

# BMJ Open Neonatal outcomes and indirect consequences following maternal SARS-CoV-2 infection in pregnancy: a systematic review

Sarah Sturrock <sup>1</sup>, Shohaib Ali,<sup>2</sup> Chris Gale <sup>2</sup>, Cheryl Battersby <sup>2</sup>, Kirsty Le Doare<sup>1</sup>

**To cite:** Sturrock S, Ali S, Gale C, *et al.* Neonatal outcomes and indirect consequences following maternal SARS-CoV-2 infection in pregnancy: a systematic review. *BMJ Open* 2023;**13**:e063052. doi:10.1136/bmjopen-2022-063052

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2022-063052>).

Received 13 April 2022

Accepted 15 November 2022



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

<sup>1</sup>Centre for Neonatal and Paediatric Infection, St George's University of London, London, UK

<sup>2</sup>School of Public Health, Imperial College London Faculty of Medicine, London, UK

## Correspondence to

Dr Sarah Sturrock;  
ssturrock@sgul.ac.uk

## ABSTRACT

**Objectives** To identify the association between maternal SARS-CoV-2 infection in pregnancy and individual neonatal morbidities and outcomes, particularly longer-term outcomes such as neurodevelopment.

**Design** Systematic review of outcomes of neonates born to pregnant women diagnosed with a SARS-CoV-2 infection at any stage during pregnancy, including asymptomatic women.

**Data sources** MEDLINE, Embase, Global Health, WHOLIS and LILACS databases, last searched on 28 July 2021.

**Eligibility criteria** Case-control and cohort studies published after 1 January 2020, including preprint articles were included. Study outcomes included neonatal mortality and morbidity, preterm birth, caesarean delivery, small for gestational age, admission to neonatal intensive care unit, level of respiratory support required, diagnosis of culture-positive sepsis, evidence of brain injury, necrotising enterocolitis, visual or hearing impairment, neurodevelopmental outcomes and feeding method. These were selected according to a core outcome set.

**Data extraction and synthesis** Data were extracted into Microsoft Excel by two researchers, with statistical analysis completed using IBM SPSS (Version 27). Risk of bias was assessed using a modified Newcastle-Ottawa Scale.

**Results** The search returned 3234 papers, from which 204 were included with a total of 45 646 infants born to mothers with SARS-CoV-2 infection during pregnancy across 36 countries. We found limited evidence of an increased risk of some neonatal morbidities, including respiratory disease. There was minimal evidence from low-income settings (1 study) and for neonatal outcomes following first trimester infection (17 studies). Neonatal mortality was very rare. Preterm birth, neonatal unit admission and small for gestational age status were more common in infants born following maternal SARS-CoV-2 infection in pregnancy in most larger studies.

**Conclusions** There are limited data on neonatal morbidity and mortality following maternal SARS-CoV-2 infection, particularly from low-income countries and following early pregnancy infections. Large, representative studies addressing these outcomes are needed to understand the consequences for babies born to women with SARS-CoV-2.

**PROSPERO registration number** CRD42021249818.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Large sample size both of individual studies and overall number of pregnancies and births included.
- ⇒ Focus on neonatal outcomes and indirect consequences for infants born to mothers with a diagnosis of SARS-CoV-2 during pregnancy, as opposed to purely obstetric outcomes.
- ⇒ Limited data available from low-income and middle-income countries, early pregnancy infections and more granular neonatal outcomes such as neurodevelopmental outcomes.

## INTRODUCTION

Pregnant women have been treated as an 'at risk' group for severe disease during the SARS-CoV-2 pandemic.<sup>1</sup> Initial evidence suggested that infection with SARS-CoV-2 in pregnancy was associated with severe obstetric morbidity,<sup>2</sup> including higher rates of preterm birth, pre-eclampsia and caesarean delivery.<sup>3 4</sup> Early case reports suggested that vertical transmission was possible, although rare.<sup>2 5-9</sup> However, increasingly, research indicates that neonatal infections are mostly mild,<sup>10</sup> suggesting that the risk to neonates from maternal infection is more likely to be as a result of the indirect effects of being born to a mother with SARS-CoV-2 infection, rather than from perinatal or postnatal infection with SARS-CoV-2. Other viral infections, such as Zika virus, in early pregnancy have been associated with adverse neurodevelopmental outcomes<sup>11</sup>; however, the neurodevelopmental impact of maternal SARS-CoV-2 in pregnancy is unclear.

Previous reviews of neonatal outcomes from maternal SARS-CoV-2 infections have been limited by the quality and amount of evidence available, with many studies consisting of case reports and case series or with small sample sizes.<sup>12-14</sup> As larger, population-based

or national studies emerge, an opportunity has arisen to examine neonatal outcomes following maternal infection in greater detail, including longer-term outcomes. In this systematic review, we summarise current evidence on neonatal outcomes after maternal SARS-CoV-2 infection in pregnancy, aiming to quantify the association with specific neonatal morbidities and longer-term outcomes that will be important to families.

## METHODS

The review protocol was preregistered and is available with PROSPERO (17 May 2021, ID CRD42021249818).

### Eligibility criteria

We included peer-reviewed publications of case-control and cohort studies. Preprint articles identified from relevant living systematic reviews were included. We excluded studies of overlapping populations, identified by hospital, date of study period and number of participants. Preprint articles were identified as reporting duplicate populations by the same means. We accepted studies of the babies of pregnant women with a diagnosis of SARS-CoV-2 during pregnancy. A diagnosis of SARS-CoV-2 was defined as positive PCR testing at any stage, lateral flow/rapid antigen testing or locally accepted clinical criteria in order to enable inclusion of studies early in the pandemic or in resource-limited settings where PCR testing may not have been widely available. Studies diagnosing SARS-CoV-2 infection using serology alone were only included if their participants were recruited during the first 9 months of 2020, with the assumption that these participants would mostly have contracted their primary SARS-CoV-2 infection during pregnancy. In case-control studies, we included any study with a comparison group of pregnant women without any diagnosis of SARS-CoV-2 during pregnancy. We allowed studies published after 1 January 2020, although studies published after this date but including data from prior to 1 January 2020 were also included. No language or geographic restrictions were applied.

We included studies describing any of the following infant outcomes: preterm birth (<37 weeks gestation), small for gestational age (<10th centile birth weight for gestational age on appropriate neonatal growth charts), low birth weight (defined as <2500 g), admission and length of stay in neonatal unit, level and duration of respiratory support, diagnosis of culture-positive sepsis during neonatal admission, evidence of brain injury (including seizures, abnormal brain imaging or diagnosis of hypoxic ischaemic encephalopathy),<sup>15</sup> necrotising enterocolitis, other gastrointestinal disease, visual or hearing impairment, quality of life, neurodevelopmental outcomes, exclusive breast feeding and all-cause infant mortality. Selection of neonatal outcomes was informed by a core outcome set developed with health professionals, parents and researchers.<sup>16</sup>

### Search process

MEDLINE, Embase, Global Health, WHOLIS and LILACS databases were searched (see online supplemental appendix 1 for search terms used). The LILACS database was searched for all papers relating to 'SARS-CoV-2', 'covid' and 'coronavirus', owing to its differing search functionality from the other databases. The last search was completed on 28 July 2021.

Results were uploaded to the Rayyan QCRI platform (Rayyan—a web and mobile app for systematic reviews, 2016<sup>17</sup>), and duplicates removed using the duplicate removal tool available on this platform. All titles were screened independently by two reviewers (SS and AS) and subsequently abstracts screened by both. Where there was disagreement, the title/abstract was screened by a third reviewer (CG).

Data were extracted into Microsoft Excel (V.2201) by SS or SA using a proforma with the outcomes described above, study type and dates, location, participant definition and numbers, and method of SARS-CoV-2 diagnosis. Any outcome data not reported was assumed not to have been collected as part of the study. Pregnancies were assumed to be singleton pregnancies unless otherwise specified. A modified Newcastle-Ottawa Scale<sup>18</sup> was used for assessment of study quality, with studies scoring 4 and above (out of a possible 11) deemed as eligible for inclusion. Statistical analysis was completed using Microsoft Excel, SPSS (IBM SPSS Statistics for Macintosh, V.25, 2017)<sup>19</sup> and R (R Studio V.2021.09.01<sup>20</sup>), including calculation of proportion of infants in each study with each outcome, and descriptive statistics of rates of outcomes identified. Weighted means were calculated by dividing the number of infants included in each study by the total number of infants included in the review to find a weighting factor. Each outcome rate was then multiplied by that study's weighting factor, and all the results summed to find the overall weighted mean. Independent sample Kruskal-Wallis tests were used to determine whether there was a significant difference in outcome rates between country income levels as defined by the World Bank.<sup>21</sup> Forest plots were created using R,<sup>20</sup> using a random effects model only. Further meta-analysis was not performed due to heterogeneity in study populations and outcome reporting. Results are reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

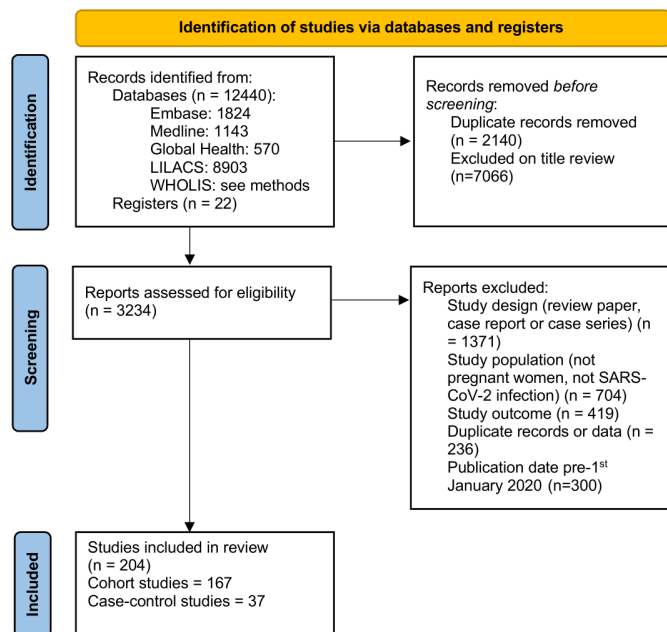
### Patient and public involvement

Patients and the public were not directly involved in the design of this study. However, this study seeks to address some of the knowledge gaps raised by expectant families as part of an online survey of women pregnant or breast feeding during the COVID-19 pandemic.<sup>22</sup>

## RESULTS

### Search results

A total of 3234 papers were identified from the literature search after duplicates were removed. A total of 204 papers were deemed as eligible for inclusion. Of these, 37 papers were case-control studies, and 167 were cohort



**Figure 1** Preferred Reporting Items for Systematic Reviews and Meta-Analyses study selection flow chart.

studies (see [figure 1](#) for PRISMA summary of study selection process). A total of 36 countries were represented, with an additional 6 international papers. Overall, 118 studies were from high-income countries, and only 1 from a low-income country.<sup>23</sup> Study periods ranged from 8 December 2019 to 18 March 2021. Across all studies, a total of 838 743 pregnancies and 786 884 live births were studied, of which 57 059 mothers had received a diagnosis of SARS-CoV-2 infection in pregnancy and had given birth to 45 646 babies. The majority of studies only included women with in their third trimester of pregnancy, with 17 (8.3%) studies including any participants in the second trimester (2%–49% of total participants in each study), and 20 (9.8%) including any first-trimester participants (1%–51% of total participants in each study). Overall, 76% of studies (156) used PCR testing alone to identify cases of SARS-CoV-2. The details of included studies can be found in [table 1](#), and a full results table is available in

|                                       |                           | Studies, n | Participants, n |
|---------------------------------------|---------------------------|------------|-----------------|
| Study type                            | Case-control              | 37         | 793 680         |
|                                       | Cohort                    | 167        | 45 063          |
| Income group                          | High                      | 118        | 809 562         |
|                                       | Upper middle              | 56         | 15 027          |
|                                       | Lower middle              | 24         | 7174            |
|                                       | Low                       | 1          | 137             |
| Stages of pregnancy included in study | First trimester included  | 20         | 2212            |
|                                       | Second trimester included | 17         | 2141            |

online supplemental appendix 2. The range of bias assessment scores according to the Newcastle-Ottawa Scale were 4–8, with a median score of 6.

### Neonatal morbidity

Of the included studies, neonatal outcomes were less commonly reported than obstetric outcomes. Need for admission to a neonatal unit was the most frequently reported outcome, with data extracted for 761 489 infants, respectively (97.2% of included infants overall). However, neonatal outcomes such as need for non-invasive respiratory support, neurological disease, sepsis and necrotising enterocolitis were only reported in a minority of infants (<95 000) and studies included in this review.

The weighted mean rate of admission to a neonatal unit for babies born to mothers infected with SARS-CoV-2 was 11%, although it was not clear in some studies how many of these admissions were for isolation purposes as opposed to clinical need. In total, 8 of the 19 case-control studies reporting neonatal unit admission rates found a significant association between neonatal unit admission and maternal infection (including 432 512 infants, in comparison to 306 407 infants included in studies finding no association, see [table 2](#) and [figure 2](#)). The need for non-invasive respiratory support among babies born to mothers with SARS-CoV-2 was reported for 6037 infants (weighted mean rate 1%, see [table 3](#)). Neurological disease (reported for 3376 SARS-CoV-2 exposed infants, range 0%–7%, weighted mean rate 0.2%), Necrotising enterocolitis (NEC - reported for 2937 SARS-CoV-2 exposed infants, weighted mean rate 0.02%) and confirmed bacterial infection (reported for 4697 SARS-CoV-2 exposed infants, range 0%–7%, weighted mean rate 0.09%) were all reported in a minority of studies. Few case-control studies reported on neonatal morbidity in detail, with only 2 studies of 88 238 infants examining the need for respiratory support, gastrointestinal disease, neurological disease and sepsis. Only 1 small case-control study of 79 infants found maternal SARS-CoV-2 infection to be associated with neurological morbidity (specifically, seizures), affecting 1 (7%) of the exposed infants and none of those non-exposed.<sup>24</sup> One large study of 88 159 infants finding an increased risk of need for respiratory support in babies born to infected mothers found that this association may be explained by prematurity.<sup>25</sup> No study controlled for prematurity in assessing the association between maternal infection and neurological morbidity.

### Birth outcomes

The method of delivery was reported in 184 studies (including 784 395 births), with a weighted mean of 38% of births occurring via caesarean. Of the 28 case-control studies reporting on caesarean delivery as an outcome, 12 studies found a significant association with maternal SARS-CoV-2, although these studies were much larger than those not finding an association (including 651 224 births as compared with 9751 births).

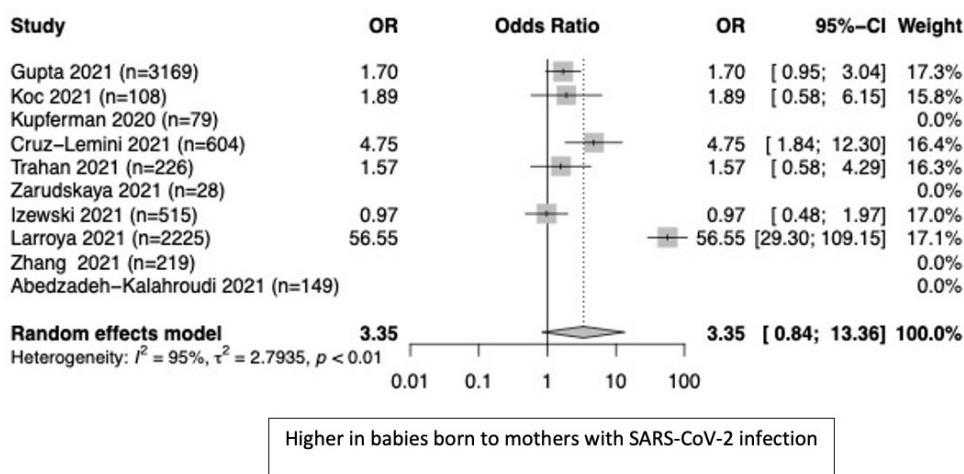
**Table 2** Results of case-control studies

|                   |   | Studies finding significant association |                            | Studies not finding significant association |                            |
|-------------------|---|---|----------------------------|---|----------------------------|
|                   |   | Studies, n                              | Participants in studies, n | Studies, n                                  | Participants in studies, n |
| Birth outcomes    | Caesarean delivery                              | 12                                      | 651 224                    | 16  | 9751                       |
|                   | Premature delivery (<37 weeks)                  | 10                                      | 648 804                    | 16  | 9807                       |
|                   | Small for gestational age                       | 1                                       | 219                        | 10  | 648 318                    |
|                   | Low birth weight                                | 1                                       | 2130                       | 1   | 110                        |
| Neonatal outcomes | Admission to neonatal care                      | 8                                       | 432 512                    | 11  | 306 407                    |
|                   | Need for non-invasive respiratory support       | 2                                       | 88 238                     | 0   | 0                          |
|                   | Need for mechanical ventilation                 | 2                                       | 88 238                     | 0   | 0                          |
|                   | Neurological disease                            | 1                                       | 79                         | 1   | 88 159                     |
|                   | Necrotising enterocolitis                       | 0                                       | 0                          | 0   | 0                          |
|                   | Other gastrointestinal disease                  | 0                                       | 0                          | 0   | 0                          |
|                   | Sepsis  | 0                                       | 0                          | 2   | 88 214                     |
| Infant outcomes   | Hearing impairment                              | 2                                       | 191                        | 0   | 0                          |
|                   | Developmental outcomes                          | 0                                       | 0                          | 0   | 0                          |
|                   | Any breast feeding (exclusive or mixed feeding) | 2                                       | 145                        | 2   | 88 422                     |
|                   | Infant or neonatal death                        | 0                                       | 0                          | 10  | 96 688                     |

Preterm birth (<37 gestational weeks) in SARS-CoV-2-affected pregnancies occurred at weighted mean rate of 14%. The median prematurity rate in SARS-CoV-2 affected pregnancies was 16%, owing to 4 smaller studies finding very high rates of prematurity. Most larger studies reported a higher risk of preterm birth (10 studies including 648 804 births), but several smaller studies did not (10 studies including 9807 births, see figure 3). Prematurity rates in pregnancies affected by SARS-CoV-2 were not significantly different across income categories, except for rates being significantly

higher in upper-middle-income countries (mean 22.7%) compared with high-income countries (mean 16.3%,  $p=0.043$ ).

