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# Perceptions and acceptance of COVID-19 vaccine among pregnant and lactating women in Singapore: a pre-vaccine rollout cross-sectional study

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## Abstract

**Introduction:** Vaccination is critical in controlling the coronavirus disease 2019 (COVID-19) pandemic. However, vaccine perception and acceptance among pregnant and lactating women is unknown in Singapore. We aimed to determine the acceptance of COVID-19 vaccination among these two groups of women in Singapore and the factors associated with vaccine acceptance.

**Methods:** We conducted an anonymous, online survey on the perceptions of the COVID-19 vaccine and its acceptance by pregnant and lactating women at a tertiary maternal and child hospital in Singapore from 1 March to 31 May 2021. Information on their demographics and knowledge was collected. These factors were assessed for their relationship with vaccine acceptance.

**Results:** A total of 201 pregnant and 207 lactating women participated. Vaccine acceptance rates in pregnant and lactating women were 30.3% and 16.9%, respectively. Pregnant women who were unsure or unwilling to take the vaccine cited concerns about safety of the vaccine during pregnancy (92.9%), while lactating women were concerned about its potential long-term negative effects on the breastfeeding child (75.6%). Factors that were positively associated with vaccine acceptance included a lower monthly household income or education level, appropriate knowledge regarding vaccine mechanism and higher perceived maternal risk of COVID-19. Most pregnant (70.0%) and lactating women (83.7%) were willing to take the vaccine only when more safety data during pregnancy and breastfeeding were available.

**Conclusion:** COVID-19 vaccine acceptance was low among pregnant and lactating women in Singapore. Addressing the safety concerns when more data are available and education on the mechanism of vaccine action will likely improve acceptance among these women.

**Keywords:** Acceptance, breastfeeding, COVID-19, pregnancy, vaccine

## INTRODUCTION

In this current coronavirus disease 2019 (COVID-19) pandemic, vaccination remains a critical strategy to curb infections and reduce disease severity. Currently approved mRNA COVID-19 vaccines in Singapore (Pfizer-BioNTech and the Moderna COVID-19 mRNA vaccines) have been found to be safe and efficacious in preventing severe disease.<sup>[1,2]</sup> As these initial vaccine trials did not include pregnant and lactating women, Singapore's Ministry of Health (MOH) initially cautioned against vaccination in pregnant women,

and recommended lactating women to stop breastfeeding for 5–7 days following vaccination.<sup>[3,4]</sup> These were in contrast to recommendations from the Society for Maternal–Fetal

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Medicine (SMFM) and the American College of Obstetricians and Gynecologists (ACOG) which have maintained that the vaccine should be offered to pregnant and lactating women based on their risk, and that the mRNA-based vaccines are thought to pose a low risk to the foetus as the mRNA is expected to degrade in circulation.<sup>[5,6]</sup> The World Health Organization and the Academy of Breastfeeding Medicine also recommended that lactating women should continue to breastfeed post-vaccination as it is unlikely for mRNA-based vaccines to be transmitted via breast milk.<sup>[7,8]</sup>

These initial differences in local recommendations were likely due to the low national infection rates in Singapore at that time. The total number of cases in Singapore between January 2021 and May 2021 was 3,422, with a daily range of 8–50 cases,<sup>[9]</sup> while the USA was reporting an average of over 60,000 new cases daily during this time.<sup>[10]</sup> With the emerging local and international clinical reports on the safety and efficacy of mRNA-based COVID-19 vaccines, Singapore's MOH, has since approved the use of these vaccines for pregnant women. On 31 May 2021, the MOH recommended lactating women to continue breastfeeding after vaccination. Pregnant women are a vulnerable group in this pandemic, with an increased risk for severe disease and adverse outcomes if infected. Pregnancy complications, including preterm birth, venous thromboembolism and severe respiratory complications requiring invasive ventilation, have been reported.<sup>[11–14]</sup> Breastfeeding mothers with COVID-19 could also potentially infect the infant postnatally via contact and droplets.<sup>[15,16]</sup> Despite the benefits of vaccination in preventing maternal and foetal complications, studies have demonstrated varying rates of vaccine acceptance in pregnant and lactating women.<sup>[17–20]</sup> Reported factors affecting acceptance included confidence in the safety and efficacy of the vaccine, level of trust in public health agencies, the perceived lack of vaccine research and fear of harming the foetus.<sup>[17–20]</sup> In their survey across 16 countries, Skjefte *et al.*<sup>[17]</sup> reported that vaccine acceptance rates in countries with low COVID infection rates similar to Singapore, such as New Zealand and Australia, were below 45% for pregnant women and below 56% for non-pregnant women.

Anticipating similar results in Singapore, we undertook this survey to evaluate the perceptions and factors affecting acceptance of the COVID-19 vaccine among pregnant and lactating women in a tertiary maternal and child hospital. We propose that the results will inform healthcare providers and policymakers on reasons for vaccine refusal, which can help develop strategies to improve vaccine uptake in these groups of women.

