

RESEARCH PAPER

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The association between social media use and hesitancy toward COVID-19 vaccine booster shots in China: A web-based cross-sectional survey

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ABSTRACT

COVID-19 vaccine booster shots are necessary to provide durable immunity and stronger protection against the emerging SARS-CoV-2 variants. As a major platform for access to information, social media plays an important role in disseminating health information. This study aimed to evaluate hesitancy toward COVID-19 vaccine booster shots in China, assess its association with social media use, and provide information to manage social media. We conducted a cross-sectional study across all 31 provinces in mainland China from November 12, 2021, to November 17, 2021. In total, 3,119 of 3,242 participants completed the questionnaire (response rate = 96.2%). COVID-19 vaccine booster shot hesitancy rate in China was 6.5% (95% CI: 5.6–7.3). Unemployment (adjusted odds ratio [aOR] 2.428, 95% CI: 1.590–3.670), low monthly income (aOR 2.854, 95% CI: 1.561–5.281), low scores of knowledge (aOR 0.917, 95% CI: 0.869–0.968) and low level of cues to action (aOR 0.773, 95% CI: 0.689–0.869) were associated with vaccine hesitancy. Compared with public social media, lower vaccine hesitancy was associated with high perceived importance of social media (aOR 0.252, 95% CI: 0.146–0.445) and official social media use (aOR 0.671, 95% CI: 0.467–0.954), while higher vaccine hesitancy was associated with traditional media use (aOR 3.718, 95% CI: 1.282–10.273). More efforts are needed to regulate the content of social media and filtering out misinformation. The role of official social media in disseminating health information should be enhanced.

ARTICLE HISTORY

Received 2 February 2022
Revised 28 March 2022
Accepted 8 April 2022

KEYWORDS

Social media; COVID-19; vaccine hesitancy; booster shot; third dose

Introduction





Safe and effective vaccines are imperative to prevent COVID-19, but widespread vaccination leading to herd immunity is necessary to effectively curtail the pandemic. In addition, studies have shown that protection against the coronavirus and the ability to prevent infection with variants may decrease over time due to the emergence of variants of concern, which highlights the importance of booster shots to strengthen the vaccine-induced immunity and reduce the burden to the health care system.^{1–3}


In August 2021, a Chinese expert group reported data on the safety and efficacy of COVID-19 booster shots, and suggested that high-risk populations should be prioritized for booster shots. In September, the Joint Prevention and Control Mechanism of the State Council in China announced that new regulations about booster shots were in progress; more than one-third of the provinces had launched a vaccination campaign. Up to November 2021, all 31 provinces in China had initiated booster vaccination. According to the latest official statistics, about 46% of the population in mainland China had received booster shots by 18 March 2022.

Delay in acceptance or refusal of the available vaccines, known as “vaccine hesitancy”,⁴ is a threat to the progress of vaccination programs and one of the top 10 threats to global

health in 2019 listed by WHO.⁵ The existing literature has reported many factors that contribute to vaccine hesitancy including the concerns of the safety and effectiveness of rapidly-developed vaccines,⁶ lack of knowledge about diseases and vaccines,⁷ and lack of recommendations from medical personnel.⁷ However, the role of social media has been relatively neglected. As sources of information and platforms to spread health information, social media influence people’s attitudes toward vaccination and could be used as tools for public health interventions.^{8–10} During COVID-19 pandemic, especially in the period of social distancing and quarantine, people depended on social media to contact each other and acquire information.¹¹ On the one hand, their knowledge about COVID-19 and vaccines increases, which may alleviate people’s vaccine hesitancy. On the other hand, misinformation and rumors regarding COVID-19 vaccines may intensify and hinders people’s vaccination. Given the suboptimal global epidemic situation of emerging variants with high infectivity, policymakers must address people’s refusal to receive vaccine booster shots and ensure equity.

In the global COVID-19 pandemic with viruses constantly mutating, social media plays a more important role than ever in disseminating vaccine-related health information and promoting vaccination, which highlights the importance of

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 Supplemental data for this article can be accessed on the publisher’s website at <https://doi.org/10.1080/21645515.2022.2065167>

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seeking the association between social media use and vaccine hesitancy toward COVID-19 vaccine booster shots. However, studies about this topic are relatively lacking. Hence, we conducted a national wide cross-sectional online survey in China to understand better the association between social media use and vaccine hesitancy. This study could provide guidance for effective vaccination strategy to address vaccine hesitancy, establish vaccine confidence, and promote vaccination on a large scale.

