**BKM Public Health & Community Medicine**
(Berita Kedokteran Masyarakat)

**Volume** 39 **Number** 2, 2023, **Pages** e6630
DOI: 10.22146/bkm.v39i02.6630

# COVID-19 infection during pregnancy on perinatal and neonatal outcomes: a scoping review

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**Submitted :**
January 15th, 2023
**Accepted:**
February 25th, 2023
**Published:**
February 28th, 2023

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## Abstract

**Purpose:** COVID-19 infection has rapidly spread and caused a global pandemic, as stated by the World Health Organization on March 10, 2020. The incidence of COVID-19 tends to increase worldwide, including Indonesia, occasionally. With 6,422,529 confirmed cases, including 158,014 as of September 25, 2022, Indonesia has surpassed India and Bangladesh to become the nation with the third-highest confirmed cases in Asia. Although there have been reports of several cases of vertical transmission, the transmission of COVID-19 from mother to fetus was initially considered uncertain. Case reports of newborns (within the first 12 hours) with COVID-19 infection prove the possibility of intrauterine or extrauterine mother-infant vertical transmission. This study aimed to determine the effect of COVID-19 infection during pregnancy on perinatal and neonatal outcomes. **Methods:** This study employed the scoping review method, searching articles across several databases, including PubMed, Scopus, and Google Scholar, and adhered to the guidelines of PRISMA-ScR. Search for articles using the main keywords” pregnant women” or “pregnant” and “coronavirus” (or COVID-19 or 2019NCOV or SARS-CoV-2) AND (” perinatal outcome” or “neonatal outcome” or “pregnancy outcome”) published in 2019–2022. **Results:** The articles obtained were related to symptoms of COVID-19-positive pregnant women, perinatal and neonatal outcomes of COVID-19 pregnant women, and the identification of COVID-19 occurrence during pregnancy. **Conclusion:** A total of 22 articles reviewed found that pregnant women with COVID-19 symptoms experience adverse outcomes in perinatal and neonatal compared to those not infected with COVID-19. Pregnant women with COVID-19 infection show a higher risk of perinatal and neonatal outcomes such as premature, LBW, and NICU admission.

**Keywords:** COVID-19; perinatal and neonatal outcomes; pregnant women; vertical transmission

## INTRODUCTION

The body undergoes several physiological changes during pregnancy, i.e., changes in hematology, respiration, cardiology, hormones, and immunity. As a result, this can increase the risk of susceptibility to diseases and infections, including COVID-19 [1,2]. The emergence of COVID-19 poses new challenges for healthcare systems and practitioners, especially in the handling of pregnant women [3].

In March 2020, COVID-19 cases reached 180,000 confirmed worldwide, with 7,000 of those cases resulting in the deaths of pregnant women and fetuses, another high-risk category during the COVID-19 outbreak [4]. More than 90% of pregnant women infected with COVID-19 and hospitalized have pneumonia and premature birth [5]. The incidence of COVID-19 infection tends to rise, and serious complications that can occur due to changes in estrogen and progesterone levels, as well as alterations in immune function, may lead to an increase in the number of COVID-19 cases. Hormonal changes that begin in the first trimester of pregnancy cause respiratory, cardiovascular, and immune changes, making pregnant women and fetuses more vulnerable to COVID-19 infection [6].

Pregnant women have a high risk of developing complications from respiratory viral infections [7]. Physiological or immunological changes during pregnancy may have a systemic effect that predisposes women to complications of respiratory infections that result in maternal and fetal mortality and morbidity [8]. Severe COVID-19 has caused maternal-fetal death, intrauterine fetal growth restriction, spontaneous abortion, and premature birth [9].

Case reports of newborns (first 12 hours) infected with COVID-19 prove the possibility of mother-infant vertical transmission through intrauterine or extrauterine. This is supported by studies that demonstrate the presence of the COVID-19 virus in the placenta, amniotic fluid, cord blood, and breast milk, as well as maternal viremia [10-14]. In addition, not many studies have reported the impact of COVID-19 on the fetus, such as fetal distress, stillbirth, premature birth, neonatal asphyxia, and vertical transmission. However, there is a risk of fatal inflammatory response syndrome or other conditions that endanger the fetus [15,16].

