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Patterns and influencing factors of COVID-19 vaccination willingness among college students in China



Xi-Mei Zhu^{a,1}, Wei Yan^{a,1}, Jie Sun^{b,1}, Lin Liu^{c,d}, Yi-Miao Zhao^{c,d}, Yong-Bo Zheng^{a,e}, Jian-Yu Que^a, Si-Wei Sun^a, Yi-Miao Gong^{a,e}, Na Zeng^{c,d}, Kai Yuan^a, Le Shi^a, Yan-Kun Sun^a, Sui-Huai Guo^f, Yu Lu^f, Mao-Sheng Ran^g, Samuel Yeung Shan Wong^h, Jie Shi^c, Zheng-Dong Jiang^{f,*}, Yan-Ping Bao^{c,d,*}, Lin Lu^{a,c,e,*}

^a Institute of Mental Health, National Clinical Research Center for Mental Disorders, Key Laboratory of Mental Health and Peking University Sixth Hospital, Peking University, Beijing 100191, China

^b Center for Pain Medicine, Peking University Third Hospital, Beijing 100191, China

^c National Institute on Drug Dependence and Beijing Key Laboratory of Drug Dependence, Peking University, Beijing 100191, China

^d School of Public Health, Peking University, Beijing 100191, China

^e Peking-Tsinghua Center for Life Sciences and PKU-IDG/McGovern Institute for Brain Research, Peking University, Beijing 100191, China

^f Wuhan Wuchang Hospital, Wuhan University of Science and Technology, Wuhan, China

^g Department of Social Work and Social Administration, University of Hong Kong, Hong Kong, China

^h JC School of Public Health and Primary Care, The Chinese University of Hong Kong, Hong Kong Special Administrative Region

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ABSTRACT

Background: Vaccination is an important preventive measure against the coronavirus disease 19 (COVID-19) pandemic. We aimed to examine the willingness to vaccination and influencing factors among college students in China.

Methods: From March 18 to April 26, 2021, we conducted a cross-sectional online survey among college students from 30 universities in Wuhan, Hubei Province, China. The survey was composed of the sociodemographic information, psychological status, experience during pandemic, the willingness of vaccination and related information. Students' attitudes towards vaccination were classified as 'vaccine acceptance', 'vaccine hesitancy', and 'vaccine resistance'. Multinomial logistic regression analyses were performed to identify the influencing factors associated with vaccine hesitancy and resistance.

Results: Among 23,143 students who completed the survey, a total of 22,660 participants were included in the final analysis with an effective rate of 97.9% after excluding invalid questionnaires. A total of 60.6% of participants would be willing to receive COVID-19 vaccine, 33.4% were hesitant to vaccination, and 6.0% were resistant to vaccination. Social media platforms and government agencies were the main sources of information vaccination. Worry about the efficacy and adverse effects of vaccine were the top two common reason of vaccine hesitancy and resistance. Multiple multinomial logistic regression analysis identified that participants who worried about the adverse effects of vaccination were more likely to be vaccine hesitancy (aOR = 2.44, 95% CI = 2.30, 2.58) and resistance (aOR = 2.71, 95% CI = 2.40, 3.05).

Conclusion: More than half of college students are willing to receive the COVID-19 vaccine, whereas nearly one-third college students are still hesitant or resistant. It is crucial to provide sufficient and scientific information on the efficacy and safety of vaccine through social media and government agencies platforms to promote vaccine progress against COVID-19 and control the pandemic in China.

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* Corresponding authors at: Wuhan Wuchang Hospital, Wuhan University of Science and Technology, Wuhan, China (Z.-D. Jiang). National Institute on Drug Dependence, School of Public Health, Peking University, 38 Xueyuan Road, Beijing 100191, China (Y.-P. Bao). Institute of Mental Health/National Clinical Research Center for Mental Disorder/Peking University Sixth Hospital, Peking University, 51 HuayuanBei Road, Beijing 100191, China (L. Lu).

E-mail address: linlu@bjmu.edu.cn (L. Lu).

¹ These authors contribute equally for the manuscript.

1. Background

The severe acute respiratory syndrome coronavirus 2 pandemic, which is widely referred to as “COVID-19” [1], has been infecting more than 440 million over 200 countries and regions up to Mar 7, 2022 [2]. The pandemic posed a significant threat to the public health system [3–5], including lack of personal protective

equipment and increasing numbers of people who require services [6]. COVID-19 also impacted communities and businesses globally, subsequently affecting the financial markets and the global economy [7]. A vaccine is considered to be the most effective intervention and hundreds of global institutions were engaged in unprecedented speed to develop the vaccine [8]. Timely vaccination will help protect more populations from infection, thereby safeguarding health system and economies from further disruption and damage [9].

Although researches on COVID-19 vaccine have progressed very rapidly, public acceptance of COVID-19 vaccines is still a social issue to be investigated. Recent studies found that the acceptance rates of COVID-19 vaccine ranged from 28.7% to 76.3% with large variation [10–14]. What's more, learning about determinants of vaccine acceptability is also important in implementation of the vaccination strategy [15,16]. Previous studies have shown several factors for vaccine acceptance of COVID-19 vaccine [17], which include safety and efficacy of the vaccine, health outcomes of vaccination, trust towards the health system, lack of knowledge among the community on vaccine-preventable diseases [18].

