



COLLEGE of AMERICAN  
PATHOLOGISTS

# ARCHIVES

of Pathology & Laboratory Medicine

## **EARLY ONLINE RELEASE**

This article was posted on the *Archives* Web site as an Early Online Release. Note: Due to the extremely time sensitive nature of the content of this article, it has not been copyedited or formatted per journal style. Changes or corrections may be made to this article when it appears in a future print issue of the *Archives*. Early Online Release articles are citable by using the Digital Object Identifier (DOI), a unique number given to every article.

The DOI for this manuscript is doi: [10.5858/arpa.2020-0901-SA](https://doi.org/10.5858/arpa.2020-0901-SA)

The final published version of this manuscript will replace the Early Online Release version at the above DOI once it is available.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23

**An Analysis of 38 Pregnant Women with COVID-19, Their Newborn Infants, and Maternal-Fetal Transmission of SARS-CoV-2: Maternal Coronavirus Infections and Pregnancy Outcomes**

Corresponding author:

David A. Schwartz, MD, MS Hyg

Department of Pathology

Medical College of Georgia, Augusta University

1950 Grace Arbor Court

Atlanta, GA 30329

Email: davidalanschwartz@gmail.com

***The author has no relevant financial interest in the products or companies described in this article.***

## 24 **Abstract**

25 The emergence of a novel coronavirus, termed SARS-CoV-2, and the potentially life-threatening respiratory  
26 disease that it can produce, COVID-19, has rapidly spread across the globe creating a massive public  
27 health problem. Previous epidemics of many emerging viral infections have typically resulted in poor  
28 obstetrical outcomes including maternal morbidity and mortality, maternal-fetal transmission of the  
29 virus, and perinatal infections and death. This communication reviews the effects of two previous  
30 coronavirus infections - severe acute respiratory syndrome (SARS) caused by SARS-CoV and Middle East  
31 respiratory syndrome (MERS) caused by MERS-CoV - on pregnancy outcomes. In addition, it analyzes  
32 literature describing 38 pregnant women with COVID-19 and their newborns in China to assess the  
33 effects of SARS-CoV-2 on the mothers and infants including clinical, laboratory and virologic data, and  
34 the transmissibility of the virus from mother to fetus. This analysis reveals that unlike coronavirus  
35 infections of pregnant women caused by SARS and MERS, in these 38 pregnant women COVID-19 did  
36 not lead to maternal deaths. Importantly, and similar to pregnancies with SARS and MERS, there were  
37 no confirmed cases of intrauterine transmission of SARS-CoV-2 from mothers with COVID-19 to their  
38 fetuses. All neonatal specimens tested, including in some cases placentas, were negative by rt-PCR for  
39 SARS-CoV-2. At this point in the global pandemic of COVID-19 infection there is no evidence that SARS-  
40 CoV-2 undergoes intrauterine or transplacental transmission from infected pregnant women to their  
41 fetuses. Analysis of additional cases is necessary to determine if this remains true.

42 (*Arch Pathol Lab Med.* doi: 10.5858/arpa.2020-0901-SA)

43

44

45

46

47

## 48 **Introduction**

49           The emergence of the novel coronavirus infection that occurred in Wuhan China in December  
50 2019 has resulted in an epidemic that has rapidly expanded to become one of the most significant public  
51 health threats in recent times.<sup>1-5</sup> This newly emergent coronavirus was isolated in China in early January  
52 2020, initially referred to as 2019-nCoV and subsequently termed SARS-CoV-2 – the disease it produces  
53 has been termed COVID-19.<sup>6</sup> Since then it has become an increasingly widespread and important cause  
54 of respiratory infection which can progress to severe pneumonia and, in a small number of cases, death.  
55 Since its initial identification in Wuhan, Hubei province, China, COVID-19 has now been reported from all  
56 continents except for Antarctica, affecting 125,048 persons in 118 countries and resulting in 4613 deaths  
57 as of March 12, 2020.<sup>7</sup> COVID-19 was declared a pandemic by the World Health Organization on March  
58 11, 2020.<sup>8</sup>

59           There has been a rapid increase in knowledge of the genetic, virologic, epidemiologic and clinical  
60 aspects of this emerging agent – the 7<sup>th</sup> coronavirus identified to cause human infection.<sup>9</sup> Recently the  
61 initial description of the pulmonary pathology that occurs from fatal COVID-19 has been described.<sup>10</sup>

62           An important question that remains unanswered is whether SARS-CoV-2 can be transmitted  
63 from a pregnant woman to her fetus, a process termed vertical transmission, and to determine the  
64 mechanism(s) if it does occur.<sup>9,11-17</sup> Not only is this a significant public health issue, but also represents  
65 an obstetrical management issue in determining the care received by pregnant women. The question is  
66 especially relevant given the recent history of vertical maternal-fetal transmission of such emerging viral  
67 infections as the Zika virus, Ebola virus, Marburg virus and other agents which can threaten the health  
68 and survival of an infected mother and fetus.<sup>18-21</sup>

## 69 **Previous Experiences with Coronavirus Infections During Pregnancy**

70           Pregnancy increases the risk of adverse obstetrical and neonatal outcomes from many  
71 respiratory viral infections. The physiologic and immunologic changes that occur as a normal component

72 of pregnancy can have systemic effects that increase the risk for complications from respiratory  
73 infections. Changes in the cardiovascular and respiratory systems, including increased heart rate, stroke  
74 volume, oxygen consumption, and decreased lung capacity, as well as the development of immunologic  
75 adaptations that allow a mother to tolerate an antigenically distinctive fetus, increase the risk for  
76 pregnant women to develop severe respiratory disease.<sup>22</sup> Outcomes data from multiple studies of  
77 influenza have demonstrated an increased risk of maternal morbidity and mortality when compared  
78 with non-pregnant women.<sup>22,23</sup> This association has also been previously demonstrated to occur when  
79 pregnant women became infected with either of two pathogenic coronavirus infections – severe acute  
80 respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS).<sup>9</sup>

