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Impact of prior SARS-CoV-2 infection on college students' hesitancy to receive additional COVID-19 vaccine booster doses: A study from Taizhou, China

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ABSTRACT

Purpose: This study aimed to examine the impact of a history of SARS-CoV-2 infection on the hesitancy of college students to receive additional COVID-19 vaccine booster doses.

Methods: A population-based self-administered online survey was conducted in July 2024 in Taizhou, China. A total of 792 respondents were included in this study. Logistic regression was conducted to identify factors associated with college students' hesitation to receive booster doses of the COVID-19 vaccine.

Results: Of 792 respondents, 32.2 % hesitated to receive additional doses of the COVID-19 vaccine booster. Furthermore, 23.5 % of the respondents reported an increase in hesitancy to receiving additional COVID-19 vaccine booster doses compared to before they were infected with SARS-CoV-2. In the regression analyses, college students who had a secondary infection were more hesitant to receive additional COVID-19 vaccine booster doses (OR = 0.481, 95 % CI: (0.299–0.774), P = 0.003). Moreover, students with secondary infections who were male (OR = 0.417, 95 % CI: 0.221–0.784, P = 0.007), with lower than a bachelor's degree (OR = 0.471, 95 % CI: 0.272–0.815, P = 0.007), in non-medical majors (OR = 0.460, 95 % CI: 0.248–0.856, P = 0.014), and sophomores or below (OR = 0.483, 95 % CI: 0.286–0.817, P = 0.007) were more hesitant to receive additional COVID-19 vaccine booster doses.

Conclusion: A history of SARS-CoV-2 infection affects college students' hesitation to receive additional COVID-19 vaccine booster doses, which was higher in those who experienced secondary infections.

1. Introduction

Vaccines are the most effective means of treating infectious diseases (Abbas et al., 2020; Jentsch et al., 2021). In the face of the sudden outbreak of the coronavirus disease 2019 (COVID-19), COVID-19 vaccination played an active role in reducing serious illness and death from SARS-CoV-2 infections (Mohamed et al., 2022). However, despite the success of vaccination, several people still have doubts and concerns regarding vaccination and delay or refuse it, a phenomenon known as vaccine hesitancy (Dubé et al., 2014; Yaqub et al., 2014). Moreover, vaccine hesitancy has been ranked as one of the top ten global health threats, potentially undoing all historic achievements made in reducing the global burden of vaccine-preventable diseases and jeopardizing the global health system (Kumar et al., 2021; The Lancet Child Adolescent Health, 2019). Hesitancy extends across different vaccines, including the COVID-19 vaccine (Mangla et al., 2021). In China, although COVID-19 vaccine coverage is high, some people are hesitant about getting vaccinated (Liu and Kuang, 2023; Yang et al., 2019). Therefore, it is necessary to explore the factors affecting COVID-19 vaccine hesitancy in China in different contexts.

Abbreviations: COVID-19, the coronavirus disease 2019; WHO, The World Health Organization.

