Knowledge, attitudes, and practices related to the COVID-19 pandemic among pregnant women in Bangkok, Thailand

Jadsada Kunno1, Pataraporn Yubonpunt2, Busaba Supawattanabodee3, Chavanant Sumanasrethakul3 and Budsaba Wiriyasirivaj4*

Abstract

Background: Pregnancy is associated with increased risk for severe COVID-19. Few studies have examined knowledge, attitudes, and practices (KAP) related to pregnancy during the pandemic. This study investigated the association between socio-demographic characteristics and KAP related to COVID-19 among pregnant women in an urban community in Thailand.

Methods: A cross-sectional online survey was distributed among pregnant women in Bangkok, Thailand from July–August 2021. Binary logistic regression was conducted to test the association between socio-demographic characteristics and KAP related to COVID-19, and a Spearman’s analysis tested correlations between KAP scores.

Results: A total of 150 pregnancy survey responses were received. Most participants were third trimester (27–40 weeks gestation; 68.0%). Pregnancy had never been risked contracting COVID-19 (84.7%). Most expressed concerns about being infected with COVID-19 during pregnancy and following birth (94.0 and 70.0%, respectively). The results of binary logistic regression analysis found associations between knowledge and marital status (OR = 4.983, 95%CI 1.894–13.107). In addition, having a bachelor’s degree or higher was associated with higher attitude scores (OR = 2.733, 95%CI 1.045–7.149), as was being aged 26–30 (OR = 2.413 95%CI 0.882–6.602) and 31–35 years of age (OR = 2.518–2.664, 95%CI 0.841–8.442). Higher practice scores were associated with having a bachelor’s degree or higher (OR = 2.285 95%CI 1.110–6.146), and income ≥15,001 bath (OR = 4.747 95%CI 1.588–14.192). Correlation analysis found a weak positive correlation between knowledge and practice scores (r = 0.210, p-value = 0.01).

Conclusion: Participants overall had high KAP scores. This study can guide public health strategies regarding pregnant women and COVID-19. We recommend that interventions to improve and attitude and practice scores. Knowledge on pregnancy and COVID-19 should focus on reducing fear and improving attitudes toward the care of patients as well as the promotion of preventive practices.

Keywords: Knowledge, Attitudes, Practices, COVID-19 pandemic, Pregnant, Thailand

© The Author(s) 2022. Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.
mild-to-moderate respiratory illness and recover without requiring special treatment [3]. Pregnant women may be at increased risk for severe COVID-19 illness [4–6]. To reduce the chances of infection, pregnant women should be aware of their potential risk and preventative measures [5], and potential barriers to their adherence to such measures should be addressed [7]. Although pregnant women infected with COVID-19 have been found to be less likely to have symptoms compared with non-pregnant women in similar age groups, studies have indicated that they are at increased risk for ICU admission and more likely to experience preterm labor, and their newborns are more likely to be in a neonatal ICU [4]. Moreover, cases have been reported of COVID-19-related complications such as hydrops fetalis and intrauterine fetal demise [8], which are possibly related to changes in infants’ immune system and respiratory physiology [9]. Although limited data are available about COVID-19 during pregnancy, information on the impacts of other highly pathogenic coronaviruses such as severe acute respiratory syndrome and the Middle East respiratory syndrome on pregnancy can provide insights into COVID-19 effects [10]. Such viruses may predispose pregnant women to higher risks of severe disease and poorer neonatal outcomes [11]. Thus, a better understanding of knowledge, attitudes and practices around COVID-19 among pregnant women and mothers of infants is needed [12].

People's adherence to infection control measures will be largely affected by their knowledge, attitude, and practices (KAP). “KAP theory” is a health behavior change framework wherein factors contributing to human behavioral change are divided into three successive processes, namely the acquisition of proper knowledge, generation of attitudes, and adoption of behaviors (or practices) [13]. The public's KAP play a major role in the prevention and control of infectious diseases [14]: thus, it is expected that KAP levels will be a deciding factor in the battle against COVID-19. The public must routinely practice precautionary behaviors to control the spread of COVID-19 and requiring people to adhere to social distancing and appropriate preventative practices can help prevent or contain outbreaks [11, 15]. However, effective pandemic management requires an adequate understanding of the factors that influence behavioral changes [16], including the ways that KAP affect individuals’ adherence to government measures [17]. As the same time knowledge about COVID-19 infection in pregnant women and newborns is scarce [18].

The issue of pregnancy during this global pandemic deserves a more sensitive approach and mutual understanding among clinicians and other healthcare workers; however, A few studies assessing attitudes and perceptions of the effect of COVID-19 among pregnant women [19–22]. As the COVID-19 pandemic continues to intensify globally, it is important to understand the mentality of pregnant women towards COVID-19. The only preventive measures available are social distancing, hand washing and face masks; however, few studies have focused on KAP. To help address this gap, this paper reports the results of a cross-sectional survey of pregnant women in Bangkok, Thailand. Specifically, this study aimed to: 1) collect information on pregnant women's baseline knowledge, attitudes, and practices related to COVID-19; 2) examine potential associations between socio-demographic characteristics and COVID-19-related knowledge, attitudes, and practices, and 3) investigate possible correlations between knowledge, attitude, and practice dimensions. In so doing, this study can help identify various characteristics of pregnant women who are more likely to be vulnerable to the effects of COVID-19.

Methods
Study design
This study entailed the analysis of a cross-sectional survey distributed among pregnant women attending the obstetrics and gynecology clinic at the Faculty of Medicine Vajira Hospital, Bangkok, Thailand from July–August 2021. The study was approved by the ethics committee of the Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand. (COA 116/2564). All experiments were performed in accordance with relevant guidelines and regulations, in the Declarations section.