Data on the impact of the COVID-19 virus from the mother on the fetus is still limited. It has been reported that viral pneumonia in pregnant women is associated with an increased risk of preterm birth, Fatal Growth Restriction (FGR), and perinatal death [17]. Research conducted by [18,19] found that of the nine pregnant women with COVID-19, 6% in the third trimester were negative for COVID-19 in samples of amniotic fluid, umbilical cord blood, throat and anal swabs, sputum, venous blood, and urine. These observations revealed no proof of vertically transmitted intrauterine infection in COVID-19 infected late-pregnant women. Meanwhile, another study found evidence of vertical transmission through intrauterine transmission, transmission during labor, breast milk transmission, and postnatal contact [20,21]. Vertical transmission can cause perinatal miscarriage, FGR, premature birth, and even stillbirth [22].

Based on the aforementioned research reports, variations exist in the relationship between COVID-19 and pregnancy, as well as neonatal and perinatal outcomes. Therefore, researchers are interested in conducting further studies to obtain more accurate and up-to-date results. Thus, more information and evidence about COVID-19 during pregnancy are needed to provide an overview of the consequences, management, and handling of neonatal and perinatal outcomes.

## METHODS

Secondary data, using the scoping review method, began with determining the research question or problem formulation. The search for scientific articles to answer the research questions was then conducted by analyzing and interpreting these articles. The articles in question meet the inclusion and exclusion criteria under the PRISMA-ScR 2020 guidelines [23]. Information was obtained by reviewing scientific articles from several databases, including PubMed, ScienceDirect, and Google Scholar. The title, abstract, and content of the scientific article were screened based on the inclusion and exclusion criteria that have been determined. The information obtained was reviewed regarding 1) symptoms of pregnant women who are positive for COVID-19, 2) perinatal and neonatal outcomes of COVID-19 pregnant women, and 3) identification of COVID-19 events during pregnancy.

### Eligibility criteria

The provisions of scientific articles used in conducting research and writing the scoping review method meet the inclusion and exclusion criteria determined as follows: First, the inclusion criteria include articles using original studies, i.e., case-control, cohort, and cross-sectional, in English and Indonesian, Articles published in 2019–2021 on the influence of coronavirus infection during pregnancy on perinatal and neonatal outcomes, The population consisting of pregnant women infected with COVID-19, Intervention during the pregnancy lab-confirmed or clinically diagnosed COVID-19 infections in all health services, and Outcome containing information related to the effects of COVID-19 on neonatal and perinatal outcomes; and published in an electronic database in full or free full-text and both exclusion criteria. The criteria include limiting articles to those using the literature review method, conducting systematic and editorial reviews, excluding articles in languages other than Indonesian and English, and excluding pregnant women who tested negative from the study.

### Data source

A search was conducted through the PubMed, Scopus, and Google Scholar databases to identify studies published from December 2019 to September 30, 2022. Problem formulation: “What is the influence of coronavirus infection 2019 (COVID-19) during pregnancy on neonatal and perinatal externalities?". This study adopts the PICO (Population, Intervention, Comparison, Outcome) framework to systematically formulate the research question and ensure a focused approach to the investigation. The Population (P) in this study comprises pregnant women, representing a high-risk group for complications during pregnancy, particularly amidst the COVID-19 pandemic. The Intervention (I) refers to infection with COVID-19 during pregnancy, while the Comparison (C) group consists of pregnant women without COVID-19 infection. The primary Outcomes (O) assessed include perinatal and neonatal outcomes. Table 1 shows search strategies that include keyword combinations compatible with medical subject headings (MeSH) with Boolean combinations to expand or limit the literature search as follows:

**Table 1. Search keyword PICO**

| Database | Keywords |
|---|---|
| Pubmed | (Pregnancy[MeSH] OR “pregnant women”[MeSH] OR Pregnancy OR pregnant OR Pregnant*) AND (Coronavirus[MeSH] OR COVID-19[MeSH] OR “severe acute respiratory syndrome coronavirus 2”[MeSH] OR Covid[All Fields] OR Covid19[All Fields] OR COVID-19[All Fields] OR “covid 19”[All Fields] OR “corona”[All Fields] OR "2019 nCoV”[All Fields] OR 2019nCoV[All Fields] OR "2019 novel coronavirus"[All Fields] OR "COVID 19"[All Fields] OR "SARS CoV-2"[All Fields] OR "new coronavirus"[All Fields] OR "novel coronavirus"[All Fields] OR (Wuhan AND coronavirus)[All Fields] OR "SARS-CoV"[All Fields]) AND (“Perinatal outcome*” OR “neonatal outcome*” OR “Pregnancy outcome*”) |
| Science Direct | (pregnant women OR Pregnant*) AND (Coronavirus OR COVID-19 OR 2019nCoV OR SARS CoV-2) AND (Perinatal outcome OR neonatal outcome OR Pregnancy outcome) |
| Google Scholar | (Pregnant mother OR pregnant woman) AND (Coronavirus OR COVID-19 OR 2019nCoV OR SARS CoV-2) AND (Perinatal outcome OR neonatal outcome OR Pregnancy outcome ) |

