Characteristics and Outcomes of Women With COVID-19 Giving Birth at US Academic Centers During the COVID-19 Pandemic

Justine Chinn, BS; Shaina Sedighim, MD; Katharine A. Kirby, MS; Samuel Hohmann, PhD; Afshan B. Hameed, MD; Jennifer Jolley, MD; Ninh T. Nguyen, MD

Abstract

IMPORTANCE Prior studies on COVID-19 and pregnancy have reported higher rates of cesarean delivery and preterm birth and increased morbidity and mortality. Additional data encompassing a longer time period are needed.

OBJECTIVE To examine characteristics and outcomes of a large US cohort of women who underwent childbirth with vs without COVID-19.

DESIGN, SETTING, AND PARTICIPANTS This cohort study compared characteristics and outcomes of women (age ≥18 years) who underwent childbirth with vs without COVID-19 between March 1, 2020, and February 28, 2021, at 499 US academic medical centers or community affiliates. Follow-up was limited to in-hospital course and discharge destination. Childbirth was defined by clinical classification software procedural codes of 134-137. A diagnosis of COVID-19 was identified using International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) diagnosis of U07.1. Data were analyzed from April 1 to April 30, 2021.

EXPOSURES The presence of a COVID-19 diagnosis using ICD-10.

MAIN OUTCOMES AND MEASURES Analyses compared demographic characteristics, gestational age, and comorbidities. The primary outcome was in-hospital mortality. Secondary outcomes included hospital length of stay, intensive care unit (ICU) admission, mechanical ventilation, and discharge status. Continuous variables were analyzed using t test, and categorical variables were analyzed using χ².

RESULTS Among 869,079 women, 18,715 (2.2%) had COVID-19, and 850,364 (97.8%) did not. Most women were aged 18 to 30 years (11,550 women with COVID-19 [61.7%]; 447,534 women without COVID-19 [52.6%]) and were White (806,0 White women [43.1%] in the COVID-19 cohort; 499,501 White women [58.7%] in the non–COVID-19 cohort). There was no significant increase in cesarean delivery among women with COVID-19 (6088 women [32.5%] vs 273,810 women [32.3%]; P = .57). Women with COVID-19 were more likely to have preterm birth (3072 women [16.4%] vs 97,967 women [11.5%]; P < .001). Women giving birth with COVID-19, compared with women without COVID-19, had significantly higher rates of ICU admission (977 women [5.2%] vs 7943 women [0.9%]; odds ratio [OR], 5.84 [95% CI, 5.46-6.25]; P < .001), respiratory intubation and mechanical ventilation (275 women [1.5%] vs 884 women [0.1%]; OR, 14.33 [95% CI, 12.50-16.42]; P < .001), and in-hospital mortality (24 women [0.1%] vs 71 [≤0.01%]; OR, 15.38 [95% CI, 9.68-24.43]; P < .001).

CONCLUSIONS AND RELEVANCE This retrospective cohort study found that women with COVID-19 giving birth had higher rates of mortality, intubation, ICU admission, and preterm birth than women without COVID-19.
Introduction

Although there has been extensive research on COVID-19 since its initial emergence, the broad range of perinatal COVID-19 outcomes continues to emerge. A study by Jering and colleagues reported the largest US cohort, to date, including 6380 women with COVID-19 giving birth, and found that the absolute death rates in women with COVID-19 were considerably higher than in women without COVID-19. They also found higher rates of preterm birth, preeclampsia, and thrombotic events. Prior studies on the effects of COVID-19 on pregnancy have reported higher rates of cesarean delivery, preterm birth, and maternal morbidity and mortality index scores. As the COVID-19 pandemic has progressed, mortality and outcomes in the general population have improved. The aim of this study was to examine the characteristics and outcomes of a large US cohort of women who underwent childbirth with vs without COVID-19 during the first year of the pandemic, examining a larger single data set cohort of women with COVID-19 over a longer period than prior studies, to our knowledge.

