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SARS-CoV-2 Infection during Pregnancy in a Rural Midwest All-delivery Cohort and Associated Maternal and Neonatal Outcomes

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Abstract

Objective This study aimed to estimate the prevalence of severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) among pregnant patients at the time of delivery in a rural Midwest tertiary care hospital and to examine demographics, clinical factors, and maternal and neonatal outcomes associated with SARS-CoV-2 infection during pregnancy.

Study Design This prospective cohort study included all delivering patients between May 1 and September 22, 2020 at the University of Iowa Hospitals and Clinics. Plasma SARS-CoV-2 antibody testing was performed. SARS-CoV-2 viral reverse-transcription polymerase chain reaction (RT-PCR) results and maternal and neonatal outcomes were collected from the electronic medical record. Data were analyzed using univariate statistical methods with clustering for multiple births.

Results In total, 1,000 patients delivered between May 1 and September 22, 2020. Fifty-eight (5.8%) were SARS-CoV-2 antibody positive. Twenty-three also tested viral positive during pregnancy. Three of 1,000 (0.3%) were viral positive on admission but antibody negative. The median age was 30 years (interquartile range [IQR]: 26–33 years) and body mass index was 31.75 kg/m^2 (IQR 27.7–37.5 kg/m^2). The cesarean delivery rate was 34.0%. The study population was primarily white (71.6%); however, 41.0% of SARS-CoV-2 infected patients identified as Black, 18.0% as Hispanic/Latino, 3.3% as Native Hawaiian/Pacific Islander, and only 27.9% as White ($p < 0.0001$). SARS-CoV-2 infection was more likely in patients without private insurance ($p = 0.0243$). Adverse maternal and/or neonatal outcomes were not more likely in patients with evidence of infection during pregnancy. Two SARS-CoV-2 infected patients were admitted to the intensive care unit. There were no maternal deaths during the study period.

Keywords
- COVID-19
- pregnancy
- racial disparities
- SARS-CoV-2
- seroprevalence

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Conclusion In this largely rural Midwest population, 6.1% of delivering patients had evidence of past or current SARS-CoV-2 infection. Rates of SARS-CoV-2 during pregnancy were higher among racial and ethnic minorities and patients without private insurance. The SARS-CoV-2 infected patients and their neonates were not found to be at increased risk for adverse outcomes.

Key Points

- SARS-CoV-2 seroprevalence rate in pregnant population in Iowa is 5.8%.
- Infections are higher among minorities, non-English speakers, and patients without private insurance.
- No increased adverse maternal/neonatal outcomes observed for SARS-CoV-2 infected mothers.

First appearing in Wuhan, China, in December of 2019, severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) is a novel respiratory virus that has caused a worldwide pandemic. Although initially more rampant in urban areas, the virus has affected urban and rural areas alike across the United States. In Iowa, the first cases of SARS-CoV-2/novel coronavirus disease 2019 (COVID-19) were diagnosed in March 2020, but cases have continued to accumulate with 1 in 24 Iowans testing positive for the virus as of this writing.[1] While the literature on COVID-19 has expanded rapidly in recent months, no studies have yet reported on COVID-19 in pregnancy in a largely rural population; and few studies have reported on an all-delivery cohort to determine an accurate COVID-19 antibody seroprevalence in a pregnant population.

It remains unclear how infection with SARS-CoV-2 in pregnancy is related to maternal and neonatal outcomes. Previous reports regarding other coronaviruses, such as SARS-CoV and Middle East respiratory syndrome coronavirus (MERS-CoV), showed potential for poor obstetric and perinatal outcomes when women were infected during pregnancy,[2] with maternal hypoxia as a possible mechanism.[3] Reports to date of COVID-19 in pregnancy have described maternal respiratory symptoms, including severe respiratory distress, similar to the nonpregnant population. Research suggests that hospital and intensive care unit (ICU) admission rates are higher in pregnant patients with COVID-19 than nonpregnant patients of reproductive age with COVID-19.[4] Current limited literature also suggests possible associations between COVID-19 infection in pregnancy and adverse outcomes including fetal distress, premature rupture of membranes, preterm delivery, preeclampsia, and fetal growth restriction.[5–7]

