ORIGINAL ARTICLE

Influence of perceived stress and workload on work engagement in front-line nurses during COVID-19 pandemic

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ABSTRACT

Aims and objectives: To clarify both the potential influencing factors and the current status of front-line nurses' work engagement, and thus provide a reference for targeted interventions.

Background: After coronavirus disease 2019 outbreak, front-line nurses embraced remarkable potential stress and huge workload when caring for coronavirus disease 2019 patients, which may lead to new challenges to work engagement.

Design: A large sample survey was conducted at the end of February 2020 in a designated hospital treating coronavirus disease 2019 patients in Wuhan, the capital of Hubei Province, in China. t Test, one-way ANOVA, chi-squared test, Pearson's correlation and hierarchical multiple regression were performed among 1,040 nurses using SPSS 24.0. The STROBE checklist was followed for observational studies.

Results: The final model interpreted 27.3% of the variance, of which each block could explain 11.7%, 10.3% and 7.9% R^2 changes including sociodemographic characteristics, stress and workload, respectively. Work engagement was negatively correlated with stress and workload. The potential influencing factors included sociodemographic characteristics (married, rescue staff, cabin ward), stress (infection control, PPE discomfort) and workload (mental demand, performance, frustration).

Conclusions: Front-line nurses perceived low stress and workload, but high work engagement, especially in self-dedication. However, infection control, PPE discomfort and frustration were negatively associated with nurses' work engagement, while mental demand and good performance were positively associated with nurses' work engagement. Future interventions focused on decreasing front-line staff's infection risk and enhancing their self-confidence may be recommendable to promote their work engagement.

KEYWORDS
coronavirus disease 2019, influencing factors, nurses, work engagement

1 | INTRODUCTION

The pandemic of coronavirus disease 2019 (COVID-19) was a serious global public health disaster, which has caused nearly 64,603,428 confirmed cases and claimed over 1,500,614 lives worldwide as of December 2020 (World Health Organization, 2020a). However, there were still no pharmaceutical treatment or vaccine available. Preventive measures were currently focused on contact tracing, quarantine and social distancing. According to the transmission dynamics of COVID-19 post-pandemic period, professor Kissler projected that prolong or intermittent social distancing may be necessary into 2022 (Kissler et al., 2020). The COVID-19 might be existed for a long term and without effective vaccine, and these unfavourable conditions may lead to new challenges for health care workers. Today, little evidence exists on the influencing factors associated with nurses' work engagement during COVID-19 pandemic. It is necessary to explore the working status and potential influencing factors of work engagement on front-line nurses caring for COVID-19 patients. Our study may help prepare the work-engaged nurses rapidly respond to the ongoing epidemic.

2 | BACKGROUND

Healthcare professionals, with particular regard to nurses, are exposed to several job stressors from infectious diseases such as COVID-19 that can adversely affect both their mental and physical health, which may also decrease work engagement (Wang et al., 2020). During previous Taiwan SARS pandemic, 71.9% of nurses believed they were 'at great risk of exposure to SARS', 49.9% felt 'an increase in workload', and 7.6% of the nurses considered looking for another job or resignation (Shiao et al., 2007). The rate of nurse turnover remained high since the first outbreak of SARS epidemic (Shiao et al., 2007). After COVID-19 outbreak, healthcare workers were challenged by working in a new context, exhaustion due to heavy workloads and insufficient PPE, the fear of becoming infected and infecting others, feeling powerless to handle patients' conditions and managing relationships in this stressful situation (Liu et al., 2020). In addition, the perceived stress and excessive workloads in nursing staff may directly affect their work engagement and quality of care provided to patients with COVID-19. Therefore, more attention should be paid to the work engagement of front-line nurses during the COVID-19 pandemic.

In the nursing profession, work engagement is a positive, fulfilling state of mind about work that is characterised by vigour, dedication and absorption (Bargagliotti, 2012).

Vigour is defined as strong energy, mental resilience and eagerness to commit exertion in one's worth of effort. Dedication refers to high levels of involvement in one's worth of effort and a sense of significance, pride, challenge, inspiration and enthusiasm. Absorption is characterised as being completely concentrated and joyfully in one's worth of effort and having challenge on detaching oneself from work (Schaufeli & Bakker, 2003). Facilitators of and barriers to nurse's work engagement centre around six areas of organisational life, namely workload, control, reward, fairness, community and values (Freeney & Tiernan, 2009). Specifically, general health and psychological stress levels were negatively correlated with work engagement (Gonzalez-Gancedo et al., 2019). Previous research indicated that the most significant organisational and personal influencing factors associated with work engagement on nurses were workload, mental health and practice environment (Fiabane et al., 2013; Wan et al., 2018).

