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Original Research

Consequences of SARS-CoV-2 disease on maternal, perinatal and neonatal outcomes: a retrospective observational cohort study

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Novel coronavirus disease 2019 (COVID-19) continues to affect pregnant women with concerns for adverse maternal and fetal outcomes and is rapidly spreading throughout many countries since it was first reported in China on 31 December 2019. The aim of this study is to describe characteristics, maternal and fetal outcomes among mothers with confirmed maternal SARS-CoV-2 infection. This study presents a retrospective observational cohort study of 62 test-positive cases of coronavirus disease 2019 that presented at an affiliated tertiary university medical city from March 2020 to May 2020. A total of 14 patients (22.5%) presented with obvious typical symptoms of coronavirus disease 2019 associated viremia and were identified after they developed symptoms during admission or after the implementation of universal testing for all obstetric admissions. A total of 62 mothers were screened positive for the SARS-CoV-2 infection. Length of stay was higher in the symptomatic group. The median length of stay was 4 days for the asymptomatic cases while it was 6 days for the symptomatic cases. Amniotic fluid was meconium stained in (12.5%) of the asymptomatic group and in 30.8% in the symptomatic group. Post discharge mothers with asymptomatic SARS-CoV-2 infection were more likely to breastfeed their infants. OR (95% CI) was 1.4 (1.02--1.90) and *P*-value was 0.0327. There was non-statistically significant absence of perinatal morbidities or mortalities among symptomatic and asymptomatic mothers.

Keywords

COVID-19; Novel coronavirus; Pregnancy

1. Introduction

On the eve of the year 2020, the WHO received the first report of a novel coronavirus that was found in Wuhan, Hubei province, China [1]. Over the ensuing months, the widespread transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19), has been reported globally in many countries.

Generally, countries with few cases either do not freely report the true numbers or many people go undiagnosed and death is attributed to something else. This has been confirmed now in China, Russia with clear under reporting being present [2]. Although current literature on COVID-19 continues to shape our perspectives on the course of the disease, its pregnancy-specific impact is still undetermined [3]. In previous pandemics such as SARS and H1N1, pregnant women were more susceptible to associated serious illness and had greater mortality rates than the general population [4]. Data on the clinical characteristics of SARS-CoV-2 infection in pregnant women still remains to be determined. *However, according to NIH data, women in third trimester have high risk for severe illness, ICU admission, higher admission rates, need for mechanical ventilation, and death rates for pregnant women with the disease* [5]. *According to a recent study, the complication rate in asymptomatic women infected with SARS-CoV-2 demonstrated that COVID-19 does not seem to affect early first-trimester miscarriage rates in those patients* [6]. Here, we present our experience with test-positive COVID-19 cases during pregnancy that presented at an affiliated tertiary university medical city for 3 months, from the beginning of March to the end of May 2020.

2. Material and methods

2.1 Study design and patients

A retrospective observational cohort study of 62 test-positive cases of coronavirus disease 2019 together with a review of their medical records was performed over a period of 3 months. The study started with the first polymerase chain reaction (PCR) confirmed COVID-19 case of a preg-

nant patient at our institution on the first of March, 2020. As a matter of protocol, patients screened for COVID-19 and diagnosed upon presentation at the labor and delivery triage unit or during direct admission to the labor unit at King Saud University Medical City (KSUMC), King Khalid University Hospital, and Riyadh, Saudi Arabia. The KSUMC is a tertiary care referral center with approximately 4700 deliveries per year.

During the early days of the COVID-19 pandemic (March 2020), our hospital screened all patients for signs, symptoms, or risk factors for COVID-19 before presenting at the labor unit at 20 weeks of gestation and restricted testing of pregnant women based on our institutions' infection prevention and control (IPAC) criteria. These criteria were based on the presence of typical COVID-19 symptoms, including fever 37.8 °C (100.0 F), dry cough, dyspnea, myalgia, or headache, and known COVID-19 exposures and/or recent travel to high-risk areas.