Participants
Pregnant women aged 18 years and older living in Bangkok, Thailand availing themselves of gynecology and obstetrics services at Faculty of Medicine Vajira Hospital, Bangkok were eligible to participate in the study. The sample size was calculated using G*Power based on the estimated population of pregnant women in the city.

Data collection
Data was collected using an online survey distributed on social media using a snowball technique. The invitation asked participants to confirm that informed consent was obtained from all subjects, voluntary participation and provided instructions for filling in the questionnaire. All participants have been performed in accordance with the Declaration of Helsinki and have been approved by an appropriate ethics committee.
The questionnaire takes about 10 min to complete and is divided into four sections. (see Supplementary files 1 for details). The questions were designed and modified by an expert team of researchers and previous study [11, 23]. The first section collected socio-demographic information, including age, occupation, education level, marital status, income, and religion, in addition to clinical characteristics such as pregnancy trimester, number of pregnancies, type of conception, history of miscarriages, current and previous pregnancy complications, settlement type, and questions designed to gauge participants’ risk of contracting COVID-19 (see Table 1 for details). The knowledge section consists of 13 items (K1–K13) scored as False = 0 and True = 1. Knowledge item responses were summed to a total score from 0 to 13 and the cut-off point for adequate/inadequate overall knowledge was set at 60% (≥ 9 points). The Attitudes section consisted of 17 items (A1–A17) assessing perceptions of whether the country could win the fight against the COVID-19 pandemic, for which responses were scored as Agree = 2, Not Sure = 1, and Disagree = 0. Attitude item responses were summed to a total score ranging from 0 to 34, and the cut-off point for overall favorable/unfavorable attitudes was set at 27 points. The Practices section consisted of 11 questions (P1–P11) scored as Practiced = 2, Not sure = 1, and Not practiced = 0. Practice item responses were summed to a total score ranging from 0 to 22, and the cut-off point for proper/improper practices was set at 18 points. Practice items were based on perceptions of whether the country could win the fight against the COVID-19 pandemic (see Table 2 for details).

### Statistical analysis
In addition to descriptive statistics of the characteristics and dispersion measures (mean and standard deviation). Binary logistic regression was used to test the association between socio-demographic characteristics and COVID-19-related knowledge, attitudes, and practiced. Spearman’s correlation analysis was used to examine associations between knowledge, attitude, and practice scores. The level of statistical significance was set at p-value < 0.05 was considered to indicate statistical significance. 

---

**Table 1** Characteristics of participants (n = 150)

| Socio-demographic characteristics | n (%) |
|----------------------------------|-------|
| Pregnancy                        | 150 (100.0%) |
| **Age (years)**                  |       |
| 18–25                            | 46 (30.7%) |
| 26–30                            | 43 (28.7%) |
| 31–35                            | 32 (21.3%) |
| ≥ 36                             | 29 (19.3%) |
| **Occupation**                   |       |
| Civil servant                    | 18 (12.0%) |
| Employee                         | 87 (58.0%) |
| Housewife                        | 45 (30.0%) |
| **Education**                    |       |
| < Bachelor’s degree              | 104 (69.3%) |
| ≥ Bachelor’s degree              | 46 (30.7%) |
| **Status**                       |       |
| Unmarried                        | 41 (27.3%) |
| Married                          | 109 (72.7%) |
| **Income (Thai baht)**           |       |
| <15,000                          | 101 (67.3%) |
| ≥15,000                          | 49 (32.7%) |
| **Religion**                     |       |
| Buddhism                         | 146 (97.3%) |
| Christianity                     | 1 (0.7%) |
| Islam                            | 3 (2.0%) |
| **Trimester**                    |       |
| First ≤12 weeks gestation        | 12 (8.0%) |
| Second 13–26 weeks gestation     | 36 (24.0%) |
| Third 27–40 weeks gestation      | 102 (68.0%) |
| **Number of pregnancies**        |       |
| 1                                | 64 (42.7%) |
| 2                                | 49 (32.7%) |
| 3                                | 27 (18.0%) |
| ≥4                               | 10 (6.7%) |
| **Type of conception**           |       |
| Naturally conceived               | 148 (98.7%) |
| Not naturally conceived          | 2 (1.3%) |
| **Number of miscarriages**       |       |
| 0                                | 124 (82.7%) |
| 1                                | 23 (15.3%) |
| ≥2                               | 3 (2.0%) |
| **Current complications**        |       |
| No                               | 127 (84.7%) |
| Yes                              | 23 (15.3%) |
| **Previous complications**       |       |
| No                               | 135 (90.0%) |
| Yes                              | 15 (10.0%) |
| **Settlement type**              |       |
| Urban                            | 150 (100.0%) |
| Risk of contracting COVID-19     |       |
| Infection COVID-19               | 1 (0.7%) |

---

**Table 1** (continued)

| Socio-demographic characteristics | n (%) |
|----------------------------------|-------|
| At risk (ever had a screening test) | 8 (5.3%) |
| Never at risk                    | 127 (84.7%) |
| Not sure                         | 14 (9.3%) |

---

**Table 2** (continued)

| Socio-demographic characteristics | n (%) |
|----------------------------------|-------|
| At risk (ever had a screening test) | 8 (5.3%) |
| Never at risk                    | 127 (84.7%) |
| Not sure                         | 14 (9.3%) |
significance. The statistical analysis was performed using the Statistical Package for the Social Sciences Program (SPSS), version 22 (IBM Corp., Armonk, NY, USA).

**Results**

A total of 150 questionnaire responses were obtained, and socio-demographic and clinical characteristics are presented in Table 1. The largest group of participants (30.7%) was aged 18–25 years, and the majority were married (72.7%), Buddhists (97.3%), and private employees or civil servants (70.0%), had attained less than a bachelor’s degree (69.3%), and reported incomes less than 15,000 Thai-bath (67.3%). These results indicate that population was representative of the wider population of pregnant women residing in Bangkok.