Van's research, which targeted on Netherlands nurses, showed that work engagement counterbalanced work-related stress reactions, but workload did not evitably affect the work engagement levels (Van Mol et al., 2018). Work stress is intrinsic to nursing. Work stressors mentioned by the majority of nurses were workload, time pressure, insufficient reward, lack of patient interaction and uncontrollable emotions (Thian et al., 2015). After the outbreak of COVID-19 pandemic, the remarkable changes of front-line nurses occurred, especially in the aspect of nursing workload, psychological stress and infectious practice environment. Consequently, the enormous stress and high workload from a totally new situation would affect the work engagement of nurses in COVID-19 pandemic. However, the research focused on the increased stress and workload in front-line nurses' work engagement during COVID-19 pandemic was rare (Rosa et al., 2020), which may have a limited effect on improving the work engagement of front-line nurses.

To address the above issue, a further survey was needed to clarify the current status of front-line nurses' work engagement and identify its potential influencing factors, and thus provide evidence for intervention reference.

3 | METHODS

3.1 | Design

A cross-sectional, descriptive study was conducted to identify the effect of perceived stress and workload on work engagement in front-line nurses caring for patients with COVID-19. The STROBE (STrengthening

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What does this paper contribute to wider global clinical community?

- Front-line nurses perceived low stress and workload, but high work engagement, especially in self-dedication in China.
- Stress and workload may be the main influencing factors of work engagement.
- More attention should be paid to reduce the stress and workload of the coronavirus disease 2019 front-line nurses, especially in decreasing front-line staff's infection risk and increasing their self-confidence in handling nursing tasks for infectious patients.

the Reporting of OBservational studies in Epidemiology) checklist was followed to guide this article (see Supplementary File 1).

3.2 | Setting

We conducted the survey in a hospital which was designated to treat patients with COVID-19. The hospital is a tertiary hospital, which is located in Wuhan, Hubei Province, China. During the COVID-19 epidemic, the hospital had more than two thousand beds and approximately eight thousand medical staff participating in caring for patients with COVID-19, treating the most COVID-19 patients in China. More than thirty rescue teams from other provinces were dispatched to the hospital by the Chinese Communist Party Central Committee.

3.3 | Participants

We purposely chose the qualified registered nurses working in the hospital which was designated to treat patients with COVID-19 in February 2020. We excluded those who had confirmed COVID-19 and who refused to participate. All participants could speak fluent Chinese, understand the content of the instruments and give written informed consents.

3.4 | Measurements

A self-administration questionnaire was designed to collect sociodemographic information. The general information included items of gender (female and male), age, work years, marital status (single, married, divorced), number of children (none, one, ≥2), education level (associate's degree, bachelor's degree, master's degree), seniority (junior, intermediate, senior), workplace (isolation ward, fever clinic, cabin ward, other location), work condition (front line, observation period, end of the observation period), rescue staff (yes or no), previous work department, previous infectious disease experience (yes or no) and number of days spent caring for COVID-19 patients.

'The Stress Scale of Caring for Highly Infectious Disease Patients among Health Care Workers Based on SARS' was developed by Baoyu Zhuang in 2005 (Chuang & Lou, 2005). The scale has 4 dimensions including social isolation, PPE discomfort, infection control and caring burden. Totally, 32 items were scored by 4-point Likert (0 = no pressure, 3 = severe pressure, total score from 0 to 96). The higher score indicates more pressure when caring for infectious disease patients. The content validity index of the scale was 0.92 and Cronbach's α of the scale and each dimension ranged from 0.84 to 0.90 (Chuang & Lou, 2005). We did cross-cultural adaptation to test the feasibility and reliability in mainland Chinese by four steps: translation from traditional Chinese to simplified Chinese, synthesis, revision and pretesting. Cronbach's α in the pilot study was 0.968.

The NASA Task Load Index (NASA-TLX) was developed in 1970 in the use of assessing pilot and air traffic controller workload and applied to health care afterwards (Hancock & Meshkati, 1988; Hart, 1988). The NASA-TLX is a subjective assessment scale consisting of six dimensions (mental demand, physical demand, temporal demand, performance, effort and frustration). Each dimension scores from 0 to 20, resulting in a total scale score between 0–120 by summarising the six items (Hart, 2006). Reliability (Cronbach's alpha) for overall and each subscale ranged from 0.72 to 0.80 (Hoonakker et al., 2011; Xiao et al., 2005).

