Severity and Associated Factors of COVID-19 Infection among Pregnant and Postpartum Women: A Cross-Sectional Study in Thailand

Pimolphan Tangwiwat[*]
Titiporn Tuangrattananon[†,‡]
Wanchanok Limchumroon[†]
Benjawan Ingthom[†]
Chompoonut Topothai[†,‡,§]
Thitikorn Topothai[‡,§,ꝗ]

Corresponding author: Pimolphan Tangwiwat

Abstract

Background: COVID-19 posed a significant global health crisis, affecting millions worldwide, with pregnant women being particularly susceptible to severe illness and mortality. Pregnant individuals infected with COVID-19 were more likely to require intensive care and invasive ventilation compared to non-pregnant individuals. This study aimed to investigate the severity of COVID-19 in pregnant and postpartum women in Thailand and its associated factors.

Methodology: This cross-sectional quantitative study utilized data from the National Pregnant Women and 6-Week Postpartum Women COVID-19 Infection Report System, Health Promotion Bureau, Department of Health, from December 1, 2020, to May 31, 2022. The outcome was the level of severity of COVID-19 infection (no or mild symptoms, and moderate to severe symptoms) among pregnant and postpartum women. The exposures were participants' characteristics, including age, nationality, COVID-19 vaccination status, and gestational age when infection was assessed. Multivariable logistic regression was

[*] *Office of Senior Advisors, Department of Medical Services, Ministry of Public Health, Nonthaburi, Thailand*
[†] *Bureau of Health Promotion, Department of Health, Ministry of Public Health, Nonthaburi, Thailand*
[‡] *International Health Policy Program, Ministry of Public Health, Nonthaburi, Thailand*
[§] *Saw Swee Hock School of Public Health, National University of Singapore and National University Health System, Singapore, Singapore*
[ꝗ] *Division of Physical Activity and Health, Department of Health, Ministry of Public Health, Nonthaburi, Thailand*

used to examine the associations between these characteristics and COVID-19 severity.

Results: The study recruited 12,579 pregnant or postpartum women infected with COVID-19 in Thailand. Most participants experienced no or mild symptoms (87.0%), while the rest had moderate to severe symptoms (13%). Pregnant women with higher age (≥35 years) had the highest likelihood of severe symptoms (adjusted odds ratio: AOR = 1.79, 95%CI: 1.44, 2.24), and non-Thai participants had a significantly higher likelihood of severe symptoms compared to Thais (AOR = 1.17, 95%CI: 1.03, 1.34). Pregnant women who received three doses of the COVID-19 vaccine had the lowest likelihood of severe symptoms (AOR = 0.16, 95%CI: 0.10, 0.27). Participants being infected during the third trimester of pregnancy had a higher likelihood of severe symptoms (AOR = 1.52, 95%CI: 1.22, 1.90).

Conclusion: This study offers significant insights into the severity of COVID-19 among pregnant and postpartum women in Thailand. Despite most participants experiencing no or mild symptoms, it was imperative for the public to implement preventive measures to reduce the risk of severe symptoms and optimize care for this vulnerable group. Moreover, the study identified the influence of maternal age, nationality, COVID-19 vaccination status, and timing of infection on COVID-19 severity. The findings revealed important implications for the implementation of preventive strategies and the optimization of healthcare services for pregnant women during the COVID-19 pandemic.

Keywords: COVID-19, pregnancy, mother, severity, Thailand

ความรุนแรงและปัจจัยเสี่ยงของการติดเชื้อโควิด-19 ในหญิงตั้งครรภ์และหลังคลอด: การศึกษาแบบภาคตัดขวางในประเทศไทย

พิมลพรรณ ต่างวิวัฒน์[*], **ฐิติภรณ์ ตวงรัตนานนท์**[†,‡], **วรรณชนก ลิ้มจำรูญ**[†], **เบญจวรรณ อิ้งทม**[†],
ชมพูนุท โตโพธิ์ไทย[†,‡,§], **ฐิติกร โตโพธิ์ไทย**[‡,§,ꟼ]

[*] สำนักที่ปรึกษา กรมการแพทย์ กระทรวงสาธารณสุข นนทบุรี ประเทศไทย
[†] สำนักส่งเสริมสุขภาพ กรมอนามัย กระทรวงสาธารณสุข นนทบุรี ประเทศไทย
[‡] สำนักงานพัฒนานโยบายสุขภาพระหว่างประเทศ กระทรวงสาธารณสุข นนทบุรี ประเทศไทย
[§] คณะสาธารณสุขศาสตร์ Saw Swee Hock, National University of Singapore และ National University Health System
   ประเทศสิงคโปร์
[ꟼ] กองกิจกรรมทางกายภาพและสุขภาพ กรมอนามัย กระทรวงสาธารณสุข นนทบุรี ประเทศไทย
ผู้รับผิดชอบบทความ: พิมลพรรณ ต่างวิวัฒน์, pimolphantang@gmail.com

