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COVID-19 exposure, pandemic-related appraisals, coping strategies, and psychological symptoms among the frontline medical staff and gender differences in coping processes

Chen Chen[1] | Ziqi Guan[2] | Liqun Sun[3] | Ting Zhou[1] | Ruiyuan Guan[1]

[1]Department of Medical Psychology, School of Health Humanities, Peking University, Beijing, China

[2]Teachers College, Columbia University, New York, New York, USA

[3]Intensive Care Unit, the Second Affiliated Hospital of Nanjing Medical University, Nanjing, China

Correspondence
Ting Zhou and Ruiyuan Guan, Department of Medical Psychology, School of Health Humanities, Peking University,
No. 38 Xueyuan Road, Beijing 100191, China.
Email: zhouting.92@bjmu.edu.cn and guanry@bjmu.edu.cn

Abstract

This study sought to explore the effects of COVID-19 exposure, pandemic-related appraisals and coping strategies on psychological symptoms among the front-line healthcare workers based on the transactional theory of stress and coping. A cross-sectional study was conducted in a Wuhan hospital designated for inpatients with COVID-19, assessing COVID-19 exposure (whether or not exposed to confirmed patients at workplace), psychological symptoms, appraisals, and coping strategies in 311 participants. Results revealed that the pandemic markedly affected healthcare workers' mental well-being through appraisal and coping, with 38.9% reporting high levels of psychological symptoms. Primary appraisal related closely with COVID-19 exposure, especially in female, while secondary appraisal was associated with problem-focused coping. Both problem-focused and emotion-focused coping had a protective effect against psychological symptoms, but also showed gender differences in its relations with other variables. These findings could potentially benefit to enrich relevant theories, and to develop psychological programs for future epidemics.

KEYWORDS
coping, COVID-19 related appraisal, gender differences, medical staff, psychological symptoms

1 | INTRODUCTION

Mankind has developed to this day thanks to the efforts of defeating infectious diseases, and to this day there are still many people who are fighting against viruses for the sake of human health. COVID-19 pandemic is the most widespread and influential infectious disease challenge after severe acute respiratory syndrome coronavirus (SARS-CoV) in 2002 and Middle East respiratory syndrome coronavirus (MERS-CoV) in 2012, representing the third introduction of a highly pathogenic epidemic coronavirus in the 21st century (Guo et al., 2020). By October 1, 2021, the World Health Organization (WHO) had reported more than 233 million confirmed cases around the world, including 4 million death cases.[1]

Frontline medical workers were exposing to higher pressure during the fight with the COVID-19 virus than people in other occupation. They are one of the most important barriers between people and the virus, thus should receive more attention and protection. Because of the high intensity of their work and the psychological stress, front-line healthcare workers are at greater risk of having mental and physical problems. They were experiencing severe negative emotions, like fear and anxiety, at the same time worrying about being infected and transmitting the virus to their families and colleagues. Additionally, because the government was unprepared to deal with the pandemic when the outbreak first began, healthcare workers faced an extreme lack of medical resources, which left many of them facing mental breakdowns. Therefore, we could see that they were exposed to elevated dangers that put them at risk of not only infection, but also considerable psychological distress (Neto et al., 2020). In addition, the daily new deaths and the constant flow of patients keep them

overworked, increasing their mental stress and the risk of psychological problems (Xiang et al., 2020).

Several studies investigated the emotion and psychological distress of front-line healthcare workers under the circumstances of high pressure and workload caused by contagious disease. Excluding the effect of age, gender, and comorbidities, researchers found that depression, anxiety, stress, and posttraumatic stress disorders (PTSD) were significantly associated with the presence of physical symptoms experienced in the preceding month (Chew et al., 2020). Anxiety, fear, loneliness, helplessness, conflict, and anger have been reported in the studies of SARS outbreak (Maunder et al., 2003). Furthermore, the experience fighting against Ebola epidemic taught us that poor mental health, such as anxiety, depressive disorders, and PTSD are some of the psychological catastrophes that can result in hazards exceeding the consequence of the outbreak itself (Shultz et al., 2015). Thus, there is an urgent need to detecting and working on protecting healthcare workers' mental health and treat their mental health disorder symptoms (Suryavanshi et al., 2020).