In terms of clinical characteristics, the majority of participants were in their third trimester (27–40 weeks gestation; 68.0%), and over 40% were in their first pregnancy. Most pregnancies were naturally conceived (98.7%). The majority of participants reported no history of miscarriage (82.7%), had experienced no current or previous complications (84.7 and 90%, respectively). In addition, most reported that they had never been in a situation in which they risked contracting COVID-19 (84.7%).

**Knowledge, Attitude, and Practice scores on COVID-19**

Participants’ knowledge, attitude, and practice item scores were showed in Table 2. The mean knowledge score was (9 ± 2.3). Nearly 90% of participants knew that COVID-19 can be spread by droplets and aerosols (K2), and 65% knew that there is currently no treatment for COVID-19 (K5). Over 83% responded that the pneumococcal vaccine cannot protect against COVID-19 (K6), and 75% reported that regular rinsing nasal mucus with saline cannot prevent infection (K10). However, 64% responded that wearing two masks are more effective than a single mask to prevent infection (K8).

The mean attitudes score was (27 ± 3.9). The majority (66.0%) of participants were not sure if COVID-19 could be controlled (A1), agreed that the pandemic had affected daily life 142 (94.7%) (A2), and agreed that pregnant women were at higher risk of infection a chance than other populations 133 (88.7%) (A3). Most expressed concerns about being infected with COVID-19 during pregnancy and following birth (94.0 and 70.0%, respectively) (A5–A6). In addition, 38.7% were not sure if diagnosed have COVID-19, is the risk of infection to the baby after delivery (A12), and 77.3% agreed that they would isolate themselves for 2 weeks if they became infected with COVID-19 (A13). Most participants agreed that they would breastfeed by themselves (92.7%) (A14) and indicated that they would not breastfeed if infected with COVID-19 after delivery (51.3%) (A15).

The mean practice score was (18 ± 1.9). The majority of participants (99.3%) stated that they wore a mask every time they left the house (P3) and frequently washed their hands or cleaned them with alcohol (P4). Most participants claimed to avoid crowds and public places (91.3%) (P7) and follow news updates about the COVID-19 situation (92.7%) (P8).

**Associations between knowledge and socio-demographic characteristics**

Table 3 shows the bivariate analysis of knowledge scores and socio-demographic characteristics. The variables of being a housewife and married status were significantly associated with knowledge levels, as were all age groups (p-value < 0.05). In addition, having a bachelor’s degree or higher was likely associated with knowledge (p-value = 0.061). The results of the multivariate analysis indicated a significant association between marital status and knowledge about COVID-19 (p-value = 0.001), whereby married participants had greater knowledge than those who were unmarried (OR = 4.983, 95%CI 1.894–13.107).

**Associations between attitudes and socio-demographic characteristics**

As Table 4 shows the bivariate analysis found a significant association between attitudes and education at or beyond the bachelor’s degree as well as the age group of 31–35 years (p-value < 0.05). In addition, working as a regular employee and being in the 26–30 years age group were nearly associated with attitudes. The multivariate analysis found that individuals with at least a bachelor’s degree had more favorable attitudes about COVID-19 than those with less education (p-value = 0.040; OR = 2.733, 95%CI 1.045–7.149). In addition, those aged 26–30 and 31–35 years had more favorable attitudes than those aged 25 years or younger (OR = 2.518–2.664, 95%CI 0.841–8.442).

**Associations between practices and socio-demographic characteristics**

As Table 5 shows, the bivariate analysis found that the age group of 26–30 years and income ≥15,001 were significantly associated with practices (p-value < 0.05). The multivariate analysis found that participants with at least a bachelor’s degree reported more proper practices than those with less education (p-value = 0.04; OR = 2.285 95%CI 1.110–6.146), and higher income was associated with higher practice scores (p-value = 0.005; OR = 4.747 95%CI 1.588–14.192). The age group of 26–30 years was more closely associated with
Table 2  Frequency scores for knowledge, attitudes, and practice items

| Knowledge items | n (%) | False |
|-----------------|-------|-------|
| True            |       |       |
| K1 Human-to-Human transmission of COVID-19 | 142 (94.7%) | 8 (5.3%) |
| K2 COVID-19 can be spread by droplets and aerosols. | 134 (89.3%) | 16 (10.7%) |
| K3 COVID-19 symptoms include mild fever, tiredness, dry cough, and muscle pain.| 135 (90.0%) | 15 (10.0%) |
| K4 Everyone has the same risk of infection from COVID-19. | 126 (84.0%) | 24 (16.0%) |
| K5 There currently is no treatment for COVID-19. | 97 (64.7%) | 53 (35.3%) |
| K6 The pneumococcal vaccine can protect against COVID-19. | 25 (16.7%) | 125 (83.3%) |
| K7 Not everyone with COVID-19 will have severe symptoms. But people with underlying or chronic diseases are more likely to have severe symptoms. | 111 (74.0%) | 39 (26.0%) |
| K8 Wearing two of masks can prevent infection from COVID-19 better than one layer. | 96 (64.0%) | 54 (36.0%) |
| K9 Wash your hands frequently | 128 (85.3%) | 22 (14.7%) |
| K10 Regular rinsing nasal mucus with saline can prevented with COVID-19. | 38 (25.3%) | 112 (74.7%) |
| K11 A person who comes into contact with someone infected with COVID-19 should be isolated immediately in 14 days. | 137 (91.3%) | 13 (8.7%) |
| K12 Vaccination against COVID-19 prevents severe symptoms. | 88 (58.7%) | 62 (41.3%) |
| K13 There currently is no information on the efficacy and safety of vaccinations against COVID-19. | 69 (46.0%) | 81 (54.0%) |