### 81 **Severe acute respiratory syndrome (SARS)**

82 The SARS epidemic occurred from November 2002 to July 2003, affecting greater than 8000  
83 persons in 26 countries and resulting in 774 fatalities.<sup>24</sup> The causative agent, a coronavirus termed  
84 SARS-CoV, was transmitted through close person-person contact, respiratory droplets, environmental  
85 contamination, and potentially sewage.<sup>9,25</sup> There were 12 pregnant women reported who developed  
86 SARS during the epidemic, of whom 3 died during pregnancy (case fatality rate of 25%).<sup>9</sup> Miscarriages  
87 during the 1<sup>st</sup> trimester occurred in 4/7 women. Two of 5 women in the 2<sup>nd</sup> and 3<sup>rd</sup> trimester had a  
88 neonate with intrauterine growth restriction (IUGR). In addition, 4/5 pregnancies resulted in preterm  
89 birth – 1 spontaneous and 3 induction deliveries that were performed for maternal conditions.<sup>26</sup> Vertical  
90 transmission of the SARS-CoV virus did not occur in any of the infants; however, the clinical outcomes of  
91 pregnant women with SARS were worse than those occurring in infected women who were not  
92 pregnant.<sup>9,26-29</sup>

### 93 **Middle East respiratory syndrome (MERS)**

94 MERS is another coronavirus infection that causes potentially severe respiratory disease. It was  
95 first reported from Saudi Arabia in 2012, after which it spread to over 27 countries both within and

96 outside of the Arabian Peninsula.<sup>9,30</sup> MERS-CoV has been identified in camels, which have been  
97 suggested as the primary source of human infections, as well as in bats, but more research is needed to  
98 understand the role that these and other animals may play in transmission. MERS-CoV is characterized  
99 by sporadic zoonotic transmission events as well as spread between infected patients and close contacts  
100 (i.e., intra-familial transmission). Outbreaks of MERS in health care settings are characteristic of MERS,  
101 and which result from poor infection control and preventative measures.<sup>30,31</sup>

102 MERS-CoV infection has been reported from 11 pregnant women, where it has been associated  
103 with a variety of adverse clinical outcomes among 10 (91%) of them. These outcomes have included  
104 maternal deaths, premature delivery, intensive care treatment for newborns, and perinatal death. There  
105 have been no confirmed cases of vertical transmission of MERS-CoV.<sup>9</sup>

## 106 **Current clinical features and obstetrical outcomes of pregnant women with** 107 **COVID-19**

108 There has been a total of 38 pregnant women reported with COVID-19 originating from the  
109 epicenter of the pandemic in China.<sup>13-17</sup> All women were in the 3<sup>rd</sup> trimester of pregnancy, and included  
110 37 women whose SARS-CoV-2 positivity was confirmed by rt-PCR. These pregnancies resulted in 39  
111 infants (one set of twins); detailed clinical information, obstetrical outcomes and SARS-CoV-2 status  
112 were available for 30 neonates.

### 113 **Zhongnan Hospital of Wuhan University, Wuhan, China**

114 Nine pregnant women with COVID-19 have been described in a retrospective review of medical  
115 records by Chen et al. (Table 1).<sup>13</sup> The women were tested for SARS-CoV-2 using rt-PCR kits  
116 recommended by the Chinese Center for Disease Control and Prevention (BioGerm, Shanghai, China).  
117 Samples were tested simultaneously using rt-PCR at the of Clinical Laboratory of Zhongnan Hospital and  
118 State Key Laboratory of Virology/Institute of Medical Virology, School of Basic Medical Sciences, Wuhan  
119 University. Positive confirmatory cases of SARS-CoV-2 infection were reported when a positive test

120 result from either laboratory was obtained. The mothers varied in age between 26 and 40 years of age,  
121 had documented exposure to the novel coronavirus and were in the 3<sup>rd</sup> trimester of pregnancy when  
122 they developed COVID-19 infection. Although none of the women had a preexisting chronic condition  
123 such as diabetes, cardiovascular disease or hypertension, 3 women had co-morbid conditions that  
124 developed during their pregnancy – influenza (Case 1), gestational hypertension occurring since 27  
125 weeks gestation (Case 3), and preeclampsia developing at 31 weeks gestation (Case 4). Seven women  
126 were febrile upon admission; additional findings included cough (4/9), myalgia (3/9), sore throat (2/9)  
127 malaise (2/9), gastrointestinal symptoms (1/9) and shortness of breath (1/9). Laboratory findings  
128 included elevated C-reactive protein (6/9), lymphopenia (5/9), and increased alanine aminotransferase  
129 (ALT) and aspartate aminotransferase (AST)(3/9). Chest CT scans were abnormal in 8 of the 9 women,  
130 demonstrating lungs with patchy ground-glass shadows. Four women had preterm labor, but none  
131 occurring prior to 36 weeks gestation. Cases 5 and 8 had fetal distress, and cases 7 and 9 had premature  
132 rupture of membranes (PROM). None of the women developed severe pneumonia, and there were no  
133 maternal deaths.

134 All 9 women underwent cesarean sections. Two of the 4 preterm infants were delivered at 36  
135 weeks 2 days and weighed less than 2500 grams (Cases 4 and 7) – one of the newborn infants (Case 4)  
136 had a birthweight of 1880 grams and was delivered to a mother with preeclampsia. All of the infants had  
137 good Apgar scores.

138 The presence of SARS-CoV-2 was evaluated in 6 of the 9 cases from amniotic fluid, breastmilk,  
139 umbilical cord blood and neonatal throat swabs - all tests were negative. The specific cases that were  
140 tested was not specified. All of the 6 neonatal samples tested were negative for SARS-CoV-2.

#### 141 **Tongji Hospital of Tongji Medical College, Huazhong University, Wuhan, China**

142 Liu et al. reported 3 pregnant women from the Tongji Hospital who became infected with SARS-  
143 CoV-2 during the 3<sup>rd</sup> trimester.<sup>14</sup> These 3 women were among a total of 17 pregnant women admitted to

144 the Obstetrics Ward during the study period - a COVID-19 prevalence of approximately 18 percent. The  
145 women's ages ranged from 30 to 34 years (Table 2). COVID-19 testing was performed using the rt-PCR  
146 assay with a SARS-CoV-2 ORF1ab/N gene detection kit (Shanghai Huirui Biotechnology Co.,Ltd, Shanghai,  
147 China), a product based on the recommendation of the National Institute for Viral Disease Control and  
148 Prevention, Chinese Center for Disease Control and Prevention.

