Evaluation and improvement of emergency capacity of medical staff for the COVID-19: A cross-sectional study in China

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Abstract

Background: The coronavirus disease 2019 (COVID-19) has spread to 215 countries around the world. In the studies of responding to public health emergencies, most of them are focused on health systems, local governments or medical organizations, but less on individuals. Medical staff, however, are the core strength for responding to public health emergencies. The aims of this study are to investigate the status of medical staff’s emergency capacity during the Pandemic and to provide intellectual support for further enhancing the medical staff's ability to ensure the smooth operation of medical rescue.

Methods: This study conducted a cross-sectional survey of four hospitals, which were designated to treat patients with COVID-19 in China. Based on the emergency capacity system for infectious diseases of medical staff, an improved Emergency Preparedness Information Questionnaire was used to evaluate the emergency capacity of medical staff. Linear regression and one-way analysis of variance were used to test the difference in the emergency capacity of medical staff; Spearman correlation analysis was used to study the correlation between self-efficacy and emergency capacity of medical staff.

Results: The overall emergency capacity of the surveyed medical staff was at a medium level. There was a correlation between emergency capacity and age, working years, position, educational background and area where medical staff work. Emergency capacity was not related to the hospital grades. Emergency capacity was significantly related to whether medical staff had participated in frontline Pandemic prevention work. There was also a positive correlation between emergency capacity and self-efficacy of medical staff.

Conclusions: The results highlighted the importance of the training mechanism for emergency personnel. The emergency input for public health emergencies should be increased to improve the emergency capacity of medical staff. In addition, it is necessary to pay attention to the mental health of medical staff.

1. Background

Since December 2019, the coronavirus disease 2019 (COVID-19) outbreak caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has occurred in Wuhan, China [1, 2]. With the aggressive spread of SARS-CoV-2, the death toll has been rising worldwide. As of August 1, 2020, COVID-19 has swept across 215 countries and territories, with over 17.39 million cases and 675,060 deaths reported. There are serious political, economic and social consequences caused by COVID-19 for many countries and regions around the world [3].

Swift action to control further spread of the virus and to improve the response capabilities of countries with the severe Pandemic is therefore urgent. To minimise the mortality risk of COVID-19, governments and the medical community are taking steps to prevent transmission, ranging from common sense recommendations to radical quarantine measures [4]. In response to public health emergencies, the World Health Organization (WHO) has developed a medical rescue evaluation system for the health system [5]. The Federal Emergency Management Agency (FEMA) and the National Emergency Management Association (NEMA) have jointly proposed Rescue Self-Assessment Tool [6]. The United States Centers for Disease Control and Prevention (CDC) has presided over the development of a reference manual for state and local public health emergencies [7]. And the Indiana State Department of Health has compiled an evaluation tool for the Long-Term Care Facility [8]. However, in general, most of the research focuses on the health system level, the state government level or the medical organization level, but less on the individual level. In the studies of hospital emergency rescue, although some of the indicators of medical staff on emergency rescue are involved, they are the overall requirements for medical staff from the perspective of hospitals, and there is no specific dimension to analyze.

Medical staff, however, are the main force involved in handling the epidemic of major infectious diseases. There are many busy medical staff who provides technical and intellectual support for emergency medical rescue in every public health emergency. First-line medical staff and scientists in China have played a crucial role in fighting the outbreak of COVID-19 [9]. We have watched that although the Pandemic has caused a state of panic, Chinese speed is slowly reassuring. Chinese scientists, public health professionals and medical staff are striving to pursue pathogens, formulate major measures to reduce the impact of the epidemic, and transparently share the treatment plan and results of epidemic treatment to the global health community. We can see this effort is amazing [10]. The COVID-19 places unprecedented pressure on societies and health-care systems around the world. In response to this ongoing public health emergency, preparedness and reducing risk of the global spread of COVID-19 are key concerns [11]. The emergency capacity of medical staff is an essential factor in reducing the case fatality rate and controlling further spread of the Pandemic [12]. Therefore, it is necessary to understand the current status of the core emergency capacity of medical staff, so as to provide a reference basis for the improvement of emergency levels and the improvement of corresponding measures to deal with the development of the Pandemic in the future.

The Emergency Capacity referred to in this study is the basic ability required for medical staff involved in emergency rescue of infectious disease emergencies, including relevant knowledge, skills and attitudes. The evaluation index system can be usually used to evaluate the emergency capacity of medical staff [13]. In order to understand the status of medical staff's emergency response capacity in this Pandemic, we adopted a medical staff's infectious disease emergency response capacity system and Emergency Preparedness Information Questionnaire (EPIQ) that has been improved to distribute a questionnaire online to hospitals in China.

During the Pandemic, rapid and robust research is significant to help guide clinical practices and public health policies. The purposes of this study are to analyze the differences in the prevention, preparation and coping capabilities of medical staff with different demographic characteristics; to discuss the correlation between medical staff's prevention, preparation, coping, and self-efficacy; and to investigate the factors that motivate and hinder medical staff to participate in emergency rescue. Understanding the current status of the core emergency capacity of medical staff in China would provide timely information to guide intervention policies, control the development of the COVID-19 outbreak rapidly and reduce the mortality of patients with pneumonia. This information will be crucial to inform intervention policies in real-time, not only for China, but also for other countries with COVID-19 transmission. The results would provide an opportunity to review the emergency capacity of other countries and apply key recommendations from other major public health emergencies to better protect the world from future health emergencies. This will also prompt the health department to pay attention to frontline doctors and provide adequate protective equipment to reduce their risk of infection. Only in this way can the Pandemic be controlled, and patients can continue to seek treatment for other health problems in hospital.

