

RESEARCH PAPER



# Medical and non-medical students' knowledge, attitude and willingness towards the COVID-19 vaccine in China: a cross-sectional online survey

Liyan Gao<sup>1</sup>, Siman Su<sup>1</sup>, Niuniu Du<sup>1</sup>, Yu Han<sup>1</sup>, Jiayi Wei<sup>1</sup>, Meijuan Cao<sup>1</sup>, Qunfang Miao<sup>2</sup>, and Xiaolei Wang<sup>1</sup>

<sup>1</sup>Nursing School, Hangzhou Normal University, Hangzhou, Zhejiang, China; <sup>2</sup>School of Clinical Medicine, Hangzhou Normal University, Hangzhou, Zhejiang, China

## ABSTRACT

In the context of the novel Coronavirus outbreak and China's official policy of free vaccination against COVID-19 for all, medical students' attitudes and knowledge toward vaccines can influence public acceptance to some extent, however, the large base of non-medical students cannot be ignored. We aimed to investigate the knowledge, attitude, and willingness toward the COVID-19 vaccine among medical and non-medical students. Online surveys were completed by 652 medical students and 590 non-medical students to compare differences in knowledge and attitude of COVID-19 vaccine and vaccination willingness from three universities in the Zhejiang Province. The awareness rate of the vaccine among medical students (65.3%) was higher than that of non-medical students (53.6%). The approval rate of medical students for the safety and efficacy of the COVID-19 vaccine was higher than that of non-medical students. 81.8% of university students were willing to be vaccinated against COVID-19; Multiple stepwise regression analyses showed that lower class grades, rural students' origin, COVID-19 vaccine attitude and higher cognition level of health self-management influenced the acceptance of COVID-19 vaccination among medical students. However, urban origin, COVID-19 vaccine attitude were the factors hindering non-medical students' vaccination against COVID-19. The knowledge, attitude and willingness toward the COVID-19 vaccine on medical and non-medical students had different characteristics. Moreover, health self-management was associated with COVID-19 vaccination willingness. Staff involved in the university should pay more attention to the self-managementability of students, send out accurate and transparent information to enhance their cognitive level, further improving the students' willingness to receive the COVID-19 vaccine.

## ARTICLE HISTORY

Received 28 December 2021  
Revised 22 April 2022  
Accepted 1 May 2022

## KEYWORDS

COVID-19 vaccination; knowledge; attitude; willingness; health self-management; medical and non-medical student

## Introduction

At the end of 2019, an outbreak of respiratory infectious diseases happened in Wuhan, Hubei Province, China, then, the World Health Organization (WHO) named the new virus SARS-COV, and the disease caused by the virus was called "COVID-19".<sup>1</sup> The Chinese government had taken a series of effective epidemic prevention measures to achieve a partial victory in COVID-19 management. In particular, the vaccination strategy is in accordance with the "Two-step" program,<sup>2</sup> the first step is mainly to carry out vaccination for some key groups of people, the second step is that more vaccines will be put into use with the approval of the vaccine for marketing or the increase of vaccine production. With increased accessibility to vaccine, COVID-19 vaccination was widely implemented in China to achieve herd immunity.<sup>3</sup> China officially implemented a free vaccination policy for all people on 5 January 2021.<sup>4</sup>

Herein, we investigated the vaccination policy and acceptance by university students. As the Chinese government had put forward the call to "do as much as possible", institutions needed to fully and timely understand university students' knowledge and attitude toward the emerging COVID-19 vaccine. In addition, the internet information available was divided, whereby university students could not distinguish between whether inoculation was beneficial or not. University is one of the key units of epidemic

prevention and control, and university students were the focus group of the COVID-19 vaccination program. The clustering, mobility, and complexity of university personnel and students could increase the risk of group infection. Moreover, university students have a relatively strong immunity and resistance. They would usually have mild symptoms after being infected with COVID-19,<sup>5</sup> which would not be conducive to the early discovery. Therefore, achieving a high vaccine coverage among university students was conducive to returning to social normality.<sup>6</sup> Nevertheless, it was important to improve the awareness and willingness of university students to receive COVID-19 vaccination.

The theory of KAP (Knowledge, Attitude and Belief, Practice, KAP) shows knowledge is the basis of behavior change, attitude and belief are the motive force of behavior change. For example, in previous study,<sup>7</sup> there was a positive relationship the willingness to be vaccinated and the adequacy of information about the COVID-19 vaccine. Therefore, understanding university students' knowledge, attitude, and influencing factors of COVID-19 vaccines would provide a reference for universities to carry out further publicity and education to improve vaccination coverage. Medical students are the ones that will provide health care services in the future and should shoulder the responsibility of promoting public

health. Their knowledge and attitude toward the COVID-19 vaccine could influence public acceptance. However, the role of non-medical students in promoting the COVID-19 vaccine could not be ignored, the “School-Family-Society” vaccine promotion model, centered on university students, is beneficial to the radiation of more individuals and the acceptance of the COVID-19 vaccine. Therefore, a comparative study on the knowledge and attitude between medical students and non-medical students of COVID-19 vaccines would be conducive to clarifying the health education programs and corresponding strategies for COVID-19 vaccines in different populations.