## METHODS

### Study design and participants

This was a cross-sectional, web-based survey conducted at a tertiary maternal and child hospital in Singapore. Pregnant

and lactating women over 21 years of age, attending outpatient clinics or admitted to the hospital were invited to participate in an anonymous, online survey from 1 March to 31 May 2021. Participation was voluntary, and no incentive was offered for participation. Survey respondents attending these outpatient clinics or admitted to the hospital may be seeing a specific obstetric provider or may have different providers throughout their pregnancy. No personally identifiable data were collected. The survey was advertised at the outpatient clinics, inpatient nurseries and obstetric wards, and among the hospital's healthcare workers via posters and flyers. Ethics approval was obtained from the Singhealth Institutional Review Board (CIRB Ref No. 2020/2648) with a waiver for informed consent.

### Survey development

Separate surveys were designed for lactating mothers and for pregnant women using input from other published studies and healthcare professionals.<sup>[21,22]</sup> The surveys were developed and administered in English, and consisted of questions on demographics, vaccine acceptance, general health status, COVID-19 experience, knowledge regarding the COVID-19 vaccine and participants' perceptions and concerns regarding the COVID-19 vaccine. The full survey consisted of 22 questions for pregnant women and 28 questions for lactating mothers [see Appendix]. Responses to all the questions were in multiple-choice format. Perceptions of COVID-19 vaccine were rated on a 5-point Likert scale.

The surveys were hosted on an online self-service form builder which stores responses in an encrypted format and is accessible only to the creator via a special code (Form.gov.sg, GovTech, Singapore). Entry into the survey was via a QR code printed on the invitation posters and flyers given to the respondents. The poster and flyer also assured participants of confidentiality of information, and participation implied informed consent. All the questions were mandatory and displayed in running order on the respondent's screen. Respondents were prompted to complete the outstanding questions before submitting the form and were unable to save responses or change their answers after submission.

All submitted surveys were included in the analysis of this study. Vaccine acceptance was defined as a response of 'strongly agree' or 'agree' to take the vaccine if offered, while vaccine non-acceptance was defined as a response of 'unsure', 'disagree' or 'strongly disagree'. Responses to knowledge questions were categorised into correct and wrong responses, while responses to perception questions were organised into similar categories (e.g. 'strongly agree' and 'agree' were taken to be one category).

### Statistical analysis

Univariate logistic regression analysis was used to determine demographics, vaccine knowledge and vaccine safety perception

factors associated with vaccine acceptance in pregnant and lactating women separately. Factors most strongly associated with vaccine acceptance in the univariate analyses were entered sequentially into a multivariable forward stepwise regression analysis with significance levels to enter/stay of 0.10/0.05. Model goodness-of-fit was also assessed using the Akaike information criterion (AIC). All data was analysed using IBM SPSS Statistics version 19.0 (IBM Corp, Armonk, NY, USA). The Checklist for Reporting Results of Internet E-Surveys (CHERRIES) was used in the reporting of this study.<sup>[23]</sup>

## RESULTS

A total of 201 pregnant women and 207 lactating women participated in the survey [Table 1]. The majority of the respondents in both pregnant and lactating groups were 21–34 years old (77.6% and 66.7%, respectively), Singapore citizens (79.1% and 73.9%, respectively), of Chinese ethnicity (48.3% and 52.7%, respectively) and without pre-existing medical conditions (97% and 92.7%, respectively).

### Pregnant women

The majority of pregnant women were aware of the mRNA vaccine's mode of action (69.6%). However, only 32.9% of pregnant women reported being aware that the vaccine was efficacious in reducing the risk of COVID-19 in pregnant women [Table 2]. Only 30.3% (61/201) were agreeable to take the COVID-19 vaccine if it was offered to them, while the rest of the participants were unsure ( $n = 91$ , 45.3%) or unwilling ( $n = 49$ , 24.4%). Of those who were unsure or unwilling to take the vaccine, 92.9% (109/140) had doubts about the safety of the vaccine, 92.1% (129/140) were worried about the unknown short- and long-term effects of the vaccine on the pregnancy and unborn child, and 78.6% (110/140) were concerned about the side effects they would experience from the vaccine. Most of the women in this group (119/140, 70.0%) reported that they would take the vaccine only if there were more data available on its safety during pregnancy.

Regression analysis demonstrated that the following factors were positively associated with vaccine acceptance in pregnant women: a lower monthly household income, having appropriate knowledge regarding vaccine mechanism, higher maternal perceived risk of COVID-19 and having a perception that vaccines were safe [Table 3].

### Lactating women

Up to 61.7% of the lactating women were aware of the vaccine's mode of action, and 72.9% were aware of its efficacy in reducing COVID-19 risk [Table 4]. Among lactating women, 129 (62.3%) were unsure, 43 (20.8%) were unwilling and 35 (16.9%) were agreeable to take the vaccine.

