HHS Public Access

Author manuscript

Pediatrics. Author manuscript; available in PMC 2023 December 01.

Published in final edited form as:

Pediatrics. 2022 December 01; 150(6): . doi:10.1542/peds.2022-059009.

Six-Month Outcomes of Infants Born to People With SARS-CoV-2 in Pregnancy

Lucas Gosdin, PhD, MPH[a,b], **Bailey Wallace, MPH**[a], **Tatiana M. Lanzieri, MD, MPH**[a], **Emily O'Malley Olsen, PhD**[a], **Elizabeth L. Lewis, MPH**[a], **Daniel J. Chang, MSPH, MHS**[a,c], **Salma Khuwaja, MD, MPH, DrPH**[d], **Sarah Chicchelly, MPH**[e], **Kristen D. Ojo, MHS, CPH**[f], **Mamie Lush, MA**[g], **Daniel Heitner, MPH**[h], **Nicole D. Longcore, MPH**[i], **Camille Delgado-López, MPH**[j], **Brian K. Humphries, MS**[k], **Lindsey Sizemore, MPH**[l], **Deborah Mbotha, PhD**[m], **Aron J. Hall, DVM, MSPH**[a], **Sascha Ellington, PhD, MSPH**[a], **Suzanne M. Gilboa, PhD**[a], **Van T. Tong, MPH**[a], **Kate Woodworth, MD, MPH**[a]

[a]COVID-19 Emergency Response, Centers for Disease Control and Prevention, Atlanta, Georgia;

[b]Epidemic Intelligence Service, Centers for Disease Control and Prevention, Atlanta, Georgia;

[c]Oak Ridge Institute for Science and Education, U.S. Department of Energy, Oak Ridge, Tennessee;

[d]Houston Health Department, Houston, Texas;

[e]Kansas Department of Health and Environment, Topeka, Kansas;

[f]Minnesota Department of Health, Saint Paul, Minnesota;

[g]Nebraska Department of Health and Human Services, Lincoln, Nebraska;

[h]New Jersey Department of Health, Trenton, New Jersey;

[i]New York State Department of Health, Albany, New York;

[j]Puerto Rico Department of Health, San Juan, Puerto Rico;

[k]South Carolina Department of Health and Environmental Control Columbia, South Carolina;

[l]Tennessee Department of Health, Nashville, Tennessee;

[m]Washington State Department of Health, Olympia, Washington

Abstract

Address correspondence to Lucas Gosdin, PhD, MPH, 4770 Buford Hwy, Atlanta, GA 30341. setnet@cdc.gov.

Dr Gosdin conceptualized the study, conducted analyses, interpreted data, drafted the initial manuscript, and revised the manuscript; Dr Woodworth conceptualized the study and interpreted data; Ms Wallace cleaned data, conducted analyses, and interpreted data; Mr Chang cleaned and interpreted data; Dr Lanzieri and Ms Lewis performed a review of clinical outcomes and interpreted data; Dr Olsen calculated sampling weights and interpreted data; Ms Tong and Drs Gilboa, Ellington, and Hall interpreted data; Dr Khuwaja, Ms Chicchelly, Ms Ojo, Ms Lush, Mr Heitner, Ms Longcore, Ms Delgado-Lopez, Mr Humphries, Ms Sizemore, and Dr Mbotha acquired and interpreted data; and all authors reviewed the manuscript, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

CONFLICT OF INTEREST DISCLOSURES: The authors have indicated they have no potential conflicts of interest relevant to this article to disclose.

OBJECTIVES: To assess the 6-month incidence of laboratory-confirmed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, postnatal care, hospitalization, and mortality among infants born to people with laboratory-confirmed SARS-CoV-2 infection during pregnancy by timing of maternal infection.

METHODS: Using a cohort of liveborn infants from pregnancies with SARS-CoV-2 infections in the year 2020 from 10 United States jurisdictions in the Surveillance for Emerging Threats to Mother and Babies Network, we describe weighted estimates of infant outcomes from birth through 6 months of age from electronic health and laboratory records.

RESULTS: Of 6601 exposed infants with laboratory information through 6 months of age, 1.0% (95% confidence interval: 0.8–1.1) tested positive, 19.1% (17.5–20.6) tested negative, and 80.0% (78.4–81.6) were not known to be tested for SARS-CoV-2. Among those ≤14 days of age, SARS-CoV-2 infection occurred only with maternal infection ≤14 days before delivery. Of 3967 infants with medical record abstraction, breastmilk feeding initiation was lower when maternal infection occurred ≤14 days before delivery compared with >14 days (77.6% [72.5–82.6] versus 88.3% [84.7–92.0]). Six-month all-cause hospitalization was 4.1% (2.0–6.2). All-cause mortality was higher among infants born to people with infection ≤14 days (1.0% [0.4–1.6]) than >14 days (0.3% [0.1–0.5]) before delivery.

CONCLUSIONS: Results are reassuring, with low incidences of most health outcomes examined. Incidence of infant SARS-CoV-2, breastmilk feeding initiation, and all-cause mortality differed by timing of maternal infection. Strategies to prevent infections and support pregnant people with coronavirus disease 2019 may improve infant outcomes.

Infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) during pregnancy is associated with increased preterm birth and stillbirth risk and may be associated with preeclampsia.[1–3] Confirmed intrauterine transmission of SARS-CoV-2 is rare.[4] Maternal infection proximal to delivery is reported to increase the rate of positive neonatal testing.[5,6] However, infant infections beyond the neonatal period have not been fully described, in part because of the lack of maternal–infant linked longitudinal data.

Maternal SARS-CoV-2 antibodies are transferred across the placenta after SARS-CoV-2 infection during pregnancy. Anti-SARS-CoV-2 neutralizing antibody levels are detectable ? 7 days after infection and increase thereafter. Although antibody transfer mechanisms are complex, generally with increasing intervals between onset of maternal infection and delivery, maternal antibody levels decrease while transfer ratios (cord blood relative to maternal antibody concentrations) increase.[7–9] Thus, the timing of maternal SARS-CoV-2 infection by gestational age and relative to delivery may influence the risk of infant infection, although evidence is lacking. The protection offered by antibodies alone, without cellular immunity, is unclear.[10]

Few studies have examined health outcomes among infants born to people with SARS-CoV-2 infections during pregnancy (SARS-CoV-2-exposed infants) and those published have been limited to small, nonrepresentative samples.[11,12] Despite public health and clinical organization recommendations to prioritize in-person evaluations of newborns,[13] infection prevention and control measures implemented during the coronavirus disease 2019 (COVID-19) pandemic may have influenced the clinical care of infants who either were

themselves positive for SARS-COV-2 or whose mothers were under isolation precautions after delivery, such as reduced in-person visits or lack of lactation support services. Maternal and infant SARS-CoV-2 infections may have also influenced the frequency and duration of breastmilk feeding. Because of waves of high SARS-CoV-2 transmission, the number of SARS-CoV-2-exposed infants may be substantial, requiring a better understanding of their clinical outcomes to inform public health guidance.