In addition to knowledge and attitude may affect college students’ willingness to vaccination, health self-management is also regarded as one of the possible influencing factors. Health self-management ability is the behavioral ability to promote one’s own health, that is, individuals use the knowledge and skills of health and disease prevention to monitor their own health status, evaluate their own health risks, and then adjust their own psychology and behavior to achieve the purpose of improving health and preventing diseases.<sup>8</sup> One study<sup>9</sup> found that health participation and initiative in managing health problems were predictors of COVID-19 vaccination acceptance. Therefore, we tried to explore whether the ability of health self-management of medical students and non-medical students could influence the willingness of vaccination. Health self-management was composed of environment, cognition, and behavior, environment referred to the utilization of resources and the management of the environment; cognition referred to individuals’ health beliefs and self-efficacy; behavior referred to the behavior taken by individuals to manage their health.<sup>10</sup> Gutierrez-Colina<sup>11</sup> found that university students had strong subjectivity and independence in their health self-management, so we tried to explore which elements of health self-management could play a role in students’ willingness to receive COVID-19 vaccine. This could be the starting point and breakthrough point of later health intervention.

Our study aimed to understand the differences between medical students and non-medical students in knowledge, attitude, and vaccination willingness of the COVID-19 vaccine. The aim was to provide a reference for targeted awareness education of COVID-19 vaccine among different populations and subsequent health education and relevant measures.

## Methods

### Design and sample

This survey is a cross-sectional study. Due to the impact of COVID-19, our study has been conducted as an invitation to complete a brief online survey with a convenience sampling, which was produced and published on the platform of *Wenjuanxing* (<https://www.wjx.cn/>). It is one of the most popular online survey platforms.<sup>12</sup> The survey was open from March 27nd through April 7th of 2021, which coincided with the “Notice on Novel Coronavirus Vaccination in the Education System” by the Ministry of Education of the People’s Republic of China.<sup>13</sup> The education department paid great attention to the novel coronavirus vaccination and prevention. Undergraduate students who were at least 18 years

old, come from Zhejiang Province, and willing to participate after checking the informed consent were included; students who refused to participate in this study and were unable to fill the questionnaire due to the existence of serious physical and mental disorders were excluded.

### Sample size and enrollment

Our study was based on the sample size calculation formula, which has been used in previous studies.<sup>14</sup> For the conventional, level of confidence of 95.0%, Z value is 1.96, d represents that the allowable error is specified as 0.03. We carried out a pilot research in Hangzhou Normal University, and willingness rate of COVID-19 vaccination of college students is  $p = 65.0\%$  in preliminary investigation. Therefore, the sample size is  $N = 971$ . In addition, considering the rejection rate of 20.0%, it is established that the sample size to be included should be 1,165.

$$N = p \times (1 - p) \times \left(\frac{z}{d}\right)^2 \quad (1)$$

Our study used the stratified sampling method on three randomly selected university students (Hangzhou, Jiaxing, Lishui) in each city region of the Zhejiang province based on their GDP ranking and randomly selected high, medium, and low economic development levels. Then one online convenience sampling was carried out for Hangzhou Normal University, Jiaxing University, and Lishui University. Our study contacted the counselors of three universities to carry out unified online training by instructing them to improve the understanding of the questionnaire content. After the training, they forwarded the questionnaire link or QR (Quick Response) code for distribution. All respondents indicated informed consent.

A total of 1,321 questionnaires were collected, including 79 invalid ones (<100 seconds answer time, regular answer, inconsistent logic answer) and 1,242 valid ones, with an effective rate of 94.0%. In our study, informed consent was included in the questionnaire, and participants were required to check the box to indicate their consent. During this study, the researchers strictly adhered to the ethical principles of respect for autonomy, fairness, justice, do no harm, and implemented strict confidentiality. The questionnaires were filled out anonymously, informing the subjects of the right to quit the study at any time.

### Measures

The research tools included a general data questionnaire, COVID-19 vaccine knowledge and attitude questionnaire, and adult health self-management ability scale.

General information questionnaire included gender, age, place of origin, grade, major, only child or not, parents’ education and source of information on COVID-19 vaccines, whether future jobs are vulnerable to the COVID-19, whether relatives or friends are infected with COVID-19, whether relatives or friends are engaged in medical work, etc.

COVID-19 vaccine Knowledge and Attitude questionnaire had 10 questions in total, which was developed based on a previous research.<sup>15</sup> The first 4 questions involved university students' attitudes toward the safety, efficacy, adverse reactions, and vaccination effect of the COVID-19 vaccine. The last 6 questions were mainly related to university students' knowledge of vaccines. For example, whether COVID-19 vaccines need to be stored and transported in the cold chain, etc. There were three options (yes/no/not sure) for each question. 1 point for correct answers of knowledge and attitude, 0 point for wrong answers, and calculate the total score respectively.