As per our hospital policy which follows the guideline of the Saudi CDC infants exposed to a SARS-CoV mother should have 2 nasopharyngeal swabs the first being done at 24 hour followed by another swab 24 hours after the first swab. If a symptomatic patient requires admission and the symptoms have been determined to be typical to COVID-19 and/or there is no alternative explanation for these symptoms, COVID-19 testing using a SARS-CoV-2 quantitative PCR nasopharyngeal swab is done in addition to a PCR respiratory pathogen panel. For the symptomatic patient that did not require admission, testing was done after review and approval by the IPAC department. As per our hospital policy, all pregnant women were diagnosed at one time, they got a SARS-CoV-2 swab done prior to admission to the labour and delivery room. All our included pregnant women had a positive SARS-CoV-2 nasopharyngeal swab done within 48 hours prior to the delivery. In order to avoid outcomes mis-interpretation and remove time-laps bias between women having labour during the SARS-CoV-2 infection or past SARS-CoV-2 infection. Pregnant women with stable vital signs, whose clinical conditions did not have oxygen requirement, or who denied significant shortness of breath or respiratory symptoms, were discharged home on discharge education with outpatient follow-up by telehealth as appropriate. This study was reviewed and approved by the institutional review board by KSUMC # E-20-5130 and, informed consent was obtained (signed) after the nature of the study was fully explained to all participants in our study. A comparison was done between the symptomatic and the asymptomatic women to see if there is any difference related to any of the items; being in contact with positive cases, age, parity, miscarriage, BMI, length of stay, receiving antenatal care, gestational age at delivery, having abnormal Doppler findings, the presence of meconium in the amniotic fluid, the delivery method and the occurrence of complications.

2.2 Data collection

Data of SARS-CoV-2 positive pregnant women and their infants was collected from their electronic records upon receiving the IRB approval. Patients were followed up after discharge by phone call. Demographic information was collected and reviewed including clinical characteristics, gestational age (GA) at birth, parity, the number of newborns, and comorbid conditions among mothers. Other factors considered include rupture of amniotic membranes, miscarriage, BMI (define), length of hospital stays, antenatal booking status, Doppler results, meconium-stained amniotic fluid, maternal Intrapartum complications, maternal post-partum complications, and delivery method. Also, we collected data related to the postpartum period for the newborns, including fetal intrapartum complications, low birth weight ($<$ 2500 g), premature infants, and breastfeeding/compound feeding. Others include positive nasopharyngeal swab (24 hours), negative nasopharyngeal swab (2–5 days), Apgar score- 1 and 5 minutes. We followed guidelines from CDC for case definition. Case definition is a person with positivity of the nasopharyngeal swab for SARS-CoV-2 by RT-PCR, with or without symptoms.

2.3 Statistical analysis

Descriptive statistics were done in the form of frequencies and relative frequencies for the categorical variables. Numeric variables were presented in the form of mean and standard deviation when the variables are normally distributed, while presented in the form of median, minimum and maximum if not normally distributed. Comparison of the characteristics and outcomes of the symptomatic and the non-symptomatic cases was done using Chi square test or Fisher's exact test when comparing categorical variables. The comparison was done using independent t test for the normally distributed numeric variables while using Mann Whitney test for the non-normally distributed ones. Non parametric tests were used also due to small sample size. IBM SPSS statistics software, version 26, was used for the analysis and P-value < 0.05 was considered statistically significant.

3. Results

A total of 62 women were included in this study, mean age of the women is 31.9 $\pm$ 6.3 years and their median parity is 2 ranging from 1 to 7. The median number of miscarriages they had is 0 ranging from 0 to 3. The mean BMI of the women is 32.4 $\pm$ 5.5 kg/m^2. The median length of stay in the hospital was 4 days, while the minimum was 2 days, and the maximum was 61 days. The expected length of stay for COVID-19 patients varied from less than a week to nearly 2 months according to recent literature. The length of hospital stay for patients exceeded more than expected was due to maternal, obstetric and clinical causes rather than COVID-19. For example, fibromyalgia, rheumatoid arthritis, bronchial asthma or obstetric complications (Table 1).

