

## Original Research

**Cite this article:** Ma S, Ge J, Qi Y, *et al.* Impact of the COVID-19 pandemic on the professional attitudes of medical students: A pre-post-like study. *Disaster Med Public Health Prep.* 17(e555), 1–9. doi: <https://doi.org/10.1017/dmp.2023.213>.

### Keywords:


COVID-19; SARS-CoV-2; professional attitudes; medical students; pandemic

### Corresponding author:

Yuehui Jia; Email: [superyuehui@163.com](mailto:superyuehui@163.com).

Shuli Ma and Jie Ge contributed equally to this study.

# Impact of the COVID-19 Pandemic on the Professional Attitudes of Medical Students: A Pre-Post-Like Study

Shuli Ma MD<sup>1</sup>, Jie Ge PhD<sup>1</sup>, Yanbo Qi MD<sup>1</sup>, Linlin Du PhD<sup>1</sup>, Yunfeng Han MPH<sup>1</sup>, Zhiping Xie MD<sup>1</sup>, Xingsan Li BS<sup>1</sup>, Hongjie Li MD<sup>1</sup>, Zhe Chen MD<sup>1</sup>, Xiaoting Chen MD<sup>2</sup>, Xiaowei Tang MD<sup>2</sup>, Jiyuan Li BS<sup>1</sup>, Jiping Li MD<sup>1</sup>, Qiong Xiao MD<sup>3</sup>, Yu Wu MD<sup>3</sup>, Ying Gao MD<sup>4</sup>, Wenting Li MD<sup>1</sup>, Lei Liu BS<sup>5</sup> and Yuehui Jia PhD<sup>1</sup> 

<sup>1</sup>School of Public Health, Qiqihar Medical University, Qiqihar, China; <sup>2</sup>Sanitary Analysis Center, Scientific Research Office, Qiqihar Medical University, Qiqihar, China; <sup>3</sup>School of Nursing, Qiqihar Medical University, Qiqihar, China; <sup>4</sup>School of mental health, Qiqihar Medical University, Qiqihar, China and <sup>5</sup>Modern Educational Technology Center, Qiqihar Medical University, Qiqihar, China

## Abstract

**Objective:** This study assesses the difference in professional attitudes among medical students, both before and after coronavirus disease 2019 (COVID-19), and identifies the determinants closely associated with it, while providing precise and scientific evidence for implementing precision education on such professional attitudes.

**Methods:** A pre-post-like study was conducted among medical students in 31 provinces in mainland China, from March 23, to April 19, 2021.

**Results:** The proportion of medical students whose professional attitudes were disturbed after the COVID-19 pandemic, was significantly lower than before the COVID-19 pandemic ( $\chi^2 = 15.6216$ ;  $P < 0.0001$ ). Compared with the “undisturbed-undisturbed” group, the “undisturbed-disturbed” group showed that there was a 1.664-fold risk of professional attitudes disturbed as grade increased, 3.269-fold risk when others suggested they choose a medical career rather than their own desire, and 7.557-fold risk for students with COVID-19 in their family, relatives, or friends; while the “disturbed-undisturbed” group showed that students with internship experience for professional attitudes strengthened was 2.933-fold than those without internship experience.

**Conclusions:** The professional attitudes of medical students have been strengthened during the COVID-19 pandemic. The results provide evidence of the importance of education on professional attitudes among medical students during public health emergencies.

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has swiftly spread to more than 200 regions and countries worldwide since it was first reported in December 2019.<sup>1–3</sup> The World Health Organization (WHO) announced that COVID-19 was an international public health emergency on January 31, 2020, and later, classified it as a global pandemic on March 11, 2020.<sup>4–6</sup> It has the characteristics of strong infectivity, long latency, and rapid disease progression.<sup>7,8</sup> The population is generally susceptible to COVID-19. Globally, as of 6:33 PM CEST, September 2, 2022, there have been 601,189,435 confirmed cases of COVID-19, including 6,475,346 deaths, reported to WHO; surprisingly, there were 618,970 new cases thereof in the past 24 h. China, as one of many seriously affected countries, has reported 6,477,468 confirmed cases of COVID-19, including 24,883 deaths.<sup>9</sup> The COVID-19 pandemic has led to an unprecedented setback for the lives and health of the public, the production of enterprises, and the global economy.<sup>10–12</sup>

The first outbreak of COVID-19 occurred in Wuhan, Hubei Province, China, at the end of December 2019.<sup>13</sup> Since then, the overall situation of the pandemic in mainland China was characterized by sporadic or local, small-area clustering. The second outbreak occurred in the Shanghai and Jilin Provinces, China, in March 2022.<sup>13</sup> More than 500,000 confirmed cases of COVID-19 were reported from March 1 to April 20, 2022, and worryingly, more than 20,000 new cases thereof were reported daily, since early April 2022. In response to this pandemic, governments and health administrative departments issued policies of prolonged lockdown, isolation, cessation of work, and postponement of university and school semesters.<sup>14,15</sup> Therefore, this pandemic continues to be a global public health crisis.

In the battle against the COVID-19 pandemic, health professionals were the main force in treating confirmed cases, observing people isolated because of close contact with confirmed cases, and performing epidemiological investigations during the COVID-19 pandemic. As of February 28, 2020, the National Health Commission of China had organized more than 330 medical teams

and 40,000 medical staff in mainland China to support Hubei Province, China.<sup>16</sup> In April 2022, the National Health Commission of China organized more than 5000 medical staff in mainland China to support Jilin Province, and more than 38,000 medical staff, also in mainland China, to support Shanghai. Furthermore, in the initial stages of the pandemic, there were also problems such as the shortage of medical supplies and protective equipment. Therefore, medical workers not only had to complete high-intensity work, but also faced the risk of infection and strong psychological pressure.<sup>17–19</sup> Unfortunately, as of March 6, 2020, the COVID-19 pandemic had infected nearly 3000 medical workers, and more than 30 have died.<sup>20</sup> The pandemic was not only a major public health emergency, but also a major psychological crisis. The pandemic caused medical staff to experience a variety of psychological crises, according to several studies.<sup>21,22</sup>

