

BMJ Open COVID-19 vaccination status and associated factors among lactating women during the COVID-19 outbreak: a cross-sectional study in southern China

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ABSTRACT

Objectives Different countries and institutions around the world have debated whether lactating women should receive the COVID-19 vaccine during the COVID-19 pandemic. In China, lactating is not a contraindication to vaccination, but many women are still hesitant to get vaccinated. The purpose of this study was to investigate the current status of COVID-19 vaccination among lactating women and the related factors affecting vaccination.

Methods An online cross-sectional survey involving 506 lactating women was conducted in southern China. We explored the related factors affecting COVID-19 vaccination of lactating women from three aspects: general information, knowledge–attitude–behaviour towards COVID-19 and its vaccine, and postpartum psychological state.

Results A total of 432 lactating women completed the questionnaire, 198 of whom had received the COVID-19 vaccine. On the knowledge–attitude–behaviour questionnaire on COVID-19 and its vaccines, the vaccinated group scored higher than the unvaccinated group on both the three subdimensions of the questionnaire and the total score ($p < 0.01$). The results of binary logistics regression analysis showed that mixed feeding (OR=2.68, 95% CI: 1.82 to 3.96), longer breastfeeding duration (OR=1.31, 95% CI: 1.16 to 1.49), better physical condition (OR=5.28, 95% CI: 1.82 to 15.32), higher attitude score of COVID-19 and its vaccine (OR=1.18, 95% CI: 1.10 to 1.27), and having a travel history in medium high-risk areas (OR=3.49, 95% CI: 1.46 to 8.37) were significantly associated with COVID-19 vaccination in lactating women. Having a master's degree or above (OR=0.03, 95% CI: 0.01 to 0.30), and having higher anxiety score (OR=0.66, 95% CI: 0.54 to 0.81) and depression score (OR=0.84, 95% CI: 0.75 to 0.93) were inversely associated with COVID-19 vaccination in lactating women.

Conclusion 45.8% of lactating women were vaccinated against COVID-19. Education level, feeding methods, duration of breast feeding, travel history in medium high-risk areas, physical condition, attitude score of COVID-19 and its vaccine, anxiety symptom and depressive symptom score were associated with vaccination of lactating women. More interventions based on these factors were

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study explores the status and related factors of vaccination against COVID-19 among lactating women during the COVID-19 outbreak in a setting where there are limited data.
- ⇒ A self-developed and pre-validated knowledge–attitude–behaviour questionnaire was used to investigate the cognition and performance of lactating women on COVID-19 and its vaccine.
- ⇒ The willingness of lactating women to be vaccinated is time limited and may be influenced by the high prevalence and mortality rates of the current outbreak.
- ⇒ This is a cross-sectional study and causality could not be inferred.
- ⇒ There are other possible biases such as sampling bias due to lower responses in lactating women with limited internet access, social desirability bias in responses and recall bias in responses.

needed to reduce concerns for lactating women and increase their vaccination rates.

INTRODUCTION

The global pandemic of COVID-19 has brought a huge disease burden and high mortality to all countries. According to the WHO, the virus has caused more than 6 million deaths from the pandemic so far.^{1 2} Therefore, countries around the world are intensively carrying out research on COVID-19 and its vaccines to reduce the risk of contracting this disease. As the ongoing available data showed, as of 26 June 2022, more than 11 billion doses of vaccine have been administered globally.² Previous studies have explored the scope and safety of COVID-19 vaccines, but there is insufficient epidemiological evidence to support the efficacy and safety of vaccinating lactating women because of the absence of clinical

trials.^{3–5} Many scientific institutions and epidemiologists, based on their previous experience with other vaccines and finite experimental data on COVID-19 vaccines, and fully weighing the benefits and risks of vaccination for lactating women, concluded that the administration of COVID-19 vaccines should be given to all lactating women^{6–9}; and if their conditions put them at greater risk, they should be in the priority group.⁴ Given the developmental and health benefits of breast feeding, neither the WHO nor the Academy of Breastfeeding Medicine recommends that mothers should stop breast feeding after receiving the COVID-19 vaccine.^{9 10}

Lactating women might be more hesitant to be vaccinated against COVID-19, a possible hypothesis partly because their bodies have not fully recovered after giving birth and they need to avoid vaccine-related risks, and another because of concerns that the vaccine could threaten the health of newborns or infants through breast milk.¹¹ An important and easily overlooked point is that some lactating women might experience more severe postpartum anxiety and depressive symptoms during the pandemic,¹² which would also affect their vaccination status. Therefore, the purpose of this study was to investigate the vaccination status of lactating women against COVID-19, analyse the factors affecting their vaccination and provide a reference for healthcare providers to carry out COVID-19 vaccination for lactating women.