Two key factors that shape the process and results of pandemic reactions are cognition and coping. Researchers have shown that fear of contracting COVID-19 and perceived probability of being the source of contagion could predict psychological distress among healthcare workers in COVID-19 (Gorini et al., 2020; Kader et al., 2021). Other studies found that coping strategies played an important role in the mental well-being of both ordinary people and medical workers (Fluharty et al., 2021; Lorente et al., 2021). According to Lazarus and Folkman's (1987) transactional theory, cognitive appraisal and coping are two critical mediators of stressful person-environment relations, leading to both immediate as well as long-range outcomes. Cognitive appraisal is the process through which a person evaluates the particular encounter and identifies the potential stressors (Folkman, Lazarus, Dunkel-Schetter, et al., 1986; Folkman, Lazarus, Gruen, & DeLongis, 1986), and was classified into two kinds: primary and secondary appraisal. In primary appraisal, the person evaluates situational demands and personal relevance to determine the extent to which environmental stressors are threatening or challenging (Lazarus & Folkman, 1984), while in secondary appraisal, various coping options are assessed to see if anything can be done to overcome the problem or prevent harm. In the context of COVID-19, therefore, primary appraisal of medical workers should stand mainly for perceived risk and danger of infection in life and of failing in jobs, and secondary appraisal for perceived control and trust in whether the pandemic can be effectively dealt with. Researches showed that stress-related primary and secondary appraisals were closely associated with individual optimism, coping, and adjustment (Chang, 1998). Coping consists of the particular thoughts and behaviors a person is using to manage "the internal and external demands of the person-environment transaction" (Lazarus & Folkman, 1987). In Lazarus and Folkman's theory, coping was divided into categories: problem-focused coping (PFC) and emotion-focused coping (EFC). PFC refers to the efforts made to alter the situation and eliminate the threat, while EFC stands for strategies taken to reduce emotional discomfort triggered by the situation. In previous studies, PFC has been reported

to be positively related to well-being indicators and decreased psychological discomfort under stress (Grossi, 1999; Wong et al., 2016), whereas EFC has presented more inconsistent results about its relationship with mental health (Lorente et al., 2021). Cognitive appraisal and coping strategies have been proved to be closely related. Studies found that PFC strategies such as planful problem solving were used more when a goal at work was assessed to be at stake in primary appraisal, and when situations were evaluated as capable of being changed in secondary appraisal (Folkman, Lazarus, Dunkel-Schetter, et al., 1986; Folkman, Lazarus, Gruen, & DeLongis, 1986). EFC, in turn, were applied more if one's own health was in danger or when the encounters were appraised as unchangeable. For front-line healthcare workers in COVID-19 pandemic, both goals at work and physical health were at stake. Perceived threats from the disease, as well as distrust in infection control may directly bring about emotional disturbance in medical workers, and by reducing effective coping, further aggravates depressive symptoms and anxiety.

In the meantime, individuals of different genders may perceive the pandemic very differently, and these differences may lead to different responses for men and women, as well as different effects of the pandemic on the mental health of male and female healthcare workers. A study on female and male characteristics showed that masculine traits had a positive relationship with challenge appraisals, and had a negative relationship with threat appraisals, whereas feminine traits appeared no robust correlations with challenge appraisals, but were positively associated with threat appraisals (Sarrasin et al., 2014). This suggested that while male healthcare workers may tend to view the outbreak as manageable, female workers are more likely to view the demands of the situation exceeding the resources they possess. Thus, the latter may be more vulnerable to negative environmental stimulus of COVID-19, growing more negative thoughts that cause further impact on their mental health. Additionally, research focusing on sex difference on trauma indicates that, compared with men, women tend to evaluated traumatic events more negatively (for all types of trauma) and the relationship between trauma and mental disorder symptoms was also stronger in women (Kucharska, 2017). In addition to the ease of being impacted, there are also differences in coping strategies. In Howerton and Van Gundy (2009), female respondents were more likely to conduct emotion-oriented strategies compared to male respondents, such conduction did not prove to be fundamentally harmful for women. However, they also brought up that the effects of using emotion-focused strategies, such as the expression of feelings, actually reduced depressed mood for women, but not for men. Therefore, whether male and female appraise and cope with COVID-19 differently needs to be further discussed.

This study focuses on investigating how pandemic has influenced frontline healthcare workers' mental health through appraisal and coping, and the role gender plays in these effects. We hypothesized that: (a) front-line healthcare workers who are exposed of confirmed patient would be more likely to experience psychological symptoms and other mental health issues, through the mediation of pandemic-related cognitive appraisal and coping strategies. (b) Among these

effects, gender would play as an important moderator, with women appraising the pandemic more negatively, coping with the pandemic differently and tending to report worse mental health than men. (c) PFC would have a positive effect on mental well-being of medical staff, while an exploratory test to be conducted on the efficiency of EFC. By testing these hypotheses, we hope to contribute to relevant theories on appraisal and coping, and provide suggestions on psychological health programs for medical workers in future infectious outbreaks.

2 | METHODS

2.1 | Participants and procedure

A cross-sectional survey using an online questionnaire was conducted in mid-February 2020. A hospital in Wuhan that was set to treat patients with new coronary pneumonia was chosen, and we then contacted its doctors in charge of the ward through the social network WeChat (the most popular messaging app in China). The survey link was then distributed to the staff through WeChat to be filled in anonymously, in which participants were informed that their participation was completely voluntary, and consent was implied on completion of the questionnaire. After the completion of the questionnaire, participants were compensated a small amount of test fees (10 RMB). The inclusion criteria were: working in designated hospitals for the treatment of patients with COVID-19; local or assigned medical staff from other cities.