Medical students, who are the reserves and future of the medical profession, paid close attention to the pandemic situation.<sup>23,24</sup> Therefore, the conditions of frontline medical workers fighting against the COVID-19 pandemic will inevitably have a psychological impact on medical students.<sup>25,26</sup> The attitudes of medical students toward their profession, not only directly affects how they develop far-reaching professional ideals and cultivate noble professional ethics during their studies, but also affects their ability to adhere to professional commitment and good professional ethics in the future, when they become fully qualified medical workers. There are several studies that have addressed COVID-19 in students, such as the psychological status (anxiety or depression) of students during the pandemic<sup>27–29</sup>; the knowledge, attitude, and practice regarding COVID-19 among students<sup>30,31</sup>; and the willingness of medical students to work in frontline jobs during the pandemic.<sup>32–34</sup> However, there has been no scientific assessment or in-depth analysis of the impact of the pandemic on the professional attitudes of medical students in China. Therefore, exploring the difference in professional attitudes before and after the COVID-19 pandemic is essential as doing so will benefit the development of the medical students.

Therefore, an online pre-post-like survey was conducted among medical students, through network platforms, from March 23 to April 19, 2021, which assessed the difference in professional attitudes among Chinese medical students before and after the pandemic and identifies the determinants associated with it. This study explores the weaknesses of education in professional attitudes among college students and provides precise and scientific evidence in favor of an educational strategy to enhance these professional attitudes.

## Methods

### Study Design

An online pre-post-like survey was conducted among medical students from March 23 to April 19, 2021. The professional attitudes after the outbreak of the COVID-19 pandemic were measured based on current-pandemic attitudes of professionalism, and those before the outbreak of the pandemic were measured based on previously recalled answers to the same questions in professional attitudes.

### Participants

In total, 5069 medical students participated in the study. After removing participants with incomplete questionnaires for quality control, 5022 participants aged 15–27 y (mean: 21.23 ± 1.72 y)

from 31 provinces in mainland China were included in the study. The effective response rate was 99.07%. Of the 5022 participants, 1986 (39.55%) were males, and 3036 (60.45%) were females. There were 2292 (45.64%) participants living in urban areas and 2730 (54.36%) participants living in rural areas. The provincial spatial distribution of the participants is presented in Figure 1 (Panels A through D). The inclusion criteria for the participants were full-time medical students in Mainland China. This study was approved by the ethical committee of Qiqihar Medical University (ref: [2021] 31). This study was approved by the ethical committee of Qiqihar Medical University (ref: [2021] 31). All participants provided online informed consent.

### Investigation Method

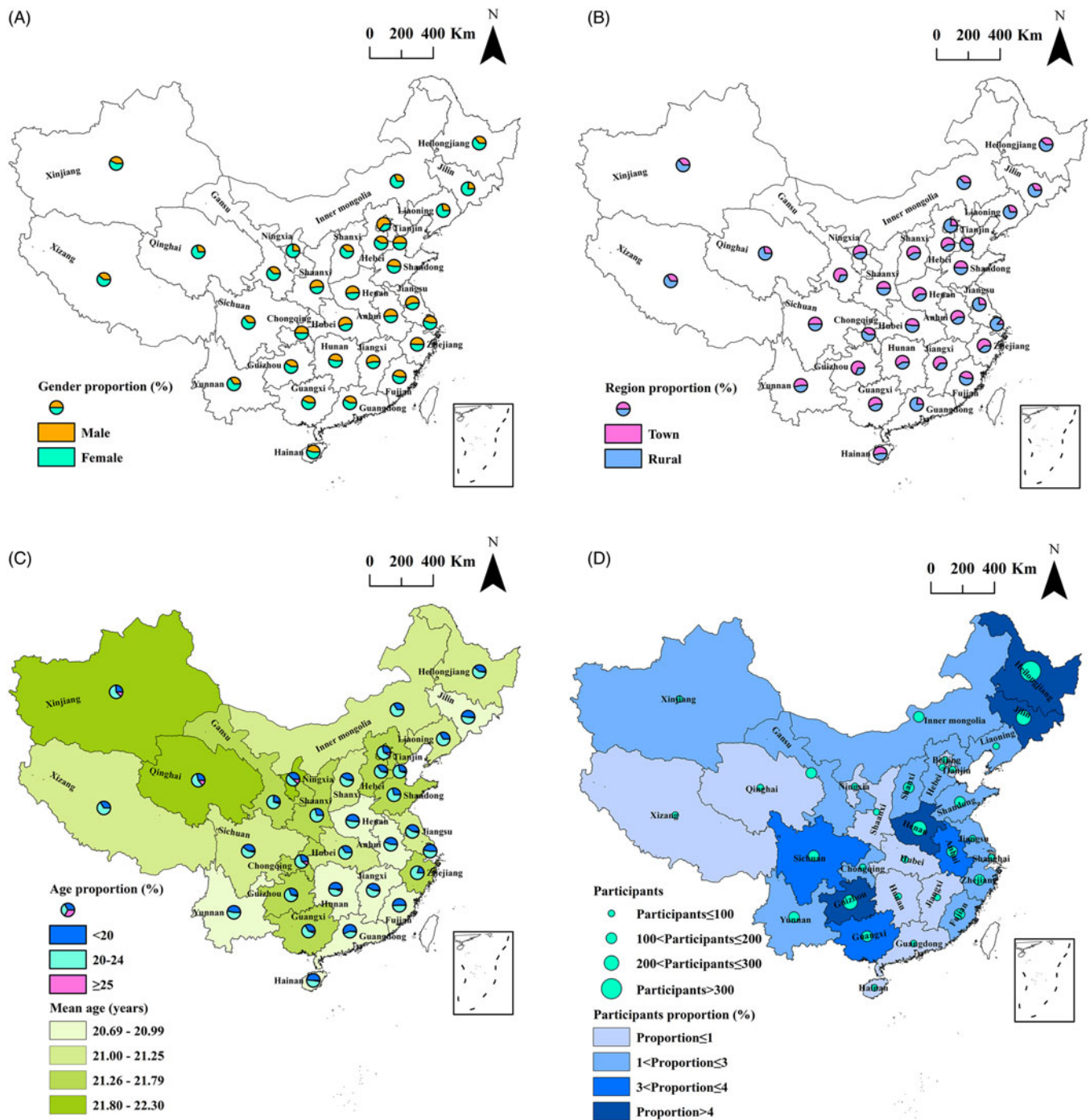
An anonymous online pre-post-like survey was conducted through the Wen-Juan-Xing platform in China (<https://www.wjx.cn/app/survey.aspx>). First, an electronic 2-dimensional code for the questionnaire was created through this online platform. Second, it was sent to the counselors by the researchers. Finally, the code was sent to the potential participants through QQ and WeChat. Furthermore, the participants were also encouraged to recruit valid respondents in the same way as above. The participants voluntarily participated in this study and scanned the electronic 2-dimensional code of the questionnaire with electronic equipment and completed it. Each IP address was set to submit anonymously only once. Identity information and sensitive content of the questionnaire were excluded.