The health self-management ability scale was compiled by Zhao and Huang,<sup>16</sup> and the Cronbach's coefficient was 0.933, and the content validity was 0.895, which had good reliability and validity. It included three subscales of health self-management behavior, cognition, and environment, including 7 dimensions and 38 items. The total score was 38–190, with 1–5 points for each subscale. The behavior subscale and the environment subscale adopted “Never” to “Always”, assigning a score in a range of 1–5. The cognition subscale adopted “Disagree” to “Agree” and “Not too confident” to “Confident”, assigning a score in a range of 1–5. A higher score meant the better health self-management ability. According to Feng's study,<sup>17</sup> the behavior subscale and the cognition subscale were divided into the low level (14–27), medium level (28–55), and high level (56–70). The scores of the environmental subscale were further divided into the low level (10–19), medium level (20–39) and high level (40–50). The total scores of health self-management were divided into the low level (38–76), medium level (77–152) and high level (153–190).

### Statistical analysis

SPSS Statistics 25 Software (IBM Corporation, New York, NY, United States) was used for the data analysis. The measurement data were expressed in terms of mean or standard deviation, while the counting data were described using frequencies or percentages. The chi-square test was used to assess the degree of correlation between variables. The differences in vaccination attitude, knowledge, and health self-management ability between medical and non-medical students were compared. Logistic regression analysis method was used to analyze multiple factors. The alpha level was set at 0.05, and  $P < .05$  was considered to be statistically significant.

### Ethics approval

The Ethics Committee approved the study of in the three universities according to the Declaration of Helsinki<sup>18</sup> and the students participating in the survey understood the purpose, content and significance of the survey.

## Results

### Participant characteristics

In total, 1,242 university students with an average age of (20.70  $\pm$  1.95) years were included in this study. Most of students were female ( $n = 878$ , 70.7%), nearly half of them were from rural areas ( $n = 654$ , 52.7%), and the majority were non-only child ( $n = 707$ , 56.9%). 324 (26.1%) were freshmen, 267 (21.5%) were sophomores, 359 (28.9%) were juniors, and 292 (23.5%) were seniors or above. In this study, the undergraduates were divided into two groups: medical students and non-medical students, out of which 652 (52.5%) were medical students and 590 (47.5%) were non-medical students. The students' general information in the three universities is shown in Table 1.

### Knowledge toward vaccine

The awareness rate of the vaccine among medical students (65.3%) was higher than that of non-medical students (53.6%). Chi-square test was used to compare and analyze the knowledge of COVID-19 vaccine between medical students and non-medical students in the three universities. It was found that the awareness rate of medical students about: storage and transportation conditions of COVID-19 vaccine, precautions before vaccination, and protective measures after vaccination were higher than that of non-medical students. The difference was statistically significant ( $P < .05$ ). The results are shown in Table 2.

It is worth noting that the reverse scoring item was involved in this study, namely, “Is it necessary to test for antibodies before receiving COVID-19 vaccines?”. Regarding this question, both medical students and non-medical students generally answered that testing was required in advance. However, it may be not necessary, indicating that university students still had doubts about the vaccination procedure of the COVID-19 vaccine. The survey found that medical and non-medical students accessed knowledge related to the COVID-19 vaccine through online media such as Weibo, WeChat, and Douyin (72.9%), and public listening through school lectures (33.7%) while active counseling from doctors (28.2%) was relatively small.

### Attitudes toward vaccine

We compared the medical and non-medical students' COVID-19 vaccine attitudes using the chi-square test. As a result, the approval rate of medical students (64.4%) for the safety of COVID-19 vaccine was higher than that of non-medical students (60.9%), differences were statistically significant ( $P < .05$ ). The results are shown in Table 3. Interestingly, 44.0% of medical students and 35.8% of non-medical students believed that the COVID-19 vaccine would cause certain adverse reactions. The majority of medical and non-medical students held uncertain attitudes, accounting for 45.1% and 48.0%, respectively.