The influencing factors of COVID-19 vaccine acceptability in different populations have also been studied [19,20]. For instance, perceived safety and efficacy of COVID-19 vaccine was associated with vaccine acceptability among general population in USA, while similar results were also found in Japan and China [11,21,22]. Certain subgroups have an increased risk of being infected, such as healthcare workers who struggle with viruses at the frontline of the COVID-19 pandemic [23]. Compared to other subgroups, college students often live and study in crowded surroundings and respond more quickly to public health issues; therefore, their attitudes towards COVID-19 vaccines could be different from other groups of individuals [24]. Previous studies also reported that the acceptance rates of COVID-19 vaccine among university students in China ranged from 36.4% to 76.3% with large variation [10,25,26]. A recent study on 2,881 college students found that 76.3% college students were willing to accept a COVID-19 vaccine in the future [10], but this study didn't clarify the vaccine hesitant subgroup and the associated factors, which was considered as a major threat to global health [27]. Little is known about the associated factors of Chinese college students' attitudes (acceptance, hesitancy and resistance) towards COVID-19 vaccine uptake in the epicenter areas. Hence, in this study, we aim to examine the willingness of COVID-19 vaccine in college students in Wuhan city, the pandemic epicenter in China, and to investigate associated factors influencing students' attitudes towards COVID-19 vaccine uptake. We also investigated from which sources college students collect information about the COVID-19 vaccine.

2. Methods

2.1. Study design and participants

We conducted a cross-sectional online study from March 18 to April 26, 2021 on college students at all grades from 30 universities in Wuhan, Hubei Province, China, by convenience sampling method [28]. This study received approval from the ethics committee of Peking University Sixth Hospital (Institute of Mental Health) and followed the American Association for Public Opinion Research reporting guidelines. With the help of class instructors, self-administered questionnaire was sent to students through Class Wechat groups to which university students pay attention routinely [29]. The investigation was anonymous with confidentiality assured for all information. Informed consent was received online before the participants began to fill the questionnaire.

2.2. Measurements

All participants completed the questionnaire after signed the informed consent. The survey was composed of 4 parts and needed approximately 20 min to complete. The first part gathered sociodemographic information of the participants, including gender, age, nationality, relationship status, monthly household income, educational level, major, and academic performance. The second part of the questionnaire evaluated participants' psychological status and consisted of 3 psychological scales, including the Chinese version of Patient Health Questionnaire-9 (PHQ-9) [30], Generalized Anxiety Disorder-7 (GAD-7) [31], and Posttraumatic stress disorder (PTSD) checklist for DSM-5 (PCL-5) [32]. Depressive symptoms severity was reported by PHQ-9 with the cutoff value of 0–4 as normal, 5–9 as mild, 10–27 as moderate to severe. Anxiety symptoms severity was reported by GAD-7 with the cutoff value of 0–4 as normal, 5–9 as mild, 10–21 as moderate to severe. The cutoff value for positive PTSD symptoms was a score of 33 or more in PCL-5 [33]. The third part asked pandemic-related questions, such as psychological stress during persistent pandemic period, perceived risk of future COVID-19 infection, and family members' and friends' COVID-19 infection status. The fourth part evaluated vaccination-related information including participants' willingness to be vaccinated, whether they have family members already vaccinated, whether they worried about the adverse effects of vaccination, the attitude towards adverse effects of vaccines, whether they actively search COVID-19 vaccine-related information, and sources of vaccine-related information.

The willingness of COVID-19 vaccination was measured by the question "Are you willing to get the COVID-19 vaccine?" with the following 5 response categories. Participants were categorized into 'vaccine acceptance' group if they already vaccinated, hoped to be vaccinated as soon as possible, and had contraindications of the vaccine but hope to be vaccinated in the future. Participants who delay vaccination until confirmation of vaccine's efficacy and safety were classified as 'vaccine hesitancy' group. Participants who were unwilling to be vaccinated were classified as 'vaccine resistance' group. Additionally, vaccine resistance participants chose the reasons of vaccine resistance from five options: worry about the efficacy of the vaccine, worry about the safety of the vaccine, do not need to be vaccinated, worry about the quality of the vaccine, and have contraindications to vaccination.

2.3. Statistical analysis

Classification of 'vaccine acceptance', 'vaccine hesitancy', and 'vaccine resistance' of students' attitudes towards vaccination was described above. We used Chi-square tests to compare the sociodemographic, psychological status, experience of pandemic, and vaccination-related information among three groups. Multiple multinomial logistic regression analyses were performed to identify the risk factors associated with vaccine hesitancy and resistance, based on the results of univariate multinomial logistic analysis. Only the variables with statistic significant association in univariate analysis model and with the actual implication or systematic theory were involved in the multiple multinomial logistic model. For these analyses, the vaccination acceptance group was set as the reference category. All associations between the predictor and outcome variables were represented as adjusted odds ratios (aOR) with 95% confidence intervals (CI) (i.e. all predictors were adjusted for all other covariates in each model). All data analyses were conducted using SPSS software, version 22 (IBM Corp). Statistically significant differences were reported at the standard alpha level ($P < 0.05$).