Among lactating women who were unsure or unwilling to take the vaccine ( $n = 172$ ), many were worried about the side effects that they would experience (147/172, 85.5%)

**Table 1. Characteristics of pregnant and lactating women participants.**

Demographic	n (%)	
	Pregnant (n=201)	Lactating (n=207)
Age group (yr)		
21–34	156 (77.6)	138 (66.7)
≥35	45 (22.4)	69 (33.3)
Nationality		
Singapore citizen	159 (79.1)	153 (73.9)
Singapore Permanent Resident	41 (20.4)	26 (12.6)
Non-resident	1 (0.5)	28 (13.5)
Ethnicity		
Chinese	97 (48.3)	109 (52.7)
Malay	77 (38.3)	49 (23.7)
Indian	14 (7.0)	21 (10.1)
Others	13 (6.5)	28 (13.5)
Marital status		
Single	7 (3.5)	3 (1.4)
Married	192 (95.5)	203 (98.1)
Divorced/separated	2 (1)	1 (0.5)
Highest education level		
No formal education/primary level	9 (4.5)	4 (2.9)
Secondary or post-secondary level	103 (51.2)	65 (31.4)
Undergraduate/postgraduate	89 (44.3)	136 (65.7)
Employment status		
Self-employed	13 (6.5)	12 (5.8)
Employed for wages	148 (73.6)	156 (75.4)
Unemployed	40 (19.9)	39 (18.8)
Average monthly household income		
≤SGD 5000	83 (41.3)	52 (25.1)
SGD 5001–10,000	50 (24.9)	67 (32.4)
SGD 10,001–15,000	24 (11.9)	33 (15.9)
SGD 15,001–30,000	23 (11.4)	32 (15.5)
≥SGD 30,001	21 (10.4)	23 (11.1)
Parity		
Primiparous	0	92 (44.4)
Multiparous	201 (100.0)	116 (55.6)
Age of youngest infant (mth)	NA	
<1		120 (58.0)
1–<3		26 (12.6)
3–<6		15 (7.2)
6–<12		21 (10.1)
≥12		25 (12.1)
Pre-existing medical condition		
No	195 (97.0)	192 (92.8)
Yes	4 (2.0)	15 (7.2)

NA: not applicable

and the transmission of virus via breastmilk to the infant (105/172, 61.6%) and most of them were anxious about the potential negative long-term effects of the vaccine on the breastfeeding child (130/172, 75.6%). Lactating women also reported to be willing to take the vaccine only if more data on its safety in breastfeeding were available (144/172, 83.7%).

Regression analysis demonstrated that those who received primary school level education were more willing to accept the

**Table 2: Survey responses obtained from pregnant women.**

Question	Response	n (%)		
		Total (n=201)	Accept vaccine (n=61)	Unsure or decline vaccine (n=140)
<b>Health status</b>				
Have you had previous experience with COVID-19 (e.g. infection in self/family member/friend/work-related contact)?	Yes	4 (2.0)	1 (1.6)	3 (2.1)
	No	197 (98.0)	60 (98.4)	137 (97.9)
How do you rate your current overall health status?	Good or very good	170 (85.5)	54 (88.5)	116 (82.8)
	Fair	31 (15.4)	7 (11.5)	24 (17.1)
	Poor or very poor	0	0	0
<b>Knowledge</b>				
The vaccine works by training the body's immune system to produce antibodies against COVID-19 faster in case of a real infection	Agree or strongly agree	124 (61.7)	58 (95.1)	66 (47.1)
	Unsure	71 (35.3)	3 (4.9)	68 (48.6)
	Disagree or strongly disagree	6 (3.0)	0 (0)	6 (4.3)
How effective do you think the COVID-19 vaccination is in preventing pregnant women from getting infected with the virus?	Very or somewhat effective	66 (32.9)	37 (60.7)	29 (20.7)
	Unsure	123 (61.2)	24 (39.3)	99 (70.7)
	Not too effective or not effective at all	12 (6.0)	0	12 (8.6)
<b>Perceptions</b>				
My risk of contracting COVID-19 is	High or very high	23 (11.5)	14 (23.0)	9 (6.4)
	Neutral	121 (60.2)	27 (60.7)	84 (60.0)
	Low or very low	57 (28.4)	10 (16.4)	47 (33.6)
How worried are you about contracting COVID-19?	Concerned or very concerned	128 (63.1)	42 (68.9)	86 (61.4)
	Neutral	62 (30.8)	17 (27.9)	45 (32.1)
	Not concerned or not concerned at all	11 (5.5)	2 (3.3)	9 (6.4)
I will only take the vaccine when more data about its safety in pregnancy is available	Agree or strongly agree	170 (84.6)	51 (83.6)	119 (85.0)
	Unsure	24 (11.9)	8 (13.1)	16 (11.4)
	Disagree or strongly disagree	7 (3.5)	2 (3.3)	5 (3.6)
If a pregnant woman gets COVID-19, how likely will the virus harm her pregnancy and her unborn child?	Very to somewhat likely	127 (63.1)	44 (72.1)	83 (59.3)
	Unsure	62 (30.8)	13 (21.3)	49 (35.0)
	Very to somewhat unlikely	12 (6.0)	4 (6.6)	8 (5.7)
How safe do you think the COVID-19 vaccinations are for pregnant women?	Completely safe to somewhat safe	36 (17.9)	26 (42.6)	10 (7.1)
	Unsure	133 (66.2)	34 (55.7)	99 (70.7)
	Completely unsafe or somewhat unsafe	32 (15.9)	1 (1.6)	31 (22.1)
I am concerned that I can transmit the virus to people around me if I take the vaccine	Agree or strongly agree	84 (41.8)	29 (47.5)	55 (39.3)
	Unsure	69 (34.3)	17 (27.9)	52 (37.1)
	Disagree or strongly disagree	48 (23.9)	15 (24.6)	33 (23.6)
I am concerned about the side effects I may experience post-vaccination (pain, swelling, headache, body ache, fever, allergic reaction)	Agree or strongly agree	158 (78.6)	48 (78.7)	110 (78.6)
	Unsure	17 (8.5)	5 (8.2)	12 (8.6)
	Disagree or strongly disagree	26 (12.9)	8 (13.1)	18 (12.9)
I am worried about the unknown short- and long-term effects of the COVID-19 vaccine on my pregnancy and my unborn baby	Agree or strongly agree	181 (90.1)	52 (85.2)	129 (92.1)
	Unsure	18 (9.0)	8 (13.1)	10 (7.1)
	Disagree or strongly disagree	2 (1.0)	1 (1.6)	1 (0.7)