### Assessment Tools and Procedures

A self-made questionnaire was administered to participants. It consisted of 25 items, including socio-demographic information (13 items) and professional attitudes (12 items) before and after the COVID-19 pandemic. The 12 questions on professional attitudes of the medical students, were scored on a 5-point scale in terms of “strongly disagree” (1 point), “disagree” (2 points), “basically agree” (3 points), “agree” (4 points), and “strongly agree” (5 points). The sum of the scores of each item was the total score. The highest score for professional attitudes was 60, and responses ranged from 12 to 60. The mean score of professional attitudes was equal to the total score divided by 12. If the mean score of professional attitudes was less than 3, it was considered “disturbed”, and if it was more than or equal to 3, it was considered “undisturbed”. The questionnaire was designed according to the “Pneumonia Prevention and Control Plan for Novel Coronavirus Infection (Second Edition),” “Health Education Manual for Novel Coronavirus Pneumonia,” and “Guidelines for Public Protection of Novel Coronavirus Pneumonia.”<sup>35–37</sup> Moreover, the questionnaire was enriched and perfected through expert consultation, argumentation, and pre-survey and finally formalized. The Cronbach’s alpha coefficient of the questionnaire was 0.898.

### Statistical Analysis

SPSS V.22.0 was used for statistical analysis. Categorical variables of the socio-demographic characteristics were expressed as frequency and percentages (%). The Kolmogorov-Smirnov test was applied for assessing the normality. Continuous variables of professional attitudes were expressed as a mean ± SD (standard deviation, SD). Difference of professional attitudes, before and after the pandemic, were compared using the chi-squared test, or Fisher’s exact probability for categorical variables and the paired



**Figure 1.** The spatial distribution of the participants by provinces. (A) Gender of the subjects. (B) Region of the subjects. (C) Age of the subjects. (D) Participants and their proportion by provinces.

*t*-test, and 1-way analysis of variance (ANOVA) for normally distributed continuous variables. Multinomial logistic regression was performed, to identify the determinants associated with professional attitudes. The risks of the determinants were shown as odds ratios (OR) and the corresponding 95% confidence intervals (CIs). The professional attitudes before and after the COVID-19 pandemic, were taken as the dependent variable, which included 4 groups, namely “undisturbed-undisturbed,” “undisturbed-disturbed,” “disturbed-undisturbed,” and “disturbed-disturbed.” The “undisturbed-undisturbed” term, represented the professional

attitudes of participants who were all undisturbed before and after the COVID-19 pandemic, was taken as the reference for dependent variables in the multinomial logistic regression model. The “undisturbed-disturbed” term represented the professional attitudes of participants who were undisturbed before the pandemic, but challenged after the pandemic, that is, the professional attitudes of these participants had been altered during the COVID-19 pandemic. The “disturbed-undisturbed” term represented the professional attitudes of participants who were disturbed before the pandemic, but unaltered thereafter, that is, their professional attitudes had been

strengthened during the COVID-19 pandemic. The “disturbed-disturbed” term represented the professional attitudes of participants who were all disturbed before and after the COVID-19 pandemic. The stepwise method was used to filter independent variables. The  $P$ -value  $< 0.05$  (2-sided) was considered statistically significant.

## Results

### *Differences in Professional Attitudes of the Participants Before and After the COVID-19 Pandemic*

A total of 5022 medical students participated in this study. The mean scores of professional attitudes of the 5022 participants before the COVID-19 pandemic was  $3.89 \pm 0.62$ , which was statistically significantly lower than after the COVID-19 pandemic ( $3.95 \pm 0.62$ ),  $t = -24.47$ ;  $P < 0.0001$ . Furthermore, the mean scores of professional attitudes of the participants in the group of “disturbed-undisturbed” before the COVID-19 pandemic was  $2.80 \pm 0.14$ , which was statistically significantly lower than after the COVID-19 pandemic ( $3.35 \pm 0.41$ ),  $t = -8.57$ ,  $P < 0.0001$ ; while the mean scores of professional attitudes of the participants in the group of “undisturbed-disturbed” before the COVID-19 pandemic was  $3.44 \pm 0.34$ , which was statistically significantly higher than after the COVID-19 pandemic ( $2.79 \pm 0.16$ ),  $t = 6.97$ ,  $P < 0.0001$ .

For the professional attitudes of 5022 medical students, 305 (6.07%) were disturbed and 4717 (93.93%) were undisturbed before the COVID-19 pandemic; 271 (5.40%) were disturbed and 4751 (94.60%) were undisturbed after the pandemic. The proportion of medical students whose professional attitudes were disturbed after the COVID-19 pandemic were significantly lower than before the COVID-19 pandemic (5.40% vs 6.07%,  $\chi^2 = 15.6216$ ;  $P < 0.0001$ ). The details are shown in Table 1.

