



BMJ Open Research on the influencing factors of fatigue and professional identity among CDC workers in China: an online cross-sectional study

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To cite: Cui Q, Liu L, Hao Z, *et al.* Research on the influencing factors of fatigue and professional identity among CDC workers in China: an online cross-sectional study. *BMJ Open* 2022;**12**:e058762. doi:10.1136/bmjopen-2021-058762

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-058762>).

Received 29 October 2021
Accepted 16 March 2022



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ABSTRACT

Objective This study aimed to investigate the status quo and the influencing factors of fatigue and professional identity among the Centers for Disease Control and Prevention (CDC) workers in China during the pandemic.

Design A cross-sectional design.

Setting CDC workers employed by the Liaoning CDC system were enrolled (administrative staffs were excluded).

Participants 1020 CDC workers.

Primary outcome measures Fatigue scores and professional identity scores.

Secondary outcome measures Postcompetency scores, respect scores, occupational stress scores, resilience scores and self-efficacy scores.

Results The average scores of fatigue and professional identity were 8.23, 38.88, respectively. Factors including perceived public respect ($\beta=-0.129$, $p<0.01$), resilience ($\beta=-0.104$, $p<0.05$) and self-efficacy ($\beta=-0.22$, $p<0.01$) were negatively associated with fatigue. Educational background (bachelor vs junior college or below) ($\beta=0.105$, $p<0.01$), (master or above vs junior college or below) ($\beta=0.092$, $p<0.05$), workplace (county vs district) ($\beta=0.067$, $p<0.05$), (city vs district) ($\beta=0.085$, $p<0.05$), fighting the COVID-19 on the front line ($\beta=0.059$, $p<0.05$) and occupational stress ($\beta=0.166$, $p<0.01$) were positively correlated with fatigue. Educational background (bachelor vs junior college or below) ($\beta=-0.097$, $p<0.01$), (master or above vs junior college or below) ($\beta=-0.114$, $p<0.01$), workplace (city vs district) ($\beta=-0.114$, $p<0.01$), fighting the COVID-19 on the front line ($\beta=-0.047$, $p<0.05$) and occupational stress ($\beta=-0.105$, $p<0.01$) were negatively associated with professional identity. Factors including postcompetency ($\beta=0.362$, $p<0.01$), perceived public respect (general vs low) ($\beta=0.219$, $p<0.01$), (high vs low) ($\beta=0.288$, $p<0.01$), resilience ($\beta=0.097$, $p<0.05$) and self-efficacy ($\beta=0.113$, $p<0.01$) were positively connected with professional identity.

Conclusion The fatigue among the CDC workers was at a higher level. The level of professional identity was high, and administrators should take measures to alleviate fatigue and maintain professional identity. In addition, methods aiming to attenuate occupational stress, and improve resilience and self-efficacy should be immediately put into action.

Strengths and limitations of this study

- The independent samples t-test, one-way ANOVA and hierarchical multiple regression analysis were conducted to identify the influencing factors of fatigue and professional identity.
- An online survey method was used to collect samples with a big sample size.
- This is a cross-sectional survey no causal relationship can be drawn among the variables.
- Participants in this study should be enrolled across the country.

INTRODUCTION

The COVID-19 has caused heavy economic losses and psychological problems within the whole population including the occupational groups.^{1 2} WHO has declared it as a Global pandemic.³ However, new coronavirus variants are constantly deriving, and the pandemic impacts would continue to exist.

During public health emergencies, people have suffered from a wide range of adverse psycho-social impacts, and this situation is even worse among the front-line medical staff who have taken great responsibilities during the pandemic.^{1 4} Centers for Disease Control and Prevention (CDC) serves the public by publicising the health knowledge and conducting disease surveillance and prevention, etc. During the pandemic, CDC workers in China have undertaken the responsibilities of epidemiological investigation of the patients and close contacts, specimen collection and examination, and surveillance of high-risk populations, etc; therefore, they are subjected to various psychological and physical pressures. However, compared with the extant studies covering medical staff in this regard,^{2 5} few have been conducted concerning the mental health status of the occupational group.



Fatigue is a self-recognised state in which an individual experiences undermined labour ability for overwhelming physical and mental work demands, and feels persistent tiredness and weakness, which can't be alleviated by taking a rest.⁶ Fatigue is significantly associated with an individual's both physical and mental health.⁷ Among the professional staff, fatigue intrigues negative mood, lowers work efficiency and leads to human errors and physical problems.⁸ Healthcare workers are observed with severe symptoms of fatigue, which adversely impact their health status and the quality of the provided medical service.^{9 10} The prevalence of fatigue among the healthcare workers under the pandemic varies from 69% to 72.2%, and studies have concluded the influencing factors of fear of infection, sleep difficulty and psychological factors.^{2 4} However, similar findings concerning the CDC workers during the same period have been rarely reported and the influencing factors remain less discovered.

Professional identity refers to the combination of a worker's knowledge, skills, values and behaviours with his or her own unique identity and core values.¹¹ Workers usually take professional identity for self-assessment over the matching level of themselves and the job they are engaged. Among healthcare staff, professional identity is conducive to enhancing their work performance and job satisfaction and reduces their turnover intention.^{12 13} During the COVID-19 pandemic, professional identity could effectively relieve their job burn-out symptoms.¹⁴ Thus, research on professional identity is beneficial for maintaining the mental health of CDC staff.