A total of 54 studies reported rates of small for gestational age births, including 753 945 infants. The range was 0%–44%, and the weighted mean was 4%. Overall, 25 studies examined the rates of low birth weight. These included only 5108 infants and found a range of low birth weight rates of 0%–50%, with a weighted mean of 1%.

**Figure 2** Forest plot for neonatal intensive care unit admission.

**Table 3** Results from all COVID-19-positive pregnancies (pooled cohort studies and case-control studies)

|                          |   | Studies reporting, n | SARS-CoV-2 exposed infants included, n | Weighted mean | Range   |
|--------------------------|---|----------------------|--|---------------|---------|
| Birth outcomes           | Premature delivery (<37 weeks)            | 165                  | 42 726                                 | 13.8%         | 0%–81%  |
|                          | Small for gestational age                 | 55                   | 23 911                                 | 4.0%          | 0%–44%  |
|                          | Low birth weight                          | 25                   | 3629                                   | 1.0%          | 0%–50%  |
| Neonatal outcomes        | Admission to neonatal care                | 118                  | 31 413                                 | 11.0%         | 0%–100% |
|                          | Need for non-invasive respiratory support | 27                   | 6037                                   | 1.0%          | 0%–80%  |
|                          | Need for mechanical ventilation           | 27                   | 5341                                   | 0.4%          | 0%–20%  |
|                          | Neurological disease                      | 13                   | 3376                                   | 0.2%          | 0%–7%   |
|                          | Necrotising enterocolitis                 | 10                   | 2937                                   | 0.0%          | 0%–22%  |
|                          | Other gastrointestinal disease            | 6                    | 360                                    | 0.0%          | 0%–5%   |
|                          | Sepsis                                    | 15                   | 4697                                   | 0.1%          | 0%–7%   |
|                          | Infant outcomes                           | Hearing impairment   | 4                                      | 197           | 0.1%    |
| Developmental outcomes   | 2   | 339                  | 0.0%                                   | 0%–64%        |         |
| Breast feeding           | 38  | 7565                 | 12.0%                                  | 0%–100%       |         |
| Infant or neonatal death | 99  | 23 826               | 0.4%                                   | 0%–18%        |         |

### Breast feeding

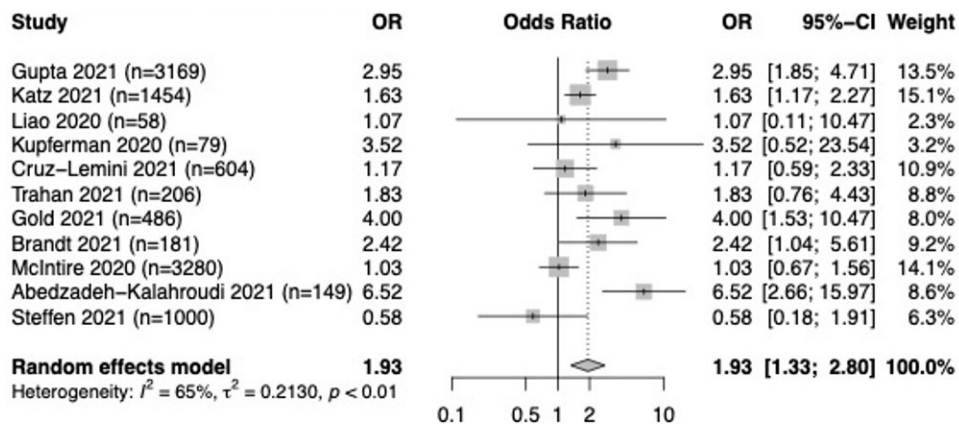
Breastfeeding rates among babies born to mothers with SARS-CoV-2 varied significantly across the 39 studies (96 174 infants) reporting this outcome: 0%–100% (weighted mean 12%). Of the studies reporting breast feeding as an outcome, 11 (28.2%) reported breastfeeding status at hospital discharge and 8 (20.5%) reported breastfeeding status at hospital discharge. The longest follow-up of breast feeding was 2 months, in three studies. In seven studies, it was unclear at what point breastfeeding status was recorded.

Four case-control studies including 88 567 babies examined breast feeding by maternal SARS-CoV-2 infection status: 2 small studies (145 infants) found a significant negative association between maternal SARS-CoV-2 infection and breast feeding,<sup>24 26</sup> whereas 2 other studies (88 422 infants) did not find any significant association

between maternal SARS-CoV-2 and breast feeding. Among studies without a SARS-CoV-2-negative comparator group, one found that asymptomatic mothers were more likely to breast feed than those with symptoms,<sup>27</sup> and one found a significant difference in breastfeeding rates both in hospital and at home between those who were separated (0% in hospital, 12.2% at home) from their babies and those who were not (22.2% in hospital, 27.8% at home).<sup>28</sup>

### Neurodevelopmental outcomes

In total, 2 cohort studies of 339 infants examined developmental outcomes. One study found that psychomotor development was normal at 6 months in all 282 infants born following maternal SARS-CoV-2 infection during pregnancy.<sup>29</sup> A second study examined neurobehavioural development using the Ages and Stages Questionnaire



Higher in babies born to mothers with SARS-CoV-2 infection

**Figure 3** Forest plot for premature delivery.



at 3 months in 57 exposed infants,<sup>30</sup> and found that 28 (63.6%) had concerning features in the social–emotional developmental domain,<sup>30</sup> and that abnormal development was associated with length of mother–baby separation.<sup>30</sup> In total, 2 studies of 191 infants found higher rates of abnormal auditory brainstem response hearing tests (44.9%, 53 vs 23.7%, 28) and poorer otoacoustic emission test results in babies born to mothers infected with SARS-CoV-2.<sup>31 32</sup>

### Mortality

In all studies reporting neonatal or infant mortality, there were 512 deaths reported. A total of 10 case–control studies of 96 688 infants examined neonatal mortality, and none found a significant difference in mortality rate between neonates born to infected mothers and controls. The only study in a low-income country reported no neonatal deaths.<sup>23</sup>

### DISCUSSION

We report the largest systematic review of neonatal and infant outcomes of babies born to women with SARS-CoV-2 in pregnancy, including 57 059 pregnancies and 45 646 babies where mothers had been infected with SARS-CoV-2 during pregnancy from 114 countries. Building on previous studies which concentrated on timing and method of delivery,<sup>3 4</sup> we have examined available data on neonatal morbidity, which may have long-term consequences. Additionally, we included pregnancies with a maternal SARS-CoV-2 infection irrespective of whether the mother was symptomatic or asymptomatic, in contrast to earlier studies focusing on hospitalised or severely unwell mothers. Unfortunately, limited study numbers made it impossible to meta-analyse outcomes in symptomatic women compared with asymptomatic women. The exclusion of case series and case reports reduced the impact of selection bias, and we excluded duplicate populations from our analysis.

### Obstetric outcomes

As in other reviews, we found that maternal infection with SARS-CoV-2 during pregnancy is associated with higher rates of prematurity.<sup>8 33 34</sup> We found that prematurity rates were highest in upper-middle-income countries, although they were similar to those in lower-middle-income countries. This could be due to iatrogenic premature delivery rather than spontaneous preterm labour, but more study will be required to determine the aetiology.

### Neonatal outcomes

We also found some evidence that maternal infection with SARS-CoV-2 is associated with increased rates of admission to the neonatal intensive care unit. The reason for this could be the increase in prematurity, as reported above, but it should be noted that some of these admissions may be for isolation purposes, an observation period, or for the care of a baby whose mother is severely unwell

and unable to care for the baby herself. Additionally, in resource-limited settings, specialist neonatal intensive care may not be available—hence, this is not a generalisable marker for neonatal morbidity in all settings.

Evidence is limited and conflicting as to the association between maternal SARS-CoV-2 in pregnancy and short-term or long-term neonatal morbidity. The strongest evidence supports an association between maternal infection and an increased risk of respiratory disease mediated by preterm birth, but not of neurological or gastrointestinal morbidity.<sup>25</sup> We identified few, small studies that examined longer-term developmental outcomes; these found an apparent association between maternal SARS-CoV-2 infection and adverse outcomes in early infancy (3 months),<sup>29 30</sup> but more studies that follow infants up over a longer time period will be needed to determine the true effect of maternal SARS-CoV-2 infection on development. It is imperative that these concerning findings are examined using standardised and validated neurodevelopmental assessments, and with the same assessment tools throughout multiple studies to allow meta-analysis. These findings also highlight the critical importance of examining neurodevelopment of offspring exposed to SARS-CoV-2 in-utero or in early life definitively through larger studies. Two small studies reported an association between maternal SARS-CoV-2 infection and offspring hearing impairment in healthy newborns without any specific risk factors for hearing impairment,<sup>31 32</sup> further supporting the importance of following up children exposed to SARS-CoV-2 in pregnancy. More recently, a systematic review has also found a potential link between maternal SARS-CoV-2 and hearing impairment, although this association remains controversial.<sup>35</sup>

We were unable to examine the impact by trimester of maternal SARS-CoV-2 infection due to a paucity of studies examining offspring of first or second trimester infection. Other viruses such as Zika virus are known to be harmful to the developing fetus when contracted in the first or second trimester,<sup>36</sup> so there is a reasonable suspicion that this could be true for SARS-CoV-2. Future studies should focus on examining this critical question, particularly as the virus becomes endemic.

Our study did not find clear evidence that maternal SARS-CoV-2 infection is associated with a reduction in breast feeding. Reductions reported in some studies may relate to mother–baby separation or maternal symptoms as opposed to a direct effect of the virus: one study finding lower breastfeeding rates in cases was based in China, which recommended against breast feeding if a lactating woman was infected with SARS-CoV-2.<sup>26</sup> Those finding no difference were based in Sweden<sup>25</sup> where there were no recommendations to restrict breast feeding, and in the USA,<sup>37</sup> we were unable to verify the exact guidance used by USA-based study hospitals at the time of data collection. We chose not to report vertical transmission of SARS-CoV-2 in this review, as identified studies varied widely in the timing and type of SARS-CoV-2 testing undertaken in

newborns, making a true diagnosis of vertical transmission difficult to accurately report.

Reassuringly, we did not find any evidence of an increased risk of neonatal or infant death with maternal SARS-CoV-2 infection. This is in contrast to other coronaviruses such as MERS, which has been linked with neonatal mortality rates of up to 33%.<sup>4</sup> However, in the studies we identified, it was difficult to determine which neonatal or infant deaths might be attributable specifically to SARS-CoV-2 infection during pregnancy. We elected not to include case reports and case series in this review, but it should be noted that cases of severe SARS-CoV-2 infections in neonates have been reported.<sup>38–40</sup> Although the incidence is likely to be low, this review does not seek to exclude severe neonatal infection with SARS-CoV-2 as a possibility.

### Country income groups

This review identifies a crucial lack of data regarding the consequences for women in lower-income settings. Our findings suggest that some of the adverse perinatal outcomes may be more common in lower-middle-income and upper-middle-income countries than in high-income countries, such as prematurity, but we had insufficient evidence to determine whether this trend continued into low-income countries. Birth rates are consistently higher in lower-income settings,<sup>41</sup> and so many more pregnant women may be affected by SARS-CoV-2 infection in these regions<sup>42</sup> where specialist neonatal care may be limited.

### Limitations

Our study has several limitations. First, we chose to include studies defining SARS-CoV-2 infection by locally accepted clinical criteria as well as by PCR test confirmation. This decision was made as, particularly in lower-resourced settings, the availability and use of PCR testing may have been limited at various points throughout the pandemic and we wanted to ensure data from these settings would be included wherever possible. Although our data may therefore include women with similar, non-COVID-19 illnesses, the majority of included studies did use PCR testing.

Although we identified many studies reporting perinatal outcomes, there was little information reporting neonatal morbidity in depth. Granular detail describing the indirect neonatal consequences of maternal SARS-CoV-2 infection during pregnancy remain unclear. This limitation is particularly pronounced for neurodevelopmental outcomes. With the SARS-CoV-2 declared pandemic 2 years ago, we hope that more information regarding these crucial outcomes will emerge soon; one trial is currently recruiting (the ASPIRE trial) which will follow-up infant outcomes for 1.5 years,<sup>43</sup> and another (the SINEPOST study) will examine development from 18 months onwards.<sup>44</sup>

It should also be acknowledged that given the time taken to accurately extract, synthesise and report outcomes, our search was last updated over a year ago. Furthermore,

we found that studies varied widely on their reporting of severity of maternal disease and maternal symptoms; therefore, we were unable to study the effect of maternal symptomology on neonatal outcomes.

Finally, we found limited evidence from middle-income, and particularly, low-income countries, and little data regarding infections in early pregnancy. These are key research priorities to allow clinicians to adequately inform expectant families.

### CONCLUSION

There is a lack of evidence surrounding neonatal morbidity and longer-term outcomes for babies born to SARS-CoV-2-infected mothers, although there is an association with prematurity, caesarean delivery and admission to the neonatal unit. Neonatal and child health researchers should attempt to address this crucial evidence gap to adequately inform families, healthcare professionals and public health responses.

**Twitter** Chris Gale @DrCGale and Cheryl Battersby @DrCBattersby

**Contributors** The study was designed by SS and SA with input from CG, CB and KLD. Data extraction and analysis was completed by SS and SA, with CG participating where there was disagreement over inclusion of papers. SS prepared the manuscript, which was reviewed and edited by all. SS is responsible for the overall content as guarantor.