149 Case 1 was a 34-year-old woman with hypothyroidism who was febrile prior to her hospital  
150 admission. She had a chest CT that showed progressively worsening bilateral pulmonary infiltrates. The  
151 mother had positive rt-PCR tests for SARS-CoV-2 from an oropharyngeal swab and feces; testing of  
152 breast milk, vaginal mucus and placenta were negative. Her 3250-gram infant was delivered at 40 weeks  
153 gestational age by cesarean section with chronic fetal distress, chorioamnionitis, meconium-stained  
154 membranes but had good Apgar scores. Specimens from the infant including whole blood, plasma  
155 serum, umbilical cord blood and an oropharyngeal swab were negative for SARS-CoV-2 by rt-PCR.

156 Case 2 was a 34-year-old woman with no significant obstetrical history or co-morbid conditions.  
157 She developed a fever at 37 weeks of gestation, and a CT scan of the chest revealed bilateral ground  
158 glass opacities and pulmonary consolidation, nodules in the left lower lobe and patchy consolidation in  
159 the right middle lobe. A oropharyngeal swab taken one day prior to delivery was positive for SARS-CoV-2  
160 by rt-PCR. A 3250-gram infant was delivered by cesarean section at 38 weeks 4 days gestation with good  
161 Apgar scores. The newborn had slightly decreased muscle tone and responsiveness that had improved  
162 the day after delivery. Testing for SARS-CoV-2 from whole blood, serum, oropharyngeal swabs, urine  
163 and feces using rt-PCR were all negative for the novel coronavirus.

164 Case 3 was a 30-year-old woman who had developed gestational hypertension during her first  
165 pregnancy. She developed cough at 37 weeks gestation, and upon admission to the hospital had a chest  
166 CT scan that demonstrated ground glass opacities, subsolid patch and linear fibrosis in the left lung and  
167 enlarged mediastinal lymph nodes. An rt-PCR test for SARS-CoV-2 performed on an oropharyngeal swab



168 was positive; follow-up testing of an anal swab, vaginal mucus and breast milk were all negative. She  
169 delivered a 3670-gram infant by vaginal delivery at 39 weeks 5 days gestation with good Apgar scores.  
170 Two rt-PCR tests for SARS-CoV-2 were performed on successive days using whole blood, plasma,  
171 oropharyngeal swabs, urine and feces, and all were negative.

172 The mothers in this report all presented with either fever or cough accompanied by CT  
173 abnormalities during the course of their COVID-19 disease. None of the women developed severe  
174 pneumonia or died, and all 3 had successful perinatal outcomes with no evidence of intrauterine  
175 transmission of SARS-CoV-2.

176 **Maternal and Child Health Hospital of Hubei Province, Union Hospital, Renmin Hospital, Tianmen First**  
177 **People's Hospital, Jingzhou Municipal Hospital and Child Health Hospital, and Pediatric Hospital**  
178 **affiliated with Fudan University, China**

179 Zhu et al. described in detail the pregnancies of 9 pregnant women with COVID-19 and their 10  
180 infants (including one set of twins) from 5 hospitals in Hubei Province (Tables 2 and 3).<sup>15</sup> The women  
181 ranged in age between 25 and 35 years of age, and had a 1 to 6 day interval between the onset of  
182 symptoms and delivery. All women had a chest CT revealing ground glass opacities, patchy pulmonary  
183 consolidation and blurred borders typical of viral pneumonia. Viral testing for SARS-CoV-2 nucleic acid  
184 was performed on throat swab specimens from the 9 women, and results were positive for all patients  
185 except the mother of the twins - her test was negative. She had typical clinical symptoms of COVID-19  
186 and viral interstitial pneumonia by chest CT scan, and other diseases that could cause fever and lung  
187 infection were excluded. The local Chinese Centers for Disease Control and Prevention then registered  
188 her as a confirmed 2019-nCoV case, and she was included in the current study.

189 The initial symptoms among these women was fever and/or cough. Prenatal conditions included  
190 fetal distress in 6 cases, premature rupture of membranes in 3 cases (5 to 7 hours prior to the onset of  
191 labor), oligohydramnios and polyhydramnios in 1 case each, umbilical cord abnormalities in 2 cases, and

192 placenta previa in 1 case. Third trimester obstetrical ultrasounds were all normal. Seven of the mothers  
193 underwent cesarean sections, and 2 had vaginal deliveries. There were no cases of severe pneumonia or  
194 maternal death among the 9 women.

195           There were 8 singletons and 1 set of twins delivered to the mothers with COVID-19 – 4 were full-  
196 term and 6 were premature. Two newborns were small for gestational age and one was large for  
197 gestational age. The infants were evaluated for well-being using the Pediatric Critical Illness Score (PCIS),  
198 the most widely used pediatric critical illness scoring method in China. Six of the newborns had a PCIS of  
199 less than 90 – 6 infants had shortness of breath, 2 were febrile and 1 had a rapid heart rate.

200 Gastrointestinal symptoms were present in 4 infants – these included gastric bleeding, refusal of milk,  
201 bloating and feeding intolerance. Chest radiographs revealed that 7 newborns had abnormalities at the  
202 time of admission that included infection in 4, neonatal respiratory distress syndrome in 2, and  
203 pneumothorax in 1 infant. Two infants had the onset of thrombocytopenia associated with liver  
204 dysfunction. One premature infant developed shortness of breath and fluctuations of oxygenation and  
205 decreased platelets treated with respiratory support and transfusions. There was one neonatal fatality  
206 among the cohort (Case 4) – a premature newborn developed shortness of breath, refractory shock,  
207 multiple organ failure and disseminated intravascular coagulation and died on the 9<sup>th</sup> day of life. Four  
208 neonates remained hospitalized at the time of submission of the report. Pharyngeal swab specimens  
209 were collected from 9 of the neonates between 1- and 9-days following delivery and tested for SARS-  
210 CoV-2, and all were negative.