3. Results

3.1. Sociodemographic characteristics

A total of 23,143 came from 31 province-level regions in China and attended 30 universities in Wuhan, Hubei Province, completed the questionnaires. Among these participants, 483 individuals were excluded because of invalid questionnaires including extreme or out of range values and inconsistent responses to the same questions in different parts of the questionnaire. Thus, 22,660 individuals were included in the final analysis with an effective rate of 97.9%. Overall, a total of 22,660 participants were included in the final analysis. Of the total sample, 9,146 (40.4%) were male, 14,705 (64.9%) were between 15 and 20 years old, and 14,007 (61.8%) lived in Hubei province. 16,175 (71.4%) had a bachelor degree or higher. 497 (2.2%) had family members and friends who were confirmed or suspected to have COVID-19. A considerable proportion of participants reported they had experienced high level of psychological stress due to pandemic (7,398 [32.6%]), 13.0% of participants reported moderate to severe depressive symptoms, 7.8% reported moderate to severe anxiety symptom, and 6.9% reported PTSD symptom. Table 1 provides other sociodemographic details, psychological status, experience of pandemic, and vaccination-related information.

3.2. Prevalence and characteristics of vaccine acceptance, hesitancy, and resistance groups

Overall, 13,738 (60.6%) of respondents were willing to accept a COVID-19 vaccine, among whom, 3,985 (17.6%) individuals were already vaccinated, 7,754 (34.2%) individuals hoped to be vaccinated as soon as possible, and 1,999 (8.8%) individuals had contraindication and hoped to be vaccinated in the future. In addition, 7,559 (33.4%) of respondents were hesitant about vaccine and 1,363 (6.0%) were resistant to vaccine. Fig. 1 displays the distribution of college students' attitudes towards COVID-19 vaccination. We further compared the differences across three groups in sociodemographic characteristics, psychological status, pandemic-related experiences, and vaccination-related information. Results showed that COVID-19 vaccine hesitant or resistant individuals were distinguished from vaccine accepting respondents in academic performance, stress level during persistent pandemic period, anxiety symptoms, and PTSD symptoms. As for pandemic-related experiences, three groups were different in perceived risk of future infection, family members' or friends' infection status, subjects' knowledge of the COVID-19 vaccine, and whether or not feeling worried about the adverse effects of vaccination rather (Table 2).

3.3. Sociodemographic, psychological status, and pandemic-related experience associated with COVID-19 vaccine hesitancy and resistance

The results of the univariate multinomial logistic model of sociodemographic, psychological status, and pandemic-related experience are presented in Table S1 in the Supplementary materials. Multiple multinomial logistic regression analysis was conducted to explore influencing factors associated with vaccine hesitancy and resistance. Compared with vaccine resistance participants, participants with family members vaccinated (aOR = 0.37, 95% CI = 0.32, 0.43), actively searched the information of the COVID-19 vaccine (aOR = 0.48, 95% CI = 0.42, 0.56), and with moderate (aOR = 0.77, 95% CI = 0.67, 0.89) or high psychological stress about the persistent pandemic (aOR = 0.73, 95% CI = 0.63, 0.85) compared with low level stress were more likely to be vaccine acceptance and less resistance. Moreover, participants reported

Table 1
The sociodemographic characteristics of college students (n = 22,660).

Characteristics	Participants, n (%)
Gender	
Male	9,146 (40.4)
Female	13,514 (59.6)
Age, y	
15–20	14,705 (64.9)
21–31	7,955 (35.1)
Nationality	
Han nationality	21,019 (92.8)
Other nationality	1,641 (7.2)
Places of home	
Hubei Province	14,007 (61.8)
Other Provinces	8,653 (38.2)
Relationship status	
Single	16,902 (74.6)
In relationship ^a	5,758 (25.4)
Monthly household income, ¥ ^b	
≤10,000	17,269 (76.2)
>10,000	5,391 (23.8)
Education level	
Less than bachelor degree	6,485 (28.6)
Bachelor degree or higher	16,175 (71.4)
Major	
Medicine	790 (3.5)
Non-medicine	21,870 (96.5)
Academic performance	
Last 50%	12,803 (56.5)
Top 50%	9,857 (43.5)
Depressive symptoms	
Moderate to severe	2,938 (13.0)
Mild	5,771 (25.5)
Normal	13,951 (61.5)
Anxiety symptoms	
Moderate to severe	1,773 (7.8)
Mild	4,993 (22.0)
Normal	15,894 (70.2)
PTSD symptoms	
Yes	1,558 (6.9)
No	21,102 (93.1)
Level of stress during persistent pandemic period	
High	7,398 (32.6)
Moderate	9,089 (40.1)
Low	6,173 (27.3)
Perceived risk of future COVID-19 infection	
High	93 (0.4)
Medium	1,406 (6.2)
Low	21,161 (93.4)
Family members or friends who are confirmed or suspected COVID-19	
Yes	497 (2.2)
No	22,163 (97.8)
Family members being vaccinated	
Yes	7,798 (28.6)
No	14,862 (71.4)
Willingness to be vaccinated	
Vaccine acceptance	13,738 (60.6)
Vaccine hesitancy	7,559 (33.4)
Vaccine resistance	1,363 (6.0)
Actively search the information of the COVID-19 vaccine	
Yes	19,440 (82.3)
No	3,220 (17.7)
Worried about the adverse effects of vaccination	
Yes	11,662 (58.3)
No	10,998 (41.7)

Abbreviation: COVID-19, coronavirus disease 2019; PTSD, posttraumatic stress disorder.

^a The in relationship category included participants who were married or in a relationship.

^b As of Mar 7, 2022, 1¥ = \$0.16 US.

with lower academic performance (aOR = 1.16, 95% CI = 1.04, 1.31) and worried about the adverse effects of vaccination (aOR = 2.71, 95% CI = 2.40, 3.05) were more likely to be vaccine resistance.

