not were included in the questionnaire as demographic characteristics.

### Duration of Quarantine

This was measured by quarantined days at home, which the participants would calculate and fill in according to the individual situation by the date of answering the questionnaire.

### Stress Perception

We calculated quarantine stress at home for the participants as individual's subjective feeling about the state of life in the meantime. It was assessed by 10 items involving the general stress perception and nine specific perceptions on the stressors including living provisions, risk of infection, family dysfunction, children learning online, medical or medicine demand, economic income, negative information, cramped space, and working load at home, which were integrated from the previous studies<sup>24,27,32</sup> and were included according to the actual situation in Shanghai during quarantine. All perceptions were rated on a 9-point Likert scale ranging from 1 (no stress at all) to 9 (an enormous stress). The average score of 10 items was calculated to represent the state of stress perception, meaning people with higher scores had higher perceived stress.

### Emotion States

We tried to make an emotional states inventory adapted to the non-clinical groups, which was not only focusing on the negative subjective experience of individuals, but also involving the disappearance of pleasure which is the core component of depression.<sup>33</sup> Seven items with emotion states of binary opposites were included as orderly–flustered, calmed–jittery, delighted–indignant, meaningful–meaningless, active to social interaction–lonely, interested–bored, and hopeful–hopeless, with one side positive and the other side negative on a continuous axis. These emotion states were referenced to the State/Trait Depression Scale in Chinese Version (STDEP)<sup>33</sup> and the Positive and Negative Affect Scale (PANAS). All items were rated on a 9-point Likert scale ranging from 1 (positive state) to 9 (negative state), with the instruction as “Scoring from 1 to 9 to express your psychological feelings since pandemic quarantine at home”. The average score of seven items was calculated to represent the state of emotion, meaning people with a higher score had more negative emotions.

## Statistical Analysis

Statistical analysis was performed using IBM SPSS version 21.0. A two-tailed test was used, and  $p < 0.05$  was considered as statistically significant. Descriptive and frequency statistics (mean, [SD] and percentages) were used to describe baseline demographic information. First, descriptive statistics were calculated for the demographic variables, the average score of different perceived stresses, and negative emotion states of population. Then, one-way analysis of variance (ANOVA) was used to analyze the perceived stress and negative emotion state between different demographic categories. Next, hierarchical regression analysis was used to determine the independent variables related to perceived stress. Last, mediation analyses were conducted to determine the potential mediating effect on the relationship between quarantined days at home and perceived stress.

## Results

### Demographic Information of Participants

A total of 1,101 people were recruited to complete the survey. Of the 1,101 respondents, 38 participants were removed due to too many missing values or illogical answers (for example, all choices were one or zero), and 12 were removed

