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Knowledge, attitude, and acceptance of COVID-19 vaccine in pregnant women

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Abstract

Background: Due to the COVID-19 situation, vaccination is a key factor in reducing the severity and transmission of the disease, especially in the vulnerable population, which includes pregnant women. Currently, various policies are in place to promote the vaccination of pregnant women against COVID-19; however, some pregnant women decline vaccination.

Objectives: To study pregnant women's knowledge, attitude, and acceptance regarding the COVID-19 vaccine.

Design: A cross-sectional study was conducted among pregnant women who received antenatal care at King Chulalongkorn Memorial Hospital, Chulalongkorn University, Bangkok, Thailand.

Methods: Pregnant women who received antenatal care at King Chulalongkorn Memorial Hospital, Chulalongkorn University from November 2021 to April 2022 were included. The participants answered an online questionnaire through their electronic devices. Univariate and multivariate logistic regression analyses were performed to analyze the data.

Results: A total of 500 pregnant women participated in this study. Among them, 67.4% and 81.4% had great knowledge and a positive attitude toward the COVID-19 vaccine, respectively, with scores of 80% or higher in each section. Of the 500 participants, 468 (93.6%) accepted to receive the COVID-19 vaccine. After adjusting for certain variables through multivariate analysis, the factor associated with the decision to receive the COVID-19 vaccine was having great knowledge about the vaccine (adjusted odds ratio (OR) 13.25, 95% confidence interval (CI) 2.45–71.61). However, the most significant factor associated with the decision to reject the COVID-19 vaccine was the recent COVID-19 infection (adjusted OR 0.11, 95% CI 0.02–0.62).

Conclusion: The COVID-19 pandemic presents severe and life-threatening conditions for both pregnant women and their fetuses. The majority of the pregnant women in this study had great knowledge and acceptance of the vaccine and a positive attitude toward it. The pregnant women who had prior knowledge of the vaccine tended to accept to receive it during pregnancy, whereas those who recently contracted COVID-19 were hesitant to receive the vaccine.

Plain language summary

Knowledge, attitude and acceptance of COVID-19 vaccine in pregnant women

Due to the COVID-19 situation, vaccination is a key factor in reducing the severity and transmission of the disease, especially in the vulnerable population, which includes pregnant women. Currently, various policies are in place to promote the vaccination of pregnant women against COVID-19; however, some pregnant women decline vaccination. This study aimed to investigate pregnant women's knowledge, attitude, and acceptance

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regarding the COVID-19 vaccine. A total of 500 pregnant women were recruited. The study found that 67.4% and 81.4% had great knowledge and a positive attitude toward the COVID-19 vaccine, respectively, with scores of 80% or higher in each section. 93.6% accepted to receive the COVID-19 vaccine. The factor associated with the decision to receive the COVID-19 vaccine was having great knowledge about the vaccine. However, the most significant factor associated with the decision to reject the COVID-19 vaccine was the recent COVID-19 infection. In summary, the majority of the pregnant women in this study had great knowledge and acceptance of the vaccine and a positive attitude towards it.

Keywords: acceptance, attitude, COVID-19 vaccine, knowledge, pregnancy

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Introduction

In December 2019, the World Health Organization announced that SARS-CoV-2, a new virus, was the cause of the pandemic. It is a single-stranded, capsulated RNA virus that can be spread through droplet transmission or airborne transmission by aerosol-generating procedures. This viral infection can cause severe pneumonia that leads to respiratory failure or even death.[1,2]

Pregnant women who have COVID-19 infection are at greater risk of being admitted to hospital intensive care units and mortality. COVID-19 infections tend to cause more severe respiratory illnesses in pregnant women than in the general population, mainly due to the decrease in residual lung volume and pulmonary reserve during pregnancy.[3,4] Moreover, pregnant women are also at higher risk of developing thromboembolic events as a result of an altered hypercoagulable state during pregnancy.[4]

For fetuses and newborns, there is no serious complication other than preterm birth, which only occurs in severe cases of maternal COVID-19 infection.[4–6] Congenital COVID-19 infection is rare, as the SARS-CoV-2 viral RNA level is usually undetectable in newborns and asymptomatic.[4]

From the latest update on December 2022, the COVID-19 pandemic has caused a major effect on our global health system, with more than six million deaths from a total of 600 million infections worldwide.[2] Meanwhile, in Thailand, there have been approximately four million reported cases of infection, with 30,000 deaths.[7]

Several vaccines have been invented to prevent and mitigate the severity of COVID-19. Currently, the Food and Drug Administration of Thailand has approved six vaccines: AstraZeneca, CoronaVac, Johnson & Johnson, Moderna, Sinopharm, and Pfizer-BioNTech.[8] The Pfizer-BioNTech and Moderna vaccines, which contain a part of the mRNA virus, have good efficacy in preventing COVID-19 infection, at 95% and 94.1%, respectively.[9,10] The AstraZeneca and Johnson & Johnson vaccines, both adenovirus vector vaccines, have preventive efficacy rates of 70.4% and 66.9%, respectively.[11] The CoronaVac and Sinopharm vaccines, made of dead SARS-CoV-2 viruses, have a preventive efficacy rate of 50%–84% and 79%, respectively.[12,13] The World Health Organization strongly recommends the vaccination of pregnant women against COVID-19 as the benefits outweigh the potential risks.[14]

In a literature review examining the acceptance of the COVID-19 vaccines, a cross-sectional study conducted in Libya in 2020 interviewed 15,087 people above 18 years old via electronic mail and social media. The study revealed that 79.6% of the respondents expressed willingness to receive the vaccine with an efficacy rate of over 90%, 60.6% were willing to receive the vaccine with an

efficacy rate of over 70%, and only 41.2% were willing to receive the vaccine with an efficacy rate exceeding 50%.[15] Another cross-sectional study conducted in 2020 interviewed 17,871 people from 16 countries via an online questionnaire. The participants were pregnant women, non-pregnant women aged 18 years and above, and mothers of children under 18 years old. The results of the study revealed that 52% of the pregnant women expressed a preference for receiving the COVID-19 vaccine during pregnancy.[16] Previous study regarding COVID-19 vaccine acceptance in general population in Thailand found that 88.4% of the participants accepted the vaccine. Males and high education significantly correlated with vaccine acceptance.[17]

Some studies demonstrated hesitancy in the COVID-19 vaccine in pregnant women[18,19] and parents.[20,21] The vaccine hesitancy rate in pregnant women was 40.7%–57%.[18,19] Women with vaccine hesitancy were more likely to fear adverse reactions, safety, and efficacy compared to those without vaccine hesitancy.[19] The vaccine hesitancies were largely based on the lack of knowledge about the impacts of vaccination on pregnancy, fetal development, and later child well-being.[18] Regarding the hesitancy of the COVID-19 vaccine in parents, behavior, safety and efficacy, and general attitudes of parents toward childhood vaccines were the risk factors associated with the hesitancy in the parents from Zhejiang.[21] Previous systemic review found that vaccine hesitancy rates ranged from 26% to 57% among different studies. Fear of adverse events and lack of knowledge were shown to be the main drivers of hesitancy.[22]

Due to the COVID-19 situation, vaccination is a key factor in reducing the severity and transmission of the disease, especially in the vulnerable population, which includes pregnant women. Currently, various policies are in place to promote the vaccination of pregnant women against COVID-19; however, some pregnant women decline vaccination. This study aimed to examine Thai pregnant women's knowledge, attitude, and acceptance regarding the COVID-19 vaccine. The research questions of this study were as follows: (1) What is the level of knowledge regarding COVID-19 vaccination among pregnant women? (2) What is the COVID-19 vaccine acceptance associated with pregnancy?

