

# Association between clinical competencies and mental health symptoms among frontline medical staff during the COVID-19 outbreak: A cross-sectional study

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## Research article

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## Abstract

**Background:** In China, mental health of frontline medical staff might be influenced by clinicians' ability to handle the outbreak of coronavirus disease 2019 (COVID-19). Few studies to-date have addressed the association between clinicians' competencies and mental health in this context. This cross-sectional study has examined the prevalence of mental health symptoms among frontline medical staff handling the COVID-19 outbreak, and explored the associations between their competencies, and separate and concurrent depressive and anxiety symptoms.

**Methods:** A total of 623 frontline medical staff were included in this study, which took place from January 20, 2020 to February 20, 2020. Competencies, depressive symptoms, and anxiety symptoms were assessed using the short form of the Chinese clinical physicians' competency model, Patient Health Questionnaire-9, and Generalized Anxiety Disorder-7 questionnaire, respectively. Logistic regression models were used to estimate the associations between one standard deviation increase in competency scores and the prevalence of mental health problems. Multivariate-adjusted odds ratios (ORs) and corresponding 95% confidence intervals (CIs) were calculated.

**Results:** Among 623 staff members, the prevalence of depressive, anxiety, and comorbid depressive and anxiety symptoms was 40.93%, 31.78%, and 26.00%, respectively. Among the medical staff with higher total competency scores, the prevalence of depressive (OR=0.67, 95% CI: 0.55-0.81), anxiety (OR=0.68, 95% CI: 0.56-0.83), and comorbid anxiety and depressive symptoms (OR=0.69, 95% CI: 0.55-0.83) was lower than among their lower-scoring counterparts. Subgroup analyses stratified by core competency scores revealed similar associations as the main analyses.

**Conclusions:** The present findings highlight the association between high core competency scores and lower prevalence of depressive, anxiety, and comorbid anxiety and depressive symptoms. Improving medical staff's core competencies might help prevent mental health problems among frontline medical staff responding to COVID-19.

## Background

Coronavirus disease 2019 (COVID-19, previously referred to as 2019-nCoV), with an epicentre in Wuhan, the capital of Hubei province in China, has spread globally [1]. The World Health Organization Emergency Committee declared COVID-19 outbreak an international public health emergency in late January 2020[2]. By March 1, 2020, in China, there have been 79,968 confirmed COVID-19 cases, including 2,873 associated deaths [3]. Scientists have been concerned about the risk of many large outbreaks outside of China. According to a recent report by the National Health Commission of China, a total of 277 medical teams with 33,759 medical workers have been sent to Hubei to contain COVID-19.

Such large-scale public health threat associated with infectious disease poses several challenges. For example, frontline medical staff are under physical and psychological pressure, in particular, given scarce information about the disease's mode of transmission. The present epidemic has features comparable to

the 2003 outbreak of severe acute respiratory syndrome (SARS-CoV), which was caused by another coronavirus, resulting in 349 deaths out of 5,327 confirmed cases in China [4]. Previous studies have reported that in the initial phase of the SARS outbreak, medical staff felt vulnerable, uncertain, and concerned for their lives, which manifested with physical and psychological symptoms [5-6]. Moreover, staff members who experienced symptoms of depression were at increased risk of making errors in patient care [7]. Maintaining good mental health among medical staff is essential to preventing infectious disease spread and ensuring long-term wellbeing of staff [8-9]. Therefore, mental health of frontline medical staff should be supported during the outbreak of COVID-19.

Competence is a concept that refers to an ability to perform a specific activity, integrating knowledge, skills, values, and attitudes, often used to distinguish average and outstanding performance of a role [10-11]. Competence is measurable and can be developed through training. In the early stages of the COVID-19 outbreak, frontline medical staff have experienced challenges to their competencies [12]. Mental health among frontline medical staff might be influenced by their ability to deal with an outbreak, such as COVID-19 in China.