The gestational age of the women on diagnosis was calculated in weeks and the mean was 37.67 $\pm$ 4.78 and all of

Table 1. Association between maternal factors and symptomatic cases of COVID.

Associated factors	All mothers (Non-symptomatic/Symptomatic)	Symptoms at admission N (%)		Odds ratio (95% CI)	*P*-value	*P*-value**
		Not symptomatic	Symptomatic			
Mother contacted with +ve case	48/14	22 (45.8)	3 (21.4)	0.96 (0.91–1.01)	0.101	0.13
Age, median (min, max)	31.9 ± 6.3 (19, 44)	30.5 (19, 42)	35 (22, 44)	0.92 (0.84–1.01)	0.303	0.82
Parity, median (min, max)	2 (1, 7)	2 (1, 7)	2.5 (1, 6)	1.06 (0.91–1.24)	0.461	0.59
Miscarriage, median (min, max)	0 (0, 3)	0 (0, 3)	0 (0, 1)	0.66 (0.42–1.04)	0.488	0.33
BMI, mean (SD)	32.4 ± 5.5	31.9 (5.8)	33.7 (4.1)	0.78(0.13–1.02)	0.273	0.46
Length of hospital stays, median (min, max)	4 (2, 61)	4 (2, 61)	6 (2, 23)	0.36(1.04–1.13)*	0.022*	0.031**
Booked mothers	48/14	18 (37.5)	7 (50.0)	3.26 (0.99–3.54)	0.402	0.81
GA at delivery, mean (SD)	37.67 ± 4.78	38.47 (1.78)	38.58 (1.24)	1.48 (0.31–1.68)	0.0819	0.72
Abnormal Doppler	41/12	10 (24.40)	0 (0)	0.62 (0.46–1.83)	0.093	0.12
Meconium stained amniotic fluid	48/13	6 (12.5)	4 (30.8)	0.85 (0.78–0.92)*	0.0198*	0.09
Maternal Intrapartum complications	48/13	7 (14.6)	3 (23.1)	0.82 (0.77–0.87)*	0.0432*	0.07
Maternal Post-partum complications	47/10	3 (6.4)	1 (10.0)	0.83 (0.78–1.89)	0.099	0.61
Delivery method (Caesarean Section)	48/14	14 (29.2)	5 (35.7)	1.61 (0.44–1.80)	0.0891	0.66

*significance level was calculated on P-value < 0.05.

**non parametric tests (Mann Whitney test) significance level was calculated on P-value < 0.05.

them gave birth to singleton except for one woman who gave birth to a twin. So the total number of babies we had was 63. 40% of the women reported contact with positive cases and the same percentage received antenatal care. 14 women representing 22.6% were symptomatic pre-admission. The Doppler was normal for 80% of the women and the delivery method was SVD in 60% of cases, CS in 32% and KIWI in 8% of cases. Umbilical artery Doppler sonography was performed routinely for cases suspected to have foetal problems and intra-uterine growth restriction (IUGR) less than 10% (Table 2). The Apgar score at 1 min was 8 for 56 babies and 7 for three, while the Apgar score at 5 min was 9 for 58 babies and was 8 for only one baby. The amniotic fluid was clear in 84% of cases while had meconium in 16% of cases. Low birthweight ($<$ 2500 g) was observed in 7 babies (11.3%) and 11 babies (17.7%) were premature. One case had PPH, 10 had intrapartum complications, (CTG bradycardia and bleeding) and 4 had post-partum complications (post-partum haemorrhage, manual removal of placenta and 3^{rd} degree tear). The naso-pharyngeal swab that was done for the babies during the first 24 hours of life was positive for one case and negative for 56 cases, the remaining five new-borns had swabs between 2–5 days for the first time and they were all negative. Swabs done between 2–5 days was negative for 50 cases who had it (Table 2). As for our included new born he was followed for a total of 5 days during which he was asymptomatic, he had a total of 3 swabs done (the first one at 24 hours of life was positive, while the remaining swabs were negative). This infant had both IgM and IgG titles done for SARS-CoV-2 which was negative. Given this information this raises the concern of the first swab being false positive. As for the number of new-borns who were tested positive, we had one infant only with a positive SARS-CoV-2 which is the infant described above.

