

Research Article

Maternal and Neonatal Characteristics and its Contact Tracing of Covid-19 in Pregnancy in Cipto Mangunkusumo General Hospital

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Received 14 February 2022; Accepted 31 October 2022

<http://doi.org/10.23886/ejki.10.127.144>

Abstract

Pregnant women might be at greater risk for common pregnancy complications and baby abnormalities if they are infected with COVID-19. This cross-sectional study aims to investigate the characteristics of pregnant women with COVID-19, using secondary data from medical records of subjects treated with COVID-19 at Cipto Mangunkusumo Hospital from January to June 2021. 102 pregnant women with confirmed COVID-19 were enrolled and 77 were delivered during admission. Enrolled subjects mostly consisted of multigravida 58 (56.8%) between 29-36 weeks gestation 42 (41.1%). No comorbidities were present in the majority of subjects that were enrolled. Most presented with mild symptoms 50 (49%) and 21 (20.6%) with moderate symptoms. Most were delivered by Caesarean section (CS) a total of 58 out of 102 cases (75.4%). A total of 8 (7.9%) of those with severe cases with acute respiratory distress syndrome were admitted to intensive care. Pulmonary consolidation corresponding to pneumonia on chest x-ray were findings in 43 (42.2%) women. The majority of neonates born 36 (37.1%) had a birth weight of 1500-2499 grams. There were no positive COVID-19 findings of neonatal nasopharyngeal swab results. Perinatal complications occurred in 28 (36.3%) neonates that experienced respiratory distress and 22 (28.6%) experienced neonatal sepsis. A total of 44 (57.1%) infants with birth weight <2500 grams. Among these neonates 41 (55.4%) required NICU admission, 10 (13.5%) required ventilators due to respiratory distress. Most of the subjects on contact tracing, contracted COVID-19 from their neighbors or close relatives; 56(54.9%). There was 1 case of maternal death. In addition, we found that most of COVID-19 transmissions originated from asymptomatic close relatives and neighbors.

Keywords: pregnancy, COVID-19, contact tracing, neonatal, perinatal.

Luaran Hasil Ibu dan Bayi serta Penelusuran Kontak Ibu Hamil yang Bersalin di Rumah Sakit Dr. Cipto Mangunkusumo

Abstrak

Wanita hamil berisiko lebih besar mengalami komplikasi kehamilan umum dan kelainan bayi jika terpapar COVID-19. Tujuan penelitian ini adalah mengetahui luaran ibu dan bayi dengan COVID-19, serta penelusuran kontak selama kehamilan, yang dirawat di RS dr. Cipto Mangunkusumo di Jakarta, Indonesia dimulai dari Januari hingga Juni 2021 dimasukkan ke dalam penelitian. Variabel yang dinilai adalah karakteristik, hasil ibu dan bayi, dan contact tracing diambil dari rekam medis dan wawancara. Didapatkan 102 subjek ibu hamil terkonfirmasi COVID-19, 77 melahirkan di RSCM, lainnya dilahirkan konservatif. Paritas terbanyak multigravida yaitu 58 subjek (56,8%) dengan kehamilan 29 sampai 36 minggu sebanyak 42 subjek (41,1%). Sebagian pasien tidak memiliki komorbid. Sebagian besar dengan gejala ringan didapatkan 50 subjek (49%) dan gejala sedang 21 subjek (20,6%). Operasi Seksio Cesarea (SC) sebanyak 58 subjek (75,4%). Pasien dengan perawatan intensif dengan kasus berat, sindrom gangguan pernapasan akut sebanyak 8 subjek (7,9%). Pada foto rontgen dada dengan temuan konsolidasi suspek pneumonia sebanyak 43 perempuan (42,2%). Mayoritas bayi lahir dengan berat 1500-2499 g yaitu 36 bayi (37,1%). Tidak ditemukan bayi dengan hasil swab nasofaring positif. Komplikasi perinatal terjadi pada 28 bayi (36,3%) yang mengalami gangguan pernapasan dan 22 bayi (28,6%) mengalami sepsis neonatorum. Jumlah bayi <2500 gram sebanyak 44 (57,1%) dengan kebutuhan NICU mencapai 41 (55,4%), dengan 10 (13,5%) membutuhkan ventilator karena prematuritas. Sebanyak 56 subjek (54,9%) terpapar virus COVID-19 dari tetangga/kerabat. Sebagian besar ibu hamil datang dengan infeksi ringan, untuk metode terminasi adalah SC, dan ditemukan 1 kasus kematian ibu. Pada penelitian ini didapatkan dengan penelusuran kontak bahwa sebagian besar subjek terpapar atau tertular dari keluarga dekat atau tetangga yang tidak bergejala.