#### 211 **The Second Affiliated Hospital and The Affiliated Infectious Hospital of Soochow University, Suzhou,** 212 **China**

213           In a case report Wang et al. described a 28-year-old pregnant woman who presented to the  
214 hospital with a fever of one-week duration (Table 3).<sup>16</sup> She was at 30 weeks gestation at the time of her  
215 admission and 2 throat swabs tested negative for SARS-CoV-2 using rt-PCR. Chest CT examination 2 days

216 later showed left-sided subpleural patchy consolidation and right-sided ground-glass opacities. A repeat  
217 rt-PCR examination of sputum performed 4 days after admission was positive for SARS-CoV-2. She was  
218 transferred to the Intensive Care Unit where she was placed in isolation. An obstetrical ultrasound  
219 revealed a normal fetus of 30 weeks gestation. On hospital day 3 decreased fetal movement was  
220 observed with absent variability of the fetal heart rate, and an emergence cesarean section was  
221 performed. A preterm male infant was delivered that weighed 1.83 kg and with Apgar scores of 9 and 10  
222 at 1 and 5 minutes, respectively. Samples were taken of placenta, amniotic fluid, umbilical cord blood,  
223 gastric juice and throat swabs of the infant - all results tested negative for SARS-CoV-2 using rt-PCR.  
224 Three days following delivery rt-PCR testing of the neonatal throat swab and stool samples were  
225 negative. Seven and 9 days after birth throat swab and rt-PCR tests from the mother and the infant  
226 remained negative for the novel coronavirus.

227 **Renmin Hospital of Wuhan University, Wuhan and the Central Hospital of Qianjiang City, Qianjiang,**  
228 **China**

229 Zhang and colleagues retrospectively examined medical records of 16 pregnant women with rt-  
230 PCR confirmed COVID-19 and their newborn infants, and compared these results with a cohort of 45  
231 pregnant women who were not infected (translated from Simplified Chinese by DAS) – this constituted  
232 the first comparison study between women with and without SARS-CoV-2 infection during pregnancy.<sup>17</sup>  
233 Throughout this study testing for SARS-CoV-2 was performed using the New Coronavirus (2019) Nucleic  
234 Acid Detection Kit (Dual Fluorescence PCR) provided by Jiangsu Shuo Shi Biotechnology Co., Ltd. All  
235 women were in their 3rd trimester of pregnancy. Diagnosis of COVID-19 was based on the diagnostic  
236 criteria of the New Coronavirus Infected Pneumonia Diagnosis and Treatment Plan (Trial Fifth Edition)  
237 issued by the National Health and Health Commission.

238 In the COVID-19 cohort the women varied from 24 to 34 years of age, had previously been  
239 pregnant between 1 and 4 times, and had parity varying from 0 to 1 (Table 4). The gestational age at the

240 time of delivery varied between 35 weeks 5 days up to 41 weeks, averaging 38.7 weeks. In the cohort of  
241 women who were not infected with SARS-CoV-2 the maternal ages varied between 24 and 40 years, had  
242 1 to 5 previous pregnancies and parity of 0 or 1, and delivered their infants between 35 weeks 2 days  
243 and 41 weeks with an average of 37.9 weeks. The women with COVID-19 had infants weighing between  
244 2300 and 3750 grams (average 3139 g), and the women without COVID -19 had infants weighing  
245 between 2180 and 4100g (average 3260g). There were no significant differences between the 2 cohorts  
246 in gravidity, parity, gestational age at delivery, birthweight or intraoperative blood loss. The maternal  
247 ages were significantly different – mothers in the COVID-19 cohort were younger than those in the non-  
248 COVID-19 cohort ( $P=.01$ ).

249         Among the 16 women with COVID-19 there were several mothers with co-morbid obstetrical  
250 conditions – 3 women had gestational diabetes, 3 had premature rupture of membranes, 3 had preterm  
251 deliveries, 2 had scarred uterus, 2 required B-Lynch suture procedure (a form of compression suture  
252 used in obstetrics to mechanically compress an atonic uterus in the clinical setting of severe postpartum  
253 hemorrhage). There was one incident of severe preeclampsia, meconium-stained amniotic fluid, fetal  
254 distress and fetal asphyxia. Three of 16 women with COVID-19 had cough, chest tightness, shortness of  
255 breath, and diarrhea that did not improve significantly with treatment. One of these mothers had  
256 COVID-19 pneumonia – she was 35 weeks 6 days gestation with oxygen saturation of 93% accompanied  
257 by chest tightness and shortness of breath, and with decreased fetal movement and abnormal fetal  
258 heart monitoring. All of the women with COVID-19 underwent cesarean deliveries.

259         There were no significant differences between the groups of pregnant women with and without  
260 COVID-19 in occurrence of severe preeclampsia, gestational diabetes, premature rupture of  
261 membranes, fetal distress, meconium-stained amniotic fluid, premature delivery, neonatal asphyxia, B-  
262 Lynch suture procedure or other compression sutures. The proportion of uterine scarring in the non-

263 COVID-19 group was statistically higher than that in COVID-19 group ( $p=0.032$ ) – this abnormality  
264 predated the development of COVID-19.

265         Among the cohort of 16 mothers with COVID-19 there were 10 infants for whom SARS-CoV-2  
266 infection status was known – all were negative using rt-PCR analysis of throat swabs. Nine of these  
267 newborns were full-term and 1 was preterm (36 weeks 2 days). Three of the neonates had bacterial  
268 pneumonia based on their symptoms, laboratory testing, sputum culture, and imaging results – all of  
269 them recovered following treatment. After discharge of the newborns from the hospital, follow-up  
270 examinations demonstrated no neonatal illness or deaths.

## 271 **Conclusions**

272         Intrauterine transmission is one of the most serious complications of viral diseases occurring  
273 during pregnancy. It can occur with maternal infection by congenitally-transmitted TORCH agents  
274 (acronym for **T**oxoplasma, **O**ther, **R**ubella, **C**ytomegalovirus, **H**erpes) which also include Zika virus and  
275 Ebola virus.<sup>32</sup> Maternal-fetal transmission of viral diseases (with the exception of herpes virus) is usually  
276 through the hematogenous route in which the virus circulating in the maternal blood stream enters the  
277 placenta, reaches the chorionic villous tree and fetal blood vessels, and is transmitted to the fetus.  
278 Fortunately, this mechanism of transmission has been shown not to occur with infection of pregnant  
279 women with 2 other pathogenic coronaviruses – SARS-CoV and MERS-CoV, although the clinical  
280 infections caused by these coronaviruses has resulted in severe maternal pneumonia, maternal deaths  
281 and early pregnancy losses.<sup>12</sup>

282         In this analysis of the detailed published reports of 38 pregnant women with COVID-19, of  
283 whom 37 had rt-PCR-confirmed SARS-CoV-2 infection, there were no cases of either severe pneumonia  
284 or maternal deaths. Although there were co-morbid conditions present in some of the women, some of  
285 which were obstetrical in etiology, they apparently did not result in life-threatening maternal SARS-CoV-  
286 2 disease. It is significant that these co-morbid maternal conditions, which included preeclampsia,