2. Materials And Methods

2.1. Participants and Data Collection

We adopted a cross-sectional survey design and an anonymous online questionnaire to assess the emergency capacity of medical staff during the Pandemic of COVID-19. A stratified sampling method was used to select hospitals in each province in northern, central and southern China, which were all designated to treat patients with SARS-CoV-2 pneumonia. The online survey questionnaires were first sent to the managers of the selected hospitals, and they were encouraged to forward it to the medical staff of each department of the hospitals to fill out and submit.

As the Chinese government advocated going out less and not gathering during the Pandemic of COVID-19, the use of online questionnaires could obtain large sample data without time and geographical restrictions. Respondents filled out the questionnaire in Chinese on an online survey platform ("SurveyStar", Changsha Ranxing Information Technology Co., LTD, Hunan, China). Data collection took place after the number of patients with SARS-CoV-2 pneumonia in China began to decrease gradually, and it lasted for over three days (April 5 - 8, 2020). The link to the questionnaire was forwarded to WeChat groups of medical staff by hospital administrators after the questionnaire was edited on the website.

2.2. Design of the Survey

EPIQ is a widely used emergency capacity assessment tool with good reliability and validity [14]. The scale can be used to develop an evaluation tool that comprehensively evaluates the ability to cope with infectious disease emergencies and the training needs of medical staff. Based on the questionnaire of Core Emergency Response Capability Indicators of Medical Staff Infectious Diseases Emergencies compiled by Chinese scholar Ting Kan and others [15], and in conjunction with other issues related to the COVID-19, we limited the scope of infectious diseases to the COVID-19. On the basis of the original questionnaire, we deleted the "understand the response to bioterrorism attacks" in Item 36, and modified the "understand the emergency response to infectious diseases after natural disasters" in Item 37 to "understand COVID-19 emergency response". The final scale was composed of three dimensions, i.e., prevention ability, preparation ability and coping ability, with a total of 37 items. The response scale for each question was a seven-point Likert scale, where 1 = very unfamiliar and 7 = very familiar. The higher the score, the stronger the core emergency response capability. Targeted training in response to the lack of emergency capacity can enhance the self-efficacy of medical staff in response to public health emergencies, thereby enhancing their willingness to participate in rescue [16]. Therefore, at the end of the questionnaire, the content of medical staff's self-efficacy was added. The structured questionnaire includes the following aspects:

Sociodemographic data were collected on gender, age, working years, position, educational attainment, region and hospital grade. Respondents were asked to answer whether they had participated in the first-line anti-Pandemic activities.

Prevention Capabilities are composed of 1 secondary indicator and 3 items. Respondents were asked to what extent they grasp the infection spectrum of the COVID-19, including the concepts and significance of incubation period, infectious period, recessive infection, and dominant infection. They were also asked if they know the spread of the COVID-19 and the principles in mastering the prevention and control the COVID-19.

Preparation Capabilities are composed of 4 secondary indicators and 6 items. Variables about preparation ability included the familiarity with the responsibilities of medical staff in the National Emergency Response Plan for Public Health Emergencies and the National Emergency Response Plan for Medical Emergencies; and the degree of understanding of the Emergency Regulations on Public Health Incidents and the Law of the People's Republic of China on the Prevention and Control of Infectious Diseases. Respondents were asked whether they regularly participated in emergency exercise for infectious disease emergencies and whether they regularly participated in training for common and emerging infectious diseases.

Coping Capabilities are composed of 6 secondary indicators and 28 items, including the contents of monitoring, reporting, medical response, public health response, risk communication, and the response to the COVID-19 in specific situations. Respondents were asked whether they understand the meaning of symptom monitoring and whether they remember the definition of syndrome and the reporting period of legal infectious diseases. They were also asked whether they have memorized the scope and process of the COVID-19 related information report, whether the basic knowledge of medical response to the COVID-19 was mastered, and whether the patients were implemented with the collection of specimens. In addition, variables also included the degree of understanding of the precautions for specimen storage and transportation, and whether key information could be obtained from the selected information sources. Respondents were also asked about the degree of mastery of safety protection, infection control, and isolation measures; whether to participate in the health education program for infectious disease control; and whether they have the ability to communicate with patients on psychological counseling and other risks. Finally, respondents were asked about some precautions for specific circumstances such as a global pandemic and participating in international rescue.

The self-efficacy of medical staff was measured by using the General Self-Efficacy Scale (GSES) [17-19]. The GSES of Chinese version has been well-validated in China for determining the individual's perception or belief that he can adopt adaptive behavior in the face of challenges in the environment [20]. The GSES in this research had a total of 10 items, involving medical staff's self-confidence when they encounter setbacks or difficulties during fighting against the COVID-19. The response scale for each question was a five-point Likert scale. For each item, the respondent answered "completely incorrect", "somewhat correct", "uncertain", "mostly correct", or "completely correct" according to their actual situation. When we were scoring, "completely incorrect" scored 1 point, "somewhat correct" scored 2 points, "uncertain" scored 3 points, "mostly correct" scored 4 points, and "completely correct" scored 5 points.