Knowledge mean ± SD = 9 ± 2.3; Max score = 13

| Attitudes items | n (%) |
|-----------------|-------|
| Agree | Not Sure | Disagree |
| True | False |
| A1 COVID-19 can be controlled | 33 (22.0%) | 99 (66.0%) | 18 (12.0%) |
| A2 COVID-19 has affected daily life. | 142 (94.7%) | 6 (4.0%) | 2 (1.3%) |
| A3 Pregnant women may have a higher chance than other populations of being infected with COVID-19. | 133 (88.7%) | 16 (10.7%) | 1 (0.7%) |
| A4 Pregnancy may increase the risk of respiratory failure than other population. | 105 (70.0%) | 43 (28.7%) | 2 (1.3%) |
| A5 I am concerned about being infected with COVID-19 during pregnancy. | 141 (94.0%) | 9 (6.0%) | 0 |
| A6 I am concerned about being infected with COVID-19 following pregnancy. | 105 (70.0%) | 39 (26.0%) | 6 (4.0%) |
| A7 Do you think the fetus can be infected? | 78 (52.0%) | 66 (44.0%) | 6 (4.0%) |
| A8 Do you think your baby can be infected after birth? | 78 (52.0%) | 69 (46.0%) | 3 (2.0%) |
| A9 Do you think the baby can be infected during delivery? | 80 (53.3%) | 68 (45.3%) | 2 (1.3%) |
| A10 Contracting COVID-19 during pregnancy may increase the risk of miscarriage | 83 (55.3%) | 65 (43.3%) | 2 (1.3%) |
| A11 Do you agree if your doctor will be advised you for caesarean section over a vaginal delivery if you are diagnosed with COVID-19? | 94 (62.7%) | 56 (37.3%) | 0 |
| A12 If you are diagnosed have COVID-19, how likely do you think is the risk of infection to the baby after delivery | 44 (29.3%) | 58 (38.7%) | 48 (32.0%) |
| A13 If infected with COVID-19 after delivery, will you isolate yourself for 2 weeks? | 116 (77.3%) | 30 (20.0%) | 4 (2.7%) |
| A14 Will you breastfeed by yourself? | 139 (92.7%) | 7 (4.7%) | 4 (2.7%) |
| A15 If infected with COVID-19 after delivery, will you breastfeed? | 16 (10.7%) | 57 (38.0%) | 77 (51.3%) |
| A16 Do you want to be vaccinated against COVID-19 during pregnancy? | 79 (52.7%) | 51 (34.0%) | 20 (13.3%) |
| A17 Do you want to be vaccinated against COVID-19 during breastfeeding? | 81 (54.0%) | 48 (32.0%) | 21 (14.0%) |

Attitudes mean ± SD = 27 ± 3.9, Max score = 34

| Practice items | n (%) | Not practiced |
|----------------|-------|---------------|
| Practiced | Not sure |
| P1 Will/have been tested for COVID-19 during pregnancy | 52 (34.7%) | 9 (6.0%) | 89 (59.3%) |
| P2 Will be tested if you experience COVID-19 symptoms during pregnancy | 133 (88.7%) | 15 (10.0%) | 2 (1.3%) |
| P3 You wear a mask every time you leave the house. | 149 (99.3%) | 1 (0.7%) | 0 |
| P4 You frequently wash your hands or clean them with alcohol. | 149 (99.3%) | 1 (0.7%) | 0 |
| P5 You cover your mouth and nose with your elbow or a cloth or tissue when you cough or sneeze | 135 (90.0%) | 8 (5.3%) | 7 (4.7%) |
| P6 You maintain at least 1 m distance from others in public places. | 138 (92.0%) | 11 (7.3%) | 1 (0.7%) |
| P7 You avoid crowds and public places. | 137 (91.3%) | 9 (6.0%) | 4 (2.7%) |
higher practice scores than ages 25 years and below (OR = 2.413 95%CI 0.882–6.602).

Correlation between knowledge, attitude, and practice scores
Table 6 indicates a weak but significant positive correlation between knowledge and practice scores ($r = 0.210$, $p$-value $= 0.010$). The correlation between attitude and practice scores approached significance ($r = 0.159$, $p$-value $= 0.052$).

Discussion
This study was conducted during the third wave of the COVID-19 pandemic in Thailand. To the best of our knowledge, it is the first study performed with pregnant women in an urban community. We found that socio-demographic factors such as occupation, age, education, marital status, and income influenced the knowledge, attitudes, and practices of pregnant women living in Bangkok. In addition, we found that knowledge score significantly increased along with practice scores, and attitude scores were nearly significantly correlated with practice scores. In addition, the best result reported that they had never been in a situation in which they risked contracting COVID-19 (84.7%). However, this study is based on the current situation of women pregnant during the COVID-19 pandemic in Bangkok Thailand.

Association between knowledge and socio-demographic characteristics
Our study found most participants knew that COVID-19 can be spread by droplets and aerosols, this result is agreed with other reported studies [24]. Our finding over responded that the pneumococcal vaccine cannot protect

