



OPEN Vaccination burnout impedes the compliance with multiple-dose administration of vaccines

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Timely and complete administration of multiple-dose vaccines is essential to guarantee the efficacy. Our study aimed to investigate how people's vaccination attitudes changed over the course of the multi-dose vaccination schedule and comprehensively reported a phenomenon of vaccination burnout. The participants' vaccination burnout levels were quantified by our designed vaccination burnout scale. This study is a retrospective cross-sectional study. Among 3068 valid participants, 2991 had finished the routine two shots of COVID-19 vaccine, and 2367 had a positive attitude towards the primary doses of vaccination. Notably, 232 participants who previously had a positive attitude towards primary doses of vaccination refused to take additional multiple shots, and another 83 had changed their positive attitudes to negative, despite having taken the third shot. Participants whose attitudes or behaviors had changed had higher scores of vaccination burnout than those who still maintained a positive attitude ($Z = -8.491$, $P < .001$). The frequency of actively paying attention to the related disease news, occupation, monthly income, and residence of the participants were key factors associated with the vaccination burnout. Interventions should be implemented to alleviate the exhausted attitudes and improve people's compliance with vaccination schedules against the future pandemic.

Keywords Vaccination burnout, COVID-19 vaccine, Public health, Multiple-dose vaccination, Case study

Vaccination is one of the most effective public health interventions for preventing infectious diseases¹. Mass immunization campaigns not only enable a substantial proportion of the immunized population to achieve herd immunity and interrupt the transmission chain, but also decrease disease severity and mortality among those infected^{2,3}. Vaccination adherence refers to the timely completion of recommended vaccination. High vaccination adherence is crucial for ensuring the effectiveness of vaccines in real-world scenarios against infection and death^{4,5}.

Among vaccine-preventable diseases (VPDs), several vaccines, such as varicella, hepatitis A, and hepatitis B vaccines, offer the option of two or more doses for optimal protection. Since 2008, China has begun implementing the national expanded programme on immunization (EPI), providing 14 kinds of free and mandatory vaccines for children aged 0–6, including hepatitis B vaccine, BCG vaccine, polio vaccine, DTP vaccine, measles vaccine, MMR vaccine, JE vaccine, hepatitis A vaccine, etc⁶. The scope of China's EPI has been expanding over time. Meanwhile, there are self-funded and voluntary vaccines, including varicella vaccine, pneumonia vaccine, rotavirus vaccine, rabies vaccine. In addition, there are vaccination campaigns targeting specific periods or some key populations, such as influenza vaccines for elderly people, HPV vaccine for female students in high school, COVID-19 vaccine during COVID-19 pandemic. Notably, to promote the willingness to get booster shots of COVID-19 vaccination, China has made a lot of efforts, including free vaccination, health agencies setting up a large number of temporary vaccination sites, and a nationwide registration platform for vaccination information.

However, a previous study indicated that the compliance with multiple-dose vaccine series among older children, adolescents, and adults was unsatisfactory⁷. Meanwhile, due to the gradual decay of specific immunity in the body after primary vaccination, another booster vaccination is usually needed to maintain protection efficacy. For example, the immunity induced by existing seasonal influenza vaccines is very limited against the different variants circulating each year, thus requiring annual influenza vaccination. Moreover, the COVID-19 pandemic presents a comparable scenario, wherein the protective efficacy of the existing vaccines may not fully

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encompass the impacts of emerging variants, necessitating multiple shots of COVID-19 vaccines^{8–12}. The WHO recommends two doses for optimal protection against COVID – 19 in early 2021, but the emergence of increasing variants made third, fourth, and more booster shots necessary for COVID – 19 vaccination recommendation by the end of 2021, and even made it necessary to receive a vaccination every 6 months later.

Timely and complete vaccination with multiple - dose schedules is important for public health, because an incomplete series may yield suboptimal protection. Although adherence to multi - dose vaccination has been a topic in some prior studies, the determinants influencing this adherence are intricately complex. For example, one study showed that parental reluctance to adhere to childhood vaccination protocols may be ascribed to a multitude of contributing factors, particularly prevalent in regions where children have undergone 15 or more doses of vaccine administrations¹³.