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SARS-CoV-2 is evolving and, in response to emerging variants and the vaccine immune protection getting weaker over time, the WHO has further emphasized the importance of receiving additional COVID-19 vaccine booster doses (Qin et al., 2022). Booster doses notably reduce the chances of hospitalization or death owing to breakthrough infections in individuals who have completed basic COVID-19 vaccine immunizations (Patalon et al., 2022). On April 6, 2023, China released the latest COVID-19 vaccination program, which divided the target population for COVID-19 vaccination into infected and uninfected populations, creating a gap in immunity levels for different target populations (National Health Commission of the People's Republic of China, 2023). However, some individuals who have completed basic COVID-19 vaccine immunization have a negative attitude towards booster vaccinations (Paul et al., 2021). The willingness of the population to be vaccinated with additional booster doses of the COVID-19 vaccine is associated with many factors, such as age, level of education, history of SARS-CoV-2 infection, presence of chronic diseases, and concerns about the side effects of booster doses of COVID-19 vaccine (Abdelmoneim et al., 2022; Galanis et al., 2022). Several studies have indicated that SARS-CoV-2 infection affects the attitude of individuals towards the COVID-19 booster vaccination, with a high uncertainty regarding vaccine acceptance (Limbu and Huhmann, 2023; Paul et al., 2021). Since December 2022, China has adjusted its management measures for the COVID-19 outbreak, followed by a surge in infections caused by the Omicron sublines BA.5.2 and BF.7 (Ge et al., 2023). Similar to other vaccination programs, periodic or seasonal booster doses of the COVID-19 vaccine may be necessary to counteract the declining immune protection and provide protection against emerging viral variants (Stamm et al., 2023). This implies that the COVID-19 vaccine can be included in the national non-expanded program on immunization (non-EPI). Previous studies have shown that the rate of non-EPI vaccines in China is extremely low. For example, in the general population of China, the influenza vaccination rate is only 1.9 % (Deng et al., 2021; Liu et al., 2021; J. Yang et al., 2016; Zhang et al., 2018). Although an individual's perception of infection risk varies with the environment, significant congruence exists between risk perception and vaccination behavior (Caserotti et al., 2021; Ebrahimi et al., 2021; Peng and Bai, 2024). Thus, the newly developed nature of the COVID-19 pandemic may have impacted vaccine hesitancy.

College students are a special group: first, they are more active on the Internet and social media and are prone to passing wrong information to others; second, the willingness to vaccinate against COVID-19 may be the first time college students have made a medical decision independently, and the experience of the decision can influence their subsequent medical decisions; third, the environment of intensive interactions on campus can be a source of community outbreaks and the transmission of infectious diseases (Caleb et al., 2022; Ryan et al., 2019; Silva et al., 2021). Hence, we must highlight university students' societal roles, understand their public health attitudes, and enhance their coping skills. Therefore, this study aimed to examine the impact of a history of SARS-CoV-2 infection on college students' hesitance to receive additional COVID-19 booster doses.

2. Methods

2.1. Study design and data collection

This cross-sectional study was conducted from July 20, 2023, to August 7, 2023. The study participants were students from two colleges in Taizhou, China, and the WeChat-incorporated Wen-Juan-Xing platform was used as the survey platform. A total of 1,071 participants were invited to complete the survey. For the convenience of research conduct, this study was conducted using a convenience sampling method. The researchers shared the questionnaires with WeChat groups from their respective departments. The selected participants were informed that the survey was voluntary and that there were no correct or incorrect answers. The participants voluntarily accessed and completed a self-help questionnaire by scanning a QR code linked to an online questionnaire.

The sample size was determined using G*Power software (v3.1.9.2; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) (Cohen, 1992; Kang, 2021). We used two-sided testing with an odds ratio of 2, Pr $(Y = 1 \mid X = 1) = 0.1$, $a = 0.05$, power $= 0.95$, and R^2 of the other independent variables $(X) = 0.5$. The minimum sample size was 573. Considering the 20 % invalid questionnaires, the theoretical sample size required is therefore a total of 688. A total of 792 participants were enrolled in this study. A logical check was performed, and outliers were eliminated before data analysis. The average response time for the survey was 258 s. The time taken to complete the questionnaire was converted logarithmically, and if it exceeded mean $\pm$ 3 SD, it was considered an outlier and was also excluded from the analysis. Hence, 1,043 of the 1,071 healthcare workers who completed and submitted questionnaires (response rate = 97.4 %) were included. We excluded college students who completed two booster doses of the COVID-19 vaccine, leaving 792 individuals for our study. The sample selection flowchart is presented in Fig. 1.

This study was approved by the Ethics Committee of Taizhou Hospital, Zhejiang Province, China (approval number: K20230716). All procedures were performed in accordance with the guidelines of our institutional ethics committee and in compliance with the Declaration of Helsinki. Interviewees' information remained anonymous.

2.2. Structured questionnaires and measurements

Data were collected using a self-administered questionnaire. This included participants'basic demographic information, SARS-CoV-2 infection, and their hesitancy to be vaccinated with additional COVID-19 vaccine booster doses.