ภูมิหลังและเหตุผล: การแพร่ระบาดของโรคโควิด-19 (COVID-19) ก่อให้เกิดวิกฤติทางสุขภาพที่สำคัญ โดยมีผู้ป่วยหลายล้านคนทั่วโลก หญิงตั้งครรภ์เป็นกลุ่มที่เสี่ยงต่อการเจ็บป่วยที่รุนแรงจนถึงการเสียชีวิต ผู้ที่ตั้งครรภ์และติดเชื้อโควิด-19 มีโอกาสต้องเข้ารับการรักษาในหอผู้ป่วยหนักและใช้เครื่องช่วยหายใจสูงกว่าผู้ที่ไม่ได้ตั้งครรภ์ การศึกษานี้ มีวัตถุประสงค์เพื่อศึกษาระดับความรุนแรงของการติดเชื้อโควิด-19 ในกลุ่มหญิงตั้งครรภ์และหลังคลอดในประเทศไทย และค้นหาปัจจัยเสี่ยงที่เกี่ยวข้องกับระดับความรุนแรง

ระเบียบวิธีศึกษา: การศึกษานี้ เป็นการศึกษาแบบภาคตัดขวาง โดยใช้ข้อมูลจากระบบรายงานทั่วประเทศของหญิงตั้งครรภ์และหญิงหลังคลอดที่ติดเชื้อโควิด-19 ในประเทศไทย โดยสำนักส่งเสริมสุขภาพ กรมอนามัย โดยผลลัพธ์ที่ต้องการในการศึกษานี้คือระดับความรุนแรงของการติดเชื้อโควิด-19 ในกลุ่มหญิงตั้งครรภ์และหลังคลอด (ไม่มีอาการหรือมีอาการเล็กน้อย และอาการรุนแรงระดับปานกลางถึงมาก) ตัวแปรที่เกี่ยวข้องคือลักษณะของผู้เข้าร่วม ประกอบด้วย อายุ สัญชาติ จำนวนวัคซีนโควิด-19 ที่ได้รับ และอายุครรภ์ขณะเกิดการติดเชื้อ การวิเคราะห์ใช้การถดถอยโลจิสติกแบบหลายตัวแปรเพื่อศึกษาความสัมพันธ์ระหว่างตัวแปรเหล่านี้และความรุนแรงของการติดเชื้อโควิด-19

ผลการศึกษา: การศึกษานี้ วิเคราะห์ข้อมูลหญิงตั้งครรภ์หรือหลังคลอดที่ติดเชื้อโควิด-19 จำนวน 12,579 ราย

ซึ่งส่วนใหญ่อยู่ในกลุ่มไม่มีอาการหรือมีอาการเล็กน้อย คือร้อยละ 87 ส่วนกลุ่มที่มีอาการรุนแรงระดับปานกลางถึงมากมี ร้อยละ 13 หญิงตั้งครรภ์ในกลุ่มอายุตั้งแต่ 35 ปีขึ้นไป มีโอกาสสูงสุดที่จะมีอาการรุนแรงระดับปานกลางถึงมาก (adjusted odds ratio: AOR = 1.79, 95%CI: 1.44, 2.24) หญิงตั้งครรภ์ที่ไม่ใช่สัญชาติไทยมีโอกาสที่จะมีอาการรุนแรงสูงกว่าหญิง ตั้งครรภ์สัญชาติไทย (AOR = 1.17, 95%CI: 1.03, 1.34) ส่วนหญิงตั้งครรภ์ที่ได้รับวัคซีนโควิด-19 จำนวน 3 ครั้ง มีโอกาส ต่ำที่สุดในการมีอาการรุนแรง (AOR = 0.16, 95%CI: 0.10, 0.27) นอกจากนี้ หญิงตั้งครรภ์ที่ติดเชื้อในไตรมาสที่ 3 ของการ ตั้งครรภ์มีโอกาสสูงที่จะมีอาการรุนแรง (AOR = 1.52, 95%CI: 1.22, 1.90)