287 pregnancy-induced hypertension, uterine scarring, gestational diabetes, and uterine atony, did not  
288 appear to be risk factors for intrauterine transmission of SARS-CoV-2 to the fetus. Gestational age  
289 among these 22 mothers at the time of onset of COVID-19 varied between 30 and 40 weeks, and at least  
290 in this range did not appear to be associated with heightened risk for maternal-fetal viral transmission

291         Among the 30 neonates delivered to these women who underwent testing, there were no cases  
292 of rt-PCR-confirmed SARS-CoV-2 infection, despite the existence of perinatal complications in some of  
293 the infants. An interesting observation is that in those cases where placentas were tested for SARS-CoV-  
294 2, the results were negative. This lack of maternal-fetal transmission of SARS-CoV-2 is consistent with  
295 past experiences with other coronavirus infections – SARS and MERS - occurring in pregnant women.

296         Early in the epidemic there were two cases of neonatal SARS-CoV-19 infection reported. One  
297 was an infant diagnosed at 17 days of life having a history of close contact with 2 confirmed cases of  
298 SARS-CoV-2 infection (mother and nanny), and the other was a neonate who was found to be infected  
299 36 hours following delivery. In both infants there was no direct evidence for vertical transmission, and  
300 because viral testing was delayed, a postpartum neonatal infection acquired through an infected contact  
301 could not be eliminated.<sup>11,12</sup>

302         A joint mission by the World Health Organization consisting of 25 national and international  
303 experts travelled to the affected regions of China between 16 and 24 February 2020.<sup>33</sup> They investigated  
304 147 pregnant women (64 confirmed, 82 suspected and 1 asymptomatic with COVID-19). Among these  
305 women 8% had severe disease and 1% were critical. The joint mission concluded that pregnant women  
306 were not at higher risk for developing severe disease due to COVID-19. This report did not examine  
307 vertical transmission or neonatal outcomes.

308         As this global epidemic continues to expand there will be additional information available on the  
309 effects of COVID-19 on pregnant women and their infants. In the unfortunate event of mortality  
310 resulting from SARS-CoV-2 infection among pregnant women or neonates, pathological evaluation of

311 tissues together with molecular characterization of the virus would be useful in determining the  
312 pathogenesis of the disease as it has in many cases of emerging infections.<sup>34</sup> There are currently updated  
313 recommendations available on the obstetrical management of SARS-CoV-2 infection in pregnant  
314 women.<sup>35</sup> In addition, it must be remembered that as vaccine development proceeds for COVID-19 that  
315 pregnant women should be considered for inclusion in the clinical trials as well as the eventual  
316 distribution of the vaccine unless the risks outweigh the potential benefits.<sup>36</sup>

317

## 318 REFERENCES

- 319 1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with  
320 pneumonia in China, 2019. *N Engl J Med.* 2020;382(8):727-733. Available from:  
321 <https://www.nejm.org/doi/10.1056/NEJMoa2001017> (accessed 4 March 2020).
- 322 2. Huang C, Wang Y, Li X, Ren, L., Zhao, J., Hu, Y., et al. Clinical features of patients infected with 2019  
323 novel coronavirus in Wuhan, China. *The Lancet.* 2020;395(10223):497-506. doi:  
324 [https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5) Available from:  
325 [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)30183-5/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30183-5/fulltext) (accessed 3  
326 March 2020).
- 327 3. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y. et al. Epidemiological and clinical characteristics of 99  
328 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *The Lancet.* 2020;395  
329 (10223):507-513. doi: [https://doi.org/10.1016/S0140-6736\(20\)30211-7](https://doi.org/10.1016/S0140-6736(20)30211-7) Available from:  
330 [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)30211-7/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30211-7/fulltext) (accessed 1  
331 March 2020).
- 332 4. European Centre for Disease Prevention and Control. Update: Cluster of pneumonia cases associated  
333 with novel coronavirus – Wuhan, China – 2019. 14 January 2020. Available from:

- 334 <https://www.ecdc.europa.eu/en/news-events/update-cluster-pneumonia-cases-associated-novel->  
335 [coronavirus-wuhan-china-2019](https://www.ecdc.europa.eu/en/news-events/update-cluster-pneumonia-cases-associated-novel-coronavirus-wuhan-china-2019) (accessed 1 March 2020).
- 336 5. She J, Jiang J, Ye L, Hu L, Bai C, Song C. 2019 novel coronavirus of pneumonia in Wuhan, China:  
337 emerging attack and management strategies. *Clin Trans Med.* 2020;9:19. doi:  
338 <https://doi.org/10.1186/s40169-020-00271-z>. Available from:  
339 <https://clintransmed.springeropen.com/articles/10.1186/s40169-020-00271-z#citeas> (accessed 3  
340 March 2020).
- 341 6. World Health Organization. Naming the coronavirus disease (COVID-2019) and the virus that causes it.  
342 Available from: [https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it)  
343 [guidance/naming-the-coronavirus-disease-\(covid-2019\)-and-the-virus-that-causes-it](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it) (accessed 23  
344 February 2020).
- 345 7. World Health Organization. Coronavirus disease 2019 (COVID-19). Situation Report – 52. 12 March  
346 2020. Available from: [https://www.who.int/docs/default-source/coronaviruse/20200312-sitrep-52-](https://www.who.int/docs/default-source/coronaviruse/20200312-sitrep-52-covid-19.pdf?sfvrsn=e2bfc9c0_2)  
347 [covid-19.pdf?sfvrsn=e2bfc9c0\\_2](https://www.who.int/docs/default-source/coronaviruse/20200312-sitrep-52-covid-19.pdf?sfvrsn=e2bfc9c0_2) (accessed 13 March 2020).
- 348 8. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-  
349 19 - 11 March 2020. Available from: [https://www.who.int/dg/speeches/detail/who-director-general-s-](https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020)  
350 [opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020](https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020) (accessed 11 March 2020).
- 351 9. Schwartz DA, Graham AL. Potential maternal and infant outcomes from Coronavirus 2019-nCoV  
352 (SARS-CoV-2) infecting pregnant women: Lessons from SARS, MERS, and other human coronavirus  
353 infections. *Viruses.* 2020;12:194. Available from: <https://www.mdpi.com/1999-4915/12/2/194>  
354 (accessed 28 February 2020).
- 355 10. Xu Z, Shi L, Wang Y, et al. Pathological findings of COVID-19 associated with acute respiratory distress  
356 syndrome [published online ahead of print February 18, 2020]. *The Lancet Resp Med.* 2020. doi:  
357 [https://doi.org/10.1016/S2213-2600\(20\)30076-X](https://doi.org/10.1016/S2213-2600(20)30076-X) Available from:



