

# Associations among Knowledge, Attitudes, Health Behaviors, and Stress of Pregnant Women in Thailand during the New Coronavirus-2019

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## **Abstract:**

A descriptive correlational study aimed to examine the associations among knowledge about COVID-19, attitudes toward COVID-19, health behaviors, and stress of pregnant women in Thailand during the COVID-19 pandemic. A sample of 283 pregnant women who met the inclusion criteria was recruited and participated via self-administered online questionnaires. The questionnaires requested personal information, knowledge about COVID-19, attitudes toward COVID-19, health behaviors related to COVID-19 in pregnancy, and stress. Descriptive statistics and Spearman's rank correlations were applied for data analysis. The results showed that most pregnant women had a high level of knowledge about COVID-19 and good health behaviors (75.62% and 88.34%, respectively), a neutral attitude, and a moderate stress level (78.09% and 76.32%, respectively). Also, findings revealed a significant positive association between knowledge and health behaviors, negative attitudes toward COVID-19 and health behaviors, and negative attitudes toward COVID-19 and stress. However, significant associations were not found between knowledge and attitudes, knowledge and stress, and health behaviors and stress. Therefore, pregnant women should receive reliable health information about the novel coronavirus disease, which may influence attitudes toward this disease, to help them engage in health behaviors and prevent such infections. Importantly, accurate information should make the pregnant women gain more understanding of COVID-19. Psychological support is needed to help pregnant women manage their stress appropriately.

**Keywords:** Knowledge, Attitude, Health behaviors, Stress, Pregnant women, COVID-19

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# ความสัมพันธ์ระหว่างความรู้ ทักษะ พฤติกรรมปฏิบัติด้านสุขภาพ และ ความเครียดของสตรีตั้งครรภ์ในประเทศไทยระหว่างการระบาดของเชื้อไวรัส โคโรนาสายพันธุ์ใหม่ 2019

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## บทคัดย่อ :

การศึกษาครั้งนี้เป็นการวิจัยเชิงพรรณนามีวัตถุประสงค์เพื่อศึกษาความสัมพันธ์ระหว่างความรู้เกี่ยวกับไวรัสโคโรนาสายพันธุ์ใหม่ 2019 ทักษะต่อไวรัสโคโรนาสายพันธุ์ใหม่ 2019 พฤติกรรมปฏิบัติด้านสุขภาพ และความเครียดของสตรีตั้งครรภ์ในประเทศไทยในช่วงสถานการณ์การระบาดของโรคติดเชื้อไวรัสโคโรนาสายพันธุ์ใหม่ 2019 กลุ่มตัวอย่างเป็นสตรีตั้งครรภ์ตามคุณสมบัติที่กำหนดจำนวน 283 ราย ตอบแบบสอบถามด้วยตนเองผ่านทางออนไลน์ ประกอบด้วย ข้อมูลส่วนบุคคล แบบประเมินความรู้ ทักษะ และพฤติกรรมการปฏิบัติด้านสุขภาพที่เกี่ยวข้องกับโควิด-19 ในสตรีตั้งครรภ์ และแบบประเมินความเครียดวิเคราะห์ข้อมูลโดยใช้สถิติบรรยายและสถิติสหสัมพันธ์สเปียร์แมน ผลการศึกษาพบว่า สตรีตั้งครรภ์ส่วนใหญ่มีความรู้และพฤติกรรมการปฏิบัติด้านสุขภาพอยู่ในระดับสูง (ร้อยละ 75.62 และ ร้อยละ 88.34 ตามลำดับ) มีทักษะและความเครียดอยู่ในระดับปานกลาง (ร้อยละ 78.09 และ ร้อยละ 76.32 ตามลำดับ) ความรู้มีความสัมพันธ์ทางบวกกับพฤติกรรมการปฏิบัติด้านสุขภาพ ทักษะเชิงลบมีความสัมพันธ์ทางบวกกับพฤติกรรมการปฏิบัติด้านสุขภาพ และทัศนคติเชิงลบมีความสัมพันธ์ทางบวกกับความเครียดอย่างมีนัยสำคัญทางสถิติ โดยที่ความรู้ไม่มีความสัมพันธ์กับทัศนคติและความเครียด และพฤติกรรมการปฏิบัติด้านสุขภาพไม่มีความสัมพันธ์กับความเครียด ดังนั้น สตรีตั้งครรภ์จึงควรได้รับความรู้เกี่ยวกับโรคติดเชื้อไวรัสโคโรนาสายพันธุ์ใหม่อย่างต่อเนื่อง เพื่อช่วยให้สตรีตั้งครรภ์สามารถปฏิบัติตัวในการป้องกันการติดเชื้อมีประสิทธิภาพได้ รวมทั้งควรมีการส่งเสริมทัศนคติในด้านบวกและดูแลสุขภาพด้านจิตใจแก่สตรีตั้งครรภ์เพื่อจะได้จัดการกับภาวะเครียดได้อย่างเหมาะสม