When looking at which factors may affect who becomes infected with SARS-CoV-2, it has become clear that demographic factors, such as race and socioeconomic status, play a large role.[8] Preexisting health conditions and chronic disease have also been linked to increased infection rates and disease complications.[9] Multiple studies have suggested that women with asthma and obesity are more likely to have severe COVID-19 in pregnancy.[10,11]

This study aimed to estimate the prevalence of SARS-CoV-2 infection among pregnant patients at the time of delivery at the University of Iowa Hospitals and Clinics (UIHC) between May 1 and September 22, 2020. We sought to assess which demographic or clinical factors may be associated with increased risk of infection in our population, as well as to describe any maternal and/or neonatal adverse outcomes associated with SARS-CoV-2 infection during pregnancy.

Materials and Methods

This prospective cohort study included all pregnant patients who delivered at UIHC between May 1 and September 22, 2020. SARS-CoV-2 reverse-transcription polymerase chain reaction (RT-PCR) testing was performed on delivery admission for all patients as part of routine hospital care starting on April 9, 2020. Excess plasma from routinely collected blood samples was used to determine the seroprevalence of SARS-CoV-2 antibody within this population. Given the first confirmed case of COVID-19 in Iowa was documented on March 8, 2020, antibody positive patients in this study period would most likely have been infected during their current gestation. The institutional review board at the University of Iowa approved this study (institutional review board [IRB] ID no.: 202004278). The project was internally funded.

Residual EDTA plasma from patient samples was tested for antibody presence using the LIAISON SARS-CoV-2 S1/S2 immunoglobulin (Ig)-G (DiaSorin) and the Elecsys Anti-SARS-CoV-2 (Roche) assays. Prior studies have shown that these assays become positive, at the earliest, 5 to 7 days after COVID-19 RT-PCR positivity and are nearly 100% positive by 3 weeks.[12,13] Deidentified existing plasma samples from 103 healthy individuals collected at least 1 year prior to the COVID-19 outbreak were tested as negative controls. Discrepancies between the DiaSorin and Roche assays were resolved using a third assay: the EUROIMMUN Anti-SARS-CoV-2 enzyme-linked immunosorbent assay (ELISA) IgG.

Demographic and clinical data were obtained from the electronic medical record and double entered in a Research Electronic Data Capture (REDCap) database. Demographic data included race and ethnicity which was self-reported during the hospital registration process. The racial categories used correspond with the National Institutes of Health (NIH)'s racial and ethnic categories.[14] SARS-CoV-2 infection severity was categorized as follows: mild symptoms were

defined as cases limited to upper respiratory congestion, headache, and/or gastrointestinal symptoms. Moderate-to-severe cases required documentation of one or more of the following: cough, sore throat, myalgia, chest pain, loss of taste/smell, dyspnea, and/or hypoxia. Summary statistics are provided for demographic, clinical, and delivery outcome measures stratified by SARS-CoV-2 infection status. Categorical variables are displayed as counts and percentages, while continuous variables are displayed as means (standard deviations) or medians (interquartile ranges [IQRs]), depending on the normality of each distribution. Tests for differences in outcome between the SARS-CoV-2-positive and -negative subsets were conducted using Fisher's exact, two-sample *t*- or Wilcoxon rank sum tests. Further comparisons of neonatal outcome measures utilized the generalized linear mixed modeling (GLMM) framework to account for multiple births from some mothers and varying distributions (normal and binary) for the outcomes. This method allowed us to identify if the analyses were sensitive to adjusting for repeated measurements. Any comparison with a *p*-value of <0.05 was considered statistically significant. All analyses were conducted using SAS 9.4.

Results

A total of 1,000 pregnant patients delivered at UIHC between May 1 and September 22, 2020. Population characteristics are listed in ►Table 1.