## Data selection

Two reviewers evaluated and determined which title to use based on its categorization, i.e., relevant, irrelevant, and potentially relevant titles. Following that, the reviewer and the researcher both evaluated the pertinent research abstract. The article was then reviewed twice—once by the researcher and once by the reviewer—as a whole. All studies that have been identified from a database search were exported to the EndNote Reference Management Software (EndNote version X9.3.3). Next, Rayyan's systematic review software was used to manage the self-screening process, which occurred concurrently with title screening, abstract screening, and full-text screening of the same articles. Full-text exclusion reasons were documented at the full-text screening stage.

## Data extraction

The data from the included article were extracted into an Excel sheet by one researcher, and reviewers checked its accuracy. The extracted data included the study's characteristics (country, year of publication, research design and methodology, study period, population and setting, number of participants, number of cases, number in the control group, and dropouts).

## Data analysis techniques

Articles were selected using filter features in each database to facilitate the search based on predetermined inclusion and exclusion criteria. Filters used in the database to select articles included the publication period (2019-2021), the article research design (e.g., observational studies), and articles written in either English or Indonesian. The search results obtained from all databases were exported and then imported into the Zotero application to check the publication. This publication check was conducted to remove duplicate articles with the same title found in two or more databases. This aims to be more efficient in the next stage of selection, specifically screening the title and abstract of the article. The abstracts of the articles with titles irrelevant to the research topic were reviewed. If the title and abstract of the article discuss the adverse fetal and newborn outcomes of pregnant women infected with COVID-19, the next stage was conducted to assess the content of the article. The articles analyzed for the scoping review meet the inclusion criteria (Figure 1).

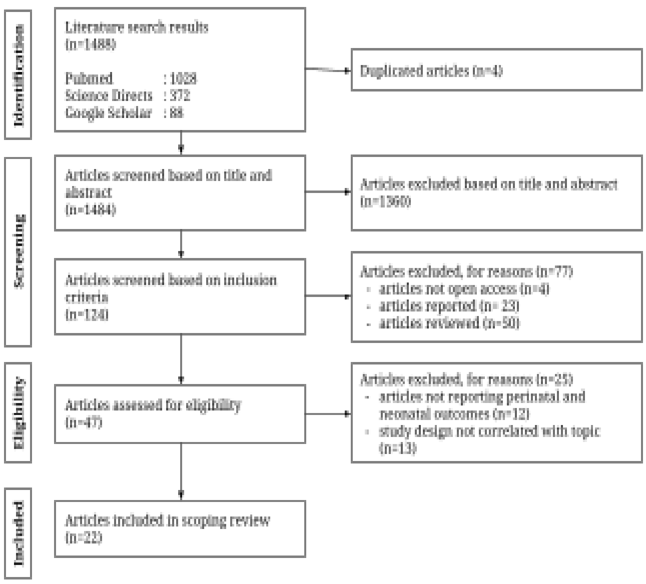


**Figure 1. ScR prism flow chart**

# RESULTS

### Literature search

The article search process was conducted from 2019 to 2022, yielding 1,488 articles (Figure 2) from multiple databases, including PubMed, ScienceDirect, and Google Scholar. The results of literature searches conducted through three databases were then screened based on inclusion and exclusion criteria using the ScrPrism guide. Twenty-two articles have been analyzed and meet the inclusion criteria for synthesis.

### Article characteristics and maternal clinical data

The general characteristics of the literature were analyzed based on the country of origin of the study, country category, study, morbidity in pregnant women, and maternal symptoms. Researchers reviewed 22 articles from the screening results, with various characteristics summarized in Table 2.