Vaccine hesitancy, a well - known phenomenon of refused or delayed acceptance of vaccination despite the availability of vaccination services, has been listed as one of the top 10 threats to global health by the World Health Organization^{14,15}. Vaccine hesitancy, which has been mentioned repeatedly over the past few years of the COVID-19 pandemic, can profoundly impede the mass vaccination campaigns^{16–18}. To date, previous studies on vaccination hesitancy have mainly focused on the unvaccinated people, while those who have received primary vaccinations are usually overlooked. Herein, we have proposed a concept of “vaccination burnout”, which reflects the phenomenon of an attitude that changes from positive to negative during the multi - dose vaccination schedule, thus not entirely the same as traditional vaccine hesitancy. The term “burnout” refers to a state of mental and physical exhaustion due to repetitive tasks¹⁹, and it is initially defined as an occupational phenomenon of workers at work²⁰. Now, this term has expanded to many other areas, including academic burnout, parental burnout, and reconstructive burnout^{21–23}. Burnout is characterized by emotional exhaustion, depersonalization, and lack of personal accomplishment²⁰. Accordingly, vaccination burnout can be defined as a syndrome characterized by emotional exhaustion, depersonalization, and lack of personal accomplishment in receiving repeated vaccinations.

Employing the context of the COVID-19 vaccination campaign in China as a case study, this research scrutinized the impact of vaccine burnout on the populace’s compliance with multi-dose administration of vaccines. The ultimate objective of this study is to delineate strategic interventions aimed at enhancing adherence to multi-dose vaccination schedules.

Methods

Sample and data

This survey was conducted from 17 August 2022 to 4 October 2022. This survey was approved by the Ethics Committee of the School of Public Health (Shenzhen), Sun Yat-sen University (Approval number: SYSU-PHS-IACUC-2022-052), and was performed in accordance with relevant guidelines and regulations after approval. The whole research process complied with the Declaration of Helsinki. Participants were recruited using convenience sampling to complete the online questionnaire from various public health services in China (including the Community of Sun Yat-sen University, Guangzhou Center for Disease Control and Prevention, Tibet Center for Disease Control and Prevention, Nanshan District Center for Disease Control and Prevention, and the other provinces across the whole country).

The minimum sample size in the formal survey was estimated based on the *formula (1)*, with a margin of error of 3% and a confidence interval (CI) of 95%. z is a certain confidence level, p is the percentage of a certain feature in the target population; d is the acceptable precision/accuracy level, which is generally set as 0.05. We estimated that 20% of the population experienced a decline in attitudes and behavior after receiving two routine shots of COVID-19 vaccine through our small sample size pre-survey ($n=71$). The minimum sample size was then estimated to be 682 by the formula, and considering invalid questionnaires in the real world (about 20%), we increased the sample size to 819.

$$n = [z_{1-\alpha}^2 \times p \times (1 - p)] / d^2 \quad (1)$$

This survey was conducted in Chinese language. The questionnaire was generated by using Wenjuanxing (<https://www.wjx.cn/>), a professional survey platform that is widely used in many large-scale online surveys in China^{24–26}. The quick response (QR) code of the questionnaire was disseminated via WeChat (<https://weixin.qq.com/>), the most popular social media platform and its users are required to be real-name registration to ensure the authenticity of the communication. Participants could scan and relay the QR code to fill in the questionnaire for free after reading the front page and selecting the option to agree the electronic informed consent for this survey. To avoid duplicate entries, we have set a limit of only one entry per account. There are no other restrictions. The inclusion criteria in this survey were individuals who (1) were between 18 and 80 years old; (2) were able to read and complete the online questionnaire independently. In addition, participants who failed to complete the questionnaire, or answered the questionnaire illogically, or answered the quality control questions incorrectly were excluded. The complete questionnaire is provided in the Supplementary file.

Measures of variables

The questionnaire used in this survey contained the following demographic characteristics: gender, age, educational level, marriage and fertility status, occupation, residence, monthly income, and chronic conditions. In addition, we collected some potentially related characteristics, including participant’s frequency of following COVID-19 news and receiving COVID-19 nucleic acid tests, SARS-CoV-2 infection status, and whether they had any discomfort after COVID-19 vaccination. To understand participants’ attitude and behavior change, we asked their vaccination status towards each shot of COVID-19 vaccines (from the first shot to the third shot), and then investigated participants’ four kinds of attitudes towards each finished shot of vaccination (1: *You are*

voluntary/proactive when you receive this dose of the COVID-19 vaccine. 2: You believed that a mass vaccination campaign was necessary. 3: You are full of expectations for the protective effect of the vaccine. 4: You believe that the vaccination will facilitate your work or life.). A 5-point Likert scale was used to score each item, with a range from strongly disagree (1 point) to strongly agree (5 points). Participants who chose “strongly agree” or “agree” in all four attitudinal questions were classified as having positive attitudes for the certain shot of vaccination, and the others were classified as having negative attitudes in that shot of vaccination.