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## **Introduction**

In late 2019 a new contagious disease called COVID-19 emerged, which is caused by a mutated coronavirus (SARS-CoV-2). The deadly disease COVID-19, similar to other respiratory diseases such as influenza, Middle East Respiratory Syndrome (caused by MERS-CoV), and Severe Acute Respiratory Syndrome (caused by SARS-CoV), has become a global pandemic. COVID-19 was first reported in Wuhan, Hubei Province, China during late December 2019,<sup>1</sup> and, since then, the number of infected persons and death tolls has increased globally. The pandemic situation continues to prevail because COVID-19 is highly contagious and transmitted via aerosols, called airborne transmission, that come from an infected person coughing or sneezing. These aerosols are comprised of droplets that contain the SARS-CoV2 virus which is spread to others when the aerosols contact the eyes, noses, mouths, or respiratory tracts.<sup>2</sup> After the first contact, people exposed to COVID-19 may become infected and contagious within 48 hours, but remain asymptomatic for a time before experiencing clinical symptoms. Common mild to moderate COVID-19 symptoms are fever, headache, anosmia, stuffy nose, cough, fatigue, muscle aches, runny nose, and sore throat, among others.<sup>3</sup> Moreover, severe cases may present with acute respiratory failure leading to death. However, the disease severity varies and depends on many factors, including the amount of infection, old age, and multiple comorbidities. Thus, the vulnerable population, including older adults and pregnant women, is of great concern for disease prevention.

With COVID-19, pregnant women are vulnerable and prone to develop severe illness or experience life-threatening events which impact a fetus's health. During pregnancy, the immune system changes, causing its response to viral infections to be functionally different from its normal state. Hence, getting a COVID-19 infection significantly impacts both the pregnant woman and the fetus, especially in pregnant women who are older, have a high body mass index, or other comorbidities.<sup>4</sup> Evidence emphasizes that the majority of pregnant women infected with COVID-19 presented with few symptoms. The most common symptoms were fever (58%) and cough (50.6%), with 1.1% suffering from severe pneumonia. Eighty-nine percent of the 185 pregnancies resulted in live births. Most of the 167 newborns were asymptomatic, and the rate of COVID-19 infection on day 5 was only 1.2%.<sup>5</sup> Notably, studies have revealed that infected pregnant women are at greater risk of developing severe symptoms that require mechanical ventilation than non-pregnant females of reproductive age. Also, infected pregnant women are at greater risk of experiencing premature labor higher than non-infected women.<sup>4</sup> At present, no evidence has confirmed the possibility of COVID-19 transmission from mother to infant. Evidence has underlined that external and internal factors impacting pregnant women's health status have either direct or indirect effects on the fetus.<sup>6</sup>