In this preliminary report, examining maternal infections in 2020, we describe the incidence of SARS-CoV-2 infection among infants through 6 months of age overall and by timing of maternal infection relative to delivery and gestational age. We describe other health outcomes, such as breastmilk feeding, all-cause hospitalization, and all-cause mortality, as well as in-person, newborn well-child visits among SARS-CoV-2-exposed infants overall and by timing of maternal infection relative to delivery.

METHODS

Data were obtained through the Surveillance for Emerging Threats to Mothers and Babies Network (SET-NET).[14] Participating state, territorial, and local health jurisdictions provided data on pregnant people with laboratory-confirmed (polymerase chain reaction [PCR] positive) SARS-CoV-2 infection and their infants. Maternal data during pregnancy and at delivery and infant information through 6 months of age were collected from existing sources (eg, electronic health records, vital statistics, laboratory reports, and health department investigations and case reporting). Jurisdictions searched laboratory databases for infant SARS-CoV-2 testing information from birth through 6 months. Data abstracted from the electronic health records of newborn (first visit after discharge, occurring before 1 month of age), 2 month, and 6 month well-child visits, included breastmilk feeding, type of well-child visit (in-person or telehealth), jaundice requiring phototherapy, hospitalization, and death. We categorized reasons for hospitalization from clinical notes and *International Classification of Diseases, 10th Revision* codes.

This analysis included live-born infants who met the following criteria: (1) born to people residing in SET-NET jurisdictions with a positive SARS-CoV-2 PCR test result from January 20 to December 31, 2020 in at least 1 clinical specimen at any point during pregnancy, up to and including the day of delivery; and (2) age 6 months before March 1, 2022 with at least 1 reported well-child visit between birth and age 9 months or had laboratory testing information ascertained from birth through 6 months. This activity was reviewed by the Centers for Disease Control and Prevention and was conducted consistent with applicable federal law and Centers for Disease Control and Prevention policy.

We analyzed data reported from 10 jurisdictions, including the city of Houston (TX), the territory of Puerto Rico, and the states of Kansas, Minnesota, Nebraska, New Jersey, New York (excluding New York City), South Carolina, Tennessee, and Washington. Because of the large number of cases among pregnant people and limited capacity to conduct medical record abstraction (MRA), 2 jurisdictions sampled cases for MRA at the end of pregnancy and provided data on all their liveborn infants, 1 jurisdiction provided data on all pregnancies and sampled cases for infant follow-up, 1 jurisdiction sampled for both

end of pregnancy and infant follow-up, whereas the other 6 jurisdictions provided data on all pregnancies and infants meeting inclusion criteria. Sampling weights accounting for selection probability and loss to follow-up were calculated for both end of pregnancy and infant follow-up time points, as appropriate in sampling jurisdictions.[15] Infant SARS-CoV-2 testing data through 6 months were available from 8 of 10 jurisdictions.

Exposures

We assessed the timing of maternal infection (first positive test result) in 2 ways. First, because of the potential effects of gestational age at infection and the interval between onset of infection and delivery on maternal antibody concentrations and transfer across the placenta, we categorized the timing of maternal infection into 3 timepoints: (1) <20 weeks' gestation and >14 days before delivery, (2) ≥20 weeks' gestation and >14 days before delivery, and (3) ≤14 days before delivery regardless of gestational age. With category 1, we hypothesized that maternal antibody concentrations may have waned leading to a lower placental transfer; with category 2, that maternal antibody concentrations were still high with optimal transfer before delivery; and with category 3, that maternal antibody concentrations were not yet high with suboptimal transfer. Second, as a proxy for whether the pregnant person was infectious at delivery, we dichotomized maternal infection at >14 days before delivery and ≤14 days before delivery.

Outcomes

We estimated the incidence of PCR-positive SARS-CoV-2 infections (classified as any positive testing, only negative testing, or not known to be tested) among infants by timing of maternal infection relative to gestational age and delivery. We examined the early postnatal period, defined as birth to 14 days of age and the late postnatal period, defined as 15 days to 6 months of age, separately because SARS-CoV-2 testing guidelines may only be applied to infants of people believed to be infectious during the peripartum timepoint[16,17] We also assessed the following outcomes: breastmilk feeding, type of newborn well-child visit, jaundice requiring phototherapy, all-cause hospitalization, and all-cause mortality, overall and by timing of maternal infection relative to delivery. In a sensitivity analysis, we estimated percent positivity by limiting the analysis to infants known to be tested with positive or negative results.

Statistical Analysis

Unweighted counts and weighted percentages are reported with 95% confidence intervals with Taylor series variance and finite population correction to account for the complex sampling. Rao-Scott χ^2 tests were used for comparisons. We used weighted Kaplan-Meier curves to examine the proportion of infants testing positive between birth and 6 months of age, stratified by timing of maternal infection relative to gestational age and delivery. Preterm birth is associated with increased SARS-CoV-2 testing[6] and adverse health outcomes. As such, to minimize confounding, infants born <34 weeks' gestation were excluded from analyses stratified by timing of maternal infection. All analyses were conducted in SAS 9.4 (SAS Institute, Cary, NC).

RESULTS

Of 13 180 infants selected from 10 jurisdictions for follow-up, 3967 (30.1%) had data from medical record abstraction. From 8 jurisdictions with complete electronic laboratory data, 6601 (50.1%) had information through 6 months of age as of March 1, 2022, although only 1695 (12.9%) were known to be laboratory tested for SARS-CoV-2 (Fig 1).

Maternal age was similar between those with infections occurring >14 days and ≤14 days before delivery. However, pregnant people identified as non-Hispanic white and those who had private insurance represented greater proportions among those with infections occurring >14 days before delivery. Most reported maternal infections occurred at ≥20 weeks' gestation (73.3% [95% confidence interval: 69.6–76.9]). Nearly one-half of maternal records (43.3% [39.7–46.8]) had insufficient information to define COVID-19 illness severity, 16.8% (13.7–19.9) had an asymptomatic infection, and illness was mild in 29.7% (26.2–33.3), moderate-severe in 8.6% (7.2–10.1) and critical in 1.6% (1.1–2.0). The proportion of asymptomatic illness was higher, and the proportions of other illness categories were lower among those with infections occurring ≤14 days before delivery (Table 1).

Most infants were born term (≥37 weeks) (85.6% [82.4–88.7]), singleton (96.0% [94.2–97.8]), and had no birth defect diagnosis through 6 months of age (96.7% [95.8–97.7]) (Table 1). There were no differences in these birth and infant characteristics by timing of maternal infection relative to delivery. Among infants with incomplete follow-up MRA, maternal age, timing of maternal infection, sex, and gestational age at birth were similar, and a higher proportion of pregnant people were Asian, had no or unreported insurance, and had unknown illness severity (data not shown).