2.2.1. Demographic characteristics

The demographic data included sex, education level, specialty, allergy history, underlying disease, grade, and COVID-19 vaccination and SARS-CoV-2 infection status.

2.2.2. SARS-CoV-2 infection

Participants were asked "How infected are you with SARS-CoV-2?" (Answers: no infection, first infection, and second infection).

2.2.3. Respondents' hesitancy to be vaccinated with additional COVID-19 vaccine booster doses

The questionnaire was based on a previous study that assessed vaccine hesitancy (Table 1) (Xu et al., 2023). Participants were asked "Do you hesitate to receive an additional COVID-19 vaccine booster dose in the current situation? (Answers: Yes, No). Additionally, participants were asked, "Changes in the current level of hesitancy to receive additional booster doses of COVID-19 vaccine compared to infection with SARS-CoV-2" (decrease in the level of hesitation, no significant change, and increase in the level of hesitation).

2.3. Statistical analysis

The primary outcome of this investigation was the impact of a history of SARS-CoV-2 infection on college students' hesitancy to be vaccinated with additional booster doses of COVID-19. General demographic characteristics and hesitation to receive additional booster doses of the COVID-19 vaccine were described using the proportion of the composition (n [%]). A chi-square test was used to assess potential factors associated with hesitation to vaccinate college students with additional booster doses of the COVID-19 vaccine. Logistic regression analysis was used to explore the factors associated with college students' hesitance to receive additional COVID-19 vaccine booster doses.

A binary logistic regression analysis was performed to determine the effect of a history of SARS-CoV-2 infection on the hesitancy to vaccinate

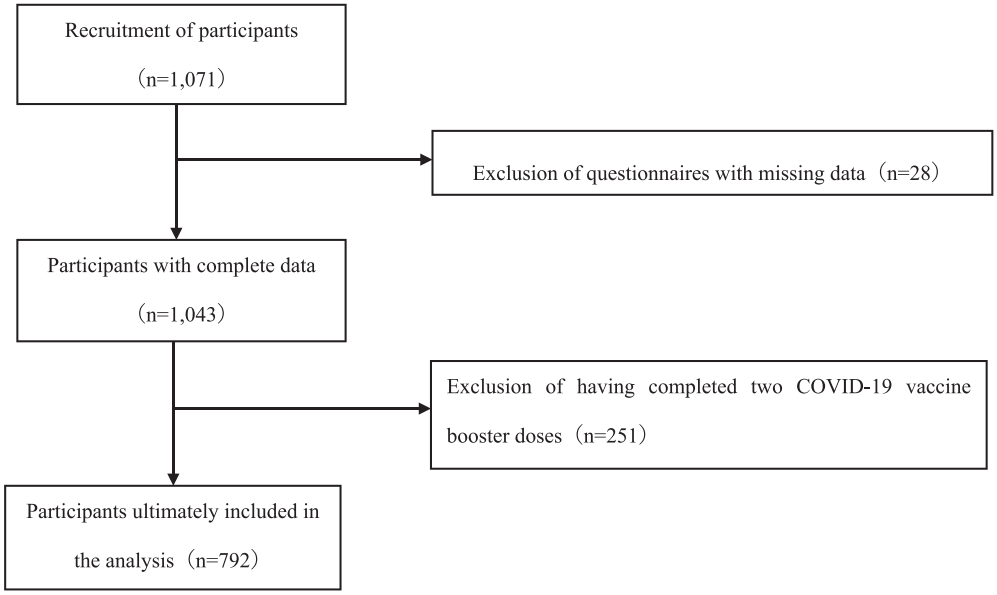

Fig. 1. Sample Selection Flowchart.

Table 1
Measurement of variables.