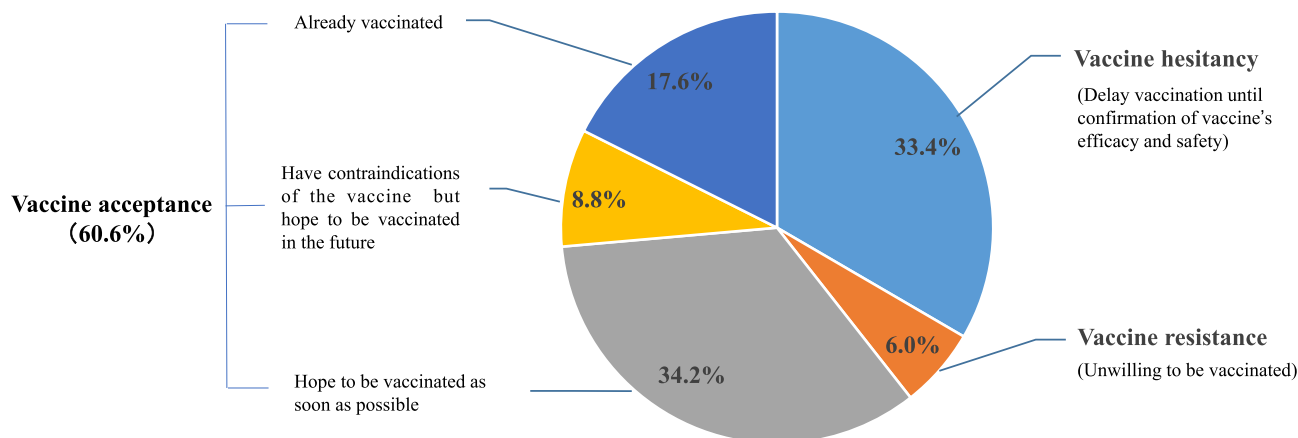


Fig. 1. The proportions of the willingness of COVID-19 vaccine among college students (n = 22,660).

Multiple multinomial logistic regression model showed that male (aOR = 0.90, 95% CI = 0.85, 0.96) and participants with younger ages (15–20 vs. 20–31 years old: aOR = 0.92, 95% CI = 0.86, 0.98) were less likely to be vaccine hesitancy and more likely to accept vaccine. Meanwhile, participants with family members and friends confirmed or suspected of COVID-19 (aOR = 0.75, 95% CI = 0.60, 0.93), those with family members vaccinated (aOR = 0.56, 95% CI = 0.52, 0.59), perceived high risk of future infection (aOR = 0.59, 95% CI = 0.35, 0.98), actively search the information of COVID-19 vaccine (aOR = 0.83, 95% CI = 0.76, 0.90), and with PTSD symptoms (aOR = 0.73, 95% CI = 0.62, 0.86) were more likely to be vaccination acceptance and less hesitancy. Moreover, vaccine hesitancy participants were more likely to be single people (aOR = 1.08, 95% CI = 1.01, 1.15), with lower academic performance (aOR = 1.10, 95% CI = 1.04, 1.17), and worried about the adverse effects of vaccination (aOR = 2.44, 95% CI = 2.30, 2.58) (Table 3).

3.4. Attitude towards adverse effects of COVID-19 vaccine and the reasons of vaccination resistance

The worry about the adverse effects of vaccination contributes the vaccination hesitancy and resistance. We further analysis the attitude towards adverse effects of COVID-19 vaccine among all the participants, which was divided into three categories: (1) fear or worry the adverse effects, (2) concern the adverse effects less than efficacy, and (3) don't worry about adverse effects. Among 13,738 vaccine acceptance participants, 10,184 (74.1%) concerned the efficacy more than adverse effects (Fig. 2a). Among 1,363 vaccine resistance participants, 826 (60.6%) mainly worried about adverse effects, which was higher than participants who believed the efficacy higher than adverse effects (331[24.3%]) or didn't worry about adverse effects (206[15.1%]) (Fig. 2a). We further analyzed the reasons of vaccine resistant and found that all 1,363 vaccine resistance participants worried about the efficacy of the vaccine (Fig. 2b). A total of 771 (56.6%) vaccine resistant participants who worried about vaccine's safety, and 669 (49.1%) of vaccine resistant respondents believed that vaccination is unnecessary because of their perceived low risk of being infection. 495 (36.3%) of vaccine resistant respondents worried about the vaccine's quality, and 104 (7.6%) worried about contraindications of vaccination.

3.5. Sources of COVID-19 vaccine related information and adverse effects of the vaccine

Fig. 3 shows the level of COVID-19 vaccine related information obtained by the three groups from different sources, including

social media platforms, government agencies, family and friends engaged in medical and news interviews, and reports of medical professionals. Social media platforms were the main source of COVID-19 vaccine related information for all three groups (vaccine acceptance (9,976 [72.6%]), hesitancy (5,481 [72.5%]), and resistance respondents (822 [60.3%])). Government agencies also played an important role in disseminating information about COVID-19 vaccine for vaccine acceptance group (9,101 [66.3%]), hesitancy group (4,637 [61.3%]), and resistance group (677 [49.7%]). Family and friends engaged in medical and news interviews and reports of medical professionals also provided relevant information for college students (Fig. 3a). Participants in the vaccine resistance groups gathered less information about the COVID-19 vaccine than those in the vaccine acceptance and hesitancy group.