Among SARS-CoV-2-exposed infants reported by jurisdictions with complete electronic laboratory records for infants (n = 6601), 0.6% (0.5–0.7) tested positive, 10.2% (9.2–11.3) tested negative, and 89.1% (88.0–90.3) were not known to be tested in the late postnatal period (15 days to 6 months of age). Results during the late postnatal period did not vary by timing of maternal infection (Table 2). The incidence of SARS-CoV-2 infection was 0.4% (0.3–0.5) in the early postnatal period (≤14 days of age); all early postnatal infant infections occurred among those exposed to maternal SARS-CoV-2 infections at ≤14 days before delivery (1.9% [1.4–2.3]). From birth through 6 months, 1.0% (0.8–1.1) tested positive, 19.1% (17.5–20.6) tested negative, and 80.0% (78.4–81.6) were not known to be tested, with differences in the incidence of infant SARS-CoV-2 infection by timing of maternal infection. Age at infant's first positive test result differed by timing of maternal infection. Survival curves reveal that most early infant infections occurred among those with maternal infections ≤14 days before delivery; no infant infections occurred during the first month of life among those with maternal infection >14 days before delivery and ≥ 20 weeks' gestation, and a similar pattern was observed among the 3 groups thereafter (Fig 2).

In a sensitivity analysis limiting data to infants known to be tested with positive or negative results (n = 1692), the percent positivity in the late postnatal period was 5.6% (4.6–6.5) overall, 5.8% (4.0–7.6) when maternal infection occurred <20 weeks' gestation and >14 days before delivery, 4.7% (3.5–5.8) when ≥20 weeks' gestation and >14 days before

delivery, and 7.3% (5.7–9.0) when ≤14 days before delivery. Percent positivity in the early postnatal period was 3.7% (2.8–4.7). Percent positivity from birth through 6 months of age was 4.8% (4.1–5.5) (data not shown).

Among infants with completed MRA (n = 3967), the prevalence of breastmilk feeding initiation among SARS-CoV-2-exposed infants was 85.8% (82.8–88.7) overall and breastmilk feeding declined at subsequent well-child visit timepoints: newborn visit (78.6% [74.5–82.6]), 2 months (59.0% [55.3–62.7]), and 6 months (41.5% [38.0–45.0]). When examining by timing of maternal infection, breastmilk feeding initiation was significantly lower when maternal infection occurred ≤14 days before delivery (77.6% [72.5–82.6]) compared with earlier maternal infections (88.3% [84.7–92.0]), but there were no differences in breastmilk feeding at subsequent visits (Table 3).

Most newborn well-child visits were in person (98.9% [98.5–99.4]). Jaundice requiring phototherapy after birth hospitalization was observed in 5.6% (4.3–6.9), with no differences by timing of maternal infection (Table 3).

The incidence of all-cause hospitalization through 6 months of age was 4.1% (2.0–6.2) and did not differ by timing of maternal infection (Table 3). The most common reasons for hospitalization were acute respiratory illness excluding COVID-19 (12%), jaundice (11%), and feeding issues (3%). COVID-19 was listed as a reason for hospitalization for 1 infant (0.2% of hospitalizations), born to a person infected >14 days before delivery. Of 1199 infants with vital records information, 17 deaths were observed. All-cause mortality from birth through 6 months of age was 0.4% (0.3–0.6), with a higher incidence among those with maternal infection ≤14 days before delivery (1.0% [0.4–1.6]) compared with maternal infection that occurred at >14 days (0.3% [0.1–0.5]) (Table 3). No deaths occurred among infants with positive SARS-CoV-2 test results nor was COVID-19 a listed cause of death (data not shown).

DISCUSSION

Our study, representative of multiple United States jurisdictions, describes the preliminary 6 month outcomes of infants born to people with SARS-CoV-2 infections in 2020, which are largely reassuring. The incidence of SARS-CoV-2 infections in the early postnatal period was higher when maternal infection occurred in the 14 days preceding delivery, and most infant infections occurred between 15 days and 6 months of age. Breastmilk feeding initiation was lower when maternal infection occurred in the 14 days preceding delivery and all-cause mortality was higher.

We found 1.0% of SARS-CoV-2-exposed infants tested positive for SARS-CoV-2 infection from birth to 6 months of age; 0.4% in the early postnatal period and 0.6% in the late postnatal period. We report an incidence of early postnatal infections among SARS-CoV-2-exposed infants similar to that reported by authors of other studies from North America.[18] Similar to previous reports on SARS-CoV-2 infections among those tested during the birth hospitalization,[6] infant infections were more common when maternal infection occurred in the 14 days preceding delivery, but SARS-CoV-2 infections occurred beyond 14 days of life

with no significant differences by timing of maternal infection. This may reflect ongoing transmission in the community and within the dyad's household.

In a previous analysis using data from 20 jurisdictions participating in SET-NET, Olsen et al found that 13% of neonates born to people with SARS-CoV-2 infection during pregnancy were known to be PCR-tested during the birth hospitalization and, of those, 3.6% tested positive.[6] In that analysis, the proportion known to be tested increased among those with maternal infection close to delivery, with 80% of infants tested at the birth hospitalization when maternal infection was ≤14 days before delivery. Here, we used data from 10 jurisdictions with 6-month infant follow-up data. When maternal infection occurred ≤14 days before delivery, infant testing was more common during the early than the late postnatal period (47% vs 8%). A possible explanation for testing differences between these 2 time periods is that neonatal testing is recommended for all newborns born to people with COVID-19, whereas late postnatal testing was likely more commonly conducted for infants with symptoms or other exposures.

The prevalence of breastmilk feeding initiation was similar among SARS-CoV-2-exposed infants (82.3%) compared with prepandemic estimates in the general population (83.9%). However, the prevalence of breastmilk feeding at newborn, 2-month, and 6-month well-child visits was lower than historical estimates.[19] In line with previous reports among SARS-CoV-2-exposed infants,[20] breastmilk feeding initiation was lower when the pregnant person tested positive for SARS-CoV-2 infection in the 14 days preceding delivery. However, at the newborn and subsequent well-child visits, those with earlier maternal infections were fed breastmilk in a similar proportion. Additional breastmilk feeding support for new parents who have experienced a SARS-CoV-2 infection during pregnancy may be needed.

The incidence of all-cause mortality, all-cause hospitalization, and most common reasons for hospitalization from birth through 6 months of age was similar to historical estimates.[21,22] There were no deaths attributed to COVID-19, and unrecognized SARS-CoV-2 infections resulting in infant death were unlikely given the population and time period examined. The reason for the observed higher mortality among infants born to people who tested positive ≤14 days before delivery is unclear and may be due to SARS-CoV-2-related factors in utero, during delivery, or in the neonatal period.

Although the COVID-19 pandemic expanded access to telehealth services,[23] SARS-CoV-2-exposed infants were seen in person for their newborn visits, as was recommended.[13] The proportion with jaundice requiring phototherapy after the birth hospitalization was 5.6%, higher than estimates reported for infants not exposed to SARS-CoV-2.[24] The reasons for the higher proportion with jaundice requiring phototherapy after birth hospitalization among SARS-CoV-2 exposed infants are unknown and may require further study.