Fifty-eight of the women (5.8%) were classified as having SARS-CoV-2 antibodies by both the DiaSorin IgG and Roche total antibody assays, with discrepancies resolved by the EUROIMMUN antibody assay. Only eight patients had discrepant results between the DiaSorin and Roche antibody assays. Four were positive by DiaSorin but negative by Roche and EUROIMMUN; these were classified as negative for COVID-19. Four were negative by DiaSorin and positive by Roche. Of these, one specimen was also positive by EUROIMMUN and was COVID-19 RT-PCR positive; this was classified as positive for COVID-19. The other three were negative by EUROIMMUN in addition to DiaSorin and were classified as negative for COVID-19. All 103 pre-COVID-19 samples were confirmed SARS-CoV-2 antibody negative.

Twenty-three women in the study tested viral positive by RT-PCR at some point during their pregnancy. Of these 23 women, 13 tested positive prior to their admission and 10 tested positive during routine admission screening for labor and delivery. Three of the patients who tested viral positive on admission were found to be antibody negative, suggesting that they were most likely infected with the virus but early in their infection course and had not yet formed antibodies to the virus. All three of these patients were asymptomatic (►Table 1). Thus, 61 delivering patients (6.1%) had evidence of past or current SARS-CoV-2 infection as defined as viral or antibody positivity at some point during their pregnancy, referred to from this point on as COVID-19 positive (absence of SARS-CoV-2 infection is referred to as COVID-19 negative).

Of the 61 COVID-19-positive patients, 31 (50.8%) remained asymptomatic during their ante- and intrapartum periods. Then, 19.7% of patients reported mild symptoms, whereas 27.9% reported moderate-to-severe symptoms. Two (3.3%) of the 61 COVID-19-positive patients required ICU admission. One of the patients received treatment with convalescent plasma and a nasal cannula for advanced respiratory support. The second patient did not receive treatment with convalescent plasma, remdesivir, or hydroxychloroquine. However, she did receive advanced respiratory support including extracorporeal membrane oxygenation (ECMO).[15]

Collected study population characteristics according to SARS-CoV-2 infection status are listed in ►Table 2. Despite nearly 92% of the study population identifying English as their preferred language, almost half (47.5%) of the COVID-19-positive patients identified a preferred language other than English. Similarly, nearly 72% of the study population self-

Table 1 Description of study population

Characteristic	Population ($n = 1{,}000$)
Maternal age (y) Median (IQR)	30 (26–33)
BMI (kg/m^2) Median (IQR)	31.7 (27.7–37.5)
Gestational age at admission (wk) Median (IQR)	$39^{0/7}$ ($37^{2/7}$–$39^{5/7}$)
Gestational age at delivery (wk) Median (IQR)	$39^{0/7}$ ($37^{3/7}$–$39^{5/7}$)
Gestation *n* (%)	
Singleton	965 (96.5)
Twin	34 (3.4)
Triplet	1 (0.1)
Mode of delivery *n* (%)	
Vaginal	647 (64.7)
Assisted vaginal	48 (4.8)
Cesarean	340 (34.0)
SARS-CoV-2 antibody positive[a]	58 (5.8)
SARS-CoV-2 RT-PCR positive prior to admission[b]	13 (1.3)
SARS-CoV-2 RT-PCR positive on admission[c]	10 (1.0)
Evidence of past/current SARS-CoV-2 infection	61 (6.1)
Asymptomatic	31 (50.8)
Mild symptoms	12 (19.7)
Moderate-to-severe symptoms	17 (27.9)

Abbreviations: BMI, body mass index; IQR, interquartile range; RT-PCR, reverse-transcription polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome-coronavirus-2.
[a]Antibody positive defined as a positive result on at least 2 of 3 assays including DiaSorin, Roche, or EUROIMMUN.
[b]All patients RT-PCR prior to admission were also antibody positive.
[c]Seven of ten patients RT-PCR positive on admission were also antibody positive.

identified as White, yet a majority of COVID-19-positive patients were Black or Hispanic/Latino (59.0%). Also, 52.5% of COVID-19-positive patients had public insurance and 8.2% had no insurance, while only 39.3% had private insurance ($p = 0.0243$), indicating significantly different rates of COVID-19 infection between insurance groups. Patients who had both private and public insurance were classified with the public insurance group. Nearly all (99.8%) of delivering mothers had access to at least some prenatal care. Any outpatient clinic visits prior to delivery admission were counted as prenatal care, including visits at the local free antenatal clinic for uninsured patients. No other antepartum clinical factors were found to be associated with SARS-CoV-2 infection, including body mass index (BMI), diabetes, hypertensive disease, asthma, or HIV.