Materials and methods

Study design

This study was a nationwide anonymous cross-sectional survey using a stratified random sampling method. It was conducted via an online survey company: Wen Juan Xing (Changsha Ranxing Information Technology Co., Ltd., Hunan, China). Wen Juan Xing is a specialized data science company with a personal information database (e.g., age, gender, and residence) from over 2.6 million Chinese residents. It allows research teams to distribute questionnaires online, and recruit target participants to fill in the questionnaires in accordance with the selected sampling method. In recent years, Wen Juan Xing has been used in many studies to assemble a representative sample and conduct a cross-sectional online survey.¹²⁻¹⁴

Sampling size estimation

The PASS software 15.0 (NCSS LLC., Kaysville, U.T., USA) was used to calculate the sample size. According to previous studies, the rate of COVID-19 vaccine hesitancy was 15%.¹⁵ Considering that the rate of COVID-19 vaccine hesitancy was 15% ($p = .15$), the alpha was set as 0.05, the confidence interval width as 0.1p (.015), and the sample size was 2,242 when using the exact (Clopper-Pearson) method for calculation. Considering that there would be invalid questionnaires, we set the sample size at the level of at least 3,000.

Sampling

We used a stratified random sampling method to select and recruit participants. First, we collected the local population of each of the 31 provinces in mainland China according to the China Statistical Yearbook, 2021.¹⁶ Then, the sample size in each province was calculated in proportion to the local population. Third, participants in each province were randomly selected in the Wen Juan Xing sample database according to the required sample size. The inclusion criteria were: 1) people who lived in mainland China; 2) people who completed their personal information in their Wenjuanxing accounts; 3) people who completed the survey during 12 November 2021 to 17 November 2021; and 4) people who agreed to participate in the study.

The study was approved by the Ethical Committee of Peking University Third Hospital and conducted according to the Helsinki Declaration (IRB00006761-M2020528). A cover letter was presented above the questions, so that all participants were

informed of the aim of the study. Furthermore, all participants provided electronic informed consent by choosing 'I agree to participate'.

Questionnaire design

This self-administered questionnaire consisted of the following sections: 1) sociodemographic characteristics, 2) social media use, 3) knowledge on COVID-19 and vaccines, 4) attitude toward COVID-19 vaccine booster shots, and 5) health belief model (HBM).

Sociodemographic characteristics included region, sex, age group, education, occupation, marital status, monthly income and history of chronic diseases (cardiovascular disease, cancer, diabetes, hypertension, or respiratory diseases).

The use of social media was evaluated by the time spent on social media per day, perceived importance of social media in influencing attitudes about COVID-19 vaccine booster shots (unimportant, moderate, important, very important), and the type of social media used to acquire information (official social media, professional social media, and public social media).¹⁷ Official social media (e.g., People Daily, CCTV news) represent the voice of the government and authorities. Professional social media provide scientific medical knowledge about COVID-19 and vaccines. Public social media (e.g., TikTok, WeChat, Weibo) could produce individuals' news and disseminate news to society. Those who used traditional media or acquired information from their friends and family members were also considered.

Questions regarding knowledge on COVID-19 and vaccines included: source of infection (confirmed patients/asymptomatic patients, 2 points), susceptible population (all people are susceptible/not all people are susceptible, 1 point), common symptoms (cough/fever/sore throat/chest pain/ . . . , 3 points), high-risk population for severe illness and death (people aged above 65 years/heavy smokers/pregnant women/ . . . , 6 points), individual preventive measures for infection (wear masks/perform physical activity/wash hands/ . . . , 5 points), policies about COVID-19 booster vaccination (free of charge/the interval between the two vaccinations is at least 6 months, 2 points), and the decrease of protection over time after vaccination (yes/no, 1 point). More than one answer was possible. The participants received one score for each correct answer. Otherwise they receive zero score. The total knowledge scores ranged from 0 to 19. The higher the scores were, the more knowledge participants had.

Attitudes toward COVID-19 vaccine booster shots were reflected by the answers to the following question: "Are you willing to receive COVID-19 vaccine booster shots if they are available?" Participants showed vaccine hesitancy if they answered, "No or Not sure."