Significant difference was observed among variables; the length of stay was higher in the symptomatic group. The median length of stay was 4 days for the asymptomatic cases while was 6 days for the symptomatic cases. Amniotic fluid was clear in the asymptomatic group (87.5%) in comparison to the symptomatic group (30.8%) meconium stained. Intrapartum complications were higher in the symptomatic group (85.4%) in comparison to the complications in the asymptomatic group (23.1%). A comparison was done between the symptomatic and the asymptomatic women at admission regarding the baby outcomes. There was no difference between the groups regarding the studied variables; being of low birth weight, being premature, the throat swabs and the Apgar score. There was a statistically significant difference between mothers with symptomatic COVID-19 and their fear of disease transmission through breast milk, so they resorted to formula feeding. While mothers with no symptoms found no fear to breast fed their infants. OR (95% CI) was 1.4 (1.02–1.90) and P value was 0.0327 (Table 2).

Results about COVID-19 positive infant born to COVID-19 positive mother

A full term baby girl, 39 weeks gestational age was delivered to 22 years old G2p1 + 0 by Spontaneous Vaginal Delivery with meconium stained liquor and was vigorous at birth and was kept along with the mother in same room with 2 meter distance, awaiting the result of mass screening for COVID-19 status for the mother over 14 hrs. When the result of the mother came to be positive for COVID-19 baby was isolated, formula fed and swab for SARS CoV-PCR was done after 24 hours, result came to be positive for COVID-19 and baby was shifted to negative pressure room in COVID ICU for further isolation. All patients who had caesarean sections were indicated for it due to maternal and/or foetal causes and not due to COVID-19.

Table 2. Association between symptomatic cases of COVID and neonatal outcome.

Associated factors	All mothers (Non-symptomatic/Symptomatic)	Symptoms at admission N (%)		Odds ratio (95% CI)	*P*-value	*P*-value**
		Not symptomatic	Symptomatic			
Fetal intrapartum complications	48/14	42 (87.5)	13 (92.85)	1.06 (4.14–7.44)	0.518	0.68
Low birthweight (< 2500 g)	48/14	6 (12.5)	1 (7.1)	1.14 (0.97–1.33)	0.683	0.31
Premature infants	48/14	9 (18.8)	2 (14.3)	1.23 (0.56–2.68)	> 0.999	0.99
Breast feeding/compound feeding	48/14	19 (39.5)	2 (14.2)	1.4 (1.02–1.90)*	0.0327*	0.072
Positive naso-pharyngeal swab (24 hours)	44/13	0 (0.0)	1 (7.7)	2.17 (1.94–3.03)	0.0507	0.63
Negative naso-pharyngeal swab (2–5 days)	Aug-42	42 (100.0)	8 (100.0)	0.79 (0.51–1.20)	0.287	0.75
Apgar score-1 min (< 8)	48/14	1 (2.0)	2 (14.3)	1.14 (0.89–1.46)	0.137	0.54
Apgar score-5 min (< 8)	48/14	0 (0.0)	1 (7.1)	1.30 (0.18–1.55)	0.237	0.86

*significance level was calculated on *P*-value < 0.05.

**non parametric tests (Mann Whitney test) significance level was calculated on *P*-value < 0.05.

Baby remained asymptomatic all throughout ICU stay. She was investigated with CBC; WBC 7.600 $\times$ 10^9/L (cells per litre), platelets 164.0 $\times$ 10^9/L (cells per litre). On day 3 of life baby was evaluated apart from elevated GGT (214 units/L), AST 94 units/L (Normal low 15-Normal high 37), Pro-calcitonin 0.11 ng/mL (normal low 0.02-normal high 0.1) which was high all other markers like CRP, serum ferritin, uric acid, G6PD were normal. SARS-CoV IgG 0.04 was Negative. Baby was discharged home on Day 5 after 2 negative consecutive swabs for SARS COV-PCR on day 4 and 5. Non parametric tests-Mann Whitney's test-was done due to small sample size. The only significantly different variable is the length of stay which was higher in the symptomatic group. The median length of stay was 4 days for the asymptomatic cases while was 6 days for the symptomatic cases. The non-statistically significant results can be attributed to the small sample size that didn't provide the needed power to detect the differences (Tables 1,2).