METHODS

This study promoted a cross-sectional online survey in Changsha City, Hunan Province, China, from September 2021 to December 2021. We divided Changsha into five regions according to the geographical location: east, south, west, north and middle. One community was randomly selected from each region and a total of five communities were selected. A community refers to the social life community composed of people living together in a certain area. The size of the community varies according to the number of nearby buildings and the number of residents within the jurisdiction. Households under jurisdiction range from 1500 to 5000, each of whom belongs to a nearby community. Each community has a community health service centre that provides basic health services to all residents within its jurisdiction. Our research was conducted with the help of community health service centres. Usually, to facilitate the management of health records of all newborns in their districts, WeChat groups have been set up in each community health service centre to inform new parents of their children's vaccinations and provide them with advice. Considering the inconvenience of lactating women going out during the epidemic, our research was carried out with the help of these WeChat groups. We sent the link of the electronic questionnaire to each lactating woman and carried out several promotions and reminders in the WeChat groups.

Patient and public involvement

Patients and the public were not involved in the study design, or in the recruitment to, and conduct of the study.

Participants

All participants consisted of women in the community who had given birth and were breast feeding, including those who were exclusively breast feeding, and mixed feeding but not exclusively milk feeding. The required sample size was calculated according to the formula: $n = \frac{u_{\frac{\alpha}{2}}^2 p(1-p)}{\delta^2}$, where α is a 5% margin of error, a 95% CI and a vaccination rate of 65% since some Chinese researchers hold that the vaccination rate of COVID-19 in the population should be 60%~70%. To account for a 10% loss from invalid answers, the theoretical sample size was 422.

Measures

The whole questionnaire consists of three parts: general information, knowledge–attitude–behaviour towards COVID-19 and its vaccine, and postpartum psychological status (online supplemental file 2).

General information

General information includes age, ethnicity, marital status, education level, place of residence, occupation, medical background, number of children, feeding methods, history of COVID-19 infection, travel history in medium high-risk areas, relationship with family members and physical condition. The questions about medical background, history of COVID-19 infection, and travel history in medium high-risk areas refer to participants and their family members. Medium high-risk areas are classified by the government based on the number of public infections and the severity of the spread of COVID-19, which can be a province, a district or a street.

Knowledge–attitude–behaviour towards COVID-19 and its vaccine

Based on China's Diagnosis and Treatment Protocol for Novel Coronavirus Infected Pneumonia (trial version 5)¹³ and related research,¹⁴ we developed a knowledge–attitude–behaviour questionnaire to assess participants' perceptions and performance of COVID-19 and its vaccines, including the following three dimensions: (1) knowledge—this dimension was assessed by seven items on a 5-point scale (1=very unknown, 5=very familiar), including clinical features, severity, treatment and protection measures for COVID-19, and the type, suitability, and contraindications of COVID-19 vaccines. (2) Attitude—participants were required to identify 10 items under certain circumstances, such as 'I think it is necessary for a national COVID-19 vaccination programme', 'Vaccination can reduce the likelihood of confirmed patients into intensive care', 'I worried that vaccination will be harmful to the baby through breast milk', etc. Each item was rated from strongly disagree to strongly agree on a scale of 1–5. (3) Behavioural—this dimension involved three items, namely 'take protective measures in public places',

'remind people around to take protective measures' and 'persuade family members to get the COVID-19 vaccine'. The answers ranged from very inconsistent (1 point) to very consistent (5 points). The sum of the scores of all items in each subdimension is the score of that dimension, and the total score of the three dimensions is the score of the whole questionnaire. The score was calculated on a scale of 100 points, with higher scores indicating better perceptions and responses to COVID-19. The content of the questionnaire was determined with the guidance of an epidemiologist, a vaccination manager and an infectious diseases doctor. The coefficient of variation and Kendall's harmony coefficient of the three experts' opinions were 0.116 and 0.483, respectively, and the Cronbach coefficient of the questionnaire was 0.857. Factor analysis was used to evaluate the structural validity; the Kaiser-Meyer-Olkin was 0.795 and Bartlett's sphericity test reached the significance level ($p < 0.001$), explaining 72.62% of the total variation, which confirmed the satisfactory reliability and validity of this questionnaire. Before the formal distribution of the questionnaire, we conducted a pretest on 10 lactating women. The effective recovery rate and survey quality were guaranteed through settings such as notification, required questions and time limit for answering questions.