One of the conceptual frameworks that has been widely used to evaluate the attitudes toward vaccines and predict vaccination behavior is the HBM.^{18,19} It was constructed based on the assumption that people tend to adopt disease prevention behaviors (e.g., vaccination) if they perceive that they are susceptible to the disease, the disease is severe, the prevention behavior is beneficial, barriers are minimal, or if they have received recommendations from family members or

health care workers.²⁰ Thirteen HBM questions were developed and were divided into five dimensions (perceived susceptibility, perceived severity, perceived benefit, perceived barriers, and cues to action). Questions were asked about the perception of the participants and their families concerning their susceptible to COVID-19 infection (perceived susceptibility), whether COVID-19 would damage the health of theirs and their family members' (perceived severity), whether booster shots were unsafe, ineffective, or might trigger COVID-19 infection (perceived barriers), whether booster shots were protective against COVID-19 or have benefits for health (perceived benefits), and whether they would receive vaccination upon the recommendation from physicians, family members or community workers (cues to action). Each answer of the questions was assigned as 3, 2, and 1 score based on a three-point Likert scale ("agree", "not sure", and "disagree"), respectively. The total score of each dimension was 6 in "perceived susceptibility" and "perceived severity", and 9 in "perceived barriers", "perceived benefits" and "cues to action".

Statistical analysis

A descriptive analysis was performed to describe sociodemographic characteristics, social media use, knowledge about COVID-19 and vaccine booster shots, and HBM dimensions by mean, standard deviation (SD), frequencies and percentages. The distribution of hesitancy toward COVID-19 vaccine booster shots was described by characteristics. Pearson's χ^2 test and Cochran-Armitage test for trend were used to compare and examine vaccine hesitancy rates by sociodemographic characteristics and social media use. Differences in scores of knowledge and HBM dimensions between vaccine hesitancy group and vaccine acceptance group were compared using t test.

A univariable and multivariable logistic regression model was used to assess the association between hesitancy toward COVID-19 vaccine booster shots and different variables of social media use. Crude odds ratios (cOR) and adjusted odds ratios (aOR) with 95% CIs for each variable were calculated. To examine the stability of the estimations, we performed a sensitivity analysis by fitting different models. Model A was a univariate model. Model B was adjusted for sociodemographic factors (region, sex, education, age group, marital status, occupation, monthly income, and history of chronic diseases), knowledge about COVID-19 and vaccines, and the other two variables about social media use. Model C was additionally adjusted for scores of five HBM dimensions. Model D was adjusted for variables that were only significant according to the Pearson's χ^2 test, Cochran-Armitage test, and t test. Stepwise logistic regression was also performed to determine the most important predictors of hesitancy toward COVID-19 vaccine booster shots.

After adjusting for all the variables, stratified analysis on sex, age, education, occupation, and marital status were performed. A heterogeneity test was performed to evaluate the differences in results between groups. The results were graphically presented using forest plots. All the data analyses were conducted by R studio (version 4.1.0), and two-sided $p < .05$ was considered statistically significant.

Results

Characteristics of the study population

A total of 3,242 participants were recruited, of which 3,119 participants completed the questionnaires and were ultimately included in the analysis (Table 1). Among them, 1,909 (61.2%) were 30 years old or below, 1,608 (51.6%) were women, 2,522 (80.9%) had an education level of Bachelor's degree or higher, 2,442 (78.3%) were employed. The rate of hesitancy toward COVID-19 vaccine booster shots was 6.5% (95%CI: 5.6%-7.3%). Public social media were most frequently used to acquire information about COVID-19 and vaccines (50.5%), followed by official social media (43.8%), professional social media (4.8%). The majority of people believed social media played an important or very important role in influencing their attitudes about COVID-19 vaccine booster shots, which accounted for 83.1% of the participants. Only 409 out of 3,119 participants (13.1%) spent more than one hour on social media.

Hesitancy toward COVID-19 vaccine booster shots by characteristics

Among sociodemographic characteristics, vaccine hesitancy varied significantly among different age groups ($p = .008$), education levels ($p = .012$), monthly income ($p = .036$), marital status ($p < .001$), and occupations ($p < .001$, Table 1). People who were older, unmarried, or unemployed, with higher education level or lower monthly income were prone to have vaccine hesitancy.

Regarding the association between social media use and hesitancy toward COVID-19 vaccine booster shots (Table 1), significant differences were observed among types of social media and among the perceived importance of social media in influencing attitudes about vaccine booster shots (both $p < .001$). In contrast to no significant difference was observed among the time spent on social media per day ($p = .132$).

The association with hesitancy toward COVID-19 vaccine booster shots differed significantly across scores of knowledge on COVID-19 and vaccines, perceived susceptibility, perceived severity, perceived barriers, perceived benefit, and cues to action (all $p \leq .001$).

