Mental fatigue and negative emotion among nurses during the COVID-19 pandemic

Difan Wang[1,2] · Xinjie Xie[1] · Huiyi Tian[1] · Tong Wu[1] · Chenjie Liu[3] · Ke Huang[4] · Rufang Gong[5] · Yaqun Yu[6] · Tinggang Luo[7] · Runda Jiao[8] · Lin Zhang[1]

Abstract

COVID-19 is a major public health event affecting the people worldwide. Nurses are still under immense psychological pressure. This study aimed to explore the relationship between mental fatigue and negative emotions among frontline medical staff during the COVID-19 pandemic. The study was conducted in August 2020, which included 419 medical staff between 17 to 28 years. The Fatigue Scale, Multidimensional Mental Flexibility Questionnaire, Cognitive Fusion Scale, and Depression-Anxiety-Stress Brief Version Scale were used. During the data collection period, the pandemic was under control in China and continued worldwide. The results indicated that 27.7% of the medical staff experienced depression, and 32.3% of them feel stressed. Specifically, first, correlation analyses showed significant positive pairwise correlations between mental fatigue, psychological inflexibility, cognitive fusion, and negative emotions among nurses. Second, mediation model tests showed statistically significant mediating effects of psychological inflexibility and cognitive fusion between mental fatigue on nurses' negative emotions, and statistically, significant chain mediating effects of psychological inflexibility and cognitive fusion. Mental fatigue indirectly affects nurses' negative effects through the mediating effects of psychological inflexibility, cognitive fusion, and the chain mediating effects of psychological inflexibility and cognitive fusion, respectively. the negative effects of mental fatigue come from impairment of cognitive functioning, and interventions using acceptance and commitment therapy for mental fatigue and negative emotions are more effective since both psychological inflexibility and cognitive fusion are important components of the therapy.

Keywords Mental fatigue · Negative emotions · Psychological inflexibility · Cognitive fusion

Introduction

Nurses, the largest component of the healthcare workforce, have played a mainstay role throughout the Coronavirus Disease 2019 (COVID-19) outbreak in December 2019 to date,

Difan Wang and Xinjie Xie contribute equally.

✉ Lin Zhang
lin_zhang@ccnu.edu.cn

1 School of Psychology, Key Laboratory of Adolescent Cyberpsychology and Behavior, Ministry of Education, Key Laboratory of Human Development and Mental Health of Hubei Province, Central China Normal University, Wuhan, China

2 Department of Field Internal Medicine, Psychological Counseling and Training Center, Graduate School of Medical College of Chinese PLA Hospital, Beijing 100853, China

3 Wuhan Children's Hospital(Wuhan Maternal and Child Healthcare Hospital), Tongji Medical College, Huazhong University of Science & Technology, Wuhan 430016, China

4 Human Resources Department, General Hospital of PLA, Beijing 100853, China

5 Liquid Distribution Center, The First Medical Center of General Hospital of PLA, Beijing 100853, China

6 Department of Cardiovascular Surgery, The First Medical Center of General Hospital of PLA, Beijing 100853, China

7 Department of Infection Control, Characteristic Medical Center of the Chinese People's Armed Police Force, Tianjin 300162, China

8 Graduate School of Medical School of General Hospital of PLA, Beijing 100853, China

containing the spread of infectious diseases in the absence of protection, high exposure, and intense workload (Mo et al., 2020). Existing studies have found that a country with a greater proportion of registered nurses can maintain lower levels of COVID-19 mortality, demonstrating the importance of a robust nursing team to national public safety (Arnetz et al., 2020). However, the psychological hazards of pandemic transmission to frontline caregivers are enormous. For example, both the 2003 outbreak of Severe Acute Respiratory Syndrome (SARS) and the 2005 outbreak of the Middle East respiratory syndrome made health care workers suffer from mental illness and psychological disorders (Lee et al., 2018; Tam et al., 2004). Moreover, a previous study found that the prevalence of anxiety, depression, and stress among nurses during COVID-19 exceeded 25%, indicating that the impact was not short-term but will jeopardize nurses' mental health in a long term (Sun et al., 2021).