Kata kunci: kehamilan, COVID-19, contact tracing, neonatal, perinatal.

Introduction

COVID-19 has been declared a pandemic. It has so far caused 3.9 million deaths in 181 million cases worldwide as of June 2021, since 2020. COVID-19 is an infection caused by the SARS-CoV-2 virus that primarily infects the respiratory tract.¹ The number of confirmed cases of pregnant women with COVID-19 in the United States from January 1 to October 13, 2020 was 25,351 cases with 44 deaths, while in Brazil there were 2,256 with 135 deaths.² In Indonesia, COVID-19 was responsible for 54,000 deaths from total cases reaching 1.9 million. There has also been an increase in COVID-19 in recent months, especially in India and Indonesia due to new SARS-CoV-2 variants that are more infectious and have a higher disease severity. This shows the significance of COVID-19 globally and in Indonesia.^{3,4} At Cipto Mangunkusumo General Hospital, pregnant women with confirmed COVID-19 increased almost three times in the 3rd wave compared to its initial numbers at the start of the pandemic. In March to December 2020, 37 cases of pregnant women with confirmed COVID-19 were admitted, within 6 months the number increased to 102 cases.

COVID-19 also has an impact on pregnancy and neonatal outcomes. Rasmusen et al,⁴ and Yu et al,⁵ shown there has been an increase in preterm births and cesarean section (CS) associated with COVID-19. Smith et al,⁶ suggested the possibility of vertical transmission, especially in the third trimester. Villar et al,⁷ found the incidence of acute respiratory distress syndrome in 3.2% of neonates with a positive RNA test result, indicating vertical transmission.

Pregnant women are considered a vulnerable population, to prevent transmission strict health protocols are implemented. In Indonesia, a "5M" slogan is promoted by the health ministry which includes wearing a mask indoor and outdoor public corridor, social distancing (at least 2 meters) from other people, hand hygiene, avoid crowds, and reduce mobility.⁸

In Indonesia, there have been several studies looking at maternal and neonatal outcomes in mothers with confirmed COVID-19, but research on maternal and neonatal outcomes along with contact tracings are very limited. This study is aimed at describing maternal and neonatal outcomes and contacts tracing in pregnant women with confirmed cases of COVID-19.

Methods

This cross sectional study was conducted at Cipto Mangunkusumo General Hospital, a general hospital (National Referral Center) affiliated with Faculty of Medicine Universitas Indonesia. This study was approved by The Ethics Committee of Faculty of Medicine Universitas Indonesia number KET-6740/EN.2F1/ETIK/PPM.00.02/2021. The data of all pregnant woman who were hospitalized from January 1 to June 30, 2021 were evaluated in terms of inclusion and exclusion criteria. Inclusion criteria were all pregnant women and neonates with confirmed cases of COVID-19 during pregnancy admitted to Cipto Mangunkusumo General Hospital.

Characteristics of pregnant women with confirmed COVID-19 including age, education, occupation, spouse occupation, parity, gestational age at delivery, body mass index (BMI), comorbidities, and COVID-19 status. Maternal characteristics observed included obstetric complications, delivery methods, family planning methods, length of stay, point of care within the hospital/ICU, and thorax photos, as for the neonatal outcome include were birth weight, apgar score, congenital abnormalities, swab results, neonatal complications, and NICU care. Data were collected by consecutive sampling from medical records sequentially until the minimum number was met and input to Microsoft Excel for further editing and coding of the data. This study utilized SPSS 20.00 software to perform all statistical analysis. Data distributions were analysed using Kolmogorov-Smirnov, a value of $p > 0.05$ was considered normal distribution. We used the non-parametric test Kruskal-Wallis to analyse data in this study, a p value < 0.05 was considered statistically significant.