สรุป: การศึกษานี้ช่วยสร้างความเข้าใจที่สำคัญเกี่ยวกับความรุนแรงของการติดเชื้อโควิด-19 ในหญิงตั้งครรภ์และ หลังคลอดในประเทศไทย แม้หญิงตั้งครรภ์ส่วนใหญ่จะไม่มีอาการหรือมีอาการเล็กน้อย มาตรการป้องกันการติดเชื้อและ การลดความเสี่ยงของอาการจากการติดเชื้อโควิด-19 ยังมีความสำคัญ การศึกษานี้พบว่า อายุมารดา สัญชาติ การฉีดวัคซีน โควิด-19 และช่วงการตั้งครรภ์ที่ได้รับเชื้อ เป็นปัจจัยที่เกี่ยวข้องกับความรุนแรงของการติดเชื้อโควิด-19 ผลการศึกษานี้ยืนยัน ความสำคัญของมาตรการป้องกันและการดูแลหญิงตั้งครรภ์ที่เหมาะสมระหว่างการระบาดของโควิด-19

คำสำคัญ: โควิด-19, การตั้งครรภ์, มารดา, ความรุนแรง, ประเทศไทย

Background and Rationale

COVID-19, caused by the SARS-CoV-2 virus, has become a global public health crisis, affecting millions worldwide.[1] Pregnant women are particularly vulnerable to severe illness and mortality from COVID-19. During pregnancy, changes in the maternal immune system and cytokine levels may elevate the risk of adverse outcomes.[2-4] The virus can also affect vital systems, including the respiratory, cardiovascular, and immune systems, as well as placental function. While maternal deaths from COVID-19 are relatively rare, pregnant individuals with COVID-19 have a higher likelihood of requiring intensive care and invasive ventilation compared to non-pregnant individuals.[4,5]

From the analysis of 192 studies, the main symptoms of COVID-19 in pregnancy were fever (40%) and cough (41%).[4] Pregnant women with COVID-19 were less likely to show symptoms compared to non-pregnant women (odds ratio and 95% confidence interval; OR = 0.28: 0.13, 0.62). They were also less likely to report fever (OR = 0.49: 0.38, 0.63).[4] Pregnant women had higher odds of admission to intensive care unit (OR = 2.13: 1.53, 2.95), invasive ventilation (OR = 2.59: 2.28, 2.94), and maternal death (OR = 2.85: 1.08, 7.52) compared to non-pregnant women of reproductive age.[4]

Severe COVID-19 in pregnancy was associated with increased maternal age, high body mass index, pre-existing comorbidities (chronic hypertension, diabetes, pre-eclampsia), and any maternal comorbidity.[4]

A study of 2,475 Brazilian pregnant cases of COVID-19 severe respiratory distress showed that the postpartum period, age over 35 years, obesity, diabetes were associated with an increased risk of adverse outcomes.[6] Other studies identified the advanced maternal age were likely linked to severe illnesses due to age-related immune system changes and heightened risk of underlying health conditions,[3,7] while the association

between gestational age and COVID-19 severity remained uncertain.[8,9] Existing evidence supports the protective benefits of COVID-19 vaccination for pregnant women and their unborn children, affirming vaccine safety and efficacy in this population.[10,11]

Thailand has witnessed a significant loss from large numbers of COVID-19 confirmed cases (4,754,784) and deaths (34,418), as of July 29, 2023.[12] Pregnant women and infants in Thailand, regardless of nationality, face increased risks of infection, barriers to maternity services utilization, and challenges due to control measures.[13] But there remains a dearth of information in Thailand, especially on the prevalence and severity of COVID-19, and its related factors in Thailand.

Understanding the severity of COVID-19 in pregnant women is essential for providing appropriate care and implementing effective strategies to mitigate the impact of the virus on this vulnerable population. This study aimed to investigate the prevalence of COVID-19 infection severity in pregnant and postpartum women in Thailand and its association with their characteristics. Our findings would aid in developing targeted strategies to mitigate the risks associated with COVID-19 infection during pregnancy in Thailand.

Methodology

Study design, setting, and participants

This cross-sectional study utilized data from the National Pregnant Women and 6-Week Post-partum Women COVID-19 Infection Report System from public and private hospitals from December 1, 2020, to May 31, 2022, through the Google Forms of Department of Health.

Tool

The report form of pregnant and 6-week postpartum women's COVID-19 infection consists of (i) personal information, including age and nationality, (ii) infection data, including gestational age or postpartum week at the diagnostic time, and severity of symptoms, and (iii) number of COVID-19 vaccinations. The researchers developed the pregnant women and 6-week postpartum women COVID-19 infection report form and conducted meetings with the maternal and childcare team for COVID-19-infected women to collect data in the form. The reporting channel was developed using Google Forms and tested in a general hospital in Samut Sakhon province. It was then refined by the working group for the health care of pregnant and postpartum women infected with COVID-19, comprising obstetricians, pediatricians, pediatric infectious disease specialists, and epidemiologists (18 individuals), under the National Maternal and Child Health Board.