Mainstream media from several countries have reported the current situation of the nurse population. This group is facing a potential risk of fatigue and emotional distress (Arnetz et al., 2020). These psychological problems can last for at least a few months and can exert a serious impact on occupation and health. Thus, understanding the possible causes and influencing factors that render the medical staff more vulnerable to psychological problems means fewer malignant nursing events and less risk of burnout and turnover (Giusti et al., 2020). Therefore, based on the problem of high fatigue and emotional distress in the nurse population during the COVID-19 pandemic, the present study aimed to examine the relationship between mental fatigue and negative emotions among nurses from a psychological perspective, explore the mechanism from mental fatigue to alleviate negative emotions of nurses and to provide theoretical support for later psychological interventions for nurses. In addition, we tested whether psychological inflexibility and cognitive fusion interact in some meaningful form between mental fatigue and negative emotions.

Mental fatigue and negative emotions

The worldwide nurse workforce has always been strained. Long working hours and lack of sleep being two important factors contributing to fatigue (Bagheri Hosseinabadi et al., 2019). During COVID-19, nurses worked more intense hours compared to the past and had a severe lack of sleep quality, resulting in high levels of chronic fatigue. Mental fatigue is a feeling of restlessness and exhaustion that arises when an individual is engaged in a single or high-intensity task that triggers physical fatigue (Sagherian et al., 2020). Its main manifestations are distracting attention and reduced efficiency, accompanied by impaired cognitive and behavioral performance (Novakov, 2021). Those nurses who feel higher levels of fatigue likewise experience more intense

negative emotions such as depression, anxiety, and stress (Mitchell et al., 2021). In terms of the manifestation of mental fatigue, increased negative emotions may be associated with impaired cognitive function. Due to the prolonged and frequent exposure of nurses to acute stressful events, the brain's reward circuitry is more likely to be impaired and thus unable to experience pleasurable emotions, thereby exacerbating negative emotions problems such as depressive tendencies in this group (Monroe et al., 2020). However, while the role of fatigue has been confirmed in studies of negative emotions (Storm & Chen, 2021), mental fatigue has been less studied. The known is that mental fatigue impairs emotion regulation without affecting emotion reactivity, (Grillon et al., 2015). Cognitive Load Theory suggests that individual cognitive resources are limited, and emotion regulation requires effortful cognitive control (Sweller et al., 1994). So mental fatigue impairs emotion regulation as increasing cognitive load. And impairment of emotion regulation may be the culprit in bringing on more negative emotions (Plass & Kalyuga, 2019). In the context of COVID-19, we believe that interventions at the psychological level are feasible and can reduce negative emotions in nurses, thus necessitating further exploration of the relationship between mental fatigue and negative emotions.

The mediating role of psychological inflexibility

Since it is believed that the effect of mental fatigue on negative emotions may be related to impaired cognitive functioning, a psychological intervention at the cognitive level would be more appropriate. Acceptance commitment therapy (ACT) is one of the most representative therapeutic approaches in cognitive-behavioral therapy, where the therapeutic goal is to help acceptance of current mental and emotional experiences, which is compatible with the negative emotions we will study (Thompson et al., 2021). psychological inflexibility (PI) is one of the core concepts of ACT, and another core concept is called psychological flexibility (PF). psychological inflexibility is a complex and dynamic psychological construct that refers to the lack of context-matched adaptation in an individual's interaction with the environment process (Hayes et al., 2006). Previous studies have shown that executive function is a major influence on psychological inflexibility, which is the brain's ability to optimally integrate cognition, i.e., purposefully refocus or rapidly shift cognitive stereotypes (van der Linden et al., 2003). However, mental fatigue makes individuals' executive functions impaired, leading to an inability to continuously focus on situational needs and thus to match and adopt optimal strategies, resulting in significantly reduced psychological flexibility (Jacquet et al., 2021). In addition, psychological inflexibility significantly affects negative emotions such as anxiety and depression, leading to a range of

psychological problems such as emotional distress, post-traumatic stress disorder (PTSD), and burnout (Fidao et al., 2021). A Spanish study during the COVID-19 pandemic showed that psychological inflexibility predicted changes in mental health (Hernández-López et al., 2021).