Variables	Definition.	Coding
Impact (Allweiss et al., 2021; Cook et al., 2020)	A variety of changes in the people associated with the research and within systemic areas of a complex sociological system that arise throughout the research process and continue to play a role after the research is completed.	Continuous variable
Booster dose (WHO, 2021)	Booster dose is defined as an additional dose of vaccine after completion of the primary vaccination series.	0, unvaccinated 1, vaccinated
Hesitant (Kaufman et al., 2015)	Hesitation is defined as the inability of people to make timely decisions.	0, Yes 1, No

college students with additional booster doses of the COVID-19 vaccine, and odds ratios (OR) and 95 % confidence intervals (CI) were calculated. Statistical significance was set at $P < 0.05$, using IBM SPSS statistical software.

2.4. Literature search strategy

We searched the literature related to hesitation against booster doses of COVID-19 vaccine after SARS-CoV-2 infection through PubMed for terms such as "SARS-CoV-2 infection," "COVID-19," "booster doses," "vaccine hesitancy," and other related terms. After reading the titles and abstracts, ten articles were selected. The following data were extracted from the included studies using a data extraction form: first author, publication date, sample size, and prevalence of hesitation in boosting doses of the COVID-19 vaccine after SARS-CoV-2 infection.

3. Results

In this study, 1,071 respondents were invited to complete the questionnaire, and 792 were included in the sample selection flowchart. As listed in Table 2, of the 792 respondents, 51.4 % were male, 69.4 % had a bachelor's degree or lower, 83.8 % were in their sophomore year or lower, and 46.3 % were majoring in a medical specialty. Among the respondents, 50.4 % indicated that they had received three COVID-19 vaccine doses and 32.2 % were hesitant to receive additional COVID-19 vaccine booster doses. Over one-third (32.0 %) of respondents infected with primary SARS-CoV-2 were hesitant to receive additional booster doses of the COVID-19 vaccine. Among respondents with secondary SARS-CoV-2 infection, 42.4 % were hesitant to receive additional booster doses of the COVID-19 vaccine. Furthermore, compared to before being infected with SARS-CoV-2, 23.5 % of the respondents reported an increase in hesitancy to receive additional COVID-19 vaccine booster doses (Fig. 2).

We further analyzed the extent to which these factors were associated with college students' hesitancy to receive additional COVID-19 vaccine boosters using binary logistic regression models. As shown in Table 2, secondary SARS-CoV-2 infection among college students was associated with hesitancy to receive additional COVID-19 vaccine boosters (OR = 0.481, 95 % CI: 0.299–0.774, P = 0.004).

Additionally, we developed a multivariate logistic regression model with different stratifications based on sex, grade, major, and education. As shown in Table 3, we found that the results of more hesitancy to receive additional booster doses of COVID-19 vaccine among students with experience of secondary SARS-CoV-2 infections were also reflected in males (OR = 0.417, 95 % CI: 0.221–0.784, P = 0.007), students enrolled in undergraduate degrees (OR = 0.471, 95 % CI: 0.272–0.815, P = 0.007), those in non-medical fields (OR = 0.460, 95 % CI: 0.248–0.856, P = 0.014), and those in sophomore and younger grades (OR = 0.483, 95 % CI: 0.286–0.817, P = 0.007).

4. Discussion

Vaccine hesitancy can have far-reaching effects on the society (Dubé et al., 2014). Table 4 shows the prevalence of hesitation in boosting the dose of the COVID-19 vaccine after SARS-CoV-2 infection in different populations. According to Table 4, the overall prevalence of hesitancy to receive additional boosters of the COVID-19 vaccine ranged from 4.4 % to 57.3 % and from 0.6 % to 56.6 % in respondents who were infected with SARS-CoV-2. These studies show that vaccine hesitancy exists in different countries and populations. They emphasize that hesitancy to administer COVID-19 booster doses exacerbates the current COVID-19 pandemic and that vaccine hesitancy fluctuates between different points in time and waves of the pandemic; thus, addressing vaccine hesitancy would benefit the current COVID-19 epidemic and future crises (Galanis et al., 2023; Lounis et al., 2022; Noh et al., 2022; Takamatsu et al., 2023).

In this study, we investigated the effects of a history of SARS-CoV-2

Table 2
Binary logistic regression analysis of factors associated with hesitation to administer additional booster shots of the COVID-19 vaccine to tertiary students (n = 792).