### *Socio-demographic Characteristics of the Participants and Association With Professional Attitudes Before and After the COVID-19 Pandemic*

Table 2 shows the socio-demographic characteristics of the participants and association with professional attitudes before and after the COVID-19 pandemic. There were not statistically significant differences between gender, major, regions, only child, poor student, student leader, parents or relatives have medical workers and professional attitudes of students before and after the COVID-19 pandemic. A significant correlation was found between professional attitudes and grades ( $\chi^2 = 128.7893$ ;  $P < 0.0001$ ), the adjusting for majors ( $\chi^2 = 16.3470$ ;  $P = 0.0010$ ), considered the reason for choosing medicine ( $\chi^2 = 224.9531$ ;  $P < 0.0001$ ), internship experience ( $\chi^2 = 47.1316$ ;  $P < 0.0001$ ), and family members or friends who had experienced COVID-19 ( $P = 0.0005$ ).

### *Multinomial Logistic Regression for Identification of the Determinants Significantly Associated With Professional Attitudes Before and After the COVID-19 Pandemic*

The “undisturbed-undisturbed” group was taken as the reference for dependent variables in the multinomial logistic regression model. Compared with the “undisturbed-undisturbed” group, grades, considered the reason for choosing medicine, and students had family, relatives, or friends who experienced COVID-19, were significantly associated with the “undisturbed-disturbed” status (decreased professional attitudes), that is, the professional attitudes of these participants had been altered during the pandemic. The

**Table 1.** The professional attitudes of the participants before and after the COVID-19 pandemic

Before the COVID-19 pandemic	After the COVID-19 pandemic		
	Disturbed	Undisturbed	All
Disturbed	251 (5.00)	54 (1.07)	305 (6.07)
Undisturbed	20 (0.40)	4,697 (93.53)	4,717 (93.93)
All	271 (5.40)	4,751 (94.60)	5,022 (100.00)

Note: Data are shown as frequency and percentages (%).

results showed that grade was the risk factor for “undisturbed-disturbed” status with a 1.664-fold risk as grade increased (OR = 1.664; 95% CI = 1.041 to 2.659). There was a 3.269-fold risk of “undisturbed-disturbed” status if the choice of a medical career was suggested by others rather than originating from their own desire (OR = 3.269; 95% CI = 1.226 to 8.716), and a 7.557-fold risk of “undisturbed-disturbed” status if the students’ family, relatives, or friends were infected with COVID-19 (OR = 7.557; 95% CI = 1.898 to 30.084).

Compared with the “undisturbed-undisturbed” group, internship experience was significantly associated with the “disturbed-undisturbed” status (increased professional attitudes), that is, the professional attitudes of these participants strengthened during the COVID-19 pandemic. The results showed that the students with internship experience for “disturbed-undisturbed” status was 2.933-fold than those without internship experience (OR = 2.933; 95% CI = 1.293 to 6.652).

Compared with the “undisturbed-undisturbed” group, grades and the reason for choosing medicine were significantly associated with the “disturbed-disturbed” status. The results showed that grade was the risk factor for “disturbed-disturbed” status with a 1.569-fold risk as grade increased (OR = 1.569; 95% CI = 1.369 to 1.799). There was a 5.162-fold risk of “disturbed-disturbed” status if the choice of a medical career was suggested by others rather than originating from their own desire (OR = 5.162; 95% CI = 3.876 to 6.874). The details are shown in Table 3.

## Discussion

This nationwide pre-post-like study simultaneously investigated the professional attitudes of medical students before and after the outbreak of the COVID-19 pandemic, through a current and a retrospective survey. Although a retrospective survey could carry a possible recall bias, nevertheless, this study could be a valuable first contribution as it was the first published manuscripts that address the importance of medical professionalism attitudes due to a public health emergency and the urgently need of strengthen these attitudes. The professional attitudes of medical students directly affected their ability to establish far-reaching professional and ethical habits in medical school, which is of great significance for their development.

The results of this study showed that the proportion of medical students whose professional attitudes were altered after the COVID-19 pandemic were significantly lower than before the pandemic, that is, the professional attitudes of medical students strengthened after the pandemic. The reasons for the results are as follows: medical workers were the main force fighting against the COVID-19 pandemic, and they not only had to complete high-intensity work, but also faced the risk of infection and strong

**Table 2.** Socio-demographic characteristics of the participants and association with professional attitudes before and after the COVID-19 pandemic