The mediating role of cognitive fusion

Cognitive fusion refers to an individual's association of negative emotional reactions with contingent events, over-confidence in internal thoughts, and immersion in thoughts, words, or evaluations, resulting in negative thoughts and emotions reinforcing each other (Geiger & Kwon, 2010). The predictive role of cognitive fusion on psychopathological indicators of stress, depression, and anxiety has been demonstrated in previous studies (Bramwell & Richardson, 2018), and excessive cognitive fusion implies poorer emotion regulation, such as mood disorders (Wersebe et al., 2018). To ensure the safety of patients' lives and the quality of care, nurses need to devote more attentional resources to and prioritize the processing of negative information in the context, such as negative emotions and symptoms of deterioration, i.e., always maintain an attentional bias towards negative information (Cabrera et al., 2021). Individuals in a state of mental fatigue may not able to perceive andinhibit negative information from entering working memory, and even long-term memory, due to impaired cognitive control, and eventually develop a negative cognitive bias (Wersebe et al., 2018).

The chain mediating role of psychological inflexibility and cognitive fusion

ACT considers cognitive fusion as a key feature of psychological inflexibility (Hayes et al., 2006), and the two are inextricably linked. A recent longitudinal study in ACT demonstrated that a correlation between mental fatigue and psychological inflexibility (Brugnera et al., 2021). Also, mental fatigue leads to reduced cognitive control and is more likely to trigger cognitive fusion (Bramwell & Richardson, 2018). Psychological inflexibility and cognitive fusion, as important diagnostic criteria for mental health, predict negative emotions (Xing et al., 2020). Thus, based on theoretical derivations and empirical evidence, mental fatigue, psychological inflexibility, and cognitive fusion all have an impact on negative emotions, and these three factors are correlated with each other. We believe that a simultaneous comparison of the three can further clarify the mechanism of the effect of mental fatigue on negative emotions and provide a strong theoretical basis for a practical psychological intervention approach.

This present study

The present study, firstly, aimed to examine the role of mental fatigue on negative emotions. Secondly, this study investigated the mediating role of psychological inflexibility between mental fatigue and negative emotions. Thirdly, this study explored the mediating role of cognitive fusion between mental fatigue and negative emotions. Finally, this study examined the role of psychological inflexibility and cognitive fusion in mediating the chain between mental fatigue and negative emotions. We proposed a conceptual model (Fig. 1) and the following hypotheses.
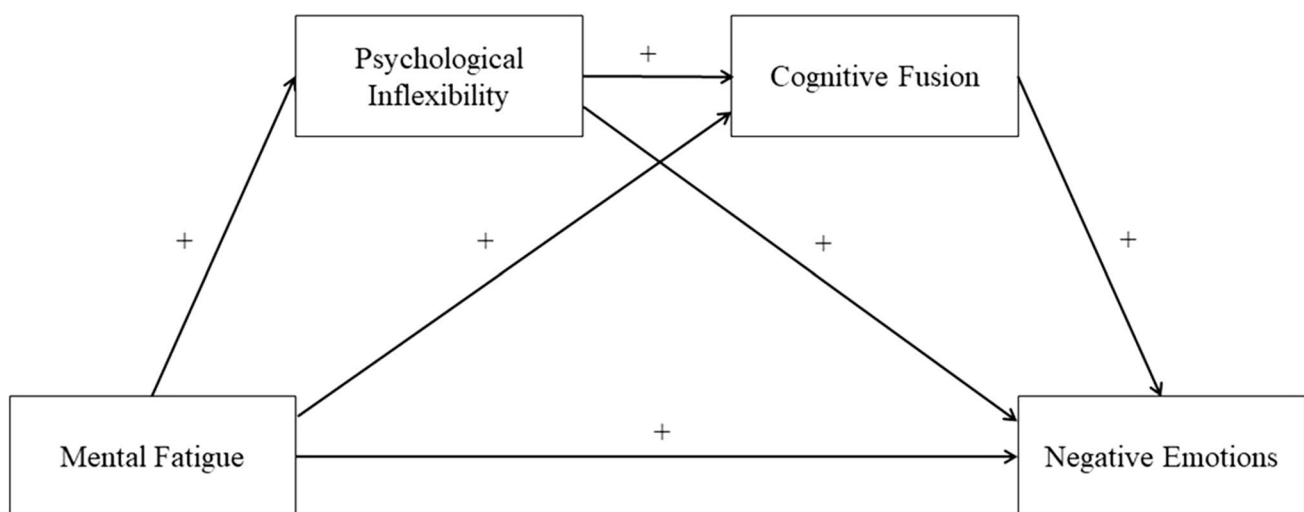

Fig. 1 Theoretical model

Hypothesis 1. Mental fatigue would be positively associated with negative emotions.