Competency depicts the personal qualities and behavioural traits affecting an individual's productivity and performance.¹⁵ Postcompetency refers to the ability to complete assigned work efficiently. The higher post-competency contributes to the higher work efficiency and better work performance,¹⁶ which reduces the possibilities of burnout. The Job Demands-Resources model points out that there is a psychological need to maintain the balance between job demands and the resources possessed by the employees,¹⁷ and once the balance breaks, burnout and stress arise, which ultimately leads to fatigue and the declined professional identity. Staff with higher postcompetency have adequate professional knowledge and skills and handle work demands effectively. Thus, such individuals are less prone to fatigue. Aforementioned, we assume that postcompetency might influence the levels of fatigue and professional identity of the CDC workers.

Respect, which is seen as an optimistic side of life, describes the feeling of being highly valued, esteemed or the satisfaction of being held in honour.¹⁸ Maslow's Hierarchy of Needs advocates that the satisfied need for respect is critical for achieving self-actualisation,¹⁹ and the sense of being respected in the workplace contributes to job satisfaction and is associated with organisation commitment and retention.²⁰ Considering these, we assume that the higher degree of being respected may reduce the occurrence of fatigue and enhance professional identity.

Due to the intense competition within the organisation and the higher demands for good health from the general population, healthcare workers in China are more vulnerable to occupational stress.²¹ According to the classical model of effort-reward imbalance (ERI), occupational stress is caused by the imbalance between extrinsic effort and reward, and workers as such would experience a failed social reciprocity that evokes occupational stress.²² During the pandemic, CDC staff are on duty to keep constant vigilance in response of outbreaks. This gives them more occupational stress which relates to fatigue and professional identity.^{23 24} Accordingly, among CDC workers, higher occupational stress level has bigger chance to induce more fatigue and less professional identity.

According to the conservation of recourse (COR) theory, when the internal and external resources are insufficient or the employees feel deficient resources, they will experience occupational stress and fatigue.²⁵ Scholars have noted the effects of positive psychological resources (eg, resilience, self-efficacy, hope and optimism) on attenuating the severity of fatigue.²¹ Resilience refers to the ability that individuals adopt to cope with stress in a healthy way, during which tasks can be completed efficiently with minimal psychological and physical cost.²⁶ Resilient people can quickly sort out the solution to tackle the challenges and restore the mental health. Self-efficacy signifies an individual's perceived ability to succeed and complete the tasks.²⁷ Studies have identified the roles of self-efficacy and resilience for relieving fatigue and maintaining the professional identity.^{21 28} Therefore, for CDC workers, we hypothesised that resilience and self-efficacy would reduce the level fatigue and enhance professional identity.

CDC workers have undertaken great psychological burden during the pandemic; however, findings on their mental health status are insufficiently reported. This study aimed to investigate the status quo and the influencing factors of fatigue and professional identity of the CDC workers. With the obtained findings, some evidence-based suggestions would be formulated to support the psychological well-being of the CDC workers.

METHODS

Study design and settings

This cross-sectional survey was conducted in Liaoning province in China, from 7 September 2020 to 18 September 2020. After communicating with and receiving support from CDC managers, a digital questionnaire was delivered through the Wenjuanxing platform to the CDC workers belonging to the Liaoning provincial CDC system.

Study participants

CDC workers belonging to the Liaoning provincial CDC system were recruited and workers engaged in administrative work were excluded from this study. A total of

1020 valid questionnaires were collected, with an effective response rate of 83.2%.

Patients and public involvement

No patients or public persons were involved in this study.

Measurement of demographic and job characteristics

Age (years), gender, marital status and educational background were set as demographic variables. Age was collected as: 21–30 years, 31–40 years, 41–50 years and >50 years. Gender. Marital status was divided into: 'single/divorced/widowed/separated' and 'married/cohabited'. Educational background was divided into three: 'junior college or lower', 'bachelor' and 'master or higher'. Job characteristics including personal monthly income (RMB, ¥) which was classified as: ≤¥3000 (≤US\$438.69), ¥3001–¥4000 (US\$438.83–\$584.92), ¥4001–¥5000 (US\$585.06–\$731.14) and >¥5000 (US\$731.14); workplace includes district, county and city; serving years was classified as ≤10 years, 11–20 years and >20 years; weekly work time (hours) was categorised as '≤40 hours/week' and '>40 hours/week'; whether having occupational allowance and whether fighting the COVID-19 in the front line.

Measurement of fatigue

The Chinese version of the Chalder Fatigue Scale (CFS) was used to assess the level of fatigue of CDC workers.²⁹ This scale includes 14 items and two dimensions: physical fatigue (8 items) and mental fatigue (6 items). The answer for each item was designed as dichotomisation: 0 (no symptom) and 1 (have symptom). The sum of the CFS score ranges from 0 to 14. The higher the CFS score is, the more severe the fatigue is. The CFS has been widely used among Chinese healthcare staff with good reliability and validity.^{21 30} Cronbach's α coefficient of CFS in this study was 0.938.