Independent Variables	Categories	Total Sample, n (%)	Hesitation for additional booster doses of COVID-19 vaccine		OR	P
			Hesitation, n(%)	No hesitation, n(%)		
		792(100.0)	255 (32.2)	537 (67.8)		
Sex	Male	407(51.4)	139 (34.2)	268 (65.8)	0.824(0.577–1.176)	0.286
	Female	385(48.6)	116 (30.1)	269 (69.9)		
Education level	Below bachelor's degree	550(69.4)	181 (32.9)	269 (67.1)	1.057(0.672–1.663)	0.811
	Undergraduate and above	242(30.6)	74 (30.6)	168 (69.4)		
Allergy history	Yes	183(23.1)	59 (32.2)	124 (67.8)	1.041(0.720–1.505)	0.829
	No	609(76.9)	196 (32.2)	413 (67.8)		
Underlying disease	Yes	44(5.6)	19 (43.2)	25 (56.8)	0.703(0.370–1.334)	0.281
	No	748(94.4)	236 (31.6)	512 (68.4)		
Specializations studied	Medical specialty	367(46.3)	110 (30.0)	257 (70.0)	1.161(0.751–1.796)	0.501
	Non-medical specialty	425(53.7)	145 (34.1)	280 (65.9)		
Grade	Sophomore and below	664(83.8)	200 (30.1)	464 (69.9)	0.577(0.381–0.874)	**0.009**
	Junior and above	128(16.2)	55 (43.0)	73 (57.0)		
Exercise habit	Yes	479(60.5)	140 (29.2)	339 (70.8)	1.426(1.033–1.968)	**0.031**
	No	313(39.5)	115 (36.7)	198 (63.3)		
Status of COVID-19 vaccination	No	16(2.0)	6 (37.5)	10 (62.5)	/	/
	A dose	41(5.2)	14 (34.1)	27 (65.9)	1.278(0.375–4.357)	0.695
	Two doses	336(42.4)	126 (37.5)	210 (62.5)	1.035(0.359–2.981)	0.950
	Three doses	399(50.4)	109 (27.3)	290 (72.7)	1.766(0.612–5.091)	0.293
Status of SARS-CoV-2 infection	No infection	246(31.1)	68(27.6)	178(72.4)	/	/
	First infection	428(54.0)	137 (32.0)	291 (68.0)	0.767(0.536–1.096)	0.146
	Second infection	118(14.9)	50 (42.4)	68 (57.6)	0.481(0.299–0.774)	**0.003**

Note 1) p-value for the Hosmer–Lemeshow test = 0.403.
Note 2) Statistical significance was set at $P < 0.05$.

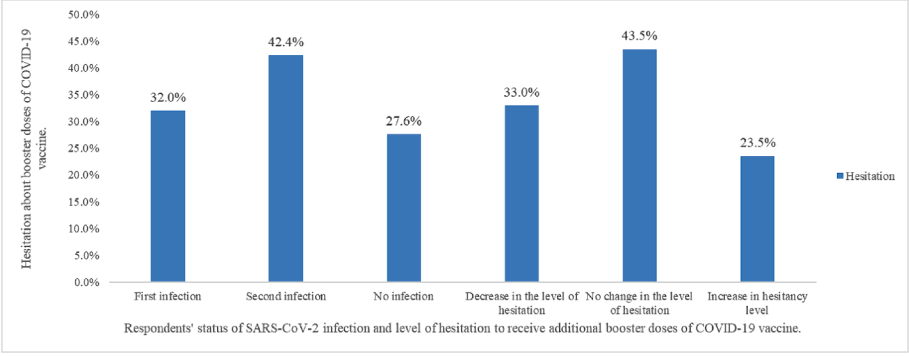

Fig. 2. Hesitation between the number of prior SARS-CoV-2 infections and additional booster doses of COVID-9 vaccination.

infection on college students' hesitance to receive additional SARS-CoV-2 vaccine booster doses. We found that students with secondary infections were more hesitant to receive additional COVID-19 vaccine booster doses (42.4 % prevalence). Male students with less than a bachelor's degree, non-medical majors, and sophomores or younger who had experienced secondary infections were more hesitant to receive additional COVID-19 vaccine booster doses. Additionally, we found that 23.5 % of the students reported increased hesitancy to receive additional COVID-19 vaccine booster doses compared to before being infected with SARS-CoV-2.