The present report is strengthened by longitudinal, representative data from geographically diverse jurisdictions. Nonetheless, some limitations need to be considered. The timing of the first positive test result is an imprecise measure of the timing of maternal infection. There are also known testing and reporting biases during the early postnatal period by timing of maternal infection, maternal characteristics, and birth outcome[6] and potential testing bias

among infants in the late postnatal period by symptom status. This analysis is limited to infants with PCR-confirmed infection and may underreport asymptomatic and nonmedically attended infections. Jurisdiction-wide records were searched making it reasonable to assume infants without reported results did not have laboratory testing performed; however, one cannot conclude whether untested infants were positive or negative for SARS-CoV-2. Several analyses relied on MRA, which was not completed for all infants selected because of delays in reporting. It is unclear how the addition of these records might change the findings. Liveborn infants with MRA not yet reported had a similar distribution of sex and gestational age at birth and were born to mothers with similar age and timing of infection but with some differences in race/ethnicity and illness severity.

Data collection through SET-NET is ongoing, with plans to include infants born to pregnant people with SARS-CoV-2 infections occurring in 2021. The current analysis included infants born to people with SARS-CoV-2 during pregnancy before the circulation of more recent variants (eg, *o*micron) and when COVID-19 vaccines were not yet widely available. Increasing evidence reveals that COVID-19 vaccination during pregnancy is safe[25–27] and effective[28] and can also help protect infants born to those vaccinated during pregnancy.[29,30] COVID-19 vaccination is recommended for people who are pregnant, breastmilk feeding, trying to get pregnant, or might become pregnant.[31]

CONCLUSIONS

In these preliminary findings, we found generally low morbidity among infants born to people with SARS-CoV-2 infection and a low incidence of postnatal PCR-confirmed SARS-CoV-2 infection. Despite the lack of an association with poor infant health outcomes, COVID-19 may pose a larger threat to infants through more immediate impacts of severe disease experienced by pregnant people and preterm birth.[32] Given a lack of vaccination and treatment options available to infants, strategies to prevent SARS-CoV-2 infection throughout pregnancy and postpartum should be implemented to reduce SARS-CoV-2 infections among infants as well as their gestational parents.

ACKNOWLEDGMENTS

We thank the staff supporting the SET-NET work, including those at participating health departments, for data collection and reporting. We thank the following persons for their contributions to this project: Miguel Valencia-Prado, MD, Puerto Rico Department of Health, Tyler Faulkner and Erika Fuchs, PhD, MPH, Nebraska Department of Health and Human Services, Mayra Trujillo, MS, Kansas Department of Health and Environment, Amber Palmer, MPH, Nadia Thomas, MS, RN, New York State Department of Health, Kirsten Short, MPH, Tahani Hamdan, MPH, Zakariya Mahmod, MPH, Syed F Imam, BDS, MPH, Dieula A. Casimyr, MPH, Ikram Shai Cheref, MPH, Elizabeth Herrera, BS, Houston Health Department, Shan-non Baack, BS, Ona Loper, MPH, Minnesota Department of Health, Tiffany Chen, MPH, Washington State Department of Health. Finally, we thank the COVID-19 Pregnancy and Infant Linked Outcomes Team, the Epidemiology and Surveillance Task Force.

FUNDING:

This study was performed as regular work of the US Centers for Disease Control and Prevention (CDC). This work is supported by the Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases Cooperative Agreement (CK19-1904) and contractual mechanisms. This project was supported in part by an appointment to the Research Participation Program at the CDC, administered by the Oak Ridge Institute for Science and Education through an interagency agreement between the US Department of Energy and the CDC.

REFERENCES

1. Aho Glele LS, Simon E, Bouit C, et al. Association between SARS-Cov-2 infection during pregnancy and adverse pregnancy outcomes: a re-analysis of the data reported by Wei et al. Infect Dis Now. 2021;52(3):123–128
2. Woodworth KR, Olsen EO, Neelam V,et al. ; CDC COVID-19 Response Pregnancy and Infant Linked Outcomes Team; COVID-19 Pregnancy and Infant Linked Outcomes Team (PILOT). Birth and infant outcomes following laboratory-confirmed SARS-CoV-2 infection in pregnancy - SET-NET, 16 jurisdictions, March 29-October 14, 2020. MMWR Morb Mortal Wkly Rep. 2020;69(44): 1635–1640 [PubMed: 33151917]
3. DeSisto CL, Wallace B, Simeone RM,et al. Risk for stillbirth among women with and without COVID-19 at delivery hospitalization - United States, March 2020-September 2021. MMWR Morb Mortal Wkly Rep. 2021;70(47):1640–1645 [PubMed: 34818318]
4. World Health Organization. Definition and categorization of the timing of mother-to-child transmission of SARS-CoV-2: scientific brief, February 8, 2021. Available at: https://apps.who.int/iris/handle/10665/339422. Accessed July 8, 2022
5. Adhikari EH, MacDonald L, SoRelle JA, Morse J, Pruszynski J, Spong CY. COVID-19 cases and disease severity in pregnancy and neonatal positivity associated with delta (B.1.617.2) and omicron (B.1.1.529) variant predominance. JAMA. 2022;327(15): 1500–1502 [PubMed: 35325015]
6. Olsen EO, Roth NM, Aveni K, et al. SARS-CoV-2 infections among neonates born to pregnant people with SARS-CoV-2 infection: maternal, pregnancy and birth characteristics. Paediatr Perinat Epidemiol. 2022;36(4): 476–484 [PubMed: 35437799]
7. Arkhipova-Jenkins I, Helfand M, Armstrong C, et al. Antibody response after SARS-CoV-2 infection and implications for immunity: a rapid living review. Ann Intern Med. 2021;174(6): 811–821 [PubMed: 33721517]
8. Atyeo C, Pullen KM, Bordt EA, et al. Compromised SARS-CoV-2-specific placental antibody transfer. Cell. 2021; 184(3):628–642.e10 [PubMed: 33476549]
9. Flannery DD, Gouma S, Dhudasia MB,et al. Assessment of maternal and neonatal cord blood SARS-CoV-2 antibodies and placental transfer ratios. JAMA Pediatr. 2021;175(6):594–600 [PubMed: 33512440]
10. Moss P The T cell immune response against SARS-CoV-2. Nat Immunol. 2022;23(2):186–193 [PubMed: 35105982]
11. Schuh TL, Mithal LB, Naureckas S, Miller ES, Garfield CF, Shah MD. Outcomes from birth to 6 months of publicly insured infants born to mothers with severe acute respiratory syndrome coronavirus 2 infection in the United States. J Perinat Med. 2021;50(3):334–342 [PubMed: 34882359]
12. Buonsenso D, Costa S, Giordano L, et al. Short- and mid-term multidisciplinary outcomes of newborns exposed to SARS-CoV-2 in utero or during the perinatal period: preliminary findings. Eur J Pediatr. 2022;181(4):1507–1520 [PubMed: 35013811]
13. American Academy of Pediatrics. Guidance on providing pediatric well-care during COVID-19. Available at: https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/guidance-on-providing-pediatric-well-care-during-covid-19. Accessed July 8, 2022
14. Woodworth KR, Reynolds MR, Burkel V, et al. A preparedness model for mother-baby linked longitudinal surveillance for emerging threats. Matern Child Health J. 2021;25(2):198–206 [PubMed: 33394275]
15. Centers for Disease Control and Prevention; Division of Birth Defects and Infant Disorders. Surveillance for emerging threats to mothers and babies network: sampling and weighting methods for COVID-19 end of pregnancy medical record abstraction. Available at: https://www.cdc.gov/ncbddd/set-net/documents/set-net-pregnancy-sampling-white-paper-508.pdf. Accessed July 8, 2022
16. American Academy of Pediatrics. FAQs: management of infants born to mothers with suspected or confirmed COVID-19. Available at: https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/faqs-management-of-infants-born-to-covid-19-mothers/. Accessed May 7, 2022