4. Discussion

4.1 Principal findings

The study showed that pregnant women that tested positive for COVID-19 on their presentation for delivery are often without symptoms (asymptomatic), suggesting a protocol of universal testing for pregnant women admitted to the labor unit. We further found that, although many of these women ultimately developed symptoms, disease severity in this small cohort of pregnant patients-all of them were mild to moderate-appeared similar to what was described in the literature for non-pregnant people [7–9]. The non-statistically significant results can be attributed to the small sample size that didn't provide the needed power to detect the differences (Table 2).

4.2 Results in the context of what is known

Our findings are similar to the published case series from China that showed an overall favorable prognosis among pregnant women with COVID-19. Although this case-cohort is small [10, 11]. In their study, Chen described 9 cases of pregnant women with COVID-19 in which none of them required ICU admission or mechanical ventilation [11]. Similarly, Liu described 15 cases of pregnant patients who developed COVID-19 [10]. None of those women had prior underlying chronic morbidities, nor required ICU admission or invasive ventilatory support. Among this group of women two of them were asymptomatic on presentation and were only tested as part of epidemiologic contact tracing of other COVID-19 infected persons. However, on CT scan of the lungs revealed typical pneumonic changes that are consistent with COVID-19. Similar to their study, none of the patients in our study had a severe disease or developed critical presentations that required intensive care. Though keep in mind that the study has a small sample size, the clinical course of COVID-19 both during pregnancy and outside of pregnancy appears to be similar. However, the conclusions are not yet definitive and may change given the evolution of the pandemic is ongoing.

There is evidence that during pandemics, the trend is inclined towards an increased disease severity among pregnant women [12]. During the 1918 influenza pandemic, out of 1350 reported cases of influenza in the group of pregnant women, the relative size of deaths was reported to be close to one-third (27%) [13]. Similarly, regarding the SARS virus, Wong reported that about 50% of pregnant women who developed SARS needed admission into the intensive care unit due to low oxygen saturation, with approximately 66% requiring invasive mechanical ventilation [14]. The mortality rate among those requiring admission to the intensive care unit was as high as 50%.

During the 2009 H1N1 influenza virus outbreak, pregnant women were found to be 4 times more likely to be hospitalized and are at a relatively higher risk of associated complications as compared with the general population [13]. Pregnant women may be more prone to pneumonia and other respiratory infections as compared to non-pregnant women due to physiological changes during pregnancy that include airway edema, diaphragmatic elevation, increased oxygen consumption, and pregnancy-related immune-alterations [15]. These physiological changes also make pregnant mothers less able to tolerate hypoxia [15]. Therefore, until we get more evidence to support otherwise, there is a reason to remain concerned

about the clinical course of COVID-19 during pregnancy, despite encouraging early experiences here and elsewhere.

Several studies have shown that breastfeeding of neonates born to COVID-19 positive mothers is safe provided that adequate infection control measures have been followed to prevent mother-baby transmission during and after delivery [16]. Safe and effective alternatives may include augmenting feeding with pasteurized donor human milk or infant formula until exclusive breastfeeding is achieved. This was obvious, as it seems to be in our study, that there was an irrational fear of starting breastfeeding especially from symptomatic mothers [17, 18].

4.3 Clinical implications

COVID-19 represents a major public health threat, and based on current trajectories for exponential disease growth, it is reasonable to expect that a large number of potentially asymptomatic COVID-19 positive pregnant women will present for care. Our findings suggest that COVID-19 is frequently asymptomatic and should be considered in all pregnant women in areas of high disease prevalence. Universal testing for all pregnant women upon admission for delivery has potential value for many reasons. First, it allows us to identify asymptomatic patients with COVID-19 [16]. Second, it allows us to conserve our already limited PPE supplies in test negative women. Third, it provides useful information for the well-baby and neonatal intensive care nurseries and reassures mothers before interacting with their newborns. And this makes in turn some psychological support and reassurance for mothers to encourage them to start early breastfeeding.