Methods

This cohort study was determined exempt from review and informed consent by the Institutional Review Board of the University of California, Irvine, owing to lack of patient-identifying information. Approval for the use of the data was obtained from Vizient. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Using the Vizient Clinical Data Base/Resource Manager (CDB/RM), we compared characteristics and outcomes of women (age ≥18 years) who underwent childbirth with vs without COVID-19 between March 1, 2020, and February 28, 2021. The CDB/RM is an administrative, clinical, and financial database of more than 650 academic centers and their community affiliates. Data represent clinical information submitted by 97% of academic medical centers across the US, representing a broad range of patients across geographic zones. Childbirth was identified based on clinical classification software procedural codes of 134 for cesarean delivery; 135 for forceps, vacuum, or breech delivery; 136 for artificial rupture of membrane to assist delivery; and 137 for other procedures to assist delivery. A diagnosis of COVID-19 was identified using International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) diagnosis of U07.1. Women who received a diagnosis of COVID-19 during the same admission in which they underwent childbirth were included. Demographic characteristics, gestational age, and comorbidities were compared between groups. Race and ethnicity were self-reported; these data were examined because research has found that individuals from racial and ethnic minority groups are disproportionately affected by COVID-19 compared with White individuals. The primary outcome was in-hospital mortality. Discharge disposition and in-hospital death were reported in all patients. Secondary outcomes included hospital length of stay (LOS), rates of intensive care unit (ICU) admission and mechanical ventilation, and discharge status.

Statistical Analysis

Comparisons were performed using t test for continuous variables and χ² analysis for categorical variables. Odds ratios (ORs) were calculated to determine the odds of mortality associated with COVID-19 for each gestational age group. Analyses were performed using Stata statistical software version 16 (StataCorp). P values were 2-tailed, and significance was set at P < .05. Data were analyzed from April 1 to April 30, 2021.

Results

Among 869 079 women who gave birth at 499 US medical centers, 18 715 women (2.2%) had COVID-19 and 850 364 women (97.8%) did not. Most women in both cohorts were aged 18 to 30 years (11 550 women with COVID-19 [61.7%]; 447 534 women without COVID-19 [52.6%]), and 8060
women (43.1%) were White in the COVID-19 cohort, compared with 499,501 women (58.7%) who were White in the non–COVID-19 cohort (Table 1). Women with COVID-19, compared with women giving birth without COVID-19, were more likely to be Hispanic (81,322 women [43.5%] vs 189,725 women [22.3%]) and/or Black (379,272 women [20.3%] vs 153,783 women [18.1%]). The most common comorbidities for women giving birth with COVID-19 included obesity (39,560 women [21.1%]), anemia (231,012 women [12.3%]), and chronic pulmonary disease (14,373 women [7.7%]). There was no significant difference in the number of cesarean deliveries performed (60,888 women with COVID-19 [32.5%] vs 273,810 women without COVID-19 [32.2%]; P = .57). The median (range) LOS was 2 (1–211) days for women with COVID-19 and 2 (1–370) days for women without COVID-19 (P < .001).

Women giving birth with COVID-19, compared with those without COVID-19, had significantly higher rates of ICU admission (9,771 women [5.2%] vs 79,432 women [0.9%]; OR, 5.84 [95% CI, 5.46–6.25]; P < .001), respiratory intubation and mechanical ventilation (275 women [1.5%] vs 884 women [0.1%]; OR, 14.33 [95% CI, 12.50–16.42]; P < .001), and in-hospital mortality (24 women [0.1%] vs 71 women [<0.01%]; OR, 15.38 [95% CI, 9.68–24.43]; P < .001) (Table 2).

Additionally, women with COVID-19, compared with women without COVID-19, were more likely to have a preterm delivery of less than 37 weeks (30,722 women [16.4%] vs 97,967 women [11.5%]; P < .001). A total of 779 women with COVID-19 (4.2%) delivered at less than 32 weeks, compared with 22,355 women without COVID-19 (2.6%) (Table 3).