The COVID-19 pandemic has led to change in the life events of pregnant women. This situation may impact pregnant women's mental health. The survey has shown that stress in pregnant women increased significantly during the pandemic.<sup>7</sup> Prior research has suggested that stress induces physiological

change, alters metabolism and hormone regulation, and increases inflammatory cytokines during pregnancy<sup>8,9</sup> resulting in pregnancy complications, such as miscarriage, premature labor,<sup>10</sup> and placental abruption.<sup>11</sup> In late pregnancy, stress has also been associated with increased neonatal hormone levels of adrenocorticotrophic hormone (ACTH). Imbalances of ACTH levels causes health problems in babies, including muscle weakness, visual and auditory stimuli impairment,<sup>12</sup> emotional and behavioral problems,<sup>13,14</sup> and increased long-term risk of developing cardiovascular problems and atherosclerosis in adulthood.<sup>15</sup>

KAP surveys method is used to explore human behavior when affected by a health problem. Some researchers explore that knowledge, attitude, and practice are related. Health knowledge is any change in attitude about health problems that translate into health behaviors.<sup>16</sup> Thus, to prevent infection and transmission, pregnant women's health status and knowledge regarding COVID-19 may be the keys to promoting health in this population. Some studies underlined that stress was affected by knowledge, attitude, and practice.<sup>17,18</sup> Also, stress and positive attitude in illness had a significant negative relationship.<sup>19</sup> Therefore, a lack of knowledge and understanding, negative attitudes, and stress may interfere with pregnant women's health during the COVID-19 pandemic.

Unfortunately, little is known about the links between knowledge, attitudes, health behaviors, and stress in pregnant women, particularly in Thailand, during the COVID-19 pandemic. These health behaviors refer to any action of a pregnant woman to purposefully prevent the COVID-19. Having a greater insight into their health behaviors and stress would yield useful

information for providing effective care, promoting health, and preventing poor outcomes in pregnant women during pandemic situations.

### **Objectives of the study**

The objectives of this study were to: 1) explore the level of knowledge about COVID-19, attitudes toward COVID-19, health behaviors, and stress of pregnant women in Thailand during the COVID-19 pandemic, 2) determine the association among knowledge, attitudes, health behaviors, and stress of pregnant Thai women.

### **Conceptual framework**

The framework of this study is based on KAP surveys (knowledge, attitude and practice surveys). With regard to promoting health, the World Health Organization (WHO) has proposed a concept called the KAP surveys related to human behavior.<sup>20,21</sup> The KAP survey concept has three steps that cover human behavior changes, specifically: acquiring knowledge, generating attitudes/beliefs, and forming practice/behaviors.<sup>22</sup> The KAP concept has been used in various health topics, including stress management. Meanwhile, three major components of stress are: 1) environmental demands on the individual or stressors, 2) a biological response to the environmental demands, and 3) the interpretation assigned by the person to the stressors.<sup>23</sup> The stressors involve physical dangers or psychological threats. The reaction to stressors is based on individual perception of stimulus events, which can promote or inhibit healthful practice.<sup>24</sup> A recent study suggests that a low level of knowledge and negative attitudes lead to stress.<sup>18</sup> In addition, there was a significant negative relationship between stress and positive

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attitude in illness.<sup>19</sup> Notably, during the pandemic, the uncertain situation or unclear knowledge regarding the virus may impact personal attitudes towards COVID-19 which makes it more likely for stress to arise.

## **Methods**

This research study was a descriptive correlational study and enrolled participants from May 12 to September 20, 2020. The participants were pregnant women who had a smartphone and were familiar with that to scan and download QR codes, then completed the questionnaires and met specific selection criteria: 1) pregnant women aged 18 years and over, 2) living in Thailand, and 3) able to read and understand the Thai language. The exclusion criteria were the pregnant women with severe condition COVID-19 infection. The sample size was calculated using the power analysis principle; power analysis [(1 - type II errors) = .9], level of significance [tolerance for type I errors (alpha) = .05], and effect size. There was no information from prior studies on this topic, then a small effect size for the correlation analysis statistic was chosen and set as .20. Therefore, a minimum of 255 pregnant women should be recruited to participate in the present study.<sup>25</sup> However, to avoid problems with missing or incomplete data, 10 percent of the estimated sample number was added to the number of participants included in the study,<sup>26</sup> bringing the final sample size to 283 participants.