Referenced to previous Maslach Burnout Inventory (MBI)²⁰, a 15 terms vaccination burnout scale was designed by our experienced epidemiologists (Caijun Sun, Jianhui Yuan, and Shiqiang Jiang). Our vaccination burnout scale contains three dimensions: emotional exhaustion (4 terms), accomplishment (6 terms), and depersonalization (5 terms), which can respectively measure people’s emotions, sense of achievement, and impersonal response towards receiving multiple shots of COVID-19 vaccination. A 5-point Likert scale was used to score each item, with a range from strongly disagree (1 point) to strongly agree (5 points). The scores of all items were added together to get a total score, and a higher score of the total scale indicates a higher level of burnout status.

Given the fourth shot of COVID-19 vaccine may be offered to the general population in the future, participants’ willingness to receive the fourth COVID-19 vaccine was also investigated by the following question: (*If you could continue to receive COVID-19 vaccination, would you be willing to continue? Answers: (1) Yes, I will; (2) Not sure yet, but it’s likely; (3) Not sure yet, but probably not; (4) No, I refuse.*) Participants who chose (1) or (2) were considered as willing, while others were considered as unwilling.

Statistical analysis

Percentages or a mean (standard deviation, SD) were used to characterize the participants recruited in our survey. The chi-square test was used to compare the characteristics between two groups of participants who were classified based on their attitude or behavior change after receiving the basic vaccination. Cronbach’s α values and confirmatory factor analysis were performed to test the reliability and validity of the adapted vaccination burnout scale. One-way analysis of variance (ANOVA) for repeated measurements was used to confirm the attitude change of participants who received three shots of COVID-19 vaccination. Then, the Wilcoxon rank-sum test was used to compare the burnout scores between two groups of participants classified by attitude changes. Next, multivariable logistic regression analyses were utilized to identify the factors that could potentially influence participants’ attitude or behavior changes. Finally, the chi-square test was used to compare the willingness to receive the fourth shot of vaccine between burnout group and non-burnout group. All analyses were performed by SPSS version 26 (IBM Corporation, Chicago, USA). Plots were generated using the ggplot2 R package (<http://ggplot2.org>), with R version 3.5.1. The alpha level was set as 0.05, and $P < .05$ was considered statistically significant.

Results

Characteristics of participants

A total of 4151 participants had provided feedback and filled in this questionnaire. Upon careful screening in accordance with our inclusion and exclusion criteria, we have identified a total of 3068 participants whose responses were eligible for subsequent analyses (Fig. 1).

Among 3068 valid participants, 34.6% were male and 65.4% were female. The participants’ average age was 32.52 (± 11.45). 80.5% of participants were urban population. 9.0% of participants had chronic conditions. 65.9% of the respondents had a bachelor’s degree, and 17.0% had a master degree or above. Moreover, 38.6% of participants followed the COVID-19 news actively at least once a week, 5.7% of participants reported that they themselves or someone close to them had been infected by SARS-CoV-2 (Table 1). These participants included in our survey were distributed in different regions across all provinces in China, and the detailed geographical distribution was collected (Table S1).

Changes in attitude or behavior towards vaccination

In this survey, 2991 participants had inoculated the two doses of COVID-19 vaccine, and 2659 participants had further inoculated the third shot of COVID-19 vaccine. Among the 2991 participants who received two doses of COVID-19 vaccine, 79.14% (2367) participants had a positive attitude towards the primary doses of vaccination. Of note, 292 participants had taken the third shot of COVID-19 vaccine, although they even had a negative attitude towards basic two shots. More importantly, 9.8% (232) participants who previously had inoculated two doses of COVID-19 vaccine refused to take the third shot of COVID-19 vaccines. Moreover, 3.5% (83) participants who had previously inoculated two doses of COVID-19 vaccine changed their positive attitude to negative attitude, although they had taken the third shot of COVID-19 vaccine. As a result, these 315 participants were classified as the “changed attitude” group, while 2052 participants who maintained their positive attitudes towards receiving three shots were classified as the “unchanged attitude” group (Fig. 1). The further analysis with chi-square test indicated that participants’ gender ($P = .03$), occupation ($P = .003$), monthly income ($P < .001$), residence ($P < .001$), and the frequency of following COVID-19 news ($P < .001$) in these two groups were significantly different (Table 2).

The differences in these participants’ attitudes towards each shot of the COVID-19 vaccine were analyzed using one-way ANOVA for repeated measurements, and results showed that the motivation or enthusiasm of participants towards the third shot was significantly reduced compared to that of the primary shots. Bonferroni multiple mean comparisons showed that participants’ attitude scores for the third shot were significantly lower than that of the first shot ($P < .001$) and the second shot ($P < .001$) (Table S2).