As a new infectious disease, COVID-19 has generated great research interest. However, epidemiological data on competencies and mental health symptoms among frontline medical staff during the COVID-19 outbreak are limited. Thus, the present cross-sectional study has examined the prevalence of mental health problems among frontline medical staff responding to the COVID-19 outbreak, and explored associations between core competency scores and prevalence of depressive, anxiety, and comorbid anxiety and depressive symptoms in this population.

## Methods

### *Participants*

This cross-sectional study was conducted using the WeChat-based survey programme Questionnaire Star. From January 20, 2020 to February 20, 2020, a total of 669 frontline medical staff responding to the COVID-19 outbreak participated in the present study. Data from participants who did not provide information on any of the variables of interest were excluded ( $n=46$ ). Overall, data from 623 participants were included in the analyses. The study protocol was approved by the ethics committee of Shengjing Hospital of China Medical University, and all participants provided written informed consent to participate. The study protocol conformed to the principles of the 1975 Declaration of Helsinki.

### *Assessment of depressive symptoms*

Depressive symptoms were assessed using the Chinese version of the Patient Health Questionnaire-9 (PHQ-9), a nine-item questionnaire designed to screen for depression in primary care and other medical settings[13]. Questionnaire items were scored from 0 (not at all) to 3 (nearly every day). The sum of these scores produced an overall score, ranging from 0 to 27; higher scores indicated greater depressive symptoms. "High" depressive symptoms were defined as an overall PHQ-9 score  $\geq 5$  [13].

### ***Assessment of anxiety symptoms***

Anxiety symptoms were assessed using the Chinese version of the Generalized Anxiety Disorder-7 (GAD-7) questionnaire, which consists of 7 questions and reflects the frequency of symptoms during the preceding 2 weeks [14]. Questionnaire items were scored from 0 (not at all) to 3 (nearly every day). The sum of these scores produced an overall score, ranging from 0 to 21, with higher scores indicating greater anxiety symptoms. "High" anxiety symptoms were defined as an overall GAD-7 score  $\geq 5$  [14].

### ***Assessment of clinicians' competencies***

Competencies among frontline medical staff were assessed using the short version of the Chinese clinical physicians' competency model, which comprised 12 items, classified into 8 components: clinical skills and patient care, mastery of medical knowledge, information and management, professionalism, interpersonal communication, health promotion and disease prevention, academic research, and teamwork[15-16]. Each component was weighted from 1 to 9, generating a global score from 8 to 72. Higher scores indicated greater competencies.

### ***Assessment and definitions of confounding factors***

All confounding factors (age, gender, profession, department, marital status, relative infected by COVID-19, working location, household income, years of service, working time after the COVID-19 outbreak, and sleeping time after COVID-19) were collected using a questionnaire. For analyses, profession was classified as "physician", "nurse", or "public health practitioner"; department was classified as "intensive care unit", "general ward", or "other"; household income was classified as " $\geq 100,000$  Yuan/year" or below; marital status was classified as "currently married" or "currently unmarried"; working location was classified as "Hubei province" or "other".

### ***Statistical analysis***

Participant characteristics were reported stratified by depressive or anxiety symptoms status. Continuous variables were presented as least-square means and 95% confidence intervals (CIs); categorical variables were presented as counts and percentages. Logistic regression models were used to estimate the associations between one standard deviation increase in clinicians' competency scores, and the prevalence of depressive and anxiety symptoms. Odds ratios (ORs) and 95% CIs were calculated. The crude model was used to calculate the crude OR (95% CI) without any adjustments. Model 1 was adjusted for age and sex. Model 2 was further adjusted for profession, department, marital status, relative infected by COVID-19, working location, household income, years of service, working time after COVID-19, and sleeping time after COVID-19. All analyses were performed using the Statistical Analysis System 9.3 edition for Windows (SAS Institute Inc., Cary, NC, USA). All *P*-values were two-tailed, and *P*-values  $<0.05$  were considered statistically significant.