Characteristics	All (n=5,022)	Undisturbed-undis- turbed (n=4,697)	Undisturbed-dis- turbed (n=20)	Disturbed-undis- turbed (n=54)	Disturbed-disturbed (n=251)	$\chi^2$ Value	P-Value
Gender						1.2498	0.7411
Male	1,986 (39.55)	1,856 (39.51)	8 (40.00)	18 (33.33)	104 (41.43)		
Female	3,036 (60.45)	2,841 (60.49)	12 (60.00)	36 (66.67)	147 (58.57)		
Grade						128.7893	<0.0001 <sup>a</sup>
First	1,446 (28.79)	1,410 (30.02)	2 (10.00)	13 (24.07)	21 (8.37)		
Second	1,121 (22.32)	1,066 (22.70)	1 (5.00)	12 (22.22)	42 (16.73)		
Third	629 (12.52)	591 (12.58)	1 (5.00)	2 (3.70)	35 (13.94)		
Fourth	1,259 (25.07)	1,139 (24.25)	13 (65.00)	13 (24.07)	94 (37.45)		
Fifth	567 (11.29)	491 (10.45)	3 (15.00)	14 (25.93)	59 (23.51)		
Major						5.4392	0.1423
Clinical medicine	2,588 (51.53)	2,415 (51.42)	9 (45.00)	22 (40.74)	142 (56.57)		
Others	2434 (48.47)	2,282 (48.58)	11 (55.00)	32 (59.26)	109 (43.43)		
Stomatology	340 (6.77)	328 (6.98)	0 (0.00)	2 (3.70)	10 (3.98)		
Anesthesiology	28 (0.56)	24 (0.51)	0 (0.00)	0 (0.00)	4 (1.59)		
Preventive medicine	402 (8.00)	372 (7.92)	1 (5.00)	8 (14.81)	21 (8.37)		
Nursing medicine	228 (4.54)	203 (4.32)	1 (5.00)	8 (14.81)	16 (6.37)		
Medical imaging	299 (5.95)	288 (6.13)	0 (0.00)	3 (5.56)	8 (3.19)		
Medical Examination	133 (2.65)	124 (2.64)	0 (0.00)	1 (1.85)	8 (3.19)		
Psychiatry	486 (9.68)	461 (9.81)	4 (20.00)	5 (9.26)	16 (6.37)		
Rehabilitation	78 (1.55)	73 (1.55)	1 (5.00)	1 (1.85)	3 (1.20)		
Other major	440 (8.76)	409 (8.71)	4 (20.00)	4 (7.41)	23 (9.16)		
Region						3.8777	0.2750
Urban areas	2,292 (45.64)	2,159 (45.97)	10 (50.00)	21 (38.89)	102 (40.64)		
Rural areas	2,730 (54.36)	2,538 (54.03)	10 (50.00)	33 (61.11)	149 (59.36)		
Only child						1.4729	0.6886
Yes	2,576 (51.29)	2,403 (51.16)	9 (45.00)	27 (50.00)	137 (54.58)		
No	2,446 (48.71)	2,294 (48.84)	11 (55.00)	27 (50.00)	114 (45.42)		
Poor student identified by the school						1.4458	0.6948
Yes	1341 (26.70)	1248 (26.57)	6 (30.00)	18 (33.33)	69 (27.49)		
No	3681 (73.30)	3449 (73.43)	14 (70.00)	36 (66.67)	182 (72.51)		
Student leader						3.6668	0.2998
Yes	1451 (28.89)	1369 (29.15)	4 (20.00)	17 (31.48)	61 (24.30)		
No	3571 (71.11)	3328 (70.85)	16 (80.00)	37 (68.52)	190 (75.70)		
The major has been adjusted						16.3470	0.0010 <sup>a</sup>
Yes	544 (10.83)	487 (10.37)	4 (20.00)	9 (16.67)	44 (17.53)		
No	4478 (89.17)	4210 (89.63)	16 (80.00)	45 (83.33)	207 (82.47)		
The reason for choosing medicine.						224.9531	<0.0001 <sup>a</sup>
Own desire	4128 (82.20)	3,960 (84.31)	12 (60.00)	32 (59.26)	124 (49.40)		
Suggested by others	894 (17.80)	737 (15.69)	8 (40.00)	22 (40.74)	127 (50.60)		

(Continued)

Table 2. (Continued)

Characteristics	All (n=5,022)	Undisturbed-undisturbed (n=4,697)	Undisturbed-disturbed (n=20)	Disturbed-undisturbed (n=54)	Disturbed-disturbed (n=251)	$\chi^2$ Value	P-Value
Do your parents or relatives have medical workers?						3.3002	0.3476
Yes	2356 (46.91)	2212 (47.09)	9 (45.00)	29 (53.70)	106 (42.23)		
No	2666 (53.09)	2485 (52.91)	11 (55.00)	25 (46.30)	145 (57.77)		
Do you have internship experience?						47.1316	<0.0001 <sup>a</sup>
Yes	2591 (51.59)	2364 (50.33)	15 (75.00)	40 (74.07)	172 (68.53)		
No	2431 (48.41)	2333 (49.67)	5 (25.00)	14 (25.93)	79 (31.47)		
Has anyone in your family, relatives or friends been diagnosed with COVID-19?						-	0.0005 <sup>a,b</sup>
Yes	109 (2.17)	92 (1.96)	3 (15.00)	2 (3.70)	12 (4.78)		
No	4913 (97.83)	4605 (98.04)	17 (85.00)	52 (96.30)	239 (95.22)		

Note: Data are shown as frequency and percentages (%).

<sup>a</sup>P<0.05 and the difference were statistically significant.

<sup>b</sup>Difference of professional attitudes before and after the COVID-19 pandemic was compared using Fisher's exact probability.

psychological pressure.<sup>17–19</sup> However, when faced with difficulties and risks, the medical workers actively participated in the prevention and control of the pandemic and the treatment of patients, and worked in the front-line against it. During the COVID-19 pandemic, medical workers have demonstrated their lofty professionalism through their practical actions and made significant contributions to prevention and control.<sup>38–40</sup> Therefore, medical workers set a great professional example for medical students, which may strengthen their professional attitudes.

As mentioned in the methodology section, professional attitudes of medical students were divided into 4 groups. Compared with the “undisturbed-undisturbed” group, we found that grades, considered the reason for choosing medicine, and students had family, relatives, or friends who experienced COVID-19, were significantly associated with the “undisturbed-disturbed” status, which is, the professional attitudes of these participants had been challenged during the pandemic. There was a 1.664-fold risk of students for “undisturbed-disturbed” status as grade increased. The reason may be that senior students are facing multiple pressures, such as graduation and employment. Furthermore, medical workers were the main force to undertake high-intensity work, and faced the risk of infection and strong psychological pressure during the pandemic.<sup>17–19</sup> Therefore, the conditions of frontline medical workers fighting against the COVID-19 pandemic would inevitably have a certain psychological impact on medical students, especially the senior students facing employment. A systematic review about the impact of COVID-19 pandemic on mental health in the general population reported that the prevalence of anxiety symptoms among the general population worldwide ranged from 6.33% to 50.9%.<sup>41</sup> A cross-sectional study conducted on college students during the COVID-19 outbreak in China revealed that 18.78% of the participants had anxiety symptoms.<sup>11</sup> Therefore, the COVID-19 pandemic was not only a major public health emergency, but also a major psychological crisis. It is recognized that negative emotions such as tension, anxiety, and depression not only endanger physical and mental health, but also may affect the professional attitudes of medical students during the COVID-19 pandemic. Moreover, studies had confirmed that the level of knowledge–attitude–practice (KAP) regarding COVID-19 was significantly negatively correlated with anxiety symptoms, and understanding the level of KAP during COVID-19 pandemic can contribute to reduce the psychological damage. Therefore, we considered that a healthy psychological status and good KAP regarding COVID-19 will be conducive to strengthening professional attitudes of medical students. Thus, it is urgent for us to actively pay attention to the mental health and KAP of medical students during a major public health emergency and carry out timely and effective mental health screening and intervention measures. Our further research direction is to explore the relationship among the professional attitudes of medical students, KAP regarding COVID-19, and psychological status. This study also showed that, if the choice of a medical career was suggested by others rather than originating from their own desire, there was a 3.269-fold risk for these students’ professional attitudes to be challenged during the COVID-19 pandemic. The reason may be that these students do not have enough knowledge and in-depth love of their major. Moreover, there was a 7.557-fold risk of “undisturbed-disturbed” status if the students’ family, relatives, or friends were infected with COVID-19. Therefore, in a public health emergency outbreak, medical schools should implement precise, targeted, and scientific interventions about professional attitudes education for the medical students. This is of great significance for strengthening the professional attitudes of these medical students.