17. Centers for Disease Control and Prevention. Evaluation and management considerations for neonates at risk for COVID-19. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/caring-for-newborns.html. Accessed May 7, 2022 (Archived)
18. Allotey J, Chatterjee S, Kew T, et al. ; PregCOV-19 Living Systematic Review Consortium. SARS-CoV-2 positivity in offspring and timing of mother-to-child transmission: living systematic review and meta-analysis. BMJ. 2022;376:e067696 [PubMed: 35296519]
19. Centers for Disease Control and Prevention, National Immunization Survey. Breastfeeding among U.S. children born 2011–2018. Available at: https://www.cdc.gov/breastfeeding/data/nis_data/results.html. Accessed July 8, 2022
20. Lewis EL, Smoots AN, Woodworth KR,et al. Breastmilk feeding of infants at birth among people with confirmed SARS-CoV-2 infection in pregnancy — SET-NET, Five States, March 29, 2020–December 31, 2020. [published online ahead of print March 2022]. Research Square. doi.org/10.21203/rs.3.rs-1498126/v1
21. United States Department of Health and Human Services (US DHHS), Centers of Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), Division of Vital Statistics (DVS). Linked birth/infant death records 2017–2019, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. CDC WONDER on-line data-base. Available at: http://wonder.cdc.gov/lbd-current-expanded.html. Accessed July 8, 2022
22. Schiltz NK, Finkelstein Rosenthal B, Crowley MA, et al. Rehospitalization during the first year of life by insurance status. Clin Pediatr (Phila). 2014;53(9):845–853 [PubMed: 24899633]
23. Demeke HB, Merali S, Marks S, et al. Trends in use of telehealth among health centers during the COVID-19 pandemic - United States, June 26-November 6, 2020. MMWR Morb Mortal Wkly Rep. 2021;70(7):240–244 [PubMed: 33600385]
24. Kuzniewicz MW, Park J, Niki H, Walsh EM, McCulloch CE, Newman TB. Predicting the need for phototherapy after discharge. Pediatrics. 2021; 147(5):e2020019778 [PubMed: 33903163]
25. Fell DB, Dhinsa T, Alton GD, et al. Association of COVID-19 vaccination in pregnancy with adverse peripartum outcomes. JAMA. 2022;327(15):1478–1487 [PubMed: 35323842]
26. Lipkind HS, Vazquez-Benitez G, DeSilva M, et al. Receipt of COVID-19 vaccine during pregnancy and preterm or small-for-gestational-age at birth - eight integrated health care organizations, United States, December 15, 2020-July 22, 2021. MMWR Morb Mortal Wkly Rep. 2022;71(1):26–30 [PubMed: 34990445]
27. Ruderman RS, Mormol J, Trawick E, et al. Association of COVID-19 vaccination during early pregnancy with risk of congenital fetal anomalies. JAMA Pediatr. 2022;176(7):717–719 [PubMed: 35377399]
28. Dagan N, Barda N, Biron-Shental T, et al. Effectiveness of the BNT162b2 mRNA COVID-19 vaccine in pregnancy. Nat Med. 2021;27(10):1693–1695 [PubMed: 34493859]
29. Halasa NB, Olson SM, Staat MA, et al. ; Overcoming COVID-19 Investigators; Overcoming COVID-19 Network. Effectiveness of maternal vaccination with mRNA COVID-19 vaccine during pregnancy against COVID-19-associated hospitalization in infants aged <6 Months - 17 states, July 2021-January 2022. MMWR Morb Mortal Wkly Rep. 2022;71(7):264–270 [PubMed: 35176002]
30. Perl SH, Uzan-Yulzari A, Klainer H, et al. SARS-CoV-2-specific antibodies in breast milk after COVID-19 vaccination of breastfeeding women. JAMA. 2021; 325(19):2013–2014 [PubMed: 33843975]
31. Centers for Disease Control and Prevention. COVID-19 vaccines while pregnant or breastfeeding. Available at: https://www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations/pregnancy.html. Accessed July 8, 2022
32. Allotey J, Stallings E, Bonet M, et al. ; 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 [PubMed: 32873575]

WHAT'S KNOWN ON THIS SUBJECT:

Neonatal SARS-CoV-2 infections are more common when maternal infection occurs near the delivery date. There is little information on the health outcomes beyond the early neonatal period of infants born to people with SARS-CoV-2 in pregnancy.

WHAT THIS STUDY ADDS:

Of infections among pregnant people during 2020, infant SARS-CoV-2 infections were rare. Hospitalization and mortality rates were similar to published rates among unexposed infants. Exposed infants had lower breastmilk feeding initiation when maternal infection occurred ≤14 days before delivery.

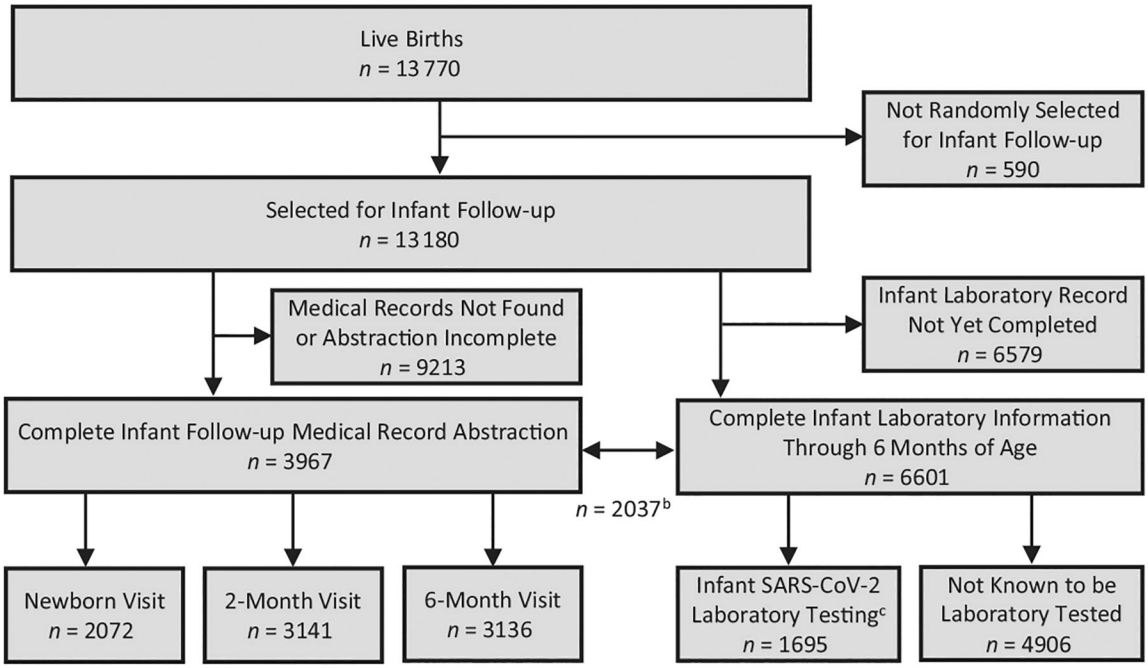

FIGURE 1.