Result

From a total of 102 subjects, 25 subjects received conservative treatment, while 77 subjects delivered during admission. Table 1 shows that the mean age of pregnant women included in the current study was 28.33 ± 4.82 years. Most subjects were elementary school and junior high school graduates (52%). Most subjects were housewives (68.6%) while their spouse's occupation were private sector employees (61.8%). Most subjects were multigravidas (56.9%). Most of the subjects admitted were of 29-36 weeks gestation (41.2%) with mild to moderate symptoms (69.7%). Most of the subjects were overweight (57.8%) and had no comorbidities (73.5%). Thirty-eight out of 77 subjects (49.4%) delivered preterm at 29-36 weeks gestation.

Table 1. Maternal Characteristics with COVID-19

Characteristics	N=%
Ages	N=102%
<20	0 (0)
21-30	55 (53.9)
31-40	40(39.2)
>40	7 (6.9)
Education	
No school	2 (2)
Elementary school and Junior high school	53 (52)
Senior high school and Undergraduate	47 (46)
Wife's job	
Housewife	70 (68.6)
Private sector employee	22 (21.6)
Civil Servant	10 (9.8)
Husband Occupation	
Not working	70 (68.6)
Private Sector Employee	22 (21.6)
Civil servant	10 (9.8)
Gestational Age	
Gravida 1	39 (38.2)
Gravida 2-4	58 (56.9)
Gravida 5	5 (4.9)
Gestational age when infected with COVID-19	
<20 weeks	7 (6.9)
21-28 weeks	22 (21.6)
29-36 weeks	42 (41.2)
>36 weeks	31 (30.4)
Body Mass Index (BMI)	
Underweight (< 18.5)	2 (2.0)
Normoweight (18.5 – 24.9)	37 (36.3)
Overweight (25 – 29.9)	59 (57.8)
Obese (> 30)	4 (3.9)
Comorbid	
Yes	27 (26.5)
No	75 (73.5)
COVID-19 Severity	
No Symptoms	15 (14.7)
Mild	50 (49)
Moderate	21 (20.7)
Severe	8 (7.8)
Critical	8 (7.8)
Gestational age at delivery	n=77(%)
21 – 28 weeks	8 (10.4)
29 – 36 weeks	38 (49.4)
> 36 weeks	31 (40.2)

*Housewives = housewives are women who don't work but take care the household

Table 2 shows that the most common mode of delivery was cesarean section (75.3%). The most

used of contraception method was Intrauterine Device IUD (77.9%). There were 7.8% subjects who had undergone treatment in the ICU while the majority (92.2%) were taken care in the infectious disease ward. On Chest X-Ray examination, there were 57.8% subjects with normal results. Obstetric complications were experienced in 3 subjects, uterine atony in 1 (1.3%) subjects and surgical wound infection in 2 (2.6%) subjects.

Table 2. Characteristics of Pregnant Women with Confirmed COVID-19

Characteristics	n(%)
Mode of delivery	
Vaginal delivery	19 (24.7)
Cesarean section	58 (75.3)
Family planning	
IUD	60 (77.9)
Tubectomy	11 (14.3)
Not use anything	6 (7.8)
	n=77 (%)
Ward	
Non-Intensive Care Unit	94 (92.2)
Intensive Care Unit	8 (7.8)
Chest x-ray	
Pneumonia	43 (42.2)
Normal	59 (57.8)
	n=102%

Length of stay for pregnant women with confirmed COVID-19 was evaluated in median. COVID-19 severity was categorized no symptoms, mild, moderate, severe and critical illness. There was significant difference between length of stay for pregnant women with confirmed COVID-19 and its severity ($p=0,001$). Those result are summarized in Table 3.