2.3. Data Analysis

Descriptive statistics were calculated to understand sociodemographic characteristics, prevention ability variables, preparation ability variables, coping ability variables, and self-efficacy variables, so as to understand the current status of medical staff's ability to prevent, prepare and rescue the COVID-19 cases. The linear regression, one-way analysis of variance and Kruskal-Wallis H test were used to study the difference of demographic characteristics in the prevention, preparation and coping capacities for the COVID-19. Spearman correlation analysis was applied to study the correlation between self-efficacy and medical staff's ability to prevent, prepare and rescue. All tests were two-tailed and the significance level was $p < 0.05$. STATA Statistics/Data Analysis 15.1 was used for statistical analysis (StataCorp LLC, Texas, United States).

3. Results

3.1. The Cure of Patients with SARS-CoV-2 in China from February 1 to March 31, 2020

Figure 1 shows the changes in the existing diagnosed patients, the cumulative number of the cured, and the cumulative death toll with SARS-CoV-2 in February and March, 2020 in Hubei province, China. The cumulative number of the cured had been increasing exponentially over the past two months. The number of the cumulative death toll had also been increasing, but not as strongly as the former. The number of the existing diagnosed patients, however, was in a bell-shaped distribution. An inflection point appeared on February 19. The number of the patients diagnosed in Hubei province had increased geometrically daily by February 19. Until February 20, the total number of the confirmed cases was gradually decreasing. It is worth noting that the cumulative number of the cured on February 29 exceeded the number of the existing diagnosed patients, and the gap between them was widening in a trumpet shape.

3.2. Participants in the Survey

We received responses from 483 participants, and 126 participants did not complete the questionnaire. In the end, we included 357 participants from 4 hospitals, which were all the selected hospitals to treat patients with SARS-CoV-2 pneumonia in China (completion rate: 73.91%). A total of 174 participants submitted the questionnaire on the first day (6 April), and 278 participants submitted the questionnaire on the second day (7 April). Only 31 participants submitted the questionnaire on the third day (8 April).

The emergency capacity of medical staff was measured by using the EPIQ scale. For simplicity, all the three variables were calculated as the means of their respective items (with negative items reverse-coded). In the overall dimension of prevention ability, the sample mean was 5.98 (SD = 1.03). Of all respondents, 5 (1.4%) were considered weak in prevention (score < 3); 90 (25.2%) were considered to have a moderate level of prevention (score: 3-5); 262 (73.4%) were considered to have strong prevention ability (score > 5). In the overall dimension of preparation ability, the sample mean was 5.11 (*SD* = 1.22). Of all respondents, 33 (9.2%) were considered weak in preparation (score < 3); 97 people (27.2%) were considered to have a moderate level of preparation (score: 3-5); 206 (57.7%) were considered to have strong preparation ability (score > 5). In the overall dimension of coping ability, the sample mean was 5.54 (*SD* = 1.07). Of all respondents, 11 (3.1%) were considered weak in coping (score < 3); 100 (28.0%) were considered to have moderate coping ability (score: 3-5); 246 (68.9%) were considered to have strong coping ability (score > 5).

The self-efficacy level of the medical staff was measured by using the GSES scale, and the overall mean of the sample was 3.86 (*SD* = 0.65). Specifically, 6 (1.7%) were not confident enough to complete the tasks they were assigned with (score: 1-2); 85 (23.8%) were considered general confidence and could barely complete the tasks they were assigned with (score: 3); 266 (74.5%) were considered to be relatively confident and could better complete the tasks they were assigned with (score: 4-5).

3.3. Sociodemographic Variables and Emergency Capacity of Medical Staff

Sociodemographic characteristics are presented in Table 1. The majority of participants were women (85.9%), aged 21 to 30 years (52.7%); had worked under 11 years (63.3%), with a bachelor's degree (59.9%), as clinical nurse (60.5%); and worked in Shaanxi province (55.2%) and secondary hospitals (89.9%). Nearly half of the respondents were frontline medical staff during the Pandemic of COVID-19 (43.7%). Male gender was significantly associated with higher scores in the EPIQ preparation ability subscale (B = 0.32, 95% Confidence Interval (95% CI): 0.00 to 0.64). Ages of 21 to 30 years were significantly associated with lower EPIQ preparation ability subscale (B = −0.54, 95% CI: −1.13 to 0.06). Low working-years were significantly associated with lower EPIQ preparation ability subscale scores (B = −0.55, 95% CI: −1.13 to 0.03), EPIQ coping ability subscale (B = −0.44, 95% CI: −0.95 to 0.07); and those with 11 to 20 working years were significantly associated with lower EPIQ coping ability subscale scores (B = −0.51, 95% CI: −1.06 to 0.05) as compared to those who have worked from 31 to 40 years. Those with high school degree were significantly associated with lower EPIQ prevention ability subscale scores (B = −2.90, 95% CI: −5.16 to −0.61) as compared to those with a PhD. Clinical nurse status was significantly associated with lower EPIQ preparation ability subscale (B = −0.45, 95% CI: −0.82 to −0.09). Clinicist status was significantly associated with lower EPIQ preparation ability subscale (B = −1.62, 95% CI: −2.84 to −0.39) and lower EPIQ coping ability subscale (B = −1.46, 95% CI: −2.53 to −0.38). The status of frontline medical staff was significantly associated with higher EPIQ prevention ability subscale (B = 0.33, 95% CI: 0.12 to 0.55), higher EPIQ preparation ability subscale (B = 0.39, 95% CI: 0.14 to 0.64), and higher EPIQ coping ability subscale (B = 0.43, 95% CI: 0.21 to 0.65). The status of Shaanxi province was significantly associated with higher EPIQ prevention ability subscale (B = 0.34, 95% CI: 0.08 to 0.60). The status of Hubei province was significantly associated with higher EPIQ prevention ability subscale (B = 0.53, 95% CI: 0.21 to 0.85), higher EPIQ preparation ability subscale (B = 0.36, 95% CI: −0.02 to 0.73), and higher EPIQ coping ability subscale (B = 0.32, 95% CI: −0.01 to 0.65). Other sociodemographic variables, such as hospital grade, were not associated with EPIQ subscale scores.