Materials and methods

This was a cross-sectional study carried out at the Department of Obstetrics and Gynecology, King Chulalongkorn Memorial Hospital, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand. The research protocol was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University (IRB no. 622/64). King Chulalongkorn Memorial Hospital is a large tertiary care hospital and a university hospital, located in Bangkok, capital city of Thailand. It has 1500 beds for inpatient admissions.

This study was conducted between November 2021 and April 2022 and included 500 Thai pregnant women aged 18 years and above who visited the antenatal care clinic at King Chulalongkorn Memorial Hospital. Pregnant women who were unable to read or write in Thai and those without access to electronic devices as the participants were to use their own electronic devices were excluded from the study. The researchers recruited the participants which were pregnant women who visited antenatal care clinic of King Chulalongkorn Memorial Hospital. Details of the questionnaire were explained, and confidentiality was confirmed. Informed consent was performed before the questionnaire was given. The recruitment period took 6 months from November 2021 to April 2022.

The eligible pregnant women at the antenatal care clinic were provided with the online Google Form questionnaire via QR code. They were assured of the confidentiality of their responses and that they would only be used for the study. Moreover, the responses to the questionnaire were anonymous and could not be traced back to the participants. There was no patient's specific identity that could trace back to the participant on the Google Form. Only the researchers had password to enter to the answers of the Google Form questionnaire.

After agreeing to participate in the study, the participants were required to provide informed consent. Agreement was provided in written form of informed consent. They were not incentivized to participate in the study. Following this, they received the QR code to access and respond to the questionnaire. It took 20 min for participants to complete the questionnaire. The researchers

provided the Google Form questionnaire and assured the confidentiality issues. It was not the same person. They did not take care of the participants.

The sample size was calculated based on the formula of single proportion ($n = Z\alpha_{/2}^2\ pq/d^2$) with p as an acceptance rate of 0.5 from the expected rate of acceptance. With an α of 0.05 and $d = 0.05$, the total number of participants needed for this research to have an adequately powered study was 500 after adding 30% of incomplete data.

The primary objective of this research was to study the acceptance of the COVID-19 vaccine in pregnant women. The secondary objectives were to study pregnant women's knowledge of and attitudes toward the COVID-19 vaccine and the factors associated with their acceptance of the vaccine.

The questionnaire was divided into five major sections:

1. Demographic data: This section comprised of questions regarding the participants' age, marital status, parity, gestational age, underlying disease, educational level, hometown, occupation, treatment rights, monthly income, past and current COVID-19 infection, family members or friends infected with or deceased from COVID-19, and main sources of information about the COVID-19 pandemic and vaccine.
2. Perception of the COVID-19 pandemic and vaccination concerns: This section comprised of questions about the government comments on the expected duration of the pandemic used to control it, trust in the government and healthcare personnel's advice, belief in the reported number of COVID-19 cases, confidence in the effectiveness and safety of the vaccines and awareness of their complications, concern about a shortage and unequal distribution of vaccines, and preference for COVID-19 vaccines.
3. Knowledge, attitude, and practice related to COVID-19 infection during pregnancy: This section covered the participants' knowledge of preventive measures when in contact with infected people, awareness of the guidelines on breastfeeding during COVID-19 infection, knowledge about the SARS-CoV-2 virus and the importance of social distancing, knowledge of good hygiene practices, and coping methods when possibly infected with COVID-19. This section consisted of a total of 21 questions, with five, seven, and nine questions allocated to the knowledge, attitude, and practice subsections, respectively. Participants received one point for each correct answer, and a total score of 80% or higher in each subsection was determined as the cut-off score for the participant's great knowledge, attitude, and practice regarding COVID-19.
4. Knowledge, attitude, and acceptance regarding the COVID-19 vaccine: This section comprised of questions on the importance of vaccination, which individuals should be vaccinated, initial gestational age at which to begin vaccination, teratogenicity and adverse effects of the vaccine on pregnancy, trust in the benefits of the vaccine, the belief that COVID-19 vaccines can be equally distributed, the participants' opinion on the cost of the COVID-19 vaccine, recommendations to friends or family to receive the vaccine, the decision to accept vaccination based on its effectiveness, the habit of receiving flu vaccines vaccination status, and finally, the specific type and number of shots of the vaccine taken. A total of 21 questions contributed to the scores, with seven, six, and eight in the knowledge, attitude, and acceptance subsections, respectively. The last two questions in the acceptance section, regarding the type and dose of the vaccine received, did not contribute to the total score. As in the previous section, each correct answer received one point. A total score of equal to or more than 80% was determined as the cut-off score for the participant's great knowledge, attitude, and acceptance regarding the COVID-19 vaccine.
5. Factors influencing the acceptance or rejection of the COVID-19 vaccine: This last section of the questionnaire consisted of two questions regarding the main factors influencing the decision to either accept or reject the COVID-19 vaccine.

The researchers created the questionnaire and took 1 month to create it. All items included in this questionnaire were modified from previous study.[15] The English questionnaire was translated to Thai, retranslated back to English, and then compared to the first English version by different translator to ensure translation accuracy. Content validation was ensured by two obstetricians. Content validity index was 0.9. A pilot study was performed in 30 participants to assess the reliability of the questionnaire. The questionnaire had an internal consistency, with Cronbach's alpha values of 0.743.

Statistical analysis was performed using the SPSS software version 22.0. Categorical variables were presented as frequencies and percentages, while continuous variables were presented as means and standard deviations. The independent *t*-test was used to compare continuous variables, whereas the Mann–Whitney *U* test was used to compare nonparametric variables. The chi-squared test and Fisher-exact test were used to compare categorical variables. Multivariate logistic regression analysis was used to evaluate the association between factors and the acceptance of the COVID-19 vaccine. The factors with a *p* value greater than 0.05 in the univariate analysis were entered into the multivariate logistic regression analysis. The odds ratio (OR) and 95% confidence interval (CI) were calculated. A *p* value of 0.05 was considered statistically significant.