Based on the results of studies that have been obtained from 22 articles, it was found that the effect of COVID-19 virus infection in pregnant women on perinatal and neonatal outcomes has ten outcomes: asphyxia, low birth weight of less than 2500 grams, respiratory distress, fetal distress, NICU admission, Oligohydramnios, prematurity, APGAR score less than seven at 5 minutes, APGAR score 4-6 at 5 minutes, and sepsis of the ten outcomes consisting of three outcomes with the highest number of occurrence, i.e., prematurity, low birth weight of less than 2500 grams, and NICU admission.

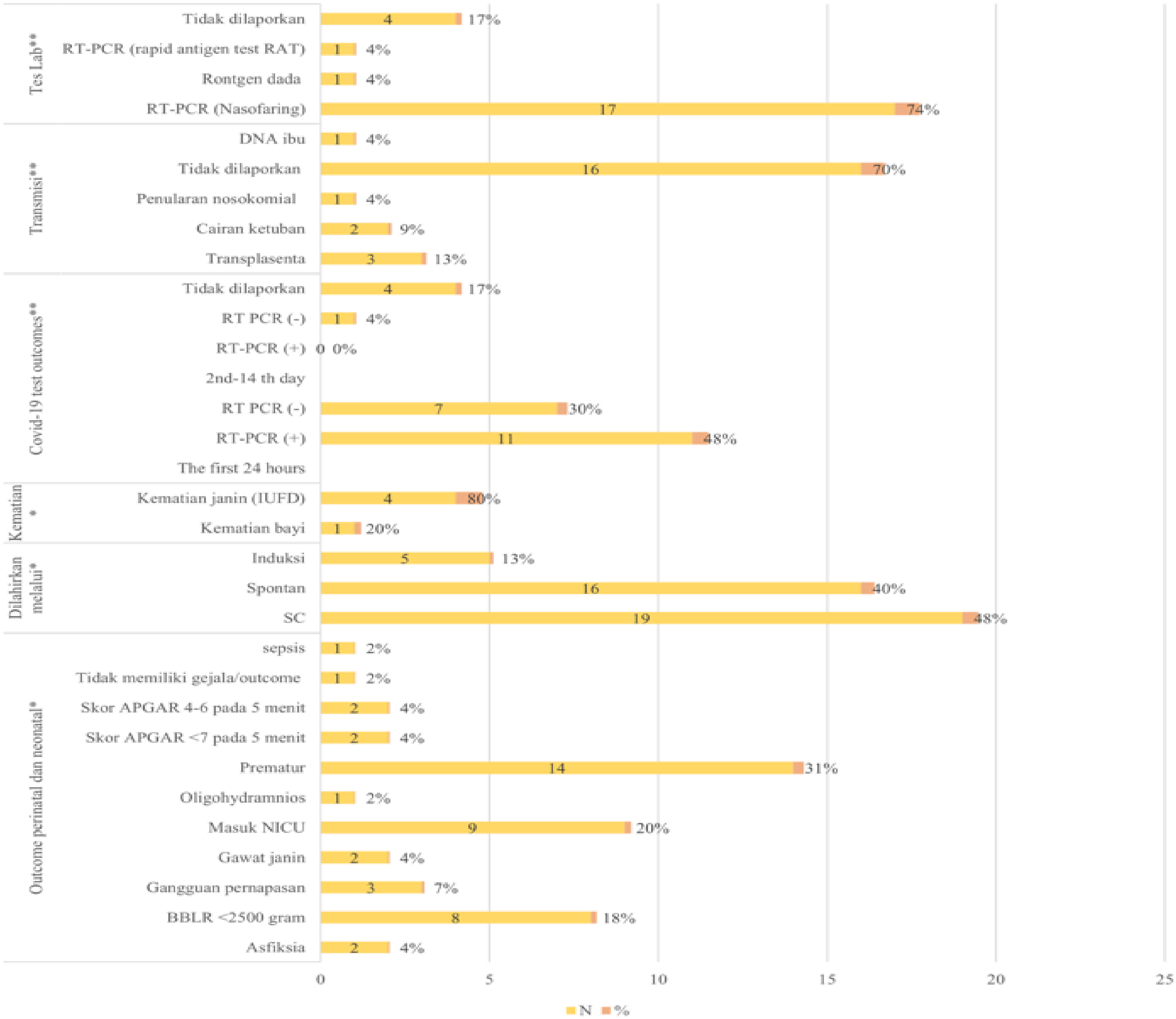


**Figure 2. Outcome review results in perinatal and neonatal**

**Table 2. Characteristics of articles reviewed**

| Author (year) | Country | Method | Population of mother | Population of baby | Outcome (baby) | OR |
|---|---|---|---|---|---|---|
| Daclin et al. (2022) [24] | France | Case-control | 86 COVID-19-positive pregnant women<br><br>86 COVID-19-negative pregnant women | 172 newborn babies | The rate of preterm births among pregnant women positive for COVID-19 was 3.5% (n=3/86), compared to 4.7% (n=4/86) in those who tested negative. | Not reported |
| Elenga et al. (2022) [25] | France | Case-control | 133 pregnant women tested positive for COVID-19<br><br>504 pregnant women tested negative for COVID-19 | 637 neonates | Preterm births among pregnant women positive and negative for COVID-19 (11%, n=15/133 vs. 7%, n=34/504).<br><br>NICU admissions among neonates born to pregnant women are positive and negative for COVID-19 (14%, n=14/133 vs. 15%, n=77/504).<br><br>Intrauterine fetal death (IUFD) among pregnant women positive and negative for COVID-19 (1.5%, n=2/133 vs. 1.0%, n=5/504). | OR= 12.5 [1.7-90.5]<br><br>OR=13.4 [3.0-60]<br><br>OR= 25.9 [2.2-305] |