Table 1. Association between demographic variables and emergency capacities of medical staff during the fight against COVID-19

Variable	N (%)	Prevention ability			Preparation ability			Coping ability		
		R-Squared (R^2)	Adjusted R-Squared (AR^2)	Beta (95% Confidence Interval) or B (95% CI)	R^2	AR^2	B (95% CI)	R^2	AR^2	B (95% CI)
Gender										
Male	68(19.1)	0.002	−0.001	0.12 (−0.15 to 0.40)	0.011	0.008	0.32** (0.00 to 0.64)	0.006	0.003	0.20 (−0.08 to 0.48)
Female	289(85.9)			Reference			Reference			Reference
Age (Years)										
(under 21)	4(1.1)			0.04 (−1.07 to 1.15)			0.09 (−1.23 to 1.41)			0.05(−1.12 to 1.21)
(21 − 30)	188(52.7)	0.044	0.033	−0.47 (−0.98 to 0.03)	0.034	0.023	−0.54* (−1.13 to 0.06)	0.009	−0.003	−0.33 (−0.86 to 0.20)
(31 − 40)	91(25.5)			−0.30 (−0.83 to 0.22)			−0.26 (−0.88 to 0.37)			−0.29 (−0.84 to 0.27)
(41 − 50)	57(16.0)			0.10 (−0.45 to 0.65)			0.02 (−0.63 to 0.68)			−0.12 (−0.70 to 0.45)
(51 − 60)	17(4.7)			Reference			Reference			Reference
Working years										
(under 11)	226(63.3)	0.039	0.031	−0.40 (−0.89 to 0.09)	0.025	0.017	−0.55* (−1.13 to 0.03)	0.016	0.007	−0.44* (−0.95 to 0.07)
(11 − 20)	64(17.9)			−0.44 (−0.97 to 0.09)			−0.51 (−1.14 to 0.13)			−0.51* (−1.06 to 0.05)
(21 − 30)	49(13.7)			0.15 (−0.40 to 0.70)			−0.07 (−0.73 to 0.59)			−0.76 (−0.76 to 0.39)
(31 − 41)	18(5.1)			Reference			Reference			Reference
Educational attainment										
Upper secondary school	3(0.8)	0.063	0.053	−2.9** (−5.16 to −0.61)	0.023	0.012	−1.61 (−4.37 to 1.15)	0.027	0.016	−1.29 (−3.69 to 1.11)
Associate degree	130(36.5)			−1.24 (−3.22 to 0.73)			−0.20 (−2.60 to 2.20)			0.10 (−1.99 to 2.19)
Bachelor degree	214(59.9)			−0.87 (−2.84 to 1.11)			0.05 (−2.35 to 2.44)			0.31 (−1.77 to 2.40)
Master degree	9(2.5)			−0.70 (−2.78 to 1.37)			0.01 (−2.52 to 2.52)			0.32 (−1.87 to 2.51)
Doctorate	1(0.3)			Reference			Reference			Reference

**p<0.01, ** p<0.05, * p<0.1

Table 1. ***Continued.***

Variable	N (%)	Prevention ability			Preparation ability			Coping ability		
		R^2	AR^2	B (95% CI)	R^2	AR^2	B (95% CI)	R^2	AR^2	B (95% CI)
Position										
Clinician	85(23.8)	0.019	0.011	0.13 (−0.23 to 0.48)	0.043	0.035	−0.03 (−0.44 to 0.39)	0.034	0.025	0.22 (−0.14 to 0.59)
Clinical nurse	216(60.5)			−0.20 (−0.51 to 0.11)			−0.45 ** (−0.82 to −0.09)			−0.06 (−0.38 to 0.26)
Clinicist	4(1.1)			−0.08 (−1.12 to 0.97)			−1.62** (−2.84 to −0.39)			−1.46*** (−2.53 to −0.38)
Others	52(14.6)			Reference			Reference			Reference
Are you a member of frontline medical staff in COVID-19 Pandemic?										
Yes	156(43.7)	0.026	0.023	0.33*** (0.12 to 0.55)	0.025	0.022	0.39*** (0.14 to 0.64)	0.040	0.037	0.43*** (0.21 to 0.65)
No	201(56.3)			Reference			Reference			Reference
Region										
Shaanxi province	197(55.2)	0.031	0.026	0.34** (0.08 to 0.60)	0.023	0.017	−0.11 (−0.42 to 0.21)	0.012	0.006	0.07 (−0.21 to 0.34)
Hubei province	78(21.9)			0.53*** (0.21 to 0.85)			0.36* (−0.02 to 0.73)			0.32* (−0.01 to 0.65)
Yunnan province	82(22.9)			Reference			Reference			Reference
Hospital grade										
Tertiary hospital	29(8.1)	0.009	0.003	−0.19 (−1.04 to 0.66)	0.005	−0.001	−0.01 (−1.02 to 1.01)	0.007	0.001	−0.03 (−0.91 to 0.85)
Secondary hospital	321(89.9)			0.16 (−0.61 to 0.93)			0.28 (−0.64 to 1.20)			0.27 (−0.53 to 1.07)
Others	7(3.0)			Reference			Reference			Reference