- 358 [https://www.thelancet.com/journals/lancet/article/PIIS2213-2600\(20\)30076-X/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS2213-2600(20)30076-X/fulltext) (accessed 27  
359 February 2020).
- 360 11. Qiao J. What are the risks of COVID-19 infection in pregnant women? [Published online ahead of  
361 print February 12, 2020]. *The Lancet*. doi: [https://doi.org/10.1016/S0140-6736\(20\)30365-2](https://doi.org/10.1016/S0140-6736(20)30365-2) Available  
362 from: [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)30365-2/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30365-2/fulltext) (accessed  
363 26 February 2020).
- 364 12. Schwartz DA. COVID-19, SARS-CoV-2 and pregnancy: Does the past predict the present?  
365 *ContagionLive*. 28 February 2020. Available from: [https://www.contagionlive.com/news/covid19-  
366 sarscov2-and-pregnancy-does-the-past-predict-the-present](https://www.contagionlive.com/news/covid19-sarscov2-and-pregnancy-does-the-past-predict-the-present) (accessed 1 March 2020).
- 367 13. Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, et al. Clinical characteristics and intrauterine vertical  
368 transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical  
369 records [Published online ahead of print February 12, 2020]. *The Lancet*. 2020.  
370 [https://doi.org/10.1016/S0140-6736\(20\)30360-3](https://doi.org/10.1016/S0140-6736(20)30360-3).  
371 [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)30360-3/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30360-3/fulltext) (accessed 28  
372 February 2020).
- 373 14. Liu W, Wang Q, Zhang Q, Chen L, Chen J, Zhang B. et al. Coronavirus disease 2019 (COVID-19) during  
374 pregnancy: A case series. *Preprints* 2020;2020020373. Available from:  
375 <https://www.preprints.org/manuscript/202002.0373/v1> (accessed 28 February 2020).
- 376 15. Zhu H, Wang L, Fang C, et al. Clinical analysis of 10 neonates born to mothers with 2019-nCoV  
377 pneumonia. *Transl Pediatr*. 2020;9(1):51-60. doi: 10.21037/tp.2020.02.06. Available from:  
378 <http://tp.amegroups.com/article/view/35919/28274> (accessed 1 March 2020).
- 379 16. Wang X, Zhou Z, Zhang J, Zhu F, Tang Y, Shen X. A Case of 2019 novel coronavirus in a pregnant  
380 woman with preterm delivery [Published online ahead of print February 28, 2020]. *Clin Infect Dis*. 2020.

- 381 doi: 10.1093/cid/ciaa200. Available from: [https://pubmed.ncbi.nlm.nih.gov/32119083-a-case-of-2019-](https://pubmed.ncbi.nlm.nih.gov/32119083-a-case-of-2019-novel-coronavirus-in-a-pregnant-woman-with-preterm-delivery/)  
382 [novel-coronavirus-in-a-pregnant-woman-with-preterm-delivery/](https://pubmed.ncbi.nlm.nih.gov/32119083-a-case-of-2019-novel-coronavirus-in-a-pregnant-woman-with-preterm-delivery/) (accessed 10 March 2020).
- 383 17. Zhang I, Jiang Y, Wei M, Cheng BH, Zhou XC, Li J, et al. 湖北地区新型冠状病毒肺炎流行期间孕妇的  
384 妊娠结局分析 [Analysis of the Pregnancy Outcomes in Pregnant Women With COVID-19 in Hubei  
385 Province]. *Zhonghua Fu Chan Ke Za Zhi* . 2020;55(0), E009. Available from:  
386 <http://rs.yiigle.com/yufabiao/1184338.htm> (accessed and translated 12 March 2020).
- 387 18. Alvarado MG, Schwartz DA. Zika virus infection in pregnancy, microcephaly and maternal and fetal  
388 health - What we think, what we know, and what we think we know. *Arch Pathol Lab Med*. 2017;141(1):  
389 26-32. doi: 10.5858/arpa.2016-0382-RA. Available from:  
390 <https://www.archivesofpathology.org/doi/10.5858/arpa.2016-0382-RA> (accessed 2 March 2020).
- 391 19. Schwartz DA. Maternal and infant death and the rVSV-ZEBOV vaccine through three recent Ebola  
392 virus epidemics - West Africa, DRC Équateur and DRC Kivu: Four years of excluding pregnant and  
393 lactating women and their infants from immunization. *Curr Trop Med Reports*. 2019;6(4).  
394 doi.org/10.1007/s40475-019-00195-w. Available from:  
395 <https://link.springer.com/article/10.1007/s40475-019-00195-w>
- 396 20. Schwartz DA., Anoko JN, Abramowitz S. Editors. *Pregnant in the Time of Ebola: Women and Their*  
397 *Children in the 2013-2015 West African Epidemic*. Springer, New York and Berlin. 2019. [ISBN-13: 978-  
398 3319976365] [ISBN-10: 3319976362] eBook published January 2, 2019.
- 399 21. Schwartz DA. Maternal filovirus infection and death from Marburg and Ravn viruses: Highly lethal to  
400 pregnant women and their fetuses similar to Ebola Virus. In: *Re-Emerging Filovirus Diseases*, S.I. Okware,  
401 Ed. IntechOpen. ISBN: 978-1-78985-550-0. DOI: 10.5772/intechopen.88270. Available from:  
402 [https://www.intechopen.com/online-first/maternal-filovirus-infection-and-death-from-marburg-and-](https://www.intechopen.com/online-first/maternal-filovirus-infection-and-death-from-marburg-and-ravn-viruses-highly-lethal-to-pregnant-women)  
403 [ravn-viruses-highly-lethal-to-pregnant-women](https://www.intechopen.com/online-first/maternal-filovirus-infection-and-death-from-marburg-and-ravn-viruses-highly-lethal-to-pregnant-women)