2.2 | Measures

The survey consisted of five sections that assessed (1) demographic background, (2) psychological symptoms, (3) infection risk related thoughts, (4) trust in infection control, and (5) pandemic coping. In the first section, besides demographic information, we also asked participants to report whether they had direct contact with confirmed patients at workplace (but not family members who were infected), as a measurement of COVID-19 exposure. The questions on infection risk related thoughts, trust in infection control and pandemic coping were adapted from scales in former pandemic studies on SARS or MERS (Lee et al., 2018; Marjanovic et al., 2007; Wu et al., 2009), which had investigated risk perception, coping strategies, or other psychological impact of either outbreak on hospital workers.

Psychological symptoms were measured by Mental Health Self-reporting Questionnaire-20 (SRQ-20), a self-reported mental health questionnaire recommended by WHO. The scale has 20 entries, each scoring 2 points. Higher score indicates higher levels of psychological imbalance. The guidance manual of SRQ published by WHO promoted the reference index to be 7 or 8 points (Beusenberg, Orley, & World Health Organization, 1994), while research has suggested a reference index of 6 or 7 so as to be more sensitive and specific in Chinese population (Chen et al., 2009). Studies by Jiang et al. (2010) have shown that the reliability and validity of the scale is good but should

be used as a one-dimensional scale for that the substructure is not yet clear.

Infection Risk Related Cognition Questionnaire measures healthcare workers' thoughts about the risk and consequences of the pandemic as a test for primary appraisal, with a total of 11 entries such as "I fear that I am infected," "I fear that my family will be infected," etc. Items are on a 5-point Likert scale ranging from 1 (completely out of line) to 5 (very consistent). Higher scores indicated more infection-related negative emotions and thoughts. Cronbach's alpha of the questionnaire in the current study is 0.93.

Trust in Infection Control Questionnaire included altogether four entries, such as "I believe the outbreak can be effectively controlled," "I think the existing protective measures can effectively block the virus," to test perceived sense of control and trust as secondary appraisal. Items are rated on a 5-point Likert scale, ranging from 1 (being completely inconsistent) to 5 (being very consistent). Higher scores indicate higher levels of trust in equipment/infection control. Cronbach's alpha of the questionnaire in the current study is 0.89.

Pandemic Coping Questionnaire assess individuals' tendency for PFC and EFC. PFC is measured through six items such as "Being aware of self-protection measures (e.g., hand washing, wearing masks, temperature detection, etc.)," while EFC is measured through 3 items such as "Releasing Emotions through Crying, Shouting, etc." Items are on a 5-point Likert scale ranging from 1 (Never) to 5 (Always). Higher total scores on either part indicate taking PFC or EFC strategies more frequently. Cronbach's alpha of the problem-focused part and emotion-focused part in the current study were 0.89 and 0.78, respectively.

2.3 | Statistical analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences, version 20.0. Reliability of the adapted questionnaires was evaluated by assessing the internal consistency of the items representing the scores. In descriptive statistics, numbers, and percentages were reported to summarize the data on categorical variables. T tests and ANOVAs were conducted to examine COVID-19 exposure and demographic differences in psychological symptoms. To further address the roles that appraisal and coping played, Pearson correlation tests were used to see the relationships among all main variables, while two-way ANOVAs were run to examine effects of COVID-19 exposure, gender, and their interactions on primary appraisal, secondary appraisal, PFC, and EFC, respectively. Afterward, the proposed model of COVID-19 exposure was tested by path analysis, with bootstrap procedure used to examine the mediating effects of primary and secondary appraisals and PFC. A p-value of less than .05 (two-tailed) was taken to indicate statistical significance.

2.4 | Ethics approval

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to and the

appropriate ethical review committee approval has been received. The survey had been reviewed by the Medical Ethics Committee of Peking University Health Science Center.

3 | RESULTS

3.1 | Sample characteristics

Characteristics of the sample are shown in Table 1. Of the 311 participants included in the study, 84 (27.0%) were male and 227 (73.0%) were female. Two hundred and seventeen (69.8%) of them were from Wuhan and 94 (30.2%) were aid medical personnel from other cities.

A majority of the participants were nurses (61.4%), 25.4% were doctors and 13.2% were medical technicians. Just over half of them reported to have direct contact with confirmed patients and about two thirds had contact with suspected patients. Seven (2.3%) participants reported that they had family members infected with COVID-19.

3.2 | Psychological symptoms of healthcare workers and effects of COVID-19 exposure and demographic variables

Overall, the mean score of SRQ-20 of medical staff was 5.06 ± 4.78, with a median score of 4 (range: 0–20). With score out of 6 defined as the cutting mark (Chen et al., 2009), 190 people (61.1%) in our sample scored less than 6 (average score of 1.80 ± 1.68), suggesting no or less psychological symptoms, and 121 (38.9%) scored 6 or more (average score of 10.16 ± 3.39), suggesting more psychological symptoms.