Results

Demographic data

A total of 500 pregnant women were eligible for inclusion in the study and consented to complete the questionnaire. The demographic data of the study population and acceptance of the COVID-19 vaccine are shown in Table 1. The age distribution ranges of the participants were as follows: 20–34 years (68.2%), ⩾35 years (31.2%), and <20 years (0.6%). Nearly half of the participants (45.4%) were in the third trimester of pregnancy, most of them had no underlying disease (79.0%), and 11.8% had previously been infected with COVID-19. Most of the participants had a bachelor's degree or higher (80.2%). The participants' information about the COVID-19 pandemic and vaccine mainly came from more than one source, with the internet and social media being the leading ones.

Perceptions of the COVID-19 pandemic and vaccination concerns

Table 2 shows the participants' perceptions of the COVID-19 pandemic and vaccination concerns and their association with COVID-19 vaccine acceptance. Most of the participants (81%) had concerns about serious complications from the vaccine. For most of the participants (59.2%), the most preferred vaccine for future vaccination was the Pfizer-BioNTech vaccine.

Knowledge, attitude, and practice related to COVID-19 infection during pregnancy

Table 3 represents the association between pregnant women's knowledge, attitudes, and practices related to COVID-19 infection during pregnancy and their acceptance to receive the COVID-19 vaccine. The table also depicts the scores received from each subsection and their association with the decision to accept the COVID-19 vaccine.

More than half of the participants had great knowledge about protecting themselves from COVID-19 patients, with 55.4% scoring 80% or higher.

In the attitude subsection of the questionnaire, 38.2% of the participants achieved a score of 80% or higher. However, in the practice subsection of the questionnaire, less than half of the pregnant women (44.8%) received a score of 80% or higher.

Knowledge, attitude, and acceptance regarding the COVID-19 vaccine

The association between the participants' knowledge, attitude, and acceptance regarding the COVID-19 vaccine, with the scores received from each section, and the decision to receive the COVID-19 vaccine is shown in Table 4. Most of the participants (67.4%) had great knowledge about COVID-19 vaccination, with a score of 80% or higher. More than half (78.8%) of the participants thought that the COVID-19 vaccine could not cause potentially adverse effects on their fetuses and newborns, and 73.0% perceived that the vaccine have no adverse effects on their pregnancy.

A great attitude toward the COVID-19 vaccine was demonstrated by 81.4% of the participants,

Table 1. Demographic data and acceptance to receive COVID-19 vaccine.

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
Age range (years)				0.160
<20	3 (0.6%)	2 (66.7%)	1 (33.3%)	
20–34	341 (68.2%)	320 (93.8%)	21 (6.2%)	
⩾35	156 (31.2%)	146 (93.6%)	10 (6.4%)	
Marital status				0.808
Married	426 (85.2%)	399 (93.7%)	27 (6.3%)	
Single	69 (13.8%)	64 (92.8%)	5 (7.2%)	
Separated	5 (1.0%)	5 (100.0%)	0 (0.0%)	
Gravida				0.376
First gravida	265 (53.0%)	251 (94.7%)	14 (5.3%)	
2–4 gravidas	229 (45.8%)	211 (92.1%)	18 (7.9%)	
5–7 gravidas	5 (1.0%)	5 (100.0%)	0 (0.0%)	
⩾8 gravidas	1 (0.2%)	1 (100.0%)	0 (0.0%)	
Gestational age (weeks)				0.862
⩽14 weeks	122 (24.4%)	115 (94.3%)	7 (5.7%)	
15–28 weeks	151 (30.2%)	142 (94.0%)	9 (6.0%)	
29–42 weeks	227 (45.4%)	211 (93.0%)	16 (7.0%)	
Underlying disease				0.306
Yes	105 (21.0%)	96 (91.4%)	9 (8.6%)	
No	395 (79.0%)	372 (94.2%)	23 (5.8%)	
Number of children				0.091
None	307 (61.4%)	292 (95.1%)	15 (4.9%)	
One child	147 (29.4%)	135 (91.8%)	12 (8.2%)	
Two children	38 (7.6%)	35 (92.1%)	3 (7.9%)	
⩾3 children	8 (1.6%)	6 (75.0%)	2 (25.0%)	
Education level				0.105
None	5 (1.0%)	5 (100.0%)	0 (0.0%)	
Elementary	6 (1.2%)	6 (100.0%)	0 (0.0%)	
Middle school	31 (6.2%)	26 (83.9%)	5 (16.1%)	

(Continued)

Table 1. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
High school	57 (11.4%)	50 (87.7%)	7 (12.3%)	
Bachelor's degree or higher	401 (80.2%)	381 (95.0%)	20 (5.0%)	
Hometown				0.652
Bangkok	239 (47.8%)	224 (93.7%)	15 (6.3%)	
North	35 (7.0%)	32 (91.4%)	3 (8.6%)	
Central	64 (12.8%)	62 (96.9%)	2 (3.1%)	
Northeast	117 (23.4%)	110 (94.0%)	7 (6.0%)	
East	15 (3.0%)	13 (86.7%)	2 (13.3%)	
South	30 (6.0%)	27 (90.0%)	3 (10.0%)	
Occupation				0.024
Government officer	47 (9.4%)	43 (91.5%)	4 (8.5%)	
Healthcare personnel	56 (11.2%)	56 (100.0%)	0 (0.0%)	
Business owner	51 (10.2%)	48 (94.1%)	3 (5.9%)	
State enterprise employee	27 (5.4%)	24 (88.9%)	3 (11.1%)	
Company employee	247 (49.4%)	235 (95.1%)	12 (4.9%)	
None	72 (14.4%)	62 (86.1%)	10 (13.9%)	
Coverage scheme				0.644
Universal coverage scheme	11 (2.2%)	9 (81.8%)	2 (18.2%)	
Social security scheme	107 (21.4%)	101 (94.4%)	6 (5.6%)	
Government officer	42 (8.4%)	40 (95.2%)	2 (4.8%)	
Health insurance	8 (1.6%)	7 (87.5%)	1 (12.5%)	
Thai red cross coverage scheme	62 (12.4%)	59 (95.2%)	3 (4.8%)	
Self-paid	262 (52.4%)	244 (93.1%)	18 (6.9%)	
Other	8 (1.6%)	8 (100.0%)	0 (0.0%)	
Monthly income (Baht)				0.282
<20,000	215 (43.0%)	196 (91.2%)	19 (8.8%)	
20,000–50,000	263 (52.6%)	251 (95.4%)	12 (4.6%)	
50,001–100,000	20 (4.0%)	19 (95.0%)	1 (5.0%)	
> 100,000	2 (0.4%)	2 (100.0%)	0 (0.0%)	

(Continued)