3.4. Participation and Emergency Capacity

Table 2 shows the difference between the scores of frontline medical staff and non-frontline medical staff in the three dimensions of emergency capacity. Overall, frontline medical staff scored significantly higher in every dimension than non-frontline medical staff ($p < 0.01$). For the prevention ability, the total score of frontline medical staff (M = 18.51, SD = 2.61) was 1 point higher than that of non-frontline medical staff (M = 17.51, SD = 3.35). For the preparation ability, the total score of frontline medical staff (M = 31.96, SD = 6.50) was 2 points higher than that of non-frontline medical staff (M = 29.62, SD = 7.79). For the coping ability, the total score of frontline medical staff (M = 161.96, SD = 24.30) was 11 points higher than that of non-frontline medical staff (M = 150.01, SD = 32.60).

Table 2. Relationship between the emergency capacity and participation of medical staff in the Pandemic prevention

Dimension	Frontline medical staff of Pandemic prevention (n = 156)	Not frontline medical staff of Pandemic prevention (n = 201)	F	P-value
Prevention ability	18.51 ± 2.61	17.51 ± 3.35	9.44	0.0023
Preparation ability	31.96 ± 6.50	29.62 ± 7.79	9.14	0.0027
Coping ability	161.96 ± 24.30	150.01 ± 32.60	14.65	0.0002

3.5. Region and Emergency Capacity

Regarding the regions where respondents worked in, Table 3 also shows a significant difference in the emergency capacity of medical staff between regions. There were differences between the three regions in terms of prevention ability and preparation ability ($p < 0.05$). In general, the emergency capacity of medical staff in Hubei was higher than that of the other two regions. For the prevention ability, the total score of medical staff in Hubei (M = 18.63, SD = 2.30) was 0.5 point higher than that of medical staff in Shaanxi (M = 18.06, SD = 3.09), and 1.5 points higher than that of medical staff in Yunnan (M = 17.04, SD = 3.53). For the preparation ability, the total score of medical staff in Hubei (M =

32.67, *SD* = 5.58) was 2.5 points higher than that of medical staff in Shaanxi (*M* = 29.89, *SD* = 8.06), and 2 points higher than that of medical staff in Yunnan (*M* = 30.52, *SD* =6.67). For the coping ability, the total score of medical staff in Hubei (*M* = 161.23, *SD* = 24.39) was 7 points higher than that of medical staff in Shaanxi (*M* = 154.10, *SD* = 30.89), and 9 points higher than that of medical staff in Yunnan (*M* = 152.24, *SD* = 31.42).

Table 3. Relationship between the emergency capacity and the region of medical staff

Dimension	Shaanxi province (n = 197)	Hubei province (n = 78)	Yunnan province (n = 82)	F	P-value
Prevention ability	18.06 ± 3.09	18.63 ± 2.30	17.04 ± 3.53	5.74	0.0035
Preparation ability	29.89 ± 8.06	32.67 ± 5.58	30.52 ± 6.67	4.08	0.0178
Coping ability	154.10 ± 30.89	161.23 ± 24.39	152.24 ± 31.42	2.15	0.1186

3.6. Self-efficacy and Emergency Capacity

Table 4 shows the relationship between emergency capacity and self-efficacy of medical staff. There was a significant positive correlation between prevention ability and preparation ability ($r = 0.598$, $p < 0.001$); there was a significant positive correlation between prevention ability and coping ability ($r = 0.627$, $p < 0.001$); and there was a significant positive correlation between preparation ability and coping ability ($r = 0.761$, $p < 0.001$). There was a significant positive correlation between self-efficacy and prevention ability ($r = 0.202$, $p < 0.001$), a significant positive correlation between self-efficacy and preparation ability ($r = 0.358$, $p < 0.001$), and a significant positive correlation between self-efficacy and coping ability ($r = 0.376$, $p < 0.001$). Figure 2 shows the relationship between medical staff's self-efficacy and various dimensions of emergency capacity. There was a strong correlation between all dimensions of emergency capacity ($r > 0.5$, $p < 0.001$). Medical staff's self-efficacy was positively correlated with all dimensions of emergency capacity, but not strongly ($r < 0.5$, $p < 0.001$).