Hypothesis 2. Psychological inflexibility would mediate the association between mental fatigue and negative emotions.

Hypothesis 3. Cognitive fusion would mediate the association between mental fatigue and negative emotions.

Hypothesis 4. Mental fatigue would affect negative emotions through a serial mediation of psychological inflexibility and cognitive fusion.

Objective

To analyze nurses' mental fatigue and negative emotions in the post-pandemic era and analyze their correlations in order to seek effective psychological interventions.

Methods

Participants

An online survey was conducted in Beijing, China, in August 2020. A priori sample size was determined by the equation $n = \frac{Z^2[P(1-P)]}{E^2}$, in which the confidence interval is 95%. That is, at least 384 valid questionnaires need to be obtained. Therefore, the online questionnaires were distributed to 515 nurses after obtaining informed consent. For eachnurse, it took 8–10 min to complete the questionnaire. Of all subjects, 419 valid questionnaires were left after deleting the questionnaires with too many missing items (i.e., more than 20% of items were not answered) or too short answer time (i.e., the questionnaire completion time was less than 1 min), with an effective response rate of 81.4% eventually. The researcher obtained ethical approval from the Ethics Committee of Chinese People's Liberation Army General Hospital.

The mean age of our respondents was 27.99 years (SD = 6.1 years). A total of 325 (77.6%) participants were employed, 94 (22.4%) were non-employed. The education was undergraduate and college totaling 410 (97.9%). The professional titles were 215 (51.3%) for nurses, 109 (26%) for nurse practitioners, and 95 (22.7%) for supervising nurse practitioners.

Data gathering instrument

Fatigue Scale (FS-14) is revised by Zhang Zuoji et al. (Zuoji, 2015), has 14 questions, and contains two dimensions: physical fatigue and mental fatigue. Subjects who selected "yes" scored 1, and those who selected "no" scored 0. The total score was summed up. In this study, the mental fatigue dimension was used, and the higher the score, the higher the

level of mental fatigue. The Cronbach alpha coefficient in this study was 0.791.

Multidimensional Psychological Flexibility Inventory (MPFI), the Chinese version of the Multidimensional Psychological Flexibility Inventory translated by Lin et al. (Lin et al., 2020), has 60 questions and contains two dimensions: psychological flexibility and psychological inflexibility. Subjects were rated on six scales from "never" to "always", with scores from 1 to 6. We used the pathological model from Acceptance and Commitment Therapy to illustrate the negative effects of mental fatigue on mental states. Therefore, the dimension of psychological inflexibility was used in this study, with higher scores representing higher psychological inflexibility. The Cronbach alpha coefficient in this study was 0.970.

The Cognitive Fusion Questionnaire (CFQ) was revised by Zhang Weichen et al. (Zhang et al., 2014), with 9 questions and a unidimensional scale. Subjects were rated on seven scales from "apparently not conforming" to "apparently conforming", with scores ranging from 1 to 7, respectively. The higher the score, the higher the degree of cognitive fusion. The Cronbach alpha coefficient in this study was 0.965.

The depression anxiety stress scale (DASS-21) was revised by Gong Xu et al. (Xue et al., 2010) and consists of 21 questions containing three dimensions of depression, anxiety, and stress. Subjects were rated on a scale of "not meeting" to "most meeting", with scores ranging from 0 to 3, respectively. The total score of the three dimensions was interpreted as the level of negative emotions. The higher the score, the more severe the negative emotions. The reliability and validity were good. The Cronbach alpha coefficient in this study was 0.962.

Data analysis

This study used the SPSS 21 software package and PROCESS 3.5 to analyze the data. Harman's one-factor test was used to test for common method bias. Then descriptive statistical analysis and correlation analysis were performed. According to the hypotheses of this study, the chain mediation model was tested using model 6 of PROCESS, and the 95% confidence interval for the parameter estimates was obtained using the bias-corrected Bootstrap method with 5000 samples.