Table 2 (continued)

| Practice mean $\pm$ SD = 18 $\pm$ 1.9, Max score = 22 |

Table 3 Bivariate and multivariate analysis of knowledge scores and socio-demographic characteristics

| Knowledge scores (1 = < 9 scores, 2 = $\geq$ 9 scores). OR Odds ratio, CI Confidence interval. Significant at $p$-value $< 0.05$ |

| Occupation | Bivariate | Multivariate |
|------------|-----------|--------------|
| Civil servant | Ref. | Ref. |
| Employee | 0.380 (0.102–1.417) | 0.150 | 0.511 (0.120–2.179) | 0.364 |
| Housewife | 0.191 (0.049–0.753) | 0.018 | 0.443 (0.090–2.173) | 0.316 |

| Age (years) | Bivariate | Multivariate |
|------------|-----------|--------------|
| 18–25 | Ref. | Ref. |
| 26–30 | 2.693 (1.135–6.390) | 0.025 | 1.450 (0.532–3.953) | 0.467 |
| 31–35 | 3.322 (1.264–8.731) | 0.015 | 1.044 (0.315–3.461) | 0.911 |
| $\geq$ 36 | 4.086 (1.457–11.457) | 0.007 | 1.413 (0.419–4.769) | 0.578 |

| Education (degree) | Bivariate | Multivariate |
|-------------------|-----------|--------------|
| < Bachelor | Ref. | Ref. |
| $\geq$ Bachelor | 2.078 (0.967–4.463) | 0.061 | 1.462 (0.524–4.769) | 0.468 |

| Status | Bivariate | Multivariate |
|--------|-----------|--------------|
| Unmarried | Ref. | Ref. |
| Married | 6.231 (2.840–13.670) | 0.01 | 4.983 (1.894–13.107) | 0.001 |

| Income (Thai baht) | Bivariate | Multivariate |
|-------------------|-----------|--------------|
| < 15,000 | Ref. | Ref. |
| $\geq$15,000 | 1.780 (0.853–3.713) | 0.124 | 0.775 (0.284–2.114) | 0.619 |
### Table 4  Bivariate and multivariate analysis of attitudes and socio-demographic characteristics

| Attitudes | Factor variables | Bivariate | Multivariate |
|-----------|------------------|-----------|--------------|
|           |                  | OR (95%CI) | p-value      | OR (95%CI) | p-value |
| Occupation| Civil servant    | Ref.      |             | Ref.       |         |
|           | Employee         | 0.370 (0.127–1.077) | 0.068 | 0.646 (0.199–2.113) | 0.478 |
|           | Housewife        | 0.438 (0.140–1.370) | 0.156 | 0.988 (0.254–3.840) | 0.986 |
| Age (years) | 18–25           | Ref.      |             | Ref.       |         |
|           | 26–30            | 2.167 (0.917–5.110) | 0.078 | 2.518 (0.946–6.702) | 0.065 |
|           | 31–35            | 3.021 (1.184–7.708) | 0.021 | 2.664 (0.841–8.442) | 0.096 |
|           | ≥ 36             | 1.929 (0.743–5.009) | 0.177 | 1.869 (0.592–5.900) | 0.286 |
| Education (degree) | < Bachelor       | Ref.      |             | Ref.       |         |
|           | ≥ Bachelor       | 2.296 (1.129–4.670) | 0.022 | 2.733 (1.045–7.149) | 0.040 |
| Status    | Unmarried        | Ref.      |             | Ref.       |         |
|           | Married          | 1.534 (0.738–3.187) | 0.251 | 0.990 (0.382–22.569) | 0.984 |
| Income (Thai baht) | < 15,000  | Ref.      |             | Ref.       |         |
|           | ≥ 15,000         | 1.296 (0.654–2.569) | 0.457 | 0.628 (0.245–1.611) | 0.333 |

Attitudes scores (1 = < 27 scores, 2 = ≥ 27 scores). OR: Odds ratio, CI: Confidence interval. Significant at p-value < 0.05

### Table 5  Bivariate and multivariate analysis of practices and socio-demographic characteristics

| Practice | Factor variables | Bivariate | Multivariate |
|----------|------------------|-----------|--------------|
|          |                  | OR (95%CI) | p-value      | OR (95%CI) | p-value |
| Occupation| Civil servant   | Ref.      |             | Ref.       |         |
|          | Employee        | 0.969 (0.349–2.693) | 0.952 | 0.674 (0.200–2.275) | 0.525 |
|          | Housewife       | 0.690 (0.227–2.097) | 0.513 | 0.649 (0.161–2.613) | 0.542 |
| Age (years) | 18–25           | Ref.      |             | Ref.       |         |
|          | 26–30            | 2.629 (1.103–6.262) | 0.029 | 2.413 (0.882–6.602) | 0.086 |
|          | 31–35            | 1.197 (0.457–3.135) | 0.714 | 1.167 (0.345–3.950) | 0.804 |
|          | ≥ 36             | 2.133 (0.815–5.581) | 0.123 | 2.314 (0.700–7.650) | 0.169 |
| Education (degree) | < Bachelor      | Ref.      |             | Ref.       |         |
|          | ≥ Bachelor       | 2.256 (1.127–4.650) | 0.035 | 0.285 (1.110–6.146) | 0.040 |
| Status   | Unmarried        | Ref.      |             | Ref.       |         |
|          | Married          | 1.141 (0.548–2.376) | 0.725 | 0.717 (0.263–1.953) | 0.515 |
| Income (Thai baht) | < 15,000  | Ref.      |             | Ref.       |         |
|          | ≥ 15,000         | 2.041 (1.020–4.082) | 0.044 | 4.747 (1.588–14.192) | 0.005 |

Practice scores (1 = < 18 scores, 2 = ≥ 18 scores). OR: Odds ratio, CI: Confidence interval. Significant at p-value < 0.05
against COVID-19, was likely reported from WHO that pneumococcal vaccine does not provide protection against the new coronavirus [25]. Knew that there is currently no treatment for COVID-19 and reported that regular rinsing nasal mucus with saline cannot prevent infection, previously result suggested that limited clinical evidence concerning the curative or preventive role of saline water gargling and nasal irrigation against COVID-19 infection [26]. However, participants responded that wearing two masks are more effective than a single mask to prevent infection, was likely agreed with previous study [27].

The multivariate analysis indicated that marital status was significantly associated with knowledge about COVID-19, whereby married participants exhibited a 4.9-fold increase of knowledge scores over unmarried participants. This finding is in agreement with previous studies [28, 29]. Although having a higher education degree was not significantly associated with knowledge, participants with at least a bachelor’s degree showed a 1.4-fold increase of knowledge scores over those with less education. It is important for clinicians to keep less educated pregnant women informed on preventative measures and provide them with psychological support [16]. In addition, Interventions are needed to improve educational levels of girls and women in the region [30].