Table 3. Length of Stay of Hospitalization for Pregnant Women with Confirmed COVID-19 and its Association with Severity

Severity	LOS* Median (Min-Max)	p
No Symptoms	3 (1-4)	
Mild	3 (1-7)	
Moderate	7 (3-10)	
Severe	6 (5-22)	
Critical	9 (7-32)	
		(p: 0.0001)

*LOS = Length of Stay

Out of 77 deliveries, 3 babies were died right after delivery, 2 of them had a congenital abnormally while 1 baby was born at 21 weeks gestation. Most babies were born <2500 g (57.1%). The highest apgar scores both in the first and fifth minutes were 7-10 (50%) and 86.5% respectively. In all neonates, the nasopharyngeal swab for COVID-19 were negative; the most perinatal morbidity encountered were respiratory distress (36.3%). More than half (55.4%) we admitted to the NICU and 13.5% required mechanical ventilation (Table 4). Two neonates died while undergoing treatment in the NICU.

Table 4. Characteristics of Neonatal with Confirmed COVID-19

Characteristics	n=77 (%)
Birth weight	
>2500	33 (42.9)
1500-2499	36 (46.8)
1000-1499	6 (7.7)
<1000	2 (2.6)
First minute apgar score	
0-3	2 (2.7)
4-6	35 (47.3)
7-10	37 (50)
Fifth minute apgar score	
0-3	2 (2.7)
4-6	8 (10.8)
7-10	64 (86.5)
Congenital anomalies	
Present	3 (3.9)
Absent	74 (96.1)
Nasopharyngeal swab	
Negative	74 (96.1)
Positive	0 (0)
Not swab	3 (3.9)
Neonatal complications	
No Complications	22 (28.6)
Respiratory distress	28 (36.3)
Neonatal Sepsis	22 (28.6)
Neonatal Death	5 (6.5)
NICU Admission	
Admitted	41 (55.4)
Not Admitted	33 (44.6)

On contact tracing, their spouse also was confirmed COVID-19 in 44 (43.1%) subjects, while 56 (54.9%) subjects knew that there were relatives and neighbors who also suffered from COVID-19 and 2 subjects did not know how they contracted COVID-19. On interrogation, their spouse and relatives or neighbors were confirmed to have COVID-19 which has had close contact (without mask), of these most were asymptomatic COVID-19.

Discussion

This is a descriptive study on the maternal and neonatal characteristic and contact tracing of COVID-19. In this study 102 pregnant women with confirmed COVID-19 were enrolled and 77 was delivered. The average age of respondents is 28.33±4.82 years with a tendency towards young adults (21-30 years). Different from the previous study by Martinez et al⁹ which showed that advanced age with an increased risk of complications and maternal death. This may be influenced by the health protocols and contact tracing which comes from asymptomatic relatives or spouses.

Most subject were elementary school/junior high school graduates (51.6%). However, the previous studies obtained were similar around (46.0%). According to previous research by Nurdiana et al¹⁰ showed that the most infections based on educational status were in elementary/junior high school graduates (63.5%). Most subjects work as housewives (68.6%), followed by private employees (21.5%). According to a previous study by Temesgen et al¹¹ most mothers with COVID-19 were housewives. Most spouses work as private employees (61.7%), followed by civil servants (25.4%) and (12.7%) were unemployed. This study also reported most spouses with COVID 19 were private employees 36.3% but with similar results working as civil servants (27.5%).¹¹

Most subjects were between their 2nd to 4th pregnancy (multigravidas) (56.8%), followed by primigravida (38.2%). Temesgen et al¹¹ stated that the most were on their 2nd to 4th pregnancy (55.5%), followed by primigravida (39.0%). Most pregnancies in our study were at 29-36 weeks (41.1%). There were similarly found in term pregnancies > 36 weeks (30.3%). Kirchengast et al¹² showed that most deliveries based on gestational age with COVID-19 at gestational age > 36 weeks (59.5%). Most subjects in our study (57.8%) had elevated BMI (overweight), while Samadi et al¹³ showed that COVID-19 occurred in mothers with a normal BMI (80.2%) followed by obesity (12.8%) and showed that between BMI and the risk of COVID-19 there is no significant difference.