Table 1. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
Currently infected with COVID-19				0.600
Yes	4 (0.8%)	4 (100.0%)	0 (0.0%)	
No	496 (99.2%)	464 (93.5%)	32 (6.5%)	
Previously infected with COVID-19				0.017
Yes	59 (11.8%)	51 (86.4%)	8 (13.6%)	
No	441 (88.2%)	417 (94.6%)	24 (5.4%)	
Have a family member or friend infected with COVID-19?				0.490
Yes	87 (17.4%)	80 (92.0%)	7 (8.0%)	
No	413 (82.6%)	388 (93.9%)	25 (6.1%)	
Have family members or friends died due to COVID-19?				0.698
Yes	10 (2.0%)	10 (100.0%)	0 (0.0%)	
No	490 (98.0%)	458 (93.5%)	32 (6.5%)	
The main source of COVID-19 pandemic information?				
News and media	333 (66.6%)	314 (94.3%)	19 (5.7%)	0.802
Internet and social media	425 (85.0%)	399 (93.9%)	26 (6.1%)	0.377
Thailand Department of disease control	94 (18.8%)	94 (100.0%)	0 (0.0%)	0.005
Thailand Food and drug administration	18 (3.6%)	18 (100.0%)	0 (0.0%)	0.259
World Health Organization	77 (15.4%)	75 (97.4%)	2 (2.6%)	0.138
National Center for Disease Control (NCDC)	55 (11.0%)	55 (100.0%)	0 (0.0%)	0.040
Friend or family	175 (35.0%)	166 (94.9%)	9 (5.1%)	0.399
Healthcare personnel	180 (36.0%)	170 (94.4%)	10 (5.6%)	0.563
Other	4 (0.8%)	4 (100.0%)	0 (0.0%)	0.600

with a score of 80% or higher. The vaccine acceptance rates were significantly higher in the groups with great knowledge and great attitudes, at 98.2% and 96.3%, respectively. Regarding the acceptance of the COVID-19 vaccine during pregnancy, 53.2% of the participants had a score of 80% or higher, and 93.6% expressed their choice to receive the vaccine. When stratified by efficacy, it was observed that a vaccine with an efficacy rate of 95% gained acceptance from 99.0% of the participants, while a vaccine with an efficacy rate of 70% rate gained acceptance from

Table 2. Association between perception toward the COVID-19 pandemic and vaccination concerns and acceptance to receive COVID-19 vaccine.

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
How long will it take to control the COVID-19 pandemic with the current situation and facilities available?				0.031
2–6 months	3 (0.6%)	2 (66.7%)	1 (33.3%)	
4–6 months	20 (4.0%)	17 (85.0%)	3 (15.0%)	
6–12 months	91 (18.2%)	89 (97.8%)	2 (2.2%)	
More than 12 months	386 (77.2%)	360 (93.3%)	26 (6.7%)	
How confident are you in the advice given by the government and healthcare providers?				0.920
Completely confident	6 (1.2%)	6 (100.0%)	0 (0.0%)	
Fairly confident	36 (7.2%)	33 (91.7%)	3 (8.3%)	
Somewhat confident	157 (31.4%)	148 (94.3%)	9 (5.7%)	
Slightly confident	207 (41.4%)	194 (93.7%)	13 (6.3%)	
Not confident at all	94 (18.8%)	87 (92.6%)	7 (7.4%)	
Do you think that the numbers of the reported cases of COVID-19 are being exaggerated?				0.721
Yes	70 (14.0%)	64 (91.4%)	6 (8.6%)	
No	351 (70.2%)	330 (94.0%)	21 (6.0%)	
Maybe	79 (15.8%)	74 (93.7%)	5 (6.3%)	
Do you think that the numbers of the reported cases of COVID-19 are being underreported?				0.929
Yes	229 (45.8%)	214 (93.4%)	15 (6.6%)	
No	116 (23.2%)	108 (93.1%)	8 (6.9%)	
Maybe	155 (31.0%)	146 (94.2%)	9 (5.8%)	
The COVID-19 vaccines, in general, will be useful in controlling disease?				0.287
Strongly agree	27 (5.4%)	25 (92.6%)	2 (7.4%)	
Agree	212 (42.4%)	204 (96.2%)	8 (3.8%)	
Neutral	239 (47.8%)	218 (91.2%)	21 (8.8%)	
Disagree	19 (3.8%)	18 (94.7%)	1 (5.3%)	
Strongly disagree	3 (0.6%)	3 (100.0%)	0 (0.0%)	

(Continued)

Table 2. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
There are a shortage and difficulty in obtaining vaccines.				0.206
Yes	302 (60.4%)	285 (94.4%)	17 (5.6%)	
No	114 (22.8%)	108 (94.7%)	6 (5.3%)	
Maybe	84 (16.8%)	75 (89.3%)	9 (10.7%)	
Receiving an authorized vaccine for the COVID-19 will be safe and trusty?				0.135
Strongly agree	16 (3.2%)	15 (93.8%)	1 (6.3%)	
Agree	189 (37.8%)	183 (96.8%)	6 (3.2%)	
Neutral	266 (53.2%)	242 (91.0%)	24 (9.0%)	
Disagree	20 (4.0%)	19 (95.0%)	1 (5.0%)	
Strongly disagree	9 (1.8%)	9 (100.0%)	0 (0.0%)	
There will be difficulty distributing the COVID-19 vaccine equitably?				0.628
Yes	304 (60.8%)	287 (94.4%)	17 (5.6%)	
No	98 (19.6%)	91 (92.9%)	7 (7.1%)	
Maybe	98 (19.6%)	90 (91.8%)	8 (8.2%)	
Are you concern about serious complications of the vaccines?				0.010
Strongly agree	117 (23.4%)	102 (87.2%)	15 (12.8%)	
Agree	288 (57.6%)	272 (94.4%)	16 (5.6%)	
Neutral	35 (7.0%)	34 (97.1%)	1 (2.9%)	
Disagree	59 (11.8%)	59 (100.0%)	0 (0.0%)	
Strongly disagree	1 (0.2%)	1 (100.0%)	0 (0.0%)	
Which of the following COVID-19 vaccine do you prefer to use in the future?				0.021
Pfizer and BioNTech	296 (59.2%)	280 (94.6%)	16 (5.4%)	
AstraZeneca	25 (5.0%)	23 (92.0%)	2 (8.0%)	
Moderna	126 (25.2%)	121 (96.0%)	5 (4.0%)	
CoronaVac	2 (0.4%)	1 (50.0%)	1 (50.0%)	
Johnson & Johnson	34 (6.8%)	29 (85.3%)	5 (14.7%)	
Sinopharm	5 (1.0%)	4 (80.0%)	1 (20.0%)	
Novavax	8 (1.6%)	7 (87.5%)	1 (12.5%)	
Other vaccines	4 (0.8%)	3 (75.0%)	1 (25.0%)	

Table 3. Association between knowledge, attitude, and practice toward COVID-19 infection in pregnant women with scores received from each section and acceptance to receive COVID-19 vaccine.