### Association between attitudes and socio-demographic characteristics

Our study found most participants were aware that pregnancy could increase their risk of COVID-19 infection and intended to self-isolate for 2 weeks if they became infected after delivery, the WHO has concluded that mothers with suspected or confirmed COVID-19 should not be separated from their infants, but should rather practice respiratory hygiene and wear a mask, wash their hands before and after touching their infant, and routinely clean and disinfect surfaces [27, 31, 32]. This study found that most participants intended to breastfeed unless they became infected with COVID-19, which aligns with the results of a previous study [33, 34]. One study has emphasized the need to address pregnancy and breastfeeding in the ongoing pandemic [35, 36]. However, the WHO suggests that mothers and infants should be kept together regardless of COVID-19 status but that mothers should wash their breasts before every feeding in addition to the aforementioned measures [34]. Mothers who are too ill to breastfeed should explore alternatives such as using donated human milk or formula as a last resort [34]. In addition, previously suggested that knowledge about COVID-19 infection in pregnant women and newborns is scarce [18]. Moreover, our study found most participants that there is a very high percentage of pregnant women who would agree to be vaccinated of COVID-19 during pregnancy (52.7%), as other studies have reported low acceptability rates [21, 37, 38]. In addition, some study suggestion that many pregnant women are still reluctant to get vaccinated, vaccination is an effective and safe protective measure in these special population and should be encouraged by healthcare professionals and immunization programs should be organized by the states [39, 40].

The multivariate analysis found that participants with at least bachelor’s degree showed a 2.7-fold increase of favorable attitudes over less educated participants, and those aged 26–30 and 31–35 years showed a 2.5-fold increase in favorable attitudes over those aged 25 years and younger. One study has argued that providing relevant and reliable information along with comprehensive counseling is crucial for alleviating the psychological effects of the COVID-19 pandemic on pregnant women [33]. Hence, strategies should focus on reducing fear and improving attitudes toward the care of COVID-19 patients as well as the promotion of preventive practices [41, 42].

### Table 6 Spearman correlation analysis between knowledge, attitudes, and practices

| Variables | Practice | p-value |
|-----------|----------|---------|
| Knowledge | 0.210    | 0.010   |
| Attitudes | 0.159    | 0.052   |
| Practice  | 1        | –       |

Correlation coefficient significant at p-value < 0.05

**Association between practices and socio-demographic characteristics**

Our study found most participants reported wearing a mask every time they left the house and frequently washing their hands with soap and water or cleaning them with alcohol. Our findings are agreement with previous studies in which most participants expressed positive attitudes towards hand hygiene; however, a considerable gap was evident between attitudes and knowledge and reported hand hygiene behavior [43]. Most participants in this study reported avoiding crowds and public places as well as following news updates on the COVID-19 situation. Another study found that doctors, nurses/midwives, and the television were the most trusted sources of COVID-19 information among pregnant women [11].

The multivariate analysis found that a 2.2-fold increase in practice scores among participants with at least a bachelor’s degree compared with those with less education One study of pregnant women’s behaviors found that
most participants paid close attention to news updates on COVID-19 [44]. In addition, there was a 4.7-fold increase in practice scores among participants reporting higher incomes. One study found that half of the respondents reported experiencing a significant decline in income during the pandemic [45]. Our study found a 2.4-fold increase of practice scores among participants aged 26–30 years compared with those aged 25 years and younger. A previous study suggested that healthcare providers need to counsel pregnant women aged 35 years and older on COVID-19 prevention practices [46].

**Correlation between knowledge, attitudes, and practices**

We found a weak but significant positive correlation between knowledge and practice scores ($r = 0.210$, $p$-value $= 0.010$). This result aligns with previous research in which the majority of pregnant women reported healthy practices and adequate knowledge related to the COVID-19 pandemic [47–49], as well as studies showing that urban residents were more likely to evince adequate knowledge and practices [50, 51]. Special consideration should be given to people living in rural areas and less educated women. In addition, our study showed that attitude scores were not significantly correlated with practice scores, was recommend that interventions to improve attitude and practice scores ($r = 0.159$, $p$-value $= 0.052$). Another study found gaps between COVID-19-related attitudes and practices among pregnant Syrian refugees and advocated for further health education measures [52]. Implications for practice include the need for health care providers to consider the impact of the pandemic on patients’ mental status, access to resources and behaviors [53, 54]. Future interventions and policies should emphasize a “person-centered” approach that targets and embraces vulnerable subgroups to close the gaps in COVID-19-related KAP and should be educated and advised about physiological and immunological changes in pregnancy make women more susceptible to severe illness from respiratory infections.

**Limitations**

This study was a cross-sectional study conducted at a single hospital; it does not reflect the general population, which may introduce selection bias. The questionnaire responses were based on the perceptions and experiences of a specific group of current situations during the COVID-19 pandemic. Finally, we did not evaluate the questionnaire’s reliability because its aim was to measure participants’ perceptions of whether measures such as social distancing and other restrictive measures would enable the country to win the fight against the COVID-19 pandemic.

**Conclusion**

During the third wave of the COVID-19 pandemic in Thailand, the pregnant women who participated in this study evinced overall high levels of knowledge, attitudes, and practices. Our study identified several influencing factors related to pregnant women’s COVID-19-related knowledge, attitudes and practices, and the results can guide public health strategies. In particular, we recommend that interventions to improve knowledge on pregnancy should focus on reducing fear and improving attitudes toward the care of COVID-19 patients as well as the promotion of preventive practices.