The association between social media use and hesitancy toward COVID-19 vaccine booster shots

As shown in Table 2, in the univariable logistic regression model, vaccine hesitancy was positively associated with those who used traditional media or acquired information from friends and family members (cOR = 6.063, 95%CI: 2.668–12.964, $p < .001$), and negatively associated with those who used official social media most often (cOR = 0.499, 95%CI: .357–.691, $p < .001$) compared with people who frequently used public social media. Perception that social media played an important (cOR = .205, 95%CI: .125–.347, $p < .001$) or very important (cOR = .056, 95%CI: .029–.106, $p < .001$) role in influencing their attitudes toward vaccination were negatively associated with COVID-19 vaccine booster shot hesitancy. Time spent on social media had no significant association.

Table 1. Hesitancy toward COVID-19 vaccine booster shots in China by characteristics (N = 3119).

Characteristics	Number of participants	Hesitancy toward COVID-19 vaccine booster shots (N, %)	p value
Region			.102
Eastern	1,473	110 (54.5)	
Central	1,019	56 (27.7)	
Western	627	36 (17.8)	
Sex			.066
Male	1,511	111 (55.0)	
Female	1,608	91 (45.0)	
Age group			.008
≤20	162	12 (5.9)	
21–30	1,747	98 (48.5)	
31–40	934	59 (29.2)	
41–50	194	17 (8.4)	
>50	82	16 (7.9)	
Education			.012
Less than high school	29	1 (0.5)	
High school or some college	568	63 (31.2)	
Bachelor's degree	2,357	122 (60.4)	
Postgraduate degree	165	16 (7.9)	
Monthly income (RMB)			.036
≤3,000	411	28 (13.9)	
3,001–5,000	558	52 (25.7)	
5,001–10,000	1,370	86 (42.6)	
10,001–20,000	641	31 (15.3)	
>20,000	139	5 (2.5)	
Marital status			<.001
unmarried	970	88 (43.6)	
married	2,149	114 (56.4)	
Occupation			<.001
unemployed	677	68 (33.7)	
employed	2442	134 (66.3)	
Chronic disease (cardiovascular disease, cancer, diabetes, hypertension, or respiratory diseases)			.052
Yes	238	23 (11.4)	
No	2,881	179 (88.6)	
Social media use on acquiring COVID-19 vaccine information			<.001
Traditional media or from friends and family members	30	10 (5.0)	
Official social media	1,365	54 (26.7)	
Professional social media	149	18 (8.9)	
Public social media	1,575	120 (59.4)	
Perceived importance of social media in influencing attitudes about COVID-19 vaccine booster shots			<.001
Unimportant	114	24 (11.9)	
Moderate	414	89 (44.1)	
Important	1,367	71 (35.1)	
Very important	1,224	18 (8.9)	
Time spent on social media per day			.132
<1 h	2,710	183 (90.6)	
>1 h	409	19 (9.4)	
Total	3119	202 (100.0)	

Note: $p < .05$ are marked in bold.

The results were stable in model A, B and C, which indicated that adjusting for different covariates did not substantially alter the estimates (Table S1). In Model B, adjusted for all covariates, hesitancy toward COVID-19 vaccine booster shots was positively associated with those who used traditional media (aOR = 3.718, 95%CI: 1.282–10.273, $p = .013$), and negatively associated with those who used official social media most often (aOR = .671, 95%CI: .467–.954, $p = .028$) and perceived that social media played an important (aOR = .252, 95%CI: .146–.445, $p < .001$) or very important (aOR = .075, 95%CI: .037–.149, $p < .001$) role in influencing their attitudes toward vaccination.

Table 3 showed the results of stepwise logistic regression, which were similar to the results in Table 2. Use of traditional media (aOR = 4.115, 95%CI: 1.497–10.869, $p = .005$), use of official social media (aOR = .676, 95%CI: .472–.958, $p = .030$),

important (aOR = .233, 95%CI: .137–.407, $p < .001$) and very important (aOR = .066, 95%CI: .033–.130, $P < .001$) perception of social media were all associated factors. Monthly income, occupation, scores of knowledge and cues to action were also important predictors of vaccine hesitancy. Low monthly income, unemployment, low scores of knowledge, and low level of cues to action were all associated with vaccine hesitancy (all $p < .001$).

Stratified analysis of the association between hesitancy toward COVID-19 vaccine booster shots and social media use

Figure 1, Figure S1, and Figure S2 presented the results of stratified analysis of the association between hesitancy toward COVID-19 vaccine booster shots and time spent on social media, type of social media, and perceived importance. In the

Table 2. Summary of the association between use of social media and hesitancy toward COVID-19 vaccine booster shots in China by logistic regression models.