One study found that respondents believed they had acquired natural immunity after infection and did not require booster doses (Rzymski et al., 2021). Additionally, expected regret is an important factor influencing vaccination, and people's misperceptions about the safety and efficacy of the COVID-19 vaccine and the state of pandemic development after infection with SARS-CoV-2 increase their expected regret for COVID-19 vaccination; therefore, they are unwilling to receive booster vaccines (Luo et al., 2022; Wong and Yang, 2022). However, in the context of this study, there may be other reasons. First, the spread of the pandemic and human behavior are fundamentally interactive and intertwined (Hong et al., 2023). From one standpoint, a sudden outbreak can prompt people to take precautionary measures, including vaccination, wearing masks, keeping a distance, etc.; Alternatively, the precautionary measures adopted by individuals can, to a certain extent, contribute to containing the outbreak development. However, as the pandemic continues, interest in maintaining safety measures will be exhausted, leading to a reduction in preventive behaviors (e.g., booster vaccinations), a phenomenon known as "pandemic fatigue," and individual fatigue from the epidemic may substantially increase over time (Bendezu-Quispe et al., 2022; Delussu et al., 2022; Jørgensen et al., 2022). As a result, individuals faced a 3-year COVID-19 pandemic and experienced increased fatigue, which led to a decrease in their motivation to receive additional COVID-19 vaccine booster doses. Second, according to psychological immunity theory, repeated exposure to stressful events can numb the ego, thereby raising its perception threshold (Jinshan, 2023; Lewitus and Schwartz, 2009). This may explain why people are hesitant to receive additional COVID-19 vaccine booster doses after a second infection with the virus. When people experience multiple SARS-CoV-2 infections, their perceived threshold for the danger of an outbreak is elevated, which reduces their perceived risk of an outbreak and subsequently leads to hesitation in receiving additional COVID-19 vaccine booster shots. Moreover, the fact that the outbreak plateaued at the time of the second infection compared with the first COVID-19 infection led to a decrease in the perceived risk of a

Table 3
Associations between low ontological insecurity and the behavior of recommending COVID-19 vaccines to anyone in different models.

Model	Stratification	Categories	P	OR	95 %CI
1	Total	Second infection vs. No infection	0.003	0.481	0.299–0.774
2	Men	Second infection vs. No infection	0.007	0.417	0.221–0.784
	Women	Second infection vs. No infection	0.105	0.536	0.252–1.138
3	Below bachelor's degree	Second infection vs. No infection	0.007	0.471	0.272–0.815
	Undergraduate and above	Second infection vs. No infection	0.264	0.563	0.206–1.543
4	Medical specialty	Second infection vs. No infection	0.088	0.511	0.237–1.105
	Non-medical specialty	Second infection vs. No infection	0.014	0.460	0.248–0.856
5	Sophomore and below	Second infection vs. No infection	0.007	0.483	0.286–0.817
	Junior and above	Second infection vs. No infection	0.309	0.538	0.163–1.776

Model 1: Adjusted for sex, education, profession, grade, exercise habits, history of allergies, chronic diseases, and self-vaccination status.
Model 2: Adjusted for education, allergy history, underlying disease, specialty, grade, exercise habits, and self-vaccination status.
Model 3: Adjusted for sex, allergy history, specialty, grade, underlying disease, exercise habits, and self-vaccination status.
Model 4: Adjusted for sex, education, allergy history, grade, underlying disease, exercise habits, and self-vaccination status.
Model 5: Adjusted for sex, education, allergy history, underlying disease, specialty, exercise habits, and self-vaccination status.
Bold values indicate $P < 0.05$, which was considered statistically significant.