T tests and ANOVAs were used to examine COVID-19 exposure and demographic differences in psychological symptoms. Results indicated that effect of COVID-19 exposure was significant. Healthcare workers directly contacting with patients with COVID-19 reported higher level of psychological symptoms than those who did not have to contact with the patients (5.90 ± 4.73 vs. 4.07 ± 4.66, $t(309) = -3.42$, $p = .001$).
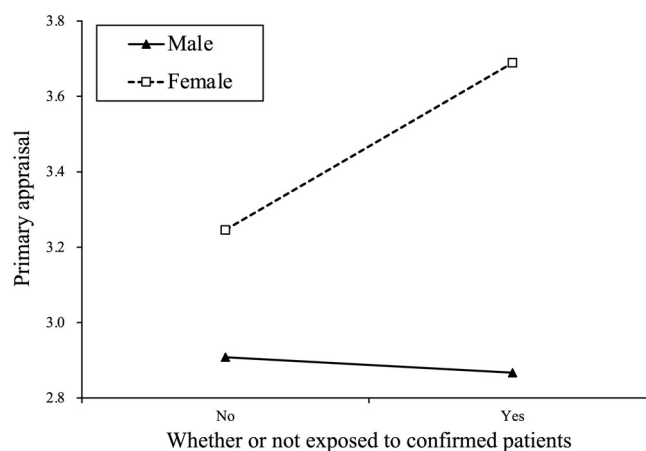
Regarding the demographic differences, effects of gender and affiliation of participants were significant and the effect of career was marginally significant. Specifically, female healthcare workers reported higher level of psychological symptoms compared with male healthcare workers (5.49 ± 4.87 vs. 3.89 ± 4.33, $t(309) = -2.64$, $p = .009$). Local healthcare workers reported greater psychological symptoms than the aid team members from other cities (5.61 ± 5.08 vs. 3.79 ± 3.73, $t(309) = -3.53$, $p = .001$). Nurses (5.56 ± 4.87) reported the highest level of psychological symptoms, followed by doctors (4.47 ± 4.49) and administrators (3.85 ± 4.64), $F(2, 308) = 3.00$, $p = .051$.

3.3 | Effects of COVID-19 exposure and gender on pandemic-related appraisals and coping strategies

Two-way ANOVAs were run to examine effects of COVID-19 exposure, gender, and their interactions on primary appraisal, secondary appraisal, PFC, and EFC, respectively. Results yielded significant main effects of COVID-19 exposure ($F(1, 307) = 3.89$, $p = .050$, $\eta^2 = .013$) and gender ($F(1, 307) = 14.27$, $p < .01$, $\eta^2 = .045$) and a significant interaction effect on primary appraisal ($F(1, 307) = 4.41$, $p = .037$, $\eta^2 = .014$). Higher levels of risk perception were reported by healthcare workers contacting with patients with COVID-19 and females. Moreover, as displayed in Figure 1, as level of exposure rose, female medical staff developed more negative thoughts, while among male workers, the number of negative thoughts did not change significantly.

Using secondary appraisal as the independent variable, only the effect of gender was significant ($F(1, 307) = 8.04$, $p = .005$, $\eta^2 = .026$), suggesting that female healthcare workers had higher level of secondary appraisal than men regardless of exposure to confirmed patients.

Effects of COVID-19 exposure, gender, and their interaction term were not significant on PFC and EFC.

TABLE 1 Sample characteristics (N = 311)

Variable		N (%)
Gender	Male	84 (27.0)
	Female	227 (73.0)
Affiliation	Local hospital	217 (69.8)
	Aid teams	94 (30.2)
Career	Doctors	79 (25.4)
	Nurses	191 (61.4)
	Administrators	41 (13.2)
Contact with confirmed patients	Yes	168 (54.0)
	No	143 (46.0)
Family member infected	Yes	7 (2.3)
	No	304 (97.7)

FIGURE 1 Interactive effects of gender and COVID-19 exposure

3.4 | Correlations among COVID-19 exposure, pandemic-related appraisals, coping strategies, and psychological symptoms

Correlations among main variables are demonstrated in Table 2. COVID-19 exposure and pandemic-related primary appraisal were positively correlated with psychological symptoms while PFC and EFC were negatively correlated with psychological symptoms.