| Gurol-Urganci et al. (2021) [26] | United Kingdom | Kohort | 3,527 pregnant women tested positive for COVID-19<br><br>338,553 pregnant women tested negative for COVID-19 | 342,080 neonates | Preterm births among pregnant women positive and negative for COVID-19 (12.1%, n=369/3,047 vs. 5.8%, n=18,572/322,494).<br><br>Low birth weight (LBW) among neonates born to pregnant women positive and negative for COVID-19 (6.4%, n=191/3,009 vs. 5.5%, n=17,521/320,188).<br><br>Fetal death among pregnant women positive and negative for COVID-19 (0.85%, n=30/3,527 vs. 0.34%, n=1,140/338,553) | OR= 2.17 [1.96e2.42]<br><br>OR=0.99 [0.8e1.16]<br><br>OR= 2.21 [1.58e3.11] |
| Farhadi et al. (2022) [27] | Iran | Cross-sectional | 58 pregnant women tested positive for COVID-19 | 60 newborns (including 2 twin pregnancies) | Among the 60 neonates included in this study, 41.2% (n = 25) were born prematurely. A total of 33.3% (n = 20) of the neonates tested positive for COVID-19. Low birth weight (LBW) was observed in 5.0% (n = 3) of the cases. Additionally, 56.7% (n = 34) of the neonates required admission to the Neonatal Intensive Care Unit (NICU), indicating a high rate of complications requiring specialized care. | Not reported |
| Gale et al. (2021) [28] | United Kingdom | Prospektif (cohort) | 66 pregnant women tested positive for COVID-19 | 66 neonates | Out of the 66 neonates analyzed, 24% (n = 16) were born prematurely. COVID-19 positivity was detected in 42% (n = 28) of the neonates, indicating a significant rate of vertical or perinatal transmission. Furthermore, 12% | Not reported |