Additionally, social media platforms and government agencies were the main sources of information about adverse effects of vaccination (Fig. 3b). Information released by government agencies was the main source of adverse effects among vaccine acceptance (10,657 [77.6%]), hesitancy (5,655 [74.8%]), and resistance participants (838 [61.5%]). Vaccine researches reported by internet media platforms and adverse effects of people being vaccinated also were the sources of information about adverse effects of vaccination.

4. Discussion

This large-sample, cross-sectional, online investigation focusing on Chinese college students' attitudes towards COVID-19 vaccination reported that 60.6% of participants were willing to accept COVID-19 vaccine, 33.4% of participants were hesitant about vaccination, and 6.0% of participants refused vaccination. The study identified several key factors associated with vaccine hesitancy and resistance in college students, such as female, older ages, single status, lower academic performance, family and friends without confirmed or suspected COVID-19, family members without vaccinated, concerned the safety and efficacy of the vaccination, and PTSD symptom. It is necessary for health officials and policy makers to take supportive measures, such as providing sufficient and specific information about COVID-19 vaccine, as well as elaborating on the efficacy and safety of the vaccine, to promote the COVID-19 vaccination progress.

Vaccine resistance rate reported in the present study is different with the results of a recent study that was conducted among the college students in China which indicated that 23.7% college students were resistant to accept a COVID-19 vaccine in the future [10]. The previous study was conducted from December 27, 2020

Table 2
Sociodemographic, psychological status, and epidemic-related experience of participants by COVID-19 vaccination willingness.

Characteristics	Intent to be vaccinated, n (%)			P value
	Vaccine acceptance (n = 13,738)	Vaccine hesitancy (n = 7,559)	Vaccine resistance (n = 1,363)	
Gender				<0.001
Male	5,638 (41.0)	2,913 (38.5) ^a	595 (43.7)	
Female	8,100 (59.0)	4,646 (61.5)	768 (56.3)	
Age, y				0.048
15–20	8,988 (65.4)	4,822 (63.8) ^a	895 (65.7)	
20–31	4,750 (34.6)	2,737 (36.2)	468 (34.3)	
Nationality				0.634
Han nationality	12,755 (92.8)	7,008 (92.7)	1,256 (92.1)	
Other nationality	983 (7.2)	551 (7.3)	107 (7.9)	
Places of home				0.449
Hubei Province	8,451 (61.5)	4,716 (62.4)	840 (61.6)	
Other Provinces	5,287 (38.5)	2,843 (37.6)	523 (38.4)	
Relationship status				0.002
Single	10,171 (74.0)	5,706 (75.5) ^a	1,025 (75.2)	
In relationship	3,567 (26.0)	1,853 (24.5)	338 (24.8)	
Monthly household income, ¥				0.439
≤10,000	10,432 (75.9)	5,799 (76.7)	1,038 (76.2)	
>10,000	3,306 (24.1)	1,760 (23.3)	325 (23.8)	
Education level				0.041
Less than bachelor degree	3,848 (28.0)	2,230 (29.5)	407 (29.9)	
Bachelor degree or higher	9,890 (72.0)	5,329 (70.5)	956 (70.1)	
Major				0.805
Medicine	486 (3.5)	260 (3.4)	44 (3.2)	
Non-medicine	13,252 (96.5)	7,299 (96.6)	1,319 (96.8)	
Academic performance				<0.001
Last 50%	7,625 (55.5)	4,359 (57.7) ^a	819 (60.1) ^b	
Top 50%	6,113 (44.5)	3,200 (42.3)	544 (39.9)	
Depressive symptoms				0.001
Moderate to severe	1,794 (13.1)	921 (12.2)	223 (16.4) ^b	
Mild	3,477 (25.3)	1,947 (25.8)	347 (25.5)	
Normal	8,467 (61.6)	4,691 (62.1)	793 (58.2)	
Anxiety symptoms				<0.001
Moderate to severe	1,103 (8.0)	527 (7.0) ^a	143 (10.5) ^b	
Mild	3,021 (22.0)	1,644 (21.7)	328 (24.1)	
Normal	9,614 (70.0)	5,388 (71.3)	892 (65.4)	
PTSD symptoms				<0.001
Yes	1,003 (7.3)	418 (5.5) ^a	137 (10.1) ^b	
No	12,735 (92.7)	7,141 (94.5)	1,226 (89.9)	
Level of stress during persistent pandemic period				<0.001
High	4,559 (33.2)	2,400 (31.8) ^a	439 (32.2)	
Moderate	5,412 (39.4)	3,168 (41.9)	509 (37.3)	
Low	3,767 (27.4)	1,991 (26.3)	415 (30.4)	
Perceived risk of future COVID-19 infection				<0.044
High	62 (0.5)	20 (0.3)	11 (0.8)	
Medium	850 (6.2)	470 (6.2)	86 (6.3)	
Low	12,826 (93.4)	7,069 (93.5)	1,266 (72.9)	
Family members or friends are confirmed or suspected COVID-19				<0.001
Yes	345 (2.5)	121 (1.6) ^a	31 (2.3)	
No	13,393 (97.5)	7,438 (98.4)	1,332 (97.7)	
Family members being vaccinated				<0.001
Yes	5,547 (40.4)	1,992 (26.4) ^a	259 (19.0) ^b	
No	8,191 (59.6)	5,567 (73.6)	1,104 (81.0)	
Actively search the information of the COVID-19 vaccine				<0.001
Yes	12,038 (87.6)	6,383 (84.4) ^a	1,019 (74.8) ^b	
No	1,700 (12.4)	1,176 (15.6)	344 (25.2)	
Worried about the adverse effects of vaccination				<0.001
Yes	5,868 (42.7)	4,873 (64.5) ^a	921 (67.6) ^b	
No	7,870 (57.3)	2,686 (35.5)	442 (32.4)	

^a There were significantly differences between vaccine hesitancy and acceptance by multiple comparisons.