Postpartum psychological status

Postpartum psychological status was assessed primarily for anxiety and depressive symptoms, using the seven-item Generalized Anxiety Disorder Scale (GAD-7)¹⁵ and the Edinburgh Postpartum Depression Scale (EPDS),¹⁶ respectively. Both scales use a 4-point scale from 0 to 3, a score of 5 or above in the former indicates anxiety symptoms, while a score of 9 or above in the latter indicates depressive symptoms. The higher the participant's scores, the more severe their anxiety or depressive symptoms were. Both scales have been widely demonstrated to have appropriate reliability and validity. The internal consistency coefficient of GAD-7 was 0.92, and the test-retest reliability was 0.83.¹⁷ The Cronbach's alpha for EPDS was 0.87, and the concurrent validity of the EPDS evaluated against the Beck Depression Inventory scores was $r = 0.79$.¹⁸

Statistical analysis

All analyses were performed using SPSS V.22.0 (SPSS/IBM). Data on demographic information and vaccination status were presented as the mean \pm SD and percentage. χ^2 and t-tests were used to analyse differences in variables between vaccinated and unvaccinated groups. Logistic regression models were applied to identify factors for vaccination against COVID-19 in lactating women. Bilateral tests were used for all analyses, and a p value of < 0.05 was considered statistically significant.

RESULTS

Sample characteristics

A total of 506 lactating women were invited to participate in the study, of whom 457 filled out questionnaires

and 432 were included in the final analysis (12=too many missing items, 8=logical error, 5=consistent answer). As shown in [table 1](#), the age of these participants ranged from 20 to 45 years (average 30.9 years), 95.1% of them were Han Chinese and 81.7% were urban residents. Fifty-two (12.0%) had a master's degree or above, and 95 (22.0%) were housewives. A total of 282 (65.3%) were exclusively breast feeding, and 150 (34.7%) were mixed breast and formula feeding. The duration of breast feeding for these mothers ranged from 1 to 24 months, with an average of 6.9 months. Ten participants (2.3%) reported a history of COVID-19 infection in themselves or family members, and 124 (28.7%) reported a travel history to medium high-risk areas. Their score on the COVID-19 knowledge-attitude-behaviour questionnaire was 59.8 (8.8). One hundred twenty-two (28.2%) lactating women reported anxiety symptoms, 93 (21.5%) reported depressive symptoms, and 68 (15.7%) reported both anxiety and depressive symptoms.

Vaccination status

In total, 198 (45.8%) participants received the COVID-19 vaccine, of which 69 (16.0%) reported they were vaccinated entirely voluntarily, 23 (5.3%) at the recommendation of family members and 43 (10.0%) at community advocacy. After vaccination, 49 (11.3%) showed stopping breast feeding and 104 (24.1%) resumed breast feeding after a pause. Of all those vaccinated, 114 (57.6%) said they were willing to get a booster shot if needed, 65 (32.8%) said they were unsure and 19 (9.6%) categorically refused. Among all the reasons why lactating women were not vaccinated against COVID-19, the biggest one is 'I'm afraid the vaccine will affect the baby through breast milk' (74.4%), followed by 'It's hard to make an appointment or go out so that I have no chance to get vaccinated' (8.1%). Allergies to vaccine ingredients (3.4%) and worries about vaccine side effects harming their health (3.0%) also account for a certain proportion ([table 2](#)).

Comparison of variables between vaccinated and non-vaccinated

The χ^2 test and t-test were performed to analyse the differences between different participants whether they were vaccinated against COVID-19 or not (0=unvaccinated, 1=vaccinated) as the dependent variable, and the characteristics of the participants as the independent variable. The results showed that there were statistically significant differences in ethnicity, marital status, educational level, medical background, number of children, feeding methods, travel history in medium high-risk areas, physical condition, duration of breast feeding, scores for COVID-19 knowledge-attitude-behaviour, anxiety scores and depressive scores between the two groups ($p < 0.05$). On the contrary, age, place of residence, occupation, history of COVID-19 infection and relationship with family members showed no statistically significant difference between participants ($p > 0.05$) ([table 3](#)).