vaccine than those who had at least an undergraduate degree. Vaccine acceptance was also greater in those with appropriate knowledge regarding vaccine's mechanism of action, high maternal perceived risk of COVID-19 and low perceived long-term negative effects on the breastfeeding child [Table 5].

## DISCUSSION

In this pre-vaccine roll-out survey, we sought to determine factors associated with COVID-19 vaccine acceptance among pregnant and lactating women in Singapore to guide vaccination efforts in these vulnerable populations. In this

survey, we found low vaccine acceptance, varying levels of understanding of vaccine efficacy and high proportions of safety concerns regarding its possible side effects on the unborn or breastfeeding child in our local population.

Reported rates of COVID-19 vaccine acceptance in pregnant women vary worldwide, from 77% in a study conducted in China to 37% in a study conducted in Turkey.<sup>[19,20,24,25]</sup> Vaccine acceptance in our population appears to be low at 30%, suggesting the need for an action plan to improve acceptance to achieve adequate vaccination rates in this population. The vaccine acceptance rate in the general population in Singapore in the

**Table 3: Regression analysis for vaccine acceptance among pregnant women.**

Factor	Adjusted OR (95% CI)	P
Monthly household income (SGD)		
≤5000	Ref	NA
5001–15,000	0.39 (0.16, 0.94)	0.04
> 15,000	0.23 (0.07, 0.78)	0.02
Knowledge about the mechanism of action		
Unsure/disagree or strongly disagree	Ref	NA
Agree or strongly agree	18.52 (5.05, 68.00)	<0.001
Maternal perceived risk of COVID-19		
Low or very low	Ref	NA
Neutral	2.98 (1.13, 7.86)	0.03
High or very high	6.25 (1.59, 24.56)	0.009
Perceived general safety of vaccine		
Somewhat or completely unsafe	Ref	NA
Unsure	5.23 (0.61, 44.96)	0.13
Somewhat or completely safe	38.55 (3.93, 377.82)	0.002

CI: confidence interval, NA: not applicable, OR: odds ratio, Ref: reference variable

same time period was reported to be between 70% and 82%.<sup>[26]</sup> There is also a need to consider the time period during which the survey was conducted, as various factors including local infection rates and availability of vaccine information could have affected acceptance. The changing national recommendations for vaccination in these groups over time would have been expected to impact on general vaccine acceptance. At the point of starting this survey, the COVID-19 vaccine was not indicated for pregnant women and lactating mothers were discouraged from breastfeeding for 5–7 days after vaccination.<sup>[3,4]</sup> In the USA, where organisations support vaccination of pregnant and lactating women, vaccine acceptance appeared to be higher than in our population (44%–58% and 55% in pregnant and lactating women, respectively).<sup>[18,27]</sup> Although current recommendations in Singapore were revised to encourage vaccinations in pregnant and lactating women on 31 May 2021, it is uncertain whether this will increase vaccine acceptance. ‘Mixed messages’, a reflection of evolving and available evidence, may be perceived by the public as a lack of certainty on the safety or efficacy of the vaccine, leading to low vaccine acceptance. Our low vaccine acceptance would also appear to be guided by a low perceived risk of infection due to low national infection rates at that time (less than 50 new cases per day).<sup>[9]</sup> Perception of COVID-19 infection risk was significantly associated with vaccine acceptance in both pregnant and lactating women in our study.

Surprisingly, a larger proportion of pregnant women were agreeable for the vaccine, compared to lactating mothers. This is contrary to other studies that reported lower mRNA vaccine acceptance in pregnant compared to non-pregnant or lactating

women due to concerns among pregnant women regarding potential unknown long-term consequences in the developing foetus.<sup>[17-20]</sup> A possible explanation is that pregnant women may have been informed of the greater risk for severe disease in infected pregnant women, thus increasing their vaccine acceptance. Pregnant women are also more likely to have had contact with their healthcare providers compared to lactating women, which could have helped to alleviate their concerns and doubts regarding vaccine safety. Nevertheless, this demonstrates that the concerns of both lactating and pregnant women need to be addressed to increase their vaccine acceptance.

Several studies have reported safety concerns of mothers about their children’s health or their own health as the primary reason for low vaccine acceptance among pregnant and lactating women.<sup>[18-20,25,27]</sup> Similarly, the lack of safety data of the COVID-19 vaccine was a significant factor affecting vaccine acceptability in our population. Pregnant women were concerned about general safety of the vaccine during pregnancy, while lactating mothers were concerned about the possible long-term side effects that the vaccine could have on their child. The safety concerns of pregnant and lactating women are unsurprising, as both pregnant and lactating women were excluded from the initial mRNA-based vaccine trials, limiting the available data on safety and efficacy in these groups. However, since then, observational data from other countries have shown that the mRNA-based vaccines are safe in pregnant and lactating women without any discernible short- or medium-term side effects to the foetus or child.<sup>[28-32]</sup> Dissemination of this safety and efficacy data in a timely manner is the key to increasing vaccine uptake in these populations.