Utrecht Work Engagement Scale short version (UWES-9) (Schaufeli & Bakker, 2003) is a short-form self-report scale with three subscales including vigour, dedication and absorption. Each is scored on seven Likert point (0 = never; 6 = always) with a total score ranging from 0 to 54. The mean subscale score was computed by dividing the sum by the number of items involved. Higher scores indicate higher levels of work engagement. The original UWES tool reliability exceeded 0.90 (Schaufeli & Bakker, 2003). Cronbach's alpha for the whole scale and each subscale ranged from 0.87 to 0.93 in other studies with different cultural contexts (Fong & Ng, 2012; Laschinger et al., 2009; Littman-Ovadia & Balducci, 2013).

3.5 | Data collection

At the end of February 2020, the nursing department recruited all nurses caring for patients with COVID-19 in the first line participating in this survey to identify nurses' work engagement status. Research assistants in different departments were specially trained to distribute the questionnaire in a WeChat group. It was a web-based questionnaire by convenient sampling. A web-based QR code was given to the participant if he/she was interested in this study by our research assistants. Under the guidance of the research assistants, the participants could have a clear understanding of the research purpose, research process and instructions. The data of the web-based questionnaires were submitted to the central database anonymously. Only the research team had access to central database for academic research. A total convenience sample of 1,071 nurses took part in this study with a response rate of 23.72%. After excluding thirty-one invalid questionnaires, ultimately, the efficiency rate was 97.11% when 1,040 complete questionnaires were obtained.

3.6 | Data analysis

Descriptive statistics were performed in SPSS 24.0. Continuous variables were presented in means and standard deviations, while category or rank variables were shown in frequencies or percentages. *t* Test and one-way ANOVA were used to test the influence of work engagement with different sociodemographic characteristics. Chi-squared test was used to compare characteristics based on median value of stress and workload (as high and low). Pearson's correlation analyses were dealt with the relationships among stress, task load and work engagement. Hierarchical multiple regression was performed with work engagement as the dependent variable. The

TABLE 1 Participants' sociodemographic characteristics and comparison of the variables (N = 1040)

| Variables	N (%)	Perceived stress			Workload			Work engagement	
		Low (n)	High (n)	χ^2	Low (n)	High (n)	χ^2	M ± SD	t/F
Age (years)									
≤30	616 (59.23)	333	283	6.982[*]	336	280	6.383[*]	41.65 ± 8.76	27.755[*]
31–40	384 (36.92)	175	209		178	206		44.85 ± 8.49	
≥40	40 (3.85)	19	21		20	20		49.53 ± 7.39	
Work years (years)									
≤2	88 (8.50)	50	38	6.955	58	30	17.867[**]	41.20 ± 8.28	13.268[*]
3–5	390 (37.50)	206	184		217	173		41.63 ± 8.57	
6–10	331 (31.80)	167	164		155	176		43.32 ± 8.87	
11–20	189 (18.20)	81	108		82	107		45.62 ± 8.63	
≥21	42 (4.00)	23	19		22	20		49.24 ± 7.62	
Gender									
Male	28 (2.70)	21	7	6.813[**]	19	9	3.14	47.25 ± 8.12	2.710[*]
Female	1012 (97.30)	506	506		515	497		43.02 ± 8.82	
Marital status									
Single	437 (42.00)	241	196	6.683[*]	250	187	10.573[**]	41.23 ± 8.52	18.969[*]
Married	593 (57.00)	280	313		280	313		44.57 ± 8.78	
Divorced	10 (1.00)	6	4		4	6		41.20 ± 9.041	
Number of children									
None	539 (51.80)	288	251	3.474	300	239	8.768[*]	41.61 ± 8.53	17.427[*]
One	417 (40.10)	200	217		192	225		44.69 ± 8.96	
≥2	84 (8.10)	39	45		42	42		45.21 ± 8.825	
Educational level									
Associate's degree	77 (7.40)	49	28	5.592	56	21	16.454[**]	41.96 ± 8.63	2.904
Bachelor's degree	935 (89.90)	464	471		467	468		43.13 ± 8.83	
Master's degree	28 (2.70)	14	14		11	17		46.64 ± 8.40	
Seniority									
Junior	772 (74.23)	401	371	1.934	418	354	10.037[**]	42.39 ± 8.78	12.138[*]
Intermediate	253 (24.32)	119	134		108	145		45.08 ± 8.63	
Senior	15 (1.45)	7	8		8	7		48.73 ± 7.51	
Workplace									
Isolation ward	828 (79.60)	420	408	3.078	443	385	10.980[*]	42.62 ± 8.76	5.137[*]