## **Research instruments**

There were five measurement instruments used in the study, namely the Personal Information Questionnaire,

the Knowledge Assessment of Coronavirus 2019 Questionnaire, the Attitude Assessment Questionnaire on Coronavirus 2019, the 2019 COVID-19 Prevention and Transmission Health Behavior Assessment and stress measurement model for Thai people (Thai version of the 10-Item Perceived Stress Scale-10: T-PSS-10), which are discussed in detail below.

1. The Personal Information Questionnaire was developed to collect the participants' personal information, including age, religion, education level, occupation, family characteristics, income, and place of residence. The questions regarding pregnancy information were focused on gestational age, number of pregnancies, number of miscarriages, and number of living children.

2. The Knowledge Assessment of Coronavirus 2019 Questionnaire was used to evaluate knowledge about COVID-19. The questions focused on general knowledge regarding infection transmission, signs and symptoms of infection, severity and the effect on pregnancy, and self-prevention practices for pregnant women. The questionnaire consisted of 20 questions with three simple answer options: yes, no, and unsure. The summation of the total score ranged from 0-20 points. Knowledge can be classified into 3 levels which are 1) low knowledge (scores of 0-7 points), 2) moderate knowledge (scores of 7.01-14 points), and 3) high knowledge (scores of 14.01-20 points).

3. The Attitude Assessment Questionnaire on Coronavirus 2019 was used to investigate the participants' opinions about the novel coronavirus infection, infected persons, the infection situation in the country, and infections in pregnant women. The questionnaire consisted of 13 questions with

a 5-point Likert scale with responses of: strongly disagree, disagree, somewhat agree, agree, and strongly agree, which had a value of 0 to 4 points each. A higher score for a response indicates a more negative attitude. The total score for the 13 questions ranged from 0 to 52 points. Therefore, the total scores were classified into 3 levels which are 1) positive attitude toward the disease (scores of 0–17 points), 2) neutral attitude toward disease (scores of 17.01–35 points), and 3) negative attitude toward the disease (scores of 35.01–52 points).

4. The 2019 COVID-19 Prevention and Transmission Health Behavior Assessment was used to evaluate the health behaviors of pregnant women to prevent COVID-19 infection. This questionnaire consisted of 20 questions with a 4-point Likert scale. The possible responses were: never, rarely, sometimes, and routinely perform and received a score of 0 to 3 points, respectively. For each question, the higher the score for a response was, the more routinely the participant performed that preventive health practice. The total score for the 20 items ranging from 0 to 60 points, which was classified into 3 levels of preventive health practices behaviors: 1) poor performance (scores 0–20 points), 2) moderate performance (scores 20.01–40 points), and 3) good performance (scores 40.01–60 points).

The researcher created the KAP survey, comprised of knowledge, attitude, and health Behavior assessment. The items were developed based on a literature review on learning about the new coronavirus (SARS-CoV-2), infection-prevention recommendations, and health practices during the COVID-19 pandemic. This knowledge is related to the WHO and the Royal

College of Obstetricians and Gynecologists of Thailand guidelines. To validate the validity of the KAP survey questions, 3 experts, an obstetric physician, an obstetric nurse and an infection control specialist, were invited to review the questionnaire's quality and validity. As a result, the content validity index (CVI) of the knowledge assessment was .97 and the attitude evaluation and health performance evaluations were rated at 1. Regarding reliability testing, KR-20 analysis was used for the knowledge evaluation for coronavirus 2019 and yielded a precision coefficient value of .75. In addition, the alpha Cronbach coefficients for the attitude and preventive health behavior evaluations in this study were .88 and .91, respectively.