^b There were significantly differences between vaccine resistance and acceptance by multiple comparisons.

followed by the first Chinese inactivated vaccine was approved on December 31, 2020 in which time vaccines have just appeared in the public's field of vision without enough information around the vaccines [34]. Our study was conducted from March 18 to April 26, 2021 when the public already had a certain understanding of vaccines and their willingness of vaccination was relatively stable. Rate of vaccine acceptance (60.6%) and resistance (6.0%) reported in the present study were less than that in previous study [10].

Because we classified students with hesitant attitudes towards COVID-19 vaccination apart from those who would definitely accept or refuse to be vaccinated. Learning about rate of vaccine hesitancy and influencing factors will be useful in encouraging more people to consider getting the vaccination and promoting COVID-19 vaccination progress [35]. The number of participants included in this study was also much higher than previous studies [26].

Table 3
Sociodemographic, psychological status, and epidemic-related experience associated with COVID-19 vaccine hesitancy and resistance according to multiple multinomial logistic regression.

Characteristics	Vaccine hesitancy		Vaccine resistance	
	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Gender				
Male	0.90 (0.85–0.96)	0.001	1.04 (0.93–1.17)	0.496
Female	1 [Reference]		1 [Reference]	
Age, y				
15–20	0.92 (0.86–0.98)	0.008	1 (0.89–1.13)	0.967
20–31	1 [Reference]		1 [Reference]	
Relationship status				
Single	1.08 (1.01–1.15)	0.027	1.07 (0.93–1.21)	0.344
In relationship	1 [Reference]		1 [Reference]	
Education level				
Less than bachelor degree	0.98 (0.92–1.04)	0.499	0.98 (0.86–1.11)	0.717
Bachelor degree or higher	1 [Reference]		1 [Reference]	
Academic performance				
Last 50%	1.10 (1.04–1.17)	0.002	1.16 (1.04–1.31)	0.012
Top 50%	1 [Reference]		1 [Reference]	
Depressive symptoms				
Moderate to severe	1.04 (0.91–1.18)	0.600	1.01 (0.79–1.31)	0.910
Mild	0.99 (0.91–1.08)	0.823	0.93 (0.79–1.11)	0.421
Normal	1 [Reference]		1 [Reference]	
Anxiety symptoms				
Moderate to severe	0.95 (0.80–1.12)	0.532	1.17 (0.86–1.60)	0.319
Mild	0.94 (0.86–1.03)	0.217	1.16 (0.97–1.40)	0.104
Normal	1 [Reference]		1 [Reference]	
PTSD symptoms				
Yes	0.73 (0.62–0.86)	<0.001	1.15 (0.88–1.51)	0.296
No	1 [Reference]		1 [Reference]	
Level of stress during persistent pandemic period				
High	0.94 (0.87–1.02)	0.123	0.73 (0.63–0.85)	<0.001
Moderate	1.03 (0.96–1.11)	0.365	0.77 (0.67–0.89)	<0.001
Low	1 [Reference]		1 [Reference]	
Perceived risk of future COVID-19 infection				
High	0.59 (0.35–0.98)	0.043	1.55 (0.80–3.02)	0.198
Medium	0.95 (0.84–1.08)	0.440	0.92 (0.73–1.17)	0.504
Low	1 [Reference]		1 [Reference]	
Family members or friends are confirmed or suspected COVID-19				
Yes	0.75 (0.60–0.93)	0.008	1.09 (0.75–1.60)	0.644
No	1 [Reference]		1 [Reference]	
Family members being vaccinated				
Yes	0.56 (0.52–0.59)	<0.001	0.37 (0.32–0.43)	<0.001
No	1 [Reference]		1 [Reference]	
Actively search the information of the COVID-19 vaccine				
Yes	0.83 (0.76–0.90)	<0.001	0.48 (0.42–0.56)	<0.001
No	1 [Reference]		1 [Reference]	
Worried about the adverse reactions of vaccination				
Yes	2.44 (2.30–2.58)	<0.001	2.71 (2.40–3.05)	<0.001
No	1 [Reference]		1 [Reference]	

Multinomial logistic regression analyses were performed to identify impacting factors on vaccine hesitancy and vaccine resistance. Vaccine acceptance was set as the reference category.

Several sociodemographic factors, such as female, older ages, and single status, were associated with vaccine hesitancy or resistance. Women were less likely to accept the COVID-19 vaccine which is consistent with the previous studies identifying gender-related discrepancies in vaccine uptake and acceptance [36]. This finding were same with results of recent studies which found that UK residents aged 25 to 34 years were more hesitant to take the vaccine compared to those aged below 24 years [37,38]. Compared to people with close relationship, single people were more likely to display vaccine hesitancy, just as previous studies had reported that married people were more likely to accept the COVID-19 vaccine [22,36,39]. Experience related to COVID-19 affected participants' judgment about the necessity of vaccination. People with psychological stress during persistent pandemic period and PTSD symptom were more likely to accept the vaccination rather than hesitancy and resistance, because COVID-19 related stress made people understand the importance of vaccine [40,41]. This study showed that people's perceived high risk of future infection was

a significant predictor in the willingness to receive COVID-19 vaccine [22,42]. People with family members and friends who were being suspected of infection or who have close contacts of people with COVID-19 were more likely to accept vaccination than vaccine hesitancy, because people realized the necessity of the vaccination when they were close and suspected of infection. Similarly, family members with vaccination decreased the resistance to receiving the vaccine, suggesting that family members' vaccination have positive effect on the willingness of COVID-19 vaccine perhaps through social modeling [43].