(Continues)

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TABLE 1 (Continued)

Variables	N (%)	Perceived stress			Workload			Work engagement	
		Low (n)	High (n)	χ^2	Low (n)	High (n)	χ^2	M ± SD	t/F
Fever clinic	83 (8.00)	48	35		34	49		45.77 ± 8.89	
Cabin ward	19 (1.80)	8	11		12	7		46.42 ± 7.98	
Other locations	10 (10.60)	51	59	2.595	45	65	1.844	44.44 ± 8.87	6.482*
Rescue staff									
Yes	131 (12.60)	75	56		60	71		47.72 ± 8.87	
No	909 (87.40)	452	457		474	435		42.47 ± 8.62	
Previous work department									
Respiratory department	41 (3.90)	21	20	4.934	21	20	11.178*	45.63 ± 8.43	3.029*
Emergency department	63 (6.10)	24	39		20	43		43.57 ± 8.98	
Infectious disease department	13 (1.30)	8	5		6	7		43.77 ± 8.96	
ICU	90 (8.70)	48	42		51	39		45.52 ± 10.66	
Other departments	833 (80.00)	426	407		436	397		42.71 ± 8.56	
Previous infectious disease experience									
Yes	78 (7.50)	44	34	1.11	44	34	0.866	47.18 ± 9.25	4.243*
No	962 (92.50)	483	479		490	472		42.81 ± 8.71	
workdays for nursing COVID-19 patients									
≤10	56 (5.40)	32	24	4.166	34	22	11.797**	42.18 ± 7.49	2.201
11–20	456 (43.80)	241	215		256	200		43.43 ± 8.42	
21–30	461 (44.40)	218	243		214	247		42.65 ± 9.34	
≥31	67 (6.4)	36	31		30	37		45.30 ± 8.56	

*p < .05 (2-tailed).
**p < .01 (2-tailed).
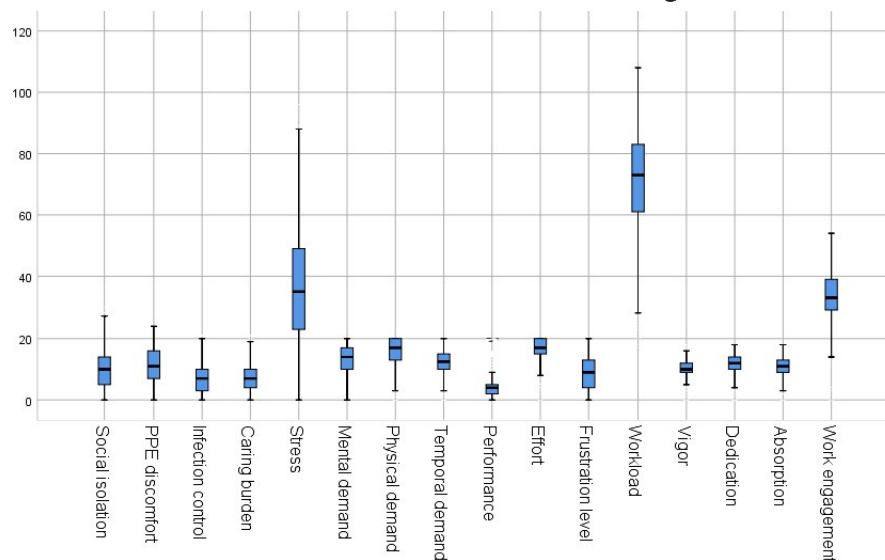
independent variables were entered in regression model by block 1 (sociodemographic characteristics), block 2 (stress) and block 3 (workload) step by step. The method was used by entering sociodemographic characteristics (such as gender, age and working years) in the first block to see whether main effects of these variables could influence work engagement; with four dimensions of stress entered into block 2 to identify whether each dimension had a significant contribution once the main effects of sociodemographic characteristics have been considered; and six dimensions of workload entered into block 3. The relative importance of the variables retained in the final multiple regression models contributed to the variance explained by the work engagement. Statistical significance was set at $p < .05$ two-tail.