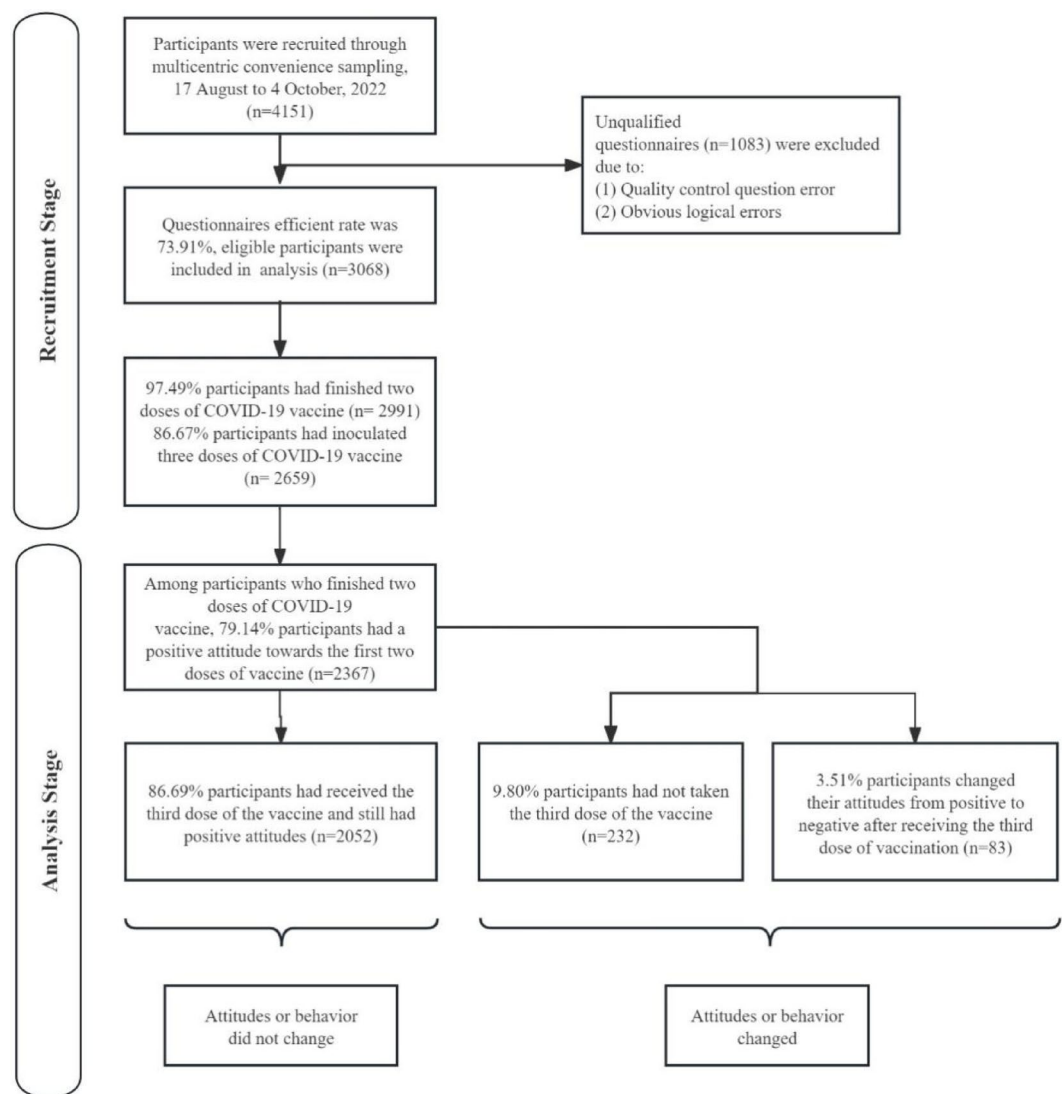


Fig. 1. Flow chart of participant's inclusion and classification.

Vaccination burnout can characterize these changes

Next, we further explored the underlying cause which might be related to the changed attitude towards multiple shots of COVID-19 vaccine. To assess people's burnout status towards the multiple shots of COVID-19 vaccine, a scale was specifically designed and used to investigate whether these attitude changes might be associated with the burnout status. The Cronbach's α for our developed scale was 0.86, indicating an acceptable reliability. Respectively, the Cronbach's α of the three subscales is 0.93 (for emotional exhaustion), 0.91 (for accomplishment), 0.88 (for depersonalization). The confirmatory factor analysis also showed that this vaccination burnout scale had a good construct validity (Table S3). The correlation analysis results among the three dimensions of the vaccination burnout scale suggest good internal consistency of the vaccination burnout scale (Table S4). Consistent with our hypothesis, participants whose attitudes or behavior changed from positive to negative had a significantly higher burnout score than participants whose attitudes and behaviors are consistently positive (Fig. 2; Table 3).