3.5 | Model testing and comparisons

The PFC model was examined with COVID-19 exposure as the independent variable, the score of SRQ-20 as the outcome variable and primary and secondary appraisals and PFC as mediators.[2] Results indicated that psychological symptoms were positively predicted by COVID-19 exposure ($\beta = .13$, $p < .05$) and primary appraisal ($\beta = .55$, $p < .01$) while negatively predicted by secondary appraisal ($\beta = -.30$, $p < .01$) and PFC ($\beta = -.26$, $p < .01$). PFC was negatively related with COVID-19 exposure ($\beta = .11$, $p < .05$) and positively related with secondary appraisal ($\beta = .50$, $p < .01$) but not associated with primary appraisal ($\beta = -.11$, $p > .05$). COVID-19 exposure was positively associated with primary appraisal ($\beta = .21$, $p < .01$) and usage of PFC ($\beta = .11$, $p < .05$) while not associated with secondary appraisal ($\beta = .08$, $p > .05$). All the path coefficients were displayed in Figure 2.

As results of mediation analyses indicated, the direct effect of COVID-19 exposure was significant ($\beta = .13$, $SE = 0.05$, 95% CI = [0.04, 0.22]), mediating effect of primary appraisal was significant (effect = 0.11, $SE = 0.03$, 95% CI = [0.05, 0.19]) and the mediating effect of PFC was also significant (effect = -0.03, $SE = 0.01$, 95% CI = [-0.07, -0.01]). Other hypothesized mediating effects were not significant.

The PFC model was also examined using gender as the grouping variable. Frist, all the pathway coefficients were estimated freely (Model 1). Next, pathway coefficients for the models of different genders were set identical (Model 2). As demonstrated in Table 3, the model fitness became worse significantly, $\Delta\chi^2(10) = 21.27$, $p = .019$. Therefore, the pathway coefficients for males and females were different.

For female participants, COVID-19 exposure impacted psychological symptoms through the mediation of primary appraisal and PFC. Secondary appraisal directly predicted decrease of psychological symptoms and also impacted symptoms through the mediation of PFC (Figure 3a). For male participants, COVID-19 exposure was not associated with pandemic-related primary appraisal, secondary appraisal, and PFC (Figure 3b).

The EFC model was also examined. Results of path analysis suggested that psychological symptoms was positively predicted by COVID-19 exposure ($\beta = .10$, $p < .05$) and primary appraisal ($\beta = .58$, $p < .01$) and negatively predicted by secondary appraisal ($\beta = -.43$, $p < .01$) and EFC ($\beta = -.17$, $p < .01$). Different from PFC, EFC was neither significantly related with COVID-19 exposure ($\beta = .03$, $p > .05$), primary appraisal ($\beta = -.02$, $p > .05$) nor secondary appraisal ($\beta = -.03$, $p > .05$) (see in Figure 4).

The bootstrap procedure was used to examine the mediating effects. As results indicated, the direct effect of COVID-19 exposure was significant ($\beta = .10$, $SE = 0.05$, 95% CI = [0.01, 0.19]) and the

TABLE 2 Correlations among COVID-19 exposure, pandemic-related appraisals, coping strategies, and psychological symptoms

|	1	2	3	4	5	6	7
1. Gender	1						
2. COVID-19 exposure	.14*	1					
3. Primary appraisal	.23**	.21**	1				
4. Secondary appraisal	.17**	.08	.57**	1			
5. Problem-focused coping	.08	.13*	.20**	.45**	1		
6. Emotion-focused coping	.06	−.03	<.001	−.02	.36**	1	
7. Psychological symptoms	.15**	.19**	.35**	−.09	−.26**	−.17**	1

Note: *p < .05, **p < .01.
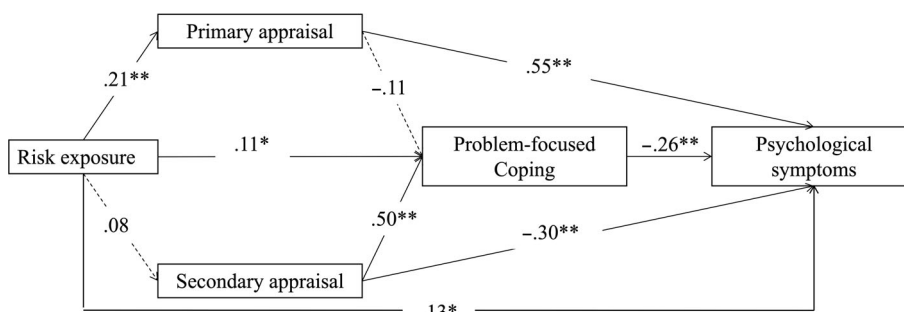
FIGURE 2 The associations among COVID-19 exposure, pandemic-related appraisals, problem-focused coping (PFC), and psychological symptoms. *p < .05, **p < .01, ***p < .001

	χ^2	df	CFI	TLI	RMSEA	$\Delta\chi^2$	Δdf	*p*
The PFC[a] model								
Model 1	0	0	1	1	0			
Model 2	21.27	10	0.96	0.93	0.085	21.27	10	0.019
The EFC[b] model								
Model 1	0	0	1	1	0			
Model 2	18.90	10	0.96	0.92	0.076	18.90	10	0.045