**Table 3.** Multinomial logistic regression for analysis of the determinants significantly associated with professional attitudes before and after the COVID-19 pandemic

Variables	$\beta$	$S_x$	Wald $\chi^2$	<i>P</i>	OR	95% CI
Undisturbed-disturbed group ( <i>n</i> =20)						
Grade	0.5090	0.2393	4.5233	0.0334	1.664	1.041–2.659
The reason for choosing medicine.						
Own desire	ref					
Suggested by others	1.1843	0.5004	5.6012	0.0179	3.269	1.226–8.716
Has anyone in your family, relatives or friends been diagnosed with COVID-19?						
No	ref					
Yes	2.0224	0.7049	8.2318	0.0041	7.557	1.898–30.084
Disturbed-undisturbed group ( <i>n</i> =54)						
Do you have internship experience?						
No	ref					
Yes	1.0761	0.4178	6.6348	0.0100	2.933	1.293–6.652
Disturbed-disturbed group ( <i>n</i> =251)						
Grade	0.4507	0.0697	41.8321	<0.0001	1.569	1.369–1.799
The reason for choosing medicine						
Own desire	ref					
Suggested by others	1.6413	0.1461	126.1153	<0.0001	5.162	3.876–6.874

Note: The professional attitudes before and after the COVID-19 pandemic, were taken as the dependent variable, which included 4 groups, namely “undisturbed-undisturbed,” “undisturbed-disturbed,” “disturbed-undisturbed,” and “disturbed-disturbed.” The “undisturbed-undisturbed” group was taken as the reference for dependent variables in the multinomial logistic regression model.

Compared with the “undisturbed-undisturbed” group, internship experience was significantly associated with the “disturbed-undisturbed” status, which is, the professional attitudes of these participants had been strengthened during the COVID-19 pandemic. The results showed that the students with internship experience for “disturbed-undisturbed” status was 2.933-fold than those without internship experience. The reason may be that, first, the students with internship experience may pay more attention to the pandemic, and thus have stronger professional attitudes. Second, these students may have more in-depth learning of medical knowledge; finally, they may have a deeper understanding of the work and responsibilities of medical workers and their future career development. Therefore, it is likely that they will recognize and love their majors more, and thus strengthen their professional attitudes. Thus, all these results demonstrated that the provision of targeted education for professional attitudes should be implemented among medical students during a public health emergency.

### Strengths and Limitations

The major innovations of this study are that this was the first nationwide pre-post-like study of the impact of the pandemic on the professional attitudes of medical students in mainland China. Moreover, this study simultaneously investigated the professional attitudes of medical students before and after the COVID-19 pandemic and aimed to assess the differences in such attitudes. It also identifies the determinants considerably associated with it. This study may help to explore the weaknesses of education in professional attitudes among medical students and provide precise and scientific evidence for implementing precision education to professional attitudes. Therefore, this study is of great significance for the development of the medical students. The limitations of this study are that probability sampling was not performed. Additionally, the professional attitudes of medical students before the COVID-19 pandemic were a retrospective survey, which may have recall bias.

### Conclusions

The professional attitudes of medical students have been strengthened during the COVID-19 pandemic. A significant correlation was found between grades, the reason for choosing medicine, and students whose family, relatives, or friends experienced COVID-19 and the “undisturbed-disturbed” status (decreased professional attitudes), while an internship experience was significantly associated with the “disturbed-undisturbed” status (increased professional attitudes). The results provide evidence of the importance of education on professional attitudes among medical students during public health emergencies, and attention must be focused on students from higher grades, choosing medicine as suggested by others, whose family, relatives, or friends experienced COVID-19, and students without internship experience.

**Acknowledgments.** Thanks to all the 5069 medical students who had voluntarily participated the survey, and thanks to all the authors in present study for their efforts on this project.

**Funding statement.** This work was supported by the Department of Education, Heilongjiang Province (Grant numbers 2020-KYYWF-0051 and 2020-KYYWF-0054); and the Social Science Foundation of Qiqihar Medical University (Grant number QYSKL2023-04YB).

**Competing interests.** There are no conflicts of interest.

**Ethical standard.** This study was approved by the ethical committee of Qiqihar Medical University (ref: [2021] 31). This study adheres to the Helsinki declaration. Participants in this research participate voluntarily and conduct anonymously through an online platform. The researchers had provided electronic informed consent for all subjects before the survey. The electronic informed consent included all ethical considerations of the study and the survey, the private use of the information, and the use only for research purpose. The participants read and selected “Agree” at the interviewee’s informed consent were considered as consent to participate in our investigation. All participants provided online informed consent.