**Abbreviations**

COVID-19: Coronavirus disease; KAP: Knowledge, Attitudes, Practices; ICU: Intensive Care Unit; WHO: World Health Organization; OR: Odds Ratio; CI: Confidence Interval; $r$: Correlation coefficient.

**Supplementary Information**

The online version contains supplementary material available at https://doi.org/10.1186/s12884-022-04612-3.

Additional file 1. The full English language version of the questionnaire.

**Acknowledgments**

The authors would like to acknowledge the pregnancy data gathered by the Department of obstetrics and gynecology clinic at the Faculty of Medicine Vajira Hospital, Bangkok, Thailand from July - August 2021. This research receives any specific grant from funding of the Faculty of Medicine Vajira Hospital and Nava- mindradhiraj University, Bangkok, Thailand, was used in the design of the study, the data collection, and English language editing service for the manuscript. In addition, authors would like to acknowledge the Faculty of Public and Environmental Health, Huachiew Chalermprakiet University, Bangkok, Thailand.

**Authors’ contributions**

JK., contributed to study design, data collection, data analysis, interpretation, writing and revision of the manuscript. PY., contributed to data analysis, interpretation, and writing. BS., contributed to study design, data analysis, interpretation. CS., contributed to study design, data analysis, interpretation. BW., contributed to data collection, design, data analysis, interpretation, and writing. All authors read and approved the final manuscript.

**Funding**

None.

**Availability of data and materials**

The data sets generated and analyzed during the current study are not publicly available due to identifiable information but are available from the corresponding author on reasonable request answering the survey.

**Declarations**

**Ethics approval and consent to participate**

This study was approved by the ethics committees of Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand. (Approval no. (COA 116/2564). All women participating in this study provided written informed consent before.

**Consent for publication**

Not applicable.
Competing interests
The authors declare that they have no conflicts of interest, Not Applicable.

Author details
1. Department of Research and Medical Innovation, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand. 2. Department of Public Health, Faculty of Public and Environmental Health, Huachiew Chalermprakiet University, Samut Prakan, Thailand. 3. Department of Urban Medicine, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand. 4. Department of Obstetrics and Gynecology, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand.

Received: 8 September 2021  Accepted: 24 March 2022
Published online: 23 April 2022

References
1. Sohrabi C, et al. World Health Organization declares global emergency: a review of the 2019 novel coronavirus (COVID-19). Int J Surg. 2020;76:71–6.
2. WHO. Weekly epidemiological update on COVID-19 - 3August2021. 2021.
3. Pradhan D, et al. A review of current interventions for COVID-19 prevention. Arch Med Res. 2020;51(5):363–74.
4. Allotey J, 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.
5. Delahoy MJ, et al. Characteristics and maternal and birth outcomes of hospitalized pregnant women with laboratory-confirmed COVID-19 - COVID-NET, 13 States, March 1-August 22, 2020. MMWR Morb Mortal Wkly Rep. 2020;69(38):1347–54.
6. Barrero-Castillero A, et al. COVID-19 neonatal–perinatal perspectives. J Perinatol. 2021;41(5):940–51.
7. Ellington S, et al. Characteristics of women of reproductive age with laboratory-confirmed SARS-CoV-2 infection by pregnancy status - United States, January 22-June 7, 2020. MMWR Morb Mortal Wkly Rep. 2020;69(25):769–75.
8. Popescu DE, et al. A case of COVID-19 pregnancy complicated with hydrops fetalis and intrauterine death. Medicina (Kaunas). 2021;57(7).
9. Ellington S, Strid P, Tong VT. Characteristics of women of reproductive age with laboratory-confirmed SARS-CoV-2 infection by pregnancy status. MMWR Morb Mortal Wkly Rep. 2020;69(25):769–75 United States, January 22–June 7.
10. Rasmussen SA, et al. Coronavirus Disease 2019 (COVID-19) and pregnancy: what obstetricians need to know. Am J Obstet Gynecol. 2020;222(5):415–26.
11. Lee RWK, et al. Attitudes and precaution practices towards COVID-19 among pregnant women in Singapore: a cross-sectional survey. BMC Pregnancy Childbirth. 2020;20(1):600. https://doi.org/10.1186/s12884-020-03283-2 PMID: 33028237; PMCID: PMC7539281.
12. Parra-Saavedra M, Villa-Villa I, Pérez-Olivo J, Guzman-Polania L, Galvis-Cen-turion P, Cumplido-Romero A, et al. Attitudes and collateral psychological effects of COVID-19 in pregnant women in Colombia. Int J Gynaecol Obstet. 2020;151(2):203–8. https://doi.org/10.1016/j.igoto.2013.348- Epub 2020 Sept 11. PMID: 32799318.
13. Marbán-Castro E, Pons-Duran C, García-Otero L, Chen H, Herrera LB, Gil MM, et al. Acceptability of clinical trials on COVID-19 during pregnancy among pregnant women and healthcare providers: a qualitative study. Int J Environ Res Public Health. 2021;18(20):10717. https://doi.org/10.3390/ijerph182010717.
14. Karavadra B, Stockl A, Prosser-Snellling E, Simpson P, Morris E. Women's perceptions of COVID-19 and their healthcare experiences: a qualitative thematic analysis of a national survey of pregnant women in the United Kingdom. BMC Pregnancy Childbirth. 2020;20(1):600. https://doi.org/10.1186/s12884-020-03283-2 PMID: 33028237; PMCID: PMC7539281.
15. Popescu DE, et al. A case of COVID-19 pregnancy complicated with hydrops fetalis and intrauterine death. Medicina (Kaunas). 2021;57(7).
16. Kakkar N, et al. Knowledge, attitude, practices, and concerns regarding COVID-19 vaccination among the general population. Diabetes Metab Syndr Clin Res Rev. 2021;15(3):919–25.
17. Jayaweera M, et al. Transmission of COVID-19 virus by droplets and aerosols: a critical review on the unresolved dichotomy. Environ Res. 2020;188:109619.
18. WHO. Coronavirus disease (COVID-19) advice for the public: Mythbusters. 2021. https://www.who.int/westernpacific/emergencies/covid-19/infor-mation/mythbusters.
19. Kratzke IM, et al. Effect of clear vs standard covered masks on communication with patients during surgical clinic encounters: a randomized clinical trial. JAMA Surg. 2021;156(4):372–8.
20. Carvalho Alves MdF, et al. Knowledge, attitudes and practices towards COVID-19: a cross-sectional study in the resident cape-verdean popula-tion. Soc Sci Human Open. 2021;4(1):100184.
21. Maharouei N, et al. Knowledge and attitude regarding COVID-19 among pregnant women in southwestern Iran in the Early period of its outbreak: a cross-sectional study. Am J Trop Med Hyg. 2020;103(6):2368–75.
22. Rabbani U, Al Saigul AM. Knowledge, attitude and practices of health care workers about corona virus disease 2019 in Saudi Arabia. J Epidemiol Glob Health. 2021;11(1):60–8.
23. WHO. COVID-19 Clinical management: living guidance. 2021.
24. Doctor PN, Kamat D, Sood BG. Changes in clinical care of the newborn during COVID 19 pandemic: from the womb to first newborn visit. Pediatr Clin N Am. 2021;2;100403 Epub 2021 May 25. PMID: 32799318.
25. Yassa M, et al. Near-term pregnant women’s attitude toward, concern about and knowledge of the COVID-19 pandemic. J Matern Fetal Neonatal Med. 2020;33(22):3827–34.
26. WHO. Update 65 – Breastfeeding and newborn care in the context of COVID-19. 2021.
27. Atmuri K, et al. Perspectives of pregnant women during the COVID-19 pandemic. A qualitative study. Women Birth. 2021; https://pubmed.ncbi.nlm.nih.gov/35376650/.
28. Sutton D, D’Alton M, Zhang Y, Kahe K, Cepin A, Goffman D, et al. COVID-19 vaccine acceptance among pregnant, breastfeeding, and nonpregnant reproductive-aged women. Am J Obstet Gynecol MFM. 2021;3(5):100403. https://doi.org/10.1016/j.ajogmf.2021.100403 Epub 2021 May 25. PMID: 34048965; PMCID: PMC8146275.
29. Skjefte M, Nigribabul 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 Epi-demiol. 2021;36(2):197–211. https://doi.org/10.1007/s10654-021-01078-6 Epub 2021 Mar 1. PMID: 33569879; PMCID: PMC7920642.
30. Sahin D, Tanaran A, Erol SA, et al. Management of pregnant women with COVID-19: a tertiary pandemic center experience on 1416 cases. J Med Virol. 2021;11–1. https://doi.org/10.1002/jmv.27423.
40. Goncu Ayhan S, Oluklu D, Atalay A, Menekse Beser D, Tanacan A, Moraloğlu Tekin O, et al. COVID-19 vaccine acceptance in pregnant women. Int J Gynaecol Obstet. 2021;154(2):291–6. https://doi.org/10.1002/ijgo.13713 Epub 2021 May 1. PMID: 33872386.