Results

Common method biases

The Harman's one-factor test was used to test for common method bias. It was found that there were 18 factors

with characteristic roots greater than one, and the variance explained by the first common factor was 27.78%, which was less than the critical criterion of 40%, indicating that there was no common method bias in this study.

Correlations between all variables

Correlation analysis between the four variables, detailed in Table 1, revealed that psychological inflexibility, mental fatigue, and cognitive fusion were all significantly and positively correlated with negative emotions, and all three variables were significantly and positively correlated with each other in two ways.

Chain mediation effect test

All variables were standardized and model 6 of PROCESS software was used to analyze the chain mediating role of psychological inflexibility and cognitive fusion in mental fatigue and negative emotions, and the results showed (shown in Table 2) that mental fatigue significantly and positively predicted psychological inflexibility ($\beta = 0.244$, $p < 0.001$), cognitive fusion ($\beta = 0.319$, $p < 0.001$) and negative emotions ($\beta = 0.157$, $p < 0.01$). psychological

inflexibility significantly predicted cognitive fusion ($\beta = 0.389$, $p < 0.001$) and negative emotions ($\beta = 0.152$, $p < 0.01$) positively; cognitive fusion significantly predicted negative emotions positively ($\beta = 0.559$, $p < 0.001$). It can be seen that psychological inflexibility and cognitive fusion can be seen to play a significant mediating role between nurses' mental fatigue and negative emotions, respectively, and psychological inflexibility and cognitive fusion play a chain mediating role (Fig. 2).

The results of the mediation analysis (see Fig. 2) indicated that mental fatigue and cognitive fusion played a mediating role in the effect of psychological inflexibility on negative emotions. The indirect effect had an impact on negative emotions through the following three paths: (1) indirect effect 1 (0.037, 13.85% of the total effect): mental fatigue → psychological inflexibility → negative emotions; (2) indirect effect 2 (0.178, 66.41% of the total effect): Mental Fatigue → cognitive fusion → negative emotions; (3) indirect effect 3 (0.05, accounting for 19.74% of the total effect): mental fatigue → psychological inflexibility → cognitive fusion → negative emotions. The 95% confidence intervals for the three pathways were statistically significant.

Table 1 Descriptive statistics and correlation coefficients between variables

Variables	$M \pm SD$	1	2	3	4	5	6	7
1 Age	27.99 ± 6.02	1						
2 Gender	-	0.245**	1					
3 Duty	1.72 ± 0.82	0.868**	-0.214**	1				
4 MF	2.62 ± 1.46	0.254***	-0.018	-0.070	1			
5 PI	81.71 ± 26.76	-0.004	0.026	0.059	0.248**	1		
6 CF	28.84 ± 11.36	0.021	0.089	0.032	0.417**	0.471**	1	
7 NE	62.99 ± 21.78	0.019	0.074	0.038	0.429**	0.455**	0.698**	1

** $p < 0.01$, *** $p < 0.001$(two-tailed)

MF Mental Fatigue; *PI* Psychological Inflexibility; *CF* Cognitive Fusion; *NE* Negative Emotions

Table 2 Regression analysis of variables

Predictors	Model 1 (PI)		Model 2 (CF)		Model 3 (NE)	
	β (95%CI)	t	β (95%CI)	t	β (95%CI)	t
gender	0.029 (-7.181, 13.269)	0.5853	0.072 (-0.498, 6.899)	1.7013	0.017 (-4.528, 7.361)	0.468
age	0.020 (-0.390, 0.563)	0.3575	0.015 (-0.1436, 0.201)	0.3283	0.011 (-0.238, 0.315)	0.275
duty	0.057 (-3.2012, 10.468)	0.2966	0.010 (-2.2163, 2.732)	0.2049	0.009 (-3.507, 4.420)	0.227
MF	0.244 (2.412, 5.423)	5.1153***	0.319 (1.615, 2.7373)	7.6215***	0.157 (1.097, 3.017)	4.212**
PI			0.389 (0.1302, 0.200)	9.2942***	0.152 (0.063, 0.186)	3.963**
CF					0.559 (0.917, 1.227)	13.595***
R^2	0.065		0.323		0.529	
F	7.135***		39.442***		77.064***	