**Table 1.** Characteristics of study participants.

Item	Category	Medical students (652)		Non-medical students (590)	
		Number	Ratio (%)	Number	Ratio (%)
Gender	Male	167	25.6	197	33.4
	Female	485	74.4	393	66.6
Grade	Freshman	140	21.5	184	31.2
	Sophomore	116	17.8	151	25.6
	Junior	230	35.2	129	21.9
	Senior and above	166	25.5	126	21.4
Origin	Rural	374	57.4	280	47.5
	Urban	278	42.6	310	52.5
Only child	Yes	290	44.5	245	41.5
	No	362	55.5	345	58.5
Father's education	Primary and below	89	13.7	55	9.3
	Junior high school	237	36.4	199	33.7
	High school or junior college	238	36.5	215	36.4
	Bachelor degree or above	88	13.5	121	20.5
Mother's education	Primary and below	152	23.3	110	18.6
	Junior high school	250	38.3	200	33.9
	High school or junior college	196	30.1	196	33.2
	Bachelor degree or above	54	8.3	84	14.2
Per capita monthly household income/ 10000 yuan	<0.3	112	17.2	77	13.1
	0.3~	236	36.2	204	34.6
	0.5~	203	31.1	205	34.8
	1.0~	101	15.5	104	17.6
Future jobs are vulnerable to the novel coronavirus	Yes	503	77.15	114	19.3
	No	149	22.85	476	80.7
Friend or relative had COVID-19	Yes	40	6.1	54	9.2
	No	612	93.9	536	90.8
Family or friends who practice medicine	Yes	378	58.0	253	42.9
	No	274	42.0	337	57.1
Willing to promote the vaccination to your friends, relatives	Yes	563	86.3	485	82.2
	No	89	13.7	105	17.8

### Willingness toward vaccine

In this study, 178 university students were vaccinated with the COVID-19 vaccine, 1,016 university students (81.8%) were willing to be vaccinated (including those who had already been vaccinated), consisting of 550 medical students (54.1%) and 466 non-medical students (45.9%). There was a statistically significant difference between both groups ( $\chi^2 = 6.006$ ,  $P < .001$ ). The main reasons for medical students' willingness to be vaccinated included avoiding COVID-19 infection (83.1%). In comparison, fear of vaccine safety (70.6%) was the primary reason for medical students' reluctance, with similar results for non-medical students. "Avoiding COVID-19 infection" (82.8%) was the main reason to be vaccinated and "worrying about the safety of vaccines" (69.4%) was the main reason reluctance to vaccination among non-medical students.

### Multivariate analyses for vaccine willingness

The total score of medical students' health self-management ability was  $148.31 \pm 20.36$ , and that of non-medical students' health self-management ability was  $146.96 \pm 20.51$ , differences were statistically significant ( $t = 2.209$ ,  $P < .05$ ). In this study, general information, knowledge and attitude toward vaccine and health self-management ability were regarded as factors that might affect the COVID-19 vaccination of medical and non-medical students according to our logistic regression analysis. The results are shown in Tables 5 and 4. This study showed that lower grades, rural students' origin, COVID-19 vaccine attitude and higher cognitive

level of health self-management influenced the acceptance of COVID-19 vaccination among medical students. While, urban origin, low vaccine attitude were the factors hindering non-medical students' vaccination against COVID-19.

### Discussion

This study evaluated university students' knowledge, attitude, and willingness to receive the COVID-19 vaccine in Zhejiang province and compared the differences between medical and non-medical students in three universities. Concurrently, we analyzed whether the difference in health self-management ability could affect the vaccination willingness of medical and non-medical students. Considering the large number of colleges and universities in Zhejiang province and the three full-time comprehensive universities all contain medical and non-medical specialties, we took samples according to the difference of economic level to ensure the homogeneity of the samples, so a nationwide sample was not conducted owing to the limited time and energy.

This study showed that the awareness rate of the COVID-19 vaccine among medical students was 65.3%, close to the awareness rate of 45.5%~68.3% among American university students,<sup>19</sup> and higher than 58.4% of nursing students in the United States.<sup>20</sup> Regarding the correct rate of answers, the awareness rate of medical students on storage and transportation conditions of COVID-19 vaccine, precautions before vaccination, and protective measures after vaccination was higher than that of non-medical students. The reason could be that

**Table 2.** Knowledge of COVID-19 vaccine in medical students and non-medical students.

Item	Category	Medical students (652)		Non-medical students (590)		$\chi^2$	p-value
		Number	Ratio(%)	Number	Ratio(%)		
Whether COVID-19 vaccines need to be stored and transported in the cold chain?	Yes	512	78.5	409	69.3	14.835	0.001
	No	27	4.1	44	7.4		
	Not sure	113	17.3	137	23.2		
Can the COVID-19 vaccine be administered together with other vaccines?	Yes	88	13.5	91	15.4	3.452	0.178
	No	380	58.3	313	53.1		
	Not sure	184	28.2	186	31.5		
Is it necessary to test for antibodies before receiving COVID-19 vaccines?	Yes	357	54.8	318	53.9	9.015	0.011
	No	165	25.3	118	20.0		
	Not sure	130	19.9	154	26.1		
Do you know the indications and contraindications for COVID-19 vaccination?	Yes	580	89.0	493	83.6	8.240	0.016
	No	27	4.1	42	7.1		
	Not sure	45	6.9	55	9.3		
Do you know when antibodies develop after the COVID-19 vaccination?	Yes	225	34.5	182	30.9	3.450	0.178
	No	252	38.7	258	43.7		
	Not sure	175	26.8	150	25.4		
Do you still need to take protective measures after receiving COVID-19 vaccines?	Yes	605	92.8	490	83.1	30.017	<0.001
	No	17	2.6	49	8.3		
	Not sure	30	4.6	51	8.6		