Social media use	Univariate model		Multivariate model ^a	
	Crude odds ratio (95%CI)	<i>p</i> value	Adjusted odds ratio (95%CI)	<i>p</i> value
Time spent on social media per day				
<1 h	Reference		Reference	
>1 h	0.673 (0.402–1.064)	.109	0.651 (0.363–1.109)	.130
Social media use on acquiring COVID-19 vaccine information				
Traditional media or from friends and family members	6.063 (2.668–12.964)	<.001	3.725 (1.308–10.050)	.011
Official social media	0.499 (0.357–0.691)	<.001	0.650 (0.454–0.922)	.017
Professional social media	1.666 (0.955–2.756)	.057	1.669 (0.890–2.991)	.096
Public social media	Reference		Reference	
Perceived importance of social media in influencing attitudes about COVID-19 vaccine booster shots				
Unimportant	Reference		Reference	
Moderate	1.027 (0.626–1.734)	.918	1.206 (0.705–2.126)	.505
Important	0.205 (0.125–0.347)	<.001	0.260 (0.152–0.458)	<.001
Very important	0.056 (0.029–0.106)	<.001	0.077 (0.039–0.153)	<.001

p < .05 are marked in bold.

Odds ratios were adjusted for sociodemographic factors (region, sex, education, age group, marital status, occupation, monthly income (RMB), history of chronic diseases (cardiovascular disease, cancer, diabetes, hypertension, or respiratory diseases), knowledge about COVID-19 and vaccines, perceived susceptibility, perceived severity, perceived barriers, perceived benefits, cues to action, and the other two variables about social media.

Table 3. Summary of factors associated with hesitancy toward COVID-19 vaccine booster shots in China by stepwise logistic regression model.

Characteristics	Adjusted odds ratio (95%CI)	<i>p</i> value
Social media use on acquiring COVID-19 vaccine information		
Traditional media or from friends and family members	4.115 (1.497–10.869)	.005
Official social media	0.676 (0.472–0.958)	.030
Professional social media	1.595 (0.841–2.891)	.137
Public social media	Reference	
Perceived importance of social media in influencing attitudes about COVID-19 vaccine booster shots		
Unimportant	Reference	
Moderate	1.131 (0.664–1.986)	.658
Important	0.233 (0.137–0.407)	<.001
Very important	0.066 (0.033–0.130)	<.001
Monthly income (RMB)		
≤3,000	Reference	
3,001–5,000	2.854 (1.561–5.281)	<.001
5,001–10,000	2.883 (1.568–5.389)	<.001
10,000–20,000	2.312 (1.145–4.682)	.019
>20,000	1.851 (0.550–5.319)	.280
Occupation		
Employed	Reference	
Unemployed	2.428 (1.590–3.670)	<.001
Scores of knowledge	0.917 (0.869–0.968)	.002
Cues to action	0.773 (0.689–0.869)	<.001

p < .05 are marked in bold.

stratified analysis (Table 4), the association between hesitancy toward COVID-19 vaccine booster shots and social media use was not modified by sex, education level, occupation, and marital status (all *p* for interaction >.05). However, significant differences in the association between vaccine hesitancy and professional social media use (*p* = .011), moderate perceived importance (*p* = .030), high perceived importance (*p* < .001), and very high perceived importance (*p* = .007) were found when stratified by age.

Discussion

To our knowledge, this is the first study to evaluate the association between social media use and hesitancy toward COVID-19 vaccine booster shots in China. We conducted a web-based national wide cross-sectional survey of vaccine booster shot hesitancy across 31 provinces in mainland China via an online

platform. This study aims to understand the effect of social media on vaccine hesitancy, and provide evidence for policy initiatives, educational campaigns, and novel approaches to reduce vaccine hesitancy. We found that higher perceived importance of social media was associated with lower vaccine hesitancy. Using official social media was associated with lower vaccine hesitancy, while using traditional media and acquiring information from friends and family members were associated with higher vaccine hesitancy. Official social media played an important role in reducing vaccine hesitancy and should be promoted.

Extant literature has indicated that the antibody level triggered by COVID-19 vaccines wanes over time.² Shrotri et al.¹ found that 21–41 days and 70 days or more after completion of two-dose vaccination, antibody levels to the spike protein were reduced by two-fold for BNT162b2. The significant trend remained consistent when stratified by sex, age, and clinical vulnerability. Mizrahi et al.²¹ reported a significant 1.51 fold