5. The Stress Measurement Model for Thai people (the Thai version of the 10-Item Perceived Stress Scale-10: T-PSS-10) was originally developed by Cohen, Kamarck, and Mermelstein.<sup>27</sup> The original 1983 PSS measurement was developed based on Lazarus' concept to assess the level of daily stress awareness. This measurement had 14 questions, four of which were suitable for telephone interviews. For the Thai version, Nahathai Wongpakaran<sup>28</sup> translated and modified it to contain 10-questions. This questionnaire consisted of 2 main domains, which were 1) stress perceptions (6 questions) and 2) stress control (4 questions). The response for each question was a 5-Likert scale (0–4 points) for self-rating of stress awareness with the possible selections being: none, rarely, sometimes, quite frequently, and very often. Total scores range from 0 to 40 points, and lower scores indicate less stress. Stress are classified as 1) low stress (scores 0–13 points), 2) moderate stress (scores 13.01–26 points), and 3) high stress



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(scores 26.01–40 points). This questionnaire demonstrated exceptional reliability and validity. The Thai version of the measurement showed an excellent value ( $p < .0001$ ) for validity when examined for concurrent validity with the State-Trait Anxiety Inventory (STAI), Thai Depression Inventory (TDI), and Rosenberg Self-Esteem Scale (RSES) ( $r = .60, .55, -.46$  respectively), and strong, reliable Cronbach's alpha coefficient values of .85. In the present study, the Cronbach coefficient value was .83.

### **Human Protection**

The present study was approved by the Institutional Review Board: Ethical Review Committees for Human Research (IRB) of the Faculty of Medicine Ramathibodi Hospital, Mahidol University (No. COA. MURA2020/731). Before starting data collection, the researcher clarified the information about the objectives and addressed the benefits of participating in the research to the participants. Participants were informed that they had the right to withdraw from participation at any time without risking any disadvantage related to their treatment or care. The data collection started after the participants voluntarily signed an online informed consent form. All information, about personal and pregnancy, was presented as general information without any personal identification.

### **Data collection**

After receiving the IRBs approval and the department of gynecology's permission, the researchers started to invite pregnant women who met inclusion criteria via social media. Posters were also posted at

the Antenatal Unit at the Faculty of Medicine, Ramathibodi Hospital, Mahidol University. Additionally, all research questionnaires were made available for download using a QR code. The participants could answer the questionnaires for about 30 minutes in any place.

### **Data analysis**

This study analyzed data using descriptive statistics, including frequencies, percentages, mean scores, and standard deviations of personal data. The scores for knowledge about and attitudes towards the novel coronavirus disease 2019, practices in the prevention and spread of the novel coronavirus 2019, and the stress of pregnant women, were tested for statistics assumptions to perform correlation analyses. Spearman's rho statistics, a non-parametric, was employed for the statistical analysis of the non-normal distribution.

### **Results**

A total of 283 pregnant women participated in the study. Their mean age was 28.61 years ( $SD = 6.74$ ), and the gestational age was between 6 and 41 weeks with a mean of 26.77 weeks ( $SD = 9.70$ ). Most of them were Buddhists (94.35%). About one-fourth (26.86%) had a bachelor's degree level education, and 26.50% of them were employees or workers, with the same percentage working in a private business or self-employed. More than half (65.02%) were living in a single-family situation. About one-third of participants (39.58%) had an income of 10,001–20,000 baht per month, followed by more than

30,000 baht per month (28.27%). With regard to the location of their current living place, 52.30% of the participants lived in the eastern region, and 36.39% lived in the central region of Thailand. More than half of the participants (58.65%) had a prior pregnancy history, and 82.69% of the ones with a prior pregnancy had never had a miscarriage. Nearly half of the participants (46.29%) did not have any children. In addition, it was found that pregnant women were most likely to receive their information from sources on social media (49.82%), and 22.26% of them received information from only one source.

The pregnant women's mean knowledge about the novel coronavirus 2019 (COVID-19) epidemic situation was 16.02 points (SD = 2.93). Most of the participants (75.62%) had a high level of knowledge. The mean score for their attitudes was 27.11 (SD = 8.58). Most of the participants (78.09%) had a neutral attitude about COVID-19. With regard to their health behaviors, most of the participants (88.34%) had good health practice, with a total mean score of 50.52 (SD = 9.44). The mean score for stress among the participants was 18.42 (SD = 6.58); most of them had moderate levels of stress (76.32%). The details of the study variables are displayed in Table 1.