medical students received basic courses such as microbiology, immunology and had a certain understanding of the mechanism of action and precautions needed for handling vaccines. However, due to the lack of knowledge about the COVID-19 vaccine, only 25.3% of medical students and 20.0% of non-medical students pointed out that nucleic acid test was not necessary before vaccination, which was similar to Jiang's conclusion.<sup>21</sup> Perhaps because the survey was conducted at an earlier time. The first COVID-19 vaccine Technical Guide in China was officially released on March 29 in 2021, but it was not widely publicized.<sup>22</sup> Regarding "Is it necessary to test for antibodies before receiving COVID-19 vaccines?", 54.8% of medical students and 53.9% of non-medical students hold the view that testing was required in advance. However, it may be not necessary, indicating that university students still had doubts about the vaccination procedure of the COVID-19 vaccine.

In terms of information sources, social media served as a primary source of health behavior information and an important way for university students to learn about the novel coronavirus vaccine. For the analysis of information sources,

social media was the main source of health behavior information and an important way for university students to access the knowledge related to the COVID-19 vaccine.<sup>23</sup> In the digital age, people could access health information through multiple channels such as the Internet and social media platforms.<sup>24</sup> Future work should develop and analyze effective strategies to promote vaccination and evidence-based health literacy. However, the percentage of doctors who consulted and attended public lectures at schools was low. It showed that the knowledge propaganda of government departments through the mainstream media had achieved some results. Still, according to the previous literature,<sup>25</sup> the suggestion of doctors, experts, and other authorities was one of the most strongly relevant factors for public acceptance of vaccines. Therefore, universities, especially the doctor's office or clinic, would need to be a foothold in the public health prevention. This would widen the channel of the publicity. Richer forms of propaganda would include inviting experts for lectures to enhance university students knowledge, especially for medical students' health protection consciousness and to strengthen the importance and knowledge of the COVID-19 vaccination.

**Table 3.** Attitudes toward COVID-19 vaccine among medical students and non-medical students.

Item	Category	Medical students (652)		Non-medical students (590)		$\chi^2$	p-value
		Number	ratio(%)	Number	ratio(%)		
Safety of a COVID-19 vaccine	Yes	420	64.4	359	60.9	8.433	0.015
	No	22	3.4	41	6.9		
	Not sure	210	32.2	190	32.2		
Efficacy of the COVID-19 vaccine	Yes	456	69.9	413	70.0	1.050	0.592
	No	16	2.5	20	3.4		
	Not sure	180	27.6	157	26.6		
Adverse reactions to COVID-19 vaccination	Yes	287	44.0	211	35.8	12.487	0.002
	No	71	10.9	96	16.3		
	Not sure	294	45.1	283	48.0		
Vaccination effect of COVID-19 vaccine	Yes	321	49.2	238	40.3	23.714	0.000
	No	50	7.7	94	15.9		
	Not sure	281	43.1	258	43.7		

**Table 4.** Regression models predicting COVID-19 vaccination intention of non-medical students.

Variables	$\beta$	S.E.	Wald	<i>p</i> -value	OR	95%CI
Place of origin (Rural = 1, town = 2)	-0.658	0.254	6.734	0.009	0.518	0.315–0.851g
COVID-19 vaccine attitude	0.660	0.108	37.206	1.935	0.660	1.565–2.392
Constant	1.065	1.342	0.63	0.427	2.900	

**Table 5.** Regression models predicting COVID-19 vaccination intention of medical students.

variables	$\beta$	S.E.	Wald	<i>p</i> -value	OR	95%CI
Grade (Freshman = 1, sophomore = 2, junior = 3, senior and above = 4)	-0.257	0.108	5.638	0.018	0.774	0.314–0.916
Place of origin (Rural = 1, town = 2)	-0.623	0.273	5.203	0.023	0.537	0.626–0.956
Health self-management cognition (low level = 1, medium level = 2, high level = 3)	0.734	0.306	5.762	0.016	2.083	1.144–3.792
COVID-19 vaccine attitude	0.357	0.097	13.555	0.000	1.429	1.182–1.728
Constant	0.051	1.545	0.001	0.973	1.053	

KAP theory divided the process of individual behavior change into three steps: acquiring knowledge, generating attitude or belief, and carry out the practice. Knowledge is the basis, belief or attitude is the motivation, and behavior change is the goal. Therefore, improving university students' attitudes toward COVID-19 vaccination is an important step to optimize the vaccination plan. This study showed that medical students had higher approval rates for the safety of the COVID-19 vaccine than non-medical students. This difference could be related to medical education received, with clinical practice experience affecting an individual's knowledge and attitude. For example, medical students would obtain from courses, academic works, and peer exchanges the latest progress of COVID-19 vaccine and frontier information through various channels. Especially our survey showed that 58.0% of medical students, with relatives and friends in the medical industry, were more optimistic about the future prospects of COVID-19 vaccines.<sup>26</sup> An interesting finding of this study is that a higher proportion of medical students than non-medical students believe that COVID-19 vaccination causes adverse reactions. The possible reason could be that medical students were more likely to get close to real clinical situations than non-medical students, and were relatively more likely to receive information on adverse reactions caused by the COVID-19 vaccine in the process of contacting with patients and practical learning.