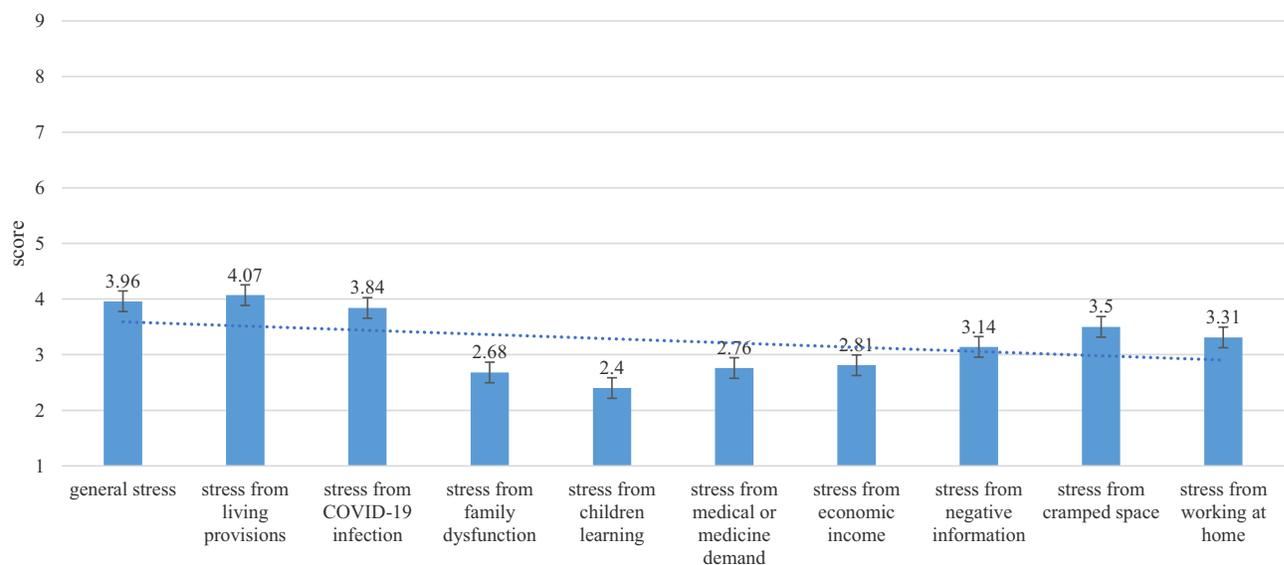
due to spending more than 30 minutes or less than 2 minutes answering the questionnaire. Therefore, 1,051 participants were included in this analysis. As illustrated in Table 1, the average days of being quarantined at home were  $20.08 \pm 8.411$ . The sample comprised 626 males and 425 females with an average age of  $32.38 \pm 11.112$  years and an average annual household income of  $273.45 \pm 27.075$ . Most of these participants were bachelor degree (30.7%) level of education. There were 151 (14.4%) students and retired or unemployed personnel, 229 (21.8%) specialized persons (eg, teacher, doctor, government related staff), 206 (19.6%) company employees or managers, 388 (36.9%) military personnel, and 77 (7.3%) other occupations (eg, service workers, freelancer, no response). A total of 208 (19.8%) participants lived with the elderly and 439 (41.8%) lived with children when quarantined at home.

## Perceived Stress and Emotion States During Quarantine at Home

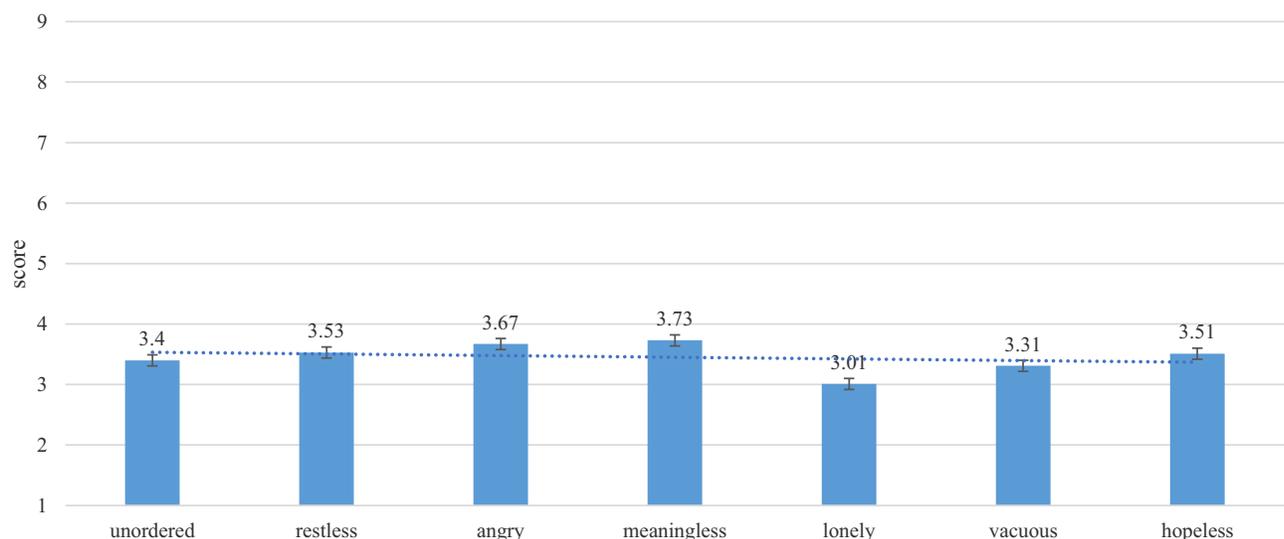
The average scores of different perceived stress and emotion states are shown in Figures 1 and 2, respectively. The average score of different perceived stress were  $3.248 \pm 1.936$ , while emotion states were  $3.453 \pm 2.094$ . During quarantine at home due to COVID-19, the participants reported moderate-to-mild perceived stress and emotions, regardless of the type. In detail, the stress from living provisions was significantly higher than others, and the stress from children's learning was