Measurement of professional identity

The Chinese version Occupational Identity Scale (OIS) was used to assess professional identity.³¹ It comprises of 10 items, and all items are scored from 1 (absolutely inconsistent) to 5 (absolutely consistent). Then, the scores would be summed to indicate the level of professional identity: the higher the sum the higher level of professional identity. The Chinese version OIS has been widely used among Chinese occupational groups with good reliability and validity.^{12 32} Cronbach's α coefficient of scale in this study was 0.949.

Measurement of postcompetency and respect

The assessment of CDC worker's postcompetency adopts self-compiled questions, based on the instructions from the Association of Schools of Public Health in the European Region and the Council on Linkages Between Academia and Public Health Practice (Council on Linkages).^{33 34} Three self-administrated questions were used to evaluate CDC worker's mastery of their professional knowledge, public health emergency knowledge as well as communication and cooperation: (1) Please rate the

level of your knowledge about public health expertise (epidemiology, preventive medicine, health education, laws and regulations, etc); (2) Please rate the level of your knowledge of public health emergencies (classification and grading of public health emergencies, corresponding emergency response criteria and skills, etc); (3) Please rate your teamwork and communication skills (with superiors, colleagues and the public). Each was estimated from 0 (none) to 7 (have a good command of it), the scores would be summed to indicate the level of post-competency: the higher the sum the higher postcompetency. Respect was measured by a single item (Please rate the level of public recognition and respect the work you do: low, general and high).

Measurement of occupational stress

The Chinese version ERI's subscale of extrinsic effort and reward was used to measure CDC worker's occupational stress.^{35 36} The effort/reward ratio (ERR) = (11×effort)/(6×reward) represent the occupational stress. Item for extrinsic effort and reward are rated by a 5-point Likert-type scale, from 1 (not stressful) to 5 (very stressful). When ERR>1, the occupational stress exists. The Chinese version of the ERI has been widely used among Chinese occupational groups with good reliability and validity.^{21 30} In this study, Cronbach's α coefficients for the extrinsic effort and reward subscales were 0.879, 0.898, respectively.

Measurement of resilience and self-efficacy

CDC worker's resilience and self-efficacy were measured by the Psychological Capital Questionnaire (PCQ) which has 24 items and four components (self-efficacy, hope, resilience and optimism), and each item was scored from 1 (strong disagreement) to 6 (strong agreement).³⁷ Higher total scores mean higher level of Psychological Capital and its components. The Chinese version PCQ has been widely applied among Chinese people and has shown satisfactory reliability and validity.^{12 38} In this study, the Cronbach's α coefficients for resilience and self-efficacy subscales were 0.919 and 0.94, respectively.

Statistical analysis

The demographic and job variables were described with mean, SD, number (n) and percentage (%). Group differences of continuous variables were analysed with t-test or one-way ANOVA. Hierarchical multiple regression (HMR) analysis was conducted to identify the influencing factors. Variables were entered as follows: step 1, input demographic and job characteristics with statistically significant differences in fatigue and professional identity at t-test or one-way ANOVA (analysis of variance); step 2, competence and respect were added; step 3, occupational stress, resilience and self-efficacy were entered. In this study, SPSS V.21.0 (IBM, Asia Analytics Shanghai) was used for statistical analysis. A two-tailed $p < 0.05$ was considered statistically significant.

RESULTS

Descriptive statistics

The average score of fatigue and professional identity for CDC workers were 8.23 and 38.88, respectively. Results of univariate analyses are shown in [table 1](#). Workers aged 31–40 years had higher level of fatigue ($p<0.01$), while those aged 21–30 showed higher professional identity ($p<0.01$). Female CDC workers had higher professional identity than male ($p=0.016$); but there was no statistical difference for fatigue by gender. CDC workers, who were married or cohabiting, indicated higher fatigue levels ($p=0.016$) and lower professional identity ($p<0.01$). Participants with higher levels of education tended to be fatigued ($p<0.01$) and had lower professional identity ($p<0.01$). As for job characteristics, we found significant differences in fatigue and professional identity among CDC workers for the variables of workplace grade, weekly work time, receipt of occupational allowance and fighting the COVID-19 on the front line, respectively ($p<0.01$). Professional identity differed across serving years, but fatigue was not statistically different in terms of the same variable. CDC workers who perceived low public recognition and respect for their work, had higher levels of fatigue ($p<0.01$) and lower professional identity ($p<0.01$).

Correlations of continue variables

[Table 2](#) shows the correlations among age, post-competence, occupational stress, resilience, self-efficacy, professional identity and fatigue. As the table shows, postcompetence was negatively correlated with fatigue, while positively correlated with professional identity. For psychological factors, occupational stress was positively correlated with fatigue, but resilience and self-efficacy were negatively correlated with fatigue. Resilience and self-efficacy were positively correlated with professional identity, while occupational stress was negatively connected with it.