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
1. Knowledge				
1.1 Which of the following liquids is recommended for disinfecting surfaces that have come in contact with COVID-19 patients?				0.784
Warm water	5 (1.0%)	5 (100.0%)	0 (0.0%)	
25% Alcohol	1 (0.2%)	1 (100.0%)	0 (0.0%)	
70% Alcohol	275 (55.0%)	255 (92.7%)	20 (7.3%)	
95% Alcohol	219 (43.8%)	207 (94.5%)	12 (5.5%)	
1.2 The probability of contracting SARS-CoV-2 infection from an infected person is lower in the case of:				0.204
Talking without social distancing	43 (8.6%)	38 (88.4%)	5 (11.6%)	
Sleep with an infected person	17 (3.4%)	17 (100.0%)	0 (0.0%)	
Online video chat	440 (88.0%)	413 (93.9%)	27 (6.1%)	
1.3 Have you ever been taught how to wear and take-off the facemask according to international safety standards?				0.388
Yes	409 (81.8%)	381 (93.2%)	28 (6.8%)	
No	91 (18.2%)	87 (95.6%)	4 (4.4%)	
1.4 Do you think that COVID-19 infected women are safe to breastfeed their babies?				0.273
Yes	155 (31.0%)	149 (96.1%)	6 (3.9%)	
No	212 (42.2%)	197 (92.9%)	15 (7.1%)	
I do not know	133 (26.6%)	122 (91.7%)	11 (8.3%)	
1.5 Do you think COVID-19 is a severe disease that may cause severe complications?				0.406
Yes	444 (88.8%)	414 (93.2%)	30 (6.8%)	
No	25 (5.0%)	25 (100.0%)	0 (0.0%)	
I do not know	31 (6.2%)	29 (93.5%)	2 (6.5%)	
Knowledge scores				0.640
Score $\geqslant$ 80%	277 (55.4%)	258 (93.1%)	19 (6.9%)	
Score $<$ 80%	223 (44.6%)	210 (94.2%)	13 (5.8%)	

(Continued)

Table 3. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
2. Attitude				
2.1 The novel Corona virus is human-made to implement particular agendas?				0.056
Yes	117 (23.4%)	104 (88.9%)	13 (11.1%)	
No	156 (31.2%)	149 (95.5%)	7 (4.5%)	
Maybe	227 (45.4%)	215 (94.7%)	12 (5.3%)	
2.2 Do you think that the local government policies would help reduce the spread of the SARS-CoV-2 virus?				0.278
Yes	383 (76.6%)	361 (94.3%)	22 (5.7%)	
No	117 (23.4%)	107 (91.5%)	10 (8.5%)	
2.3 Do you believe maintaining a social distance from COVID-19 suspected and confirmed cases would negatively impact their psychology?				0.826
Yes	225 (45.0%)	210 (93.3%)	15 (6.7%)	
No	275 (55.0%)	258 (93.8%)	17 (6.2%)	
2.4 Do you think you are not a risk of contracting the COVID-19 because your immunity is strong, and you do not need to follow any precautionary measures?				0.445
Yes	51 (10.2%)	49 (96.1%)	2 (3.9%)	
No	449 (89.8%)	419 (93.3%)	30 (6.7%)	
2.5 Should family members take care of their COVID-19 patients to reduce the risk of transmitting the infection to a single person?				0.066
Yes	353 (70.6%)	335 (94.9%)	18 (5.1%)	
No	147 (29.4%)	133 (90.5%)	14 (9.5%)	
2.6 To which extent do you agree that physical distancing can protect you and your family from contracting COVID-19 disease?				0.003
Strongly agree	290 (58.0%)	278 (95.9%)	12 (4.1%)	
Agree	179 (35.8%)	165 (92.2%)	14 (7.8%)	
Neutral	27 (5.4%)	22 (81.5%)	5 (18.5%)	
Disagree	2 (0.4%)	1 (50.0%)	1 (50.0%)	
Strongly disagree	2 (0.4%)	2 (100.0%)	0 (0.0%)	

(Continued)

Table 3. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
2.7 Do you think that following precautionary measures on a personal-level would help the community fight against the COVID-19 pandemic?				0.006
Yes	474 (94.8%)	447 (94.3%)	27 (5.7%)	
No	26 (5.2%)	21 (80.8%)	5 (19.2%)	
Attitude scores				0.225
Score ⩾ 80%	191 (38.2%)	182 (95.3%)	9 (4.7%)	
Score < 80%	309 (61.8%)	286 (92.6%)	23 (7.4%)	
3. Practice				
3.1 In case you have had contact with the COVID-19 case in the last 2 weeks, and you then have felt feverish or shortness of breath, which of the following steps should you do?				0.828
Go to a hospital to have a COVID-19 test	452 (90.4%)	424 (93.8%)	28 (6.2%)	
Inform family and friends	14 (2.8%)	13 (92.9%)	1 (7.1%)	
Isolate myself	34 (6.8%)	31 (91.2%)	3 (8.8%)	
3.2 What should you do if you have been exposed to the COVID-19, and you only informed later on?				0.006
Isolate yourself and your family	495 (99.0%)	465 (93.9%)	30 (6.1%)	
Performing daily activities as usual	2 (0.4%)	1 (50.0%)	1 (50.0%)	
Leave home only in urgent situations	3 (0.6%)	2 (66.7%)	1 (33.3%)	
3.3 Which of the following steps should you follow to take care of a family member who has been in contact with a case infected with SARS-CoV-2?				0.914
Keep him/her in an isolated room with all windows closed to prevent the transmission of infection	416 (83.2%)	390 (93.8%)	26 (6.3%)	
Cleaning his/her personal items such as bedding and clothes on a daily basis	83 (16.6%)	77 (92.8%)	6 (7.2%)	
Allowing friends and relatives to visit him/her but only individually, not in groups	1 (0.2%)	1 (100.0%)	0 (0.0%)	

(Continued)

Table 3. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
3.4 What is the best method to clean your hands?				0.006
Wash hands only with water	6 (1.2%)	4 (66.7%)	2 (33.3%)	
Wash hands with soap and water	320 (64.0%)	305 (95.3%)	15 (4.7%)	
Wash hands with 95% alcohol	174 (34.8%)	159 (91.4%)	15 (8.6%)	
3.5 How do you greet your colleagues at work or school?				0.056
By touching hands	3 (0.6%)	2 (66.7%)	1 (33.3%)	
By hugging	0 (0.0%)			
Only verbal greeting	497 (99.4%)	466 (93.8%)	31 (6.2%)	
3.6 What would you do when you are about to cough or sneeze?				<0.001
Cough or sneeze into a cloth which cover my mouth and noses	484 (96.8%)	457 (94.4%)	27 (5.6%)	
I prevent myself from coughing/ sneezing	13 (2.6%)	9 (69.2%)	4 (30.8%)	
Cough or sneeze openly without covering my mouth and noses	3 (0.6%)	2 (66.7%)	1 (33.3%)	
3.7 Do you practice social distancing, especially when dealing with people who express symptoms of a cold or a fever?				0.050
Yes	491 (98.2%)	461 (93.9%)	30 (6.1%)	
No	9 (1.8%)	7 (77.8%)	2 (22.2%)	
3.8 Do you routinely wear a face mask when you go out?				<0.001
Yes	497 (99.4%)	467 (94.0%)	30 (6.0%)	
No	3 (0.6%)	1 (33.3%)	2 (66.7%)	
3.9 Do you perform the protective measures including social distancing?				<0.001
Yes	496 (99.2%)	466 (94.0%)	30 (6.0%)	
No	4 (0.8%)	2 (50.0%)	2 (50.0%)	
Practice scores				0.111
Score ⩾ 80%	224 (44.8%)	214 (95.5%)	10 (4.5%)	
Score < 80%	278 (55.2%)	254 (92.0%)	22 (8.0%)	

Table 4. Association between knowledge, attitude, and acceptance of COVID-19 vaccine in pregnant women with scores received from each section and decision to receive COVID-19 vaccine.