| Author (year) | Country | Method | Population of mother | Population of baby | Outcome (baby) | OR |
|---|---|---|---|---|---|---|
| | | | | | (n = 8) of the neonates developed nosocomial infections. | |
| Alipour et al. (2021) [29] | Iran | Retrospektif (cohort) | 53 pregnant women tested positive for COVID-19<br><br>135 pregnant women tested negative for COVID-19 | 188 neonates | Preterm births among pregnant women positive and negative for COVID-19 were 47.2% (n = 25/53) and 13.3% (n = 18/135), respectively. | OR = 3.01, 95% CI 1.4–6.54 |
| | | | | | NICU admissions among neonates born to COVID-19-positive and COVID-19-negative mothers were 34.0% (n=18/53) and 7.4% (n=10/135), respectively. | |
| | | | | | Fetal distress was observed in 37.7% (n=20/53) of neonates from COVID-19 positive mothers, compared to 5.2% (n=7/135) from COVID-19 negative mothers. | |
| | | | | | The 1-minute Apgar score among neonates born to mothers with COVID-19 was 8 ± 1.7 (mean ± SD). | OR = 5.7, 95% CI 2.13–15.59 |
| | | | | | The 5-minute Apgar score among neonates born to mothers with COVID-19 was 9 ± 1.5 (mean ± SD). | OR = 3.04, 95% CI 1.21–7.70 |
| | | | | | Neonates testing positive for COVID-19 born to mothers who were COVID-19-positive accounted for 4% (n=4/53). | |
| Salvatore et al. (2020) [30] | United States of America | Cohort | 116 pregnant women tested positive for COVID-19 | 120 neonates (including 4 twin pregnancies) | Eighty-two neonates were repeatedly tested, and all results were negative; none of the neonates showed symptoms. | Not reported |
| Wijaya & Wiyati (2021) [31] | Semarang, Indonesia | Case Control | 51 pregnant women tested positive for COVID-19 | 51 neonates | Among the 51 neonates evaluated, 45% (n = 23) were classified as having low birth weight (LBW). Stillbirths occurred in 15.6% of cases (n = 8). Regarding birth asphyxia, 78.5% (n = 40) experienced mild asphyxia, 13.7% (n = 7) had moderate asphyxia, and 7.8% (n = 2) suffered from severe asphyxia. | Not reported |
| Sharma et al. (2021) [32] | India | Ambispective (including retrospective and prospective) | 41 pregnant women tested positive for COVID-19 | 44 neonates (including 3 twin pregnancies) | Among the 44 neonates, 15.9% (n = 7) were born preterm. Low birth weight (LBW) was identified in 25% (n = 11) of the cases. A total of 13.6% (n = 6) required admission to the Neonatal Intensive Care Unit (NICU). Birth asphyxia was observed in 11.4% (n = 5), and an APGAR score of less than 7 at 5 minutes was recorded in the same proportion of | Not reported |

| Author (year) | Country | Method | Population of mother | Population of baby | Outcome (baby) | OR |
|---|---|---|---|---|---|---|
| | | | | | neonates (11.4%, n = 5). | |
| Choudhary et al. (2022) [33] | India | Retrospective cohort | 107 pregnant women tested positive for COVID-19 | 107 neonates | Among the 107 neonates included in the analysis, 20.22% (n = 18) were born preterm, while low birth weight (LBW) was observed in 26.44% (n = 23) of the cases. Intrauterine fetal demise (IUFD) occurred in 3.81% (n = 4) of the pregnancies. Additionally, 2.25% (n = 3) of the newborns tested positive for COVID-19. | Not reported |
| Babic et al. (2022) [34] | Saudi Arabia | Retrospective cohort | 209 pregnant women tested positive for COVID-19 | 209 neonates | Of the 209 neonates included in the study, 8.2% (n = 17) required admission to the Neonatal Intensive Care Unit (NICU). Neonatal COVID-19 infection was confirmed in 4.7% (n = 10) of the cases. | Not reported |
| Vural et al. (2022) [35] | Turkey | Retrospective cohort | 61 pregnant women tested positive for COVID-19 | 63 neonates (including 2 twin pregnancies) | Among the 63 neonates studied, 9.52% (n = 6) were born prematurely. Respiratory disorders were identified in 31.75% (n = 20) of the cases, highlighting a significant burden of respiratory complications in this population. | Not reported |
| Shree et al. (2022) [36] | India | Retrospective cohort | 49 pregnant women tested positive for COVID-19 | 49 neonates | Among the 49 neonates, 4.1% (n = 2) were born prematurely before 34 weeks of gestation. Low birth weight (LBW) was observed in 20.4% (n = 10) of the newborns. An APGAR score between 4 and 6 at 5 minutes was recorded in 8.2% (n = 4) of the cases. Additionally, neonatal COVID-19 positivity was confirmed in 2.0% (n = 1) of the neonates. | Not reported |
| Cuñarro- López et al. (2021) [8] | Spain | Ambispective cohort | (846 pregnant women positive for Covid-19 in the first wave);<br><br>(449 pregnant women positive for Covid-19 in the second wave) | 1295 neonates | The rate of prematurity was 12.4% (n=105/846) in the first wave compared to 8.7% (n=39/449) in the second wave. | Not reported |
| Norman et al. (2021) [37] | Sweden | Cohort | (2,323 pregnant women positive for Covid-19);<br><br>(85,836 pregnant women negative for Covid-19) | (2,323 infants born to mothers positive for SARS-CoV-2);<br><br>(85,836 infants born to mothers negative for SARS-CoV-2) | Premature with gestational age <32 weeks (10.5%, n=4/38 vs. 8.3%, n=56/675)<br><br>Positive SARS-CoV-2 test results in infants, based on age:<br><br>Early neonates (0–6 days) (0.7%, n=16/2,323 | OR= -1.6;95%[CI] -14.1-10.9<br><br>OR= 0,7; 95%[CI] 0.4-1.0 |