Influencing factors of fatigue

The results of the analysis of factors influencing fatigue are displayed in [table 3](#). The variance inflation factors (VIFs) of all independent variables in this analysis were less than 10, which means that collinearity didn't affect the results. A total of 21.7% of variance was interpreted by the final model. The improvement model fits caused by each step (R^2 changes) were 7%, 5.8% and 8.9%, respectively. In the final model, perceived public respect (general vs low, and high vs low) (both $\beta=-0.129$, $p<0.01$), resilience ($\beta=-0.104$, $p<0.05$) and self-efficacy ($\beta=-0.22$, $p<0.01$) were significantly and negatively connected with fatigue. Educational background (bachelor vs junior college or below) ($\beta=0.105$, $p<0.01$), (master or above vs junior college or below) ($\beta=0.092$, $p<0.05$), workplace grade (county vs district) ($\beta=0.067$, $p<0.05$), workplace (city vs district) ($\beta=0.085$, $p<0.05$), fighting the COVID-19 on the front line ($\beta=0.059$, $p<0.05$) and occupational stress ($\beta=0.166$, $p<0.01$) were significantly and positively correlated with fatigue.

Influencing factors of professional identity

The results of the HMR analysis are shown in [table 4](#). The results indicated that postcompetency ($\beta=0.362$, $p<0.01$), perceived public respect (general vs low) ($\beta=0.219$, $p<0.01$), (high vs low) ($\beta=0.288$, $p<0.01$), resilience ($\beta=0.097$, $p<0.05$), and self-efficacy ($\beta=0.113$, $p<0.01$) were significantly and positively connected with professional identity. Educational background (bachelor vs junior college or below) ($\beta=-0.097$, $p<0.01$), (master or above vs junior college or below) ($\beta=-0.114$, $p<0.01$), workplace (city vs district) ($\beta=-0.114$, $p<0.01$), fighting the COVID-19 on the front line ($\beta=-0.047$, $p<0.05$) and occupational stress ($\beta=-0.105$, $p<0.01$) were significantly and negatively associated with professional identity. The VIFs of all independent variables in this analysis were less than 10, meaning that collinearity did not affect the results. Finally, the final model explained 47.6% variance of professional identity, the R^2 changes for step1, step2 and step3 were 10.6%, 33.3% and 3.6%, respectively.

DISCUSSION

The current study revealed that compared with health-care workers, CDC workers had higher level of fatigue and professional identity.^{12 39} In this sense, measures to alleviate fatigue and maintain professional identity should be implemented immediately.

The study found that educational background, workplace, experience of fighting the COVID-19 on the front line, and occupational stress were positively associated with fatigue. Workers with higher education were more likely to be fatigued than those with junior college or lower educational level, which is consistent with previous studies.^{21 38} During the pandemic, the CDC workers are assigned with the work that consumes more resources to complete and this situation breaks the balance between the work demand and the possessed resources. Based on the COR theory, once employees' resources become insufficient, they are vulnerable to fatigue.²⁵ As for the workplace, compared with those working at the district level, the county and municipal CDC staff had more fatigue, a possible consequence of workload differences between the two levels. Staff at the municipal level are responsible for the health well-being of the people of the entire city (a city is comprised of several counties and districts). Besides, the facilities of the county level are less developed, so staff working at the county level need to invest more energy to complete the same tasks than those at the district level. For educational background and workplace grade factor, CDC managers should recruit staff with higher educational level and apply more frequent rotations to attenuate the level of fatigue.

Workers on the front line of COVID-19 containment are vulnerable to fatigue, which is consistent with previous studies.^{4 39} CDC managers could support the employees to keep away fatigue by applying paid vacation, counselling and incentive payments. We found occupational stress was positively connected with fatigue which

Table 1 Univariate analysis result (n=1020)

Variables	N (%)	Fatigue			Professional identity		
		Mean±SD	F/t	P value	Mean±SD	F/t	P value
Age (years)			9.35	<0.01		12.307	<0.01
21–30	162 (15.9%)	7.03±3.952			41.31±8.139		
31–40	370 (36.3%)	8.79±3.409			37.21±8.542		
41–50	320 (31.4%)	8.35±3.411			39.2±7.164		
> 50	168 (16.5%)	7.93±3.634			39.57±6.337		
Gender			1.704	0.089		–2.417	0.016
Male	282 (27.6%)	8.53±3.4			37.88±8.367		
Female	738 (72.4%)	8.12±3.648			39.26±7.613		
Marital status			–2.428	0.016		2.603	<0.01
single/ divorced/separated/widowed	229 (22.5%)	7.7±3.857			40.06±8.578		
Married/cohabiting	791 (77.5%)	8.39±3.488			38.53±7.596		
Educational background			8.463	<0.01		14.983	<0.01
Junior college or below	219 (21.5%)	7.39±3.843			41.16±6.557		
Bachelor	648 (63.5%)	8.39±3.509			38.6±7.782		
Master or above	153 (15%)	8.76±3.33			36.76±9.014		
Personal monthly income (¥)			6.554	<0.01		7.667	<0.01
≤¥3000	215 (21.1%)	7.39±3.871			41.06±8.009		
¥3001–¥4000	394 (38.6%)	8.48±3.507			38.27±8.184		
¥4001–¥5000	258 (25.3%)	8.16±3.564			38.51±7.538		
>¥5000	153 (15%)	8.9±3.181			38±6.689		
Workplace			13.777	<0.01		30.57	<0.01
City	403 (39.5%)	8.89±3.286			40.63±7.616		
County	207 (20.3%)	8.22±3.434			39.8±7.267		
District	410 (40.2%)	7.6±3.824			36.62±7.837		
Serving years			2.327	0.098		15.403	<0.01
≤10	457 (44.8%)	8.09±3.742			39.71±7.901		
11–20	252 (24.7%)	8.65±3.333			36.52±8.473		
>20	311 (30.5%)	8.11±3.528			39.56±6.822		
Weekly work time (hours)			–2.997	<0.01		2.915	<0.01
≤40 hours/week	676 (66.3%)	8±3.672			39.38±7.743		
>40 hours/week	344 (33.7%)	8.69±3.364			37.88±7.969		
Occupational allowance			4.128	<0.01		–5.641	<0.01
No	417 (40.9%)	7.67±3.821			40.52±7.407		
Yes	603 (50.1%)	8.62±3.358			37.74±7.95		
Fighting the COVID-19 on the front line			4.298	<0.01		–4.458	<0.01
No	655 (64.2%)	7.89±3.735			39.71±7.426		
Yes	365 (35.8%)	8.85±3.21			37.37±8.358		
Respect			26.601	<0.01		92.708	<0.01
Low	256 (25.1%)	9.48±2.781			34.26±8.977		
General	575 (56.4%)	8.02±3.682			39.34±6.708		
High	189 (18.5%)	7.2±3.797			43.71±5.837		