41. Mendoza-Jiménez M-J, Hannemann T-V, Atzendorf J. Behavioral risk factors and adherence to preventive measures: evidence from the early stages of the COVID-19 pandemic. Front Public Health. 2021;9(674597).

42. Mendoza Millán DL, et al. Knowledge, attitudes, and practices regarding COVID-19 among healthcare workers in Venezuela: an online cross-sectional survey. Front Public Health. 2021;9(633723).

43. Liyanage G, et al. Hand hygiene behavior among Sri Lankan medical students during COVID-19 pandemic. BMC Med Educ. 2021;21(333).

44. Ding W, et al. Knowledge, attitudes, practices, and influencing factors of anxiety among pregnant women in Wuhan during the outbreak of COVID-19: a cross-sectional study. BMC Pregnancy Childbirth. 2021;21(1):80.

45. Karijo E, et al. Knowledge, attitudes, practices, and the effects of COVID-19 among the youth in Kenya. BMC Public Health. 2021;21(1):1020.

46. Fikadu Y, et al. Covid-19 preventive measure practices and knowledge of pregnant women in guraghe zone hospitals. Int J Women’s Health. 2021;13:39–50.

47. Syed Anwar Aly SA, et al. Pregnancy and COVID-19 pandemic perception in Malaysia: a cross-sectional study. Int J Environ Res Public Health. 2021;18(11):5762.

48. Whlaker KM, et al. Variations in health behaviors among pregnant women during the COVID-19 pandemic. Midwifery. 2021;95:102929.

49. Javadi R, et al. The impact of COVID-19 on prenatal care in the United States: qualitative analysis from a survey of 2519 pregnant women. Midwifery. 2021;98:102991.

50. Besho M, et al. Knowledge, attitude and practice toward coronavirus infection among pregnant women attending antenatal care at public hospitals in three Wollega zones, Ethiopia. Int J Gen Med. 2021;14:3563–73.

51. Shbabejnejad L, et al. Knowledge, attitude and practice of Sari birth cohort members during early weeks of COVID-19 outbreak in Iran. BMC Public Health. 2021;21(1):928.

52. Hamadneh S, et al. Knowledge and attitudes regarding Covid-19 among Syrian refugee women in Jordan. Int J Clin Pract. 2021;75(S):14021.

53. Mohamed AAQ, et al. Knowledge, attitude and practice of the Sudanese people towards COVID-19: an online survey. BMC Public Health. 2021;21(1):274.

54. Giuliani C, et al. Breastfeeding during the COVID-19 pandemic: suggestions on behalf of woman study group of AMD. Diabetes Res Clin Pract. 2020;165:108239.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.