To identify the potential factors associated with vaccination burnout, the characteristics that were significantly different in two groups in the univariate analysis. Results indicated that people from other professions are more likely to experience vaccination burnout than health care workers (AOR (adjusted odds ratio): 0.67, 95%CI 0.49–0.92). The rural participants were less prone to burnout than the urban participants (AOR 1.74, 95% CI 1.22–2.48). Participants whose monthly income over 15000RMB (AOR: 0.45, 95% CI 0.30–0.69) were more likely to have vaccination burnout than the participants with a monthly income of less than 5000. In addition, the participants who followed COVID-19 news more frequently than once a day were less prone to burnout than participants nearly not paying attention to the news (AOR: 0.54, 95% CI 0.39–0.76) (Table 4).

Characteristics	<i>n</i> (%) or Mean (SD)
Gender	
Male	1063(34.6)
Female	2005(65.4)
Age	32.52(11.45)
Education level	
Junior high school or below	163(5.3)
High school	363(11.8)
College or bachelor	2021(65.9)
Master or above	522(17.0)
Marital status	
Unmarried	1372(44.7)
Married	1670(54.4)
Others	26(0.8)
Occupation	
Health care workers	745(24.3)
Others	2323(75.7)
Residence	
Urban	2469(80.5)
Rural	599(19.5)
Monthly income (RMB)	
≤ 5000	1774(57.8)
5001–10,000	724(23.6)
10,001–15,000	346(11.3)
≥ 15,001	224(7.3)
Chronic conditions	
Yes	275(9.0)
No	2793(91.0)
Frequency of following COVID-19 news	
Once a day	603(19.7)
Once a week	1185(38.6)
Nearly not paying attention	1280(41.7)
You or someone close to you has been infected by SARS-CoV-2	
Yes	176(5.7)
No	2797(91.2)
Not sure	95(3.1)

Table 1. Characteristics of participants involved in this survey (*N* = 3068).

Willingness to get the fourth shot of COVID-19 vaccine

We also investigated participant's willingness to get the fourth shot of COVID-19 vaccine if they had inoculated the third shot. Consistently with above findings, our result further demonstrated that participant's willingness in the group of vaccination burnout was significantly lower than that in the group of non-vaccination burnout (65.1% vs. 95.4%, $P < .001$) (Table 5).

In addition, the possible reasons of participants who were willing to receive the fourth shot were asked. As for the positive answer to the question "it is safe to receive multiple shots of COVID-19 vaccines", participants in group of vaccination burnout had a lower option proportion than that in group of non-vaccination burnout (63.0% vs. 85.7%) (Table S5), implying that the most key reason for vaccination burnout might be the safety concern.

Discussion

Completing multiple doses of a vaccine is essential to ensure vaccine effectiveness, but various factors can impact the completion of vaccination regimens. Our study focused on the consequence of vaccine burnout towards potential multi-dose vaccination requirements. In this study, we identified some participants who had positive attitudes towards the primary doses of vaccination had come to refuse to take additional booster shots, or whose attitudes to receiving the multiple shots of COVID-19 vaccine moved from positive to negative. Consistent with our hypothesis, these participants showed a higher score of vaccination burnout than the others. Nevertheless, our survey and some previous surveys have concluded that China's COVID-19 vaccine coverage is still at a high