¥1=US\$0.146 (9 July 2020).

**Table 2** Correlations among continue variables

	Mean±SD	1	2	3	4	5	6	7
1. Age	40.42±9.32	1						
2. Postcompetency	18.15±2.30	-0.02	1					
3. ERR	1.32±0.63	0.119**	-0.022	1				
4. Resilience	29.04±4.36	-0.037	0.535**	0.012	1			
5. Self-efficacy	29.23±4.47	-0.065*	0.521**	-0.02	0.824**	1		
6. Professional identity	38.88±7.85	-0.038	0.547**	-0.187**	0.445**	0.444**	1	
7. Fatigue	8.23±3.58	0.059	-0.205**	0.226**	-0.313**	-0.338**	-0.373**	1

*P<0.05, **p<0.01 (two tailed).

ERR, effort-reward ratio.

is in line with previous study.²¹ CDC workers have spent much time and energy in keeping their duties during the pandemic. While the psychological energy depletes faster than it is replenished, occupational stress would occur and fatigue would entail. Thus, CDC managers should

assign the work rationally and provide timely support to reduce occupational stress and alleviate fatigue.

This research found that perceived public respect, resilience and self-efficacy were negatively associated with fatigue. Concurring with the previous result,⁴⁰ perceived

Table 3 Hierarchical multiple regression results of fatigue

Variables	Step1		Step2		Step3	
	β	VIF	β	VIF	β	VIF
Age (years)	0.059	2.776	0.064	2.779	0.027	2.801
Marital status	0.027	1.225	0.02	1.227	0.02	1.228
Education1	0.131**	1.952	0.121**	1.953	0.105**	1.966
Education2	0.102*	2.044	0.099*	2.044	0.092*	2.046
Income1	0.073	2.208	0.059	2.228	0.038	2.242
Income2	0.012	2.85	0.012	2.87	-0.001	2.881
Income3	0.051	3.012	0.063	3.031	0.058	3.039
Workplace1	0.077*	1.273	0.087**	1.278	0.067*	1.302
Workplace2	0.111**	1.439	0.093**	1.444	0.085*	1.453
Weekly work time (hours)	0.065*	1.037	0.053	1.043	0.024	1.087
Occupational allowance	0.062	1.227	-0.039	1.236	-0.03	1.238
Fighting the COVID-19 on the front line	0.091**	1.049	0.076*	1.059	0.059*	1.073
Postcompetency			-0.151**	1.063	0.009	1.474
Respect1			-0.171**	1.502	-0.129**	1.538
Respect2			-0.182**	1.514	-0.129**	1.55
ERR					0.166**	1.143
Resilience					-0.104*	3.326
Self-efficacy					-0.22**	3.263
F	6.268**		9.789**		15.393**	
Adjusted R ²	0.058		0.115		0.203	
ΔR^2	0.07		0.058		0.089	

Marital status, married/cohabiting vs unmarried/ divorced/separated/widowed; education1, bachelor vs junior college or lower; education2, master or higher vs junior college or lower; income1, ¥3001-¥4000 vs ≤¥3000; income2, ¥4001-¥5000 vs ≤¥3000; income3, >¥5000 vs ≤¥3000; ¥1=US\$0.146 (9 July 2020); workplace1, county vs district; workplace2, city vs district; weekly work time (hours), >40 hours/week vs ≤40 hours/week; occupational allowance, yes vs no; working on front line to defeat the COVID-19, yes vs no; respect1, general vs low; respect2, high vs low.

*P<0.05, **p<0.01.

ERR, effort-reward ratio; VIF, variance inflation factor.