Although there is no current proof of vertical transmission or transmission of the virus via maternal breast milk, viral shedding from asymptomatic or symptomatic women may also have implications in the management of neonates, with the possibility of neonatal infection from droplet transmission or nosocomial infection [17, 19]. Our findings from a large proportion of asymptomatic positive patients also support more restrictive visitor policies, strict hand and respiratory hygiene precautions, and masking for all patients, birth partners, and the labor unit staff. We also found that when common perinatal and postoperative infections or respiratory complications (such as chorioamnionitis, fever, or postoperative shortness of breath) arise in untested women, COVID-19 should be part of the differential diagnosis, and testing is indicated.

4.4 Research implications

The implications of asymptomatic COVID-19 in pregnant women are just now being understood. An evaluation of COVID-19 detection rate with our current hospital testing strategy that includes universal testing for admitted patients is the focus of a planned follow-up study with more sample size that is currently underway. Finally, we need more data to understand whether the virus is vertically transmitted. A case report revealed that although elevated IgM levels in an infant 2 hours after cesarean delivery, serial nasopharyngeal swabs until (day of life 16) were all negative [16]. In our small series, no neonates have tested positive or even have bad outcomes, to date and are being followed up serially.

5. Strengths and limitations

In fact, unfortunately the number of patients (sample size) was smaller than it should be. It was one of the study limitations. This might occur due to very low prevalence of the disease in Saudi Arabia in general, although our hospital is a tertiary university medical city in the capital of the country (Riyadh), and it has a bed capacity of 1300 beds. We tried our best to collect all admitted cases with inclusion criteria from the beginning of the pandemic. In spite of low COVID-19 prevalence in Saudi Arabia, we were able to provide one of the largest case series to date of pregnant women with COVID-19 although, admittedly, this series remains small. This cohort includes a relatively small number of COVID-19 patients presenting for healthcare at our affiliated hospital with close proximity and similar clinical practices. There is also no loss to follow-up in this study. In areas with high disease prevalence, there may be a different rate of asymptomatic individuals with COVID-19, and our findings may not be generalizable to other centers or regions.

Existence of control group in the study will increase the level of scientific evidence. However, in our study we just tried to find the prevalence of morbidities and mortality among mothers and newborns due to COVID-19 which is a new and vague era of pandemic. So, we tried to describe the extent and variables associated with the problem rather than to find associations and correlations between variables.

6. Conclusions

Due to small sample size we tend to be neutral regarding our conclusion. There were non-significant absence of maternal or fetal complications that were associated with COVID-19, most probably due to strict precautions followed. Early breastfeeding need to be encouraged for COVID patients, considering all the infection control precautions and reassurance of mothers. Further research with bigger sample size is needed to understand the true magnitude of risks and improve management. COVID-19 disease severity in pregnant women-100% mild to moderate-appears slightly different from that in non-pregnant adults. Our strategy of universal testing identified many asymptomatic women with COVID-19, some of whom subsequently developed temperature elevations or other COVID-19 symptoms. We believe that universal testing for all pregnant women admitted to the labour unit, in addition to those who present for triage evaluation of symptomatic complaints, has obvious benefits that should inform best practices to protect patients, their families, and the obstetric care providers.

Author contributions

LS designed the research study. SA performed the research. MB provided help and advice on the experiments. MH analyzed the data. SH and AH wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Our manuscript reporting study involving human participants and human data: so we had an ethical approval and consent. We had the approval from IRB/KSUMC ethics committee that approved the study and the committee's reference number # E-20-5130.

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Conflict of interest

The authors declare no competing interests.

References

[1] World Health Organization. Novel Coronavirus-China. Available at: https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.5.200131e?crawler=true (Accessed: 02 April 2020).