Maternal outcomes according to SARS-CoV-2 infection status are listed in ►Table 3. No significant associations were seen between having past or current SARS-CoV-2 infection and maternal adverse outcomes. COVID-19-positive patients did not have a significantly increased length of stay. In the study population, 23% of COVID-19-positive patients experienced postpartum hemorrhage versus 16.3% of COVID-19-negative patients ($p = 0.213$). Postpartum hemorrhage is defined as blood loss of greater than 1 L.

Neonatal outcomes according to maternal SARS-CoV-2 infection status are listed in ►Table 4. There were also no significant associations between mothers' SARS-CoV-2 infection status and any of the studied neonatal outcomes. Of the 65 neonates born to mothers with evidence SARS-CoV-2 infection, 17 underwent SARS-CoV-2 RT-PCR testing. The neonatal testing was performed either because the mother had a symptomatic SARS-CoV-2 infection or as part of routine asymptomatic testing in the neonatal ICU (NICU). All neonates tested were negative, but 48 neonates were not tested during their newborn hospital stay. Overall, there was no evidence of neonatal SARS-CoV-2 infection. Neonates with four or more separate malformations or with chromosomal abnormalities were categorized as having a genetic/syndromic malformation. Of the 65 babies born to COVID-19 positive mothers, 10 (15.4%) had malformations, compared to 117 (12.1%) of 971 babies born to COVID-19 negative mothers ($p = 0.413$). Three of 65 (4.6%) babies born to COVID-19-positive mothers and 12 of 971 (1.2%) of babies born to COVID-19-negative mothers were not born alive. In the COVID-19-positive population, these were due to intrauterine fetal demise (IUFD) at 22 weeks, IUFD at 26 weeks, and labor induction at 21 weeks due to multiple fetal anomalies. In the COVID-19-negative population, these situations included termination of pregnancy by dilation and evacuation or induction of labor for cases that included IUFD or fetal anencephaly. There were 10 total neonatal deaths within 28 days of life (1.0%), and all these infants were born to mothers who were COVID-19 negative.

Discussion

Principal Findings

At our Midwest tertiary care hospital from May 1 to September 22, 2020, 6.1% of delivering patients had evidence of past or current SARS-CoV-2 infection. The seroprevalence of SARS-CoV-2 antibodies in the population was 5.8%. Overall, 50.8% of COVID+ patients in our study were completely asymptomatic. We did not find a higher rate of SARS-CoV-2 infection or worse outcomes among patients with higher BMI or with asthma. The number of SARS-CoV-2 infections in pregnant women at UIHC was disproportionately greater among racial and ethnic minorities as represented by self-identified primary language and race/ethnicity, as well as among patients without private insurance. There were no significant associations found between SARS-CoV-2 infection during pregnancy and adverse maternal or neonatal outcomes.

Comment

We found a SARS-CoV-2 seroprevalence of 5.8%, which is lower than studies of more urban areas. A seroprevalence of 16.1% was identified in a recent study of New York women admitted to Labor and Delivery using the Roche assay.[16] Another study of seroprevalence in three universities in Barcelona, Spain, from April 14 to May 5, 2020, found a seroprevalence of 14% using assays different from our study.[17] As of September 22, the Iowa Department of Public Health reported a seroprevalence of 6% for the state of Iowa.[18] Over 50% of COVID-19-positive patients in our study population had asymptomatic infections. A high asymptomatic infection rate has also been noted in other pregnant populations where RT-PCR viral testing of asymptomatic individuals was performed. A description of universal SARS-CoV-2 testing in an obstetric population in New York showed that 13% of women were positive for the virus by RT-PCR but had no symptoms. Only 1.9% of the patients screened positive and had symptoms.[18] Similar findings were reported in a Chicago hospital in April, where 3.6% of 635 women admitted for delivery were viral positive but 43% of these women were asymptomatic.[19]