Distrust towards the efficacy and safety of vaccines are the main obstacles to college students getting vaccinated. Compared to infections, people who worry about adverse effects were more likely to be hesitant and resistant about vaccination. The majority of vaccine-resistant participants worried about the efficacy of vaccines and refused vaccination for fear of unknown adverse effects. On the one hand, the short cycle of vaccine development and unknown efficacy and safety decreased the confidence of efficacy

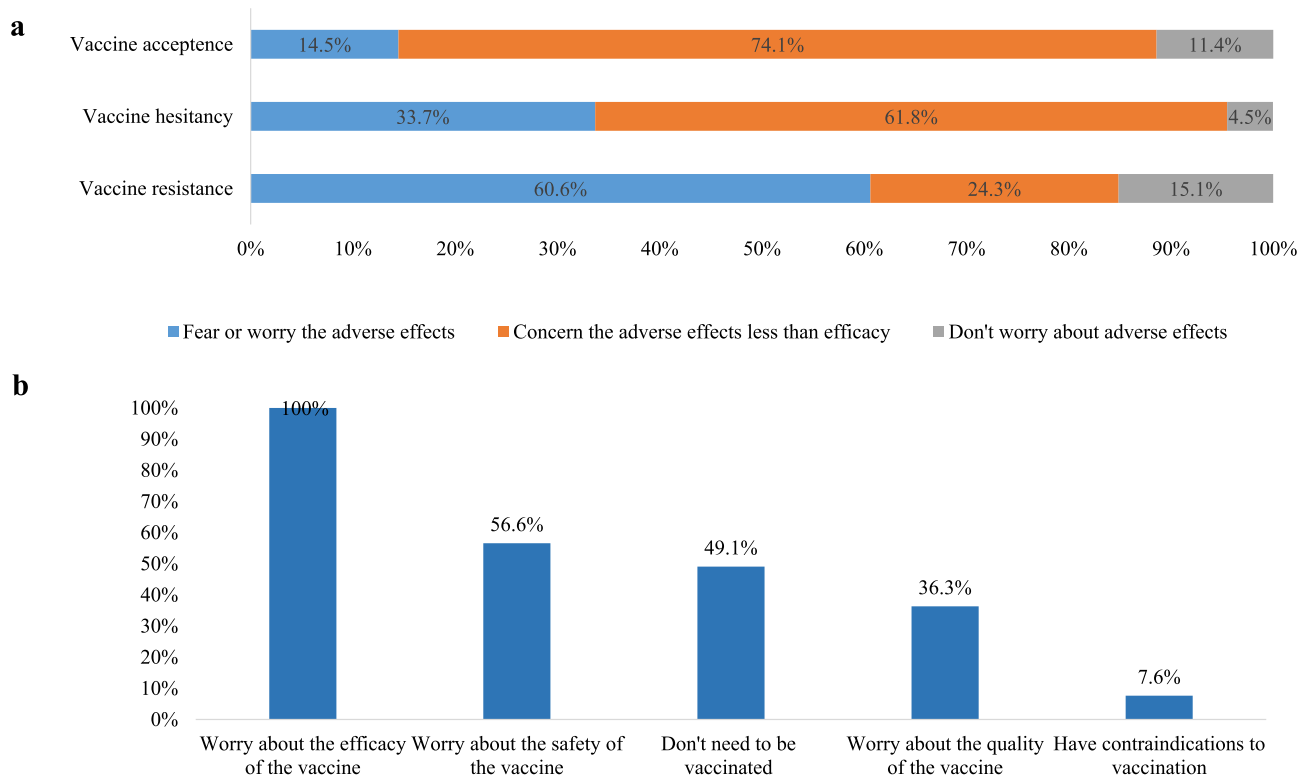


Fig. 2. a. Attitude towards adverse effects of COVID-19 vaccination in vaccine acceptance, hesitancy, and resistance participants (n = 22,660); b. The reasons of vaccine resistant among vaccine resistance participants (n = 1,363).