There are a large number of teachers and students in institutions of higher learning, which are not only densely populated but also circulate frequently, so it is an important measure to speed up the COVID-19 vaccination. Our study found that although the general level of knowledge about the COVID-19 vaccine is not high, it does not affect the willingness to vaccinate. Our study showed that the overall vaccination willingness rate of COVID-19 vaccine among university students was

81.8%, slightly higher than the vaccination willingness rate of 6,922 university students in Mainland China (78.9%).<sup>7</sup> Vaccination could prevent infection with COVID-19, but most students were still reluctant to get vaccinated due to concerns about the safety of vaccines, indicating that the safety of vaccines has always been the primary concern of university students.<sup>27,28</sup> Therefore, we should focus on the vaccine's safety in subsequent promotion and education to lessen the public's doubts. The percentage of medical students willing to be vaccinated was 54.1%, slightly higher than that of non-medical students, the finding was similar to those reported in the literature.<sup>29,30</sup>

Given the specific nature of medical education, which often required medical students to participate in internships at all levels of hospitals and primary care services in China generally. Vaccination was the most cost-effective health measure to prevent COVID-19 and avoid infection.<sup>31</sup> Moreover, for medical students who had received systematic medical education, their acceptance of vaccines was higher than that of non-medical students. According to WHO,<sup>32</sup> the three fastest strategies to increase COVID-19 vaccine acceptance were: leveraging the social influence of medical students' peers, increasing incentives for vaccination, and creating an enabling environment. Thus we should give full play to the advantages of medical students, such as using medical knowledge for health education, promote the propaganda and education of the epidemic situation. Schools can strengthen the education and popularization of COVID-19 vaccine, especially the elective courses of health education for non-medical students, strengthen the belief of students' inoculation and speed up the inoculation speed, considering the form of inoculation in school under the premise of fully respecting students' will.

Logistic regression analysis showed that university students from rural areas were more willing to be vaccinated. The possible reason was that university students from rural areas had easier access to vaccination resources with free vaccination being available, similar to the study by scholar Yoda and Katsuyama.<sup>33</sup> They were less worried about the effectiveness and safety of vaccines, hence more willing to be vaccinated. It was worth noting that this study included the health self-management ability into the student group for factor analysis. Accurate assessment of health self-management ability is the premise of effectively improving health level. It was found that the cognitive dimension impacted the vaccination willingness of medical students. There is a positive correlation between health literacy and individual health self-management ability.<sup>34</sup> It was inferred that the accessibility of health resources and the initiative of medical health cognition could promote individual vaccination behavior. With the accumulation of students' professional knowledge, health knowledge can be directly or indirectly transformed into healthy behavior and lifestyle through health concept and health skills. Relevant governments and departments ought to improve the research and development process of the COVID-19 vaccine, accelerate vaccine production, and ensure vaccine supply. Vaccinated university students would be recruited as propagandists to remove the doubts of non-vaccinated students. They would talk about their

inoculation experience and feelings to improve the latter's willingness to be vaccinated against COVID-19 and build an immune barrier early on. Interestingly, in this study, medical students in the lower grades were more willing to be vaccinated against COVID-19, may be that senior students learned about the risks and effects of the vaccine during their clinical practice, which was related to the event of vaccine problem, the complicated process of vaccine development, and the uncertainty of the result, consistent with the results of previous study<sup>35</sup> and student attitude toward vaccines affected their willingness to get vaccinated, conform to the KAP theory.

Nevertheless, this study has the following limitations. Firstly, the samples of this study were mainly from three universities in Zhejiang Province, and the conclusions might not represent the vaccination willingness of university students in other provinces and regions in China. Secondly, this study is cross-sectional, so it could not directly confirm the causal relationship between health self-management ability and COVID-19 students' willingness to vaccinate. Additionally, this study adopted a subjective online questionnaire survey. It was unable to obtain more objective and accurate measurement data. There might be selection bias, as the number of students majoring in medicine in the selected sample was relatively high. Whether or not there was a separation between university students COVID-19 vaccination willingness, the actual vaccination rate would still be worthy of further exploration in the future.

To sum up, the willingness of university students to receive a COVID-19 vaccine in Zhejiang province was high, but the knowledge was much less. It showed that immunization departments in universities should be dynamically update and promote vaccine information, creating the atmosphere of vaccination, helping university students establish inoculation confidence. Health self-management was associated with COVID-19 vaccination willingness among students. Health management ability should be introduced into the health education of university students to improve the vaccination rate of the COVID-19 vaccine.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

The present study was supported by grants from the Teaching reform research project of Hangzhou Normal University School of Nursing [Nos. HLXYJG202105].