**Table 1** Demographic Information of Participants

		Total (n=1,051)	
		n	%
Age	≤18	9	0.9
	19–29	504	48.0
	30–49	459	43.7
	≥50	79	7.5
Quarantined days at home (M±SD)		20.08	8.411
Annual household income	Less than 150	464	44.1
	150–320	316	30.1
	More than 320	271	25.8
Gender	Male	626	59.6
	Female	425	40.4
Occupation	Student and retired or unemployed personnel	151	14.4
	Specialized person (eg, teacher, doctor, government related staff)	229	21.8
	Company employee or manager	206	19.6
	Military personnel	388	36.9
	Others (eg, service workers, freelancer, no response)	77	7.3
Education	High school or less	150	14.3
	Junior college	295	28.1
	Bachelor degree	323	30.7
	Master degree or above	283	27
Live with the elderly	No	843	80.2
	Yes	208	19.8
Live with children	No	612	58.2
	One child	342	32.5
	Two children	95	9.0
	Three children	2	0.2



**Figure 1** The average score of different perceived stress.



**Figure 2** The average score of different negative emotion states.

reported the lowest. It was reported that the negative emotion state of flustered, jittery, indignant, meaningless, lonely, bored, and hopeless, were 3.4, 3.53, 3.67, 3.73, 3.01, 3.31, and 3.51, respectively. [Supplementary Materials Figure S2](#) shows a scatterplot of perceived stress and emotion states for every participant. There was a significant relationship between perceived stress and emotion states, suggesting that individuals with high negative emotions also had high levels of perceived stress.

## Profile of Perceived Stresses and Emotion States in Different Demographic Categories

The effect of demographic categories on the perceived stress and emotion state was analyzed ([Table 2](#)). The average score of perceived stress of participants at the age of 30–49 years ( $4.271 \pm 1.783$ ) was significantly higher than at the age of  $\leq 18$  ( $p=0.023$ ), 19–29 ( $p<0.001$ ), and  $\geq 50$  ( $p=0.014$ ). And the average score of emotional state of participants at the age of 30–49 years ( $4.504 \pm 1.842$ ) was significantly higher than at the age of  $\leq 18$  ( $p=0.011$ ) or 19–29 ( $p<0.001$ ). Those with more quarantined days at home had higher perceived stress ( $F=50.494$ ,  $p<0.001$ ) and a more negative emotional state ( $F=42.410$ ,

**Table 2** Perceived Stress and Negative Emotion State by Demographic Information

		Perceived Stress		F	p	Negative Emotion State		F	p					
		M	SD			M	SD							
Age	≤18	2.989	1.501	121.366	0.000***	2.952	1.849	115.625	0.000***					
	19–29	2.240	1.569			2.377	1.774							
	30–49	4.271	1.783			4.504	1.842							
	≥50	3.770	1.627			4.271	1.944							
Quarantined days at home	More	3.776	1.899	50.494	0.000***	3.979	2.118	42.410	0.000***					
	Less	2.923	1.887			3.129	2.014							
Annual household income	Less than 150	2.546	1.819	67.017	0.000***	2.714	1.819	61.451	0.000***					
	150–320	3.574	1.881			3.833	1.995							
	More than 320	4.071	1.765			4.278	1.893							
Gender	Male	2.590	1.768	215.836	0.000***	2.751	1.979	208.349	0.000***					
	Female	4.218	1.757			4.487	1.813							
Occupation	Student and retired or unemployed personnel	3.375	1.752	81.161	0.000***	3.796	2.106	80.907	0.000***					
	Specialized person (eg, teacher, doctor, government related staff)	4.083	1.757			4.334	1.773							
	Company employee or manager	4.397	1.857			4.642	1.851							
	Military personnel	2.116	1.488			2.212	1.661							
	Others (eg, service workers, freelancer, no response)	3.147	1.896			3.239	2.188							
	Live with the elderly	No	2.957			1.837	106.151			0.000***	3.204	2.073	64.069	0.000***
	Yes	4.429	1.879			4.464					1.866			
Live with children	No	2.477	1.642	102.778	0.000***	2.705	1.937	78.027	0.000***					
	One child	4.281	1.770			4.519	1.826							
	Two children	4.540	1.853			4.484	1.886							
	Three children	1.25	0.07			1.29	0.20							