While the majority of pregnant women and mothers were aware of the mechanism of action of the mRNA-based vaccines, approximately a third were unsure or unaware of this. Lack of knowledge regarding vaccine’s mechanism of action was associated with poor vaccine acceptance in both pregnant and lactating women, indicating the potential for educating women on the vaccine’s mechanism of action, so as to increase vaccine acceptance rates. At the time of this survey, only mRNA vaccines were available for vaccination in Singapore. However, as other types of vaccines become available in the future, adequate public education regarding the different mechanisms of action of each vaccine may become important. Considering the result that majority of the pregnant and lactating women were unsure if they would take the vaccine (45% and 62%, respectively), a significantly higher national vaccination rate could be achieved by motivating and convincing these women who have expressed uncertainty. Strategies such as providing these women with accurate, transparent information during their antenatal and child vaccination visits and involving these women in shared decision-making may help to increase the acceptance rates.

We found that lower monthly household income and lower education level were associated with higher vaccine acceptance

**Table 4: Survey responses obtained from lactating women.**

Question	Response	n (%)		
		Total (n=207)	Accept vaccine (n=61)	Unsure or decline vaccine (n=140)
<b>Health status</b>				
Have you had previous experience with COVID-19 (e.g. infection in self/family member/friend/work-related contact)?	Yes	13 (6.3)	6 (17.1)	7 (4.1)
	No	194 (93.7)	29 (82.9)	165 (95.9)
How do you rate your current overall health status?	Good or very good	177 (85.5)	34 (97.1)	143 (83.1)
	Fair	29 (14.0)	1 (2.9)	28 (16.3)
	Poor or very poor	1 (0.5)	0 (0)	1 (0.6)
<b>Knowledge</b>				
The vaccine is currently recommended to breastfeeding mothers	Agree or strongly agree	69 (33.3)	26 (74.3)	43 (25.0)
	Unsure	97 (46.9)	6 (17.1)	91 (52.9)
	Disagree or strongly disagree	41 (19.8)	3 (8.6)	38 (22.1)
The vaccine works by training the body's immune system to produce antibodies against COVID-19 faster in case of a real infection	Agree or strongly agree	144 (69.6)	34 (97.1)	110 (64.0)
	Unsure	57 (27.5)	1 (2.9)	56 (32.6)
	Disagree or strongly disagree	6 (2.9)	0 (0)	6 (3.5)
Taking the vaccine reduces my chances of getting COVID-19	Agree or strongly agree	151 (72.9)	31 (88.6)	120 (69.8)
	Unsure	40 (19.3)	3 (8.6)	37 (21.5)
	Disagree or strongly disagree	16 (7.7)	1 (2.9)	15 (8.7)
<b>Perceptions</b>				
My risk of contracting COVID-19 is	High or very high	28 (13.5)	14 (40.0)	14 (8.1)
	Neutral	110 (53.1)	10 (28.6)	100 (58.1)
	Low or very low	69 (33.3)	11 (31.4)	58 (33.7)
How worried are you about contracting COVID-19?	Concerned or very concerned	138 (77.3)	25 (71.4)	113 (65.7)
	Neutral	19 (9.2)	5 (14.3)	49 (28.5)
	Not concerned or not concerned at all	28 (13.5)	5 (14.3)	10 (5.8)
I will only take the vaccine when more data about its safety in breastfeeding is available	Agree or strongly agree	160 (77.3)	16 (45.7)	144 (83.7)
	Unsure	19 (9.2)	3 (8.6)	16 (9.3)
	Disagree or strongly disagree	28 (13.5)	16 (45.7)	12 (7.0)
I am willing to pay for the vaccine if needed	Yes	105 (50.7)	11 (31.4)	91 (52.9)
	No	102 (49.3)	24 (68.6)	81 (47.1)
I am concerned about the side effects I may experience post-vaccination (pain, swelling, headache, body ache, fever, allergic reaction)	Agree or strongly agree	170 (82.1)	23 (65.7)	147 (85.6)
	Unsure	20 (9.7)	4 (11.4)	16 (9.3)
	Disagree or strongly disagree	17 (8.2)	8 (22.9)	9 (5.2)
I am concerned that I can transmit the virus to people around me if I take the vaccine	Agree or strongly agree	76 (36.7)	12 (34.3)	64 (37.2)
	Unsure	49 (23.7)	2 (5.7)	47 (27.3)
	Disagree or strongly disagree	82 (39.6)	21 (60.0)	61 (35.5)
I am concerned that the virus can be transmitted via milk to my breastfeeding infant if I take the vaccine	Agree or strongly agree	117 (56.5)	11 (31.4)	106 (61.6)
	Unsure	49 (23.7)	7 (20.0)	42 (24.4)
	Disagree or strongly disagree	41 (19.8)	17 (48.6)	24 (14.0)
I am worried that the COVID-19 vaccine can have long-term effects on my breastfeeding infant	Agree or strongly agree	144 (69.6)	13 (40.0)	130 (75.6)
	Unsure	44 (21.3)	8 (20.9)	8 (22.9)
	Disagree or strongly disagree	19 (9.2)	13 (37.1)	6 (3.5)
I will temporarily stop breastfeeding for 5–7 days following vaccination	Agree or strongly agree	72 (34.8)	10 (28.6)	62 (36.0)
	Unsure	69 (33.3)	8 (22.9)	61 (35.5)
	Disagree or strongly disagree	66 (31.9)	17 (48.6)	17 (48.6)
I believe that taking the vaccine will protect my baby from the virus when I resume breastfeeding after vaccination	Agree or strongly agree	79 (38.2)	26 (74.3)	53 (30.8)
	Unsure	112 (54.1)	7 (20.0)	105 (61.0)
	Disagree or strongly disagree	16 (7.7)	2 (5.7)	14 (8.1)