Table 4. **Correlation between emergency capacity and self-efficacy of medical staff**

	Prevention ability	Preparation ability	Coping ability	Self-efficacy
Prevention ability	1.0000			
Preparation ability	0.5981*	1.0000		
	0.0000		1.0000	
Coping ability	0.6266*	0.7608*		
	0.0000	0.0000		
Self-efficacy	0.2017*	0.3576*	0.3759*	1.0000
	0.0001	0.0000	0.0000	

* shows the significance at the 0.05 level

4. Discussion

In order to ease the further spread of the COVID-19, and for the safety of the people, the Chinese government has sent all its strength to contain the disease. Both in the supply of medical equipment and medical staff, as well as the stable development of other industries, China has made all efforts to stabilize the Pandemic [21]. Wuhan city, Hubei province, was the center of the COVID-19 in China. However, due to the strong leadership of the Communist Party of China, a series of major decisions such as the concentration of outstanding national medical staff to support Hubei were issued immediately. For the sake of people's security and national stability, the Chinese government has urgently deployed 68 medical teams, including more than 8000 medical staff from all over China. They were the most famous and proficient medical staff in their respective provinces and cities. They were on a mission to Hubei province, the hardest hit province, to fight side by side in hospitals with people from Wuhan and other parts of the country [22, 23]. Healthcare professionals had been working day and night since January 20, unwilling to give up any patient; as a result, the number of newly cured patients and the cure rate were gradually rising in February and March, 2020, while the increase in the cumulative number of the cured was much greater than the increase in the number of deaths. This proves once again that medical staff are indispensable in Pandemic prevention and control.

We analysed the correlation of medical staff's emergency capacity scores with demographic variables such as gender, age, working years, education, occupation, and hospital grade. Our estimates suggest that the younger age groups had a lower emergency capacity than the older, more senior and highly educated medical staff. In the past outbreaks, scholars had done a lot of investigation and research. It was found that gender had some influence on the ability of health intervention. During the Ebola outbreak in Africa from 2014 to 2016, scholars found that women were more susceptible to the disease due to their primary role as caregivers in the family and frontline medical workers [24]. In order to promote gender equality and meet public health standards, scholars advocate that gender should be included in disaster preparedness and response to improve health effectiveness, because women have lower voice and decision-making power than men at the time of outbreak [25]. In this study, our results further supported this view, as males were significantly better than females in terms of Pandemic preparedness.

It is clear from the data in three regions of China that the emergency capacity of frontline medical staff was significantly higher than that of non-frontline medical staff. Our results also suggest the emergency capacity of medical staff in Hubei was higher than that of the other two regions. From those that have, it is unclear why emergency capacity had such a significant difference in regions, but many medical teams supporting Hubei had received pre-job training from local experts in Hubei before going to the front line of the fight against the COVID-19 [26, 27]. The pre-job training aims to improve the prevention and control level of medical staff, help medical staff strengthen their awareness of protection, implement personal protection measures, and protect their health during the anti-Pandemic period. The experts mainly introduced the discovery and report of SARS-CoV-2 cases, epidemiological investigation, medical treatment, hospital infection prevention and control, close contact management, personal protection and other contents for the medical teams supporting Hubei, in combination with the characteristics of the local outbreak [28]. This may be the reason why medical staff who had participated in the first-line Pandemic prevention have a stronger emergency capacity than the medical staff who had not.

In this study, we also analyzed the relationship between medical staff's self-efficacy and emergency capacity. The existing studies have shown that training experience can affect the willingness of medical staff to participate in the rescue of public health emergencies [29, 30], and targeted training can enhance the self-efficacy of medical staff in responding to public health emergencies, thereby enhancing their willingness of participation in rescue [16]. Training experience is also a positive predictor of the coping ability of medical staff [31]. Our findings suggest that there was indeed a significant positive correlation between medical staff's self-efficacy and emergency capacity.

Training of medical staff on responding public health emergency and specific COVID-19 program is critical [32-34]. Medical staff have played a crucial role in responding to disease outbreaks such as SARS, Ebola virus, cholera and measles. The main lesson of these public health emergencies is to ensure that these skills are further developed [35]. Given the low capacity of many countries to effectively prevent and respond to health emergencies, our data reinforce this notion.

Personnel training is essential to ensure preparedness and success in dealing with any Pandemic. No matter how the COVID-19 evolves, medical staff must be prepared and trained to apply early and optimal interventions. We call on governments and global health institutions to consider the role of training programs in improving emergency abilities. With the huge efforts from medical staff to treat patients, we hope the downward turning points for both the new cases of COVID-19 and the resulting fatal events can come soon. Practical measures can be taken: First, hospital administrators, governments, and policymakers must work with medical staff. They must protect medical staff from cross-infection, physical exhaustion, and mental health issues, ensure access to drugs and protective equipment, discuss advance care plans, provide better training and preparation across the health workforce. Second, medical staff will also be under enormous psychological pressure due to overwork, shortage of medical resources, bad doctor-patient relationship, or other detrimental experience [36]. Medical staff should be provided with adequate psychological support, to grasp their own psychological characteristics, learn to diagnose their own psychological problems, reasonably ease their emotions, and improve their sense of self-efficacy. Third, training programmes should be led by expert members of the local team, with support from other professionals (e.g., infection control), and formulated into guidelines for clinical management; such guidelines should be provided to all members of the local teams. Fourth, online platforms with medical advice should be provided to share information on how to reduce the risk of transmission between patients in the medical environment, which aims to eventually reduce the pressure on medical staff. Fifth, the proper use of personal protective equipment and handling of infected bodily secretions and laboratory specimens are the basic skills to medical staff and all other institutional staff to manage any Pandemic. After sufficient training, all equipment related to emergency rescue must be drilled as a team in a high-fidelity simulation environment.