Notably, the average BMI at delivery for our entire population was obese, with a median BMI of 31.7 kg/m^2. The lack of findings in our study for patients with obesity and asthma contrasts with prior studies from other institutions, but likely reflects the low disease severity overall in the population. The cesarean delivery rate at UIHC (34.0%) for the study period is slightly above the 2018 national average of 31.9%,[20] likely reflecting our referral base of high-risk patients and the large number of patients with high BMI. The obesity of the general population in Iowa is approximately 35%.[21] For reference, BMI changes due to pregnancy weight gain vary significantly but increases 0.5 to 10 points on average.[22]

While only 8.5% of our study patients were non-English speaking, this group accounts for 52.5% of COVID-19-positive cases. Also, 59.0% of COVID-19-positive cases were in patients identified as Black or Hispanic/Latino ethnicity, although they only made up 20.5% of the total study population. These results support previous studies that suggest patients facing language barriers and/or members of racial and ethnic minorities are at higher risk of SARS-CoV-2 infection in the United States. A study analyzing confirmed COVID-19 cases at a Louisiana medical center from May 2020

Table 2 Study population characteristics by SARS-CoV-2 infection status

Demographic/clinical characteristic	Population $n = 1{,}000$	COVID-19+ $n = 61$	COVID-19– $n = 939$	*p*-Value[a]
Maternal age (y) Median (IQR)	30, 26–33	28, 24–32	30, 26–33	0.028
BMI (kg/m^2) Median (IQR)	31.7 (27.7–37.5)	31.7 (27.7–37.5)	32.0 (27.5–37.7)	0.933
Gestational age at admission (wk) Median (IQR)	$39^{0/7}$ ($37^{2/7}$–$39^{5/7}$)	$38^{6/7}$ ($37^{0/7}$–$39^{4/7}$)	$39^{0/7}$ ($37^{3/7}$–$39^{5/7}$)	0.231
Gestational age at delivery (wk) Median (IQR)	$39^{0/7}$ ($37^{3/7}$–$39^{5/7}$)	$39^{0/7}$ ($37^{1/7}$–$39^{4/7}$)	$39^{0/7}$ ($37^{3/7}$–$39^{5/7}$)	0.272
Diabetes (T1DM, T2DM, gestational) *n* (%)	172 (17.2)	8 (13.7)	147 (15.6)	0.709
Antepartum/intrapartum hypertension				
Chronic	89 (8.9)	4 (6.6)	85 (9.1)	0.646
Gestational	98 (9.8)	4 (6.6)	94 (10)	0.506
Preeclampsia without severe features	38 (3.8)	3 (4.9)	35 (3.7)	0.500
Preeclampsia with severe features	55 (5.5)	6 (9.8)	49 (5.2)	0.140
Eclampsia	1 (0.1)	0	1 (0.11)	>0.999
Asthma *n* (%)	133 (13.3)	4 (6.6)	129 (13.7)	0.122
HIV *n* (%)	2 (0.2)	0	2 (0.2)	>0.999
Language *n* (%)				
English	915 (91.5)	32 (52.5)	883 (94.0)	<0.001
Spanish	30 (3.0)	7 (11.5)	23 (2.5)	
French	17 (1.7)	11 (18.0)	6 (0.6)	
Portuguese	1 (0.1)	0	1 (0.11)	
Mandarin	2 (0.2)	0	2 (0.21)	
Lingala	2 (0.2)	1 (1.6)	1 (0.1)	
Arabic	12 (1.2)	1 (1.6)	11 (1.2)	
Haka Chin	2 (0.2)	2 (3.3)	0	
Other	19 (1.9)	7 (11.5)	12 (1.2)	
Race/ethnicity *n* (%)				
White	716 (71.6)	17 (27.9)	699 (74.4)	<0.001
African American/Black	118 (11.8)	25 (41.0)	93 (9.9)	
Hispanic/Latino	87 (8.7)	11 (18.0)	76 (8.1)	
American Indian/Alaska Native	3 (0.3)	1 (1.6)	2 (0.2)	
Native Hawaiian/Pacific Islander	4 (0.4)	2 (3.3)	2 (0.2)	
Asian	45 (4.5)	4 (6.6)	41 (4.4)	
Multiracial/two or more races	19 (1.9)	0	19 (2.0)	
Declined to answer	8 (0.8)	1 (1.6)	7 (0.8)	
Insurance type *n* (%)				
Private only	513 (51.3)	24 (39.3)	489 (52.1)	0.0243
Medicare/Medicaid	456 (45.6)	32 (52.5)	424 (45.2)	
None	31 (3.1)	5 (8.2)	26 (2.8)	
Any prenatal care *n* (%)	998 (99.8)	61 (100)	937 (99.8)	>0.999