[2] Khan N, Fahad S, Naushad M, Faisal S. Critical Review of COVID-2019 in the World. Available at SSRN: https://scholar.google.com/citations?user=XqTAvPUAAAAJ&hl=en (Accessed: 23 April 2020).

[3] Li N, Han L, Peng M, Lv Y, Ouyang Y, Liu K, *et al.* Maternal and neonatal outcomes of pregnant women with COVID-19 pneumonia: a case-control study. Clinical Infectious Diseases. 2020; 71: 2035–2041.

[4] Rasmussen SA, Jamieson DJ, Bresee JS. Pandemic influenza and pregnant women. Emerging Infectious Diseases. 2008; 14: 95–100.

[5] Boushra MN, Koyfman A, Long B. COVID-19 in pregnancy and the puerperium: a review for emergency physicians. The American Journal of Emergency Medicine. 2020; 40: 193–198.

[6] Rotshenker-Olshinka K, Volodarsky-Perel A, Steiner N, Rubenfeld E, Dahan M H. COVID-19 pandemic effect on early pregnancy: are miscarriage rates altered, in asymptomatic women? Archives of Gynecology and Obstetrics. 2020; 1–7.

[7] Breslin N, Baptiste C, Miller R, Fuchs K, Goffman D, Gyamfi-Bannerman C, *et al.* Coronavirus disease 2019 in pregnancy: early lessons. American Journal of Obstetrics & Gynecology MFM. 2020; 2: 100111.

[8] Wu Z, McGoogan JM. Characteristics of and important lessons from the Coronavirus disease 2019 (COVID-19) outbreak in China. Journal of the American Medical Association. 2020; 323: 1239.

[9] Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, *et al.* China medical treatment expert group for COVID-19. Clinical characteristics of coronavirus disease 2019 in China. The New England Journal of Medicine. 2020; 382: 1708–1720.

[10] Liu D, Li L, Wu X, Zheng D, Wang J, Yang L, *et al.* Pregnancy and perinatal outcomes of women with coronavirus disease (COVID-19) pneumonia: a preliminary analysis. American Journal of Roentgenology. 2020; 215: 127–132.

[11] Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, *et al.* Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. The Lancet. 2020; 395: 809–815.

[12] Centers for Disease Control and Prevention. Pregnant women & influenza. Available at: https://www.cdc.gov/flu/highrisk/pregnant.htm (Accessed: 29 March 2020).

[13] Jamieson DJ, Honein MA, Rasmussen SA, Williams JL, Swerdlow DL, Biggerstaff MS, *et al.* H1N1 2009 influenza virus infection during pregnancy in the USA. The Lancet. 2009; 374: 451–458.

[14] Wong SF, Chow KM, Leung TN, Ng WF, Ng TK, Shek CC, *et al.* Pregnancy and perinatal outcomes of women with severe acute respiratory syndrome. American Journal of Obstetrics and Gynecology. 2004; 191: 292–297.

[15] Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, *et al.* SARS-CoV-2 viral load in upper respiratory specimens of infected patients. New England Journal of Medicine. 2020; 382: 1177–1179.

[16] Zeng L, Xia S, Yuan W, Yan K, Xiao F, Shao J, *et al.* Neonatal early-onset infection with SARS-CoV-2 in 33 neonates born to mothers with COVID-19 in Wuhan, China. JAMA Pediatrics. 2020; 174: 722–725.

[17] Pereira A, Cruz-Melguizo S, Adrien M, Fuentes L, Marin E, Forti A, *et al.* Breastfeeding mothers with COVID-19 infection: a case series. International Breastfeeding Journal. 2020; 15: 69.

[18] Lubbe W, Botha E, Niela-Vilen H, Reimers P. Breastfeeding during the COVID-19 pandemic-a literature review for clinical practice. International Breastfeeding Journal. 2020; 15: 82.

[19] Hong KH, Lee SW, Kim TS, Huh HJ, Lee J, Kim SY, *et al.* Guidelines for laboratory diagnosis of coronavirus disease 2019 (COVID-19) in Korea. Annals of Laboratory Medicine. 2020; 40: 351–360.