**Table 1** Numbers, percentages, means and standard deviations for knowledge, attitude, health behavior, and stress among pregnant women (N = 283)

Variables	Range of score	Number (%)	Possible score	Actual score	Mean (SD)
Knowledge			0-20	0-20	16.02 (2.93)
High	14.01-20	214 (75.62)			
Moderate	7.01-14	65 (22.97)			
Low	0-7	4 (1.41)			
Attitude			0-52	0-52	27.11 (8.58)
Positive	0-17	24 (8.48)			
Neutral	17.01-35	221 (78.09)			
Negative	35.01-52	38 (13.43)			
Health Practice			0-60	0-60	50.52 (9.44)
Good	40.01-60	250 (88.34)			
Moderate	20.01-40	28 (9.89)			
Poor	0-20	5 (1.77)			
Stress			0-40	0-40	18.42 (6.58)
High	26.01-40	25 (8.84)			
Moderate	13.01-26	216 (76.32)			
Low	0-13	42 (14.84)			

For the correlation among the study variables, the findings revealed that knowledge about COVID-2019 was significantly positively correlated to health behavior ( $r_s = .37$ ,  $p < .01$ ). Statistically significant positive correlations were also found between attitude and health

behavior, and between attitude and stress ( $r_s = .12$ ,  $p < .05$ , and  $r_s = .23$ ,  $p < .01$ , respectively). There were no statically significant associations between knowledge and attitude, knowledge and stress, and health behavior and stress ( $p > .05$ ), as shown in Table 2



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**Table 2** Coefficient of Spearman's rank correlation among knowledge, attitude, health behavior, and stress among pregnant women (N = 283)

Variables	1	2	3	4
1. Knowledge	1			
2. Attitude	.05	1		
3. Health Behavior	.37**	.12*	1	
4. Stress	-.04	.23**	.07	1

\*p < .05, \*\*p < .01

## Discussion

The present study found that knowledge and health behaviors among pregnant women were at a high level. This may be due to the seriousness of COVID-19's effects on the respiratory system which, in turn, may make pregnant women enthusiastic about learning about COVID-19 and its variants and following the instructions given to prevent infection. In addition, there has been a campaign by the Thai government and public relations efforts across various media platforms that are currently easily accessible to make it easy for people to gain more information about the virus and how to perform good practices for transmission prevention. It was found that pregnant women in this study were most likely to receive the kind of information which would make them more knowledgeable about the proper actions to take from social media and television. The findings of this study are consistent with prior studies that found that most people, including pregnant women, had a high level of knowledge about COVID-19 and were able to properly prevent infection.<sup>29,30-32</sup> Notably, the present study revealed that pregnant women's knowledge was positively correlated with their health behaviors for preventing COVID-19 infection. Educational

status was also found to be related to knowledge and health behaviors. Compared to those with low education levels, pregnant women with a higher level of education are more likely to seek more information and gain more understanding, resulting in better health behaviors. Consistency, Hoque, and colleagues (2021) found that knowledge and education were positively correlated with COVID-19 prevention practices among pregnant women in South Africa.<sup>33</sup>

Approximately three-fourths of the pregnant women in the present study had a neutral attitude (78.09%) toward COVID-19. Some of these were negative attitudes (13.43%), and there were also a small number of positive attitudes (8.48%). The phenomenon of their attitudes towards COVID-19 which this presents could be explained by COVID-19 being an emerging disease. The rapidly growing volume of news and information about the infection situation in various countries may be causing pregnant women to feel insecure about their life. Therefore, the results revealed mostly neutral to negative thoughts and attitudes about the disease. This finding is contrary to that of Kamal and colleagues (2020), who indicated that most pregnant women had positive attitudes about COVID-19.<sup>30</sup> It could be argued that the result showing a positive attitude towards COVID-19 was due to

the different factors related to the COVID-19 pandemic situation and disease control in the two countries. Thus, geographical concerns and local health policy may be significant aspects affecting attitudes toward this newly emerging virus that require further exploration.