## References

- Kanu S, James PB, Bah AJ, et al. Healthcare workers' knowledge, attitude, practice and perceived health facility preparedness regarding COVID-19 in Sierra Leone. *J Multidiscip Healthc*. 2021;14:67-80. doi: [10.2147/JMDH.S287156](https://doi.org/10.2147/JMDH.S287156)
- Yang X, Zhang Y, Li S, et al. Risk factors for anxiety of otolaryngology healthcare workers in Hubei province fighting coronavirus disease 2019 (COVID-19). *Soc Psychiatry Psychiatr Epidemiol*. 2021;56(1):39-45. doi: [10.1007/s00127-020-01928-3](https://doi.org/10.1007/s00127-020-01928-3)
- Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA*. 2020;323(11):1061-1069. doi: [10.1001/jama.2020.1585](https://doi.org/10.1001/jama.2020.1585)
- Gohel KH, Patel PB, Shah PM, et al. Knowledge and perceptions about COVID-19 among the medical and allied health science students in India: an online cross-sectional survey. *Clin Epidemiol Glob Health*. 2021;9:104-109. doi: [10.1016/j.cegh.2020.07.008](https://doi.org/10.1016/j.cegh.2020.07.008)
- Safiabadi Tali SH, LeBlanc JJ, Sadiq Z, et al. Tools and techniques for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)/ COVID-19 detection. *Clin Microbiol Rev*. 2021;34(3):e00228-20. doi: [10.1128/CMR.00228-20](https://doi.org/10.1128/CMR.00228-20)
- Al Hourani H, Alkhatib B, Abdullah M. Impact of COVID-19 lockdown on body weight, eating habits, and physical activity of Jordanian children and adolescents. *Disaster Med Public Health Prep*. 2022;16(5):1855-1863. doi: [10.1017/dmp.2021.48](https://doi.org/10.1017/dmp.2021.48)
- Rossi R, Socci V, Talevi D, et al. COVID-19 Pandemic and lockdown measures impact on mental health among the general population in Italy. *Front Psychiatry*. 2020;11:790. doi: [10.3389/fpsy.2020.00790](https://doi.org/10.3389/fpsy.2020.00790)
- Azzi Y, Parides M, Alani O, et al. COVID-19 infection in kidney transplant recipients at the epicenter of pandemics. *Kidney Int*. 2020;98(6):1559-1567. doi: [10.1016/j.kint.2020.10.004](https://doi.org/10.1016/j.kint.2020.10.004)
- World Health Organization. WHO coronavirus disease (COVID-19) dashboard. 2022. Accessed April 22, 2022. <https://covid19.who.int/>
- Awadasseid A, Wu Y, Tanaka Y, et al. Initial success in the identification and management of the coronavirus disease 2019 (COVID-19) indicates human-to-human transmission in Wuhan, China. *Int J Biol Sci*. 2020;16(11):1846-1860. doi: [10.7150/ijbs.45018](https://doi.org/10.7150/ijbs.45018)
- Jia Y, Qi Y, Bai L, et al. Knowledge-attitude-practice and psychological status of college students during the early stage of COVID-19 outbreak in China: a cross-sectional study. *BMJ Open*. 2021;11(2):e045034. doi: [10.1136/bmjopen-2020-045034](https://doi.org/10.1136/bmjopen-2020-045034)
- Ren Z, Xie Z. Predictors of anxiety and depression in medical professionals during the time of COVID-19 outbreak. *Disaster Med Public Health Prep*. 2022;16(5):1929-1934. doi: [10.1017/dmp.2021.67](https://doi.org/10.1017/dmp.2021.67)
- Chan JF-W, Yip CC-Y, To KK-W, et al. Improved molecular diagnosis of COVID-19 by the novel, highly sensitive and specific COVID-19-RdRp/Hel real-time reverse transcription-pcr assay validated in vitro and with clinical specimens. *J Clin Microbiol*. 2020;58(5):e00310-20. doi: [10.1128/JCM.00310-20](https://doi.org/10.1128/JCM.00310-20)
- Tu HL, Tu S, Gao S, et al. Current epidemiological and clinical features of COVID-19; a global perspective from China. *J Infect*. 2020;81(1):1-9. doi: [10.1016/j.jinf.2020.04.011](https://doi.org/10.1016/j.jinf.2020.04.011)
- Yang K, Liu H, Ma L, et al. Knowledge, attitude and practice of residents in the prevention and control of COVID-19: an online questionnaire survey. *J Adv Nurs*. 2021;77(4):1839-1855. doi: [10.1111/jan.14718](https://doi.org/10.1111/jan.14718)
- The State Council Information Office of the People's Republic of China. Information Release Dashboard. 2022. Accessed April 10, 2022. <http://www.scio.gov.cn/xwfbh/xwfbh/wqfbh/42311/42626/wz42628/Document/1674306/1674306.htm>
- Ashton J. The nation's doctor and the COVID-19 pandemic. *J R Soc Med*. 2021;114(9):451-453. doi: [10.1177/01410768211043442](https://doi.org/10.1177/01410768211043442)
- Gillam S. COVID-19 and the death of the family doctor. *Br J Gen Pract*. 2020;70(697):402-403. doi: [10.3399/bjgp20X712025](https://doi.org/10.3399/bjgp20X712025)
- Gordon L, Scanlan GM, Tooman TR, et al. Heard, valued, supported? Doctors' wellbeing during transitions triggered by COVID-19. *Med Educ*. 2022;56(5):516-526. doi: [10.1111/medu.14698](https://doi.org/10.1111/medu.14698)
- The State Council Information Office of the People's Republic of China. Information release dashboard. 2022. Accessed April 10, 2022. <http://www.scio.gov.cn/xwfbh/xwfbh/wqfbh/42311/42682/wz42684/Document/1674782/1674782.htm>
- Elbay RY, Kurtuluş A, Arpacioğlu S, et al. Depression, anxiety, stress levels of physicians and associated factors in Covid-19 pandemics. *Psychiatry Res*. 2020;290:113130. doi: [10.1016/j.psychres.2020.113130](https://doi.org/10.1016/j.psychres.2020.113130)
- Xiong N, Fritzsche K, Pan Y, et al. The psychological impact of COVID-19 on Chinese healthcare workers: a systematic review and meta-analysis. *Soc Psychiatry Psychiatr Epidemiol*. 2022;57(8):1515-1529. doi: [10.1007/s00127-022-02264-4](https://doi.org/10.1007/s00127-022-02264-4)
- Muntz MD, Franco J, Ferguson CC, et al. Telehealth and medical student education in the time of COVID-19-and beyond. *Acad Med*. 2021;96(12):1655-1659. doi: [10.1097/ACM.0000000000004014](https://doi.org/10.1097/ACM.0000000000004014)
- Soled D, Goel S, Barry D, et al. Medical student mobilization during a crisis: lessons from a COVID-19 medical student response team. *Acad Med*. 2020;95(9):1384-1387. doi: [10.1097/ACM.0000000000003401](https://doi.org/10.1097/ACM.0000000000003401)
- Hu J, Huang Y, Liu J, et al. COVID-19 related stress and mental health outcomes 1 year after the peak of the pandemic outbreak in China: the mediating effect of resilience and social support. *Front Psychiatry*. 2022;13:828379. doi: [10.3389/fpsy.2022.828379](https://doi.org/10.3389/fpsy.2022.828379)
- Salem MR, Al Hanafy SH, Bayad AT, et al. Assessment of knowledge, attitudes, and precautionary actions against COVID-19 among medical students in Egypt. *J Infect Public Health*. 2021;14(10):1427-1434. doi: [10.1016/j.jiph.2021.07.022](https://doi.org/10.1016/j.jiph.2021.07.022)
- Cao W, Fang Z, Hou G, et al. The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Res*. 2020;287:112934. doi: [10.1016/j.psychres.2020.112934](https://doi.org/10.1016/j.psychres.2020.112934)
- Wang ZH, Yang HL, Yang YQ, et al. Prevalence of anxiety and depression symptom, and the demands for psychological knowledge and interventions in college students during COVID-19 epidemic: a large cross-sectional study. *J Affect Disord*. 2020;275:188-193. doi: [10.1016/j.jad.2020.06.034](https://doi.org/10.1016/j.jad.2020.06.034)
- Zhang Y, Zhang H, Ma X, et al. Mental health problems during the COVID-19 pandemics and the mitigation effects of exercise: a longitudinal study of college students in China. *Int J Environ Res Public Health*. 2020;17(10):3722. doi: [10.3390/ijerph17103722](https://doi.org/10.3390/ijerph17103722)
- Jia Y, Ma S, Bai L, et al. Health literacy and disparities in knowledge, attitude and practice regarding COVID-19 among college students during the COVID-19 outbreak in China: a cross-sectional study. *Risk Manag Healthc Policy*. 2021;14:4477-4488. doi: [10.2147/RMHP.S319331](https://doi.org/10.2147/RMHP.S319331)
- Alrasheedy AA, Abdulsalim S, Farooqui M, et al. Knowledge, attitude and practice about coronavirus disease (COVID-19) pandemic and its psychological impact on students and their studies: a cross-sectional study among pharmacy students in Saudi Arabia. *Risk Manag Healthc Policy*. 2021;14:729-741. doi: [10.2147/RMHP.S292354](https://doi.org/10.2147/RMHP.S292354)
- Seah B, Ho B, Liaw SY, et al. To volunteer or not? Perspectives towards pre-registered nursing students volunteering frontline during COVID-19 pandemic to ease healthcare workforce: a qualitative study. *Int J Environ Res Public Health*. 2021;18(12):6668. doi: [10.3390/ijerph18126668](https://doi.org/10.3390/ijerph18126668)
- Martin-Delgado L, Goni-Fuste B, Alfonso-Arias C, et al. Nursing students on the frontline: impact and personal and professional gains of joining the health care workforce during the COVID-19 pandemic in Spain. *J Prof Nurs*. 2021;37(3):588-597. doi: [10.1016/j.profnurs.2021.02.008](https://doi.org/10.1016/j.profnurs.2021.02.008)
- Kim EA, Kim HR, Kim B. Factors influencing medical and nursing students' willingness to care for COVID-19 patients in South Korea: a cross-sectional study. *BMC Med Educ*. 2022;22(1):161. doi: [10.1186/s12909-022-03229-6](https://doi.org/10.1186/s12909-022-03229-6)
- The Central People's Government of the People's Republic of China. Disease prevention and control bureau dashboard. 2020. Accessed February 5, 2020. <http://www.nhc.gov.cn/jkj/s3577/202001/c67cfe29cfl470e8c7fc47d3b751e88.shtml>
- National Health Commission of the People's Republic of China. Prevention and control of the novel coronavirus pneumonia dashboard. 2020. Accessed February 17, 2020. <http://www.gov.cn/fuwu/2020-2/10/5476794/files/f2304d900f90446da02ae37f44650220.pdf>
- Chinese Center for Disease Control and Prevention. The novel coronavirus pneumonia dashboard. 2020. Accessed January 31, 2020.