Abbreviations: BMI, body mass index, COVID-19, novel coronavirus disease 2019; HIV, human immunodeficiency virus; IQR, interquartile range; SARS-CoV-2, severe acute respiratory syndrome-coronavirus-2; T1DM, type 1 diabetes mellitus, T2DM, type 2 diabetes mellitus.
[a]Wilcoxon's rank sum and Fisher's exact tests used to determine *p*-values.

Table 3 Maternal outcomes and SARS-CoV-2 infection status

Maternal Outcome	Population $n = 1{,}000$ (%)	COVID-19+ $n = 61$ (%)	COVID-19– $n = 939$ (%)	*p*-Value
Premature rupture of membranes	90 (9.0)	6 (9.8)	84 (8.9)	0.816
Preterm labor	77 (7.7)	3 (4.9)	74 (7.9)	0.618
Antenatal hypertensive disease	242 (24.2)	14 (23.0)	228 (24.3)	0.879
Placental abruption	21 (2.1)	1 (1.6)	20 (2.1)	>0.999
Chorioamnionitis	32 (5.2)	2 (6.3)	30 (5.2)	0.680
Nonreassuring fetal status during labor	71 (11.6)	5 (15.6)	66 (11.4)	0.403
Morbidly adherent placenta	1 (0.2)	0	1 (0.2)	> 0.999
Unscheduled cesarean	206 (20.6)	15 (24.6)	191 (20.3)	0.416
Pyelonephritis	6 (0.6)	1 (1.6)	5 (0.5)	0.315
Postpartum hemorrhage	167 (16.7)	14 (23)	153 (16.3)	0.213
Postpartum hypertensive disease during the delivery admission	204 (20.4)	14 (23)	190 (20.2)	0.623
Postpartum endometritis during the delivery admission	9 (0.9)	2 (3.3)	7 (0.7)	0.100
Postpartum preeclampsia	85 (8.5)	8 (13.1)	77 (8.2)	0.230
Intensive care unit admission	6 (0.6)	2 (3.3)	4 (0.4)	0.047
Prolonged postpartum stay	30 (3.0)	4 (6.6)	26 (2.8)	0.104

Abbreviations: COVID-19, novel coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome-coronavirus-2.

Table 4 Neonatal outcomes and maternal SARS-CoV-2 Infection Status

Neonatal Outcome	Population $n = 1{,}036$ (%)	Maternal COVID-19+ $n = 65$ (%)	Maternal COVID-19– $n = 971$ (%)	*p*-Value
Sepsis	39 (3.8)	2 (3.1)	37 (3.8)	>0.999
Hypoglycemia	264 (25.5)	13 (20)	251 (25.9)	0.377
Malformations	127 (12.3)	10 (15.4)	117 (12.1)	0.434
Cardiac	52 (5)	3 (4.6)	49 (5.1)	> 0.999
Genitourinary	28 (2.7)	3 (4.6)	25 (2.6)	0.413
Neuro/brain	9 (0.9)	1 (1.5)	8 (0.8)	0.443
Head and neck	8 (0.8)	0	8 (0.8)	>0.999
Gastrointestinal	5 (0.5)	1 (1.5)	4 (0.4)	0.277
Musculoskeletal	20 (1.9)	0	20 (2.1)	0.631
Genetic/syndromic	24 (2.3)	4 (6.2)	20 (2.1)	0.058
Absence of live birth	15 (1.4)	3 (4.6)	12 (1.2)	0.062
Neonatal death	10 (1)	0	10 (1)	>0.999