Table 4 Hierarchical multiple regression results of professional identity

Variables	Step1		Step2		Step3	
	β	VIF	β	VIF	β	VIF
Age (years)	-0.028	4.075	-0.034	4.08	0.001	4.123
Gender	0.053	1.088	0.019	1.1	0.017	1.124
Marital status	-0.022	1.227	0	1.229	0	1.23
Education1	-0.131**	1.968	-0.106**	1.97	-0.097**	1.985
Education2	-0.128**	2.12	-0.116**	2.121	-0.114**	2.126
Income1	-0.108*	2.236	-0.059	2.256	-0.046	2.27
Income2	-0.083	2.992	-0.068	3.014	-0.058	3.023
Income3	-0.066	3.196	-0.079	3.217	-0.073	3.223
Workplace1	-0.037	1.295	-0.059*	1.301	-0.046	1.321
Workplace2	-0.164**	1.472	-0.13**	1.476	-0.122**	1.487
Serving years	0.027	3.367	0.024	3.368	0.006	3.387
Weekly work time (hours)	-0.049	1.041	-0.03	1.045	-0.012	1.088
Occupational allowance	-0.091**	1.242	-0.041	1.251	-0.034	1.253
Fighting the COVID-19 on the front line	-0.082**	1.073	-0.059*	1.08	-0.047*	1.09
Postcompetency			0.466**	1.066	0.362**	1.486
Respect1			0.246**	1.51	0.219**	1.544
Respect2			0.322**	1.514	0.288**	1.551
ERR					-0.105**	1.163
Resilience					0.097*	3.342
Self-efficacy					0.113**	3.268
<i>F</i>	8.534**		46.199**		45.326**	
Adjusted <i>R</i> ²	0.094		0.43		0.465	
ΔR^2	0.106		0.333		0.036	

Note: Gender, female vs male; marital status, married/cohabiting vs unmarried/ divorced/separated/widowed; education1, bachelor vs junior college or lower; education2, master or higher vs junior college or lower; income1, ¥3001–¥4000 vs ≤¥3000; income2, ¥4001–¥5000 vs ≤¥3000; income3, >¥5000 vs ≤¥3000; ¥1=US\$0.146 (9 July 2020); workplace1, county vs district; workplace2, city vs district; weekly work time (hours), >40 hours/week vs ≤40 hours/week; occupational allowance, yes vs no; working on front line to defeat the COVID-19, yes vs no; respect1, general vs low; respect2, high vs low.

P*<0.05, *p*<0.01.

ERR, effort–reward ratio; VIF, variance inflation factor.

public respect negatively related to fatigue, which can be explained by that respect constitutes a fundamental psychological need and determines a worker's job satisfaction and performance. With this finding, CDC administrators can use the new media to publicise the contributions made by the CDC workers in epidemic prevention and control, and raise public recognition and respect. Resilience and self-efficacy were negatively associated with fatigue and they are consistent with the results obtained in the healthcare workers.²¹ Special training programmes (mindfulness intervention, resilience enhancement project, psychological capital intervention) have been found to effectively improve an employee's resilience and self-efficacy.^{41–43} CDC managers can take the aforementioned information to develop interventions that cater to CDC staff to enhance their levels of resilience and self-efficacy.

As for professional identity, we found that postcompetency, perceived public respect, resilience and self-efficacy were the protective factors. Postcompetency, which describes the extent to which a person fits the job, was positively associated with professional identity and this supports the previous result.⁴⁴ Considering these findings, measures for training professional knowledge and stimulating active learning could be taken to improve professional competence. Meanwhile, professional identity would be enhanced as well. Respect was positively associated with professional identity, which supports our hypothesis. Respect is negatively associated with burnout and positively relates to job satisfaction and retention.^{40 45} Accordingly, CDC administrators could use both traditional and online media to enhance the recognition and respect for CDC workers. Resilience and self-efficacy were positively related to professional identity, which concur



with the former results,^{28 46} that workers with higher levels of resilience and self-efficacy tend to possess more energy and willingness to adjust their emotions and perceptions. Previous study has indicated resilience and self-efficacy can be improved by psychological capital intervention⁴¹; therefore, interventions in this regard can be used to increase professional identity.

This study showed that educational background, workplace, fighting the COVID-19 on the front line, and occupational stress were negatively associated with professional identity. CDC workers with better educational background tended to experience lower professional identity, which is different from the former studies.^{12 46} In the workplace, employees with better educational background tend to be assigned with critical workloads and responsibilities, and this scenario results in more fatigue and lower professional identity. This issue could be solved by upgrading the professional competence of existing staff to take on more work and this would help to maintain the professional identity with better educational background. CDC workers in cities, compared with those at district level, were inclined to have a lower professional identity, which can be explained by that city CDC workers are assigned with heavier workloads than those at the district level and they have more work stress. A proper personnel assignment is needed to improve the manpower of the municipal CDC, so that the work pressure would be relived and the professional identity would be enhanced.

Inconsistent with former studies,⁴⁷ CDC workers fighting on the front line to defeat COVID-19 have a lower professional identity. With the successful control during the early phase of the pandemic, occasional outbreaks caused by mutated strains of the virus require CDC workers to keep cautious at all time, and this lowers their level of professional identity.⁴⁸ Therefore, substitutes who sustain the duties are needed, and in this way, the level of professional identity could be maintained. A negative relationship between occupational stress and professional identity was identified, which is similar to previous study.⁴⁹ CDC workers have been under great stress during the pandemic and much physical and psychological energy is needed to get rid of this situation. The consequence is that the professional identity is lowered. Based on the ERI model and the COR theory,^{22 25} CDC administrators should rationalise work assignments, establish a scientific evaluation system and offer interventions to reduce the stress level and to maintain the professional identity.