**Funding** SS is an academic clinical fellow funded by the NIHR.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** Ethical approval was not required for this study, as it involved only retrieval and synthesis of data from previously published studies.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

### ORCID iDs

Sarah Sturrock <http://orcid.org/0000-0002-7968-0189>

Chris Gale <http://orcid.org/0000-0003-0707-876X>

Cheryl Battersby <http://orcid.org/0000-0002-2898-553X>

### REFERENCES

- 1 World Health Organization. Coronavirus disease (COVID-19): pregnancy and childbirth. Available: 2021. <https://www.who.int/news->



- room/q-a-detail/coronavirus-disease-covid-19-pregnancy-and-childbirth [Accessed 17 Sep 2021].
- 2 Galang RR, Chang K, Strid P, *et al.* Severe coronavirus infections in pregnancy: a systematic review. *Obstet Gynecol* 2020;136:262–72.
  - 3 Diriba K, Awulachew E, Getu E. The effect of coronavirus infection (SARS-cov-2, MERS-cov, and SARS-cov) during pregnancy and the possibility of vertical maternal-fetal transmission: a systematic review and meta-analysis. *Eur J Med Res* 2020;25:39.
  - 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;2:100107.
  - 5 Zhang P, Heyman T, Greechan M, *et al.* Maternal, neonatal and placental characteristics of SARS-cov-2 positive mothers. *J Matern Fetal Neonatal Med* 2022;35:5783–91.
  - 6 Chi H, Chiu N-C, Tai Y-L, *et al.* Clinical features of neonates born to mothers with coronavirus disease-2019: a systematic review of 105 neonates. *J Microbiol Immunol Infect* 2021;54:69–76.
  - 7 Fenizia C, Biasin M, Cetin I, *et al.* Analysis of SARS-cov-2 vertical transmission during pregnancy. *Nat Commun* 2020;11:5128.
  - 8 Chi J, Gong W, Gao Q. Clinical characteristics and outcomes of pregnant women with COVID-19 and the risk of vertical transmission: a systematic review. *Arch Gynecol Obstet* 2021;303:337–45.
  - 9 Bwire GM, Njiro BJ, Mwakawanga DL, *et al.* Possible vertical transmission and antibodies against SARS-cov-2 among infants born to mothers with COVID-19: a living systematic review. *J Med Virol* 2021;93:1361–9.
  - 10 Gale C, Quigley MA, Placzek A, *et al.* Characteristics and outcomes of neonatal SARS-cov-2 infection in the UK: a prospective national cohort study using active surveillance. *Lancet Child Adolesc Health* 2021;5:113–21.
  - 11 Royal College of Obstetricians and Gynaecologists. Zika virus infection and pregnancy. 2019.
  - 12 Chmielewska B, Barratt I, Townsend R, *et al.* Effects of the COVID-19 pandemic on maternal and neonatal outcomes: a systematic review and meta-analysis. *Lancet Glob Health* 2021;9:e759–72.
  - 13 Di Toro F, Gjoka M, Di Lorenzo G, *et al.* Impact of COVID-19 on maternal and neonatal outcomes: a systematic review and meta-analysis. *Clin Microbiol Infect* 2021;27:36–46.
  - 14 Banaei M, Ghasemi V, Saei Ghare Naz M, *et al.* Obstetrics and neonatal outcomes in pregnant women with covid-19: a systematic review. *Iran J Public Health* 2020;49(Suppl 1):38–47.
  - 15 Gale C, Statnikov Y, Jawad S, *et al.* Neonatal brain injuries in England: population-based incidence derived from routinely recorded clinical data held in the National neonatal research database. *Arch Dis Child Fetal Neonatal Ed* 2018;103:F301–6.
  - 16 Webbe JWH, Duffy JMN, Afonso E, *et al.* Core outcomes in neonatology: development of a core outcome set for neonatal research. *Arch Dis Child Fetal Neonatal Ed* 2020;105:425–31.
  - 17 Ouzzani M, Hammady H, Fedorowicz Z, *et al.* Rayyan-a web and mobile APP for systematic reviews. *Syst Rev* 2016;5:210.
  - 18 Wells G, Shea B, O'Connell D, *et al.* The newcastle-ottawa scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. *ottawa hosp. res. inst.* 2020. Available: [http://www.ohri.ca/programs/clinical\\_epidemiology/oxford.asp](http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp) [Accessed 6 Nov 2015].
  - 19 IBM. SPSS statistics for macintosh. 2020.
  - 20 R Core Team. R: A language and environment for statistical computing. 2021.
  - 21 World Bank. World bank country and lending groups. Available: 2020. <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups> [Accessed 21 May 2015].
  - 22 Sturrock S, Turner K, Lee-Wo C, *et al.* The COVID19 pandemic has changed women's experiences of pregnancy in the UK. *Infectious Diseases (except HIV/AIDS)* [Preprint] 2021.
  - 23 Hcini N, Maamri F, Picone O, *et al.* Maternal, fetal and neonatal outcomes of large series of SARS-cov-2 positive pregnancies in peripartum period: a single-center prospective comparative study. *Eur J Obstet Gynecol Reprod Biol* 2021;257:11–8.
  - 24 Farghaly MAA, Kupferman F, Castillo F, *et al.* Characteristics of newborns born to SARS-cov-2-positive mothers: a retrospective cohort study. *Am J Perinatol* 2020;37:1310–6.
  - 25 Norman M, Navér L, Söderling J, *et al.* Association of maternal SARS-cov-2 infection in pregnancy with neonatal outcomes. *JAMA* 2021;325:2076–86.
  - 26 Peng S, Zhu H, Yang L, *et al.* A study of breastfeeding practices, SARS-cov-2 and its antibodies in the breast milk of mothers confirmed with COVID-19. *Lancet Reg Health West Pac* 2020;4.
  - 27 Abdulghani SH, Shaiba LA, Bukhari MA. Consequences of SARS-cov-2 disease on maternal, perinatal and neonatal outcomes: a retrospective observational cohort study. *Clinical and Experimental Obstetrics & Gynecology* 2021;48:353.
  - 28 Popofsky S, Noor A, Leavens-Maurer J, *et al.* Impact of maternal severe acute respiratory syndrome coronavirus 2 detection on breastfeeding due to infant separation at birth. *J Pediatr* 2020;226:64–70.
  - 29 Vazquez SV, Carrasco I, Perez AP, *et al.* Microbiological features and follow-up of neonates born to mothers with covid-19. *Top Antivir Med* 2021;29. Available: <https://120qrk11gh163n79gg1cg656-wpengine.netdna-ssl.com/wp-content/uploads/2021/03/march-2021.pdf>
  - 30 Wang Y, Chen L, Wu T, *et al.* Impact of covid-19 in pregnancy on mother's psychological status and infant's neurobehavioral development: a longitudinal cohort study in china. *BMC Med* 2020;18:347.
  - 31 Alan MA, Alan C. Hearing screening outcomes in neonates of SARS-cov-2 positive pregnant women. *Int J Pediatr Otorhinolaryngol* 2021;146:110754. 10.1016/j.ijporl.2021.110754 Available: <http://orcid.org/0000-0002-2039-8701>
  - 32 Celik T, Simsek A, Koca CF, *et al.* Evaluation of cochlear functions in infants exposed to SARS-cov-2 intrauterine. *Am J Otolaryngol* 2021;42:102982.
  - 33 Khalil A, Kalafat E, Benlioglu C, *et al.* SARS-cov-2 infection in pregnancy: a systematic review and meta-analysis of clinical features and pregnancy outcomes. *EClinicalMedicine* 2020;25:100446.
  - 34 Di TF, Gjoka M, Di LG, *et al.* Since january 2020 elsevier has created a COVID-19 resource centre with free information in english and mandarin on the novel coronavirus COVID- 19. the COVID-19 resource centre is hosted on elsevier connect, the company ' s public news and information. 2020.
  - 35 Meng X, Zhu K, Wang J, *et al.* Can SARS-cov-2 positive pregnant women affect the hearing of their newborns: a systematic review. *Am J Otolaryngol* 2022;43:103523.
  - 36 Souza JP, Méio M, de Andrade LM, *et al.* Adverse fetal and neonatal outcomes in pregnancies with confirmed zika virus infection in rio de janeiro, brazil: a cohort study. *PLoS Negl Trop Dis* 2021;15:e0008893.
  - 37 Flaherman VJ, Afshar Y, Boscardin WJ, *et al.* Infant outcomes following maternal infection with severe acute respiratory syndrome coronavirus 2 (SARS-cov-2): first report from the pregnancy coronavirus outcomes registry (priority) study. *Clin Infect Dis* 2021;73:e2810–3.
  - 38 Shaiba LA, Hadid A, Altirkawi KA, *et al.* Case report: neonatal multi-system inflammatory syndrome associated with SARS-cov-2 exposure in two cases from saudi arabia. *Front Pediatr* 2021;9:652857.
  - 39 Sagheb S, Lamsehchi A, Jafary M, *et al.* Two seriously ill neonates born to mothers with COVID-19 pneumonia- a case report. *Ital J Pediatr* 2020;46:137.
  - 40 Hinojosa-Velasco A, de Oca P-M, García-Sosa LE, *et al.* A case report of newborn infant with severe COVID-19 in mexico: detection of SARS-cov-2 in human breast milk and stool. *Int J Infect Dis* 2020;100:21–4.
  - 41 World Bank. Data bank. 2021. Available: <https://databank.worldbank.org/reports.aspx?source=2&series=SP.DYN.IMRT.IN&country=LIC,HIC,MIC> [Accessed 15 Jun 2021].
  - 42 Our World in Data. Total confirmed COVID-19 cases. Available: <https://ourworldindata.org/grapher/covid-cases-income> [Accessed 15 Jun 2021].
  - 43 Huddleston H, Jaswa E, Gaw S, *et al.* ASPIRE: A ssessing the S afety of P regnancy I n the co R onavirus pand E mic our team. 2021. Available: <https://aspire.ucsf.edu> [Accessed 4 Aug 2021].
  - 44 Action Medical Research For Children. COVID-19 – understanding the impact of exposure to SARS-cov-2 early in life on a child's brain development and mental health. 2021. Available: <https://action.org.uk/research/covid-19-understanding-impact-exposure-sars-cov-2-early-life-childs-brain-development-and> [Accessed 4 Aug 2021].



Appendix 1 – Search strategy

Embase search via Ovid, last updated 28/07/2021.

| #  | Searches   | Results |
|----|--|---------|
| 1  | Pregnan*   | 723025  |
| 2  | Third trimester pregnancy/ or first trimester pregnancy/ or “parameters concerning the fetus, newborn and pregnancy”/ or pregnancy/ or pregnancy complication/ or high risk pregnancy/ or pregnancy disorder/ or second trimester pregnancy/ or pregnancy outcome/ | 498419  |
| 3  | Antenat*   | 51397   |
| 4  | Gestat*  | 297546  |
| 5  | Matern*  | 379690  |
| 6  | Maternity ward/ or maternity care/   | 21247   |
| 7  | Breastfeed*  | 35731   |
| 8  | Breast feeding/ or mother/ or breast milk/   | 140234  |
| 9  | Lactat*  | 227694  |
| 10 | Lactation/   | 39318   |
| 11 | 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10  | 1220052 |
| 12 | COVID*   | 147977  |
| 13 | Sars-cov-2   | 52773   |
| 14 | Coronavirus  | 166814  |
| 15 | Severe acute respiratory syndrome coronavirus 2/ or coronavirus disease 2019/ or coronavirus infection/  | 146237  |
| 16 | 12 or 13 or 14 or 15   | 187862  |
| 17 | Stillb*  | 23397   |
| 18 | Stillbirth/ or congenital malformation/  | 98283   |
| 19 | Intrauterine adj demise  | 239     |
| 20 | Intrauterine adj death   | 1647    |
| 21 | Pregnancy adj loss   | 10662   |
| 22 | Miscarr*   | 25084   |
| 23 | Spontaneous adj abortion   | 39613   |
| 24 | Spontaneous abortion/  | 38012   |
| 25 | Fetus death/   | 15764   |
| 26 | 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25   | 158662  |
| 27 | Neonat*  | 303927  |
| 28 | Infan*   | 701133  |
| 29 | Newborn/   | 366307  |
| 30 | Infant/ or hospitalized infant/ or infant disease/ or infant mortality/ or high risk infant/ or infant care/   | 477647  |
| 31 | 27 or 28 or 29 or 30   | 995198  |
| 32 | Infect*  | 2546071 |
| 33 | Infection/ or infection complication/ or infection risk/ or intrauterine infection/ or perinatal infection/  | 378561  |

|    |  |         |
|----|--|---------|
| 34 | Sepsis   | 201867  |
| 35 | Newborn sepsis/ or sepsis/   | 157457  |
| 36 | Nicu or neonatal adj admission   | 2739    |
| 37 | Newborn intensive care/ or neonatal intensive care unit/   | 37168   |
| 38 | Premat*  | 263202  |
| 39 | Prematurity/ or premature labour/  | 130336  |
| 40 | Small adj for adj gestational adj age or sga   | 20340   |
| 41 | Small for date infant/   | 15970   |
| 42 | Low adj birthweight  | 7252    |
| 43 | Low birth weight/  | 31063   |
| 44 | Operative adj delivery   | 1711    |
| 45 | Instrumental delivery/   | 3855    |
| 46 | Caesarean or c-section or cesarean   | 107540  |
| 47 | Cesarean section/  | 92477   |
| 48 | Instrumental delivery or ventouse or forceps or vacuum extraction  | 27358   |
| 49 | Vacuum extraction/ or forceps delivery/ or forceps/  | 13907   |
| 50 | Ventilat*  | 291355  |
| 51 | Respiratory adj distress   | 100158  |
| 52 | CPAP or BiPAP  | 18918   |
| 53 | Ventilated patient/ or artificial ventilation/   | 137133  |
| 54 | Continuous positive airway pressure/ or bilevel positive airway pressure   | 3083    |
| 55 | Respiratory distress/  | 32246   |
| 56 | Seizure or convulsion or fit   | 361565  |
| 57 | Seizure/ or "seizure, epilepsy or convulsion"/   | 133064  |
| 58 | Hypoxic ischaemic encephalopathy or hie  | 12140   |
| 59 | Hypoxic ischaemic encephalopathy/  | 8490    |
| 60 | Therapeutic cooling or induced hypothermia   | 171749  |
| 61 | Brain ischemia/ or induced hypothermia/ or cooling/  | 171749  |
| 62 | MRI or magnetic resonance imaging or eeg or electroencephalogram or cruss or cranial ultrasound or brain scan or brain imaging | 1108432 |
| 63 | Neuroimaging/ or nuclear magnetic resonance imaging/ or functional magnetic resonance imaging/ or electroencephalogram/        | 1011212 |
| 64 | Hypoton* or hyperton* or abnormal tone or spasticity or cerebral palsy or neurological disease or neurological abnormality     | 118366  |
| 65 | Spasticity/ or cerebral palsy/ or muscle hypertonia/ or neurologic disease/  | 176148  |
| 66 | Cognitive ability or learning difficulty or learning disability or developmental delay   | 36605   |
| 67 | Learning disorder/ or developmental delay/ or developmental disorder/ or mental deficiency/                                    | 93582   |

|    |   |         |
|----|---|---------|
| 68 | Gastrointestinal disease or nec or necrotising enterocolitis or necrotizing enterocolitis | 104188  |
| 69 | Gastrointesinal disease/ or necrotizing enterocolitis/                                    | 95690   |
| 70 | Visual impairment or visually impaired or blind*  | 494101  |
| 71 | Visual impairment/ or blindness/  | 73184   |
| 72 | Hearing impair* or deaf*  | 87073   |
| 73 | Hearing impairment/   | 46891   |
| 74 | Quality of life or "quality of life"/   | 637206  |
| 75 | Vertical transmi*   | 17715   |
| 76 | Vertical transmission/  | 14908   |
| 77 | 32-76, combined with OR   | 5907734 |
| 78 | 77 and 31   | 459481  |
| 79 | 78 or 26  | 593511  |
| 80 | 11 and 16 and 79  | 1824    |

Medline search via Ovid, last updated 28/07/2021.

| #  | Searches  | Results |
|----|---|---------|
| 1  | Pregnan*  | 1047802 |
| 2  | Pregnancy trimester, third/ or pregnancy trimester, second/ or pregnancy trimester, first/ or pregnancy/ or pregnancy, high-risk/ or pregnancy outcome/ or pregnancy complications/ | 911420  |
| 3  | Antenat*  | 41206   |
| 4  | Prenatal care/  | 29574   |
| 5  | Gestat*   | 261469  |
| 6  | Matern*   | 359413  |
| 7  | Perinatal care/   | 4983    |
| 8  | Breastfeed*   | 30017   |
| 9  | Breast feeding/ or mothers/   | 81408   |
| 10 | Lactat*   | 224527  |
| 11 | Lactation/  | 44082   |
| 12 | 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11   | 1454976 |
| 13 | COVID*  | 156147  |
| 14 | Sars-cov-2  | 99388   |
| 15 | Coronavirus   | 98845   |
| 16 | Covid-19/ or sars-cov-2/ or coronavirus/  | 97776   |
| 17 | 13 or 14 or 15 or 16  | 175760  |
| 18 | Stillb*   | 17756   |
| 19 | Stillbirth/   | 5353    |
| 20 | Intrauterine adj demise   | 142     |
| 21 | Intrauterine adj death  | 1477    |
| 22 | Pregnancy adj loss  | 6997    |
| 23 | Miscarr*  | 15892   |
| 24 | Spontaneous adj abortion  | 7719    |

|    |  |         |
|----|--|---------|
| 25 | Spontaneous abortion/  | 20453   |
| 26 | Fetal death/ or congenital abnormalities/  | 57641   |
| 27 | 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26   | 106523  |
| 28 | Neonat*  | 309101  |
| 29 | Infan*   | 1335539 |
| 30 | Infant, newborn/   | 626610  |
| 31 | Infant/ or infant care/ or infant mortality/ or infant death/ or infant health/                    | 841541  |
| 32 | 28 or 29 or 30 or 31   | 1450833 |
| 33 | Infect*  | 2447138 |
| 34 | Infections/  | 39946   |
| 35 | Sepsis   | 133814  |
| 36 | Neonatal sepsis/ or sepsis/  | 63823   |
| 37 | Nicu or neonatal admission   | 11656   |
| 38 | Intensive care units, neonatal/  | 15858   |
| 39 | Premat*  | 223778  |
| 40 | Infant, premature/ or gestational age/ or premature birth/   | 139364  |
| 41 | Small for gestational age or sga   | 16965   |
| 42 | Infant, small for gestational age/ or birth weight/  | 46772   |
| 43 | Low adj birthweight  | 7841    |
| 44 | Infant, low birth weight/  | 19191   |
| 45 | Operative adj delivery   | 1256    |
| 46 | Extraction, obstetrical/   | 2534    |
| 47 | Caesarean or c-section or cesarean   | 78432   |
| 48 | Cesarean section/ or delivery, obstetric/  | 72546   |
| 49 | Instrumental delivery or ventouse or forceps or vacuum extraction                                  | 14655   |
| 50 | Vacuum extraction, obstetrical/ or obstetrical forceps/  | 2720    |
| 51 | Ventilat*  | 201282  |
| 52 | Respiratory adj distress   | 61778   |
| 53 | CPAP or BiPAP or Continuous positive airway pressure or bilevel positive airway pressure           | 16071   |
| 54 | Ventilation/ or respiration, artificial/   | 58137   |
| 55 | Continuous positive airway pressure/ or positive-pressure respiration/ or noninvasive ventilation/ | 27370   |
| 56 | Respiratory distress syndrome/   | 21490   |
| 57 | Seizure or convulsion or fit   | 208598  |
| 58 | Seizures/  | 56493   |
| 59 | Hypoxic ischaemic encephalopathy or hypoxic ischemic encephalopathy or hie                         | 5083    |
| 60 | Hypoxia-ischaemia, brain/ or asphyxia neonatorum   | 13249   |
| 61 | Therapeutic cooling or induced hypothermia   | 2598    |
| 62 | Brain ischemia/ or hypothermia, induced/   | 75818   |