Data collection

The researchers prepared a letter of collaboration and distributed it to public hospitals of the Ministry of Public Health, and hospitals in other sectors including the Bangkok Metropolitan Administration, Armed Forces, Royal Thai Police,

universities, and Private Hospital Associations, for data reporting. The data reporting process to the hospitals was explained through remote meeting systems through the Google Form of Department of Health. The permission to use data from the Pregnant Women and 6-Week Postpartum Women Infection Report System was obtained by the Health Promotion Bureau, Department of Health. The researchers collected data focusing on the variables defined and covered by the research objectives. For this study, we included data from pregnant and postpartum women who were infected with COVID-19 within 14 days and received treatment as inpatients (according to the national guideline at time of data collection).

Participants' characteristics classification

Participants' characteristics in the study included age (in years), nationality, COVID-19 vaccination, gestational age when COVID-19 infection detected, and COVID-19 severity. Age was classified into three categories (less than 20, 20-34, and 35 years and over, according to the definition of teenage and elderly pregnancy). Nationality was categorized into two categories (Thai and non-Thai). COVID-19 vaccination was divided into four categories (no vaccination, 1, 2, and 3 doses). Gestational age at time of COVID-19 diagnosis was divided into four groups (less than 14 weeks, 14-27 weeks, 28-43 weeks, and postpartum period, according to pregnancy trimester).

Outcome classification

COVID-19 severity was classified into two categories: (i) no or mild symptoms (presence of fever, runny nose, cough, nausea, vomiting, diarrhea, loss of smell, loss of taste, with no lung inflammation, with normal chest x-ray showing no signs of pneumonia), and (ii) moderate to severe (with pneumonia with/without endotracheal intubation, or death); based on the medical practice guidelines by the Department of Medical Services, Ministry of Public Health since the beginning of the pandemic.[14]

Data analysis and statistical analysis

A descriptive statistical analysis was conducted to present the frequencies and percentages of COVID-19 infection severity, living and deceased mothers. The associations between participants' characteristics and their COVID-19 infection severity were reported as adjusted odds ratios (AORs), 95% confidence interval (95% CI), with chi-square test to prove statistically significant associations (at p-value<0.05). Multivariable logistic regression was used to examine relationships between participants' characteristics and their COVID-19 infection severity. Analyses were conducted with Stata Statistical Software version 17 (StataCorp LP, College Station, TX, USA).

Ethics consideration

The Health Promotion Bureau of the Department of Health authorized the data access for research purposes. This study was approved by the Institutional Review Board of the Department of Health, Ministry of Public Health, Thailand (No. 564/2565) in October 2022.

Results

Study participants

The study initially enrolled a total of 14,037 pregnant or postpartum women who were infected with COVID-19 across the country. Of these, 1,458 participants were excluded due to missing information on vaccination status and gestational age. The final sample size for analysis comprised 12,579 participants.

Participant characteristics

The characteristics of the participants are presented in table 1. Most women aged between 20 and 34 years (73.2%) and were Thai nationality (82.6%). Majority of them did not receive the COVID-19 vaccine (63.3%), followed by those received 2 doses (25.2%), 1 dose (7.5%) and 3 doses (4.0%), respectively. Around half of participants got infected with COVID-19 at the gestational age of 28-43 weeks (48.2%), followed by 23.3% at postpartum, 18.9% at 14-27 weeks, and 9.3% at < 14 weeks.

The proportion of COVID-19 infection severity

Most participants had no or mild symptom of

Table 1 Characteristics of the overall sample and according to the COVID-19 severity

Participants' characteristics	Overall (n=12,579)		No or mild symptom (n=10,939)		Moderate to severe symptom (n=1,640)		*p*-value[a]
	n	%	n	%	n	%	
Age (year)							< 0.001
< 20	1,204	9.6	1,081	89.8	123	10.2	
20-34	9,208	73.2	8,051	87.4	1,157	12.6	
≥ 35	2,167	17.2	1,807	83.4	360	16.6	
Nationality							< 0.001
Thai	10,384	82.6	9,108	87.7	1,276	12.3	
Non-Thai	2,195	17.4	1,831	83.4	364	16.6	
COVID-19 vaccination							< 0.001
No	7,964	63.3	6,605	82.9	1,359	17.1	
1 dose	936	7.5	833	89.0	103	11.0	
2 doses	3,175	25.2	3,014	94.9	161	5.1	
3 doses	504	4.0	487	96.6	17	3.4	
Gestational age when COVID-19 infection detected (week)							< 0.001
< 14	1,171	9.3	1,072	91.6	99	8.4	
14-27	2,383	18.9	2,088	87.6	295	12.4	
28-43	6,095	48.5	5,133	84.2	962	15.8	
Postpartum	2,930	23.3	2,646	90.3	284	9.7	