**Discussion**

To our knowledge, this cohort study is the largest single-database study of women giving birth with COVID-19, and we found that women with COVID had an overall peripartum death rate of 0.1%. The death rates and need for ICU admission and respiratory failure requiring intubation were significantly

### Table 1. Demographic and Clinical Characteristics of Hospitalized Women Undergoing Childbirth With and Without COVID-19

| Characteristic                        | Women, No. (%) | Without COVID-19 (n = 850,364) | P value |
|---------------------------------------|----------------|--------------------------------|---------|
|                                       | With COVID-19 (n = 18,715) |                               |         |
| Age, y                                |                |                                |         |
| 18-30                                 | 11,550 (61.7)  | 447,534 (52.6)                 | <.001   |
| 31-50                                 | 7,165 (38.3)   | 403,657 (47.5)                 |         |
| >50                                   | NA*            | 173 (0.2)                      |         |
| Race                                  |                |                                | <.001   |
| White                                 | 8,060 (43.1)   | 499,501 (58.7)                 |         |
| Black                                 | 3,792 (20.3)   | 153,783 (18.1)                 |         |
| Asian                                 | 659 (3.5)      | 49,618 (5.8)                   |         |
| Unavailable                           | 6,208 (31.2)   | 147,445 (17.4)                 |         |
| Ethnicity                             |                |                                | <.001   |
| Hispanic origin                       | 8,132 (43.5)   | 189,725 (22.3)                 |         |
| Preexisting comorbidities             |                |                                |         |
| Obesity                               | 3,956 (21.1)   | 141,486 (16.7)                 | <.001   |
| Anemia                                | 2,310 (12.3)   | 86,890 (10.3)                  | <.001   |
| Chronic pulmonary disease             | 1,437 (7.7)    | 69,394 (8.2)                   | <.001   |
| Drug abuse                            | 469 (2.5)      | 25,388 (2.9)                   | <.001   |
| Hypertension                          | 750 (4.0)      | 28,068 (3.3)                   | <.001   |
| Diabetes                              | 426 (2.3)      | 13,737 (1.6)                   | <.001   |
| Coagulation deficiency                | 949 (5.1)      | 28,702 (3.4)                   | <.001   |
| Depression                            | 972 (5.2)      | 56,430 (6.6)                   | <.001   |
| Delivery                              |                |                                |         |
| Cesarean                              | 6,088 (32.5)   | 273,810 (32.2)                 | .57     |
| Vaginal                               | 12,627 (67.5)  | 576,554 (67.8)                 |         |

*Owing to privacy concerns, groups with fewer than 10 patients are suppressed.
higher among COVID-19 women. Our findings are similar to those by Jering et al., who reported a 0.14% (9 of 6380 women) death rate for women giving birth with COVID-19 vs 0.005% (20 of 400666 women) among women without COVID-19. These data also align with the international living meta-analysis by Allotey et al., which found increased admission to ICU and increased need for invasive ventilation for pregnant and recently pregnant women with COVID-19 compared with a cohort of nonpregnant women of reproductive age.

Our study also found that women who had COVID-19 were more likely to be Black or Hispanic compared with women without COVID-19. This information is critically important given the ongoing issues surrounding health care disparities and race. When considering mortality during childbirth, it is important to understand that racial disparities have been well established preceding the COVID-19 pandemic; however, they have likely been augmented by the pandemic. In fact, previous data from the Centers for Disease Control and Prevention have demonstrated that Black and American Indian or Alaskan Native mothers in the US are 2- to 3-fold more likely to die from pregnancy-related causes. Of note, pregnancy-related mortality rate in the US has been increasing over the last 10 years and is now approximately 0.017%. The mortality rate is approximately 0.044% for Black mothers. While the reasons behind this difference are complex, much research has supported the role of health disparities, social and structural determinants of health, discrimination, health care access and quality, and disproportionate burden of underlying comorbidities. Each of these factors has been heightened during the COVID-19 pandemic, and therefore further study on the association of COVID-19 with outcomes among mothers from these communities is necessary.