Our study had several limitations. First, only a few male medical staff were involved in this study. Despite most of the nurses in China are women, women's prescribed care roles in society usually place them in a most position to identify trends at the local level that may herald disease outbreaks and thus improve the global health security. Although the WHO Executive Board recognising the need to include women in decision-making for outbreak preparedness and response [37], there are inadequate women’s representation in national and global COVID-19 policy areas, such as in the White House Coronavirus Task Force [38]. Therefore, we should consider the gender balance when distributing the questionnaire. Secondly, we actually paid more attention to the performance of the medical staff in the treatment capacity, but neglected the mental ability of medical staff. Medical staff in high-risk units are especially vulnerable to mental health problems, including anxiety and depression, during outbreaks like COVID-19, because of the demanding workload and constant fears of being cross-infected [39]. Health-care workers who worked in SARS ICUs continued to suffer from post-traumatic stress disorder years later [40]. We should consider the effects of medical staff's psychological status on self-efficacy during the Pandemic. Lastly, given the limited available resources and the outbreak of COVID-19, we adopted an online survey based on a stratified sampling strategy. Due to fear of information being leaked and not being supervised, many respondents filled out the questionnaire randomly or quit without completing it. The proportion of invalid questionnaires was very high. As a result, we could not conduct a large-scale sample survey, and the survey could not provide specific results to support the need for a focused public health initiative. Despite these limitations, this study provides valuable information on the emergency capacity status of medical staff in three regions of China. Our results could be used as a reference for other public health events. Most of all, our findings directly indicate a series of training can be used to promote the improvement of self-efficacy and emergency capacity of medical staff. This has clinical and policy implications.

5. Conclusions

In conclusion, our study provides a detailed overview of the emergency response capabilities of medical staff in the three regions of North, Central, and South China. Our findings suggest that the emergency capacity of medical staff participating in first-line Pandemic prevention were stronger than that of medical staff who have not participated; the emergency capacity of medical staff in Hubei is better than that in other regions; and there is a high positive correlation between the self-efficacy and emergency response capabilities of medical staff. These results indicate that it is necessary to provide targeted training to improve the emergency capacity of medical staff, so as to curb the rapid spread of the Pandemic. The Pandemic continues to be severe, with frontline health workers being at risk of infection and undergoing both physical and psychological tests. Apart from personal protection for medical staff, psychological support should be provided in time to improve their sense of self-efficacy. Only in this way, will they be more capable to face the challenge of the COVID-19.

Abbreviations

COVID-19: Coronavirus disease 2019; SARS-CoV-2: severe acute respiratory syndrome coronavirus 2; WHO: World Health Organization; FEMA: Federal Emergency Management Agency; NEMA: National Emergency Management Association; CDC: Centers for Disease Control and Prevention; EPIQ: Emergency Preparedness Information Questionnaire; GSES: General Self-Efficacy Scale; R^2: R-Squared; AR^2: Adjusted R-Squared; CI: Confidence Interval

Declarations

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Authors' contributions

HSX contributed significantly to the study conceptualization and writing supervision. LQ contributed significantly to data collection. CCF and ZGF contributed significantly to the analysis of data and the writing of the first draft. CHL and ZYX contributed significantly to the revisions of the manuscript. All authors have read and approved the manuscript in its current form.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of School of Medicine of Xi'an Jiaotong University (China), and the approval number was 2020-1258. Verbal informed consent was received from the participants to use the information anonymously for the purpose of this study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