Characteristics	N	Attitude or behavior		P
		Changed <i>n</i> (%)	Unchanged <i>n</i> (%)	
Gender				
Male	814	125(15.4)	689(84.6)	0.03
Female	1553	190(12.2)	1363(87.8)	
Age				
18–25	949	127(13.4)	822(86.6)	0.32
26–45	1123	156(14.7)	904(85.3)	
46–60	264	26(9.8)	328(90.2)	
≥ 61	30	5(16.7)	25(83.3)	
Education level				0.07
Junior high school or below	115	22(19.1)	93(80.9)	
High school degree	278	43(15.5)	235(84.5)	
Bachelor or above	1974	250(12.7)	1724(87.3)	
Marital status				0.36
Unmarried	1134	153(13.5)	981(86.5)	
Married	1217	158(13.0)	1059(87.0)	
Others	16	4(25.0)	12(75.0)	
Occupation				0.003
Health care workers	571	55(9.6)	516(90.4)	
Others	1796	260(14.5)	1536(85.5)	
Residence				< 0.001
Urban	1865	274(14.7)	1591(85.3)	
Rural	502	41(8.2)	461(91.8)	
Monthly income (RMB)				< 0.001
≤ 5000	1448	169(11.7)	1279(88.3)	
5001–10,000	543	76(14.0)	467(86.0)	
10,001–15,000	233	34(14.6)	199(85.4)	
≥ 15,001	143	36(25.2)	107(74.8)	
Chronic conditions				0.20
Yes	183	30(16.4)	153(83.6)	
No	2184	285(13.0)	1899(87.0)	
Frequency of following COVID-19 news				< 0.001
Once a day	501	52(10.4)	449(89.6)	
Once a week	959	98(10.2)	861(89.8)	
Nearly not paying attention	907	165(18.2)	742(81.8)	
You or someone close to you was infected by SARS-CoV-2				0.053
Yes	112	18(16.1)	94(83.9)	
No	2188	282(12.9)	1906(87.1)	
Not sure	67	15(22.4)	52(77.6)	
Frequency of COVID-19 nucleic acid tests				0.24
≤ 3 times a month	243	36(14.8)	207(85.2)	
4–10 times a month	862	106(12.3)	756(87.7)	
11–20 times a month	576	89(15.5)	487(84.5)	
> 20 times a month	686	84(12.2)	602(87.8)	
Have received COVID-19 antigen test				0.16
Yes	585	88(15.0)	497(85.0)	
No	1782	227(12.7)	1555(87.3)	
Discomfort after vaccination				0.25
Yes	908	130(14.3)	778(85.7)	
No	1459	185(12.7)	1274(87.3)	

Table 2. The characteristic difference between the two groups with changed attitude and unchanged attitude towards multiple shots of COVID-19 vaccines.