Infants born live to pregnant people with SARS-CoV-2 infection in pregnancy from January to December 2020: 10 SET-NET jurisdictions.

[a] Jurisdictions include the city of Houston (TX), the territory of Puerto Rico, and the states of Kansas, Minnesota, Nebraska, New Jersey, New York (excluding New York City), South Carolina, Tennessee, and Washington.

[b] Had both completed infant follow-up medical record abstraction and complete infant laboratory information.

[c] Includes positive, negative, and equivocal results.

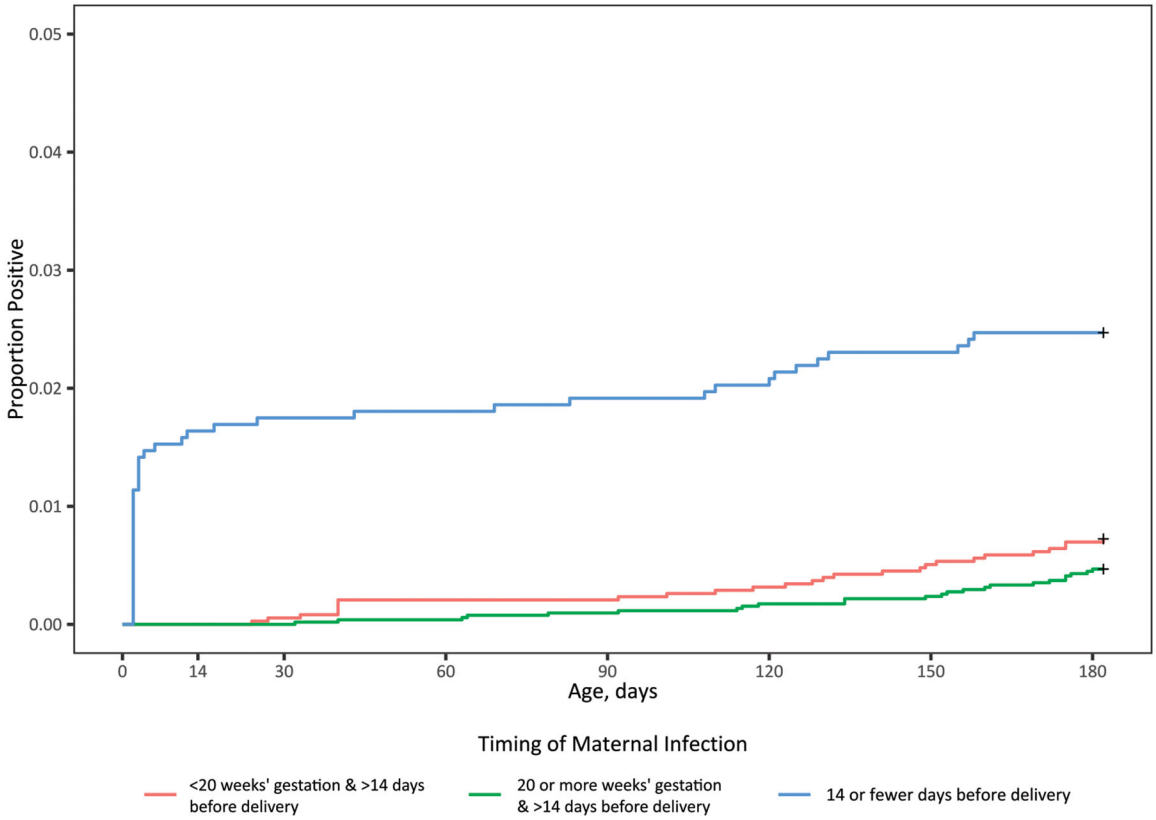

FIGURE 2.

Survival curve representing infant laboratory-positive SARS-CoV-2 testing from birth to 6 months of age by timing of maternal SARS-CoV-2 infection during pregnancy among all infants, $n = 640$.

The y-axis is scaled from 0 to 0.05 to show the small differences between each stratum. The proportion positive represents the first positive SARS-CoV-2 PCR testing from birth through 6 months of age, excluding 196 infants born <34 weeks' gestation.

TABLE 1

Characteristics of Liveborn Infants With Follow-up Medical Records Data Born to People with SARS-CoV-2 Infection in Pregnancy From January to December 2020 by Timing of Maternal Infection Relative to Delivery: 10 SET-NET Jurisdictions[a]

	Overall			Maternal Infection >14 d Before Delivery			Maternal Infection ≤14 d Before Delivery			
	n	%	(95% CI)	*n*	%	(95% CI)	*n*	%	(95% CI)	*p*[d]
Liveborn infants with infant follow-up medical records data	3967	—	—	2662	—	—	1305	—	—	—
Sex										.87
Female	1969	46.9	(43.3–50.6)	1340	46.8	(42.1–51.4)	629	47.4	(42.8–52.0)	
Male	1991	53.0	(49.3–56.6)	1315	53.1	(48.4–57.7)	676	52.6	(48.0–57.2)	
Other/not yet known	7	0.1	(0.0–0.2)	7	0.2	(0.0–0.3)	0	0.0	—	
Gestational age at birth										.88
Term (≥37 wk)	3531	85.6	(82.4–88.7)	2400	85.3	(81.2–89.4)	1131	86.3	(82.8–89.9)	
Late preterm (34–36 wk)	336	10.2	(7.3–13.0)	201	10.5	(6.8–14.2)	135	9.2	(6.5–11.9)	
Extremely to moderately preterm (<34 wk)	100	4.3	(2.5–6.1)	61	4.2	(2.0–6.5)	39	4.4	(1.9–6.9)	
Multiple gestation										.68
Singleton	3846	96.0	(94.2–97.8)	2585	96.2	(94.0–98.3)	1261	95.6	(92.6–98.6)	
Twin	112	3.9	(2.1–5.7)	74	3.8	(1.6–5.9)	38	4.1	(1.1–7.1)	
≥Triplet	9	0.1	(0.0–0.2)	3	0.0	(0.0–0.1)	6	0.2	(0.0–0.5)	
Birth defects, identified through 6 mo of age										.47
Yes	134	3.3	(2.3–4.2)	88	3.1	(1.9–4.2)	46	3.9	(2.1–5.6)	
No	3833	96.7	(95.8–97.7)	2574	96.9	(95.8–98.1)	1259	96.1	(94.4–97.9)	
Pregnant people delivering liveborn infants with infant follow-up medical records data	3905	—	—	2623	—	—	1282	—	—	—
Age, y										.35
<20	166	4.0	(3.0–5.0)	97	3.4	(2.3–4.6)	69	5.8	(3.7–7.9)	
20–24	784	21.1	(18.0–24.3)	506	20.3	(16.3–24.3)	278	23.4	(19.1–27.7)	
25–29	1121	27.6	(24.2–31.1)	765	28.0	(23.6–32.5)	356	26.4	(22.4–30.4)	
30–34	1119	28.4	(25.3–31.4)	796	29.4	(25.5–33.3)	323	25.3	(21.1–29.4)	
35–39	583	16.2	(12.9–19.5)	378	16.3	(12.0–20.6)	205	16.0	(12.6–19.3)	
40+	131	2.6	(1.8–3.4)	80	2.5	(1.5–3.4)	51	3.1	(1.6–4.6)	
Unknown/missing	1	0.0	(0.0–0.0)	1	0.0	(0.0–0.0)	0	0.0	—	