|    |  |         |
|----|--|---------|
| 63 | MRI or magnetic resonance imaging or eeg or electroencephalogram or cruss or cranial ultrasound or brain scan or brain imaging | 707043  |
| 64 | Neuroimaging/ or magnetic resonance imaging/ or electroencephalogram/  | 575390  |
| 65 | Hypoton* or hyperton* or abnormal tone or spasticity or cerebral palsy or neurological disease or neurological abnormality     | 103230  |
| 66 | Muscle spasticity/ or cerebral palsy/ or muscle hypertonia/ or muscle hypotonia/ or nervous system diseases/                   | 78506   |
| 67 | Cognitive ability or learning difficulty or learning disability or developmental delay   | 23602   |
|    | Learning disabilities/ or developmental disabilities/ or intellectual disability/  | 87101   |
| 69 | Gastrointestinal disease or nec or necrotising enterocolitis or necrotizing enterocolitis                                      | 15271   |
| 70 | Gastrointestinal diseases/ or enterocolitis, necrotizing/  | 43975   |
| 71 | Visual impairment or visually impaired or blind*   | 395483  |
| 72 | Vision disorders/  | 28486   |
| 73 | Hearing impair* or deaf*   | 62891   |
| 74 | Hearing loss/ or deafness/ or persons with hearing impairments/  | 43064   |
| 75 | Quality of life or "quality of life"/  | 380511  |
| 76 | Vertical transmi*  | 7322    |
| 77 | Infectious disease transmission, vertical/   | 17257   |
| 78 | 33-77, combined with OR  | 5028529 |
| 79 | 78 and 32  | 548597  |
| 80 | 79 or 27   | 636683  |
| 81 | 12 and 17 and 80   | 1143    |

Global health search via Ovid, last updated 28/07/2021

| # | Searches  | Results |
|---|---|---------|
| 1 | Pregnan*  | 126717  |
| 2 | Pregnancy trimester, third/ or pregnancy trimester, second/ or pregnancy trimester, first/ or pregnancy/ or pregnancy, high-risk/ or pregnancy outcome/ or pregnancy complications/ | 99638   |
| 3 | Antenat*  | 17826   |
| 4 | Prenatal care/  | 3506    |
| 5 | Gestat*   | 112821  |
| 6 | Matern*   | 86406   |
| 7 | Breastfeed*   | 25392   |
| 8 | Breast feeding/ or mothers/   | 51651   |

|    |  |         |
|----|--|---------|
| 9  | Lactat*  | 50673   |
| 10 | Lactation/   | 12941   |
| 11 | 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10  | 229179  |
| 12 | COVID*   | 36404   |
| 13 | Sars-cov-2   | 15628   |
| 14 | Coronavirus  | 44855   |
| 15 | Severe acute respiratory syndrome coronavirus/   | 5256    |
| 16 | 12 or 13 or 14 or 15   | 46013   |
| 18 | Stillb*  | 4753    |
| 19 | Stillbirth/  | 4006    |
| 20 | Intrauterine adj demise  | 9       |
| 21 | Intrauterine adj death   | 139     |
| 22 | Pregnancy adj loss   | 923     |
| 23 | Miscarr*   | 3987    |
| 24 | Spontaneous adj abortion   | 3435    |
| 25 | Spontaneous abortion/  | 2942    |
| 26 | Fetal death/ or congenital abnormalities/  | 15922   |
| 27 | 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26                                       | 21539   |
| 28 | Neonat*  | 59142   |
| 29 | Infan*   | 156485  |
| 30 | Neonates/ or infants/  | 122421  |
| 31 | Infant care/ or infant mortality/ or infant death/ or infant health/                     | 5195    |
| 32 | 28 or 29 or 30 or 31   | 176742  |
| 33 | Infect*  | 1187975 |
| 34 | Infections/  | 488566  |
| 35 | Sepsis   | 25827   |
| 36 | Sepsis/  | 18064   |
| 37 | Nicu or neonatal admission   | 2676    |
| 38 | Premat*  | 32208   |
| 39 | Premature infants/ or prematurity/   | 20675   |
| 40 | Small for gestational age or sga   | 4240    |
| 41 | Infant, small for gestational age/ or birth weight/                                      | 13532   |
| 42 | Low adj birthweight  | 3185    |
| 43 | Low birth weight infants/  | 8798    |
| 44 | Operative adj delivery   | 117     |
| 45 | Caesarean or c-section or cesarean   | 9334    |
| 46 | Caesarean section/   | 5734    |
| 47 | Instrumental delivery or ventouse or forceps or vacuum extraction                        | 863     |
| 48 | Parturition complications/   | 1384    |
| 49 | Ventilat*  | 20633   |
| 50 | Respiratory adj distress   | 6548    |
| 51 | CPAP or BiPAP or Continuous positive airway pressure or bilevel positive airway pressure | 701     |
| 52 | Ventilation/ or artificial respiration/  | 4243    |

|    |  |         |
|----|--|---------|
| 53 | Acute respiratory distress syndrome/   | 1453    |
| 54 | Seizure or convulsion or fit   | 27459   |
| 55 | Seizures/  | 3152    |
| 56 | Hypoxic ischaemic encephalopathy or hypoxic ischemic encephalopathy or hie   | 456     |
| 57 | Therapeutic cooling or induced hypothermia   | 157     |
| 58 | MRI or magnetic resonance imaging or eeg or electroencephalogram or cruss or cranial ultrasound or brain scan or brain imaging | 15860   |
| 59 | Magnetic resonance imaging/ or electroencephalogram/   | 6065    |
| 60 | Hypoton* or hyperton* or abnormal tone or spasticity or cerebral palsy or neurological disease or neurological abnormality     | 5668    |
| 61 | Cerebral palsy/ or nervous system diseases/  | 18651   |
| 62 | Cognitive ability or learning difficulty or learning disability or developmental delay   | 1816    |
| 63 | Learning disabilities/ or mental disorders/ or people with mental disabilities/  | 49942   |
| 64 | Gastrointestinal disease or nec or necrotising enterocolitis or necrotizing enterocolitis                                      | 3697    |
| 65 | Gastrointestinal diseases/   | 10201   |
| 66 | Visual impairment or visually impaired or blind*   | 48935   |
| 67 | Vision disorders/  | 3331    |
| 68 | Hearing impair* or deaf*   | 5024    |
| 69 | Hearing impairment/ or deafness/ or people with hearing impairment/  | 4259    |
| 70 | Quality of life or "quality of life"/  | 35856   |
| 71 | Vertical transmi*  | 5345    |
| 72 | Vertical transmission/   | 3839    |
| 73 | 33-72, combined with OR  | 1392378 |
| 74 | 72 and 32  | 93930   |
| 75 | 74 or 27   | 110446  |
| 76 | 75 and 16 and 11   | 570     |

## LILACS

|   |                                    |      |
|---|------------------------------------|------|
| 1 | SARS-CoV-2 or COVID or Coronavirus | 8903 |
|---|------------------------------------|------|

| Title   | Year | First author  | ID                                     | Country      | Start date | End date   | Type of study | Bias assessment | Number of mothers total | Number of case mothers | Number of babies total | Number of case babies | Population   | Exposure   |
|---|------|---------------|--|--------------|------------|------------|---------------|-----------------|-------------------------|------------------------|------------------------|-----------------------|--|--|
| Vertical transmission and kidney damage in newborns whose mothers had coronavirus disease 2019 during pregnancy   | 2020 | He            | DOI: 10.1016/j.ijantimicag.2020.106260 | China        | 01/01/2020 | 01/04/2020 | Cohort        | 4               | 22                      | 22                     | 22                     | 22                    | All neonates born to mothers with COVID-19 at one centre                         | COVID-19 diagnosed on clinical criteria  |
| Increased C-sections and preterm births in SARS-CoV-2 infection during pregnancy  | 2021 | Carrasco      | WHO: covidwho-1250003                  | Spain        | 15/03/2020 | 31/07/2020 | Cohort        | 5               | 105                     | 105                    | 107                    | 107                   | Infected pregnant women  |  |
| Microbiological features and follow-up of neonates born to mothers with covid-19  | 2021 | Vazquez       | WHO: covidwho-1250829                  | Spain        | 15/03/2020 | 30/11/2020 | Cohort        | 5               | 115                     | 115                    | 282                    | 282                   | All exposed neonates, 130 in first wave and 152 in second wave                   | Laboratory-confirmed COVID-19 infection, unclear of method of confirmation               |
| COVID-19 infection in high-risk south african pregnancies with and without HIV  | 2021 | De Waard      | WHO: covidwho-1250086                  | South Africa | 01/05/2020 | 31/07/2020 | Cohort        | 5               | 100                     | 100                    | 91                     | 91                    | All pregnant women   | Laboratory-confirmed COVID-19 infection, unclear of method of confirmation               |
| The impact of the novel coronavirus infection COVID-19 on the mother-placenta-fetus system  | 2021 | Nizyaeva      | DOI: 10.24075/brsmu.2021.020           | Russia       | 01/03/2020 | 01/05/2020 | Cohort        | 5               | 66                      | 66                     | 42                     | 42                    | All pregnant women. Multiple pregnancies excluded.                               | PCR-confirmed COVID-19 and control group with negative PCR test and no signs of COVID-19 |
| Clinical outcomes of maternal and neonate with COVID-19 infection - Multicenter study in Saudi Arabia   | 2021 | Al-Matary     | DOI: 10.1016/j.jiph.2021.03.013        | Saudi Arabia | 01/03/2020 | 01/11/2020 | Cohort        | 5               | 288                     | 288                    | 200                    | 200                   | All pregnant women   | PCR-confirmed COVID-19   |
| Characteristics, clinical and laboratory data and outcomes of pregnant women with confirmed SARS-CoV-2 infection admitted to Al-Zahra tertiary referral maternity center in Iran: a case series of 24 patients  | 2021 | Vaezi         | DOI: 10.1186/s12884-021-03764-y        | Iran         | 10/03/2020 | 15/04/2020 | Cohort        | 5               | 24                      | 24                     | 11                     | 11                    | All pregnant women   | Laboratory-confirmed COVID-19 infection, unclear of method of confirmation               |
| Outcomes of newborns to mothers with COVID-19   | 2021 | Ghema         | DOI: 10.1016/j.idnow.2021.03.003       | Morocco      | 01/01/2020 | 01/12/2020 | Cohort        | 6               | 30                      | 30                     | 30                     | 30                    | All neonates admitted to NICU whose mothers had COVID-19                         |  |
| SARS-CoV-2 prevalence and maternal-perinatal outcomes among pregnant women admitted for delivery: Experience from COVID-19-dedicated maternity hospital in Jammu, Jammu and Kashmir (India)                     | 2021 | Gupta         | DOI: 10.1002/jmv.27074                 | India        | 01/09/2020 | 30/11/2020 | Case-control  | 6               | 3165                    | 108                    | 3165                   | 108                   | All pregnant women delivering during study period                                | PCR-confirmed COVID-19   |
| Prevalence, clinical features, and outcomes of SARS-CoV-2 infection in pregnant women with or without mild/moderate symptoms: Results from universal screening in a tertiary care center in Mexico City, Mexico | 2021 | Cardona-Perez | DOI: 10.1371/journal.pone.0249584      | Mexico       | 22/04/2020 | 25/05/2020 | Case-control  | 7               | 250                     | 70                     | 219                    | 39                    | All pregnant women who were asymptomatic or with mild/moderate COVID-19 symptoms | PCR-confirmed COVID-19   |



|  |      |                      |                                       |  |            |            |        |   |      |      |      |      |   |  |
|--|------|----------------------|---------------------------------------|--|------------|------------|--------|---|------|------|------|------|---|--|
| Course of Covid 19 and fetomaternal outcome at a tertiary care hospital  | 2021 | Furrukh              | ISSN: 2957-899X                       | Pakistan                                     | 08/04/2020 | 07/07/2020 | Cohort | 5 | 47   | 47   | 24   | 24   | All pregnant women  | PCR-confirmed COVID-19   |
| Clinical and obstetric characteristics of pregnant women with Covid-19: A case series study on 26 patients   | 2021 | Abedzadeh-Kalahroudi | DOI: 10.1016/j.tjog.2021.03.012       | Iran   | 01/03/2020 | 01/05/2020 | Cohort | 5 | 56   | 56   | 55   | 55   | All pregnant women  | PCR or radiological diagnosis of COVID-19                                  |
| Fetal and perinatal outcome following first and second trimester covid-19 infection: Evidence from a prospective cohort study  | 2021 | Rosen                | DOI: 10.3390/jcm10102152              | Israel                                       | 01/03/2020 | 01/02/2021 | Cohort | 6 | 55   | 55   | 29   | 29   | All pregnant women  | PCR-confirmed COVID-19 before 26 weeks gestation                           |
| Hearing screening outcomes in neonates of SARS-CoV-2 positive pregnant women   | 2021 | Alan                 | DOI: 10.1016/j.jiporl.2021.110754     | Turkey                                       | 01/04/2020 | 01/12/2020 | Cohort | 7 | 141  | 141  | 118  | 118  | All neonates born to mothers with COVID-19, multiple gestation and risk factors for hearing loss excluded | PCR-confirmed COVID-19   |
| Perinatal outcomes of pregnancies resulting from assisted reproduction technology in SARS-CoV-2-infected women: a prospective observational study  | 2021 | Calvo                | DOI: 10.1016/j.fertnstert.2021.04.005 | Spain  | 26/02/2020 | 05/11/2020 | Cohort | 6 | 1347 | 1347 | 1347 | 1347 | All pregnant women  | PCR-confirmed COVID-19   |
| The incidence, characteristics and outcomes of pregnant women hospitalized with symptomatic and asymptomatic SARS-CoV-2 infection in the UK from March to September 2020: A national cohort study using the UK Obstetric Surveillance System (UKOSS) | 2021 | Vousden              | DOI: 10.1371/journal.pone.0251123     | UK   | 01/03/2020 | 31/08/2020 | Cohort | 7 | 1148 | 1148 | 1019 | 1019 | All hospitalised pregnant women   | PCR-confirmed COVID-19   |
| Neonatal SARS-CoV-2 infections in breastfeeding mothers  | 2021 | Shlomai              | DOI: 10.1542/peds.2020-010918         | Israel                                       | 01/03/2020 | 01/05/2020 | Cohort | 5 | 53   | 53   | 55   | 55   | All pregnant women delivering during study period   | PCR-confirmed COVID-19   |
| COVID-19 in pregnancy-characteristics and outcomes of pregnant women admitted to hospital because of SARS-CoV-2 infection in the Nordic countries  | 2021 | Engjom               | DOI: 10.1111/aogs.14160               | Denmark, Finland, Iceland, Sweden and Norway | 01/03/2020 | 30/06/2020 | Cohort | 5 | 56   | 56   | 51   | 51   | All pregnant women admitted to hospital for at least 24h  | PCR-confirmed SARS-CoV-2 in 14 days before admission                       |
| Consequences of SARS-CoV-2 disease on maternal, perinatal and neonatal outcomes: A retrospective observational cohort study  | 2021 | Abdulghani           | DOI: 10.31083/j.ceog.2021.02.2361     | Saudi Arabia                                 | 01/03/2020 | 31/05/2020 | Cohort | 6 | 62   | 62   | 63   | 63   | All pregnant women  | PCR-confirmed COVID-19   |
| Pre and post-natal epidemiological and clinical features of neonates born from mothers infected with COVID-19 and 14-day follow-up post discharge in Lima, Peru  | 2021 | Lizama               | DOI: 10.20453/RMH.V32i1.3942          | Peru   | 15/03/2020 | 30/06/2020 | Cohort | 6 | 206  | 206  | 206  | 206  | All pregnant women  | Laboratory-confirmed COVID-19 infection, unclear of method of confirmation |
| Childbirth care among sars-cov-2 positive women in Italy   | 2021 | Donati               | DOI: 10.3390/ijerph18084244           | Italy  | 25/02/2020 | 31/07/2020 | Cohort | 5 | 525  | 525  | 538  | 538  | All pregnant women; until end of March 2020 only symptomatic and contacts screened, then all              | PCR-confirmed COVID-19   |