The majority of subjects had no comorbidities (73.5%), however Martinez et al⁹ study showed that subjects with comorbidities were more common and associated with increased mortality.⁹ The presence of comorbidities in a patient does not determine the risk for COVID-19, however it can increase the patient's poor outcome. Most of the pregnant women with COVID-19 had mild to moderate

disease (69.6%) and only 7.8% were classified as critical. According to Samadi et al¹³ most were also mild-moderate COVID-19 (79.8%).¹³

The caesarean section delivery was 75.4%, compared to 24.6% vaginal delivery. Di Mascio et al¹⁴ found that cesarean section was very dominant in COVID-19 subjects (84%). Of the 71 subjects who used contraception, 84.5% subjects after giving birth either vaginally or by cesarean section received IUD.¹⁴ There are no previous studies that investigated the types of contraception in COVID-19 subjects. In 2020 (March-December), 37 COVID subjects gave birth at RSCM, but in the January-June 2021 it increased almost 3 times.

Based on a cohort study by Pirjani et al¹⁵ in Arash Hospital, Iran, the outcome of pregnant women with COVID-19 and non COVID-19 did not differ significantly, however the need for ICU increased significantly in mothers with COVID-19.¹⁵ In a study conducted by Villar et al¹⁶ there was an increase in the risk of ICU care in pregnant subjects with COVID-19, 5 times with incidence of 8.4%. In Cipto Mangunkusumo General Hospital (January - June 2021), 7.9% were admitted to intensive care due to acute respiratory distress syndrome. Intensive care unit admission was 8.4% in a previous study (RR, 5.04; 95% CI, 3.13-8.10).

The findings from our study, pulmonary consolidation on chest x-ray were 42.2%, indicating pneumonia. Liu et al¹⁷ study findings were similar, from chest CT of pulmonary consolidation were more commonly found in the pregnant group (48%) compared to non-pregnant group (28%). There was 1 subject that had uterine atony and 2 subjects with surgical site infection. There are no studies that discuss the complications of uterine atony and surgical site infections in COVID-19 pregnant subjects. The median duration of hospitalization was 4 days, with severe cases 6 days and critical cases 9 days. This is in line with a study conducted by Pierce-Williams et al¹⁸ who found the median duration of hospitalization was 6 days, with severe cases 6 days and critical cases 10.5 days.¹⁸ The majority of neonates had a birth weight of 1500-2499 grams (37.1%). According to the systematic review by Smith et al,¹⁹ 42.86% of babies from mothers with COVID-19 were born < 2500 g. The majority of the one minute and five-minute apgar scores were 7 (50%) and 10 were 86.5%. Compared with Smith et al¹⁹ the apgar score for one minute and five minute was 7-10 higher.¹⁹

Congenital anomalies were only found in 3.9%. Elsaddig et al,²⁰ reported although there are 116

million cases of COVID-19 worldwide, there is no increase in the incidence of congenital anomalies. The incidence of congenital anomalies in fetuses from pregnant women with COVID-19 corresponds to the incidence of congenital anomalies in the general population, which is 3-4%. No babies were found with positive nasopharyngeal swab results. Penfield et al carried-out swabs on the placenta and on the nasopharynx of babies from mothers with confirmed COVID-19.²¹ From 32 subjects, 11 were swabs on the placenta and 3 showed positive results while nasopharyngeal swabs on babies showed negative results on the first to fifth day of life. Perinatal complications occurred in 36.3% who experienced respiratory distress and 28.6% experienced neonatal sepsis. Nayak et al²² showed perinatal complications in the form of respiratory distress was 10.5%, sepsis 7%, prematurity 16.9%, moderate to severe hypoxic ischemic encephalopathy 3.6%, and hyperbilirubinemia 8.7%.

Total neonates with birth weight <2500 g were 57.1% and NICU admission reached 55.4%. The total number of subjects who required mechanical ventilation was 13.5%, this was also due to prematurity. Neonates admitted to NICU for transit for a few days for observation in the non-ventilator room, if the condition is stable and the swab results are negative for SARS-CoV2, they are transferred to the non-intensive newborn care room with other neonates/infants from non-COVID-19 mothers. Smith et al¹⁹ reported that 60% of neonates from mothers with COVID-19 were premature, need respiratory support, and care in the NICU.