Table 1 Characteristics of the study sample (N=432)

Variable		Frequency	Mean (SD)/prevalence (%)
Age, years		432	30.9 (4.8)
Ethnicity	Han nationality	411	95.1
	Minority	21	4.9
Marital status	Unmarried	16	3.7
	Married	416	96.3
Education level	Junior high school or below	48	11.1
	Senior high school	123	28.5
	Bachelor's degree	209	48.4
	Master's degree or above	52	12.0
Residence	Rural	79	18.3
	Urban	353	81.7
Occupation	Farmer	23	5.3
	Worker	49	11.3
	Employee of enterprises/public institutions	254	58.8
	Student	11	2.5
	Housewife	95	22.0
Medical background	No	333	77.1
	Yes	99	22.9
Number of children	1	196	45.4
	2	213	49.3
	≥3	23	5.3
Feeding methods	Exclusive breast feeding	282	65.3
	Mixed feeding	150	34.7
History of COVID-19 infection	No	422	97.7
	Yes	10	2.3
Travel history in medium high-risk areas	No	308	71.3
	Yes	124	28.7
Relationship with family	Poor	13	3.0
	Average	26	6.0
	Good	393	91.0
Physical condition	Poor	63	14.6
	Average	217	50.2
	Good	152	35.2
Duration of breast feeding, months		432	6.9 (2.8)
Score for COVID-19 knowledge–attitude–behaviour		432	59.8 (8.8)
Anxiety symptoms	No	310	71.8
	Yes	122	28.2
Depressive symptoms	No	339	78.5
	Yes	93	21.5

Factors influencing receiving COVID-19 vaccine in lactating women

A binary logistics regression analysis was conducted to investigate the independent factors influencing the vaccination of lactating women against COVID-19. After all

the variables with statistical significance in [table 3](#) were included in the model, the result has shown that women with a master's degree or above (OR=0.03, 95% CI: 0.01 to 0.30), higher anxiety scores (OR=0.66, 95% CI: 0.54 to 0.81) and higher depression scores (OR=0.84, 95% CI:

Table 2 Vaccination status (N=432)

Variable	Frequency	Prevalence (%)
Vaccinated or not (N=432)		
No	234	54.2
Yes	198	45.8
Willingness to be vaccinated (N=198)		
Completely voluntary	69	34.9
Family advice	23	11.6
Work unit advocacy	63	31.8
Community advocacy	43	21.7
Breast feeding after vaccination (N=198)		
Terminate breast feeding	49	24.8
Continue breast feeding after a period of pause	104	52.5
Breast feeding as usual	45	22.7
Whether there are adverse reactions after vaccination (N=198)		
No or slight adverse reactions	198	100.0
Moderate to severe adverse reactions	0	0
Willingness to get booster shots (N=198)		
Yes	114	57.6
No	19	9.6
Uncertain	65	32.8
Reasons for not getting vaccinated (N=234)		
I'm worried about the vaccine will affect my health	7	3.0
I'm afraid the vaccine will affect the baby through breast milk	174	74.4
I feel that the prevention and control of the epidemic are sufficient and there is no need to be vaccinated	15	6.4
There are so many types of vaccines that I don't know which one is better for vaccination	11	4.7
It's hard to make an appointment or go out so that I have no chance to get vaccinated	19	8.1
I am allergic to a component of the vaccine	8	3.4

0.75 to 0.93) were more likely to skip COVID-19 vaccination. Those who were mixed feeding (OR=2.68, 95% CI: 1.82 to 3.96), had longer breastfeeding duration (OR=1.31, 95% CI: 1.16 to 1.49), had a history of high-risk travel (OR=3.49, 95% CI: 1.46 to 8.37), had a better physical condition (OR=5.28, 95% CI: 1.82 to 15.32) and had higher COVID-19 attitude scores (OR=1.18, 95%

CI: 1.10 to 1.27) were more likely to receive COVID-19 vaccine. After controlling for age, ethnicity, marital status and place of residence, these factors remained significantly associated with vaccination among lactating women (table 4).