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p* Value
1. Knowledge				
1.1 Do you think that vaccines are important for your health?				<0.001
Yes	454 (90.8%)	433 (95.4%)	21 (4.6%)	
No	11 (2.2%)	10 (90.9%)	1 (9.1%)	
I do not know	35 (7.0%)	25 (71.4%)	10 (28.6%)	
1.2 Being vaccinated against infectious diseases reduces the morbidity and mortality rates of individuals?				<0.001
Yes	448 (89.6%)	429 (95.8%)	19 (4.2%)	
No	16 (3.2%)	11 (68.8%)	5 (31.3%)	
I do not know	36 (7.2%)	28 (77.8%)	8 (22.2%)	
1.3 Vaccination against infectious diseases is protective and improving the quality of life, especially for people with low immunity and those who suffer from chronic disease?				0.023
Yes	406 (81.2%)	385 (94.8%)	21 (5.2%)	
No	31 (6.2%)	29 (93.5%)	2 (6.5%)	
I do not know	63 (12.6%)	54 (85.7%)	9 (14.3%)	
1.4 Who should receive COVID-19 vaccine? (You can choose more than one answer)				
People aged 18–59 years old	441 (88.2%)	413 (93.7%)	28 (6.3%)	0.899
People aged more than 60 years old	425 (85.0%)	405 (95.3%)	20 (4.7%)	<0.001
Pregnant women	421 (84.2%)	405 (96.2%)	16 (3.8%)	<0.001
Breastfeeding women	266 (53.2%)	259 (97.4%)	7 (2.6%)	<0.001
People with underlying diseases	398 (79.6%)	378 (95.0%)	20 (5.0%)	0.013
Children aged <1 year old	133 (26.6%)	129 (97.0%)	4 (3.0%)	0.062
Children aged 1–17 years old	253 (50.6%)	248 (98.0%)	5 (2.0%)	<0.001
Acute COVID-19 infection	84 (16.8%)	82 (97.6%)	2 (2.4%)	0.099
People who are cured from COVID-19 infection	218 (43.6%)	210 (96.3%)	8 (3.7%)	0.028

(Continued)

Table 4. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p* Value
1.5 Which gestational age should pregnant women started to receive COVID-19 vaccine?				0.015
Since the beginning of pregnancy	39 (7.8%)	35 (89.7%)	4 (10.3%)	
12 weeks	395 (79.0%)	376 (95.2%)	19 (4.8%)	
28 weeks	66 (13.2%)	57 (86.4%)	9 (13.6%)	
1.6 Could COVID-19 vaccine severely affected the fetus and resulted in abnormal or malformation newborn?				<0.001
Yes	106 (21.2%)	88 (83.0%)	18 (17.0%)	
No	394 (78.8%)	380 (96.4%)	14 (3.6%)	
1.7 Does COVID-19 vaccine has adverse effect to pregnancy?				<0.001
Yes	135 (27.0%)	112 (83.0%)	23 (17.0%)	
No	365 (73.0%)	356 (97.5%)	9 (2.5%)	
Knowledge scores				<0.001
Score ⩾ 80%	337 (67.4%)	331 (98.2%)	6 (1.8%)	
Score < 80%	163 (32.6%)	137 (84.0%)	26 (16.0%)	
2. Attitude				
2.1 Is it possible to find an effective vaccine that could protect against the COVID-19?				< 0.001
Yes	467 (93.4%)	444 (95.1%)	23 (4.9%)	
No	33 (6.6%)	24 (72.7%)	9 (27.3%)	
2.2 If an effective vaccine was found, do you think it could be readily available for everyone?				0.032
Yes	363 (72.6%)	345 (95.0%)	18 (5.0%)	
No	137 (27.4%)	123 (89.8%)	14 (10.2%)	
2.3 The benefits of vaccines usually outweigh the risks?				<0.001
Yes	406 (81.2%)	387 (95.3%)	19 (4.7%)	
No	15 (3.0%)	11 (73.3%)	4 (26.7%)	
I do not know	79 (15.8%)	70 (88.6%)	9 (11.4%)	

(Continued)

Table 4. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p* Value
2.4 Do you think the COVID-19 vaccine should be afforded to everyone for free?				0.908
Yes	486 (97.2%)	455 (93.6%)	31 (6.4%)	
No	14 (2.8%)	13 (92.9%)	1 (7.1%)	
2.5 If the COVID-19 vaccine is available for sale, would you buy it?				0.029
Yes	138 (27.6%)	133 (96.4%)	5 (3.6%)	
No	136 (27.2%)	121 (89.0%)	15 (11.0%)	
Maybe	226 (45.2%)	214 (94.7%)	12 (5.3%)	
2.6 Would you recommend your friends or family members to receive COVID-19 vaccine?				<0.001
Yes	489 (97.8%)	463 (94.7%)	26 (5.3%)	
No	11 (2.2%)	5 (45.5%)	6 (54.5%)	
Attitude scores				<0.001
Score ⩾ 80%	407 (81.4%)	392 (96.3%)	15 (3.7%)	
Score < 80%	93 (18.6%)	76 (81.7%)	17 (18.3%)	
3. Acceptance				
3.1 Would you receive the COVID-19 vaccine?				
Yes	468 (93.6%)			
No	32 (6.4%)			
3.2 If a COVID-19 vaccine is available with an efficacy of 95%, would you be a candidate for receiving all shots?				<0.001
Yes	495 (99.0%)	468 (94.5%)	27 (5.5%)	
No	5 (1.0%)	0 (0.0%)	5 (100.0%)	
3.3 If a COVID-19 vaccine is available with an efficacy of 70%, would you be a candidate for receiving the vaccine?				<0.001
Yes	414 (82.8%)	401 (96.9%)	13 (3.1%)	
No	86 (17.2%)	67 (77.9%)	19 (22.1%)	

(Continued)