## **Results**

## ***Participant characteristics***

Among 623 participants, the prevalence of depressive, anxiety, and comorbid depressive and anxiety symptoms was 40.93%, 31.78%, and 26.00%, respectively. The mean age was 33.93 (95% CI: 33.74-34.49) years.

Participant characteristics are presented in **Table 1** and **Table 2**, divided by depressive and anxiety symptoms status, respectively. Participants with depressive or anxiety symptoms had lower clinicians' competency scores. Participants with depressive symptoms tended to be younger ( $P = 0.01$ ), not married ( $P = 0.03$ ), and have a shorter length of service ( $P = 0.01$ ). Moreover, participants with anxiety symptoms were more likely to be men ( $P = 0.02$ ), younger ( $P < 0.01$ ), working at departments other than intensive care or general wards ( $P < 0.001$ ), based in provinces other than Hubei ( $P < 0.001$ ), with a shorter length of service ( $P < 0.01$ ), and a higher likelihood of having a relative infected by COVID-19 ( $P = 0.02$ ).

### ***Clinicians' competencies and depressive symptoms***

Associations between clinicians' competency scores and prevalence of depressive symptoms are presented in **Table 3**. Among participants with higher total competency scores, the prevalence of depressive symptoms was lower. The multivariate-adjusted OR (95% CI) for depressive symptoms per one standard deviation increase in total scores of competencies was 0.67 (0.55-0.81). Furthermore, subgroup analyses stratified by eight core competency categories revealed similar associations as the total score.

### ***Clinicians' competencies and anxiety symptoms***

As shown in **Table 3**, total clinicians' competency scores were negatively associated with the prevalence of anxiety symptoms. After adjustments for confounding factors, the OR (95% CI) for anxiety symptoms per one standard deviation increase in the total competency score was 0.68 (0.56-0.83). Moreover, scores on seven core competency categories (all except academic research) were negatively associated with the prevalence of anxiety symptoms.

### ***Clinicians' competencies and comorbid anxiety and depressive symptoms***

We examined associations between clinicians' competency scores and comorbid anxiety and depressive symptoms (**Table 4**). Among participants with higher total competency scores, the prevalence of comorbid anxiety and depressive symptoms was lower than among their counterparts. The OR (95% CI) for comorbid anxiety and depressive symptoms per one standard deviation increase in total clinicians' competency score was 0.68 (0.55-0.83). Seven core competency categories (all except academic research) were negatively associated with the prevalence of comorbid anxiety and depressive symptoms.

## **Discussion**

To the best of our knowledge, the present study is the first study to explore the associations between clinicians' competencies and mental health symptoms among frontline staff responding to the COVID-19

outbreak. Mental health problems, including depressive, anxiety, and comorbid depressive and anxiety symptoms are highly prevalent in this population. Our findings suggest that higher clinicians' competency scores are associated with lower prevalence of depressive, anxiety, and comorbid depressive and anxiety symptoms. Subgroup analyses stratified by different domains of clinicians' competencies yielded results similar to the results of the main analyses.

The present findings suggest that staff members with depressive and anxiety symptoms tend to be younger and have a shorter length of service. The risk of depressive and anxiety symptoms appears to be influenced by clinicians' age and length of service [17-18]. Possible factors that account for these findings are age- and service duration-related decrease in emotional responsiveness, and increase in emotional control and psychological resilience.