|   |      |             |  |               |            |            |              |   |       |      |       |      |   |   |
|---|------|-------------|--|---------------|------------|------------|--------------|---|-------|------|-------|------|---|---|
| Association of Maternal SARS-CoV-2 Infection in Pregnancy with Neonatal Outcomes  | 2021 | Norman      | DOI: 10.1001/jama.2021.5775            | Sweden        | 11/03/2020 | 31/01/2021 | Case-control | 8 | 84719 | 2286 | 88159 | 2323 | All live-born infants, malformations excluded except PDA      | PCR-confirmed COVID-19; from June 2020 all women tested vs just symptomatic women |
| Maternal and Neonatal Morbidity and Mortality among Pregnant Women with and without COVID-19 Infection: The INTERCOVID Multinational Cohort Study   | 2021 | Villar      | DOI: 10.1001/jamapediatrics.2021.1050  | International | 02/03/2020 | 02/10/2020 | Case-control | 8 | 2130  | 706  | 2130  | 706  | All pregnant women  | PCR, radiological or clinical criteria based diagnosis of COVID-19                |
| Retrospective Analysis of Clinical Characteristics and Neonatal Outcomes of Pregnant Women with SARS-CoV-2 Infection  | 2021 | Chen        | DOI: 10.1007/s11596-021-2347-9         | China         | 01/02/2020 | 30/03/2020 | Cohort       | 5 | 8     | 8    | 9     | 9    | All pregnant women  | COVID-19 diagnosed on clinical criteria   |
| Mother-Infant Dyads with COVID-19 at an Urban, Safety-Net Hospital: Clinical Manifestations and Birth Outcomes  | 2021 | Sabharwal   | DOI: 10.1055/s-0041-1726429            | USA           | 31/03/2020 | 06/08/2020 | Cohort       | 5 | 75    | 75   | 75    | 75   | All symptomatic pregnant women delivering during study period | PCR-confirmed COVID-19  |
| Effect of SARS-CoV-2 Infection on Pregnancy Outcomes in an Inner-City Black Patient Population  | 2021 | Liu         | DOI: 10.1007/s10900-021-00988-z        | USA           | 10/04/2020 | 10/06/2020 | Case-control | 6 | 335   | 56   | 335   | 56   | All women who delivered                                       | PCR-confirmed COVID-19  |
| Short-term developmental outcomes in neonates born to mothers with COVID-19 from Wuhan, China   | 2021 | Zeng        | DOI: 10.1007/s12519-021-00426-z        | China         | 01/02/2020 | 15/05/2020 | Cohort       | 6 | 68    | 68   | 72    | 72   | All neonates born to women with COVID-19                      | COVID-19 diagnosed on clinical criteria   |
| The Society for Obstetric Anesthesia and Perinatology (SOAP) COVID-19 Registry: An analysis of outcomes among pregnant women delivering during the initial SARS-CoV-2 outbreak in the United States | 2021 | Katz        | DOI: 10.1213/ANE.0000000000005592      | USA           | 19/03/2020 | 31/05/2020 | Case-control | 7 | 1454  | 490  | 1454  | 490  |   | PCR-confirmed COVID-19 within 14 days of delivery date                            |
| Experience of covid-19 infections in neonates in tertiary care centre in North Karnataka, India: A prospective cohort study   | 2021 | Charki      | ISSN: 0971-9032                        | India         | 01/05/2020 | 01/10/2020 | Cohort       | 5 | 26    | 26   | 28    | 28   | All neonates born to women with COVID-19                      | PCR-confirmed COVID-19  |
| Outcomes of Neonates Born to Mothers with Severe Acute Respiratory Syndrome Coronavirus 2 Infection at a Large Medical Center in New York City  | 2021 | Dumitriu    | DOI: 10.1001/jamapediatrics.2020.4298  | USA           | 13/03/2020 | 24/04/2020 | Cohort       | 6 | 100   | 100  | 101   | 101  | All neonates born to women with COVID-19                      | PCR-confirmed COVID-19  |
| Management of labour, puerperium, and lactation in SARS-CoV-2 positive women. Multicentric study in the Valencian Community.  | 2021 | Vila-Candel | DOI: 10.1016/j.enfcli.2021.01.006      | Spain         | 01/03/2020 | 30/06/2020 | Cohort       | 5 | 13    | 13   | 13    | 13   | All pregnant women who delivered                              | PCR-confirmed COVID-19  |
| Impact of evolving practices on SARS-CoV-2 positive mothers and their newborns in the largest public healthcare system in America.  | 2021 | Malhotra    | DOI: 10.1038/s41372-021-01023-8        | USA           | 01/03/2020 | 09/05/2020 | Cohort       | 7 | 286   | 286  | 290   | 290  | All pregnant women who delivered                              | PCR-confirmed COVID-19  |
| Characteristics and Pregnancy Outcomes of Asymptomatic and Symptomatic Women with COVID-19: Lessons from Hospitals in Wuhan.  | 2021 | Luo         | DOI: 10.3855/jidc.14010                | China         | 30/01/2020 | 15/04/2020 | Cohort       | 5 | 41    | 41   | 42    | 42   | All pregnant patients admitted                                | PCR or radiological diagnosis of COVID-19   |
| Association of Maternal Perinatal SARS-CoV-2 Infection With Neonatal  | 2021 | Angelidou   | DOI: 10.1001/jamanetworkopen.2021.7523 | USA           | 01/03/2020 | 31/07/2020 | Cohort       | 6 | 250   | 250  | 255   | 255  | All mother-infant dyads whose delivery and                    | PCR-confirmed COVID-19  |

|  |      |                |                                    |        |            |            |              |   |      |      |      |      |   |   |
|--|------|----------------|------------------------------------|--------|------------|------------|--------------|---|------|------|------|------|---|---|
| Outcomes During the COVID-19 Pandemic in Massachusetts.  |      |                |                                    |        |            |            |              |   |      |      |      |      | discharge fell within the study period            |   |
| SARS-CoV-2 infection in pregnant women and newborns in a Spanish cohort (GESNEO-COVID) during the first wave.  | 2021 | Carrasco       | DOI: 10.1186/s12884-021-03784-8    | Spain  | 15/03/2020 | 31/07/2020 | Cohort       | 6 | 105  | 105  | 107  | 107  | All pregnant women delivering during study period | PCR, serological or clinical criteria based diagnosis of COVID-19 |
| Pregnancy and perinatal outcomes of women with coronavirus disease (COVID-19) pneumonia: a preliminary analysis.   | 2020 | Liu            | DOI: 10.2214/AJR.20.23072          | China  | 20/01/2020 | 10/02/2020 | Cohort       | 6 | 11   | 11   | 11   | 11   |   | PCR-confirmed COVID-19  |
| Characteristics and outcomes of pregnant women admitted to hospital with confirmed SARS-CoV-2 infection in UK: national population based cohort study.                 | 2020 | Knight         | DOI: 10.1136/bmj.m2107             | U.K    | 01/03/2020 | 14/04/2020 | Cohort       | 7 | 427  | 427  | 259  | 259  |   | PCR-confirmed COVID-19  |
| Clinical features and outcomes of pregnant women suspected of coronavirus disease 2019.  | 2020 | Yang           | DOI: 10.1016/j.jinf.2020.04.003    | China  | 20/01/2020 | 05/03/2020 | Case-control | 6 | 55   | 13   | 57   | 13   | All pregnant women delivering during study period | PCR-confirmed COVID-19  |
| Clinical features and obstetric and neonatal outcomes of pregnant patients with COVID-19 in Wuhan, China: a retrospective, single-centre, descriptive study.           | 2020 | Yu             | DOI: 10.1016/S1473-3099(20)30176-6 | China  | 01/01/2020 | 08/02/2020 | Cohort       | 6 | 7    | 7    | 7    | 7    |   | PCR-confirmed COVID-19  |
| Covid-19 in pregnant women: General data from a French National Survey.  | 2020 | Cohen          | DOI: 10.1186/s12958-020-00605      | France | Not stated |            | Cohort       | 4 | 88   | 88   | 14   | 14   |   | PCR, serological or radiological diagnosis of COVID-19            |
| Association Between Mode of Delivery Among Pregnant Women With COVID-19 and Maternal and Neonatal Outcomes in Spain.   | 2020 | Martinez-Perez | DOI: 10.1001/jama.2020.10125       | Spain  | 12/03/2020 | 06/04/2020 | Cohort       | 7 | 82   | 82   | 78   | 78   |   | PCR-confirmed COVID-19  |
| Vaginal delivery in SARS-CoV-2-infected pregnant women in Northern Italy: a retrospective analysis.  | 2020 | Ferrazzi       | DOI: 10.1111/1471-0528.16278       | Italy  | 01/03/2020 | 20/03/2020 | Cohort       | 5 | 42   | 42   | 42   | 42   |   | PCR-confirmed COVID-19  |
| Characteristics and Outcomes of 241 Births to Women With Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection at Five New York City Medical Centers. | 2020 | Khoury         | DOI: 10.1097/AOG.0000000000004025. | USA    | 12/03/2020 | 12/04/2020 | Cohort       | 6 | 241  | 241  | 245  | 245  |   | PCR-confirmed COVID-19  |
| Evaluating Clinical Course and Risk Factors of Infection and Demographic Characteristics of Pregnant Women with COVID-19 in Hamadan Province, West of Iran.            | 2020 | Sattari        | DOI: 10.34172/jrhs.2020.22         | Iran   | 06/01/2020 | 21/06/2020 | Cohort       | 6 | 50   | 50   | 25   | 25   |   | COVID-19 diagnosed on clinical criteria                           |
| Birth and Infant Outcomes Following Laboratory-Confirmed SARS-CoV-2 Infection in Pregnancy   | 2020 | Woodworth      | DOI: 10.15585/mmwr.mm6944e2.       | USA    | 29/03/2020 | 14/10/2020 | Cohort       | 5 | 5252 | 5252 | 4495 | 4495 |   | ?   |
| Pregnant women with COVID-19 and risk of adverse birth outcomes and maternal-fetal vertical transmission: a population-based cohort study in Wuhan, China.             | 2020 | Yang           | DOI: 10.1186/s12916-020-01798-1    | China  | 13/01/2020 | 18/03/2020 | Cohort       | 6 | 65   | 65   | 58   | 58   |   | PCR or clinical criteria based diagnosis of COVID-19              |

|   |      |                    |                                    |        |            |            |        |   |     |     |     |     |   |
|---|------|--------------------|------------------------------------|--------|------------|------------|--------|---|-----|-----|-----|-----|---|
| Maternal and neonatal outcomes in COVID-19 infected pregnancies: a prospective cohort study.  | 2020 | Pirjani            | DOI: 10.1093/jtm/taaa158           | Iran   | 01/03/2020 | 01/09/2020 | Cohort | 8 | 43  | 43  | 43  | 43  | PCR-confirmed COVID-19                                    |
| Neonatal outcome in 29 pregnant women with COVID-19: A retrospective study in Wuhan, China.   | 2020 | Wu                 | DOI: 10.1371/journal.pmed.1003195  | China  | 30/01/2020 | 10/03/2020 | Cohort | 5 | 29  | 29  | 29  | 29  | PCR or radiological diagnosis of COVID-19                 |
| Pregnancy and postpartum outcomes in a universally tested population for SARS-CoV-2 in New York City: a prospective cohort study.                                   | 2020 | Prabhu             | DOI: 10.1111/1471-0528.16403       | USA    | 24/03/2020 | 20/04/2020 | Cohort | 8 | 70  | 70  | 69  | 69  | PCR-confirmed COVID-19                                    |
| SARS-CoV-2 infection among hospitalized pregnant women: reasons for admission and pregnancy characteristics - eight U.S. health care centers, March 1-May 30, 2020. | 2020 | Panagiotakopoulos  | DOI: 10.15585/mmwr.mm6938e2.       | USA    | 01/03/2020 | 30/05/2020 | Cohort | 5 | 105 | 105 | 93  | 93  | All hospitalised pregnant women<br>PCR-confirmed COVID-19 |
| Characteristics and maternal and birth outcomes of hospitalized pregnant women with laboratory-confirmed COVID-19 - COVID-NET, 13 states, March 1-August 22, 2020.  | 2020 | Delahoy            | DOI: 10.15585/mmwr.mm6938e1.       | USA    | 01/03/2020 | 22/08/2020 | Cohort | 6 | 458 | 458 | 448 | 448 | PCR-confirmed COVID-19                                    |
| Safety of vaginal delivery in women infected with COVID-19.   | 2021 | Lopian             | DOI: 10.1016/j.pedneo.2020.10.010. | Israel | 23/03/2020 | 08/05/2020 | Cohort | 5 | 21  | 21  | 21  | 21  | PCR-confirmed COVID-19                                    |
| Pregnancy with COVID-19 infection and fetomaternal outcomes.  | 2021 | Sharma             | DOI: 10.14260/jemds/2021/5         | India  | 21/04/2020 | 07/09/2020 | Cohort | 6 | 125 | 125 | 97  | 97  | PCR-confirmed COVID-19                                    |
| Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) universal screening in gravids during labor and delivery.  | 2021 | Saviron-Cornudella | DOI: 10.1016/j.ejogrb.2020.11.069. | Spain  | 31/03/2020 | 31/08/2020 | Cohort | 4 | 6   | 6   | 6   | 6   | PCR-confirmed COVID-19                                    |
| Clinical findings and disease severity in hospitalized pregnant women with coronavirus disease 2019 (COVID-19).   | 2020 | Savasi             | DOI: 10.1097/AOG.0000000000003979. | Italy  | 23/02/2020 | 28/03/2020 | Cohort | 5 | 77  | 77  | 57  | 57  | PCR-confirmed COVID-19                                    |
| Neonatal management and outcomes during the COVID-19 pandemic: an observation cohort study.   | 2020 | Salvatore          | DOI: 10.1016/S2352-4642(20)30235-2 | USA    | 22/03/2020 | 17/05/2020 | Cohort | 8 | 116 | 116 | 120 | 120 | PCR-confirmed COVID-19                                    |
| Maternal COVID-19 infection, clinical characteristics, pregnancy, and neonatal outcome: a prospective cohort study.   | 2020 | Antoun             | DOI: 10.1016/j.ejogrb.2020.07.008  | UK     | 01/02/2020 | 01/04/2020 | Cohort | 6 | 23  | 23  | 20  | 20  | PCR-confirmed COVID-19                                    |
| Outcomes of maternal-newborn dyads after maternal SARS-CoV-2.   | 2020 | Verma              | DOI: 10.1542/peds.2020-005637      | USA    | 01/03/2020 | 10/05/2020 | Cohort | 6 | 149 | 149 | 149 | 149 | PCR-confirmed COVID-19                                    |
| Effects of severe acute respiratory syndrome coronavirus 2 infection on pregnant women and their infants: a retrospective study in Wuhan, China.                    | 2020 | Yang               | DOI: 10.5858/arpa.2020-0232-SA.    | China  | 20/01/2020 | 19/03/2020 | Cohort | 6 | 23  | 23  | 23  | 23  | PCR-confirmed COVID-19                                    |
| Coronavirus disease 2019 in pregnancy was associated with maternal morbidity and preterm birth.   | 2020 | Sentilhes          | DOI: 10.1016/j.ajog.2020.06.022.   | France | 01/03/2020 | 03/04/2020 | Cohort | 5 | 54  | 54  | 21  | 21  | PCR or clinical criteria based diagnosis of COVID-19      |
| Clinical characteristics of 46 pregnant women with a severe acute respiratory syndrome coronavirus 2  | 2020 | Lokken             | DOI: 10.1016/j.ajog.2020.05.031.   | USA    | 21/01/2020 | 17/04/2020 | Cohort | 5 | 46  | 46  | 8   | 8   | PCR-confirmed COVID-19                                    |