| Author (year) | Country | Method | Population of mother | Population of baby | Outcome (baby) | OR |
|---|---|---|---|---|---|---|
| | | | | | vs. <0.1%, n=2/85,836)<br><br>Late neonates (7–28 days) (0.2%, n=5/2,323 vs. 0.1%, n=47/85836)<br><br>Postneonatal (<28 days) (<0.1%, n=½,323 vs. 0.3%, n=230/85,836) | OR= 0,2; 95%[CI] -0.0-0.4<br><br>OR= - 0,2; 95%[CI] -0.4 - -0.1 |
| Hcini et al. (2021) [38] | France | Cohort | 137 mothers who gave birth while infected with Covid-19;<br><br>370 mothers who gave birth without Covid-19 infection | 137 neonates born to mothers positive for Covid-19;<br><br>370 neonates born to mothers negative for Covid-19, including 5 twin pregnancies | NICU admission among neonates born to Covid-19 positive and negative mothers (2.3%, n=3/127 vs. 3.2%, n=12/364)<br><br>Respiratory disorders among neonates born to Covid-19 positive and negative mothers (3.1%, n=4/127 vs. 4.3%, n=16/364)<br><br>Neonates positive for Covid-19 born to Covid-19 positive mothers (33%, n=4/29) | Not reported |
| Gupta et al. (2021) [39] | India | Retrospective cohort | 108 pregnant women tested positive for COVID-19<br><br>3057 pregnant women tested negative for COVID-19 | 3,165 neonates | 5-minute APGAR score <7 among neonates born to Covid-19 positive and negative mothers (6.48%, n=7/108 vs. 2.7%, n=83/3,057)*<br><br>Fetal distress among Covid-19 positive and negative mothers (22.2%, n=24/108 vs. 10.9%, n=334/3,057) | Not reported |
| Antoun et al. (2020) [40] | England | Retrospective cohort | 19 pregnant women tested positive for COVID-19 | 19 newborns tested negative for Covid-19 | Among the 19 neonates evaluated, 36.8% (n = 7) were born preterm. Respiratory distress syndrome was diagnosed in 15.8% (n = 3) of the cases | Not reported |
| Al Hashmi et al. (2022) [41] | Oman | Case-control | 87 pregnant women tested positive for COVID-19<br><br>87 pregnant women tested negative for COVID-19 | 87 neonates positive for Covid-19;<br>87 neonates negative for Covid-19 | Low APGAR score among neonates born to Covid-19 positive and negative mothers (1.1%, n=1/87 vs. 0%)<br>NICU admission among neonates born to Covid-19 positive and negative mothers (16.1%, n=14/87 vs. 0%) | Not reported |
| Dileep et al. (2022) [42] | United Arab Emirates | Retrospective cohort | 200 pregnant women tested positive for COVID-19 | 200 neonates | Among the 200 neonates included in the study, 35.0% (n = 70) were born preterm. Admission to the Neonatal Intensive Care Unit (NICU) was required for 33.0% (n = 66) of the cases. Low birth weight (LBW) was observed in 30.5% (n = 61) of the neonates. Additionally, neonatal infections were documented in 17.0% (n = 34) of the newborns. | Not reported |