Note: \*\*\*  $p < 0.001$ .

$p < 0.001$ ) than those with less days. In terms of sampling dates, the change of perceived stress and negative emotional state similarly supported that perceived stress and negative emotion would increase over time during home quarantine, which is shown in [Supplementary Materials Figure S3](#) in detail. Females had higher perceived stress ( $F=215.836$ ,  $p < 0.001$ ) and a more negative emotional state ( $F=208.349$ ,  $p < 0.001$ ) than males. There were significant differences between different income subgroups, meaning participants with an income of more than 320,000 exhibited higher perceived stress ( $p < 0.001$ ) and a more negative emotional state ( $p < 0.001$ ) than other income categories. The perceived stress of specialized people (eg, teacher, doctor, government related staff) was marginally significant when compared with company employees or managers ( $p=0.054$ ), but significantly higher than other occupations. In terms of negative emotion state, specialized people (eg, teacher, doctor, government related staff) registered as significantly higher than other occupations, but significantly lower than company employees or managers ( $p=0.008$ ). Those living with the elderly during quarantined days showed higher perceived stress ( $F=106.151$ ,  $p < 0.001$ ) and negative emotional state ( $F=64.069$ ,  $p < 0.001$ ). Similarly, those living with children during

quarantined days showed higher perceived stress ( $F=102.778, p<0.001$ ) and negative emotional state ( $F=78.027, p<0.001$ ), regardless of the number of children.

### Factors Related to Perceived Stress

According to the results of ANOVA, we selected the significant characteristics and incorporated them into the hierarchical regression model. The results of the hierarchical regression analysis are listed in Table 3. In the first step, the gender and occupation variables were included accounting for 27% of the variance in perceived stress. In the second step, “live with the elderly”, “live with children”, and “quarantined days at home” were included in the model, and “female” “live with the elderly or children” and “quarantined days at home” had significant effects on the perceived stress. For the occupation, specialized person (eg, teacher, doctor, government related staff) had significantly higher perceived stress than other occupations besides company employees or managers. These features accounted for 31.2% of the variance. In the third step, emotion categories were included, accounting for 59.3% of the difference in the results.

**Table 3** Regression Analyses with Perceived Stress Score as the Dependent Variable

Variables		Perceived Stress			R Square	Adjusted R Square	R Square Change	F	p-value
		B	$\beta$	t					
Step 1	Female vs male	0.883	0.224	7.255***	0.273	0.270	0.273	78.660	0.000***
	Student and retired or unemployed personnel vs specialized person	-0.657	-0.119	-3.789***					
	Company employee or manager vs specialized person	0.213	0.044	1.334					
	Military personnel vs specialized person	-1.522	-0.380	-10.09***					
	Others vs specialized person	-0.721	-0.097	-3.282**					
Step 2	Female vs male	0.647	0.164	5.208***	0.318	0.312	0.045	48.604	0.000***
	Student and retired or unemployed personnel vs specialized person	-0.453	-0.082	-2.635**					
	Company employee or manager vs specialized person	0.163	0.033	1.042					
	Military personnel vs specialized person	-1.027	-0.256	-6.261***					
	Others vs specialized person	-0.514	-0.069	-2.364*					
	Income less than 150 vs more than 320	0.139	0.036	0.889					
	Income 150–320 vs more than 320	0.134	0.032	0.967					
	Live with the elderly vs no	0.432	0.089	3.115**					
	Live with children vs no	0.850	0.217	6.174***					
	Quarantined days at home	0.014	0.063	2.433*					
Step 3	Female vs male	0.032	0.076	3.124**	0.597	0.593	0.279	128.325	0.000***
	Student and retired or unemployed personnel vs specialized person	-0.283	-0.051	-2.135*					
	Company employee or manager vs specialized person	0.096	0.020	0.801					
	Military personnel vs specialized person	-0.373	-0.093	-2.892**					
	Others vs specialized person	-0.103	-0.014	-0.610					
	Income less than 150 vs more than 320	-0.009	-0.002	-0.075					
	Income 150–320 vs more than 320	0.015	0.004	0.142					
	Live with the elderly vs no	0.425	0.087	3.977***					
	Live with children vs no	0.473	0.121	4.43***					
	Quarantined days at home	0.007	0.032	1.621					
	Middle negative emotion state vs low	2.036	0.515	22.928***					
	High negative emotion state vs low	3.991	0.395	19.144***					