In this study, contact tracing showed that 44 subjects (43.1%) contracted COVID-19 from their neighbors/relatives (54.9%), and 2 subjects (2%) did not know where they contracted from. Similar with the 8th meeting of the Scientific Advisory Group for Emergencies in the UK stated found that more than 50% of pregnant women with COVID-19 received exposure from their closest relatives. Contact tracing is an intervention carried out in cases of confirmed infection where information is needed about a potential source of transmission before the test result is positive.²³ The before mentioned meeting stated that when there is continuous transmission, contact tracing will no longer be useful.²³ The combination of self-isolation and contact tracing reduced transmission by 47%.²³

This COVID-19 vaccine is considered to be able to control this serious pandemic, thus we rarely think that anything else is needed to

control this pandemic. Even though the control of COVID-19 is not only from vaccine. Other strategies implemented, one of which is contact tracing where tracing and self-isolation can reduce further transmission and the source of infection can be identified.²⁴ With these data, it can be thought that the closest people have a big role in preventing the transmission of COVID-19 to pregnant women.

Health promotion is very important. If health promotion can be carried out within the family, the spread may be avoided. Subjects can be infected from their spouses or relatives without adhering to health protocols, because most are asymptomatic. However, when a swab examination was carried out, the results were positive. This is a reference that health protocols must be applied by everyone. It is hoped that with good health protocols, the chain of transmission will be broken.

Conclusion

Most COVID-19 in pregnancy were asymptomatic and did not have comorbidities. Most subjects were overweight with only mild infections. Concerning the delivery mode, cesarean section were applied most. We report only one case of maternal death during our study. There was no positive nasopharyngeal swab found on all neonates and from contact tracing, most subjects contracted COVID-19 from close neighbours or relatives. This study confirms that promotion and implementation of health protocols may benefit pregnant women from contracting COVID-19.

References

1. WHO Coronavirus (COVID-19) Dashboard [Internet]. [cited 2021 Jun 30]. Available from: <https://covid19.who.int>
2. PAHO/WHO. Epidemiological Update: coronavirus disease (COVID-19). [cited 2021 Jun 30]. 18 September 2020, Washington DC: PAHO/WHO; 2020. Available from: <https://bit.ly/32JDmU5>
3. CDC. Coronavirus Disease 2019 (COVID-19) [Internet]. Centers for Disease Control and Prevention. 2020 [cited 2021 Jun 30]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/variants/variant-info.html>
4. Rasmussen SA, Smulian JC, Lednicky JA, Wen TS, Jamieson DJ. Coronavirus disease 2019 (COVID-19) and pregnancy: what obstetricians need to know. *Am J Obstet Gynecol*. 2020;222:415–26.
5. Yu N, Li W, Kang Q, Xiong Z, Wang S, Lin X, et al. Clinical features and obstetric and neonatal outcomes of pregnant subjects with COVID-19 in Wuhan, China: a retrospective, single-centre, descriptive study. *Lancet Infect Dis*. 2020;20:559–64.
6. Smith V, Seo D, Warty R, Payne O, Salih M, Chin KL, et al. Maternal and neonatal outcomes associated with COVID-19: a systematic review. *PLOS ONE*. 2020;15:e0234187.
7. Villar J, Ariff S, Gunier RB, Thiruvengadam R, Rauch S, Kholin A, et al. Maternal and neonatal morbidity and mortality among pregnant women with and without COVID-19: The INTERCOVID Multinational Cohort Study. *JAMA Pediatr* [Internet]. 2021;175:817–826 [cited 2021 Jun 29]; Available from: <https://jamanetwork.com/journals/jamapediatrics/fullarticle/2779182>
8. Keputusan Menteri Kesehatan Republik Indonesia Nomor Hk.01.07/Menkes/413/2020 Tentang Pedoman Pencegahan dan Pengendalian Corona Virus Disease 2019 (COVID-19). 2020
9. Martinez-Portilla RJ, De Leon-Carbajal J, Torres-Torres J, Basurto D, Medina-Jimenez V, Gurrola Ochoa RA, et al. The interwoven effect of maternal age and co-morbidities in COVID-19 fatality among pregnant women: the Mexican national cohort. *ISUOG*. 2020;56;11–12 doi: 10.1002/uog.22224.
10. Nurdiana A, Wariah U, Yanti I. Double Threat of Indonesian Maternal Health During The Pandemic of Covid – 19. *JITek*. 2020;8(1):64–79. doi:10.32668/jitek.v8i1.429.
11. Temesgen K, Wakgari N, Debelo BT, Tafa B, Alemu G, Wondimu F, Gudisa T, et al. Maternal health care services utilization amidst COVID-19 pandemic in West Shoa zone, central Ethiopia. *PLOS ONE*. 2021;16(3): e0249214. doi: 10.1371/journal.pone.0249214.
12. Kirchengast S, Hartmann B. Pregnancy Outcome during the First COVID 19 Lockdown in Vienna, Austria. *Int J Environ Res Public Health*. 2021; 18; 3782. doi: 10.3390/ijerph18073782.
13. Samadi P, Alipour Z, Ghaedrahmati M, Ahangari R. The severity of COVID – 19 among pregnant women and the risk of adverse maternal outcomes. *Int J Gynaecol Obstet*. 2021;154:92–9. doi: 10.1002/ijgo.13700.
14. Di Mascio D, Khalil A, Saccone G, Rizzo G, Buca D, Liberati M, et al. Outcome of coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. *Am J Obstet Gynecol MFM*. 2020;2:100107. doi: 10.1016/j.ajogmf.2020.100107
15. Pirjani R, Hosseini R, Soori T, Rabiei M, Hosseini L, Abiri A, et al. Maternal and neonatal outcomes in COVID-19 infected pregnancies: a prospective cohort study. *J Travel Med*. 2020;27:taaa158. doi: 10.1093/jtm/taaa158.
16. Villar J, Ariff S, Gunier RB, Thiruvengadam R, Rauch S, Kholin A, et al. Maternal and neonatal morbidity and mortality among pregnant women with and without COVID-19: The INTERCOVID Multinational Cohort Study. *JAMA Pediatr*. 2021;175:817–26. doi: 10.1001/jamapediatrics.2021.1050.