[a] chi-square test

COVID-19 (87.0%), the rest had moderate to severe symptom (13.0%) (see Table 1). The participants aged 35 years and above had the highest proportion of COVID-19 moderate to severe symptom (16.6%, *p*-value < 0.001). Non-Thai participants had higher severity than Thai participants (16.6% vs 12.3%, *p*-value < 0.001). Those who did not receive any COVID-19 vaccination had the highest severity (17.1%, *p*-value < 0.001). Women gestational age 28-43 weeks at time of diagnosis had the highest moderate to severe symptom (15.8%, *p*-value < 0.001).

When differentiating between women who survived (living mothers, n = 12,512) and who were dead (n = 67), significant differences were found in maternal age, COVID-19 vaccination status, and the gestational age of COVID-19 infection (see Figure 1). A larger proportion of deceased mothers were elder mothers aged ≥ 35 years (37.3%). Moreover, 95.5% of deceased mothers did not receive COVID-19 vaccination. A pronounced discrepancy emerged in the timing of COVID-19 being detected during pregnancy, with 89.6% of deceased mothers being detected during the third trimester.
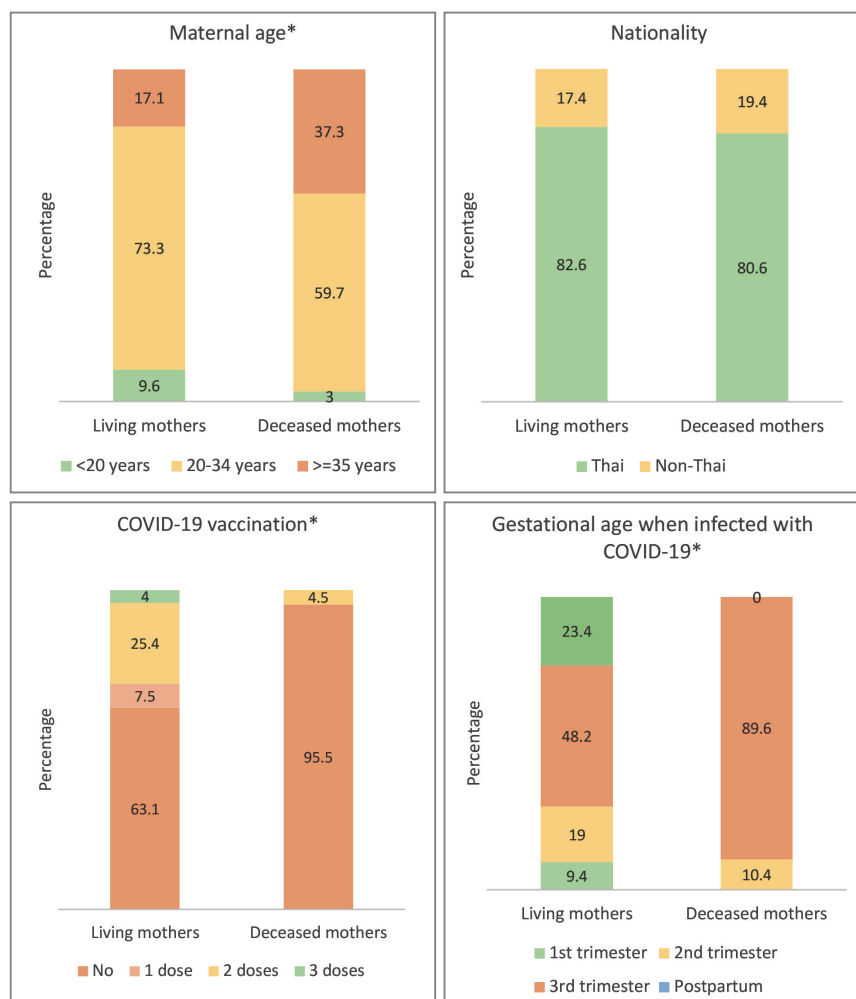
* p-value <0.001

Figure 1 Characteristics of COVID-19 infected mothers by living status (%)

Association between COVID–19 infection severity and participants' characteristics: multivariable logistic regression

Table 2 presents the results from the multivariable logistic regression examining the association between COVID-19 infection severity and participants' characteristics. Participants of elderly pregnancy (≥35 years) had the highest moderate to severe symptom (AOR = 1.79, 95%CI: 1.44, 2.24). Non-Thai participants had higher severity (AOR = 1.17, 95%CI: 1.03, 1.34) compared to Thai participants. Pregnant women who received 3 doses of COVID-19 vaccine had the lowest severity (AOR = 0.16, 95%CI: 0.10, 0.27). Participants being infected at the gestational age at 28-43 weeks had the highest severity (AOR = 1.52, 95%CI: 1.22, 1.90).