**Note:** \*  $p<0.05$ ; \*\*  $p<0.01$ ; \*\*\*  $p<0.001$ .

**Abbreviations:** B, unstandardized beta;  $\beta$ , standardized regression weight.

Female ( $\beta=0.076$ ,  $p=0.002$ ), living with the elderly ( $\beta=0.087$ ,  $p<0.001$ ), living with children ( $\beta=0.121$ ,  $p<0.001$ ), middle emotion state ( $\beta=0.515$ ,  $p<0.001$ ), and high emotion state ( $\beta=0.395$ ,  $p<0.001$ ) were positively correlated with perceived stress. Even though when we picked out the top three perceived stresses as dependent variables, such results also supported the influence of being female ( $p<0.001$ ), living with the elderly ( $p<0.001$ ) and living with children ( $p<0.001$ ). This is detailed in [Supplementary Materials Figure S4–S6](#).

## The Mediating Effect of Emotion States on the Relationship Between Quarantined Days at Home and Perceived Stress

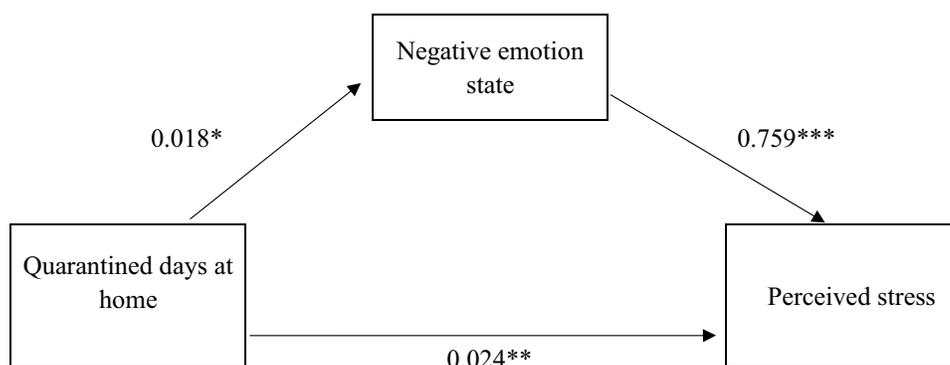
The results of ANOVA suggest that those with more quarantined days at home had higher perceived stress ( $F=50.494$ ,  $p<0.001$ ) and negative emotional state ( $F=42.410$ ,  $p<0.001$ ). Moreover, the hierarchical regression model 2 showed “quarantined days at home” had significant effects on the perceived stress. However, this significance was not noted when emotion categories were included in the third step. Therefore, it was assumed the existence of emotion state would influence the relationship between quarantined days at home and perceived stress. Thus, mediation analyses were further conducted to determine the relationship between emotion state, quarantined days at home, and perceived stress.

The average score of perceived stress was entered into the mediation model as a dependent variable, with emotion states as a possible mediator and quarantined days at home as a predictor. There were significant direct effects whereby more quarantined days at home was associated with a more negative emotional state (coefficient=0.018,  $p=0.015$ ) and emotion state predicted perceived stress (coefficient=0.759,  $p<0.001$ ). The direct effect from quarantined days at home to perceived stress was significant (coefficient=0.010,  $p=0.017$ ). There was a significant indirect effect from quarantined days at home to perceived stress through emotion state (coefficient=0.0142, 95% confidence interval of Bootstrap test=[0.003, 0.026]). Coefficient of the total effect was 0.024 with a  $p$ -value at 0.001. The result of path analysis indicated that emotion state mediated the relationship between quarantined days at home and perceived stress (Figure 3).