Table 4. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p* Value
3.4 If a COVID-19 vaccine is available with an efficacy of 50%, would you be a candidate for receiving the vaccine?				<0.001
Yes	240 (48.0%)	238 (99.2%)	2 (0.8%)	
No	260 (52.0%)	230 (88.5%)	30 (11.5%)	
3.5 If a COVID-19 vaccine was available with the desired efficacy, would you encourage your parents to get the vaccine?				<0.001
Yes	492 (98.4%)	464 (94.3%)	28 (5.7%)	
No	8 (1.6%)	4 (50.0%)	4 (50.0%)	
3.6 Did you receive the seasonal flu shot in the last 12 months?				0.078
Yes	278 (55.6%)	265 (95.3%)	13 (4.7%)	
No	222 (44.4%)	203 (91.4%)	19 (8.6%)	
3.7 Are you planning to receive a seasonal flu vaccine in the next year?				0.010
Yes	412 (82.4%)	391 (94.9%)	21 (5.1%)	
No	88 (17.6%)	77 (87.5%)	11 (12.5%)	
3.8 Did you receive a COVID-19 vaccine?				<0.001
Yes	417 (83.4%)	399 (95.7%)	18 (4.3%)	
No	83 (16.6%)	69 (83.1%)	14 (16.9%)	
3.9 If you have already received the COVID-19 vaccine, which of the following COVID-19 vaccine did you receive?				
Pfizer and BioNTech	159 (31.8%)	156 (98.1%)	3 (1.9%)	0.005
AstraZeneca	187 (37.4%)	180 (96.3%)	7 (3.7%)	0.061
Moderna	29 (5.8%)	29 (100.0%)	0 (0.0%)	0.147
CoronaVac	105 (21.0%)	101 (96.2%)	4 (3.8%)	0.222
Johnson & Johnson	3 (0.6%)	2 (66.7%)	1 (33.3%)	0.056
Sinopharm	47 (9.4%)	43 (91.5%)	4 (8.5%)	0.535
Novavax	3 (0.6%)	2 (66.7%)	1 (33.3%)	0.056
Other vaccines	0 (0.0%)			

(Continued)

Table 4. (Continued)

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p* Value
4.0 If you have already received the COVID-19 vaccine, how many shots did you already received?				<0.001
1 shot	91 (18.2%)	84 (92.3%)	7 (7.7%)	
2 shots	247 (49.4%)	238 (96.4%)	9 (3.6%)	
3 shots	79 (15.8%)	77 (97.5%)	2 (2.5%)	
Acceptance section				<0.001
Score ⩾ 80%	266 (53.2%)	266 (100.0%)	0 (0.0%)	
Score < 80%	234 (46.8%)	202 (86.3%)	32 (13.7%)	

82.8%. In contrast, vaccines with an efficacy rate of 50% gained acceptance from only 48.0% of the participants.

Factors influencing COVID-19 vaccine acceptance or rejection

Table 5 reveals the association between the factors leading to pregnant women's acceptance or rejection of the COVID-19 vaccine and the decision to receive the vaccine. The most common factor of the participant's acceptance of the vaccine was trust in the safety of the vaccine (36.2%). As for the participants' rejection of the vaccine, almost half of the participants (49.2%) did not want to put their fetuses at risk from its possible adverse effects.

The factors associated with vaccine acceptance and rejection from the univariate analysis are shown in Table 6. The participants who relied on the Thailand Department of Disease Control or National Center for Disease Control as their primary sources of information, took precautionary measures on a personal level, routinely wore face masks, implemented social distancing, and had great scores in the knowledge, attitude, and acceptance sections of the questionnaire were more likely to accept the vaccine. The negative factor that led to the participants' rejection of the vaccine was previous COVID-19 infection.

A multivariate logistic regression analysis for the association of factors leading to pregnant women's acceptance of the COVID-19 vaccine found that the participants with great knowledge of the COVID-19 vaccine were more likely to accept it (OR 13.25, 95% CI 2.45–71.61, $p = 0.003$), whereas those who had previously been infected with COVID-19 were less likely to do so (OR 0.11, 95% CI 0.02–0.62, $p = 0.013$).

Discussion

Interpretation of results

This study demonstrated that 67.4% and 81.4% of pregnant women had great knowledge of and attitudes toward the COVID-19 vaccine, respectively, while 93.6% accepted to receive the vaccine. The factor associated with the decision to receive the vaccine was having great knowledge about it. However, the factor associated with the decision to reject the vaccine was recent COVID-19 infection. Vaccination is crucial for disease control, so persuading people to join the vaccination campaign will benefit our community great immensely. Not only will this limit the pandemic, but it will also reduce the severity of COVID-19 infection. It is important to promote the COVID-19 vaccination campaign to pregnant women by emphasizing that vaccination will not cause any negative consequences for the fetus or the pregnancy.

Comparison with existing literature

Our study demonstrated that 93.6% of pregnant women accepted to receive the COVID-19

Table 5. Association between factors leading to acceptance or rejection of COVID-19 vaccine in pregnant women and decision to receive COVID-19 vaccine.

Variables	Total (%)	Accept COVID-19 vaccine	Reject COVID-19 vaccine	*p*-Value
1.0 Which of the following is the main factor that would make you accept the COVID-19 vaccine?				0.002
Trust in safety of the vaccine	181 (36.2%)	169 (93.4%)	12 (6.6%)	
The ability of the vaccine to protect you from the disease	86 (17.2%)	82 (95.3%)	4 (4.7%)	
Receive the vaccine without charges	12 (2.4%)	12 (100.0%)	0 (0.0%)	
Afraid of being infected by COVID-19	71 (14.2%)	67 (94.4%)	4 (5.6%)	
Believe that receiving the vaccine would help the community through herd immunity	107 (21.4%)	104 (97.2%)	3 (2.8%)	
Trust in the government policy	0 (0.0%)			
Your healthcare personnel advised you to receive the vaccine	40 (8.0%)	31 (77.5%)	9 (22.5%)	
Other	3 (0.6%)	3 (100.0%)	0 (0.0%)	
2.0 Which of the following is the main factor that would make you reject the COVID-19 vaccine?				0.475
Do not want to risk the fetus from possible adverse effect	246 (49.2%)	227 (92.3%)	19 (7.7%)	
Afraid of the side effects of the vaccine toward yourself	56 (11.2%)	51 (91.1%)	5 (8.9%)	
Want to wait for further information in terms of safety or efficacy of the vaccine in pregnant women	119 (23.8%)	114 (95.8%)	5 (4.2%)	
Want to wait for the future vaccine with more efficacy	46 (9.2%)	43 (93.5%)	3 (6.5%)	
Not able to get in line for the vaccine	26 (5.2%)	26 (100.0%)	0 (0.0%)	
Other	7 (1.4%)	7 (100.0%)	0 (0.0%)	

vaccine. If the efficacy rate of the vaccine is greater than 95%, 99.0% of them would undergo vaccination. In the case of vaccines with efficacy rates of more than 70%, 82.8%, and more than 50%, 48.0% of them would undergo vaccination. In a Turkish study conducted with 300 pregnant women participants, only 37.0% accepted to receive the COVID-19 vaccine.[23] Furthermore, in a 2021 Libyan study conducted with 15,087 participants, 79.6% of the participants accepted to receive the vaccine if it had an efficacy rate of more than 90%, 60.6% accepted if the efficacy rate was above 70%, and 41.2% accepted if the efficacy rate was above 50%.[15] In California,

Table 6. Univariate analysis of factors associated with COVID-19 vaccine acceptance in pregnant women.