DISCUSSION

This study explored the status and related factors of vaccination against COVID-19 among lactating women during the COVID-19 outbreak. We found that only 45.8% of lactating women received the COVID-19 vaccine, lower than the 60%–70% of population vaccination rate expected by Chinese researchers.¹⁹ Among the unvaccinated, 74.4% were concerned that the vaccine might affect the baby's health through breast milk. This suggests that most lactating women remain sceptical about the safety of vaccines, which is consistent with the findings of Kumari *et al.*¹⁴ We noticed that 53.5% of women were vaccinated under the advocacy of the unit or the community, which seems encouraging as it might show that the government made efforts to promote COVID-19 vaccination. As we know, almost all COVID-19 vaccinations in China are carried out in the community, which is the government's primary health service organisation, and the staff regularly remind people to get vaccinated for free. However, as the coronavirus continues to mutate, vaccination could become a long-term adaptation effort, meaning we might need more vaccinations. Therefore, more available data are urgently needed to confirm that COVID-19 vaccines would not threaten the health of infants through breast milk, which might greatly facilitate the acceptance of the COVID-19 vaccine in lactating women.

According to our findings, lactating women with a master's degree or above were significantly less likely to receive the COVID-19 vaccine than those with junior high school or below education. Women with higher education tend to know better how to get it to their advantage. They might pay more attention to data and documents from governments or authorities, such as literature reports or descriptions with high levels of evidence, before vaccination. Admittedly, no institution could give a positive answer currently because of the absence of lactating women in clinical trials.^{4,8} Another unexpected finding was that 38.3% of lactating women who were not vaccinated against COVID-19 were in a family with a medical background, indicating that some clinical staff hesitated to vaccinate lactating women. A previous study also confirmed that working in healthcare was not associated with vaccine acceptance.²⁰ Although this factor did not independently predict the vaccination of lactating women, it was a wake-up call for authorities as medical staff play a critical role in influencing vaccination decisions. As pointed out by previous researchers, all individuals facing patients in the clinic should be confident about the safety and effectiveness of COVID-19 vaccines.²¹ The current consensus is that the active part of these vaccines is unlikely to reach breast tissue and then the

Table 3 Comparison of variables between those vaccinated and non-vaccinated (N=432)

Variable	Non-vaccinated (N=234)		Vaccinated (N=198)		χ^2	P value	
	n	%	n	%			
Classification predictor							
Ethnicity	Han nationality	224	97.0	184	92.9	3.859	0.049
	Minority	7	3.0	14	7.1		
Marital status	Unmarried	14	6.0	2	1.0	7.436	0.006
	Married	220	94.0	196	99.0		
Education level	Junior high school or below	26	11.1	22	11.1	71.349	<0.001
	Senior high school	82	35.0	41	20.7		
	Bachelor's degree	76	32.5	133	67.2		
	Master's degree or above	50	21.4	2	1.0		
Residence	Rural	38	16.2	41	20.7	1.433	0.231
	Urban	196	83.8	157	79.3		
Occupation	Farmer	13	5.6	10	5.1	7.501	0.112
	Worker	26	11.1	23	11.6		
	Employee of enterprises/public institutions	130	55.6	124	62.6		
	Student	10	4.3	1	0.5		
	Housewife	55	23.5	40	20.2		
Medical background	No	196	83.8	137	69.2	12.886	<0.001
	Yes	38	16.2	61	30.8		
Number of children	1	124	53.0	72	36.4	12.064	0.002
	2	100	42.7	113	57.1		
	≥3	10	4.3	13	6.6		
Feeding methods	Exclusive breast feeding	193	82.5	89	44.9	66.644	<0.001
	Mixed feeding	41	17.5	109	55.1		
History of COVID-19 infection	No	231	98.7	191	96.5	2.408	0.121
	Yes	3	1.3	7	3.5		
Travel history in medium high-risk areas	No	197	84.2	111	56.1	41.462	<0.001
	Yes	37	15.8	87	43.9		
Relationship with family	Poor	10	4.3	3	1.5	4.383	0.112
	Average	17	7.3	9	4.5		
	Good	207	88.5	186	93.9		
Physical condition	Poor	48	20.5	15	7.6	16.384	<0.001
	Average	116	49.6	101	51.0		
	Good	70	29.9	82	41.4		
Continuous predictor		Non-vaccinated		Vaccinated		t	P value
Age, years		30.5±4.7		31.4±4.8		-1.938	0.053
Duration of breast feeding, months		5.4±2.4		8.6±3.4		-9.562	<0.001
Score for COVID-19 knowledge–attitude–behaviour		57.6±7.3		62.4±9.7		-5.716	<0.001
Knowledge score		20.5±3.0		22.4±4.8		-4.791	<0.001
Attitude score		27.2±3.3		29.3±3.6		-6.466	<0.001