Table 2. Clinical Outcomes of Hospitalized Women Undergoing Childbirth With and Without COVID-19

|                      | With COVID-19 (n = 18,715) | Without COVID-19 (n = 850,364) | Odds ratio (95% CI) | P value |
|----------------------|---------------------------|-------------------------------|---------------------|---------|
| In-hospital mortality| 24 (0.1)                  | 71 (<0.01)                    | 15.38 (9.68-24.43)  | <.001   |
| Median length of hospital stay, median (range), d | 2 (1-211) | 2 (1-370) | NA | <.001 |
| ICU admission        | 977 (5.2)                 | 7943 (0.9)                    | 5.84 (5.46-6.25)    | <.001   |
| Respiratory failure and mechanical ventilation | 275 (1.5) | 884 (0.1) | 14.33 (12.50-16.42) | <.001 |
| Discharge status     |                           |                               |                     |         |
| Home                 | 18,477 (98.7)             | 845,240 (99.4)                | 0.47 (0.41-0.54)    | <.001   |
| Skilled nursing facility or other inpatient care | 104 (0.6) | 1752 (0.2) | 2.71 (2.22-3.30) | <.001 |
| Left against medical advice | 102 (0.6) | 1930 (0.2) | 2.41 (1.97-2.94) | <.001 |
| Died                 | 24 (0.1)                  | 71 (<0.01)                    | 15.38 (9.68-24.43)  | <.001   |

Abbreviations: ICU, intensive care unit; NA, not available.

Table 3. Gestational Age and Associated Mortality of Hospitalized Women Undergoing Childbirth With and Without COVID-19

| Gestational age                  | Women, No. (%) | Odds ratio (95% CI) | P value |
|----------------------------------|----------------|---------------------|---------|
| <28 wk (extremely preterm)      | 380 (2.0)      | 9.22 (3.70-23.01)   | <.001   |
| Mortality                        | NA             | NA                  | NA      |
| 28-31 wk (very preterm)         | 399 (2.1)      | 12.64 (3.79-42.24)  | <.001   |
| Mortality                        | NA             | NA                  | NA      |
| 32-36 wk (moderate to late preterm) | 2293 (12.3) | 22.83 (9.74-53.49)  | <.001   |
| Mortality                        | NA             | NA                  | NA      |
| ≥37 wk                           | 15,523 (82.9)  | 0.44 (3.97-27.47)   | <.001   |
| Mortality                        | NA             | NA                  | NA      |
| Unknown                          | 120 (0.64)     | NA                  | NA      |

Abbreviation: NA, not applicable.

* Owing to privacy concerns, groups with fewer than 10 patients are suppressed.

b Odds ratio for mortality in unknown group could not be estimated owing to zero count.
Our subset analysis based on gestational age found that women with COVID-19 were more likely to deliver at less than 37 weeks than women who did not have COVID-19. Our findings were consistent with a study by Villar et al. that found higher rates of preterm birth in a multinational cohort study, as well as with Jering and colleagues, who reported that COVID-19 was associated with higher odds of preterm birth. This is in contrast to a study by Adhikari and colleagues that reported no difference in preterm birth between women with COVID-19 vs those without. Our findings suggest that additional research is warranted to understand the physiological mechanism of COVID-19 in preterm birth.

**Limitations**

There are several limitations to this study, including those inherent to retrospective administrative database studies, including missing data, misclassification, and potential coding inaccuracy. The CDB/RM database is limited to in-hospital mortality and does not contain follow-up data; thus, reported mortality likely underestimates the true mortality. Other limitations include the inability to distinguish patients with COVID-19 who were symptomatic and who were admitted for management of their symptoms versus patients who were asymptomatic and had test results positive for SARS-CoV-2 infection when they were admitted for their birth.