Variables	Adjust odds ratio (95%CI)	*p* Value
Previously infected with COVID-19	0.37 (0.16–0.86)	0.017
The main source of COVID-19 pandemic information		
Department of disease control, Thailand	1.09 (1.06–1.12)	0.005
National Center for Disease Control (NCDC)	1.08 (1.05–1.11)	0.04
Precautionary measures on a personal-level would help the community fight against the COVID-19 pandemic	3.94 (1.38–11.26)	0.006
Routinely wear a face mask	31.13 (2.75–353.17)	<0.001
Perform the protective measures including social distancing	15.53 (2.11–114.14)	<0.001
Knowledge toward COVID-19 vaccine score ⩾ 80%	10.47 (4.22–26.00)	<0.001
Attitude toward COVID-19 vaccine score ⩾ 80%	5.85 (2.80–12.21)	<0.001
Acceptance of COVID-19 vaccine score ⩾ 80%	1.16 (1.10–1.22)	<0.001

Simmons et al. reported that the vaccine hesitancy rate in pregnant women was 57%.[18] They found that younger age, living in a less urban environment, and essential worker status were associated with vaccine hesitancy.[18] In Japan, Saitoh et al. reported that the vaccine hesitancy rate in pregnant women was 40.7%. They found that women with vaccine hesitancy were more likely to fear adverse reactions, safety, and efficacy compared to those without vaccine hesitancy.[19] In Ohio, Germann et al. performed a study in pregnant and postpartum women. They found 40% COVID-19 vaccine hesitancy upon enrolment, and 52% hesitancy of the vaccine in subsequent vaccination at follow-up. Those who identified as non-Hispanic black, were Medicaid beneficiaries, and were still pregnant at follow-up were less likely to be vaccinated.[24] In Italy, Miraglia del Giudice et al. found 86.4% highly hesitant in pregnant women. Respondents who did not get a graduate degree, those less concerned that they could be infected by SARS-CoV-2, and those trusting mass media/internet/social networks for information were highly vaccine hesitant.[25] In contrast to these previous studies, our study reported a higher acceptance rate. This may be attributed to the increasing promotion of vaccination campaigns and the assurance of vaccine safety.

Regarding the percentage of knowledge, attitude, and acceptance of COVID-19 vaccination, the percentages of pregnant women with scores above 80% in the knowledge, attitude, and acceptance subsections of our questionnaire were 67.4%, 81.4%, and 53.2%, respectively. In the 2021 Libyan study, the mean ± SD scores respondents received for the knowledge, attitude, and acceptance toward COVID-19 vaccine subsections were 2.35 ± 0.9 (ranging from 0 to 3), 3.2 ± 0.9 (ranging from 0 to 6), and 3.28 ± 1.7 (ranging from 0 to 6), respectively.[15]

Compared to the Turkish study (100%) and the Libyan study (68.1%), almost all the participants in our study wore facial masks (99.4%).[15,23] The percentage of pregnant women complying with social distancing was 99.2%. In comparison, the percentage of people implementing social distancing in the Turkish and Libyan studies was 100% and 77.3%, respectively.[23] This study and the Turkish study were both conducted on pregnant women; these women may implement protective measures more than ordinary individuals in order to protect their fetuses.

The main factors that influenced the participants' decision to accept vaccination were trust in the safety of the vaccine (36.2%), belief in the

effectiveness of herd immunity (21.4%), and belief in the effectiveness of the vaccine (17.2%). The negative factors that influenced the participants' decision to reject vaccination were their concern about the adverse effects of the vaccine on their fetuses (49.2%), the need for more concrete data about the side effects and effectiveness of the vaccine (23.8%), and their concern about the side effects of the vaccine on themselves (11.2%).

After analyzing the results using the multivariate logistic regression method, we identified a significant association between the acceptance rate of the COVID-19 vaccine and having great knowledge about the vaccine, determined by a score of 80% or more (adjusted OR of 13.25, 2.45–71.61). Additionally, people who experienced prior COVID-19 infection had a lower tendency to receive another vaccine shot (adjusted OR 0.11, 0.02–0.62), probably because they assumed that they had an adequately protective immune system post-infection. Compared to the 2021 Turkish study, this study found a positive correlation between COVID-19 vaccine acceptance and the number of school-age children in the house.[23]

Implications for practice

From this study, pregnant women who already have great knowledge about the COVID-19 vaccine are more likely to get the vaccine during pregnancy, while those who have recently been infected with COVID-19 will lose interest in getting the vaccine. Therefore, healthcare providers should educate pregnant women about the COVID-19 vaccine in order to prevent COVID-19 infection.

Strengths and limitations

The strength of this study is that the study was performed in a high-reputation university hospital for quality of care for pregnant women and/or pregnancy-related conditions. This study also had a larger sample of pregnant women than other studies. The limitation of this study was that it was a cross-sectional study. This study may have bias from recall bias and convenient sampling. Another limitation was that the facilitating questionnaire completion at a Department of Obstetrics and Gynecology where the benefits of COVID-19 vaccination are promoted and recommended was peculiar. The results generated here are likely hampered by social desirability on respondents' parts, providing responses that they feel the researchers could want to hear. This may also help to explain the high COVID-19 vaccine acceptance rates routinely noted throughout the article. In the future, further studies should be conducted on breastfeeding women, as our present study results illustrate that people still believe that the COVID-19 vaccine is not safe for breastfeeding mothers.

In conclusion, Thai pregnant women who already have great knowledge about the COVID-19 vaccine tend to receive it during pregnancy, whereas those recently infected with COVID-19 lose interest in receiving the vaccine. Health authorities should educate people with a history of COVID-19 on the need to get a booster shot of the vaccine, as most of our study population still believes that it is not necessary; such an attitude is a major obstacle to disease control.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University (IRB No. 929/63). All women signed informed consent forms after being properly informed about the study's aims, methods, and ethical issues, such as voluntary participation, confidentiality, and the right to withdraw at any time of the study.

Consent for publication

Not applicable.

Author contributions

Arissara Kuptarak: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Resources; Software;, Writing – original draft; Writing – review & editing.

Vorapong Phupong: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing.

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Competing interests

The authors declare that there is no conflict of interest.

Availability of data and materials

The data and materials will be provided upon request.

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