With regard to stress, more than half of pregnant women in this study reported they have moderate levels of stress. When people are faced with an unpredictable situation, the experience often causes stress and anxiety. Another study also reported that most pregnant women had increased levels of stress about their COVID-19 infection situation.<sup>7,34</sup> Therefore, when dealing with the COVID-19 pandemic and coping with economic and social problems, multiple emotional adjustments are required.

According to the present study's findings, the attitudes of pregnant women were related to health behavior. Having a negative attitude about COVID-19 leads to improved personal health concerns. This finding may reflect that the more they fear about COVID-19, the more they protect themselves. Nevertheless, other factors being related to a negative attitude, including socioeconomic problems or low educational level which may affect pregnant women resulting in an increased in stress as they fear that COVID-19 will transmit to their babies.<sup>35</sup> As mentioned, our findings highlighted an association between negative attitudes and stress among pregnant women. However, in the present study, stress and preventive actions were not related. A possible explanation might be that many inherent factors affect a person's stress. Stress can also happen from the inside of individuals and depending on their personality.<sup>36</sup>

Thus, behavioral health responses to the stress of individuals might be different. Interestingly, the evidence emphatically demonstrated that personal beliefs are a significant factor that influences personal behavior.<sup>37</sup>

Lastly, contrary to expectations, this study revealed that knowledge had no relationship with attitude or stress. Previous studies have found a relationship between knowledge and attitudes.<sup>22</sup> However, in contrast to earlier findings, no evidence of an association between knowledge and attitudes was detected in this study. It seems possible that these findings are due to knowledge about COVID-19 infections being new and that some of the data is limited or ambiguous in the available health information, especially in regard to pregnant women. Therefore, the increased frequency of positive attitudes is not likely to indicate a relationship with COVID-19 knowledge.

In the present study, the relationships between knowledge, attitude, and health behaviors demonstrated that both knowledge and attitudes were independently related to health behaviors, but there was no correlation with knowledge or attitude. This inconsistency within the KAP model may be due to the current knowledge regarding COVID-19 during the first wave being unclear to the participants. Therefore, the underlying linkage of knowledge and attitudes requires further exploration. Additionally, no correlation was identified between knowledge and stress; this finding maybe due to inadequate COVID-19 knowledge related to pregnant women. Determining the cause of knowledge and stress is essential for further studies to investigate. Also, increased stress during the COVID-19 pandemic may not be associated with a single aspect like knowledge, but rather, it may be

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underpinned by sophisticated linking of multiple factors. Additional studies are required to develop a more complete picture of personal stress during the COVID-19 pandemic since multiple factors holistically affect pregnant women. Therefore, the present study has identified some questions that should provoke future exploration of the multiple factors which could be targeted in stress management for pregnant women during pandemic situations.

### **Implications for nursing practice**

The present study demonstrated that knowledge related to health behaviors in pregnancy during the COVID-19 pandemic is somewhat lacking and unsettled. Therefore, continually providing update knowledge about COVID-19 and the new contagious coronavirus variants are of concern for pregnant women. Furthermore, the substantial volume of new knowledge and information currently produced by many ongoing studies must synthesize into a coherent source of knowledge for pregnant women who are concerned about enhancing and performing their health and infection prevention practices properly. The negative to neutral attitude was found in most pregnant women, which should analyze the cognition about negative attitude in the new coronavirus-2019. Although negative attitudes about COVID-19 may trigger good health behavior performance, they are also simultaneously related to stress for pregnant women. As presented in the findings, during the COVID-19 pandemic in Thailand, most pregnant women have experienced moderate levels of stress. Therefore, it should be noted that identifying the

factors creating their stress because the causes of stress may be not knowledge, attitude, and health behaviors. Moreover, promoting a positive attitude and providing psychological support to moderate the effects those factors have on pregnant women will be meaningful in both the psychological and the physical care in this population.

### **Limitations of the study**

This study may be limited generalizability because of the convenience sampling technique. In addition, some pregnant women who did not have a smartphone or could not read the Thai language were not included in this study. The other limitation is the measurement of stress which is may not specific to the COVID-19 situation.

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