17. Liu H, Liu F, Li J, Zhang T, Wang D, Lan W. Clinical and CT imaging features of the COVID-19 pneumonia: focus on pregnant women and children. *J Infect.* 2020;80:e7-13. doi: 10.1016/j.jinf.2020.03.007.
18. Pierce-Williams RA, Burd J, Felder L, Khoury R, Bernstein PS, Avila K, et al. Clinical course of severe and critical coronavirus disease 2019 in hospitalized pregnancies: a United States cohort study. *Am J Obstet Gynecol MFM.* 2020;2:100134. doi: 10.1016/j.ajogmf.2020.100134.
19. Smith V, Seo D, Warty R, Payne O, Salih M, Chin K et al. Maternal and neonatal outcomes associated with COVID-19: a systematic review. *PLOS ONE.* 2020;15:e0234187. doi: 10.1371/journal.pone.0234187.
20. Elsaddig M, Khalil A. Effects of the COVID pandemic on pregnancy outcomes. *Best Pract Res Clin Obstet Gynaecol.* 2021;73:125-36. doi: 10.1016/j.bpobgyn.2021.03.004.
21. Penfield CA, Brubaker SG, Limaye MA, Lighter J, Ratner AJ, Thomas KM, et al. Detection of severe acute respiratory syndrome coronavirus 2 in placental and fetal membrane samples. *Am J Obstet Gynecol MFM.* 2020;2(3):100133. doi: 10.1016/j.ajogmf.2020.100133.
22. Nayak MK, Panda SK, Panda SS, Rath S, Ghosh A, Mohakud NK. Neonatal outcomes of pregnant women with COVID-19 in a developing country setup. *Pediatr Neonatal.* 2021;62:499-505. doi:10.1016/j.pedneo.2021.05.004.
23. Scientific Advisory Group for Emergencies. Addendum to the eighth SAGE meeting on Covid-19, 18 February 2020 Held in 10 Victoria Street, London, SW1H 0NN [accessed June 1, 2020]. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/888776/S0376_Eighth_SAGE_meeting_on_Wuhan_Coronavirus__Covid-19__.pdf
24. Kucharski AJ, Klepac P, Conlan AJK, Kissler S, Lang M L, Fry H. Effectiveness of isolation, testing, contact tracing, and physical distancing on reducing transmission of SARS-CoV-2 in different settings: a mathematical modelling study. *Lancet Infect Dis.* 2020;20:1151-60. doi: 10.1016/S1473-3099(20)30457-