in pregnant and lactating mothers, respectively. This is contrary to other studies where higher education level and socioeconomic status were associated with greater vaccine

acceptance.<sup>[33,34]</sup> A possible explanation for this is that women who were better educated and of higher socioeconomic status may have been more likely to receive conflicting information

**Table 5: Regression analysis for vaccine acceptance among lactating women.**

Factor	Adjusted OR (95% CI)	P
Highest education level		
No formal education/primary	Ref	NA
Secondary/post-secondary	0.04 (0.01, 0.48)	0.10
Undergraduate or above	0.10 (0.01, 0.90)	0.04
Knowledge about the mechanism of action		
Unsure/disagree or strongly disagree	Ref	NA
Agree or strongly agree	9.44 (1.10, 81.0)	0.04
Maternal perceived risk of COVID-19		
Low or very low	Ref	NA
Neutral	0.68 (0.22, 2.06)	0.49
High or very high	9.10 (2.40, 34.47)	0.001
Perceived long-term negative effects on breastfeeding child		
Disagree or strongly disagree	Ref	NA
Unsure	0.15 (0.03, 0.33)	0.01
Agree or strongly agree	0.08 (0.02, 0.31)	<0.001
Perceived long-term protection of baby		
Disagree or strongly disagree	Ref	NA
Unsure	0.17 (0.02, 1.42)	0.10
Agree or strongly agree	0.68 (0.09, 5.01)	0.71

NA: not applicable, Ref: reference variable

through social media channels and/or are more concerned about the lack of safety data on the vaccine. However, this should be better addressed through more targeted surveys or focus group studies. Indeed, we found that majority of both pregnant and lactating women expressed willingness to take the vaccine when more safety data became available.

### Limitations

A limitation of our study is its cross-sectional nature and the short survey study period of 3 months. Since the time this survey was conducted, government recommendations regarding vaccination in these groups of women have evolved, with an emphasis on its safety and the importance of vaccination. Therefore, perceptions of pregnant and lactating women may also have changed. However, we believe that our results are still valid in informing educational strategies in women who are unsure or unwilling to take the vaccine despite changes in recommendations. In addition, we measured vaccine acceptance via participants' reports, and not actual vaccination rates. Reported intent may not translate into actual behaviour on vaccination,<sup>[35]</sup> and whether addressing safety concerns would be adequate in increasing vaccine uptake remains to be determined. A study by Stuckelberger *et al.*<sup>[36]</sup> reported that taking the influenza vaccination in the past year was a positive predictor for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) vaccine acceptance in pregnant and lactating women. Women who usually declined influenza vaccination

were less likely to be willing to get the SARS-CoV-2 vaccine. This study also reported that pregnant women who had a fixed obstetric care provider and were in the last trimester of pregnancy were more likely to accept the vaccine, whereas women in their second trimester were more likely to refuse vaccination. Unfortunately, we did not capture any information regarding influenza vaccine uptake, gestational age or occupation status in our survey, all of which may have affected their risk for COVID-19 and thus, vaccine acceptance. Other limitations of our study include the omission of a pilot survey to test its reliability and validity. This was due to the short time frame to capture these data, especially with the evolving COVID-19 vaccination and pandemic situation locally. The demographics of our study population do not reflect the ethnic proportions in Singapore. Up to 74% of the population in Singapore is Chinese,<sup>[37]</sup> whereas Chinese women made up only 48% and 52% of our pregnant and lactating study cohort, respectively. As this was an in-hospital study, this difference likely reflects the demographics of the obstetric population visiting our hospital. Further analysis showed that ethnicity was not significantly associated with vaccine acceptance in pregnant or breastfeeding women (results not shown). As the survey was conducted online with widespread dissemination of the study invitation flyers, the actual response rate to the survey is not known. This has the potential to introduce a selection bias, as only those women who were concerned about the vaccine may have opted to participate in the survey.