COVID-19 outbreak, which may have influenced the decision to receive additional COVID-19 vaccine booster doses (Giampaolo, 2021).

Sex differences are complex (Gustafson, 1998). Previous studies have shown that men are hesitant to receive the COVID-19 vaccine (Kerr et al., 2021; Mascherini and Nivakoski, 2022; Moore et al., 2021; Price et al., 2021; Seale et al., 2021). Although attitude is a major predictor of behavior, when men are more hesitant about receiving a COVID-19 vaccine booster, they are less likely to receive it (Ajzen, 1980, 1985). These findings suggest that public health departments should examine the role of male college students in addressing vaccine hesitance. We observed hesitance to receive additional COVID-19 vaccine booster doses after experiencing secondary infections among students with less than an undergraduate degree, non-medical majors, and sophomores or younger students. Individuals with lower educational levels also have lower compliance with COVID-19 precautions (Rattay et al., 2021). They may be less focused on personal health care and maintaining good lifestyle habits and, therefore, are less inclined to adopt health-promoting behaviors (Long et al., 2020). Therefore, schools should focus on cultivating university students' health literacy. It is feasible for schools to actively provide health courses for students, and such a measure can enable them to acquire the skills needed to enhance their health literacy so that they can make informed judgments when facing health decisions (Ickes and Cottrell, 2010).

Factors influencing vaccine hesitancy are complex and include environmental, cultural, personal, and social factors (Ramanadhan et al., 2015). Individuals who are hesitant to vaccinate are more likely to seek and engage with information about vaccines and are more likely to change their attitudes and behaviors; therefore, exploring and addressing vaccine hesitancy is essential for promoting mass vaccination (Leask, 2011). Our study found that 23.5 % of students reported increased hesitancy to receive additional COVID-19 vaccine booster doses compared to before getting infected with SARS-CoV-2, suggesting that the willingness of individuals to adopt self-protective behaviors is not constant but is dependent on the severity of the outbreak (Ge et al., 2023; Silva et al., 2023).

As societies return to a "business-as-usual" lifestyle, increased mobility and social contact can lead to the development of epidemics, and as government-imposed restrictions are lifted, spontaneous behavioral responses by individuals become fundamental to the response to a pandemic (Lehto et al., 2004; Wang et al., 2022). Although past experiences can directly predict future behavior, experiencing SARS-CoV-2

Table 4
Prevalence of hesitation to receive additional booster doses of COVID-19 vaccine after SARS-CoV-2 infection in different populations.

First author	Date of publication	Type of research	Sample size	Country	Prevalence of vaccine hesitancy
(Arshad et al., 2022)	17-Oct-22	Cross-sectional study	1164	Pakistan	Total: 24.2 %; Infected: 18.4 %; Uninfected: 25.9 %
(Lounis et al., 2022)	15-Apr-22	Cross-sectional study	787	Algeria	Total: 23.4 %; Infected: 22.4 %; Uninfected: 25.3 %
(Dziedzic et al., 2022)	25-Jul-22	Cross-sectional study	443	Poland	Total: 7.9 %; Infected: 9.9 %; Uninfected: 7 %
(Klugar et al., 2021)	6-Dec-21	Cross-sectional study	3454	Czechia	Total: 12.2 %; Infected: 16.3 %; Uninfected: 10.2 %
(Kheil et al., 2022)	14-Apr-22	Cross-sectional study	1746	United States	Total: 6.7 %; Infected: 12.8 %; Uninfected: 4.1 %
(Brandt et al., 2023)	30-Mar-23	Cross-sectional study	770	United States	Total: 23.5 %; Infected: 7.3 %; Uninfected: 92.7 %
(Park et al., 2023)	22-Sep-23	Cross-sectional study	43,100	United States	Respondents with children < 5: 57.4 %(total); 56.6 % (infected); 56.9 %(Infected) Respondents with children 5 ~ 11: 43.3 % (total); 42.6 % (infected); 43.0 %(Infected) Respondents with children 12 ~ 17: 25.9 % (total); 26.3 % (infected); 24.2 %(Infected)
(Noh et al., 2022)	22-Jul-22	Cross-sectional study	2,993	Korea	Total: 48.8 %; Infection: 0.6 %; Parental: 65.8 % (total); 0.7 % (infection)
(Attia et al., 2022)	7-Apr-22	Cross-sectional study	930	German	Total: 4.4 %; Infected: 12.7 %; Uninfected: 3.9 %
(Zhang et al., 2023)	23-Nov-23	Cross-sectional study	5805	China	Total: 42.2 %; Infected: 48.1 %; Uninfected: 38.6 %