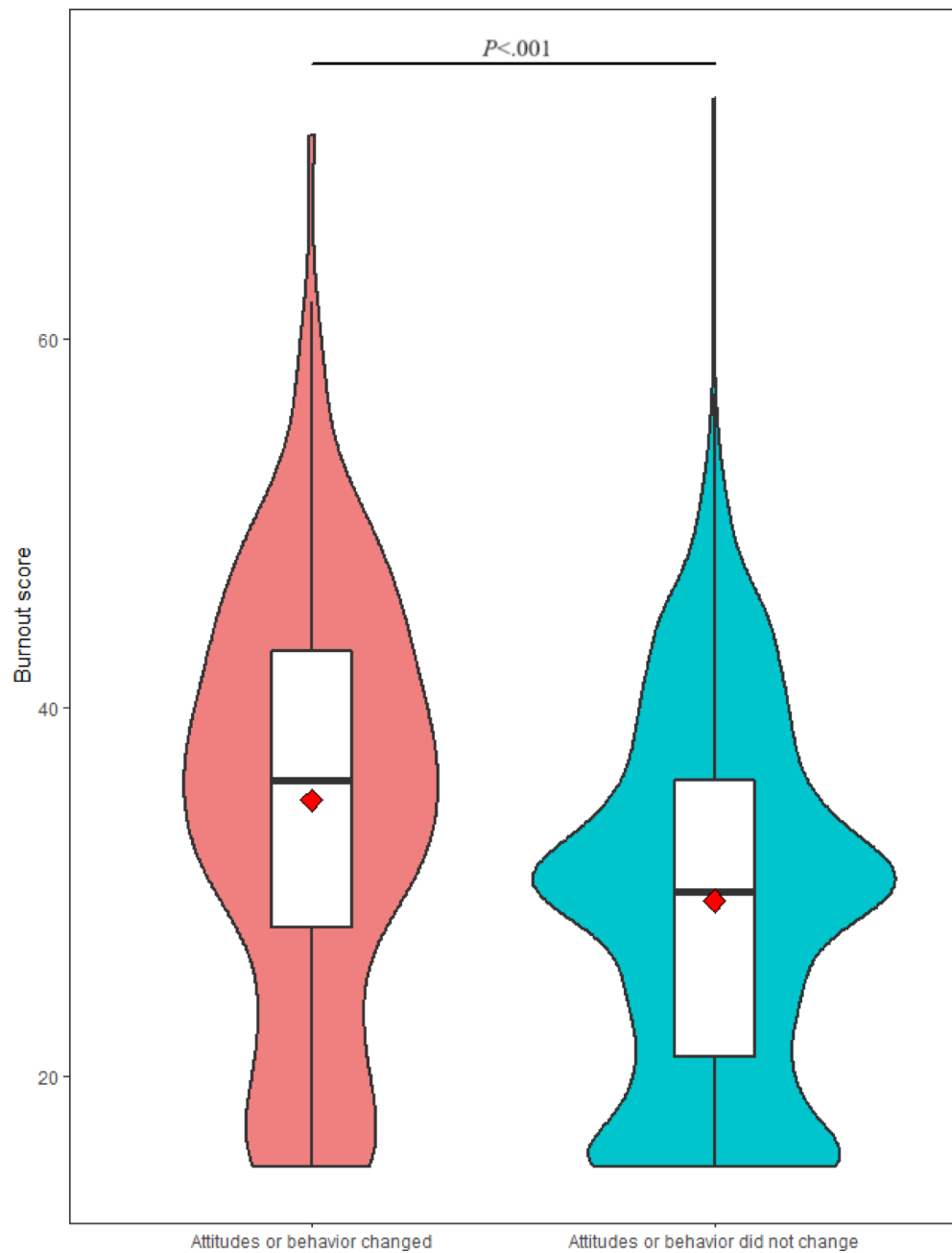


Fig. 2. Distribution of burnout score in different groups. The red part represents participants whose attitudes or behavior changed from positive to negative, and the green part represents participants whose attitudes and behaviors are consistently positive. *** $P < .001$.

Groups	Burnout score M (P25, P75)	Z	P
Attitudes or behavior changed (vaccination burnout)	36 (28, 43)	-8.49	<0.001
Attitudes or behavior unchanged (non-vaccination burnout)	30 (21, 36)		

Table 3. The comparison of vaccination burnout score between the two groups with changed attitude and unchanged attitude towards multiple shots.

Variable	Classification	AOR ^a	95% CI	P
Gender	Male	Ref		
	Female	1.19	0.93–1.54	0.17
Occupation	Health care workers	Ref		
	Others	0.67	0.49–0.92	0.01
Residence	Urban	Ref		
	Rural	1.74	1.22–2.48	0.002
Monthly income (RMB)	≤ 5000	Ref		
	5001–10,000	0.86	0.64–1.16	0.33
	10,001–15,000	0.84	0.56–1.26	0.39
	≥ 15,001	0.45	0.30–0.69	< 0.001
Frequency of active attention to COVID-19 news	Once a day	Ref		
	Once a week	0.97	0.68–1.39	0.89
	Nearly not paying attention	0.54	0.39–0.76	< 0.001

Table 4. Multivariate logistic regression to identify factors associated with vaccination burnout. ^aAOR adjusted odds ratio.

Vaccination burnout	N	Willingness to receive the fourth shot of vaccine		P
		Yes n (%)	No n (%)	
Yes	83 ^a	54(65.1)	29(34.9)	< 0.001
No	2052 ^b	1957(95.4)	95(4.6)	

Table 5. Participants’ willingness to receive the fourth shot of vaccine. ^aIn the group of vaccination burnout, 83 participants had received the third dose of vaccine. ^bIn the group of non-vaccination burnout, 2052 participants had received the third shot of vaccine.

level²⁷. 79.14% (2367) participants had a positive attitude towards the primary doses of vaccination, which is consistent with our previous investigation on the public willingness to accept COVID-19 vaccines in China^{28–31}.

Different from vaccine hesitancy, vaccine burnout is to explain the phenomenon associated with the public’s negative attitudes or behaviors towards subsequent vaccinations after completing the first inoculation. It may be more frequent in booster shots, due to different psychological expectations of vaccination recommendations.

Vaccine hesitancy can only reflect people’s attitude and willingness at a certain point in the investigation. For multi-dose vaccines, vaccination behavior is more likely to be long-term and repetitive, and vaccination willingness is dynamic and constantly developing. Based on this knowledge, we designed and validated a scale to specifically quantify public’s burnout towards receiving multiple shots of vaccination. The factors influencing the vaccination burnout are still not fully elucidated. Su et al. found that vaccine side effects, increased dosages, misinformation about the severity of the disease or the necessity of vaccination, and a lack of trust in the government or the media, might all contribute to a state of fatigue about vaccination³². According to the research conducted by Kovacs et al., the evolution of attitudes towards multiple shots appeared to be closely linked to the occurrence of relevant events³³. An upsurge in attention regarding vaccines is observed when new measures are implemented or when there is a notable increase in the number of deaths and cases. It is also important to note that there is a big difference between our concept of burnout and fatigue. The term “burnout” is referred to a state of mental and physical exhaustion due to repetitive tasks, which leads to a negative attitude towards work and a reluctance to work well. However, fatigue usually refers to a heavy workload that causes some physical fatigue, but might not be a negative attitude towards work and a reluctance to work well.