To our knowledge, this is the first survey on COVID-19 vaccine perceptions in pregnant and lactating women in Singapore. Our study is timely in informing education programmes and vaccination efforts in these groups to design a targeted action plan. Based on our results, an educational brochure highlighting the more serious nature of COVID-19 infection in pregnant women and available evidence on the safety and efficacy of the vaccine is currently being prepared to better inform pregnant women about COVID-19 vaccination. These may be used by obstetric care providers to encourage pregnant women to take up vaccination with individualised counselling to address specific concerns and barriers for vaccine hesitancy. We also propose the use of other platforms such as public forums, patient stories, mass media (radio and television talk shows) and social media (hospital's Facebook page, Instagram) to provide updated evidence-based information in order to help raise awareness and knowledge to aid improve the acceptance of the COVID-19 vaccine. With the expansion of the local vaccination programme to pregnant and lactating women, it is important for educational messages to be targeted at specific concerns regarding vaccine safety and efficacy.

In conclusion, COVID-19 vaccine acceptance among pregnant and lactating women in Singapore was found to be generally low in this pre-vaccine rollout survey. Factors affecting low vaccine acceptability among both pregnant and lactating women included a low perceived infection risk and concerns of unknown safety for the mother and child. Addressing safety



concerns and infection risk may help improve COVID-19 vaccine acceptance among pregnant and lactating women in Singapore.

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### Conflicts of interest

There are no conflicts of interest.