| Author (year) | Country | Method | Population of mother | Population of baby | Outcome (baby) | OR |
|---|---|---|---|---|---|---|
| Akbarian-Rad et al. (2021) [43] | Iran | Retrospective | 8 pregnant women tested positive for COVID-19 | 8 neonates | Among the 8 neonates assessed, low birth weight (LBW) was observed in 1.25% (n = 1) of cases. | Not reported |
| Gomez et al. (2022) [44] | Brazil | Prospective study | A total of 734 pregnant women were divided into the following groups:<br><br>C0 = 357 (Covid-19 negative results)<br><br>C1 = 127 (Covid-19 positive results, asymptomatic)<br><br>C2 = 174 (Covid-19 positive with mild symptoms)<br><br>C3 = 37 (Covid-19 positive with moderate symptoms)<br><br>C4 = 39 (Covid-19 positive with severe symptoms) | 734 neonates | NICU Admission:<br>C1 (10.4%, n=13/125)<br>C2 (22%, n=39/177)<br>C3 (18.4%, n=38/207)<br>C4 (63.9%, n=23/36)<br><br>Oligohydramnios:<br>C1 (3.3%, n=4/133)<br>C2 (8.3%, n=15/181)<br>C3 (13.2%, n=5/38)<br>C4 (12.2%, n=5/41)<br><br>Fetal distress:<br>C1 (11%, n=14/127)<br>C2 (12.8%, n=23/179)<br>C3 (10.5%, n=4/38)<br>C4 (30.7%, n=12/39) | NICU Admission:<br>C1→ OR = 1.24; 95%(CI): 0.35–4.39<br>C2→OR = 3.68; 95%(CI): 1.43–9.48<br>C3→OR = 5.21; 95%(CI): 1.15–23.67<br>C4→OR = 19.36; 95%(CI): 5.86–63.99<br><br>Oligohydramnios:<br>C1→OR = 1.37; 95%(CI): 0.40–4.63<br>C2→OR = 3.77; 95%(CI): 1.15–23.67<br>C3→OR = 19.36; 95%(CI): 5.86–63.99<br><br>Fetal distress:<br>C1→OR = 1.15; 95%(CI): 0.59–2.21<br>C2→OR = 1.31; 95%(CI): 0.74–2.31<br>C3→OR = 1.04; 95%(CI): 0.35–3.12<br>C4→OR = 4.01; 95%(CI): 1.84–8.75 |

## DISCUSSION

The results showed that prematurity in perinatal and neonatal infections with COVID-19 was caused by pregnant women infected with COVID-19 during pregnancy, including acute COVID-19 [25,27]. On the other hand, the environment can trigger a significant increase in prematurity related to the ethnicity or tribe of pregnant women infected with COVID-19 and the occurrence of nosocomial transmission [28,29]. In addition to the environmental factors identified in the research of [33,42], comorbidities such as pneumonia and liver dysfunction may be significant contributing factors to premature birth.

Based on the results of studies, it was found that NICU admission was caused by prematurity and infants infected with COVID-19 from their mothers. In addition, according to [45,34], strict breathing and observation cause neonatals infected with COVID-19 to need to receive exceptional care in the NICU room. Another study reported that NICU admission can also be caused when the mother giving birth confirms COVID-19, so it is necessary to do further examination of the neonate [32]. Findings from [42] discuss multigravid pregnant women and the incidence of low birth weight babies less than 2500 grams. Moreover, pregnant women with COVID-19 have a higher risk of giving birth to babies with LBW.

In addition to the occurrence of premature outcomes, NICU admission, and low birth weight <2500 grams, mortality is also an occurrence in perinatal and neonatal. This statement is supported by previous research showing that prenatal and neonatal mortality are significantly common in pregnant women infected with COVID-19, based on laboratory results at the time of birth (30 of 3527 or 8.5 per 1000) [26]. Regarding the increased risk of fetal death and adverse pregnancy outcomes in perinatal and neonatal settings from COVID-19-infected pregnant women, [35] states that COVID-19 infection is related to the risk of morbidity and mortality of pregnant women and babies, especially if they already have symptoms and comorbidities, thereby aggravating the baby's condition. Overall, COVID-19 pregnant women have a lower rate of spontaneous deliveries but a higher rate of sectio caesarea deliveries, which is indicative of a higher rate of pregnancy complications in pregnant women with COVID-19.

## CONCLUSION

A total of 22 articles reviewed found that pregnant women with COVID-19 symptoms experience adverse outcomes in perinatal and neonatal compared to those not infected with COVID-19. Pregnant women with COVID-19 infection show a higher risk of perinatal and neonatal outcomes, such as premature, LBW, and NICU admission.

Factors contributing to perinatal and neonatal outcomes of pregnant women with COVID-19 include: COVID-19 infection, ethnicity/race, nosocomial transmission, co-morbidities, and multigravida pregnant women. The most common clinical symptoms of COVID-19 in pregnancy are cough, fever, diarrhea, gastrointestinal symptoms, stuffy nose, malaise, rhinitis, and rhinorrhea. In addition, COVID-19 related to co-morbidities worsens the condition of the mother.

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