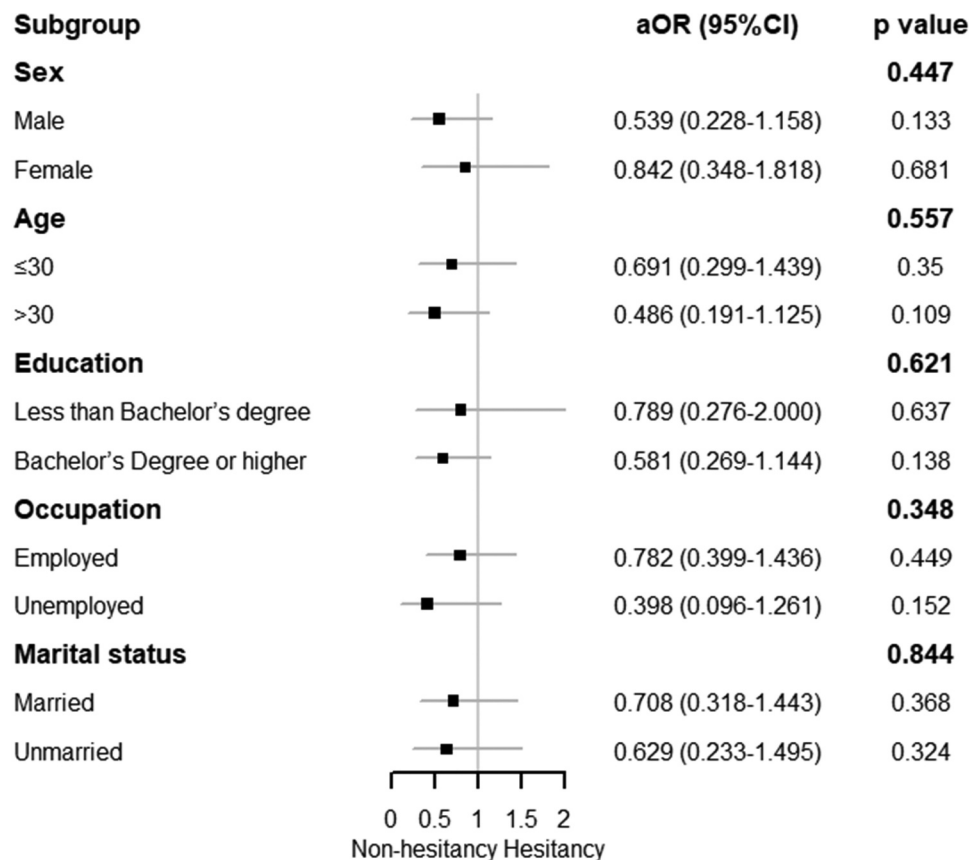


Figure 1. The association between hesitancy toward COVID-19 vaccine booster shots and time spent on social media among people who spent more than one hour on social media per day.

increased risk of breakthrough infection for people vaccinated early compared with those vaccinated later across all age groups. A decrease in the vaccine-induced response of neutralizing antibodies to the emerging variants has also been reported.²⁰ Campbell et al. has found that the effective reproduction number estimate of the Delta variant increased by 55%, 60% and 34% compared to the Alpha, Beta, and Gamma variants, respectively.²² For the BNT162b2 vaccine, the effectiveness of two-dose vaccination was 88.0% among those infected with the delta variant, compared with the rate of 93.7% among people with the alpha variant.²³ Another study in South Africa suggested that the effectiveness of two-dose BNT162b2 vaccine was only 70% against hospitalization for COVID-19 during the proxy omicron period, while it was 93% during the period that the delta variant was dominant.²⁴

The emergence of variants of concern and waning immunity could lead to increased breakthrough infections in those who were previously infected or received two-dose vaccination, which could trigger new waves of global infection. In an effort to provide more durable immunity and greater protection against emerging variants, COVID-19 vaccine booster shots are recommended especially to people who are 65 years and older, have underlying diseases, or live or work in high-risk settings.² In a study conducted among people who aged above 60 in Israel, the rates of confirmed COVID-19 infection and severe illness were substantially lower among those who had received a booster dose than those who received two doses.²⁵ The booster dose of

the BNT162b2 vaccine was also shown to efficiently neutralize infection with the omicron variant (geometric mean titer, 1.11 after the second dose vs. 107.6 after the booster dose).²⁶

In our study, the rate of hesitancy toward COVID-19 vaccine booster shots in China was 6.5% (95%CI: 5.6%-7.3%), which was lower than that in Czechia (28.7%),²⁷ United States (38.2%),²⁸ and Poland (29.0%).²⁹ In the stepwise logistic regression, we found that unemployment, low monthly income, low level of knowledge and low level of cues to action were significantly associated with vaccine hesitancy, which was consistent with findings of previous studies.³⁰⁻³² This indicated that cost-based concerns, low health literacy, low trust and interaction with healthcare professional and community workers were major barriers to booster dose vaccination. In order to improve people's willingness to vaccination and mitigate their concerns, healthcare professionals and community workers should be mobilized to inform people of the effectiveness, safety, and necessity of COVID-19 vaccine booster shots by taking full advantage of social media. Vaccination should also be more convenient to access, especially for the unemployed and for those with low income.