In the present study, the prevalence of depressive, anxiety, and comorbid depressive and anxiety symptoms among Chinese frontline medical staff responding to the COVID-19 outbreak was 40.93%, 31.78%, and 26.00%, respectively, which was higher than reported peacetime estimates as well as estimates from the initial phase of the SARS epidemic [19-23]. A previous study conducted in southern China has reported that 28.13% of physicians had depressive symptoms, 25.67% had anxiety symptoms, and 19.01% had comorbid depressive and anxiety symptoms [20]. Another study has explored the impact of the SARS epidemic on health care workers in Taiwan, reporting the prevalence of depressive symptoms at 17.3% during the SARS epidemic [23]. In a recent multicentre survey, high prevalence of depressive (50.7%) and anxiety (44.7%) symptoms of frontline medical staff has been reported during the COVID-19 outbreak in China [8]. Mental health problems among medical staff might hinder their professional performance and affect the quality of response to COVID-19. Concurrently, deterioration in staff wellbeing is likely to negatively affect on patients and professionals' overall health. Protecting mental health of medical staff is crucial for epidemic control and maintaining staff wellbeing.

In recent years, clinical core competences, including clinical skills and patient care, mastery of medical knowledge, health promotion and disease prevention, information and management, professionalism, interpersonal communication, academic research, and teamwork have become key to defining medical staff's ability worldwide [24-26]. High clinicians' competency scores have become measures of good clinical performance.

Moreover, In the present study, higher clinicians' competency scores have been associated with increased prevalence of anxiety, depressive, and comorbid anxiety and depressive symptoms. Clinicians' competency scores were negatively associated with the prevalence of mental health problems among frontline medical staff. These findings suggest that improving core competencies among frontline medical staff responding to the epidemic might help contain the spread of COVID-19. To control the epidemic, health authorities should ensure that frontline staff are competent and equipped with up-to-date knowledge and information.

### ***Strengths and limitations***

To the best of our knowledge, the present study is the first to use a competency-based survey to investigate the associations between clinicians' core competency scores and the prevalence of mental health problems among frontline medical staff. The present findings highlight the importance of clinicians' competencies in maintaining mental health. Suitable training should be provided to this population. Nevertheless, this study has several limitations, which should be considered when interpreting its findings. First, the cross-sectional design of the present study limits discussions about causality and generalizability of the findings. Second, the use of an online survey might have resulted in a biased participant sample. However, given the high transmission rate of the virus, which has restricted the opportunities to conduct face-to-face surveys, WeChat-based survey programme Questionnaire Star has been widely implemented in China [8]. Third, unmeasured confounding factors might have affected the observed associations.

## Conclusion

Mental health problems associated with clinicians' core competencies are highly prevalent among frontline medical staff responding to the COVID-19 outbreak. Protecting mental health of medical staff is important for epidemic control and staff's lasting wellbeing. Our study has highlighted the importance of clinicians' core competencies in maintaining staff wellbeing during an epidemic; providing additional training to frontline medical staff might help prevent the onset of mental health problems and support efforts to contain COVID-19. To address the COVID-19 epidemic, health authorities should ensure competent staff, equipped with up-to-date information are frontline responders.

## Abbreviations

COVID-19, Coronavirus disease 2019; OR, odds ratio; CI, confidence interval; SARS-CoV, severe acute respiratory syndrome; PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder-7

## Declarations

### Ethics approval and consent to participate

We obtained ethics approval from the Shengjing Hospital of China Medical University's Human Ethics Sub-Committee (2020PS043K).

### Consent for publication

Not applicable.

### Availability of data and materials

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

## **Competing interests**

The authors declare that they have no competing interests.

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## **Authors' contributions**

QC and Y-HZ designed the study and formulated the clinical question. All authors collected, managed, and analyzed the data. All authors prepared, reviewed, revised, and approved the manuscript. Y-HZ had full access to all data in the study and is responsible for data integrity and the accuracy of data analysis. All authors read and approved the final manuscript.