|  |      |                    |   |           |            |            |        |   |      |      |      |      |                              |  |
|--|------|--------------------|---|-----------|------------|------------|--------|---|------|------|------|------|------------------------------|--|
| infection in Washington state.   |      |                    |   |           |            |            |        |   |      |      |      |      |                              |  |
| SARS-CoV-2/COVID-19 infection in pregnancy and its outcome in a rural tertiary care centre of West Bengal.   | 2020 | Saha               | WHO: covidwho-1001351                   | India     | Not stated | Not stated | Cohort | 5 | 3    | 3    | 3    | 3    | All women attending hospital | PCR-confirmed COVID-19   |
| The impact of COVID-19 infection on labor and delivery, newborn nursery, and neonatal intensive care unit: prospective observational data from a single hospital system. | 2020 | Griffin            | DOI: 10.1055/s-0040-1713416             | USA       | 21/04/2020 | 05/05/2020 | Cohort | 8 | 27   | 27   | 27   | 27   |                              | PCR or clinical criteria based diagnosis of COVID-19                       |
| Clinical course of coronavirus disease-2019 in pregnancy.  | 2020 | Pereira            | WHO: covidwho-622517                    | Spain     | 14/03/2020 | 14/04/2020 | Cohort | 6 | 60   | 60   | 23   | 23   |                              | PCR-confirmed COVID-19   |
| Pregnancy Outcomes in COVID-19: A Prospective Cohort Study in Singapore.   | 2020 | Mattar             | DOI: 10.47102/annals-acadmedsg.2020437. | Singapore | 15/03/2020 | 22/08/2020 | Cohort | 6 | 16   | 16   | 5    | 5    |                              | PCR-confirmed COVID-19   |
| A pandemic center's experience of managing pregnant women with COVID-19 infection in Turkey: A prospective cohort study.   | 2020 | Sahin              | DOI: 10.1002/ijgo.13318                 | Turkey    | 11/03/2020 | 11/06/2020 | Cohort | 7 | 29   | 29   | 10   | 10   |                              | PCR-confirmed COVID-19   |
| Vertical Transmission of COVID-19 to the Neonate.  | 2020 | Moreno             | DOI: 10.1155/2020/8460672               | USA       | 20/03/2020 | 30/04/2020 | Cohort | 6 | 19   | 19   | 21   | 21   |                              | PCR-confirmed COVID-19   |
| Maternal and Neonatal Outcomes of Pregnant Women With Coronavirus Disease 2019 (COVID-19) Pneumonia: A Case-Control Study.   | 2020 | Li                 | DOI: 10.1093/cid/ciaa352.               | China     | 24/01/2020 | 29/02/2020 | Cohort | 6 | 16   | 16   | 17   | 17   |                              | PCR-confirmed COVID-19   |
| Maternal and perinatal characteristics and outcomes of pregnancies complicated with COVID-19 in Kuwait.  | 2020 | Ayed               | DOI: 10.1186/s12884-020-03461-2         | Kuwait    | 15/03/2020 | 31/05/2020 | Cohort | 5 | 185  | 185  | 167  | 167  |                              | PCR-confirmed COVID-19   |
| Pregnancy Outcomes Among Women With and Without Severe Acute Respiratory Syndrome Coronavirus 2 Infection.   | 2020 | Adhikari           | DOI: 10.1001/jamanetworkopen.2020.29256 | USA       | 18/03/2020 | 22/08/2020 | Cohort | 8 | 252  | 252  | 251  | 251  |                              | PCR-confirmed COVID-19   |
| SARS-CoV-2 screening of asymptomatic women admitted for delivery must be performed with a combination of microbiological techniques: an observational study.             | 2020 | Vinuela            | DOI: 10.37201/req/088.2020.             | Spain     | 06/05/2020 | 21/05/2020 | Cohort | 6 | 9    | 9    | 9    | 9    |                              | PCR-confirmed COVID-19   |
| Disease severity and perinatal outcomes of pregnant patients with coronavirus disease 2019 (COVID-19).   | 2021 | Metz               | DOI: 10.1097/AOG.0000000000004339.      | USA       | 01/03/2020 | 31/07/2020 | Cohort | 6 | 1291 | 1291 | 1196 | 1196 |                              | PCR-confirmed COVID-19   |
| Assessing disease outcome in COVID-19 pregnancies in a tertiary referral center in South India: a single-center retrospective cohort study.                              | 2020 | Nambiar            | DOI: 10.5005/jp-journals-10006-1822     | India     | 01/04/2020 | 01/09/2020 | Cohort | 5 | 350  | 350  | 253  | 254  |                              | Laboratory-confirmed COVID-19 infection, unclear of method of confirmation |
| Screening of severe acute respiratory syndrome coronavirus-2 infection during labor and delivery using polymerase chain reaction and immunoglobulin testing.             | 2021 | Saviron-Cornudella | DOI: 10.1016/j.jfs.2021.119200          | Spain     | 31/03/2020 | 30/09/2020 | Cohort | 6 | 22   | 22   | 22   | 22   |                              | PCR-confirmed COVID-19   |

|   |      |   |   |               |            |            |              |   |     |     |     |     |  |
|---|------|---|---|---------------|------------|------------|--------------|---|-----|-----|-----|-----|--|
| Management of gestational diabetes in women with a concurrent severe acute respiratory syndrome coronavirus 2 infection, experience of a single center in northern Italy. | 2020 | D'Ambrosi   | DOI: 10.1002/ijgo.13434                 | Italy         | 01/03/2020 | 30/04/2020 | Cohort       | 6 | 6   | 6   | 6   | 6   | PCR-confirmed COVID-19   |
| Epidemiology, management and risk of SARS-CoV-2 transmission in a cohort of newborns born to mothers diagnosed with COVID-19 infection.                                   | 2021 | Solis-Garcia  | DOI: 10.1016/j.janpede.2020.12.006      | Spain         | 01/03/2020 | 17/08/2020 | Cohort       | 6 | 73  | 73  | 75  | 75  | PCR-confirmed COVID-19   |
| Outcomes of neonates born to mothers with severe acute respiratory syndrome coronavirus 2 infection at a large medical center in New York city.                           | 2021 | Dumitriu  | DOI: 10.1001/jamapediatrics.2020.4298   | USA           | 13/03/2020 | 24/04/2020 | Cohort       | 6 | 100 | 100 | 101 | 101 | PCR or clinical criteria based diagnosis of COVID-19   |
| Neonates born to mothers with COVID-19: data from the Spanish society of neonatology registry.  | 2021 | Sanchez-Luna  | DOI: 10.1542/peds.2020-015065           | Spain         | 08/03/2020 | 26/05/2020 | Cohort       | 6 | 493 | 493 | 503 | 503 | PCR or serology-confirmed COVID-19   |
| Comparison of hematological parameters and perinatal outcomes between COVID-19 pregnancies and healthy pregnancy cohort.  | 2021 | Koc   | DOI: 10.1515/jpm-2020-0403              | Turkey        | 20/03/2020 | 25/07/2020 | Case-control | 7 | 39  | 39  | 39  | 39  | All pregnant women admitted<br>PCR-confirmed COVID-19  |
| SARS-CoV-2 in pregnancy: maternal and perinatal outcome data of 34 pregnant women hospitalised between may and October 2020.  | 2021 | Hall  | DOI: 10.1515/jpm-2020-0499              | Austria       | 11/05/2020 | 14/10/2020 | Cohort       | 5 | 35  | 35  | 28  | 28  | PCR-confirmed COVID-19   |
| The Relationship between Status at Presentation and Outcomes among Pregnant Women with COVID-19.  | 2020 | London  | DOI: 10.1055/s-0040-1712164             | USA           | 15/03/2020 | 10/04/2020 | Cohort       | 6 | 58  | 58  | 55  | 55  | PCR-confirmed COVID-19   |
| Analysis of vaginal delivery outcomes among pregnant women in Wuhan, China during the COVID-19 pandemic.  | 2020 | Liao  | DOI: 10.1002/ijgo.13188                 | China         | 20/01/2020 | 02/03/2020 | Case-control | 7 | 10  | 10  | 10  | 10  | All pregnant women delivering during study period<br>COVID-19 diagnosed on clinical criteria |
| A multicenter study on epidemiological and clinical characteristics of 125 newborns born to women infected with COVID-19 by Turkish Neonatal Society.                     | 2021 | Oncel   | DOI: 10.1007/s00431-020-03767-5         | Turkey        | 15/03/2020 | 15/06/2020 | Cohort       | 5 | 125 | 125 | 120 | 120 | PCR-confirmed COVID-19   |
| Assessment of Maternal and Neonatal SARS-CoV-2 Viral Load, Transplacental Antibody Transfer, and Placental Pathology in Pregnancies During the COVID-19 Pandemic.         | 2020 | Edlow   | DOI: 10.1001/jamanetworkopen.2020.30455 | USA           | 02/04/2020 | 13/06/2020 | Cohort       | 8 | 64  | 64  | 64  | 64  | PCR-confirmed COVID-19   |
| Maternal and perinatal outcomes of pregnant women with SARS-CoV-2 infection.  | 2021 | World Association of Perinatal Medicine Working Group on COVID-19 | DOI: 10.1002/uog.23107                  | Multiple      | 01/02/2020 | 30/04/2020 | Cohort       | 6 | 388 | 388 | 266 | 266 | PCR-confirmed COVID-19   |
| Impact of the Coronavirus Infection in Pregnancy: A Preliminary Study of 141 Patients.  | 2020 | Nayak   | DOI: 10.1007/s13224-020-01335-3         | India         | 01/04/2020 | 15/05/2020 | Cohort       | 7 | 141 | 141 | 131 | 131 | PCR-confirmed COVID-19   |
| Perinatal COVID-19 in Latin America.  | 2020 | Sola  | DOI: 10.26633/RPSP.2020.47              | Latin America | 06/03/2020 | 30/05/2020 | Cohort       | 5 | 86  | 86  | 86  | 86  | All pregnant women<br>PCR-confirmed COVID-19   |
| Clinical characteristics, maternal and neonatal   | 2021 | Ozsurmeli   | DOI: 10.4149/BLL_2021_023               | Turkey        | 11/03/2020 | 01/07/2020 | Cohort       | 6 | 24  | 24  | 10  | 10  | PCR-confirmed COVID-19   |

|  |      |               |                                    |               |            |            |              |   |      |      |      |      |  |  |                                    |
|--|------|---------------|------------------------------------|---------------|------------|------------|--------------|---|------|------|------|------|--|--|------------------------------------|
| outcomes of pregnant women with SARS-CoV-2 infection in Turkey.  |      |               |                                    |               |            |            |              |   |      |      |      |      |  |  |                                    |
| Maternal, fetal and neonatal outcomes of large series of SARS-CoV-2 positive pregnancies in peripartum period: A single-center prospective comparative study.  | 2021 | Hcini         | DOI: 10.1016/j.ejogrb.2020.11.068  | French Guiana | 16/06/2020 | 16/08/2020 | Cohort       | 6 | 137  | 137  | 127  | 127  |  |  | PCR-confirmed COVID-19             |
| Perinatal outcomes and serological results in neonates of pregnant women seropositive to SARS-CoV-2: A cross-sectional descriptive study.                      | 2020 | Davila-Aliaga | DOI: 10.5867/medwave.2020.11.8084. | Peru          | 15/04/2020 | 10/05/2020 | Cohort       | 5 | 114  | 114  | 114  | 114  | All pregnant women admitted            |  | Serological diagnosis of COVID-19  |
| Clinical Stratification of Pregnant COVID-19 Patients based on Severity: A Single Academic Center Experience.  | 2021 | Berry         | DOI: 10.1055/s-0041-1723761        | USA           | 01/03/2020 | 01/07/2020 | Cohort       | 6 | 91   | 91   | 60   | 60   | All pregnant women admitted            |  | PCR-confirmed COVID-19             |
| Pregnancy and neonatal outcomes of COVID-19: coreporting of common outcomes from PAN-COVID and AAP-SONPM registries.   | 2021 | Mullins       | DOI: 10.1002/uog.23619             | Worldwide     | 01/01/2020 | 25/07/2020 | Cohort       | 7 | 3050 | 3050 | 3050 | 3050 | All pregnant women                     |  | PCR-confirmed COVID-19             |
| Updated experience of a tertiary pandemic center on 533 pregnant women with COVID-19 infection: A prospective cohort study from Turkey.                        | 2021 | Sahin Surel   | DOI: 10.1002/ijgo.13460            | Turkey        | 11/03/2020 | 10/09/2020 | Cohort       | 6 | 533  | 533  | 131  | 131  |  |  | PCR-confirmed COVID-19             |
| Maternal and Neonatal Outcomes of COVID-19 in Pregnancy: A Single-Centre Observational Study.  | 2021 | Singh         | DOI: 10.7759/cureus.13184.         | India         | 15/05/2020 | 15/11/2020 | Cohort       | 6 | 132  | 132  | 125  | 125  |  |  | PCR-confirmed COVID-19             |
| Characteristics and outcomes of neonatal SARS-CoV-2 infection in the UK: a prospective national cohort study using active surveillance.                        | 2021 | Gale          | DOI: 10.1016/S2352-4642(20)30342-4 | UK            | 01/03/2020 | 30/04/2020 | Cohort       | 8 | 17   | 17   | 66   | 66   | All neonates with confirmed SARS-CoV-2 |  | PCR-confirmed COVID-19             |
| COVID-19 in a cohort of pregnant women and their descendants, the MOACC-19 study.  | 2021 | Llorca        | DOI: 10.1136/bmjopen-2020-044224   | Spain         | 23/05/2020 | 22/10/2020 | Cohort       | 6 | 14   | 14   | 14   | 14   |  |  | PCR-confirmed COVID-19             |
| Coronavirus disease 2019 in pregnancy  | 2020 | Qiancheng     | DOI: 10.1016/j.ijid.2020.04.065    | China         | 15/01/2020 | 15/03/2020 | Cohort       | 6 | 82   | 82   | 23   | 23   |  |  | PCR-confirmed COVID-19             |
| Clinical analysis of ten pregnant women with COVID-19 in Wuhan, China: A retrospective study   | 2020 | Cao           | DOI: 10.1016/j.ijid.2020.04.047    | China         | 23/01/2020 | 23/02/3030 | Cohort       | 5 | 10   | 10   | 10   | 10   |  |  | PCR-confirmed COVID-19             |
| Maternal, Perinatal and Neonatal Outcomes with COVID-19: A Multicenter Study of 242 Pregnancies and Their 248 Infant Newborns during Their First Month of Life | 2020 | Marin Gabriel | DOI: 10.1097/INF.0000000000002902  | Spain         | 13/03/2020 | 31/05/2020 | Cohort       | 6 | 242  | 242  | 248  | 248  |  |  | PCR or serology-confirmed COVID-19 |
| Clinical course of novel COVID-19 infection in pregnant women  | 2020 | Shmakov       | DOI: 10.1080/14767058.2020.1850683 | Russia        | Not stated | Not stated | Cohort       | 5 | 66   | 66   | 42   | 42   | All pregnant women admitted            |  | PCR-confirmed COVID-19             |
| Vaginal delivery in SARS-CoV-2-infected pregnant women in Israel: a multicenter prospective analysis   | 2020 | Rottenstreich | DOI: 10.1007/s00404-020-05854-2    | Israel        | 15/03/2020 | 04/07/2020 | Cohort       | 6 | 52   | 52   | 52   | 52   |  |  | PCR-confirmed COVID-19             |
| Clinical Analysis of Neonates Born to Mothers with or without COVID-19: A  | 2020 | Liu           | DOI: 10.1055/s-0040-1716505        | China         | 17/01/2020 | 04/03/2020 | Case-control | 6 | 31   | 15   | 31   | 15   |  |  | PCR or radiological                |