## Discussion

The current study aimed to investigate public psychology under the Shanghai quarantine at home and explore related risk factors on perceived stress. Results showed that the perceived stress on all sources and the emotional states of the public were moderate-to-mild. And there existed a significant relationship between perceived stress and negative emotion states, suggesting that individuals with high negative emotions also had high levels of perceived stress. Specifically, the population aged 30–49, female, with higher household income, staying with the elderly or children, were more likely to report high stress and negative emotion. Hierarchical regression and the further path analysis indicated that emotion states partially mediated the relationship between quarantined days at home and perceived stress.

Compared with the previous study that reported the psychological impact as moderate-to-severe during the initial phase of the outbreak of COVID-19 in China,<sup>20</sup> the moderate-to-mild results here seemed to indicate less psychological impact of quarantine in Shanghai. This result might relate with the different measures of emotion states, low risk perception on the



**Figure 3** Negative emotion state mediates the relationship between quarantined days at home and perceived stress.

**Note:** \*  $p<0.05$ ; \*\*  $p<0.01$ ; \*\*\*  $p<0.001$ .

Omicron pandemic, and a comparatively short duration of quarantine (13–29 days, with Mean equal to  $20.08 \pm 8.411$ ) in this study. Inconsistent with the previous finding that participants worried about their family members contacting COVID-19,<sup>20</sup> we found low risk perception on pandemic as the less stress perception from COVID-19 infection compared with stress from living provision and the general stress. This was confirmed when we further asked the participants to rank the ten stressors according to the stress perceptions changed most after quarantine at home, and mark the top three in order as 1–3, in which we found COVID-19 infection was ranked to a less important stressor compared with living provision. In other previous studies, fear seems more certainly a consequence of mass quarantine<sup>7</sup> and social isolation was the main stressor during the pandemic.<sup>24</sup> Inconsistently, we found the top three negative emotions were meaningless, indignant, and jittery, and the lowest score of lonely with more active to social interaction during the quarantine, which might also implicate the low risk of perception on pandemic or risk perception not as a most important stressor during the quarantine.

One of the main influencing factors of public psychology was the duration of quarantine.<sup>9,23</sup> It was also proved in the present study that the longer the duration of quarantine, the higher perceived stress and more negative emotional state. During the COVID-19 pandemic, there is an urgent need to study the immediate psychological impact on the workforce who returned to work. Study emphasized that 10.8% of the workforce met the diagnostic criteria for PTSD just returning to work after lockdown and quarantine in Chongqing.<sup>34</sup> Therefore, against the background of the normalization of the epidemic, governments, and company administrators to be aware of the extent and factors associated with stress, emotion states, and other mental health among members of the workforce when they just returned to work after quarantine and lockdown during the COVID-19 pandemic.

Females were more likely to report high stress and negative emotions. This was consistent with the previous findings, whether in China<sup>20</sup> or other countries.<sup>4</sup> Individuals aged 30–49 were more likely to experience a higher stress and negative emotions. Middle-aged adults are also high-risk groups for COVID-19 due to the start of decreasing function and chronic underlying diseases that may weaken the immune systems. However, the results were different from some previous studies, in which younger age (16–24 years) and lower household income were reported as the characteristics of participants associated with negative psychological impacts.<sup>18,21</sup> Future studies should further explore inconsistent results with respect to age.