**Conclusions**

This cohort study found that women with COVID-19 who were giving birth had a statistically significantly higher mortality rate of 0.13% compared with women without COVID-19. The need for ICU admission and respiratory failure requiring intubation were statistically significantly higher among women with COVID-19. Future research is needed to further understand the pathophysiology of COVID-19 during pregnancy and to better characterize the long-term sequelae.

**ARTICLE INFORMATION**

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Corresponding Author: Ninh T. Nguyen, MD, University of California, Irvine Medical Center, 333 City Bldg W, Ste 1600, Orange, CA 92868 (ninhn@hs.uci.edu).

Author Affiliations: University of California, Irvine Medical Center, Orange (Chinn, Sedighim, Kirby, Hameed, Jolley, Nguyen); Vizient, Centers for Advanced Analytics, Chicago, Illinois (Hohmann).

Author Contributions: Dr Nguyen had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Chinn, Sedighim, Nguyen.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Chinn, Sedighim, Nguyen.

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Statistical analysis: Sedighim, Kirby.

Administrative, technical, or material support: Chinn, Nguyen.

Supervision: Sedighim, Hameed, Jolley, Nguyen.

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**REFERENCES**

1. Mullins E, Evans D, Viner RM, O’Brien P, Morris E. Coronavirus in pregnancy and delivery: rapid review. Ultrasound Obstet Gynecol. 2020;55(5):586-592. doi:10.1002/uog.22014
2. Jering KS, Claggett BL, Cunningham JW, et al. Clinical characteristics and outcomes of hospitalized women giving birth with and without COVID-19. JAMA Intern Med. 2021;181(5):714-717. doi:10.1001/jamainternmed.2020.9241

3. Elshafeey F, Magdi R, Hindi N, et al. A systematic scoping review of COVID-19 during pregnancy and childbirth. Int J Gynaecol Obstet. 2020;150(1):47-52. doi:10.1002/ijgo.13182

4. Di Mascio D, Khalil A, Saccone G, et al. Outcome of coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. Am J Obstet Gynecol MFM. 2020;2(2):100107. doi:10.1016/j.ajogmf.2020.100107

5. Villar J, Ariff S, Gunier RB, et al. Maternal and neonatal morbidity and mortality among pregnant women with and without COVID-19 infection: the INTERCOVID multinational cohort study. JAMA Pediatr. 2021. doi:10.1001/jamapediatrics.2021.1050

6. Allotey J, Stallings E, Bonet M, et al; for PregCOV-19 Living Systematic Review Consortium. Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: living systematic review and meta-analysis. BMJ. 2020;370:m3320. doi:10.1136/bmj.m3320

7. World Health Organization. International Statistical Classification of Diseases, Tenth Revision (ICD-10). World Health Organization; 1992.

8. Nguyen NT, Chinn J, Nahmias J, et al. Outcomes and mortality among adults hospitalized with COVID-19 at US Medical Centers. JAMA Netw Open. 2021;4(3):e210417. doi:10.1001/jamanetworkopen.2021.0417

9. Janevic T, Glazer KB, Vieira L, et al. Racial/ethnic disparities in very preterm birth and preterm birth before and during the COVID-19 pandemic. JAMA Netw Open. 2021;4(3):e211816. doi:10.1001/jamanetworkopen.2021.1816

10. Kuehn B. Disparities in maternal mortality. JAMA. 2019;322(16):1545. doi:10.1001/jama.2019.16156

11. Webb Hooper M, Nápoles AM, Pérez-Stable EJ. COVID-19 and racial/ethnic disparities. JAMA. 2020;323(24):2466-2467. doi:10.1001/jama.2020.8598

12. Adhikari EH, Moreno W, Zofkie AC, et al. Pregnancy outcomes among women with and without severe acute respiratory syndrome coronavirus 2 infection. JAMA Netw Open. 2020;3(11):e2029256. doi:10.1001/jamanetworkopen.2020.29256