On the basis of previous findings, our study found that occupation, monthly income, residence, and frequency of active attention to COVID-19 news of the participants were the potential factors associated with vaccination burnout. Several reasons may account for these influences. Firstly, health care workers had less chance of being vaccination burnout, probably because they are more aware of the need and benefit of multiple vaccinations. In addition, health care workers can usually obtain a timely vaccination advice and appropriate information earlier than others. Secondly, participants living in urban areas or with higher incomes were more susceptible to vaccination burnout. In general, urban areas usually encounter stricter regulations to control the pandemic, which may increase residents’ discomfort and reduced their personal sense of achievement towards receiving vaccine. In addition, participants who followed the news less frequently may not have sufficient knowledge about the necessity for timely and complete vaccination with multiple-dose schedules, leading to a higher probability of vaccination burnout.

Certain initial methodologies have been devised for the detection of vaccination burnout and the imperative for interventions to bolster public adherence to multi-dose vaccination regimens. The initial step involves substantiating the safety and efficacy of the vaccine^{34,35}. Enhancing access to healthcare services, particularly

vaccination services, is crucial for enhancing adherence rates. For instance, the implementation of cost-free COVID-19 vaccination within the framework of nationwide immunization programs, heightened involvement of medical reserves in vaccination drives, establishment of supplementary temporary vaccination centers, expansion of operational hours and days of routine preventive vaccination facilities, as well as the formulation of outreach strategies tailored to diverse demographic groups, can significantly improve vaccination accessibility^{36,37}. A study demonstrated that people who had more exposure to topics related to COVID-19 vaccination and the Omicron variant were less hesitant to receive a booster dose³⁸. Therefore, the health authorities may consider disseminating information on the booster vaccination using media channels. At the same time, the communities can invite public health practitioners to answer the hot issues about vaccination. Public health practitioners should also pay close attention to the relevant discussions in society, and refute the emergence of vaccine-related rumors, conspiracies, or hate speech³⁹.

In the future, we can continue to track whether vaccination campaigns with more doses in different disease epidemiological contexts are still affected by vaccination burnout. More critically, the same phenomenon can be investigated for other multi-dose vaccines such as the influenza vaccine, in order to advance timely and complete vaccination with multiple-dose schedules from the perspective of addressing vaccination burnout.

Strength and limitation

This is the first study to use a scale to quantify the impact of vaccine burnout on vaccination campaigns after the concept of “vaccine burnout” was introduced. Before the formal questionnaire collection, a small-scale pre-collection and testing of questionnaires was carried out to ensure that the designed self-compiled questionnaires could have strong usability.

Our study has some limitations. First, participants in this study were recruited by convenience sampling approach, and they may have a high interest in vaccination and public health policies, thus introducing potential selection bias. It is well known that the bias associated with this approach is not easy to be fully addressed, though we have made efforts to minimize it, including multicenter investigation and expanded sample size for recruiting different population. Second, the survey employed self-reported questionnaires to collect subjects’ attitudes and behaviors towards previous vaccinations. Due to the anonymity of the questionnaire, the feasibility of conducting supplementary qualitative surveys of the subjects was limited in the future, potentially introducing information bias. Thus, future studies should combine quantitative and qualitative methods and employ more neutral, nuanced, and non-prompted questioning strategies to obtain more reliable responses. Third, as burnout is a complex psychological and physical state, there may be some other factors associated with the vaccination burnout but not included in this study. Finally, the vaccination burnout scale utilized in the questionnaire was self-constructed, and it still needs to be further validated in the future work, although we have tested the reliability and validity of this scale.

Conclusions

Our findings support that vaccination burnout occurs when faced with multi-dose vaccination schedules, and this phenomenon is influenced by people’s frequency of active interest in the related disease news, occupation, monthly income, and residence. We need to continue to pay attention to the existence of vaccination burnout in other multi-dose vaccines, and explore ways to mitigate vaccination burnout to maintain people’s initial enthusiasm to get vaccinated against the future pandemic.

Data availability

The datasets generated during this study are available from the corresponding authors on reasonable request.

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Author contributions

X.F., Y.Z. and X.Z. are joint first authors. X.F.: Data curation, Formal analysis, Visualization, Writing – original draft; Y.Z.: Formal analysis, Investigation, Methodology, Visualization, Writing—original draft; X.Z.: Investigation, Formal analysis, Writing—review & editing; S.L.: Investigation, Formal analysis, Writing—review & editing; F.W.: Data curation, Formal analysis, Investigation, Methodology, Writing—review & editing; M.C.: Investigation, Formal analysis, Writing—review & editing; Y.Y.: Investigation, Formal analysis, Writing—review & editing; W.D.: Resources, Writing—review & editing; S.J.: Methodology, Resources, Writing—review & editing; J.Y.: Methodology, Project administration, Supervision, Writing—review & editing; C.S.: Conceptualization, Methodology, Project administration, Software, Supervision, Writing—review & editing; All authors have read and agreed to the published version of the manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

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