3.7 | Ethical consideration

This study was approved by the ethics committees of Tongji Hospital affiliated to Tongji Medical College of Huazhong University of Science and Technology. The participants were informed about the study, were able to ask questions to provide an informed decision if they wished to participate, prior to signing a consent. The written consents were obtained from the participants if they were willing to take part. In addition, the participants could withdraw from the study at any time without prejudice. No participants' names were attached to materials to ensure confidentiality.

4 | RESULTS

4.1 | Participants' sociodemographic characteristics

The average age and work years of the 1040 participants were 30.09 ± 5.05 and 7.91 ± 5.53, respectively. 1012 (97.30%) were female, 935 (89.90%) were bachelor's degrees, 828 (79.60%) were

working in the isolation ward, and 772 (74.23%) were juniors. Among them, 539 (51.80%) did not have a child and 461 (44.40%) had worked 21–30 days for nursing patients with COVID-19. Of participants, only 207 (20%) were from the department of respiratory, emergency, infectious disease and intensive care, and 131 (12.60%) were rescue staff. Also, only 78 (7.50%) had previous infectious disease experience. Except for educational level and workdays for nursing COVID-19 patients, the other sociodemographic variables all have a significant effect on the work engagement in front-line nurses. The nurses who were aged 30 and older, female and married suffered from higher stress, while the nurses who had higher workload were those aged 30 and older, working 6 years or longer, married, having one or more children, master's degree, intermediate seniority, working in fever clinic or other location, previous working in emergency department and working 21 days or longer for nursing COVID-19 patients (Table 1).

4.2 | The scores of stress, workload and work engagement of front-line nurses

The average score of stress, workload and work engagement of front-line nurses was 36.37 ± 19.28, 71.21 ± 16.11 and 34.13 ± 8.82 respectively. The highest score of work engagement was the dimension of dedication, and the lowest one was vigour (Figure 1).

4.3 | The association between stress, workload and work engagement

The results of Pearson's correlation of relationships among stress, workload and work engagement are shown in Table 2. Work engagement was negatively correlated with stress and workload ($p < .05$).

4.4 | Influencing factors of work engagement

Table 3 shows the results of hierarchical multiple regression of work engagement. The final model (model 3) interpreted 27.3% of the variance, of which each block could explain 11.7%, 10.3% and 7.9% of R^2 changes. In model 3, significant factors were marital status (married vs. single), workplace (isolation ward vs. cabin ward), rescue staff (yes vs. no), PPE discomfort, infection control, mental demand, performance and frustration level.

5 | DISCUSSION

The average work engagement score was 34.13 ± 8.82, showing that work engagement of Chinese front-line nurses after COVID-19 outbreak was at a moderate level. Especially, the dimension of dedication in work engagement was high. Sociodemographic characteristics (married, rescued staff, cabin ward), stress (PPE discomfort, infection control) and workload (mental demand, performance, frustration) may be the main influencing factors affecting these Chinese front-line nurses' work engagement. Rescued staff were nurse volunteers from other provinces to relieve the strain on human resources of nurses in Wuhan during COVID-19 pandemic. And the cabin ward meant a large ward treating patients with mild pneumonia infected by COVID-19 together. The nurses who were married, rescued staff and working in cabin ward showed higher work engagement levels. Meanwhile, stress and workload may be the potential mediator for improving the work engagement of front-line nurses.

Among 1040 Chinese front-line nurses, their average work engagement score (3.79 vs. 3.54) in COVID-19 pandemic was higher than that during non-epidemic period (Wan, Zhou, et al., 2018). Work engagement was influenced by multiple factors, which can be divided into organisational and personal factors (Garcia-Sierra et al., 2016; Othman & Nasurdin, 2013; Peng & Tseng, 2019). Organisational factors mainly included practice environment, social supports. In the nursing field, its specific manifestations were nursing transformational leadership, nursing structural empowerment and nursing supervisor support (Basit, 2017; Fiabane et al., 2013; Othman & Nasurdin, 2013; Wan et al., 2018). In addition, dispositional factors were such as stress, self-efficacy and optimism (Fiabane et al., 2013; Garcia-Sierra et al., 2016). During COVID-19 pandemic, the increased work engagement may relate to the powerful social support from our country and government. Those supports from country and government were as follows: (a) material supports such as providing an adequate supply of front-line nurses (cumulatively more than 38,000 from almost 300 medical teams) and personal protective equipment (National Health Commision, 2020a); (b) spiritual supports: enough psychological support for front-line nurses (online or offline psychological consult service for free) and professional identity from the whole society (Bao et al., 2020); (c) logistics supports: free bus and hotels around the hospital were provided to address their commuting issues; (d) timely and open informations: the government reported COVID-19 epidemic data online everyday including the number of confirmed cases and deaths from each province, also strengthened the broadcast of infection control measures; (e) scientific researches: immense amounts of studies focusing on epidemiological characteristics of COVID-19, transmission ways of the virus, prevention and control measures, effective vaccine were encouraged by the government; and (f) legal protection: rights protection for preventing nurses from malicious harm, increased compensation and adequate rest time were guaranteed by the law, identification as work-related injury when nurses were infected or died (National Health Commission, 2020b).