- 404 22. Rasmussen SA, Jamieson DJ, Uyeki TM. Effects of influenza on pregnant women and infants. *Am J*  
405 *Obstet Gynecol.* 2012;207(3 Suppl):S3–S8. doi:10.1016/j.ajog.2012.06.068 Available from:  
406 [https://www.ajog.org/article/S0002-9378\(12\)00722-3/pdf](https://www.ajog.org/article/S0002-9378(12)00722-3/pdf) (accessed 26 February 2020).
- 407 23. Silasi M, Cardenas I, Racicot K, Kwon J-Y, Aldo P, Mor G. Viral infections during pregnancy. *Am J*  
408 *Reprod Immunol.* 2015;73(3):199–213. doi: [10.1111/aji.12355](https://doi.org/10.1111/aji.12355) Available from:  
409 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4610031/> (accessed 26 February 2020).
- 410 24. Centers for Disease Control and Prevention. CDC SARS Response Timeline. Available from:  
411 <https://www.cdc.gov/about/history/sars/timeline.htm> (accessed 25 February 2020).
- 412 25. Hung LS. The SARS epidemic in Hong Kong: what lessons have we learned? *J R Soc Med.* 2003;96(8):  
413 374–378. doi: [10.1258/jrsm.96.8.374](https://doi.org/10.1258/jrsm.96.8.374). Available from:  
414 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC539564/> (accessed 24 February 2020).
- 415 26. Wong SF, Chow KM, Leung TN, et al. Pregnancy and perinatal outcomes of women with severe acute  
416 respiratory syndrome. *Am J Obstet Gynecol.* 2004;191(1):292-297.
- 417 27. Lam CM, Wong SF, Leung TN, et al. A case-controlled study comparing clinical course and outcomes  
418 of pregnant and non-pregnant women with severe acute respiratory syndrome. *BJOG.* 2004;111(8):771-  
419 774. Available from: <https://obgyn.onlinelibrary.wiley.com/doi/full/10.1111/j.1471-0528.2004.00199.x>  
420 (accessed 19 February 2020).
- 421 28. Zhang JP, Wang YH, Chen LN, Zhang R, Xie YF. Clinical analysis of pregnancy in second and third  
422 trimesters complicated severe acute respiratory syndrome. *Zhonghua Fu Chan Ke Za Zhi.*  
423 2003;38(8):516–520.
- 424 29. Maxwell C, McGeer A, Tai KFY, Sermer M. No. 225-Management guidelines for obstetric patients and  
425 neonates born to mothers with suspected or probable severe acute respiratory syndrome (SARS). *J*  
426 *Obstet Gynaecol Can.* 2017;39(8):e130-e137. doi: 10.1016/j.jogc.2017.04.024. Available from:  
427 [https://www.jogc.com/article/S1701-2163\(17\)30464-4/fulltext](https://www.jogc.com/article/S1701-2163(17)30464-4/fulltext) (accessed 28 February 2020).

- 428 30. World Health Organization. Middle East respiratory syndrome coronavirus (MERS-CoV). Summary  
429 and literature update – as of 27 March 2014. Available from:  
430 [https://www.who.int/csr/disease/coronavirus\\_infections/MERS\\_CoV\\_Update\\_27\\_March\\_2014.pdf?ua=](https://www.who.int/csr/disease/coronavirus_infections/MERS_CoV_Update_27_March_2014.pdf?ua=1)  
431 [1](#) (accessed 27 February 2020).
- 432 31. Hui DS. Epidemic and emerging coronaviruses (severe acute respiratory syndrome and Middle East  
433 respiratory syndrome). *Clin Chest Med*. 2017;38(1):71-86. doi: 10.1016/j.ccm.2016.11.007. Available  
434 from: <https://www.sciencedirect.com/science/article/pii/S0272523116301289?via%3Dihub> (accessed  
435 25 February 2020).
- 436 32. Schwartz DA. The origins and emergence of Zika virus, the newest TORCH infection: What's old is  
437 new again. *Arch Pathol Lab Med*. 2017;141(1):18-25. Available from:  
438 <https://www.archivesofpathology.org/doi/full/10.5858/arpa.2016-0429-ED> (accessed 13 March 2020).
- 439 33. World Health Organization. Report of the WHO-China Joint Mission on Coronavirus Disease 2019  
440 (COVID-19). Available from: [https://www.who.int/docs/default-source/coronaviruse/who-china-joint-](https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf)  
441 [mission-on-covid-19-final-report.pdf](#) (accessed 8 March 2020).
- 442 34. Schwartz DA, Bryan RT, Hughes JM. Pathology and emerging infections - quo vadimus? *Am J Pathol*.  
443 1995;147(6):1525-1533. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1869939/>  
444 (accessed 4 March 2020).
- 445 35. Favre G, Pomar L, Qi X, Nielsen-Saines K, Musso D, Baud D. Guidelines for pregnant women with  
446 suspected SARS-CoV-2 infection [Published online ahead of print, March 3, 2020]. *The Lancet*. 2020. doi:  
447 [https://doi.org/10.1016/S1473-3099\(20\)30157-2](https://doi.org/10.1016/S1473-3099(20)30157-2) Available from:  
448 [https://www.thelancet.com/journals/laninf/article/PIIS1473-3099\(20\)30157-](https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30157-2/fulltext#.XI9nyRMYAv4.twitter)  
449 [2/fulltext#.XI9nyRMYAv4.twitter](#) (accessed 4 March 2020).
- 450 36. Krubiner C, Faden RF, Karron RA. In the race for coronavirus vaccines, don't leave pregnant women  
451 behind. *STAT News*. 25 February 2020. Available from:

452 <https://www.statnews.com/2020/02/25/coronavirus-vaccine-covid-19-pregnant-women/> (accessed 1  
453 March 2020).  
454

Table 1. Characteristics of 7 pregnant women with COVID-19 and their infants.