Table 2 Multivariable logistic regression analyses of the association between the COVID-19 severity and participants' characteristics

Characteristics	COVID-19 moderate to severe symptom*			
	AOR	95% CI		*p*-value
		Lower	Upper	
Age (year): ref < 20	Reference			
• 20-34	1.33	1.09	1.63	0.005
• ≥ 35	1.79	1.44	2.24	< 0.001
Nationality: ref = Thai	Reference			
• Non-Thai	1.17	1.03	1.34	0.020
COVID-19 vaccination: ref = no	Reference			
• 1 dose	0.59	0.48	0.77	< 0.001
• 2 doses	0.26	0.21	0.31	< 0.001
• 3 doses	0.16	0.10	0.27	< 0.001
Gestational age when COVID-19 infection detected (weeks): ref < 14	Reference			
• 14-27	1.48	1.16	1.89	0.002
• 28-43	1.52	1.22	1.90	< 0.001
• Postpartum	0.79	0.62	1.00	0.060

AOR = adjusted odds ratio, 95% CI = 95% confidence interval, multivariable logistic regression model adjusted for age, nationality, COVID-19 vaccination, and gestational age when COVID-19 infection detected.

* outcome 0 = no or mild symptom to severe symptom

Discussion

This is the first study in Thailand that provides novel insights into the epidemiology and factor associated with COVID-19 infection severity among pregnant women in Thailand. The study population experienced symptoms similar to those of non-pregnant individuals, such as fever, cough, fatigue, diarrhea, shortness of breath, sore throat, and muscle pain.[4,5] Implementing public health preventive measures was crucial in reducing the risk of severe symptoms and optimize care for this vulnerable group. The potential risk could be attributed to changes in the maternal immune system and cytokine levels during pregnancy, potentially leading to adverse outcomes, as the virus affected various organ systems, including the respiratory, cardiovascular, and immune systems.[2-4] Close monitoring of pregnant women for severe COVID-19 cases was essential, given their high risk of requiring admission to the intensive care unit, invasive ventilation, and experiencing mortality compared to non-pregnant individuals.[4,5]

The findings showed significant association between advanced maternal age and an increased likelihood of experiencing moderate to severe symptoms of COVID-19 among pregnant women. Specifically, pregnant individuals aged 35 years or older exhibited the highest proportion of COVID-19 moderate to severe symptoms. This finding suggested that advanced maternal age was a risk factor for severe illness in pregnant individuals with COVID-19 and older pregnant women might be more susceptible to experiencing severe symptoms and complications from the virus. Our finding is consistent with previous studies,[3,4,7] and the global trend indicating that older individuals faced a higher risk of severe illness and death from COVID-19, likely attributed to age-related changes in the immune system and an increased prevalence of underlying health conditions.[15-17] The heightened susceptibility of severe illness in older pregnant women underscores the necessity for targeted interventions and close monitoring within this subgroup.

Non-Thai participants had higher moderate to severe COVID-19 symptoms compared to Thai participants. This disparity in symptom severity might be indicative of potential disparities in health literacy and low socioeconomic status among non-Thai individuals, specifically those from Myanmar, Laos, and Cambodia.[18] Factors such as limited access to healthcare services, language barriers, and cultural practices could contribute to these disparities, leading to unequal healthcare outcomes for pregnant and postpartum women from these communities.[18-22] Addressing these multifaceted factors is crucial to promote equitable healthcare access and improve health outcomes for all pregnant and postpartum women, irrespective of their nationality or ethnic background.

The study established a significant association between vaccination status and the severity of COVID-19 in pregnant women with a dose-response relationship. Pregnant individuals who did not receive any COVID-19 vaccination had

the highest proportion of moderate to severe symptoms while those who received three doses of vaccine exhibited the lowest likelihood of experiencing moderate to severe symptoms. Our finding emphasized the benefits of full vaccination in reducing COVID-19 severity, aligning with existing evidences that highlighted the critical role of COVID-19 vaccination in mitigating the virus's impact and protecting pregnant women from severe illness.[10,11] Despite huge benefits of COVID-19 vaccination, our finding revealed a low COVID-19 vaccination rate (36.7%) among participants. Therefore, ensuring access to COVID-19 vaccinations for pregnant women is utmost important.[10,11,23,24]

A notable association between gestational age and COVID-19 severity in pregnant women was found in the present study. Specifically, pregnant individuals infected during the third trimester of gestation showed the highest likelihood of experiencing moderate to severe symptoms. Several factors might contribute to the association between advanced gestational age and increased COVID-19 severity. As pregnancy progresses, there are significant physiological changes in the maternal body; the immune system undergoes modifications to support the developing fetus. The growing uterus can compress the diaphragm and reduce lung capacity, leading to decreased lung function. These changes might make pregnant women more susceptible to severe respiratory infections, including COVID-19.