TABLE 3 Comparison of model fitness indices for examining gender differences in pathway coefficients

[a]PFC, problem-focused coping.
[b]EFC, emotion-focused coping.
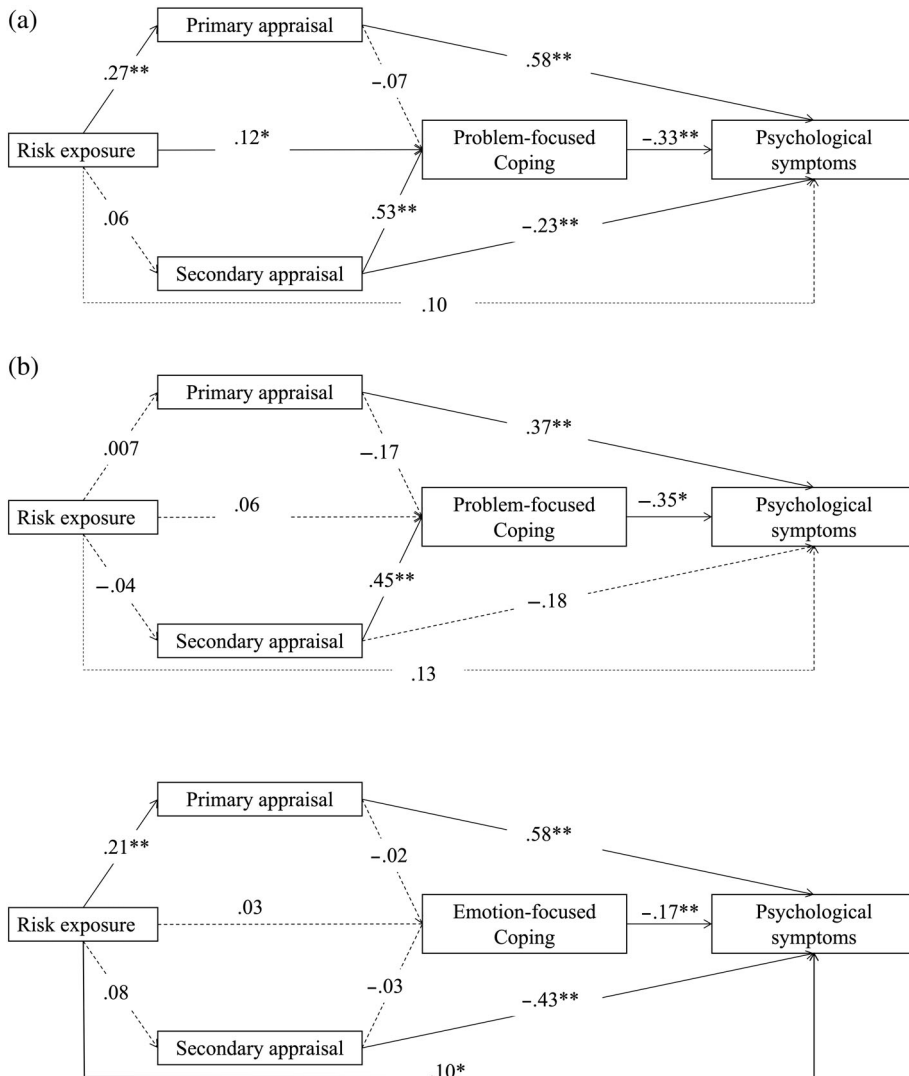
FIGURE 3 The associations among COVID-19 exposure, pandemic-related appraisals, problem-focused coping (PFC), and psychological symptoms: (a) for females and (b) for males.
*p < .05, **p < .01

FIGURE 4 The associations among COVID-19 exposure, pandemic-related appraisals, emotion-focused coping (EFC), and psychological symptoms. *p < .05, **p < .01, ***p < .001

mediating effect of primary appraisal was significant (effect = 0.12, SE = 0.04, 95% CI = [0.06, 0.20]) but all the other mediating effects were not significant.

The PFC models for females and males were estimated separately by using gender as the grouping variable. Frist, all the pathway coefficients were estimated freely (Model 1). Next, pathway coefficients for the models of different genders were set identical (Model 2). The model fitness of Model 2 became worse significantly, $\Delta\chi^2$(10) = 18.90,

p = .045. Similar to the results for the PFC model, the pathway coefficients of the EFC model for males and females were different.

For female participants, COVID-19 exposure was related with the increase of psychological symptoms through the mediation of primary appraisal. Secondary appraisal and EFC contributed to the decrease of psychological symptoms (Figure 5a). For male participants, only primary appraisal and secondary appraisal were significant predictors of psychological symptoms (Figure 5b).