As is widely acknowledged, social media played a critical role in information acquisition and has become people's major access to information. Our study found that hesitancy toward COVID-19 vaccine booster shots was negatively associated with using official social media compared with public social media, which is consistent with many previous studies.³³⁻³⁶

Table 4. Stratified analysis of the association between social media use and hesitancy toward COVID-19 vaccine booster shots.

Subgroups	Time spent > 1h (Reference: time spent < 1h)		Use traditional media (Reference: use public social media)		Use official social media (Reference: use public social media)		Use professional social media (Reference: use public social media)		Moderate perceived importance (Reference: low perceived importance)		High perceived importance (Reference: low perceived importance)		Very high perceived importance (Reference: low perceived importance)	
	aOR ^a (95%CI)	p for difference	aOR ^a (95%CI)	p for difference	aOR ^a (95%CI)	p for difference	aOR ^a (95%CI)	p for difference	aOR ^a (95%CI)	p for difference	aOR ^a (95%CI)	p for difference	aOR ^a (95%CI)	p for difference
Sex														
Male	0.539 (0.228–1.158)	.447	3.126 (0.477–16.516)	.483	0.631 (0.382–1.028)	.787	1.633 (0.683–3.694)	.724	1.555 (0.719–3.539)	.275	0.219 (0.101–0.496)	.913	0.051 (0.017–0.141)	.535
Female	0.842 (0.348–1.818)	.557	6.811 (1.782–24.098)	.728	0.698 (0.399–1.189)	.837	1.283 (0.412–2.223)	.011	0.807 (0.347–1.998)	.030	0.234 (0.101–0.575)	<.001	0.081 (0.029–0.222)	.007
Age														
≤30	0.691 (0.299–1.439)	.621	5.458 (1.403–18.766)	.416	0.685 (0.411–1.119)	.978	0.780 (0.269–1.930)	.820	3.183 (1.203–10.365)	.410	0.919 (0.352–2.966)	.416	0.242 (0.080–0.842)	.508
>30	0.486 (0.191–1.125)	.621	3.616 (0.534–23.778)	.416	0.721 (0.0399–1.279)	.978	4.403 (1.717–10.802)	.820	0.759 (0.360–1.627)	.410	0.081 (0.036–0.180)	.416	0.028 (0.009–0.076)	.508
Education														
Less than Bachelor's degree	0.789 (0.276–2.000)	.621	1.933 (0.391–9.151)	.416	0.650 (0.309–1.305)	.978	1.448 (0.373–4.811)	.820	1.911 (0.632–6.477)	.410	0.383 (0.126–1.290)	.416	0.110 (0.028–0.430)	.508
Bachelor's Degree or higher	0.581 (0.269–1.144)	.348	4.592 (1.057–17.255)	.859	0.658 (0.429–0.995)	.867	1.716 (0.800–3.459)	.983	1.097 (0.584–2.142)	.624	0.221 (0.117–0.431)	.742	0.065 (0.028–0.146)	.962
Occupation														
Employed	0.782 (0.399–1.436)	.348	4.386 (0.974–8.313)	.859	0.676 (0.436–1.035)	.867	1.600 (0.770–3.142)	.983	1.264 (0.662–2.525)	.624	0.219 (0.114–0.441)	.742	0.072 (0.031–0.207)	.962
Unemployed	0.398 (0.096–1.261)	.844	3.638 (0.817–15.793)	.195	0.632 (0.316–1.219)	.805	1.630 (0.319–7.028)	.142	0.912 (0.305–2.927)	.993	0.273 (0.092–0.858)	.106	0.069 (0.018–0.255)	.835
Marital status														
Married	0.708 (0.318–1.443)	.844	9.047 (1.899–36.108)	.195	0.719 (0.443–1.150)	.805	2.545 (1.095–5.521)	.142	1.163 (0.561–2.554)	.993	0.155 (0.073–0.345)	.106	0.061 (0.024–0.153)	.835
Unmarried	0.629 (0.233–1.495)	.844	2.393 (0.545–9.378)	.195	0.656 (0.367–1.140)	.805	0.948 (0.308–2.540)	.142	1.157 (0.492–2.880)	.993	0.400 (0.175–0.968)	.106	0.072 (0.022–0.218)	.835

p < .05 are marked in bold. Odds ratios were adjusted for sociodemographic factors (region, sex, education, age group, marital status, occupation, monthly income (RMB), chronic disease (cardiovascular disease, cancer, diabetes, hypertension, or respiratory diseases), knowledge about COVID-19 and vaccines, perceived susceptibility, perceived severity, perceived barriers, perceived benefits, cues to action, and the other two variables about social media.