According to the result of hierarchical regression analysis, it was assumed the existence of emotion state would influence the relationship between quarantined days at home and perceived stress. And path analysis confirmed a mediating effect of emotion state on the relationship between quarantined days at home and perceived stress. To be specific, the existence of more positive emotions might bring out less perceived stress at the same duration of quarantine. Positive emotions like orderly, calmed, focused, meaningful, appreciative, interested, hopeful, esteem, love et al, would benefit individuals to overcome negativity, and bring out a virtuous circle to thrive.<sup>35</sup> Given the mediating role of emotion state, interventions targeting it would contribute to stress reduction during quarantine. This is also consistent with previous studies. For example, one study confirmed the efficacy of a brief online form of Emotional Freedom Techniques in the prevention of stress, anxiety, and burnout in nurses involved in the treatment of COVID patients.<sup>30</sup> To address the needs of the general population during a future pandemic, it is worthwhile to contemplate the use of online cognitive behavior therapy (CBT) or smartphone-based psychoeducation to promote mental wellness under quarantine. It was suggested that CBT can mitigate maladaptive coping behaviors such as avoidance, antagonistic confrontation, and self-blame by enhancing their ability to manage stress.<sup>36</sup> A meta-analysis showed digital CBT significantly reduces insomnia severity index at post-intervention.<sup>37</sup> As a result, such online psychological interventions were warrant in facing future epidemics.

## Strengths and Limitations

Firstly, up to now, no mega-city has conducted such a global static management with high compulsion like Shanghai in China, which has been quarantined for almost 3 months, while all people's work and learning activity have been carried out online at home. Moreover, the effectiveness of this pandemic prevention in Shanghai may make a difference to the subsequent pandemic prevention strategy in mainland China. Secondly, although emotion and stress were discussed as the public psychological impact of quarantine in previous studies, most usually focused on one or a few particular emotional problems or stressors perception, which were nearly all negative impacts. In the current study, more comprehensive dimensions of stress sources were included and the quarantine actuality was paid more attention.

While there existed certain strengths, some limitations still need to be discussed. First, we conducted a cross-sectional study on the public psychology during the quarantine in Shanghai from April 8 to 14, with an average quarantine

duration of 20 days. The quarantine lasted nearly 3 months and the emotion states and perceived stress of the public might have changed over this period. In spite of this limitation, the results of the present study did reflect the true mentality of the participants who had been quarantined at home for an average of 20 days under the pandemic preventing measure of global static management in Shanghai. Second, the standard scales to assess the emotion state such as depression and anxiety was not used in the current study, but constructing an instrument with seven emotion states of binary opposites and asking the participants to rate on a 9-point Likert scale ranging from 1 (positive state) to 9 (negative state). This might limit the comparison with the results of previous researches. But, from another side, it was a way to avoid the limitation that the public could only report the negative subjective experiences but not present the actual emotion state under the certain context of quarantine, such as some degree of disappearance of positive emotion. In such special circumstances of prolonged isolation cases, it remains to be explored whether this would better describe emotional states and be more suitable for the general population. Third, the information of past history of COVID of participants was not collected. Given the important impact of infection history on mental health, it should also be an important factor for perceived stress. Future research should focus on the important role of COVID infection history.

## Conclusion

The pandemic and the quarantine measures brought out a big challenge for Shanghai, a mega-city with a population of 25 million in China. We focused on the psychological impact of such quarantine measures which inevitably affected people's daily life and social distance. The results showed that the perceived stress and the emotional states of the public were moderate-to-mild, and there existed a significant relationship between perceived stress and negative emotion states. The population aged 30–49, female, with higher household income, staying with the elderly or children were positively associated with a higher level of stress and negative emotion states. There existed a mediating effect of emotion state on the relationship between quarantined days at home and perceived stress, which implicated more positive emotions and less stress perception at the same duration of quarantine. It was suggested to consider the measures taken to construct positive emotions for the public to overcome negativity and bring out a virtuous circle to thrive, as the quarantine has to be continued for preventing the pandemic.

## Data Sharing Statement

The data that support the findings of this study are available from the corresponding author.

## Ethics Approval and Consent to Participate

This study was approved by the ethics committee of Naval Medical University and the informed consent obtained from the study participants prior to study commencement. All procedures were in accordance with the Helsinki Declaration.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; have taken part in drafting, revising or critically reviewing the article; have reviewed and agreed on all versions of the article before submission, during revision, the final version accepted for publication, and any significant changes introduced at the proofing stage; have agreed to take responsibility and be accountable for the contents of the article.

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## Disclosure

The authors declared that they have no conflicts of interest.

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