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## **References**

1. Wu JT, Leung K, Leung GM. Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. *2020:S0140-6736(20)30260-9*.
2. Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV). Jan, 30, 2020.  
[https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-\(2005\)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-\(2019-ncov\)](https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov)) (accessed March 2, 2020).
3. Novel Coronavirus(2019-nCoV) Situation Report-41. March, 1, 2020.  
[https://www.who.int/docs/default-source/coronavirus/situation-reports/20200301-sitrep-41-covid-19.pdf?sfvrsn=6768306d\\_2](https://www.who.int/docs/default-source/coronavirus/situation-reports/20200301-sitrep-41-covid-19.pdf?sfvrsn=6768306d_2) (accessed March 2, 2020).
4. Xiang YT, Yu X, Ungvari GS, Correll CU, Chiu HF. Outcomes of SARS survivors in China: not only physical and psychiatric co-morbidities. *East Asian Arch Psychiatry* 2014; 24: 37-38.
5. Chong MY, Wang WC, Hsieh WC, Lee CY, Chiu NM, Yeh WC, et al. Psychological impact of severe acute respiratory syndrome on health workers in a tertiary hospital. *Br J Psychiatry*. 2004;185:127-33.
6. Chen R, Chou KR, Huang YJ, Wang TS, Liu SY, Ho LY. Effects of a SARS prevention programme in Taiwan on nursing staff's anxiety, depression and sleep quality: a longitudinal survey. *Int J Nurs*

- Stud. 2006;43(2):215-25.
7. Garrouste-Orgeas M, Perrin M, Soufir L, Vesin A, Blot F, Maxime V, et al. The Iatreff study: medical errors are associated with symptoms of depression in ICU staff but not burnout or safety culture. *Intensive Care Med.* 2015;41(2):273-84.
  8. Liu S, Yang L, Zhang C, Xiang YT, Liu Z, Hu S, Zhang B. Online mental health services in China during the COVID-19 outbreak. *Lancet Psychiatry.* 2020; published online Feb 18. doi: 10.1016/S2215-0366(20)30077-8.
  9. Kang L, Li Y, Hu S, Chen M, Yang C, Yang BX. The mental health of medical workers in Wuhan, China dealing with the 2019 novel coronavirus. *Lancet Psychiatry.* 2020;7(3):e14.
  10. Holmboe ES, Call S, Ficalora RD. Milestones and Competency-Based Medical Education in Internal Medicine. *JAMA Intern Med.* 2016;176(11):1601-1602.
  11. McClelland DC. Testing for competence rather than for "intelligence". *American Psychologist.* 1973;28(1):1-14.
  12. Xiang YT, Yang Y, Li W, Zhang L, Zhang Q, Cheung T, Ng CH. Timely mental health care for the 2019 novel coronavirus outbreak is urgently needed. *Lancet Psychiatry.* 2020;7(3):228-229.
  13. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *Journal of general internal medicine.* 2001;16:606-13.
  14. Spitzer RL, Kroenke K, Williams JB, Lowe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of internal medicine.* 2006;166:1092-7.
  15. Liu Z, Tian L, Chang Q, Sun B, Zhao Y. A Competency Model for Clinical Physicians in China: A Cross-Sectional Survey. *PloS one.* 2016;11:e0166252.
  16. Liu Z, Zhang Y, Tian L, Sun B, Chang Q, Zhao Y. Application of latent class analysis in assessing the competency of physicians in China. *BMC Med Educ.* 2017;17(1):208.
  17. Kessler RC, Foster C, Webster PS, House JS. The relationship between age and depressive symptoms in two national surveys. *Psychol Aging.* 1992;7(1):119-26.
  18. Jorm AF. Does old age reduce the risk of anxiety and depression? A review of epidemiological studies across the adult life span. *Psychol Med.* 2000;30(1):11-22.
  19. Pereira-Lima K, Mata DA, Loureiro SR, Crippa JA, Bolsoni LM, Sen S. Association Between Physician Depressive Symptoms and Medical Errors: A Systematic Review and Meta-analysis. *JAMA Netw Open.* 2019;2(11):e1916097.
  20. Mata DA, Ramos MA, Bansal N, et al. Prevalence of depression and depressive symptoms among resident physicians: a systematic review and meta-analysis. *JAMA.* 2015;314(22):2373-2383.
  21. Gong Y, Han T, Chen W, Dib HH, Yang G, Zhuang R, et al. Prevalence of anxiety and depressive symptoms and related risk factors among physicians in China: a cross-sectional study. *PLoS One.* 2014;9(7):e103242.
  22. Wang JN, Sun W, Chi TS, Wu H, Wang L. Prevalence and associated factors of depressive symptoms among Chinese doctors: a cross-sectional survey. *Int Arch Occup Environ Health.* 2010;83(8):905-11.