Continued

Table 3 Continued

Variable	Non-vaccinated (N=234)		Vaccinated (N=198)		χ^2	P value
	n	%	n	%		
Behaviour score	9.9±2.7		10.7±2.9		-2.743	0.006
Anxiety scores	4.6±2.8		2.4±1.4		10.784	<0.001
Depression scores	7.0±3.5		4.2±2.8		9.495	<0.001

infant, and in the unlikely event that it reaches the infant, it is unlikely to have any biological effects.⁴

In our screening, mixed-feeding women were more likely to receive the COVID-19 vaccine than exclusively breastfeeding women. After vaccination, more than half chose to suspend breast feeding, and 24.8% of them discontinued breast feeding. These moves seemed overly negative, as a prospective cohort study found transient low levels of vaccine mRNA detected in serum from vaccinated mothers occasionally transferred to breast milk, but no evidence could be found to cause sensitisation in infants.²² Previous evidence has shown that none of the COVID-19 vaccines contain live viruses and there is no plausible biological mechanism to explain how a mother's inactivated vaccine could harm her breastfed baby.^{8,23} Breast milk has always been considered as a rich source of antibodies for infants. From the perspective of

physiology and other previous vaccination experiences, antibodies and T cells, generated by the body and stimulated by vaccines, might passively enter breast milk. Antibodies in breast milk have a strong neutralisation ability, which might bring potential protective effects to nursing infants.²⁴ Two small sample studies had also confirmed that novel coronavirus IgA antibodies were detectable in breast milk 2 weeks after the first injection of the COVID-19 vaccine, IgG antibodies were detectable 3–4 weeks later and antibodies could persist for at least 80 days.^{25,26} Therefore, while some officials hold that the benefits and risks of vaccination for lactating women should be fully assessed before vaccination, virtually every institution or study, including two evidence-based documents, recommended that breast feeding should not be interrupted or discontinued after the COVID-19 vaccine in lactating women.^{4,8,27–32}

Table 4 Independent influence of non-vaccination against COVID-19

Variable	B	S _b	Wald X ²	P value	OR	95% CI	OR*	95% CI
Constant	-4.184	2.009	4.336	0.037	0.02			
Education level								
Master's degree or above	-3.524	1.179	8.934	0.003	0.03	0.01 to 0.30	0.04**	0.01 to 0.42
Bachelor's degree	0.496	0.729	0.464	0.496	1.64	0.39 to 6.86	3.37	0.69 to 16.51
Senior high school	-0.815	0.569	2.052	0.152	0.44	0.15 to 1.35	0.59	0.17 to 2.07
Junior high school or below					1.00		1.00	
Feeding methods								
Mixed feeding	0.987	0.198	24.745	<0.001	2.68	1.82 to 3.96	3.17**	2.03 to 4.95
Exclusive breast feeding					1.00		1.00	
Duration of breast feeding, months	0.272	0.064	17.818	<0.001	1.31	1.16 to 1.49	1.32**	1.16 to 1.51
Travel history in medium high-risk areas								
Yes	1.250	0.446	7.850	0.005	3.49	1.46 to 8.37	3.88**	1.57 to 9.62
No					1.00		1.00	
Physical condition								
Good	1.664	0.544	9.357	0.002	5.28	1.82 to 15.32	4.76**	1.49 to 15.20
Average	1.242	0.507	6.002	0.014	3.46	1.28 to 9.35	2.77	0.95 to 8.09
Poor					1.00		1.00	
Attitude score for COVID-19	0.167	0.038	19.074	<0.001	1.18	1.10 to 1.27	1.11*	1.01 to 1.23
Anxiety scores	-0.415	0.107	15.092	<0.001	0.66	0.54 to 0.81	0.76*	0.61 to 0.95
Depression scores	-0.177	0.055	10.195	0.001	0.84	0.75 to 0.93	0.83**	0.74 to 0.93

*P<0.05; **p<0.01.
*Adjusted for age, ethnicity, marital status and residence.