### Supplemental digital content

Appendix at <http://links.lww.com/SGMJ/A133>

## REFERENCES

- Baden LR, El Sahly HM, Essink B, Kotloff K, Frey S, Novak R, *et al.* Efficacy and safety of the mRNA-1273 SARS-CoV-2 vaccine. *N Engl J Med* 2021;384:403-16.
- Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, *et al.* Safety and efficacy of the BNT162b2 mRNA Covid 19 vaccine. *N Engl J Med* 2020;383:2603-15.
- Ministry of Health, Singapore. Expert committee on COVID-19 vaccination endorses use of Pfizer-BioNTech COVID-19 Vaccine Singapore 2021. Available from: [www.moh.gov.sg/news-highlights/details/expert-committee-on-covid-19-vaccination-endorses-use-of-pfizer-biontech-covid-19-vaccine](http://www.moh.gov.sg/news-highlights/details/expert-committee-on-covid-19-vaccination-endorses-use-of-pfizer-biontech-covid-19-vaccine). [Last accessed on 2021 Jun 12].
- Ministry of Health, Singapore. Frequently Asked Questions (FAQs) on COVID-19 Vaccination [Online]. Available from: [www.moh.gov.sg/covid-19/vaccination/faqs](http://www.moh.gov.sg/covid-19/vaccination/faqs). [Last accessed on 2021 Feb 01].
- Rasmussen SA, Jamieson DJ. Pregnancy, postpartum care, and COVID-19 vaccination in 2021. *JAMA* 2021;325:1099-100.
- The American College of Obstetrics and Gynecology (ACOG). Vaccinating Pregnant and Lactating Patients Against COVID-19- Practice advisory, 2020. Available from: [www.acog.org/clinical/clinical-guidance/practice-advisory/articles/2020/12/vaccinating-pregnant-and-lactating-patients-against-covid-19](http://www.acog.org/clinical/clinical-guidance/practice-advisory/articles/2020/12/vaccinating-pregnant-and-lactating-patients-against-covid-19). [Last accessed on 2021 Jun 08].
- World Health Organization. COVID-19 clinical management: Living guidance, 25 January 2021. Available from: [apps.who.int/iris/handle/10665/338882](https://apps.who.int/iris/handle/10665/338882). [Last accessed on 2021 Jun 07].
- Academy of Breastfeeding Medicine. Considerations for COVID-19 Vaccination in Lactation-Policy statement. Available from: [www.bfmed.org/abm-statement-considerations-for-covid-19-vaccination-in-lactation](http://www.bfmed.org/abm-statement-considerations-for-covid-19-vaccination-in-lactation). [Last accessed on 2021 Jun 06].
- Data Against COVID 19. Dashboard of the COVID-19 virus outbreak in Singapore. Available from: <https://co.vid19.sg/singapore?start=01-01-2021&end=31-05-2021>. [Last accessed on 2021 Nov 20].
- Centers for Disease Control and Prevention. COVID Data Tracker. Available from: [https://covid.cdc.gov/covid-data-tracker/#trends\\_dailycases](https://covid.cdc.gov/covid-data-tracker/#trends_dailycases). [Last accessed on 2021 Nov 20].
- Booth A, Reed AB, Ponzio S, Yassaee A, Aral M, Plans D, *et al.* Population risk factors for severe disease and mortality in COVID-19: A global systematic review and meta-analysis. *PLoS One* 2021;16:e0247461.
- Allotey J, Stallings E, Bonet M, Yap M, Chatterjee S, Kew T, *et al.* Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: Living systematic review and meta-analysis. *BMJ* 2020;370:m3320.
- Zambrano LD, Ellington S, Strid P, Galang RR, Oduyebo T, Tong VT, *et al.* Update: Characteristics of symptomatic women of reproductive age with laboratory-confirmed SARS-CoV-2 infection by pregnancy status-United States, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69:1641-7.
- Wei SQ, Bilodeau-Bertrand M, Liu S, Auger N. The impact of COVID-19 on pregnancy outcomes: A systematic review and meta-analysis. *CMAJ* 2021;193:E540-8.
- Goh XL, Low YF, Ng CH, Amin Z, Ng YPM. Incidence of SARS-CoV-2 vertical transmission: A meta-analysis. *Arch Dis Child Fetal Neonatal Ed* 2021;106:112-3.
- Mattar CN, Kalimuddin S, Sadarangani SP, Tagore S, Thain S, Thoon KC, *et al.* Pregnancy outcomes in COVID-19: A prospective cohort study in Singapore. *Ann Acad Med Singap* 2020;49:857-69.
- Skjefte M, Ngirbabul M, Akeju O, Escudero D, Hernandez-Diaz S, Wyszynski DF, *et al.* COVID-19 vaccine acceptance among pregnant women and mothers of young children: Results of a survey in 16 countries. *Eur J Epidemiol* 2021; 36:197-211.
- Sutton D, D'Alton M, Zhang Y, Kahe K, Cepin A, Goffman D, *et al.* COVID-19 vaccine acceptance among pregnant, breastfeeding and non-pregnant reproductive aged women. *Am J Obstet Gynecol MFM* 2021;3:100403.
- Ceulemans M, Foulon V, Panchaud A, Winterfeld U, Pomar L, Lambelet V, *et al.* Vaccine willingness and impact of the COVID-19 pandemic on women's perinatal experiences and practices—A multinational, cross-sectional study covering the first wave of the pandemic. *Int J Environ Res Public Health* 2021;18:3367.
- Razzaghi H, Meghani M, Pingali C, Crane B, Naleway A, Weintraub E, *et al.* COVID-19 Vaccination Coverage Among Pregnant Women During Pregnancy — Eight Integrated Health Care Organizations, United States, December 14, 2020–May 8, 2021. *MMWR Morb Mortal Wkly Rep* 2021;70:895-9.
- Mannan KA, Farhana KM. Knowledge, attitude and acceptance of a COVID-19 vaccine: A global cross-sectional study. *SSRN Electronic Journal* 2020.
- Lin Y, Hu Z, Zhao Q, Alias H, Danaee M, Wong LP. Understanding COVID-19 vaccine demand and hesitancy: A nationwide online survey in China. *PLoS Negl Trop Dis* 2020;14:e0008961.
- Eysenbach G. Improving the quality of Web surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res* 2004;6:e34.
- Tao L, Wang R, Han N, Liu J, Yuan C, Deng L, *et al.* Acceptance of a COVID-19 vaccine and associated factors among pregnant women in China: A multi-center cross-sectional study based on health belief model. *Hum Vaccin Immunother* 2021;17:2378-88.
- Goncu Ayhan S, Oluklu D, Atalay A, Menekse Beser D, Tanacan A, Moraloglu Tekin O, *et al.* COVID-19 vaccine acceptance in pregnant women. *Int J Gynecol Obstet* 2021;154:291-6.
- Share of people willing to be vaccinated against COVID-19 in Singapore. Available from: <https://www.statista.com/statistics/1200507/singapore-vaccination-willingness-against-covid-19/>. [Last accessed on 2021 Nov 20].
- Levy AT, Singh S, Riley LE, Prabhu M. Acceptance of COVID-19 vaccination in pregnancy: A survey study. *Am J Obstet Gynecol MFM* 2021;3:100399.
- Shanes ED, Otero S, Mithal LB, Mupanomunda CA, Miller ES, Goldstein JA. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) vaccination in pregnancy: Measures of immunity and placental histopathology. *Obstet Gynecol* 2021;138:281-3.
- Gray KJ, Bordt EA, Atyeo C, Deriso E, Akinwunmi B, Young N, *et al.* Coronavirus disease 2019 vaccine response in pregnant and lactating women: A cohort study. *Am J Obstet Gynecol* 2021;225:303.e1-17.
- Shimabukuro TT, Kim SY, Myers TR, Moro PL, Oduyebo T, Panagiotakopoulos L, *et al.* Preliminary findings of mRNA Covid-19 vaccine safety in pregnant persons. *N Engl J Med* 2021;384:2273-82.
- Bertrand K, Honerkamp-Smith G, Chambers CD. Maternal and child outcomes reported by breastfeeding women following messenger RNA COVID-19 vaccination. *Breastfeed Med* 2021;16:697-701.
- McLaurin-Jiang S, Garner CD, Krutsch K, Hale TW. Maternal and child symptoms following COVID-19 vaccination among breastfeeding mothers. *Breastfeed Med* 2021;16:702-9.
- Gadoth A, Halbrook M, Martin-Blais R, Gray A, Tobin NH, Ferbas KG, *et al.* Cross-sectional assessment of COVID-19 vaccine acceptance among health care workers in Los Angeles. *Ann Intern Med* 2021;174:882-5.
- Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, *et al.* A global survey of potential acceptance of a COVID-19 vaccine. *Nat Med* 2021;27:225-8.
- Sheeran P. Intention—behavior relations: A conceptual and empirical review. *Eur Rev Soc Psychol* 2002;12:1-36.
- Stuckelberger S, Favre G, Ceulemans M, Nordeng H, Gerbier E, Lambelet V, *et al.* SARS-CoV-2 vaccine willingness among pregnant and breastfeeding women during the first pandemic wave: A cross-sectional study in Switzerland. *Viruses* 2021;13:1199.
- Singapore Department of Statistics. Population Trends 2021. Available from: <https://www.singstat.gov.sg/-/media/files/publications/population/population2021.pdf>. [Last accessed on 2021 Nov 20].