** $p < 0.01$, *** $p < 0.001$ (two-tailed)

MF Mental Fatigue; *PI* Psychological Inflexibility; *CF* Cognitive Fusion; *NE* Negative Emotions
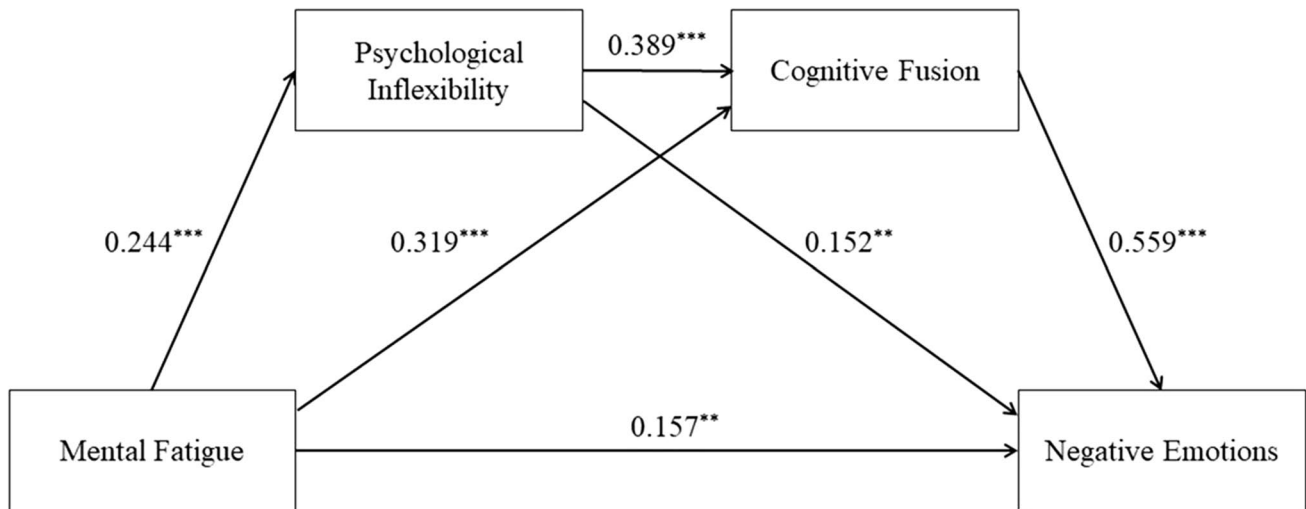
Fig. 2 Schematic diagram of chain mediated effect

Discussions

This study aimed to investigate the effect of mental fatigue on negative emotions among nurses during the COVID-19 pandemic and examine the mechanisms between them. The mental health status of nurses is crucial to the healthcare service quality and outcomes, which is directly related to life-saving success during the COVID-19 pandemic (Giménez-Espertand et al., 2020).

As the city most severely affected by COVID-19 in China, Wuhan has received numerous medical assistance during the COVID-19 outbreak. In addition to local medical personnel in Wuhan, more than 40,000 front-line medical personnel were deployed to Wuhan for support (Zhang et al., 2020). With medical personnel providing a significant contribution, China has achieved visible results in the fight against COVID-19 and has provided many successful experiences and cases for the world (Xie et al., 2020).

This study was concerned about the psychological well-being of Chinese nurses during the post-pandemic era in China, in order to explore the long-term psychological impact of the COVID-19 pandemic. Our hypotheses have been verified. We found that a high level of mental fatigue caused a high level of negative emotions. Moreover, the positive association between mental fatigue and negative emotions was mediated by psychological inflexibility and cognitive fusion independently and serially.

First, the direct effect of fatigue on nurses' negative emotions is consistent with previous research, and the direct effect of mental fatigue on nurses' emotions implies the importance of psychological interventions. A survey of the psychological state of health care workers during the COVID-19 showed that working hours and perceived stress were positively associated with psychological fatigue(Zhan

et al., 2020). Psychological support may play a crucial role in situations of high workload, understaffing, and resource shortage. For example, values, beliefs, attitudes, and adequate information allow nurses to have greater resilience (Petronella et al., 2017), and nurses who are aware of their importance and are mentally inspired are better able to face their work. Some experts suggest that offering flexible sessions, nontraditional hours, and short-term interventions through tele-mental health platforms to support health-care workers experiencing mental fatigue(Litam & Balkin, 2021). It is worth noting that the mental health of nurses in Guangdong was not as bad during COVID-19, thanks to the close cooperation among Chinese departments during the pandemic, timely information sharing, and the extremely high honor and respect from all walks of life that the Chinese government bestowed on health care workers (Li et al., 2020).