In this study, we found that lactating women whose family members had travelled to medium high-risk areas were more likely to receive the COVID-19 vaccine than those without risky travel histories. This might be related to the higher self-perceived risk they experienced while travelling. In China, when a place has a large number of new cases or a rapid transmission speed, it will be quickly classified as a medium or high-risk area by the government, and corresponding control measures such as travel restrictions, nucleic acid tests and designated medical treatments will be launched.³³ Once they experienced such strict and effective control measures, people might pay more attention to the epidemic and trust the government more. To cooperate with the authorities, strengthen resistance and make future travels more convenient, vaccination is a wise choice. We also found that lactating women with poorer health showed lower COVID-19 vaccine acceptance, which might be attributable to incomplete recoveries after childbirth, or concern about vaccine side effects, or physical inability to go out.

In the knowledge–attitude–behaviour questionnaire, only the attitude score was significantly associated with vaccination in lactating women. This is similar to previous findings on vaccination intentions among medical students and nurses.^{34–35} Almost everyone had a positive understanding of the transmission characteristics of and protective measures against COVID-19, as well as the role of vaccines, but few had full knowledge of the scope of application and contraindications of vaccines, or even showed a negative attitude. For example, 7.0% of participants agreed with the statement ‘I think healthy people do not need to receive the COVID-19 vaccine’, 36.8% agreed with ‘I am worried about the side effects of the vaccines on my body’ and 87.3% agreed with ‘I am concerned that vaccination will affect the baby’s health through breast milk’. Inappropriate attitudes and motivations are bound to influence the behaviour of participants, so a lack of trust and misinformation might be important reasons for low COVID-19 vaccination rates among lactating women. While awaiting data from phase III clinical trials in other populations and epidemiological data on large numbers of lactating women vaccinated against COVID-19, public health authorities need to make efforts to disseminate correct knowledge to help lactating women shape positive attitudes towards COVID-19 vaccines.

In this study, we found that the prevalence rates of anxiety and depression among lactating women during the pandemic were 28.2% and 21.5%, higher than commonly reported in previous studies for postpartum and lactating women.^{36–38} The main reason might be that previous data reported generalised anxiety during the postpartum period rather than specific anxiety during the epidemic. The precarious situation of the epidemic has further exacerbated maternal anxiety due to insecurity, increased vulnerability to the disease and threat to the health of infants. Maladjustment for new mothers, enforced measures such as social distancing, travel bans and lockdowns might also affect lactating women as

they had limited available resources and family support, and hinder routine hospital appointments, which might contribute to increased maternal anxiety and depression.^{12–39} This study confirmed that both anxiety and depression were significantly associated with COVID-19 vaccination in lactating women. We believed that these two might interact, and higher anxiety and depressive symptoms might increase concerns about vaccine safety, and in turn, distrust of vaccines might increase anxiety and depressive symptoms, but further data are needed to confirm this. In a word, public health authorities, biomedical sciences and healthcare researchers should pay more attention to the mental health of lactating women, in addition to the biological and physical effects of COVID-19.

Limitations and future implications

This study has several limitations. First, this is a cross-sectional study and causality could not be inferred. Second, the intentions of lactating women to be vaccinated are time bound and might be influenced by the high prevalence and mortality of the current outbreak. Third, although this study demonstrated that anxiety and depression affected vaccination in lactating women, we did not assess their prenatal or pre-epidemic psychological status, and therefore we could not draw a direct relationship between anxiety, depression and vaccination. Fourth, there were some other possible biases, such as sampling bias due to low response of lactating women with limited internet access, social desirability bias in responses and recall bias in responses.

CONCLUSION

COVID-19 vaccinations among lactating women were associated with physical conditions, education levels, feeding methods, duration of breast feeding, attitudes towards COVID-19, anxiety symptoms and depressive symptoms. Considering that less than 50% of lactating women in this study were vaccinated during the global pandemic, this would pose a huge challenge to post-pandemic vaccine roll-out. Therefore, more evidence is needed to confirm the safety of the vaccine for lactating women, and public health authorities should give lactating women more correct advice and timely interventions based on the factors for the reluctance to vaccinate.

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