23. Lu YC, Shu BC, Chang YY, Lung FW. The mental health of hospital workers dealing with severe acute respiratory syndrome. *Psychother Psychosom*. 2006;75(6):370-5.
24. Natesan P, Batley NJ, Bakhti R, El-Doueihi PZ. Challenges in measuring ACGME competencies: considerations for milestones. *Int J Emerg Med*. 2018;11(1):39.
25. Santen SA, Hemphill RR, Pusic M. The Responsibility of Physicians to Maintain Competency. *JAMA*, 2019 Dec 26. doi: 10.1001/jama.2019.21081.
26. Daouk-Öyry L, Zaatari G, Sahakian T, Rahal Alameh B, Mansour N. Developing a competency framework for academic physicians. *Med Teach*. 2017 Mar;39(3):269-277.

## Tables

Table 1. Participant characteristics, stratified by the presence of depressive symptoms<sup>a</sup>

Characteristic	Depressive symptoms status		<i>P</i> -value <sup>b</sup>
	No	Yes	
PHQ-9 scores ( $\geq 5$ , %)	368 (59.07)	255 (40.93)	
PHQ-9 scores (mean value)	1.53 (1.26, 1.81) <sup>c</sup>	8.83 (8.50, 9.16)	
Total competencies score	61.75 (60.64, 62.87)	57.48 (56.14, 58.82)	< 0.001
Information and management	7.77 (7.60, 7.93)	7.27 (7.08, 7.47)	< 0.001
Professionalism	8.40 (8.25, 8.54)	7.92 (7.47, 8.09)	< 0.001
Clinical skills and patient care	7.21 (7.03, 7.40)	6.59 (6.37, 6.81)	< 0.001
Interpersonal communication	8.13 (7.97, 8.28)	7.53 (7.35, 7.72)	< 0.001
Health promotion and disease prevention	7.71 (7.54, 7.89)	7.18 (6.97, 7.39)	< 0.001
Mastery of medical knowledge	7.99 (7.83, 8.15)	7.51 (7.32, 7.70)	< 0.001
Academic research	6.23 (6.01, 6.46)	5.73 (5.46, 6.01)	< 0.01
Teamwork	8.31 (8.17, 8.46)	7.75 (7.57, 7.93)	< 0.001
Sex (male, %)	32.88	38.04	0.18
Age (years)	34.54 (33.81, 35.26)	33.06 (32.19, 33.92)	0.01
Years of service	11.18 (10.51, 11.86)	9.80 (8.98, 10.61)	0.01
Married (yes, %)	79.62	72.16	0.03
Household income ( $\geq 100,000$ Yuan/year, %)	54.62	50.20	0.28
Working time after COVID-19 (hours/day)	8.45 (8.17, 8.72)	8.13 (7.79, 8.46)	0.15
Sleeping time after COVID-19 (hours/day)	6.82 (6.67, 6.98)	6.67 (6.49, 6.86)	0.22
Profession			
Physician	28.80	27.06	0.63
Nurse	60.60	61.96	0.73
Public health practitioner	10.60	10.98	0.88
Department			
Intensive care unit	38.86	36.86	0.61
General ward	34.24	30.59	0.34

Other	26.90	32.55	0.13
Relative infected by COVID-19	5.71	9.80	0.05
Working location (Hubei province, %)	75.54	69.02	0.07

<sup>a</sup>PHQ-9, Patient Health Questionnaire-9; COVID-19, Coronavirus disease 2019.