Second, psychological inflexibility mediated the relationship between mental fatigue and nurses' negative emotions. On the one hand, nurses' mental fatigue increased psychological inflexibility, which is consistent with previous research findings. In a study based on Baddeley's working memory model answering similar questions, switching cognitive activities requires more mental resources for cognitive control (Price & Duman, 2020), and mental fatigue diminishes the allocation of mental resources to inhibit the interference of irrelevant information, leading to an increase in psychological inflexibility. On the other hand, overcoming psychological inflexibility requires constant awareness, acquisition, and integration of new information based on current cognitive input. To complete nursing care, nurses have to pay extra physical, mental and emotional resources, and according to the theory of conservation of resources, individuals have a finite total amount of resources, which can trigger fatigue

leading to negative emotions if they are in a state of long-term resource depletion without recovery and replenishment (Prapanjaroensin et al., 2017).

Then, cognitive fusion mediates the relationship between mental fatigue and nurses' negative emotions, i.e., mental fatigue increases cognitive fusion, which in turn triggers nurses' negative emotions. On the one hand, mental fatigue positively predicted cognitive fusion, that is, the higher the nurses' mental fatigue, the more impaired the cognitive control and the weaker the inhibition of negative information, leading to a continuous focus of nurses' attention fixated on negative events, which eventually induced negative emotions and thoughts that may contribute to each other. On the other hand, cognitive fusion significantly predicted negative emotions, and the results of this study are consistent with previous research. Studies have shown a significant association between cognitive fusion and mental health, such as post-traumatic stress disorder (PTSD) and depression. When the level of cognitive fusion is high, individuals' physical and mental health levels are often negatively affected by it. Acceptance commitment therapy suggests that the key to reducing depression is to reduce cognitive fusion, and the results of the present study, in which the largest effect values were found through the mediating pathway of cognitive fusion, are consistent with this view.

Finally, the chain mediating role of psychological inflexibility and cognitive fusion is also an important pathway through which mental fatigue affects nurses' negative emotions. Based on the impaired cognitive control model, an impaired cognitive control system leads to an individual's inability to shift attentional focus away from negative information and may develop a memory bias or cognitive schema over time. And cognitive resource theory states that due to limited cognitive resources, individuals are more inclined to process and identify with information that is consistent with the schema, i.e., they devote more attention and processing to negative information and will be more inclined to identify with negative information (Jenness et al., 2021). It has been established that positive evaluations will facilitate individuals to resist negative emotions, such as stress, while individuals with high psychological inflexibility tend to make less positive evaluations of events (Garcia et al., 2019).

However, there are still some limitations in this study. First, this study was a cross-sectional design, and the causal relationship between the variables could not be determined. Second, we did not collect data about the proportion of nurses contacted with COVID patients or worked on COVID-related departments clearly, although almost all nurses in this hospital contacted with COVID patients from April to July 2020. Last, results obtained from the self-report questionnaire may have been subject to social desirability bias.

Conclusion

In this study, a cross-sectional approach was used to survey 419 nurses in Beijing. The effect of mental fatigue on negative emotions was objectively assessed. It was demonstrated that there was a positive association between mental fatigue and negative emotions and that psychological inflexibility and cognitive fusion played a mediating role and a chain mediating role in it. The mental health of nurses is the key to overcoming COVID-19 and saving more lives, and it is relevant for us to explore interventions to help nurses maintain a good mood and provide theoretical support. ACT may be the appropriate psychological intervention.

Data availability The raw data of the present study are available from the corresponding author on reasonable request.

Code availability Not applicable.

Declarations

Ethics approval The research involving human participants was reviewed and approved by the Ethical Committee for Scientific Research of Chinese PLA General Hospital. The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Consent to participate The participants gave informed consent through an online process.

Consent for publication The participants gave consent for publication through an online process.

Conflicts of interest The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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