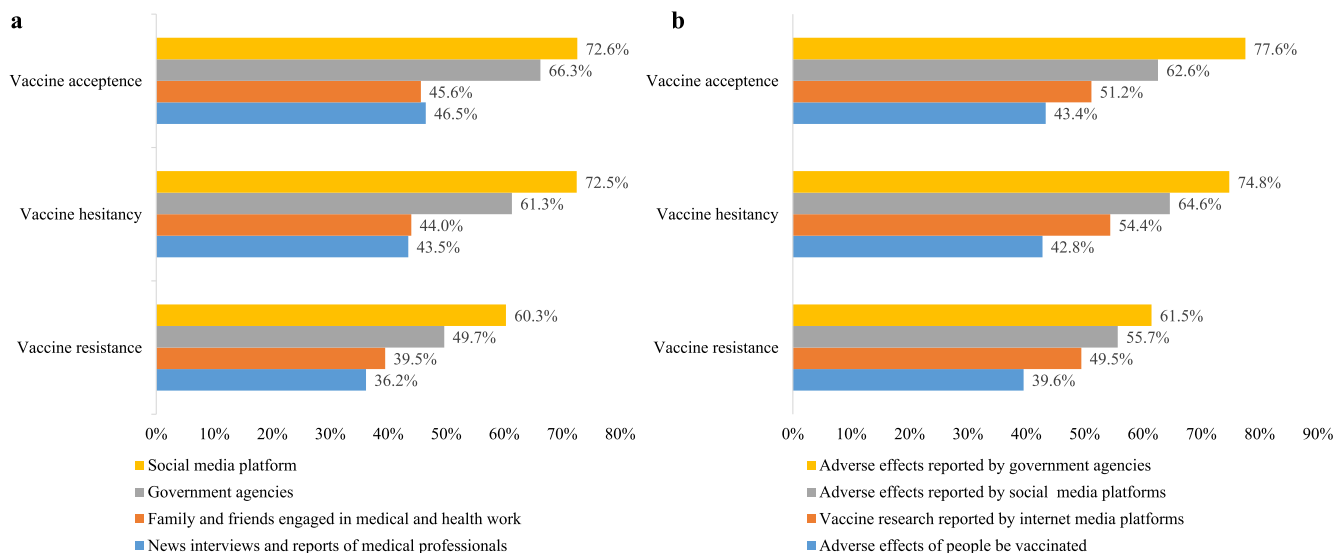


Fig. 3. Sources of COVID-19 vaccine related information in vaccine acceptance, hesitancy, and resistance participants. a. Sources of COVID-19 vaccine information in vaccine acceptance, hesitancy, and resistance participants; b. Sources of COVID-19 adverse effects information in vaccine acceptance, hesitancy, and resistance participants.

and safety. On the other hand, vaccine hesitancy has been widespread in countries and regions alike [44], and World Health Organization identified vaccine hesitancy as one of the top ten global health threats in 2019 [27]. People often makes the decision after comprehensively evaluating the safety and efficacy of vaccines. There is still a small part (14.5%) of the vaccine acceptance group who are worried about the adverse effects of the vaccine the reason maybe there are some medicine contraindications or actual need to the vaccine, however, we did not explore the detailed reason in this study. The clear definition of each classification should be con-

ducted in the future study. With the emergence of delta and omicron wave, even for those who have been vaccinated, it is still necessary to increase the trust towards the efficacy and safety of vaccines, which will facilitate further booster vaccinations shots. Therefore, it is very important to quickly popularize sufficient and reliable vaccine information and improve confidence of vaccine's efficacy in public [45].

Vaccine confidence are associated with information on the vaccine and its adverse effects obtained by participants [34]. People who actively gathered the information of vaccine could get com-

prehensive and objective information, and they would likely to accept vaccine rather than refusal [38]. Our study found that information about COVID-19 vaccine obtained by vaccine resistance participants less than vaccine acceptance and hesitancy group. Social media platform is the main source of information about the COVID-19 vaccine among college students, which allow individuals to rapidly create and share content globally without editorial oversight so that users may self-select content streams, contributing to ideological isolation [46,47]. There are considerable public health concerns raised by anti-vaccination messaging on social media platforms and the consequent potential for downstream vaccine hesitancy and resistance, including the compromise of public confidence in safety and efficacy of COVID-19 vaccine [48]. Objective reports of COVID-19 vaccine and its adverse effects by government agencies promote students to accept the vaccine, because effective communication of governments promotes public confidence in the efficacy and safety of vaccines, as well as trust in the ability to procure and distribute them efficiently and equitably [49].

Strengths of this study include using a large sample size and broad geographic coverage survey to investigate the prevalence and influencing factors associated with vaccine uptake of college students in China. This study has several limitations. First, participants from 30 universities in Wuhan cannot represent the whole college student population in China. In early 2020, Wuhan was the epicenter of China and highly impacted during the emergence of COVID-19, which may have influenced the perceptions of students about the COVID-19 vaccines. Second, this was a cross-sectional study and the causal relationship among factors could not be explored. Third, recall bias and equivocal description of investigation for self-report questions were inevitable, accurate definition and classification should be conducted in the future investigation. Finally, psychological outcomes were measured in an online survey and defined by symptom scales rather than clinical diagnosis.

5. Conclusion

More than half of college students were willing to receive the COVID-19 vaccine, while nearly one-third of college students were still on the sidelines of vaccine uptake at the early stage of vaccination in China. The distrust towards efficacy and safety of vaccine was the main reason for vaccine resistance in college students. Therefore, measures such as providing sufficient and scientific information on the COVID-19 vaccine, promoting unbiased information dissemination and propaganda are crucial for the effective promotion of the COVID-19 vaccine. The findings provide a comprehensive profile of the willingness of COVID-19 vaccine in college students in China and may contribute to develop population-specific management and intervention strategies to improve the acceptance of the COVID-19 vaccine.

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Author Contributors

Lu L, Bao Y, and Jiang ZD designed the protocol, provided the conceptualization and funding acquisition. Liu L, Zhao YM, Zeng N, Guo SH, Lu Y, and Shi J were involved in data curation and

investigation. Lu L, Bao Y, and Jiang ZD were the project administrations and supervision. Zhu XM made the formal analysis. Bao Y and Yan W made validation of the data analysis. Zhu XM made the visualization and drafted the original manuscript; Bao Y, Gong YM, Que JY, Ran MS, Wong SYS, Yan W, Sun J, Sun YK, Sun SW, Yuan K, Shi L, and Lu L revised and edited the manuscript. All the authors have read and approved the final version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2022.04.013>.

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