To prevent maternal mortality, considering factors like maternal age, COVID-19 vaccination status, and gestational age during infection is crucial as suggested by the results. Additional risks, such as maternal obesity and pregestational diabetes, should be acknowledged based on existing literature.[4,6] Non-Thai nationality and residing in crowded communities, like Bangkok, are barriers to healthcare access due to limited public healthcare resources for these groups. The low socio-economic status of non-Thai mothers contributes to this challenge. High COVID-19 prevalence in densely populated areas results in full hospital beds. Private hospitals, dealing with cost challenges, often reject infected patients. Despite government support, the Ministry of Public Health managed this by referring infected individuals to less congested local hospitals. Policy recommendations involve developing a comprehensive healthcare network, integrating public and private sectors, creating outbreak preparedness plans with a unified command system, and investing in primary healthcare units in each of 50 Bangkok districts to ease congestion in higher-level hospitals.

However, several limitations should be acknowledged. Firstly, the study focused on specific characteristics and factors, omitting potentially relevant variables such as pre-existing medical conditions (e.g., pre-eclampsia) and obstetric complications. Secondly, the variant of COVID-19 virus that played a role in severity of the infected case was not considered in our analysis due to limitation of the dataset. Future research should explore these additional factors contributing to COVID-19 severity among pregnant women.

Moreover, the cross-sectional design of the study restricted the ability to establish causal relationships between the identified factors and COVID-19 severity. Longitudinal studies would be valuable in further investigating causal associations and understanding the temporal dynamics of COVID-19 severity within this population.

Conclusion

This study provides substantial insights into the severity of COVID-19 among pregnant and postpartum women in Thailand. Despite most participants experiencing either no symptoms or mild symptoms, it is imperative for public health authorities to institute preventive measures to mitigate the risk of severe symptoms and optimize healthcare services for this vulnerable population. Furthermore, the study identifies the influence of maternal age, nationality, COVID-19 vaccination status, and timing of COVID-19 infection. These findings carry crucial implications for the implementation of targeted preventive strategies and the optimization of healthcare services for pregnant women during the COVID-19 pandemic. Overall, this study advances our understanding of the epidemiology and impact of COVID-19 on pregnant women, empowering healthcare providers to develop well-informed strategies for the management and care of this vulnerable group.

Acknowledgement

Authors' contributions

Conceptualization, PT, TT1, WL, BI; formal analysis, PT, BI, CT, TT2; resources, PT, TT1, WL, BI; writing—original draft preparation, PT, TT1, WL, BI, CT, TT2; writing—review and editing, PT, TT1, WL, BI, CT, TT2; visualization, PT, BI, TT2; project administration, PT, TT1, WL, BI; funding acquisition, PT, TT1, WL, BI. All authors have read and agreed to the published version of the manuscript.

Funding

Competing interests

The authors declare no conflict of interest.

References

1. World Health Organization. Coronavirus disease (COVID-19). Geneva: World Health Organization; 2023 [cited 2023 Jul 17]. Available from: https://www.who.int/health-topics/coronavirus#tab=tab_1.

2. Ntounis T, Prokopakis I, Koutras A, Fasoulakis Z, Pittokopitou S, Valsamaki A, et al. Pregnancy and COVID-19. J Clin Med. 2022;11(22):6645-58.

3. Simbar M, Nazarpour S, Sheidaei A. Evaluation of pregnancy outcomes in mothers with COVID-19 infection: a systematic review and meta-analysis. J Obstet Gynaecol. 2023;43(1):2162867-87.

4. 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:m3320:1-17.

5. World Health Organization. Episode #43 - Pregnancy & COVID-19. Geneva: World Health Organization; 2021 [cited 2023 Jul 17]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/media-resources/science-in-5/episode-43---pregnancy-covid-19.

6. Menezes MO, Takemoto MLS, Nakamura-Pereira M, Katz L, Amorim MMR, Salgado HO, et al. Risk factors for adverse outcomes among pregnant and postpartum women with acute respiratory distress syndrome due to COVID-19 in Brazil. Int J Gynaecol Obstet. 2020;151(3):415-23.

7. Kahankova R, Barnova K, Jaros R, Pavlicek J, Snasel V, Martinek R. Pregnancy in the time of COVID-19: towards Fetal monitoring 4.0. BMC Pregnancy Childbirth. 2023;23(1):33-50.