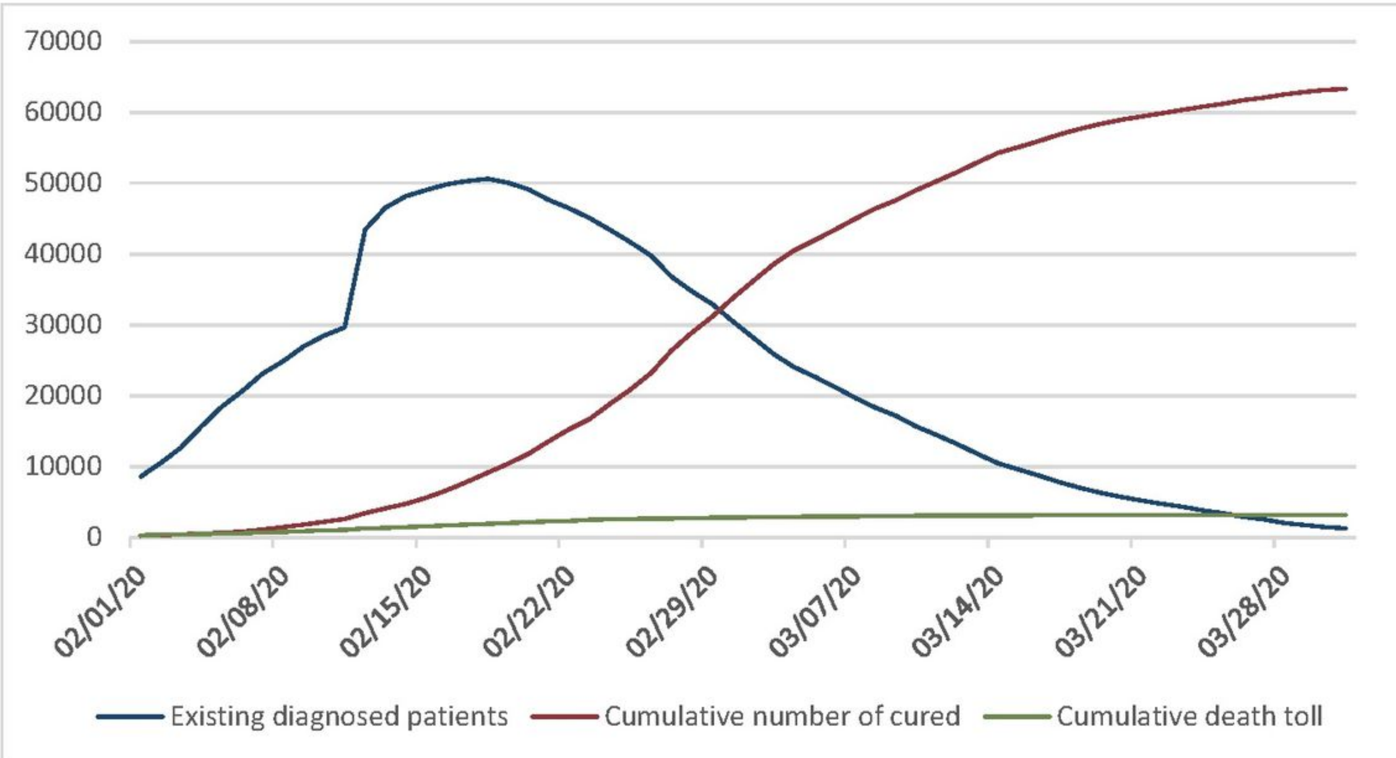

Figure 1

Changes in the number of existing diagnosed patients, cumulative number of cured, and cumulative death toll in Hubei, China from February to March 2020

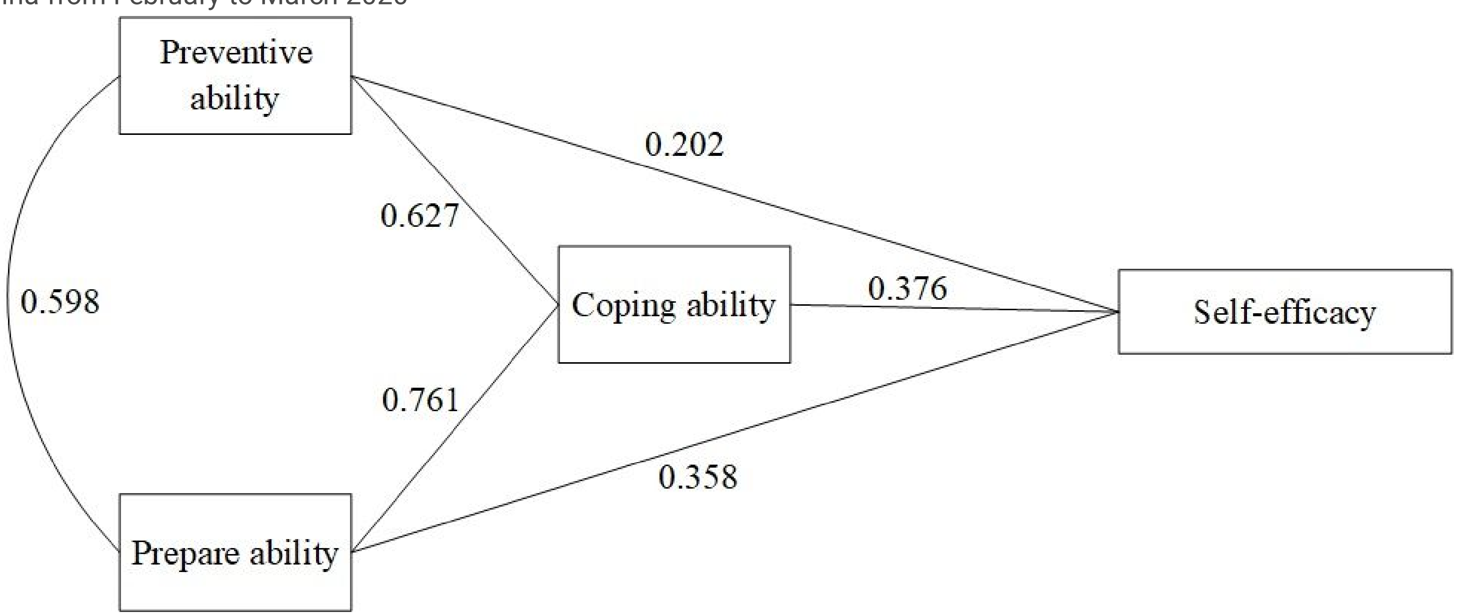

Figure 2

Pearson’s Correlations Between Emergency Capacity and Self-efficacy of Medical Staff

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Hubei.xlsx
- Data.dta