|   |      |                 |   |        |            |            |              |   |      |      |      |      |   |  |  |
|---|------|-----------------|---|--------|------------|------------|--------------|---|------|------|------|------|---|--|--|
| Retrospective Analysis of 48 Cases from Two Neonatal Intensive Care Units in Hubei Province                               |      |                 |   |        |            |            |              |   |      |      |      |      |   |  | diagnosis of COVID-19                                  |
| Characteristics of Newborns Born to SARS-CoV-2-Positive Mothers: A Retrospective Cohort Study                             | 2020 | Farghaly        | DOI: 10.1055/s-0040-1715862             | USA    | 01/03/2020 | 01/05/2020 | Case-control | 8 | 79   | 15   | 79   | 15   |   |  | PCR-confirmed COVID-19                                 |
| Poor maternal-neonatal outcomes in pregnant patients with confirmed SARS-Cov-2 infection: analysis of 145 cases           | 2021 | Di Guardo       | DOI: 10.1007/s00404-020-05909-4         | Italy  | 01/03/2020 | 01/07/2020 | Cohort       | 6 | 145  | 145  | 145  | 145  |   |  | PCR-confirmed COVID-19                                 |
| Coronavirus and birth in Italy: results of a national population-based cohort study                                       | 2020 | Maraschini      | DOI: 10.4415/ANN_20_03_17.              | Italy  | 25/02/2020 | 22/04/2020 | Cohort       | 7 | 146  | 146  | 147  | 147  |   |  | PCR, serological or radiological diagnosis of COVID-19 |
| Infant Outcomes Following Maternal Infection with SARS-CoV-2: First Report from the PRIORITY Study                        | 2020 | Flaherman       | DOI: 10.1093/cid/ciaa1411               | USA    | 22/03/2020 | 22/06/2020 | Case-control | 8 | 263  | 179  | 263  | 179  |   |  | PCR-confirmed COVID-19                                 |
| Incidence and clinical profiles of COVID-19 pneumonia in pregnant women: A single-centre cohort study from Spain          | 2020 | San-Juan        | DOI: 10.1016/j.eclinm.2020.100407       | Spain  | 05/03/2020 | 05/04/2020 | Cohort       | 6 | 52   | 52   | 6    | 6    |   |  | PCR-confirmed COVID-19                                 |
| Vaginal delivery in SARS-CoV-2-infected pregnant women in Northern Italy: a retrospective analysis                        | 2020 | Ferrazzi        | DOI: 10.1111/1471-0528.16278            | Italy  | 01/03/2020 | 20/03/2020 | Cohort       | 6 | 42   | 42   | 42   | 42   |   |  | PCR-confirmed COVID-19                                 |
| Obstetric Outcomes of SARS-CoV-2 Infection in Asymptomatic Pregnant Women   | 2021 | Cruz-Lemini     | DOI: 10.3390/v13010112.                 | Spain  | 23/03/2020 | 31/03/2020 | Case-control | 8 | 604  | 174  | 604  | 174  |   |  | PCR-confirmed COVID-19                                 |
| SARS-CoV-2 infection in pregnancy and newborn in a Spanish multicentric cohort (GESNEO-COVID)                             | 2020 | Carrasco        | DOI: doi.org/10.1186/s12884-021-03784-8 | Spain  | 15/03/2020 | 31/07/2020 | Cohort       | 6 | 105  | 105  | 107  | 107  |   |  | PCR or serology-confirmed COVID-19                     |
| Clinical course of severe and critical coronavirus disease 2019 in hospitalized pregnancies: a United States cohort study | 2020 | Pierce-Williams | DOI: 10.1016/j.ajogmf.2020.100134       | USA    | 05/03/2020 | 20/04/2020 | Cohort       | 6 | 64   | 64   | 33   | 33   |   |  | PCR-confirmed COVID-19                                 |
| Rates of seroprevalance of COVID-19 among pregnant patients in New York City  | 2021 | Baptiste        | DOI: 10.1016/j.ajog.2020.12.944         | USA    | 24/06/2020 | 16/07/2020 | Cohort       | 6 | 47   | 19   | 47   | 19   |   |  | PCR or serology-confirmed COVID-19                     |
| Maternal and neonatal outcomes of pregnant patients with coronavirus disease 2019 (COVID-19): A multistate cohort         | 2021 | Metz            | DOI: 10.1016/j.ajog.2020.12.1204        | USA    | 01/03/2020 | 31/07/2020 | Cohort       | 6 | 1219 | 1219 | 1196 | 1196 |   |  | PCR or serology-confirmed COVID-19                     |
| Obstetrical and neonatal outcomes among pregnancies with SARS-CoV-2   | 2021 | Trahan          | DOI: 10.1016/j.ajog.2020.12.385         | Canada | 22/03/2020 | 31/07/2020 | Case-control | 7 | 206  | 43   | 209  | 45   |   |  | PCR-confirmed COVID-19                                 |
| Comparison of clinical outcomes in pregnant women with and without COVID-19 based on disease severity                     | 2021 | Gold            | DOI: 10.1016/j.ajog.2020.12.585         | USA    | 01/03/2020 | 01/07/2020 | Case-control | 4 | 486  | 91   | 486  | 91   | All pregnant women delivering during study period |  | Unclear  |
| Neonatal outcomes of COVID-19 positive mothers  | 2021 | Zarudskaya      | DOI: 10.1016/j.ajog.2020.12.568         | USA    | 01/03/2020 | 01/08/2020 | Case-control | 7 | 28   | 10   | 28   | 10   |   |  | PCR-confirmed COVID-19                                 |
| Perinatal outcomes of asymptomatic versus symptomatic COVID positive pregnant women                                       | 2021 | Andrikopoulou   | DOI: 10.1016/j.ajog.2020.12.097         | USA    | 12/03/2020 | 12/08/2020 | Cohort       | 6 | 157  | 157  | 156  | 156  |   |  | PCR-confirmed COVID-19                                 |
| Neonatal outcomes in pregnant women with diagnosis of COVID-19  | 2021 | Izewski         | DOI: 10.1016/j.ajog.2020.12.809         | USA    | 01/03/2020 | 31/03/2020 | Case-control | 7 | 515  | 460  | 55   | 55   |   |  | PCR-confirmed COVID-19                                 |



|  |      |                |   |              |            |            |              |   |      |     |      |     |                                    |
|--|------|----------------|---|--------------|------------|------------|--------------|---|------|-----|------|-----|------------------------------------|
| Infant outcomes and maternal COVID-19 status at delivery   | 2021 | Zgutka         | DOI: 10.1515/jpm-2020-0481.             | USA          | 15/03/2020 | 15/06/2020 | Case-control | 5 | 184  | 60  | 186  | 62  | PCR-confirmed COVID-19             |
| Initial review of pregnancy and neonatal outcomes of pregnant women with COVID-19 infection  | 2021 | Ogamba         | DOI: 10.1515/jpm-2020-0446              | USA          | 17/03/2020 | 04/06/2020 | Cohort       | 6 | 40   | 40  | 25   | 25  | PCR or serology-confirmed COVID-19 |
| Impact of SARS-CoV-2 Infection on Pregnancy Outcomes: A Population-Based Study   | 2021 | Crovetto       | DOI: 10.1093/cid/ciab104                | Spain        | 15/03/2020 | 31/05/2020 | Case-control | 8 | 2225 | 317 | 1338 | 178 | PCR or serology-confirmed COVID-19 |
| Management and short-term outcomes of infants born to mothers with active perinatal covid-19 infection   | 2021 | Lamba          | DOI: 10.1186/s12887-021-02872-0         | USA          | 01/04/2020 | 01/10/2020 | Cohort       | 5 | 43   | 43  | 43   | 43  | PCR-confirmed COVID-19             |
| Maternal and perinatal outcomes of pandemic Covid-19 in pregnancy in Basrah  | 2021 | Sharief        | ISSN: 2515-8260                         | Iraq         | 15/03/2020 | 01/11/2020 | Cohort       | 6 | 135  | 135 | 110  | 110 | PCR-confirmed COVID-19             |
| Maternal, neonatal and placental characteristics of SARS-CoV-2 positive mothers  | 2021 | Zhang          | DOI: 10.1080/14767058.2021.1892637      | USA          | 01/03/2020 | 01/08/2020 | Case-control | 8 | 219  | 142 | 219  | 142 | PCR-confirmed COVID-19             |
| Disease severity, pregnancy outcomes, and maternal deaths among pregnant patients with severe acute respiratory syndrome coronavirus 2 infection in Washington State                     | 2021 | Lokken         | DOI: 10.1016/j.ajog.2020.12.1221        | USA          | 01/03/2020 | 30/06/2020 | Cohort       | 6 | 240  | 240 | 156  | 156 | PCR-confirmed COVID-19             |
| Maternal and perinatal outcomes in high vs low risk-pregnancies affected by SARS-COV-2 infection (Phase-2): The WAPM (World Association of Perinatal Medicine) working group on COVID-19 | 2021 | D'Antonio      | DOI: 10.1016/j.ajogmf.2021.100329       | 25 countries | 04/04/2020 | 28/10/2020 | Cohort       | 6 | 887  | 887 | 874  | 874 | PCR-confirmed COVID-19             |
| Epidemiology of coronavirus disease 2019 in pregnancy: risk factors and associations with adverse maternal and neonatal outcomes   | 2021 | Brandt         | DOI: 10.1016/j.ajog.2020.09.043         | USA          | 11/03/2020 | 11/06/2020 | Case-control | 8 | 183  | 122 | 184  | 123 | PCR-confirmed COVID-19             |
| Covid 19 infection in pregnant women and newborn infants at a single U.S. center: What disparities, testing and isolation practices can teach US   | 2020 | Camelo         | DOI: 10.1093/ofid/ofaa439.718           | USA          | 31/03/2020 | 17/06/2020 | Cohort       | 6 | 36   | 36  | 32   | 32  | PCR-confirmed COVID-19             |
| The association between SARS-CoV-2 infection and preterm delivery: a prospective study with a multivariable analysis   | 2021 | Martinez-Perez | DOI: 10.1186/s12884-021-03742-4         | Spain        | 23/03/2020 | 31/05/2020 | Case-control | 8 | 1009 | 246 | 1009 | 246 | PCR-confirmed COVID-19             |
| Pregnancy Outcomes among Women with and without Severe Acute Respiratory Syndrome Coronavirus 2 Infection  | 2020 | Adhikari       | DOI: 10.1001/jamanetworkopen.2020.29256 | USA          | 18/03/2020 | 22/08/2020 | Case-control | 8 | 3374 | 252 | 3263 | 248 | PCR-confirmed COVID-19             |
| Clinicolaboratory profile of and outcomes in neonates born to covid-19-positive mothers  | 2021 | Sehra          | ISSN: 0972-2408                         | India        | 13/04/2020 | 31/07/2020 | Cohort       | 6 | 120  | 120 | 120  | 120 | PCR-confirmed COVID-19             |
| Clinical Profile, Viral Load, Maternal-Fetal Outcomes of Pregnancy With COVID-19: 4-Week Retrospective, Tertiary Care Single-Centre Descriptive Study                                    | 2021 | Bachani        | DOI: 10.1016/j.jogc.2020.09.021         | India        | 05/05/2020 | 05/06/2020 | Cohort       | 6 | 57   | 57  | 56   | 56  | PCR-confirmed COVID-19             |

|   |      |   |                                    |          |            |            |              |   |      |      |      |      |  |
|---|------|---|------------------------------------|----------|------------|------------|--------------|---|------|------|------|------|--|
| Management and Early Outcomes of Neonates Born to Women with SARS-CoV-2 in 16 US Hospitals  | 2021 | Congdon   | DOI: 10.1055/s-0041-1726036        | USA      | 01/03/2020 | 01/05/2020 | Cohort       | 6 | 70   | 70   | 70   | 70   | PCR-confirmed COVID-19                               |
| Maternal and neonatal outcomes of pregnant patients with COVID-19: A prospective cohort study   | 2021 | Abedzadeh-Kalahrudi   | DOI: 10.1002/ijgo.13661            | Iran     | 01/03/2020 | 01/11/2020 | Case-control | 8 | 150  | 56   | 149  | 55   | PCR-confirmed COVID-19                               |
| Multicentre Spanish study found no incidences of viral transmission in infants born to mothers with COVID-19                                      | 2020 | Marin Gabriel   | DOI: 10.1111/apa.15474             | Spain    | 13/03/2020 | 29/03/2020 | Cohort       | 6 | 42   | 42   | 42   | 42   | PCR-confirmed COVID-19                               |
| SARS-CoV-2 Infection during Pregnancy in a Rural Midwest All-delivery Cohort and Associated Maternal and Neonatal Outcomes                        | 2021 | Steffen   | DOI: 10.1055/s-0041-1723938        | USA      | 01/05/2020 | 22/09/2020 | Case-control | 8 | 1000 | 61   | 1021 | 62   | PCR-confirmed COVID-19                               |
| Maternal and perinatal outcomes of pregnant women with SARS-CoV-2 infection   | 2021 | World Association of Perinatal Medicine Working Group on COVID-19 | DOI: 10.1002/uog.23107             | Multiple | 01/02/2020 | 30/04/2020 | Cohort       | 6 | 388  | 388  | 251  | 251  | PCR-confirmed COVID-19                               |
| A single-center observational study on clinical features and outcomes of 21 SARS-CoV-2-infected neonates from India                               | 2021 | Nanavati  | DOI: 10.1007/s00431-021-03967-7    | India    | 15/04/2020 | 31/07/2020 | Cohort       | 6 | 122  | 122  | 125  | 125  | PCR-confirmed COVID-19                               |
| Perinatal outcomes in pregnant women with COVID-19 in Siberia and the Russian Far East  | 2021 | Artymuk   | DOI: 10.1080/14767058.2021.1881954 | Russia   | Not stated | 25/12/2020 | Cohort       | 5 | 8485 | 8485 | 2383 | 2383 |  |
| Prevalence and Risk Factors of Neonatal Covid-19 Infection: A Single-Centre Observational Study   | 2021 | Ajith   | DOI: 10.1007/s13224-021-01436-7    | India    | 15/04/2020 | 15/10/2020 | Cohort       | 6 | 350  | 350  | 223  | 223  | PCR-confirmed COVID-19                               |
| Impact of Covid-19 in pregnancy on mother's psychological status and infant's neurobehavioral development: a longitudinal cohort study in China.  | 2020 | Wang  | DOI: 10.1186/s12916-020-01825-1    | China    | 01/05/2020 | 31/07/2020 | Cohort       | 6 | 72   | 72   | 57   | 57   | PCR-confirmed COVID-19                               |
| Vertical Transmission of Novel Coronavirus (COVID-19) from Mother to Newborn: Experience from a Maternity Unit, The Indus Hospital, Karachi.      | 2020 | Khan  | DOI: 10.29271/jcpsp.2020.10.136    | Pakistan | 27/04/2020 | 16/06/2020 | Cohort       | 6 | 66   | 66   | 67   | 67   | PCR-confirmed COVID-19                               |
| Coronavirus disease 2019 in pregnant women: a report based on 116 cases.  | 2020 | Yan   | DOI: 10.1016/j.ajog.2020.04.014    | China    | 20/01/2020 | 24/03/2020 | Cohort       | 6 | 116  | 116  | 100  | 100  | PCR or clinical criteria based diagnosis of COVID-19 |
| Clinical profile of SARS-CoV-2 infected neonates from a tertiary government hospital in Mumbai, India.  | 2020 | Kalamdani   | DOI: 10.1007/s13312-020-2070-9     | India    | 01/04/2020 | 31/05/2020 | Cohort       | 5 | 185  | 185  | 185  | 185  | PCR-confirmed COVID-19                               |
| Clinical profile, viral load, management and outcome of neonates born to COVID 19 positive mothers: a tertiary care centre experience from India. | 2020 | Anand   | DOI: 10.1007/s00431-020-03800-7    | India    | 01/04/2020 | 10/07/2020 | Cohort       | 6 | 69   | 69   | 65   | 65   | PCR-confirmed COVID-19                               |
| Clinical Manifestation and Neonatal Outcomes of Pregnant Patients With Coronavirus Disease 2019 Pneumonia in Wuhan, China.                        | 2020 | Xu  | DOI: 10.1093/ofid/ofaa283          | China    | 15/01/2020 | 15/03/2020 | Cohort       | 6 | 64   | 64   | 23   | 23   | PCR-confirmed COVID-19                               |