	Overall			Maternal Infection >14 d Before Delivery			Maternal Infection ≤14 d Before Delivery			
	n	%	(95% CI)	*n*	%	(95% CI)	*n*	%	(95% CI)	*p* [d]
Race/ethnicity										<.0001
Asian, non-Hispanic	167	4.0	(3.1–4.8)	119	3.4	(2.5–4.3)	48	5.5	(3.2–7.8)	
Black, non-Hispanic	504	21.7	(18.0–25.4)	331	21.1	(16.4–25.9)	173	23.3	(18.8–27.8)	
Hispanic	1623	31.3	(28.0–34.6)	1007	28.7	(24.6–32.8)	616	38.9	(34.5–43.3)	
White, non-Hispanic	1353	37.7	(34.2–41.3)	994	41.2	(36.6–45.8)	359	27.9	(23.6–32.2)	
Multiple or other, non-Hispanic[b]	168	4.3	(3.1–5.5)	118	4.8	(3.2–6.3)	50	2.9	(1.7–4.0)	
Unknown	90	1.0	(0.8–1.2)	54	0.8	(0.6–1.0)	36	1.6	(1.1–2.2)	
Insurance status										.003
Public	1264	37.4	(33.7–41.1)	773	36.1	(31.3–40.8)	491	41.2	(36.5–46.0)	
Private	1165	41.7	(37.9–45.6)	883	44.6	(39.7–49.4)	282	33.6	(28.8–38.4)	
None/other	244	7.2	(5.8–8.7)	144	7.1	(5.3–8.9)	100	7.6	(5.2–9.9)	
Not reported	1232	13.6	(12.7–14.5)	823	12.3	(11.1–13.4)	409	17.6	(15.6–19.6)	
Gestational age at maternal infection										—
<20 wk	1003	26.7	(23.1–30.4)	1003	36.0	(31.3–40.7)	0	0.0	—	
≥20 wk	2902	73.3	(69.6–76.9)	1620	64.0	(59.3–68.7)	1282	100.0	(100–100)	
Illness severity[c]										<.0001
Asymptomatic	475	16.8	(13.7–19.9)	229	11.2	(7.4–14.9)	246	33.0	(28.0–37.9)	
Mild	1287	29.7	(26.2–33.3)	1042	34.0	(29.4–38.7)	245	17.3	(13.9–20.8)	
Moderate–severe	433	8.6	(7.2–10.1)	357	9.9	(8.0–11.8)	76	5.1	(3.3–6.9)	
Critical	102	1.6	(1.1–2.0)	52	1.2	(0.7–1.6)	50	2.8	(1.8–3.8)	
Unknown	1608	43.3	(39.7–46.8)	943	43.8	(39.2–48.3)	665	41.8	(37.4–46.2)	

CI, confidence interval. —, could not be calculated.

[a]Jurisdictions with infant medical records data include the city of Houston (TX), the territory of Puerto Rico, and the states of Kansas, Minnesota, Nebraska, New Jersey, New York (excluding New York City), South Carolina, Tennessee, and Washington. Table values are unweighted counts and weighted % (95% CI).

[b]Other race comprises American Indian or Alaska Native, Native Hawaiian or Pacific Islander, and Asian, non-Hispanic. These were combined because of small cell sizes that yielded unreliable estimates.

[c]Categories of COVID-19 illness severity were based on modified National Institutes of Health and World Health Organization criteria as described in Galang et al.[32] Pregnant people were considered asymptomatic if reported as having an absence of symptoms. Criteria were applied to classify severity by using submitted data including symptoms, ICU admission, invasive ventilation, use of COVID-19 therapies, complications associated with COVID-19 and death.

[d]Rao-Scott χ^2 test for differences by timing of maternal infection relative to delivery. Comparisons exclude other and unknown values of sex and age.

TABLE 2

Infant SARS-CoV-2 Testing by Timing of Pregnant Person's SARS-CoV-2 Infection From January to December 2020: 8 SET-NET Jurisdictions[a]

	Total		Maternal Infection >14 d Before Delivery						
			Maternal Infection <20 wk Gestation[b]		Maternal Infection ≥20 wk Gestation[c]		Maternal Infection ≤14 d Before Delivery[d]		
	n	% (95% CI)	*N*	% (95% CI)	*n*	% (95% CI)	*n*	% (95% CI)	*P* [e]
Late postnatal period[f]									.17
Not known to be tested	5671	89.1 (88.0–90.3)	1782	87.5 (85.2–89.7)	2689	89.9 (88.3–91.6)	1042	91.7 (90.5–92.8)	
Negative[g]	869	10.2 (9.2–11.3)	338	11.8 (9.6–14.0)	364	9.6 (8.0–11.2)	132	7.7 (6.6–8.8)	
Positive[h]	60	0.6 (0.5–0.7)	23	0.7 (0.5–1.0)	23	0.5 (0.4–0.6)	11	0.6 (0.5–0.8)	
Early postnatal period[i]									—
Not known to be tested	5703	89.6 (88.7–90.5)	2106	98.5 (97.8–99.3)	2928	96.2 (95.5–96.9)	520	53.2 (47.6–58.8)	
Negative[g]	859	10.0 (9.1–10.9)	38	1.5 (0.7–2.2)	148	3.8 (3.1–4.5)	632	44.9 (39.4–50.3)	
Positive[h]	37	0.4 (0.3–0.5)	0	—	0	—	31	1.9 (1.4–2.3)	
All infant SARS-CoV-2[j]									<.0001
Not known to be tested	4906	80.0 (78.4–81.6)	1751	86.2 (83.7–88.6)	2563	86.6 (84.7–88.5)	468	49.9 (44.0–55.8)	
Negative[g]	1597	19.1 (17.5–20.6)	369	13.1 (10.7–15.5)	490	13.0 (11.1–14.9)	673	47.5 (41.9–53.2)	
Positive[h]	95	1.0 (0.8–1.1)	23	0.7 (0.5–1.0)	23	0.5 (0.4–0.6)	42	2.5 (1.9–3.0)	

CI, confidence interval. —, could not be calculated.