## ORCID

Liyan Gao  <http://orcid.org/0000-0001-9007-3825>

## Contributor

GLY conceived and designed this study, wrote the first draft of the manuscript; SSM, DUU, HY, WJY performed this study and analyzed the data; CMJ, MQF contributed the introduction and discussion; WXL critically

reviewed the manuscript. All authors contributed to and approved the final manuscript.

## References

1. World Health Organization. Listings of WHO's response to COVID-19; 2020 [accessed 2021 Dec 25]. <https://www.who.int/zh/news/item/29-06-2020-covidtimeline>.
2. China Government Network. Authoritative release of the state council's joint prevention and control mechanism; 2020 [accessed 2021 Dec 25]. <http://www.gov.cn/xinwen/gwylflkj140/index.htm>.
3. Cihan P. Forecasting fully vaccinated people against COVID-19 and examining future vaccination rate for herd immunity in the US, Asia, Europe, Africa, South America, and the World. *Appl Soft Comput*. 2021;111:107708. doi:10.1016/j.asoc.2021.107708.
4. China Government Network. Authoritative release of the state council's joint prevention and control mechanism; 2021 [accessed 2021 Dec 25]. <http://www.gov.cn/xinwen/gwylflkj144/index.htm>.
5. Ding Y, Du X, Li Q, Zhang M, Zhang Q, Tan X, Liu Q, Yi S. Risk perception of coronavirus disease 2019 (COVID-19) and its related factors among university students in China during quarantine. *PLoS One*. 2020;15(8):e0237626. doi:10.1371/journal.pone.0237626.
6. Graupensperger S, Abdallah DA, Lee CM. Social norms and vaccine uptake: college students' COVID vaccination intentions, attitudes, and estimated peer norms and comparisons with influenza vaccine. *Vaccine*. 2021;39(15):2060–67. doi:10.1016/j.vaccine.2021.03.018.
7. Mo PK, Luo S, Wang S, Zhao J, Zhang G, Li L, Li L, Xie L, Lau JTF. Intention to receive the COVID-19 vaccination in China: application of the diffusion of innovations theory and the moderating role of openness to experience. *Vaccines (Basel)*. 2021;9(2):129. doi:10.3390/vaccines9020129.
8. Weng MQ. On the elements and cultivation of self-health management ability. *Med Philos (B)*. 2016;37(11):80–3, 97. doi:10.12014/j.issn.1002-0772.2016.11b.26.
9. Graffigna G, Palamenghi L, Boccia S, Barelo S. Relationship between citizens' health engagement and intention to take the COVID-19 vaccine in Italy: a mediation analysis. *Vaccines (Basel)*. 2020;8(4):576–87. doi:10.3390/vaccines8040576.
10. Wang XL, Cheng J, Guo CY, Xu XR. The implications of childcare on grandparents' health self-management in a Chinese elderly population. *Int J Health Plann Manage*. 2020;35(1):280–89. doi:10.1002/hpm.2904.
11. Gutierrez-Colina AM, Davis M, Eaton CK, LaMotte J, Cushman G, Quast L, Blount RL, Suveg C. The role of executive functioning in health self-management and the transition to adult health care among university students. *J Am Coll Health*. 2020;1:1–7. doi:10.1080/07448481.2020.1775605.
12. Gao Z, Ying S, Liu J, Zhang H, Li J, Ma C. A cross-sectional study: comparing the attitude and knowledge of medical and non-medical students toward 2019 novel coronavirus. *J Infect Public Health*. 2020;13(10):1419–23. doi:10.1016/j.jiph.2020.06.03.
13. Ministry of Education of the People's Republic of China. The ministry of education issued a notice to deploy novel coronavirus vaccination in the education system; 2021; [accessed 2021 Dec 25]. [http://www.moe.gov.cn/jyb\\_xwfb/xw\\_zt/moe\\_357/jyzt\\_2020n/2020\\_zt03/zydt/zydt\\_jyb/202104/t20210403\\_524338.html](http://www.moe.gov.cn/jyb_xwfb/xw_zt/moe_357/jyzt_2020n/2020_zt03/zydt/zydt_jyb/202104/t20210403_524338.html).
14. Issanov A, Akhmetzhanova Z, Riethmacher D, Aljofan M. Knowledge, attitude, and practice toward COVID-19 vaccination in Kazakhstan: a cross-sectional study. *Hum Vaccin Immunother*. 2021;17(10):3394–400. doi:10.1080/21645515.2021.1925054.
15. Min F. Thirty questions about COVID-19 vaccination. *Life & Disaster*. 2021;1:34–37.