- [http://www.chinacdc.cn/jkzt/crb/zl/szkb\\_11803/jszl\\_2275/202001/W020200131495264898540.pdf](http://www.chinacdc.cn/jkzt/crb/zl/szkb_11803/jszl_2275/202001/W020200131495264898540.pdf)
38. **Giulio M, Maggioni D, Montroni I, et al.** Being a doctor will never be the same after the COVID-19 pandemic. *Am J Med.* 2020;133(6):652. doi: [10.1016/j.amjmed.2020.03.003](https://doi.org/10.1016/j.amjmed.2020.03.003)
  39. **Imperatore N, Rispo A, Lombardi G.** The price of being a doctor during the COVID-19 outbreak. *Gut.* 2020;69(8):1544-1545. doi: [10.1136/gutjnl-2020-321646](https://doi.org/10.1136/gutjnl-2020-321646)
  40. **Vance MC, Morganstein JC.** The doctor-public relationship: how physicians can communicate to foster resilience and promote mental health during COVID-19. *J Gen Intern Med.* 2020;35(12):3697-3698. doi: [10.1007/s11606-020-06243-w](https://doi.org/10.1007/s11606-020-06243-w)
  41. **Xiong J, Lipsitz O, Nasri F, et al.** Impact of COVID-19 pandemic on mental health in the general population: a systematic review. *J Affect Disord.* 2020;277:55-64. doi: [10.1016/j.jad.2020.08.001](https://doi.org/10.1016/j.jad.2020.08.001)