<sup>b</sup>Analysis of variance or chi-square test

<sup>c</sup>Least square mean (95% confidence interval) (all reported values)

Table 2. Participant characteristics, stratified by the presence of anxiety symptoms<sup>a</sup>

Characteristic	Anxiety symptoms status		<i>P</i> -value <sup>b</sup>
	No	Yes	
GAD-7 scores ( $\geq 5$ , %)	425 (68.22)	198 (31.78)	
GAD-7 scores (mean value)	1.33 (1.13, 1.53) <sup>c</sup>	8.04 (7.75, 8.33)	
Total competencies score	61.57 (60.54, 62.61)	56.64 (55.13, 58.16)	< 0.001
Information and management	7.78 (7.63, 7.93)	7.11 (6.88, 7.33)	< 0.001
Professionalism	8.43 (8.30, 8.56)	7.71 (7.52, 7.90)	< 0.001
Clinical skills and patient care	7.16 (6.99, 7.33)	6.52 (6.27, 6.77)	< 0.001
Interpersonal communication	8.09 (7.95, 8.24)	7.43 (7.22, 7.64)	< 0.001
Health promotion and disease prevention	7.69 (7.53, 7.85)	7.09 (6.85, 7.32)	< 0.001
Mastery of medical knowledge	8.00 (7.85, 8.14)	7.35 (7.13, 7.56)	< 0.001
Academic research	6.11 (5.90, 6.32)	5.86 (5.55, 6.17)	0.19
Teamwork	8.31 (8.17, 8.45)	7.59 (7.39, 7.79)	< 0.001
Sex (male, %)	32.00	41.41	0.02
Age (years)	34.48 (33.81, 35.15)	32.75 (31.77, 33.73)	< 0.01
Years of service	11.19 (10.56, 11.82)	9.38 (8.46, 10.30)	< 0.01
Married (yes, %)	77.88	73.74	0.26
Household income ( $\geq 100,000$ Yuan/year, %)	54.59	48.99	0.19
Working time after COVID-19 (hours/day)	8.26 (8.00, 8.52)	8.44 (8.06, 8.82)	0.43
Sleeping time after COVID-19 (hours/day)	6.76 (6.62, 6.91)	6.76 (6.55, 6.97)	0.96
Profession			
Physician	28.47	27.27	0.76
Nurse	61.65	60.10	0.71
Public health practitioner	9.88	12.63	0.30
Department			
Intensive care unit	42.12	29.29	< 0.01
General ward	33.41	31.31	0.60

Other	24.47	39.39	< 0.001
Relative infected by COVID-19	5.65	11.11	0.02
Working location (Hubei province, %)	77.18	63.64	< 0.001

<sup>a</sup>GAD, Generalized Anxiety Disorder-7; COVID-19, Coronavirus disease 2019

<sup>b</sup>Analysis of variance or chi-square test

<sup>c</sup>Least square mean (95% confidence interval) (all reported values)

Table 3. Associations between competencies, anxiety, and depressive symptoms among frontline medical staff during the COVID-19 outbreak