Personal factors included personal traits, professional characteristics, family issues and work orientation (Garcia-Sierra et al., 2016). In this study, married nurses were more involved than single nurses, especially young single nurses with less work experience. Moreover, single nurses may have less support from family, which had negative influence on their work engagement level (Naruse et al., 2013). Nurses working in cabin ward showed more engagement in comparison with those working in the isolation ward. Cabin ward got COVID-19 patients with mild symptoms together and had higher patient recovery rate (Shu et al., 2020). Nurses in cabin ward may display lower work frustration leading to higher work engagement. This study also found that rescue nurses had higher level of engagement. Rescue staff usually had mission (Reed et al., 2015). Besides, the experienced staff from other provinces were voluntary to fight in this battle with the belief to overcome the new virus and maybe more dedicated to work.

Similarly, our results showed stress may negatively affect the work engagement. However, infection control and discomfort caused by PPE may be the most significant stress factors of the COVID-19 front-line nurses, which may mediate the decreased work engagement. The reason for this condition may attribute to the threat of individual health right, which was caused by the increased infection risk for front-line nurses when caring for COVID-19 patients without adequate protective measures (World Health Organization, 2020b). According to Maslow's hierarchy theory (Maslow, 1943), the priority should ensure adequate PPE supply to meet the fundamental needs of front-line nurses, finally increasing their work engagement to fulfil self-actualisation.

Our results indicated that front-line nurses had low perceived stress and workload, while high work engagement in COVID-19 pandemic. Especially, there was higher level of dedication. These results may imply the essence of self-dedication in nursing profession when public health was threatened by infectious diseases. Meanwhile, the

TABLE 2 Correlation of stress, workload and work engagement (N = 1040)

Variables	1	2	3
1. Stress	1		
2. Workload	0.429[**]	1	
3. Work engagement	−0.288[**]	−0.068[*]	1

[*]$p < 0.05$ (2-tailed).

[**]$p < 0.01$ (2-tailed).

TABLE 3 Hierarchical multiple regression related to work engagement (N = 1040)