Case and 1 <sup>st</sup> author	Case 1 Chen <sup>13</sup>	Case 2 Chen <sup>13</sup>	Case 3 Chen <sup>13</sup>	Case 4 Chen <sup>13</sup>	Case 5 Chen <sup>13</sup>	Case 6 Chen <sup>13</sup>	Case 7 Chen <sup>13</sup>
Maternal age (years)	33	27	40	26	26	26	29
Gestational age at delivery	37wk 2d	38wk 3d	36 wk	36wk 2d	38wk 1d	36wk 3d	36wk 2d
Comorbid events	Influenza	None	Gestational hypertension	Pre-eclampsia	Fetal distress	None	PROM
Maternal rt-PCR for SARS-CoV-2	Positive	Positive	Positive	Positive	Positive	Positive	Positive
Symptom-to-delivery interval	1 day	6 days	4 days	3 days	1 day	4 days	2 days
C-section or vaginal	C-s	C-s	C-s	C-s	C-s	C-s	C-s
Birthweight	2870 g	3730 g	3820 g	1880 g	2970 g	3040 g	2460 g
Apgars at 1 & 5 mins	8, 9	9, 10	9, 10	8, 9	9, 10	9, 10	9, 10
Neonatal outcome	Normal	Normal	Normal	SGA	Normal	Normal	Normal
Neonatal rt-PCR for SARS-CoV-2	According to Chen et al. there were 6 of 9 neonates tested for SARS-CoV-2 and all 6 were found to be negative by rt-PCR, but which 6 neonates that were tested was not specified						

Abbreviations: SGA – small for gestational age; PROM – premature rupture of membranes

Table 2. Characteristics of additional 7 pregnant women with COVID-19 and their infants

Case and 1 <sup>st</sup> author	Case 8 Chen <sup>13</sup>	Case 9 Chen <sup>13</sup>	Case 1 Liu <sup>14</sup>	Case 2 Liu <sup>14</sup>	Case 3 Liu <sup>14</sup>	Case 1 Zhu <sup>15</sup>	Case 2 Zhu <sup>15</sup>
Maternal age (years)	28	34	34	34	30	25	35
Gestational age at delivery	38wk	39wk 4d	40wk	38wk 4d	39wk 5d	38wk 4d	33w 6d
Comorbid events	Fetal distress	PROM	Hypothyroid	Placenta accreta	Gestational diabetes	Fetal distress, oligo	Scarred uterus
Maternal rt-PCR for SARS-CoV-2	Positive	Positive	Positive	Positive	Positive	Positive	Positive
Symptom-to-delivery interval	2 days	7 days	~1 day	~7 days	~13 days	< 1 day	< 1day
C-section or vaginal	C-s	C-s	C-s	C-s	Vaginal	C-s	C-s
Birthweight	2800 g	3530 g	3250 g	3250 g	3670 g	2,450g	2,050 g
Apgars at 1 & 5 mins	9, 10	8, 10	8, 9	8, 9	8, 9	9, 10	9, 10
Neonatal outcome	Normal	Normal	Normal	Normal	Normal	SGA	SOB
Neonatal rt-PCR for SARS-CoV-2	See Table 1	See Table 1	Negative	Negative	Negative	Negative	Negative

Abbreviations: PROM – premature rupture of membranes; oligo-oligohydramnios; SGA-small for gestational age; SOB-shortness of breath

Table 3. Characteristics of additional 8 pregnant women with COVID-19 and their 9 infants including one set of twins

Case and 1 <sup>st</sup> author	Case 3 Zhu <sup>15</sup>	Case 4 Zhu <sup>15</sup>	Case 5 Zhu <sup>15</sup>	Case 6 Zhu <sup>15</sup>	Case 7 Zhu <sup>15</sup>	Case 8 Zhu <sup>15</sup>	Case 9 Zhu <sup>15</sup>	Case 10 Zhu <sup>15</sup>
Maternal age (years)	35	30	30	30	30	29		34
Gestational age at delivery	34w 2d	34wk 5d	39w	37w	34w 6d	31w		39w
Comorbid events	Fetal distress	Vaginal bleeding, fetal distress	Cholecystitis	Placenta previa, fetal distress poly	Fetal distress	Twins, fetal distress, viral pneumonia c/w with COVID-19		None
Maternal rt-PCR for SARS-CoV-2	Positive	Positive	Positive	Positive	Positive	Negative		Positive
Symptom-to-delivery interval	2 days after delivery	3 days after delivery	6 days before delivery	4 days before delivery	4 days before delivery	3 days before delivery		1 day after delivery
C-section or vaginal	Vaginal	C-s	C-s	C-s	C/s	Vaginal twin		C-s
Birthweight	2350 g	2200 g	3030 g	3800 g	2300 g	1520 g	1720 g	2810 g
Apgars at 1 & 5 mins	8, 9	8, 8	8, 9	7, 8	9, 10	9, 10	9, 10	10, 10
Neonatal outcome	SOB	Multiple organ failure, shock, gastric bleeding, DIC, death	Diffuse scattered rashes, edema, facial skin lesions	LGA, in hospital	SOB, fever, GI bleeding DIC	SOB, in hospital	SOB, in hospital	SGA, SOB, cyanosis, in hospital
Neonatal rt-PCR for SARS-CoV-2	Neg	Neg	Not performed	Neg	Neg	Neg	Neg	Neg

Abbreviations: LGA – large for gestational age; poly-polyhydramnios; SGA-small for gestational age; SOB-shortness of breath; DIC-disseminated intravascular coagulation; c/w – consistent with



Table 4. Characteristics of an additional 17 pregnant women with COVID-19 and their infants

Case and 1 <sup>st</sup> author	Case 1 Wang <sup>16</sup>	Cases 1 to 16 Zhang et al. <sup>17</sup>
Maternal age (years)	35	Varies from 24 to 34 years with mean of $29.3 \pm 2.9$
Gestational age at delivery	31 w	Varies from 35 weeks 5 days up to 41 weeks with mean of $38.7 \pm 1.4$
Comorbid events	Fetal distress	Gestational diabetes (3), PROM (3), preterm delivery (3), uterine scarring (2), B-Lynch/compression suture procedure (2), severe preeclampsia (1), fetal distress (1), fetal asphyxia (1), meconium staining (1), COVID-19 pneumonia (1)
Maternal rt-PCR for SARS-CoV-2	Positive	Positive in all 16 women
Symptom-to-delivery interval	13 days before delivery	Not stated
C-section or vaginal	C-s	C-s in all 16 women
Birthweight	1830 g	Varies from 2300 to 3750 grams with mean of $3139 \text{ g} \pm 437$
Apgars at 1 & 5 mins	9, 10	Not stated
Neonatal outcome	Normal	Bacterial pneumonia in 3 neonates, 1 preterm infant
Neonatal rt-PCR for SARS-CoV-2	Neg	Viral testing results available for 10 of 16 neonates, all of whom were negative for infection

Abbreviations: PROM – premature rupture of membranes