FIGURE 5   The associations among
COVID-19 exposure, pandemic-related
appraisals, emotion-focused coping (EFC),
and psychological symptoms: (a) for
females and (b) for males.
*p < .05, **p < .01
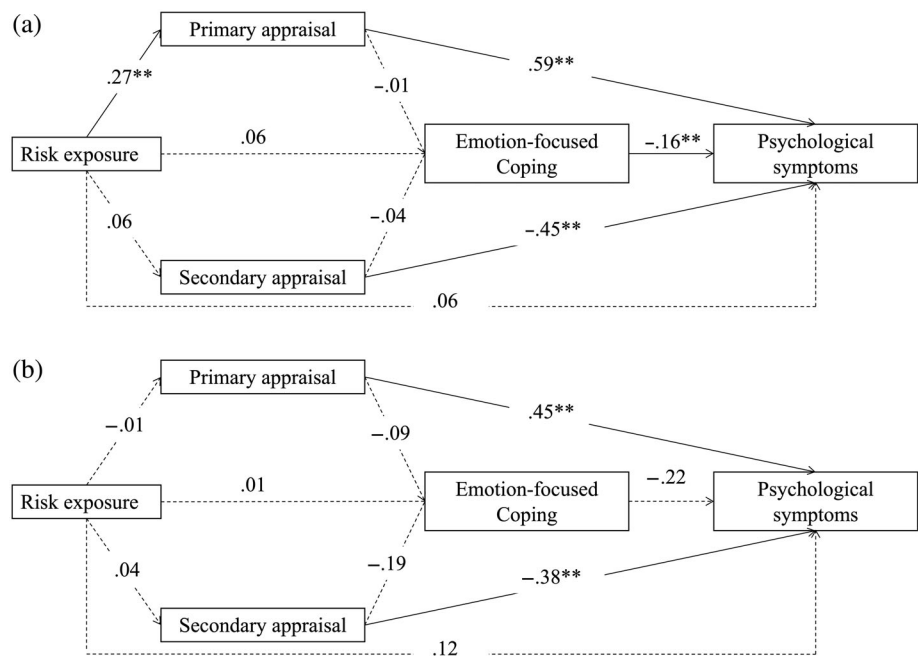
4 | DISCUSSION

The results of our study, which aimed to investigate the relationship between appraisal, and coping strategies and psychological symptoms of front-line medical staff fighting against COVID-19, showed that 38.9% of first-line healthcare workers had above threshold psychological symptoms including anxiety, depression, and somatization. This prevalence rate was similar to that stated in the study of Amin's and Zhang's, who both found an approximate 40% prevalence of anxiety/depression among frontline physicians (Amin et al., 2020; Zhang et al., 2020). The number was also close to an approximately 35% of healthcare workers having psychological symptoms during SARS (Cheng et al., 2004), providing a consistent overview on the general psychological impact of acute pandemic on frontline medical workers. Female gender, nurses, and direct contact with diagnosed patients were associated with more symptoms displayed.

Looking at the whole model, our results generally supported Lazarus and Folkman's (1987) transactional theory, in which environment and person interact through appraisal and coping. We found that COVID-19 exposure significantly affected psychological symptoms among healthcare workers, but through two divergent paths. On one hand, exposure to higher risk increased primary appraisals (risk perception) and bring about more psychological symptoms. On the other hand, COVID-19 exposure directly linked with PFC, and reduced psychological symptoms through increased usage of problem-solving strategies. These findings were consistent with several researches studying other groups, according to which perceived high risk of the infection was significantly, though sometime weakly, related to greater emotional distress and depression during a pandemic (Shi et al., 2003; Xin et al., 2020). Previous studies also reported that psychological symptoms can be reduced through more usage of PFC (Grossi, 1999; Wong et al., 2016).

Contrary to findings on primary appraisal, secondary appraisal turned out to be unrelated with COVID-19 exposure, but closely related with PFC. According to Lazarus and Folkman's definition, secondary appraisal assesses resources, coping options, and is related with subjective sense of changeability, suggesting its closer connection with individual factors such as self-efficacy and sense of control. Defined as one's belief in one's own capability to complete a task or achieve a goal (Bandura, 1997), self-efficacy working as a resource factor in coping (Schwarzer & Jerusalem, 1995) and contributing to stress reactions including secondary appraisal (Prati et al., 2010). The relation between secondary appraisal and PFC were proposed by Folkman and his colleagues, and proved in studies by them (Folkman, Lazarus, Dunkel-Schetter, et al., 1986) as well as in more recent researches (Zhou et al., 2021). While some researchers found that secondary appraisal had a direct link with individuals mental well-being (Elliott & Daley, 2013; Marjanovic et al., 2007), others discovered its indirect effect, that perceived organizational support affected PTSD symptoms through the mediation of PFC strategies and the sequential mediating effect of coping self-efficacy and PFC (Zhou et al., 2021).