CONCLUSIONS

CDC workers in China have undertaken a great deal of work to control the COVID-19 pandemic. They have more fatigue symptoms, and level of professional identity needs to be enhanced. Public respect, occupational stress, resilience and self-efficacy influence fatigue and professional identity. With these findings, administrators should raise the level of public recognition of the CDC's contribution, rationalise work assignments and

implement psychological capital interventions to improve resilience and self-efficacy of the CDC workers.

There are some limitations that need to be illustrated in this study. This study belongs to a cross-sectional study, and any causal-relationship conclusions cannot be drawn among variables in this study. Longitudinal research should be conducted in the future to address this limitation. Second, this survey was performed via internet platform, which may cause some response bias. Nevertheless, this study extends the field of research on the mental health of occupational population, and the mental health of CDC employees also requires attention.

Acknowledgements The author would like to thank all of the teachers and teammates who voluntarily assisted in obtaining written informed consent for the survey and in distributing questionnaires to the subject.

Contributors QC: formal analysis, investigation, writing-original draft, writing-review and editing. LL: methodology, writing-review and editing. HZ: writing-review and editing. LM: investigation, writing-review and editing. LC: writing-review and editing. YC: investigation. ZQ: investigation. HW: conceptualisation, data curation, funding acquisition, methodology, project administration, supervision, and acted as a guarantor.

Funding This study was supported by the Scientific Research Project of China Medical University (grant number YD2020018).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Committee on Human Experimentation of China Medical University (YD2020018).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

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REFERENCES

- Zhang W, Yang X, Zhao J, *et al*. Depression and Psychological-Behavioral responses among the general public in China during the early stages of the COVID-19 pandemic: survey study. *J Med Internet Res* 2020;22:e22227.
- Lai J, Ma S, Wang Y, *et al*. Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019. *JAMA Netw Open* 2020;3:e203976.
- Mahase E. Covid-19: WHO declares pandemic because of "alarming levels" of spread, severity, and inaction. *BMJ* 2020;368:m1036.
- Teng Z, Wei Z, Qiu Y, *et al*. Psychological status and fatigue of frontline staff two months after the COVID-19 pandemic outbreak in China: a cross-sectional study. *J Affect Disord* 2020;275:247–52.
- Gordon JM, Magbee T, Yoder LH. The experiences of critical care nurses caring for patients with COVID-19 during the 2020 pandemic: a qualitative study. *Appl Nurs Res* 2021;59:151418.
- Aaronson LS, Teel CS, Cassmeyer V, *et al*. Defining and measuring fatigue. *Image J Nurs Sch* 1999;31:45–50.
- Lock AM, Bonetti DL, Campbell ADK. The psychological and physiological health effects of fatigue. *Occup Med* 2018;68:502–11.