infection affects people's perceptions of the COVID-19 vaccine and outbreak, which, in turn, affects their willingness to be vaccinated (Glasman and Albarracín, 2006; Sapienza and Falcone, 2022). Therefore, public health departments should collaborate with news organizations to communicate information on the safety and efficacy of vaccines and the development of outbreaks in order to broaden the dissemination of information (Steffens et al., 2022). Additionally, scientists and medical practitioners, as the most reliable sources of information, should be encouraged to share more details of the existing safety-monitoring processes and highlight the number of vaccinated people and relevant safety data globally, which should be presented in a way that is easily understood by the public (Haktanir et al., 2022). Additionally, vaccination is a preventive and self-care measure that not only helps alleviate the level of pandemic fatigue but also empowers college students to make their own decisions, which can maximize their autonomy in making healthcare decisions and allow them to make decisions based on their own professional judgment without interference from external factors (da Costa et al., 2013; Martínez et al., 2021; Zhong and Xie, 2023). The role of improving college students' self-care skills is not limited to the current pandemic but also plays a vital role in maintaining their own and their families' health in the future and is a cost-effective measure (Brouwer et al., 2021; Moses et al., 2016; Zhong and Xie, 2023).

This study was conducted in the context of a new outbreak prevention and control policy to investigate the impact of a history of SARS-CoV-2 infection on college students' hesitance to receive additional COVID-19 vaccine booster doses. However, this study has some limitations. First, this study is a cross-sectional study, which can only represent the situation of students' vaccine hesitancy in a certain period of time and lacks observation of their dynamics. Second, we used questionnaires, and errors between the results and the real situation might have occurred; therefore, we need to use a combination of multiple survey methods in future studies. Third, we were unable to determine the timing of secondary infections and the specific views of the affected students on vaccination after secondary infections, which also affects their hesitation. Fourth, direct questioning was used to ascertain whether vaccine hesitancy was present and no scale was used to assess the degree of vaccine hesitancy, which may not have provided a comprehensive understanding of vaccine hesitancy. Finally, our sample was not generated by random sampling; the questionnaire was completed voluntarily by college students, implying self-selection bias.

5. Conclusion

The current study found that college students with secondary SARS-CoV-2 infections were hesitant to receive additional COVID-19 vaccine booster doses. Under the new situation of the COVID-19 pandemic, targeted education for college students will help improve COVID-19 vaccine coverage.

CRediT authorship contribution statement

Jing-Shan Deng: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Chun-Lian Huang:** Methodology, Conceptualization. **Qiong-Ying Hu:** Investigation, Conceptualization. **Lei Shi:** Investigation, Conceptualization. **Xiao-Ying Chen:** Writing – review & editing. **Xu Luo:** Methodology. **Tao-Hsin Tung:** Writing – review & editing, Supervision, Methodology, Formal analysis, Conceptualization. **Jian-Sheng Zhu:** Writing – review & editing, Supervision, Methodology, Formal analysis, Conceptualization.

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.

Data availability

Data will be made available on request.

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Ethical declaration

This study was approved by the Ethics Committee of Taizhou Hospital, Zhejiang Province (approval number: K20230716). All strategies were conducted in accordance with the guidelines of the Institutional Ethics Committee and adhered to the Declaration of Helsinki, and all participant data were anonymized. Ethics Committee of Taizhou Hospital, Zhejiang Province waived informed consent from participants.

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