Further analyses on the model reveals the moderating effect of gender in the relations found. Exposure to confirmed patients had a significant effect on female's primary appraisal and PFC, but not on male's, resulting from which the two paths of COVID-19 exposure's impact on psychological symptoms remained only in female. This discrepancy may be caused by different sensitivity toward risk among men and women. In previous researches, women have been found with a more negative cognitive style, and correspondingly higher cognitive vulnerability under stressful life events (Mezulis et al., 2010), while men were frequently reported to display higher risk propensity and more risk-taking behaviors (Gowen et al., 2019; Korn & Bonny-Noach, 2018). Besides, men and women have also been reported to

appraise and interpret risky events differently as to how challenging and threatening they are (Sarrasin et al., 2014). It is possible that male healthcare workers perceived the pandemic as more manageable, scored and maintained a low level in primary appraisal, whereas female medical staff found it more threatening, thus reporting stronger fear of being infected when exposed to confirmed patients. The gender differences in perception and reaction toward risky situations may have contributed to the distinct behaviors and outcomes found in female and male in same encounters, inspiring us to take better account of gender in measurement of stressful event processing. Further studies are also recommended regarding whether gender differences in challenge and threat appraisals contribute to the variance that men and women display on primary appraisal as well as the psychological consequences arising therefrom.

As for the other type of coping, no connection was found between EFC and the following variables respectively: primary appraisal, secondary appraisal, and COVID-19 exposure, despite EFC held a protective effect against psychological symptoms. It is possible that primary and secondary appraisals are mainly cognitive processes, so that they do not move through emotion-coping strategies toward psychological symptoms. The effect may also be neutralized as strategies targeting emotions were found to have inconsistent outcomes and can be classified as negative and positive ones, which may be affected by environmental stimulus and cognitive appraisals differently (Connor-Smith & Flachsbart, 2007). A third explanation for the irrelevance between these variables is that the result may be skewed by a floor effect for that the EFC scores reported in our research is relatively low as a whole. Future studies could draw more attentions to other factors such as individual dispositions that may affect EFC, or look at these connections in various scenarios with a more detailed classification.

Overall, this research generalized the transactional model of Lazarus and Folkman in healthcare workers during COVID-19, providing more evidence for environment-person interaction through appraisal and coping, and in particularly through primary appraisal and PFC. Gender was added as an important variable and specific relations and models among stress, appraisal, coping, and symptoms were found in male and female healthcare workers. Under high-risk circumstances, male and female differ in the inner processing model of stress, specifically on the cognitive vulnerability to environmental risk. Practically, as female healthcare workers are more sensitive to COVID-19 exposure and may lead to greater mental distress, institutional measures such as reducing the frequency or time of patient contact should be considered and investigated to see whether it can alleviant the problem. Besides, more organizational support and strategies to increase sense of control should be provided for medical workers, since secondary appraisal showed a stable effect on PFC and on relieving psychological symptoms. In addition, both PFC and EFC proved to be protective against psychological symptoms. Therefore, it may be helpful if hospitals and other facilities offer both solutions to the happening problem and advice on emotion regulation, and facilitate employees' mental relaxation.

There are several limitations in this research. First, participants were recruited in one hospital in Wuhan, some of whom were not working in isolation wards. The results need to be further replicated with larger and more diverse samples. Second, with the cross-sectional design, the findings regarding the psychological symptoms and its factors can only suggest correlated relations rather than causal relations. Also, this research has paid close attention to the time when the pandemic was most severe and when the medical staff were under biggest pressure. However, due to time limitation and other restrictions, there were no data on mental status before and after this period. It is unsure how their psychological symptoms might have changed at the sudden outbreak, and how the symptoms might have evolved with the pandemic gradually getting under control. Therefore, longitudinal researches are needed to examine the long-term effect of cognitive factors and coping strategies on meeting the challenge of major public health events.

5 | CONCLUSION

Our findings suggested that the COVID-19 pandemic had a significant impact on healthcare workers' mental well-being through the mediation of appraisal and coping, providing more evidence for Lazarus and Folkman's transactional theory. While primary appraisal was more closely related with COVID-19 exposure, secondary appraisal was more related with PFC. In addition, sex difference was found, with female medical staff showing to be more vulnerable to COVID-19 exposure. Future studies are needed to further explore the role of gender in cognitive processes relevant to stress and coping. Mental health programs based on appraisal and coping should also be developed for future infectious disease outbreaks in order to alleviate potential psychological influence.

CONFLICT OF INTEREST
The authors have no competing interests to report.

ENDNOTES
[1] WHO Coronavirus (COVID-19) Dashboard. https://covid19.who.int/ Retrieved on October 1, 2021.

[2] Affiliation and career were used as covariates because of their significant effects on psychological symptoms.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ORCID

Chen Chen 🔟 https://orcid.org/0000-0001-7828-4929
Ting Zhou 🔟 https://orcid.org/0000-0002-0988-7950

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