- 8 Chang F-L, Sun Y-M, Chuang K-H, *et al.* Work fatigue and physiological symptoms in different occupations of high-elevation construction workers. *Appl Ergon* 2009;40:591–6.
- 9 Al Barmawi MA, Subih M, Salameh O, *et al.* Coping strategies as moderating factors to compassion fatigue among critical care nurses. *Brain Behav* 2019;9:e01264.
- 10 Bérastégui P, Jaspar M, Ghuysen A, *et al.* Fatigue-related risk management in the emergency department: a focus-group study. *Intern Emerg Med* 2018;13:1273–81.
- 11 Holden MD, Buck E, Luk J, *et al.* Professional identity formation: creating a longitudinal framework through time (transformation in medical education). *Acad Med* 2015;90:761–7.
- 12 Qiu T, Liu C, Huang H, *et al.* The mediating role of psychological capital on the association between workplace violence and professional identity among Chinese doctors: a cross-sectional study. *Psychol Res Behav Manag* 2019;12:209–17.
- 13 Zhang W, Meng H, Yang S, *et al.* The influence of professional identity, job satisfaction, and work engagement on turnover intention among township health inspectors in China. *Int J Environ Res Public Health* 2018;15:988.
- 14 Chen H, Liu F, Pang L, *et al.* Are you Tired of working amid the pandemic? the role of professional identity and job satisfaction against job burnout. *Int J Environ Res Public Health* 2020;17:9188.
- 15 McClelland DC. Testing for competence rather than for "intelligence". *Am Psychol* 1973;28:1–14.
- 16 Competence at work: models for superior performance 1993.
- 17 Demerouti E, Bakker AB, Nachreiner F, *et al.* The job demands-resources model of burnout. *J Appl Psychol* 2001;86:499–512.
- 18 Rewakowski C. Respect: an integrative review. *Nurs Sci Q* 2018;31:190–9.
- 19 McLeod S. Maslow's hierarchy of needs. *Simply psychology* 2007;1:1–18.
- 20 Ştefan SC, ŞC P, Albu CF. Implications of Maslow's hierarchy of needs theory on healthcare employees' performance. *Transylvanian Review of Administrative Sciences* 2020;16:124–43.
- 21 Tian F, Shu Q, Cui Q, *et al.* The mediating role of psychological capital in the relationship between occupational stress and fatigue: a cross-sectional study among 1,104 Chinese physicians. *Front Public Health* 2020;8:12.
- 22 Siegrist J. Adverse health effects of high-effort/low-reward conditions. *J Occup Health Psychol* 1996;1:27–41.
- 23 Hughes S, Ilesue L, de Ortega Bárcenas HF, *et al.* Coping with occupational stress in journalism: professional identities and advocacy as resources. *Journal Stud* 2021;22:971–91.
- 24 Lebares CC, Guvva EV, Ascher NL, *et al.* Burnout and stress among US surgery residents: psychological distress and resilience. *J Am Coll Surg* 2018;226:80–90.
- 25 Hobfoll SE. Conservation of resources. A new attempt at conceptualizing stress. *Am Psychol* 1989;44:513–24.
- 26 Epstein RM, Krasner MS. Physician resilience: what it means, why it matters, and how to promote it. *Acad Med* 2013;88:301–3.
- 27 Huang C. Achievement goals and self-efficacy: a meta-analysis. *Educ Res Rev* 2016;19:119–37.
- 28 Gao Z, Wei X, Yang L, *et al.* Mediating role of career self-efficacy between clinical learning environment and professional identity in nursing students. *J Adv Nurs* 2022;78:1012–9.
- 29 Chalder T, Berelowitz G, Pawlikowska T, *et al.* Development of a fatigue scale. *J Psychosom Res* 1993;37:147–53.
- 30 Liu L, Wu D, Wang L, *et al.* Effort-Reward imbalance, resilience and perceived organizational support: a moderated mediation model of fatigue in Chinese nurses. *Risk Manag Healthc Policy* 2020;13:893–901.
- 31 Tyler D, McCallum RS. Assessing the relationship between competence and job role and identity among direct service counseling PSYCHOLOGISTS. *J Psychoeduc Assess* 1998;16:135–52.
- 32 Deng W, Feng Z, Yao X, *et al.* Occupational identity, job satisfaction and their effects on turnover intention among Chinese paediatricians: a cross-sectional study. *BMC Health Serv Res* 2021;21:6.
- 33 ASPHER's European List of Core Competences for the Public Health Professional. *Scandinavian Journal of Public Health* 2018;46.
- 34 Ned-Sykes R, Johnson C, Ridderhof JC, *et al.* Competency guidelines for public health laboratory professionals: CDC and the association of public health laboratories. *MMWR Suppl* 2015;64:1–81.
- 35 Li J, Yang W, Cheng Y, *et al.* Effort-reward imbalance at work and job dissatisfaction in Chinese healthcare workers: a validation study. *Int Arch Occup Environ Health* 2005;78:198–204.
- 36 Chang H-J, Huang N, Lee C-H, *et al.* The impact of the SARS epidemic on the utilization of medical services: SARS and the fear of SARS. *Am J Public Health* 2004;94:562–4.
- 37 LUTHANS F, AVOLIO BJ, AVEY JB, *et al.* Positive psychological capital: measurement and relationship with performance and satisfaction. *Pers Psychol* 2007;60:541–72.
- 38 Qiu T, Yang Y, Liu C, *et al.* The association between resilience, perceived organizational support and fatigue among Chinese doctors: a cross-sectional study. *J Affect Disord* 2020;265:85–90.
- 39 Li J, Xu J, Zhou H, *et al.* Working conditions and health status of 6,317 front line public health workers across five provinces in China during the COVID-19 epidemic: a cross-sectional study. *BMC Public Health* 2021;21:106.
- 40 Renger D, Miché M, Casini A. Professional recognition at work: the protective role of Esteem, respect, and care for burnout among employees. *J Occup Environ Med* 2020;62:202–9.
- 41 Da S, He Y, Zhang X. Effectiveness of psychological capital intervention and its influence on work-related attitudes: daily online Self-Learning method and randomized controlled trial design. *Int J Environ Res Public Health* 2020;17:8754.
- 42 Liang H-F, Wu K-M, Hung C-C, *et al.* Resilience enhancement among student nurses during clinical practices: a participatory action research study. *Nurse Educ Today* 2019;75:22–7.
- 43 Barry KM, Woods M, Martin A, *et al.* A randomized controlled trial of the effects of mindfulness practice on doctoral candidate psychological status. *J Am Coll Health* 2019;67:299–307.
- 44 Mohtashami J, Rahnama H, Farzinfard F, *et al.* A survey of correlation between professional identity and clinical competency of psychiatric nurses. *Open J Nurs* 2015;05:765–72.
- 45 Bofo IM. The effects of workplace respect and violence on nurses' job satisfaction in Ghana: a cross-sectional survey. *Hum Resour Health* 2018;16:6.
- 46 Zhang Z, Fu W, Tian C, *et al.* Professional identity of Chinese nursing students during the COVID-19 pandemic outbreak: a nation-wide cross-sectional study. *Nurse Educ Pract* 2021;52:103040.
- 47 Li Z, Zuo Q, Cheng J, *et al.* Coronavirus disease 2019 pandemic promotes the sense of professional identity among nurses. *Nurs Outlook* 2021;69:389–98.
- 48 Edwards H, Durette D. The relationship between professional identity and burnout among occupational therapists. *Occup Ther Health Care* 2010;24:119–29.
- 49 Farid EE, Peikari H, Golshiri P. Correlation of professional identity dimensions with role stress in nurses. *Journal of Health Promotion Management* 2019;8:1–8.