8. Aydin GA, Unal S, Ozsoy HGT. The effect of gestational age at the time of diagnosis on adverse pregnancy outcomes in women with COVID-19. J Obstet Gynaecol Res. 2021;47(12):4232-40.

9. Leung C, Simoes ESAC, Oliveira EA. Are in-hospital COVID-19-related mortality and morbidity in pregnancy associated with gestational age? Ultrasound Obstet Gynecol. 2022;60(2):234-42.

10. Ma Y, Deng J, Liu Q, Du M, Liu M, Liu J. Effectiveness and safety of COVID-19 vaccine among pregnant women in real-world studies: a systematic review and meta-analysis. Vaccines (Basel). 2022;10(2):1-17.

11. Tormen M, Taliento C, Salvioli S, Piccolotti I, Scutiero G, Cappadona R, et al. Effectiveness and safety of COVID-19 vaccine in pregnant women: a systematic review with meta-analysis. BJOG. 2023;130(4):348-57.

12. Worldometer. Coronavirus cases: worldometer. 2023 [cited 2023 Jul 29]. Available from: https://www.worldometers.info/coronavirus/.

13. Aye YM, Kim SJ, Suriyawongpaisal W, Hong SA, Chang YS. Utilization of postnatal care services among Thai women during the COVID-19 pandemic: results of a web-based survey. Int J Environ Res Public Health. 2022;19(11):6536-49.

14. Department of Medical Services. Guidelines for the diagnosis, management, and prevention of hospital-acquired COVID-19 infections, revised edition, April 18, 2023. Bangkok: HFocus; 2023 [cited 2023 Oct 17]. Available from: https://www.hfocus.org/sites/default/files/files_upload/aenwthangewchptibatilasud.pdf.

15. Biswas M, Rahaman S, Biswas TK, Haque Z, Ibrahim B. Association of sex, age, and comorbidities with mortality in COVID-19 patients: a systematic review and meta-analysis. Intervirology. 2020:1-12.

16. Mesas AE, Cavero-Redondo I, Alvarez-Bueno C, Sarria Cabrera MA, Maffei de Andrade S, Sequi-Dominguez I, et al. Predictors of in-hospital COVID-19 mortality: a comprehensive systematic review and meta-analysis exploring differences by age, sex and health conditions. PLoS One. 2020;15(11):e0241742:1-23.

17. Patel U, Malik P, Usman MS, Mehta D, Sharma A, Malik FA, et al. Age-adjusted risk factors associated with mortality and mechanical ventilation utilization amongst COVID-19 hospitalizations: a systematic review and meta-analysis. SN Compr Clin Med. 2020;2(10):1740-9.

18. Uansri S, Kunpeuk W, Julchoo S, Sinam P, Phaiyarom M, Suphanchaimat R. Perceived barriers of accessing healthcare among migrant workers in Thailand during the Coronavirus Disease 2019 (COVID-19) pandemic: a qualitative study. Int J Environ Res Public Health. 2023;20(10):1-11.

19. Gilder ME, Moo P, Hashmi A, Praisaengdet N, Wai K, Pimanpanarak M, et al. "I can't read and don't understand": health literacy and health messaging about folic acid for neural tube defect prevention in a migrant population on the Myanmar-Thailand border. PLoS One. 2019;14(6):e0218138:1-17.

20. Holumyong C, Ford K, Sajjanand S, Chamratrithirong A. The access to antenatal and postpartum care services of migrant workers in the Greater Mekong subregion: the role of acculturative stress and social support. J Pregnancy. 2018:1-12.

21. Phanwichatkul T, Schmied V, Liamputtong P, Burns E. The perceptions and practices of Thai health professionals

providing maternity care for migrant Burmese women: an ethnographic study. Women Birth. 2022;35(4):e356-e68.

22. Tschirhart N, Jiraporncharoen W, Thongkhamcharoen R, Yoonut K, Ottersen T, Angkurawaranon C. Including undoc-umented migrants in universal health coverage: a maternal health case study from the Thailand-Myanmar border. BMC Health Serv Res. 2021;21(1):1315:1-9.

23. Azami M, Nasirkandy MP, Esmaeili Gouvarchin Ghaleh H,

Ranjbar R. COVID-19 vaccine acceptance among pregnant women worldwide: a systematic review and meta-analysis. PLoS One. 2022;17(9):e0272273:1-19.

24. Bhattacharya O, Siddiquea BN, Shetty A, Afroz A, Billah B. COVID-19 vaccine hesitancy among pregnant wom-en: a systematic review and meta-analysis. BMJ Open. 2022;12(8):e061477:1-6.