Variables	Model 1				Model 2				Model 3			
	Standardized β	95% CI Lower	Upper	Partial eta square	Standardized β	95% CI Lower	Upper	Partial eta square	Standardized β	95% CI Lower	Upper	Partial eta square
Gender (female vs. male)	-0.048	-5.954	0.707	0.002	-0.021	-4.292	2.006	0.000	-0.007	-3.407	2.603	0.000
Age (30–40 vs. ≤30)	0.076	-0.355	3.122	0.002	0.094*	0.086	3.367	0.002	0.075	-0.201	2.929	0.002
Age (≥41 vs. ≤30)	0.065	-2.918	8.864	0.001	0.099	-1.011	10.112	0.000	0.040	-3.478	7.161	0.001
Working years (3–5 vs. ≤2)	-0.023	-2.412	1.565	0.000	-0.019	-2.219	1.542	0.001	-0.010	-1.980	1.609	0.001
Working years (6–10 vs. ≤2)	-0.038	-3.116	1.659	0.000	-0.044	-3.098	1.416	0.001	-0.045	-3.006	1.320	0.001
Working years (11–20 vs. ≤2)	0.014	-2.672	3.330	0.000	0.017	-2.440	3.238	0.000	-0.005	-2.833	2.596	0.000
Working years (≥21 vs. ≤2)	0.038	-4.501	7.871	0.000	-0.003	-5.964	5.733	0.000	0.017	-4.794	6.352	0.002
Marital status (married vs. single)	0.103	-0.025	3.693	0.004	0.132**	0.583	4.116	0.009	0.131**	0.654	4.018	0.010
Marital status (divorced vs. single)	-0.040	-9.196	1.987	0.002	-0.033	-8.238	2.298	0.001	-0.038	-8.438	1.610	0.001
Number of children (one vs. none)	0.021	-1.618	2.359	0.000	-0.005	-1.976	1.782	0.000	-0.023	-2.217	1.372	0.002
Number of children (≥2 vs. none)	0.006	-2.518	2.876	0.000	0.002	-2.501	2.608	0.000	0.000	-2.421	2.447	0.000
Education level (bachelor's degree vs. associate's degree)	0.029	-1.179	2.870	0.001	0.059	-0.192	3.650	0.006	0.002	-1.824	1.938	0.001
Education level (master's degree vs. associate's degree)	0.036	-1.857	5.771	0.001	0.052	-0.808	6.431	0.001	0.020	-2.403	4.573	0.000
Seniority (intermediate vs. junior)	-0.023	-1.986	1.040	0.000	-0.033	-2.106	0.749	0.001	-0.027	-1.923	0.807	0.002
Seniority (senior vs. junior)	-0.021	-6.727	3.626	0.000	-0.024	-6.626	3.137	0.000	-0.023	-6.364	2.924	0.000
Workplace (isolation ward vs. cabin ward)	-0.076	-3.558	0.229	0.003	-0.19**	-4.164	-0.588	0.008	-0.106**	-4.035	-0.625	0.010
Workplace (fever clinic vs. cabin ward)	0.064	-0.473	4.662	0.003	0.023	-1.670	3.191	0.000	0.018	-1.733	2.905	0.000
Work condition (front line vs. end of the observation period)	0.012	-3.450	4.060	0.000	0.022	-2.974	4.103	0.000	0.002	-3.324	3.450	0.000
Work condition (observation period vs. end of the observation period)	0.042	-2.815	5.181	0.000	0.030	-2.926	4.613	0.000	0.004	-3.480	3.717	0.001
Rescue staff (yes vs. no)	0.151**	2.279	5.761	0.020	0.122**	1.576	4.922	0.013	0.108**	1.238	4.479	0.009
Previous work department (other departments vs. pneumology department)	-0.045	-3.749	1.748	0.001	-0.043	-3.551	1.632	0.000	-0.038	-3.317	1.621	0.000
Previous work department (ICU vs. pneumology department)	0.024	-2.445	3.951	0.000	0.038	-1.813	4.219	0.001	0.029	-1.974	3.778	0.003

(Continues)

TABLE 3 (Continued)

Variables	Model 1				Model 2				Model 3			
	Standardized β	95% CI Lower	95% CI Upper	Partial eta square	Standardized β	95% CI Lower	95% CI Upper	Partial eta square	Standardized β	95% CI Lower	95% CI Upper	Partial eta square
Previous work department (infections department vs. pneumology department)	−0.034	−8.123	2.705	0.001	−0.031	−7.587	2.613	0.000	−0.022	−6.612	3.107	0.000
Previous work department (emergency department vs. pneumology department)	−0.047	−5.451	1.984	0.001	−0.032	−4.711	2.316	0.000	−0.045	−5.022	1.679	0.001
Previous infectious disease experience(yes vs. no)	0.051	−0.519	3.917	0.002	0.033	−0.997	3.185	0.001	0.027	−1.079	2.912	0.001
Number of days spent caring for COVID-19 patients (≥31 vs. ≤10)	0.058	−1.166	5.313	0.002	0.054	−1.115	4.987	0.003	0.065	−0.580	5.241	0.004
Number of days spent caring for COVID-19 patients (21–30 vs. ≤10)	0.015	−2.172	2.701	0.000	0.033	−1.708	2.888	0.001	0.006	−2.078	2.308	0.000
Number of days spent caring for COVID-19 patients (11–20 vs. ≤10)	0.083	−0.965	3.916	0.001	0.076	−0.939	3.658	0.002	0.054	−1.237	3.167	0.001
Block 2 perceived stress												
Social isolation					0.035	−0.077	0.172	0.049	0.020	−0.090	0.146	0.055
PPE Discomfort					−0.12**	−0.315	−0.051	0.025	−0.13**	−0.325	−0.071	0.028
Infection control					−0.29**	−0.733	−0.336	0.054	−0.216**	−0.589	−0.206	0.042
Caring burden					0.034	−0.129	0.255	0.038	0.061	−0.073	0.299	0.042
Block 3 workload												
Mental demand									0.15**	0.134	0.381	0.037
Physical demand									−0.062	−0.262	0.014	0.018
Temporal demand									−0.058	−0.240	0.023	0.024
Performance									0.226**	−0.793	−0.441	0.053
Effort									0.038	−0.082	0.269	0.017
Frustration level									−0.101**	−0.249	−0.058	0.024
Adjusted R^2	0.093				0.196				0.273			
ΔR^2	0.117				0.103				0.079			

*$p < 0.05$ (2-tailed).