Studies have found that people who use public social media (e.g., TikTok, YouTube, WeChat) as the main source of information have higher vaccine hesitancy than those who used official social media, which may be due to misinformation. Public social media platforms (especially unregulated accounts), compared with official social media, may spread a great deal of inaccurate, biased, or fabricated information rapidly, which largely interfered with people's risk-benefit assessment and increases their conspiracy beliefs in vaccines.³⁷ On the contrary, the information released by official social media would always be reviewed by the relevant officials and professionals in advance to guarantee its credibility and the government's authority.

We also found that people who used traditional media or mostly acquired information from friends or family members had higher hesitancy toward COVID-19 vaccine booster shots. Similar to the findings of a previous study, people who gained information mostly from their friends and family members had higher levels of skepticism toward COVID-19 vaccines, possibly because of misinformation and rumors about vaccines.³⁵ Different from other studies,^{38–40} our results suggested traditional media may enhance vaccine hesitancy. This could be influenced by people's old age and their low level of knowledge about vaccines and diseases. Previous literature has shown that older people tend to use traditional media more often than public social media.⁴¹ Unlike public social media, traditional media was not found to improve people's knowledge level of COVID-19.⁴² In our study, the proportion of people above 40 (23.3%) who used traditional media was far higher than those who used public social media (8.50%). In addition, the average scores of knowledge among people who used traditional media (10.9) were significantly lower than those of people who used public social media (13.6). High perceived importance of social media (including all types of social media) was associated with lower vaccine hesitancy. We speculated that people with high perceived importance of social media tend to be more concerned about COVID-19 booster shots. Although misinformation about COVID-19 and vaccines exists, true messages outweigh false information regarding all types of social media, which enriches people's comprehensive knowledge, informs them of the benefits and necessity of vaccination, and mitigates their concerns and doubts. Another possibility is that people who had high perceived importance of social media were younger and were therefore more willing to be vaccinated. In people above 40, the proportion of participants with high or very high perceived importance (8.0%) was significantly smaller than those with moderate or low perceived importance (13.1%).

In the context of COVID-19, social media is not only a platform for communication and disseminating information, but it can also serve as a tool to promote vaccination. Surveys have indicated that the news publicized by professionals and officials is highly trustworthy by people.⁴³ Therefore, public health professionals and government officials should make full use of social media to disseminate public health information and raise people's awareness of vaccination. Meanwhile, the effect of fake news and false information on people's vaccine hesitancy cannot be neglected.⁴⁴ Therefore, relevant officials and social media companies should regulate the content of social media,

eradicating, filtering out or marking misinformation, and guiding to evidence-based information sources. People should also be encouraged to report false information to the media platform. The publicity of official social media should be reinforced, so that official social media could gain more popularity.

The study has several limitations to be noted. First, this is a cross-sectional study, so that causal links could not be established. Therefore, the effect of social media use on vaccine hesitancy could not be fully evaluated. Second, since the questionnaire was released via an online platform, only those who had access to the online platform could participate in the study. However, participants were proportionally selected according to the population of each province, and could be considered representative of the national population. Third, we cannot assess the effect of misinformation disseminated by social media on people's vaccine hesitancy. More studies on this topic are warranted. Finally, further studies are also needed to explore the associations between vaccine hesitancy and other aspects of social media use.

Conclusion

In the web-based national cross-sectional study, COVID-19 vaccine booster shot hesitancy rate in China was 6.5%. Lower vaccine hesitancy was associated with higher perceived importance of social media and official social media use than public social media use, while higher vaccine hesitancy was associated with traditional media use and information acquisition from friends and family members. More efforts need to be made to regulate the content of social media and filtering out misinformation. The role of official social media in disseminating COVID-19 and vaccines should be enhanced.

Acknowledgments

The authors are thankful to the participants that agreed to participate in the study.

Disclosure statement

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

Funding

This study was supported by the National Natural Science Foundation of China [grant numbers 72122001, 71934002]; the National Key R & D Project of China [grant number 2021ZD0114101], National Statistical Science Research Project [grant number 2021LY038], Capital Health Development Scientific Research Public health Project [grant number 2021-1G-4281] and the National Science and Technology Key Projects on Prevention and Treatment of Major Infectious Disease of China [grant number 2020ZX10001002].

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