	Crude model	Adjusted Model 1 <sup>a</sup>	Adjusted Model 2 <sup>b</sup>
Depressive symptoms			
Total competencies score	0.67 (0.57, 0.80) <sup>c</sup>	0.70 (0.58, 0.83)	0.67 (0.55, 0.81)
Information and management	0.74 (0.63, 0.87)	0.77 (0.65, 0.90)	0.76 (0.63, 0.90)
Professionalism	0.71 (0.59, 0.83)	0.74 (0.62, 0.88)	0.71 (0.58, 0.85)
Clinical skills and patient care	0.71 (0.60, 0.83)	0.73 (0.62, 0.86)	0.69 (0.57, 0.83)
Interpersonal communication	0.67 (0.56, 0.79)	0.70 (0.58, 0.83)	0.68 (0.56, 0.82)
Health promotion and disease prevention	0.73 (0.62, 0.86)	0.75 (0.63, 0.88)	0.74 (0.62, 0.88)
Mastery of medical knowledge	0.73 (0.62, 0.86)	0.76 (0.64, 0.90)	0.76 (0.63, 0.90)
Academic research	0.80 (0.68, 0.94)	0.81 (0.69, 0.96)	0.82 (0.69, 0.97)
Teamwork	0.67 (0.56, 0.80)	0.70 (0.58, 0.83)	0.67 (0.55, 0.81)
Anxiety symptoms			
Total competencies score	0.65 (0.55, 0.77)	0.68 (0.57, 0.81)	0.68 (0.56, 0.83)
Information and management	0.67 (0.57, 0.79)	0.70 (0.59, 0.83)	0.70 (0.58, 0.84)
Professionalism	0.61 (0.51, 0.72)	0.64 (0.53, 0.76)	0.63 (0.52, 0.77)
Clinical skills and patient care	0.71 (0.60, 0.84)	0.74 (0.62, 0.87)	0.74 (0.61, 0.89)
Interpersonal communication	0.66 (0.55, 0.78)	0.69 (0.58, 0.82)	0.70 (0.58, 0.85)
Health promotion and disease prevention	0.71 (0.60, 0.84)	0.74 (0.62, 0.88)	0.75 (0.62, 0.90)
Mastery of medical knowledge	0.67 (0.57, 0.79)	0.70 (0.59, 0.83)	0.72 (0.59, 0.86)
Academic research	0.90 (0.76, 1.06)	0.92 (0.78, 1.09)	0.92 (0.77, 1.10)
Teamwork	0.62 (0.52, 0.74)	0.66 (0.55, 0.78)	0.66 (0.54, 0.80)

<sup>a</sup>Adjusted for age and gender

<sup>b</sup>Adjusted for age, gender, profession, department, marriage status, relative infected by COVID-19, working location, household income, years of service, working time after COVID-19, and sleeping time the COVID-19outbreak

<sup>c</sup>Odds ratio (95% confidence interval) per one standard deviation increase of scores of clinicians' competencies (all reported values)

Table 4. Associations between competencies, and comorbid anxiety and depressive symptoms among frontline medical staff during the COVID-19 outbreak

	Crude model	Adjusted Model 1 <sup>a</sup>	Adjusted Model 2 <sup>b</sup>
Comorbid anxiety and depressive symptoms			
Total competencies score	0.64 (0.53, 0.76) <sup>c</sup>	0.68 (0.56, 0.81)	0.68 (0.55, 0.83)
Information and management	0.69 (0.58, 0.82)	0.73 (0.61, 0.88)	0.73 (0.61, 0.89)
Professionalism	0.58 (0.49, 0.69)	0.62 (0.51, 0.74)	0.62 (0.50, 0.75)
Clinical skills and patient care	0.72 (0.60, 0.85)	0.75 (0.63, 0.90)	0.76 (0.62, 0.92)
Interpersonal communication	0.64 (0.54, 0.76)	0.68 (0.57, 0.81)	0.70 (0.57, 0.84)
Health promotion and disease prevention	0.70 (0.59, 0.84)	0.74 (0.62, 0.88)	0.75 (0.62, 0.91)
Master of medical knowledge	0.66 (0.55, 0.78)	0.69 (0.58, 0.83)	0.71 (0.58, 0.86)
Academic research	0.85 (0.71, 1.02)	0.88 (0.73, 1.05)	0.87 (0.72, 1.05)
Teamwork	0.60 (0.50, 0.72)	0.64 (0.53, 0.77)	0.64 (0.52, 0.78)

<sup>a</sup>Adjusted for age and gender

<sup>b</sup>Adjusted for age, gender, profession, department, marriage status, relative infected by COVID-19, working location, household income, years of service, working time after COVID-19, and sleeping time after the COVID-19outbreak

<sup>c</sup>Odds ratio (95% confidence interval) per one standard deviation increase of scores of clinicians' competencies (all reported values)