16. Zhao QL, Huang FF. Development and the reliability and validity test of the rating scale of health self-management for adults in Chinese. *Chin J Mod Nurs*. 2011;17:869–72. doi:10.3760/cma.j.issn.1674-2907.2011.08.001.
17. Feng LN, Chen CX, Tian MM. Correlation between mental health and the health self-management, family and social support systems among senior citizens. *Mod Prev Med*. 2014;41:2963–66. doi:CNKI:SUN:XDYF.0.2014-16-027.
18. World Medical Association. World medical association declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA*. 2013;310(20):2191–94. doi:10.1001/jama.2013.281053.
19. Kecojevic A, Basch CH, Sullivan M, Chen YT, Davi NK. COVID-19 vaccination and intention to vaccinate among a sample of university students in New Jersey. *J Community Health*. 2021;46(6):1059–68. doi:10.1007/s10900-021-00992-3.
20. Manning ML, Gerolamo AM, Marino MA, Hanson-Zalot ME, Pogorzelska-Maziarz M. COVID-19 vaccination readiness among nurse faculty and student nurses. *Nurs Outlook*. 2021;69(4):565–73. doi:10.1016/j.outlook.2021.01.019.
21. Jiang N, Wei B, Lin H, Wang Y, Chai S, Liu W. Nursing students' attitudes, knowledge, and willingness to receive the coronavirus disease vaccine: a cross-sectional study. *Nurse Educ Pract*. 2021;55:103148. doi:10.1016/j.nepr.2021.103148.
22. China National Health Commission. Technical guidelines for SARS-CoV-2 vaccination in China (1st edition). *Inter J Epidemiol Infect Dis*. 2021;48:91–92. doi:10.3760/cma.j.cn331340-20210329-00061.
23. Jain J, Saurabh S, Kumar P, Verma MK, Goel AD, Gupta MK, Bhardwaj P, Raghav PR. COVID-19 vaccine hesitancy among medical students in India. *Epidemiol Infect*. 2021;149:e132. doi:10.1017/S0950268821001205.
24. Puri N, Coomes EA, Haghbayan H, Gunaratne K. Social media and vaccine hesitancy: new updates for the era of COVID-19 and globalized infectious diseases. *Hum Vaccin Immunother*. 2020;16(11):2586–93. doi:10.1080/21645515.2020.1780846.
25. Lucia VC, Kelekar A, Afonso NM. COVID-19 vaccine hesitancy among medical students. *J Public Health (Oxf)*. 2021;43(3):445–49. doi:10.1093/pubmed/fdaa230.
26. Schaffer DeRoo S, Pudalov NJ, Fu LY. Planning for a COVID-19 vaccination program. *JAMA*. 2020;323(24):2458–59. doi:10.1001/jama.2020.8711.
27. Tavolacci MP, Dechelotte P, Ladner J. COVID-19 vaccine acceptance, hesitancy and resistancy among university students in France. *Vaccines (Basel)*. 2021;9(6):654. doi:10.3390/vaccines9060654.
28. Gan L, Chen Y, Hu P, Wu D, Zhu Y, Tan J, Li Y, Zhang D. Willingness to receive SARS-CoV-2 vaccination and associated factors among Chinese adults: a cross sectional survey. *Int J Environ Res Public Health*. 2021;18(4):1993. doi:10.3390/ijerph18041993.
29. Szmyd B, Bartoszek A, Karuga FF, Staniecka K, Błaszczyk M, Radek M. Medical students, and SARS-CoV-2 vaccination: attitude and behaviors. *Vaccines (Basel)*. 2021;9(2):128. doi:10.3390/vaccines9020128.
30. Barello S, Nania T, Dellafiore F, Graffigna G, Caruso R. 'Vaccine hesitancy' among university students in Italy during the COVID-19 pandemic. *Eur J Epidemiol*. 2020;35(8):781–83. doi:10.1007/s10654-020-00670-z.
31. Bai W, Cai H, Liu S, Liu H, Qi H, Chen X, Liu R, Cheung T, Su Z, Ng CH, et al. Attitudes toward COVID-19 vaccines in Chinese university students. *Int J Biol Sci*. 2021;17(6):1469–75. doi:10.7150/ijbs.58835.
32. World Health Organization. Behavioral considerations for acceptance and uptake of COVID-19 vaccines: WHO technical advisory group on behavioral insights and sciences for health. Meeting Report; 2020 [accessed 2021 Dec 25].
33. Yoda T, Katsuyama H. Willingness to receive COVID-19 vaccination in Japan. *Vaccines (Basel)*. 2021;9(1):48. doi:10.3390/vaccines9010048.
34. Heijmans M, Waverijn G, Rademakers J, van der Vaart R, Rijken M. Functional, communicative and critical health literacy of chronic disease patients and their importance for self-management. *Patient Educ Couns*. 2015;98(1):41–48. doi:10.1016/j.pec.2014.10.006.
35. Li M, Zheng Y, Luo Y, Ren J, Jiang L, Tang J, Yu X, Luo D, Fan D, Chen Y. Hesitancy toward COVID-19 vaccines among medical students in Southwest China: a cross-sectional study. *Hum Vaccin Immunother*; Preprint [accessed 2021 Dec 25]. doi:10.1080/21645515.2021.1957648.