[a] Jurisdictions with infant laboratory data include the territory of Puerto Rico, and the states of Kansas, Minnesota, Nebraska, New York (excluding New York City), South Carolina, Tennessee, and Washington. Table values are unweighted counts and weighted % (95% CI).

[b] Excludes 86 infants born <34 weeks' gestation.

[c] Excludes 46 infants born <34 weeks' gestation.

[d] Excludes 64 infants born <34 weeks' gestation.

[e] Rao-Scott χ^2 test for differences by timing of maternal infection relative to gestational age and delivery.

[f] Testing occurred >14 days to 6 months of age. Equivocal results not shown ($n = 1$).

[g] Infants with no positive SARS-CoV-2 PCR test and at least one negative PCR test reported.

[h] Infants with at least one positive SARS-CoV-2 PCR test during the defined period, including infants with both positive and negative PCR results.

[i] Testing occurred ≤14 d of age. Equivocal results not shown (*n* = 2). Centers for Disease Control and Prevention and the American Academy of Pediatrics recommend testing of all neonates born to pregnant people with confirmed or suspected COVID-19.[16,17]

[j] Testing occurred any time from birth to 6 months of age. Equivocal results not shown (*n* = 3).

TABLE 3

Breastmilk Feeding, Well-Child Visit Type, All-Cause Infant Hospitalization, and All-Cause Mortality by Timing of Maternal Infection Relative to Delivery among Liveborn Infants With Follow-up Medical Records Data Born to Pregnant People with SARS-CoV-2 Infections From January to December 2020: 10 SET-NET Jurisdictions[a]

	Total		Maternal Infection >14 d Before Delivery[b]		Maternal Infection ≤14 d Before Delivery[c]		
Outcomes	***n***	**% (95% CI)**	***n***	**% (95% CI)**	***n***	**% (95% CI)**	***P*[d]**
Fed breastmilk							
Birth, initiation (*n* = 2641)	2261	85.8 (82.8–88.7)	1577	88.3 (84.7–92.0)	639	77.6 (72.5–82.6)	.002
Newborn well-child visit (*n* = 1835)[e]	1514	78.6 (74.5–82.6)	1192	80.0 (75.1–84.8)	303	75.6 (68.6–82.5)	.33
2 mo well-child visit (*n* = 2705)[f]	1635	59.0 (55.3–62.7)	1125	59.8 (55.1–64.4)	474	57.8 (51.9–63.8)	.64
6 mo well-child visit (*n* = 2652)[g]	1163	41.5 (38.0–45.0)	772	41.1 (36.8–45.4)	370	44.3 (38.4–50.1)	.43
Newborn well-child visit (*n* = 3566)[e]							.001
In-person	3509	98.9 (98.5–99.4)	2349	99.5 (99.0–99.9)	1082	97.6 (96.4–98.7)	
Telehealth	26	0.6 (0.2–1.0)	8	0.4 (0.0–0.8)	18	1.4 (0.3–2.4)	
Not reported	31	0.4 (0.3–0.6)	8	0.2 (0.1–0.3)	22	1.1 (0.7–1.5)	
Jaundice requiring phototherapy after birth hospitalization (*n* = 3934)	205	5.6 (4.3–6.9)	155	6.0 (4.4–7.6)	39	4.0 (1.8–6.2)	.23
All-cause infant hospitalization (*n* = 3554)[h]	134	4.1 (2.0–6.2)	85	3.8 (1.1–6.6)	41	4.0 (2.0–6.1)	.93
Indication for hospitalization[i]							
Acute respiratory illness (not COVID-19)[j]	17	11.7 (1.5–21.9)	—	—	—	—	—
Jaundice	23	10.8 (3.5–18.1)	—	—	—	—	—
Feeding issues[k]	8	3.3 (0.0–6.7)	—	—	—	—	—
Bacterial infections	5	2.5 (0.0–5.7)	—	—	—	—	—
Born preterm	7	1.7 (0.5–3.0)	—	—	—	—	—
Failure to thrive	7	1.7 (0.5–3.0)	—	—	—	—	—
Gastrointestinal issues	6	1.5 (0.3–2.7)	—	—	—	—	—
Planned procedures and surgery	4	2.1 (0.0–5.0)	—	—	—	—	—
Fever and sepsis	3	2.6 (0.0–6.7)	—	—	—	—	—
Cerebral disturbances and seizures	3	0.7 (0.0–1.5)	—	—	—	—	—

Outcomes	Total		Maternal Infection >14 d Before Delivery[b]		Maternal Infection ≤14 d Before Delivery[c]		
	n	% (95% CI)	*n*	% (95% CI)	*n*	% (95% CI)	*p*[d]
COVID-19[l]	1	0.2 (0.0–0.7)	—	—	—	—	—
Other	9	8.1 (0.7–15.4)	—	—	—	—	—
Unknown	57	58.9 (40.2–77.7)	—	—	—	—	—
All-cause mortality (*n* = 1199)[m]	17	0.4 (0.3–0.6)	10	0.3 (0.1–0.5)	7	1.0 (0.4–1.6)	.01

CI, confidence interval. —, not calculated.

[a]Jurisdictions with infant medical records data include the city of Houston (TX), the territory of Puerto Rico, and the states of Kansas, Minnesota, Nebraska, New Jersey, New York (excluding New York City), South Carolina, Tennessee, and Washington. Table values are unweighted counts and weighted % (95% CI).

[b]Excludes 61 infants born <34 weeks' gestation, varies by outcome.

[c]Excludes 39 infants born <34 weeks' gestation, varies by outcome.

[d]Rao-Scott χ^2 test for differences by timing of maternal infection relative to delivery.

[e]Well-child visit that occurred after the delivery hospitalization up to 1 month of age.

[f]Well-child visit that occurred after 1 month, up to 3 months of age.

[g]Well-child visit that occurred after 3 months, up to 9 months of age.

[h]Infant hospitalizations that occurred after the birth hospitalization

[i]Reasons for hospitalization are not mutually exclusive. No comparisons of reasons for hospitalization were made due to small sample sizes.

[j]Includes upper acute respiratory infections, influenza, pneumonia, bronchitis, wheezing, respiratory syncytial virus, and respiratory distress.

[k]Includes feeding issues such as slow or underfeeding and feeding disorders; also includes abnormal weight gain or loss; excludes infants with dysphagia and structural feeding difficulties such as cleft lip, palate malformations, and pyloric stenosis.

[l]COVID-19 hospitalizations both occurred among infants born to people with infections >14 d before delivery.

[m]Information collected from vital records; missing indicates vital records were not collected.