Abbreviations: COVID-19, novel coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome-coronavirus-2.

found that 76.9% of patients hospitalized for COVID-19 and 70.6% of those who died from COVID-19 were Black, although Black patients only accounted for 30.9% of their patient population.[23] In July 2020, a meta-analysis by Khalil et al reported that 50.8% of all pregnant COVID-19 infected patients were Black, Asian, or of another ethnic minority group.[24]

There were no significant associations found between SARS-CoV-2 infection during pregnancy and adverse maternal or neonatal outcomes. This finding differs from other published studies showing possible associations between SARS-CoV-2 infection and preterm delivery, stillbirth, unplanned cesarean delivery, and/or preeclampsia.[6,25–27] This difference is likely multifactorial. While 61 patients in our study population were infected with SARS-CoV-2 during their pregnancy, only two of these patients experienced severe disease requiring ICU admission. Only 27.9% experienced moderate-to-severe symptoms. A report of 241 births to women at five New York Medical centers during the initial surge of the pandemic showed increased rates for preterm birth and cesarean delivery but mostly among critically ill women.[27] As the majority of our COVID-19-positive patients were not critically ill, their chance of having complications was likely lower.

Our seroprevalence rate is lower than pregnant populations in New York and Barcelona, likely reflecting an overall lower infection rate in a more rural population that is less likely to be exposed to and infected with the virus. However, our seroprevalence closely reflects that of the general

population of Iowa at the time of this study. These rates are likely similar given that our institution serves a catchment area of nearly the entire state.

We did not collect specific information about why racial and ethnic minority groups may have been at higher risk of SARS-CoV-2 infection. However, many patients in the non-English language and ethnic minority groups reported working in or living with family members who worked in high-risk occupations, such as meat processing plants, which had well-publicized outbreaks in our community during the study period.[28] Patients in these ethnic and language groups are also more likely to work in jobs that are less likely to be possible to do from home.[29]

While not statistically significant, there was a notably higher percentage of COVID-19-positive than COVID-19-negative women with postpartum hemorrhage in the study (23.0 and 16.3%, respectively). One other study by Liao et al found no significant difference in postpartum hemorrhage rates between SARS-CoV-2-positive and -negative mothers but their study population included only vaginal deliveries.[30] This relationship warrants further study in a larger cohort of patients. Additionally, we found that COVID-19-positive patients were not statistically more likely to have a stillborn infant than COVID-19-negative mothers. There were only three stillborn infants born to COVID-19-positive patients in total: two due to IUFD and one who underwent termination of pregnancy due to significant fetal anomalies. Given that other studies have found increased rates of stillbirth in COVID-19-positive patients, this finding warrants additional study.

Strengths and Limitations

A strength of this study was that the 1,000 births recorded and analyzed were consecutive and represent all deliveries during the study period; no patients were excluded from the study analysis. SARS-CoV-2 RT-PCR results were electronically available for 98% (980) of study patients; the 20 patients without results either refused testing or delivered too quickly on admission to receive testing. These results allowed for comparison between SARS-CoV-2 viral and antibody testing.

A limitation of this study was the small nature of our total delivery cohort as compared with larger centers. Some results may have reached significance with a larger cohort. Additionally, there is evidence that access to SARS-CoV-2 RT-PCR testing was limited in our community early in the pandemic. Two of the patients who were SARS-CoV-2 viral negative and antibody positive reported COVID-19-like symptoms in March or April 2020 but did not have access to viral testing until admission for delivery.

Conclusion

This study adds to the limited body of literature on COVID-19 in pregnancy. In our largely White, rural, Midwestern population, SARS-CoV-2 infection was significantly higher in racial and ethnic minorities and immigrant populations, as well as patients without private insurance, suggesting a need for interventions to improve health equity in these groups. Our low disease severity and lack of maternal and infant outcomes related to SARS-CoV-2 infection are encouraging but warrant further observation in the ongoing pandemic.

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Conflict of Interest

None declared.

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