**$p < 0.01$ (2-tailed).

results were in line with other studies that work engagement was negatively correlated with workload (Tomic & Tomic, 2011), especially significantly in inverse correlation with frustration dimension, while in positive relationship with performance and mental demand. Frequent mental thinking could significantly increase workload and engagement during the encoding period of verbal and image learning (Berka et al., 2007). The nurses would either have a sense of self-value during mental demand, mediating high-level engagement. A good performance and low frustration had been proved to be the positive factors associated with work engagement by various studies (Trépanier et al., 2015; Van Wingerden & Van der Stoep, 2018). A good performance referred to perceived success in accomplishing the task, while frustration was known as discouraged feelings that one felt while completing the task. So lower the nurses' frustration level and increase their performance in COVID-19 epidemic were the key points to enhance their work engagement, which could give implications for nurse managers in other countries. Measures should focus on enhancing the self-confidence to effectively handle COVID-19 nursing tasks, such as COVID-19-related training, recommending guidelines of self-protection, inspiring nurses learned from dedication leaders and creating a collaborative work atmosphere among nurse staff (Van Bogaert et al., 2013). The above interventions had been done in the investigated hospital, such resulting in high work engagement for nurses caring for COVID-19 patients in this study.

Although the COVID-19 pandemic was more and more serious, front-line nurses' work engagement was not decreased but increased, which attributed to self-dedication of nursing profession, particularly for married nurses, rescued staff and those from cabin ward. To ensure the steady of nurses' work engagement during COVID-19 epidemic, managers should recognise the dedication of front-line nurses and pay more attention to infection control and physical discomfort caused by PPE. For countries that lack PPE, it is suggested to guarantee material supply of PPE in priority. Furthermore, we call for attention to materials supply for front-line nurses by the country and government. Some measures such as receiving donation of PPE from the outside, encouraging large production of PPE and providing PPE for front-line nurses in the first place could be taken.

6 | LIMITATIONS

This study has several limitations. Although a large sample survey was adopted, there was a little sample of male nurses and most of these samples were collected from Wuhan district, which may lead to the limited representation of our research. Furthermore, the investigation was conducted in the middle stage of COVID-19 epidemic in China with sufficient protective materials and effective measures.

7 | CONCLUSION

The work engagement of front-line nurses during COVID-19 pandemic was higher than before in China, especially in self-dedication.

Although their perceived stress and workload were low, the perceived stress and workload level may still be the main influencing factors of their work engagement. More attention should be paid to reduce the stress and workload of the COVID-19 front-line nurses. Further interventions should focus on enhancing the self-confidence of caring for patients with infectious diseases to motivate their work engagement. For countries that lack PPE, it is necessary to ensure adequate supply of PPE in priority. When the front-line nurses gain an adequate supply of PPE, they would be more engaged in their work.

8 | RELEVANCE TO CLINICAL PRACTICE

Although the rapid spread of COVID-19 pandemic may be a tough challenge for front-line nurses. However, perceived stress and workload of these front-line nurses were low and work engagement was high. To guarantee the steady of nurses' work engagement during COVID-19 epidemic, managers should recognise the dedication of front-line nurses and pay more attention to infection control and physical discomfort caused by PPE. Effective measures to decrease their infection risk and PPE discomfort of front-line nurses may be effective to increase nurses' work engagement. In addition, the workload of mental demand, performance and frustration of nurses caring COVID-19 should be highlighted. Further interventions should focus on enhancing the self-confidence of caring for patients with infectious diseases to motivate their work engagement. It is also recommended to guarantee the supply of PPE in priority for countries that lack PPE.

CONFLICT OF INTEREST
The author declared no potential conflicts of interest concerning the research, authorship and/or publication of this article.

AUTHOR CONTRIBUTIONS
Study design: MZ, PZ, KLH; data collection: MZ, PZ, KLH, HW, YL; data analysis: MZ, PZ, MCD; and manuscript preparation: MZ, PZ, KLH, HW, YL, MCD.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.