|   |      |               |   |        |            |            |              |   |        |      |        |      |  |
|---|------|---------------|---|--------|------------|------------|--------------|---|--------|------|--------|------|--|
| Impact of SARS-CoV-2 on multiple gestation pregnancy.   | 2021 | Mahajan       | DOI: 10.1002/ijgo.13508                     | India  | 04/04/2020 | 10/09/2020 | Cohort       | 6 | 879    | 879  | 633    | 633  | PCR-confirmed COVID-19   |
| The impact of perinatal severe acute respiratory syndrome coronavirus 2 infection during the peripartum period.   | 2021 | Janssen       | DOI: 10.1016/j.ajogmf.2020.100267           | USA    | 25/03/2020 | 15/05/2020 | Cohort       | 6 | 180    | 180  | 180    | 180  | PCR-confirmed COVID-19   |
| Maternal and perinatal characteristics of pregnant women with COVID-19 in a national hospital in Lima, Peru   | 2020 | Huerta Saenz  | DOI: 10.31403/rpgo.v66i2245                 | Peru   | 24/03/2020 | 07/05/2020 | Cohort       | 6 | 37     | 37   | 35     | 35   | PCR or rapid test confirmed COVID-19                               |
| An initiative to evaluate the safety of maternal bonding in patients with SARS-CoV-2 infection  | 2020 | Cojocarú      | DOI: 10.1080/14767058.2020.1828335          | USA    | 01/03/2020 | 01/06/2020 | Cohort       | 6 | 86     | 86   | 34     | 34   | PCR-confirmed COVID-19   |
| Short-term neonatal outcomes of colocating and breastfeeding infants of mothers who tested positive for sars-cov-2                                      | 2020 | Krishnan      | DOI: 10.1542/peds.147.3_MeetingAbstract.729 | USA    | 19/03/2020 | 22/04/2020 | Cohort       | 6 | 45     | 45   | 45     | 45   | PCR-confirmed COVID-19   |
| Impact of Maternal Severe Acute Respiratory Syndrome Coronavirus 2 Detection on Breastfeeding Due to Infant Separation at Birth                         | 2020 | Popofsky      | DOI: 10.1016/j.jpeds.2020.08.004            | USA    | 25/03/2020 | 30/05/2020 | Cohort       | 6 | 160    | 160  | 160    | 160  | PCR-confirmed COVID-19   |
| SARS-CoV-2 in pregnancy: characteristics and outcomes of hospitalized and non-hospitalized women due to COVID-19  | 2020 | Barbero       | DOI: 10.1080/14767058.2020.1793320          | Spain  | 03/03/2020 | 31/05/2020 | Cohort       | 6 | 23     | 23   | 23     | 23   | PCR-confirmed COVID-19   |
| Clinical characteristics of COVID-19 in pregnant women: A retrospective descriptive single-center study from a tertiary hospital in Muscat, Oman        | 2021 | Santhosh      | DOI: 10.1002/ijgo.13427                     | Oman   | 24/03/2020 | 31/07/2020 | Cohort       | 6 | 60     | 60   | 46     | 46   | PCR-confirmed COVID-19   |
| Clinical characteristics and pregnancy outcomes of women diagnosed with SARS-CoV-2 in London's most ethnically diverse borough: A cross-sectional study | 2021 | Milln         | DOI: 10.1177/1753495X20985403               | UK     | 12/03/2020 | 22/04/2020 | Cohort       | 6 | 32     | 32   | 30     | 30   | PCR-confirmed COVID-19   |
| Evaluation of cochlear functions in infants exposed to SARS-CoV-2 intrauterine  | 2021 | Celik         | DOI: 10.1016/j.amjoto.2021.102982           | Turkey | 01/03/2020 | 01/12/2020 | Cohort       | 8 | 73     | 37   | 73     | 37   | PCR-confirmed COVID-19   |
| Ultrasound and Doppler findings in pregnant SARS-CoV-2 positive women   | 2021 | Soto-Torres   | DOI: 10.1002/uog.23642                      | USA    | 01/05/2020 | 31/08/2020 | Cohort       | 7 | 209    | 106  | 209    | 106  | PCR or rapid test confirmed COVID-19                               |
| Maternal and perinatal outcomes of pregnant women with SARS-CoV-2 infection at the time of birth in England: national cohort study                      | 2021 | GuroI-Urganci | DOI: 10.1016/j.ajog.2021.05.016             | UK     | 29/05/2020 | 31/01/2021 | Case-control | 7 | 342080 | 3527 | 338553 | 3527 | All pregnant women delivering singletons<br>PCR-confirmed COVID-19 |
| Clinical characteristics of pregnant women with COVID-19 in Wuhan, China  | 2020 | Chen          | DOI: 10.1056/NEJMc2009226                   | China  | 08/12/2019 | 20/03/2020 | Cohort       | 5 | 118    | 118  | 70     | 70   | All pregnant women<br>PCR or radiological diagnosis of COVID-19    |
| Clinical features and the maternal and neonatal outcomes of pregnant women with coronavirus 2019  | 2020 | Nie           | DOI: 10.1101/2020.03.22.20041061            | China  | 01/01/2020 | 01/02/2020 | Cohort       | 5 | 33     | 33   | 28     | 28   | All pregnant women<br>PCR-confirmed COVID-19                       |
| Coronavirus disease 2019 among pregnant Chinese women: case series data on  | 2020 | Wu            | DOI: 10.1111/1471-0528.16276                | China  | 31/01/2020 | 09/03/2020 | Cohort       | 5 | 13     | 13   | 5      | 5    | All pregnant women admitted<br>PCR-confirmed COVID-19              |

|   |      |                |  |             |            |            |              |   |     |     |     |     |   |   |
|---|------|----------------|--|-------------|------------|------------|--------------|---|-----|-----|-----|-----|---|---|
| <p>the safety of vaginal birth and breastfeeding</p> <p>Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection during pregnancy in China: a retrospective cohort study</p> <p>Prevalence of SARS-CoV-2 among patients admitted for childbirth in southern Connecticut</p> <p>Clinical characteristics of pregnant women with Coronavirus disease 2019 in Wuhan, China</p> <p>COVID-19 during pregnancy: A case series from an universally tested population from the north of Portugal</p> <p>Routine screening for SARS-CoV-2 in unselected pregnant women at delivery</p> <p>COVID-19 in the second half of pregnancy: prevalence and clinical relevance</p> <p>Racial-ethnic disparities and pregnancy outcomes in SARS-CoV-2 infection in a universally-tested cohort in Houston, Texas</p> <p>Fetomaternal outcome in COVID-19 infected pregnant women: a preliminary clinical study</p> <p>COVID-19 infection during pregnancy - maternal and perinatal outcomes: a tertiary care centre study</p> <p>A study of breastfeeding practices, SARS-CoV-2 and its antibodies in the breast milk of mothers confirmed with COVID-19</p> <p>Influence of race and ethnicity on severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection rates and clinical outcomes in pregnancy</p> <p>Vertical transmission and materno-fetal outcomes in 13 patients with coronavirus disease 2019</p> <p>Retrospective description of pregnant women infected with severe acute respiratory syndrome coronavirus 2, France</p> <p>Maternal and Fetal Outcomes of Pregnant Women Infected with Coronavirus Based on Tracking the Results of 90-Days Data in Hazrat -E-Rasoul Akram Hospital, Iran</p> <p>University of Medical Sciences</p> | 2020 | Yin            | DOI: 10.1101/2020.04.07.20053744       | China       | 28/01/2020 | 28/02/2020 | Cohort       | 7 | 31  | 31  | 17  | 17  | All female patients                               | PCR-confirmed COVID-19  |
|   | 2020 | Campbell       | DOI: 10.1001/jama.2020.8904            | USA         | 02/04/2020 | 29/04/2020 | Cohort       | 7 | 770 | 30  | 770 | 30  | All pregnant women admitted for childbirth        | PCR-confirmed COVID-19  |
|   | 2020 | Cheng          | DOI: 10.1093/ofid/ofaa294              | China       | 15/01/2020 | 23/02/2020 | Cohort       | 6 | 111 | 111 | 17  | 17  | All pregnant women admitted                       | PCR-confirmed COVID-19  |
|   | 2020 | Doria          | DOI: 10.1016/j.ejogrb.2020.05.029      | Portugal    | 25/03/2020 | 15/04/2020 | Cohort       | 5 | 12  | 12  | 11  | 11  | All pregnant women admitted                       | PCR-confirmed COVID-19  |
|   | 2020 | Diaz-Corvillon | DOI: 10.1371/journal.pone.0239887      | Chile       | 27/04/2020 | 07/06/2020 | Case-control | 5 | 583 | 37  | 586 | 37  | All pregnant women admitted                       | PCR-confirmed COVID-19  |
|   | 2020 | Ruggiero       | DOI: 10.21203/rs.3.rs-34492/v1         | Italy       | 07/04/2020 | 06/05/2020 | Case-control | 6 | 315 | 28  | 315 | 28  | All pregnant women delivering during study period | PCR-confirmed COVID-19  |
|   | 2020 | Pineles        | DOI: 10.1016/j.ejogrb.2020.09.012      | USA         | 22/04/2020 | 22/07/2020 | Case-control | 7 | 935 | 77  | 935 | 77  | All pregnant women admitted for childbirth        | PCR-confirmed COVID-19  |
|   | 2020 | Shah           | DOI: 10.18203/2320-1770.ijrcog20203843 | India       | 15/04/2020 | 10/06/2020 | Cohort       | 5 | 125 | 125 | 96  | 96  | All pregnant women                                | PCR-confirmed COVID-19  |
|   | 2020 | Hassan         | DOI: 10.18203/2320-1770.ijrcog20203853 | India       | 01/03/2020 | 30/06/2020 | Cohort       | 5 | 38  | 38  | 37  | 37  | All pregnant women in third trimester             | PCR-confirmed COVID-19  |
|   | 2020 | Peng           | DOI: 10.1016/j.lanwpc.2020.100045      | China       | 10/02/2020 | 01/04/2020 | Case-control | 7 | 64  | 24  | 66  | 25  | All pregnant women                                | PCR-confirmed COVID-19  |
|   | 2020 | Emeruwa        | DOI: 10.1097/AOG.00000000000004088     | USA         | 13/03/2020 | 23/04/2020 | Cohort       | 5 | 100 | 100 | 100 | 100 | All pregnant women delivering during study period | PCR-confirmed COVID-19  |
|   | 2020 | Masmejan       | DOI: 10.1016/j.cmi.2020.06.035         | Switzerland | 01/04/2020 | 06/05/2020 | Cohort       | 5 | 13  | 13  | 13  | 13  | All pregnant women admitted                       | PCR-confirmed SARS-CoV-2 or serology and positive contact     |
|   | 2020 | Vivanti        | DOI: 10.3201/eid2609.202144            | France      | 12/03/2020 | 12/04/2020 | Cohort       | 5 | 100 | 100 | 36  | 36  | All pregnant women                                | PCR-confirmed SARS-CoV-2                                      |
|   | 2021 | Chaichian      | DOI: 10.30476/BEAT.2021.90434.1254     | Iran        | 08/03/2020 | 28/12/2020 | Cohort       | 5 | 14  | 14  | 13  | 13  | All pregnant women hospitalised                   | PCR-confirmed SARS-CoV-2 and/or typical radiological features |

|   |      |               |                                      |         |            |            |              |   |      |      |      |      |   |   |
|---|------|---------------|--------------------------------------|---------|------------|------------|--------------|---|------|------|------|------|---|---|
| Clinical Characteristics, Management, and Short-Term Outcome of Neonates Born to Mothers with COVID-19 in a Tertiary Care Hospital in India | 2021 | Malik         | DOI: 10.1093/tropej/fmab054          | India   | 14/04/2020 | 31/07/2020 | Cohort       | 7 | 514  | 514  | 524  | 524  | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2                                      |
| Covid-19 and pregnancy: the experience of a tertiary maternity hospital   | 2021 | Antsaklis     | DOI: 10.1515/jpm-2021-0070           | Greece  | 01/03/2020 | 31/12/2020 | Cohort       | 5 | 40   | 40   | 35   | 35   | All pregnant women admitted                       | PCR-confirmed SARS-CoV-2                                      |
| Neonatal Outcomes in Pregnant Women Infected with COVID-19 in Babol, North of Iran: A Retrospective Study with Short-Term Follow-Up         | 2021 | Akbarian-Rad  | DOI: 10.1155/2021/9952701            | Iran    | 10/02/2020 | 20/05/2020 | Cohort       | 5 | 8    | 8    | 8    | 8    | All pregnant women admitted for childbirth        | PCR-confirmed SARS-CoV-2                                      |
| Maternal-perinatal outcomes in pregnant women with COVID-19 in a level III hospital in Peru   | 2021 | Davila-Aliaga | DOI: 10.17843/rpmesp.2021.381.6358   | Peru    | 01/04/2020 | 30/06/2020 | Cohort       | 5 | 43   | 43   | 43   | 43   | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2                                      |
| Neonatal outcomes of pregnant women with COVID-19 in a developing country setup   | 2021 | Nayak         | DOI: 10.1016/j.pedneo.2021.05.004    | India   | 01/05/2020 | 20/10/2020 | Cohort       | 5 | 162  | 162  | 165  | 165  | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2                                      |
| Maternal and Neonatal Outcomes of Pregnant Women with COVID-19: A Case-Control Study at a Tertiary Care Center in India                     | 2021 | Tadas         | DOI: 10.5005/jp-journals-10006-1850a | India   | 01/05/2020 | 31/08/2020 | Case-control | 7 | 362  | 181  | 362  | 187  | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2                                      |
| Pregnancy Outcomes and SARS-CoV-2 Infection: The Spanish Obstetric Emergency Group Study  | 2021 | Melguizo      | DOI: 10.3390/v13050853               | Spain   | 26/02/2020 | 05/11/2020 | Case-control | 7 | 2954 | 1347 | 2954 | 1347 | All pregnant women                                | PCR-confirmed SARS-CoV-2                                      |
| Placental pathology in COVID-19 affected pregnant women: A prospective case-control study   | 2021 | Tasca         | DOI: 10.1016/j.placenta.2021.04.002  | Italy   | 01/03/2020 | 31/08/2020 | Case-control | 7 | 128  | 64   | 128  | 64   | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2                                      |
| Obstetric, maternal, and neonatal outcomes in COVID-19 compared to healthy pregnant women in Iran: a retrospective, case-control study      | 2021 | Taghavi       | DOI: 10.1186/s43043-021-00059-2      | Iran    | 01/03/2020 | 30/11/2020 | Case-control | 7 | 110  | 55   | 110  | 55   | All pregnant women admitted                       | PCR-confirmed SARS-CoV-2 and/or typical radiological features |
| Vertical transmission of SARS-CoV2 during pregnancy: A high-risk cohort   | 2021 | Maeda         | DOI: 10.1002/pd.5980                 | Brazil  | 12/04/2020 | 30/09/2020 | Cohort       | 5 | 109  | 109  | 109  | 109  | All pregnant women admitted                       | PCR-confirmed SARS-CoV-2                                      |
| Consequences of Early Separation of Maternal-Newborn Dyad in Neonates Born to SARS-CoV-2 Positive Mothers: An Observational Study           | 2021 | Conti         | DOI: 10.3390/ijerph18115899          | Italy   | 01/04/2020 | 18/03/2021 | Cohort       | 6 | 37   | 37   | 37   | 37   | All pregnant women admitted                       | PCR-confirmed SARS-CoV-2                                      |
| Perinatal outcome and possible vertical transmission of coronavirus disease 2019: experience from North India                               | 2021 | Sharma        | DOI: 10.3345/cep.2020.01704          | India   | 01/04/2020 | 31/08/2020 | Cohort       | 5 | 41   | 41   | 44   | 44   | All pregnant women admitted                       | PCR-confirmed SARS-CoV-2                                      |
| The Relationship between Status at Presentation and Outcomes among Pregnant Women with COVID-19   | 2020 | London        | DOI: 10.1055/s-0040-1712164          | USA     | 15/03/2020 | 10/04/2020 | Cohort       | 6 | 55   | 55   | 55   | 55   | All pregnant women                                | PCR-confirmed SARS-CoV-2                                      |
| Association of SARS-CoV-2 Test Status and Pregnancy Outcomes  | 2020 | Ahlberg       | DOI: 10.1001/jama.2020.19124         | Sweden  | 25/03/2020 | 24/07/2020 | Case-control | 7 | 759  | 156  | 759  | 156  | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2                                      |
| Infants Born to Mothers with COVID-19 During Pregnancy: The First Four Months of the Pandemic   | 2020 | Murphy        | ISSN: 03323102                       | Ireland | 01/03/2020 | 01/07/2020 | Cohort       | 5 | 26   | 26   | 26   | 26   | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2                                      |

|  |      |               |                                       |                  |            |            |              |   |        |      |        |      |   |                          |
|--|------|---------------|---------------------------------------|------------------|------------|------------|--------------|---|--------|------|--------|------|---|--------------------------|
| Characteristics and outcomes of COVID-19 pneumonia in pregnancy compared with infected nonpregnant women   | 2021 | Vizheh        | DOI: 10.1002/ijgo.13697               | Iran             | 01/03/2020 | 31/10/2020 | Cohort       | 7 | 110    | 110  | 51     | 51   | All pregnant women admitted                       | PCR-confirmed SARS-CoV-2 |
| Comparing Infection Profiles of Expectant Mothers with COVID-19 and Impacts on Maternal and Perinatal Outcomes between the First Two Waves of the Pandemic | 2021 | Cunarro-Lopez | DOI: 10.3390/jpm11070599              | Spain            | 01/03/2020 | 03/11/2020 | Cohort       | 8 | 1295   | 1295 | 1295   | 1295 | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2 |
| Coronavirus disease 2019 in pregnancy: Maternal and perinatal outcome  | 2021 | Agarwal       | DOI: 10.4103/jehp.jehp_954_20         | India            | 15/04/2020 | 30/06/2020 | Cohort       | 5 | 65     | 65   | 48     | 48   | All pregnant women admitted                       | PCR-confirmed SARS-CoV-2 |
| COVID-19 infection in pregnancy: a single center experience with 75 cases  | 2021 | Cakirca       | DOI: 10.5603/GP.a2021.0118            | Turkey           | 01/04/2020 | 31/08/2020 | Cohort       | 5 | 75     | 75   | 34     | 34   | All pregnant women admitted                       | PCR-confirmed SARS-CoV-2 |
| Maternal and perinatal outcomes of pregnant women with SARS-CoV-2 infection at the time of birth in England: national cohort study                         | 2021 | Gurol-Urganc  | DOI: 10.1016/j.ajog.2021.05.016       | England          | 29/05/2020 | 31/01/2021 | Case-control | 7 | 342080 | 3527 | 302011 | 2555 | All pregnant women delivering singletons          | PCR-confirmed SARS-CoV-2 |
| Neonatal outcome following maternal infection with SARS-CoV-2 in Germany: COVID-19-Related Obstetric and Neonatal Outcome Study (CRONOS)                   | 2021 | Mand          | DOI: 10.1136/archdischild-2021-322100 | Germany, Austria | 03/04/2020 | 27/11/2020 | Cohort       | 5 | 435    | 435  | 435    | 435  | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2 |
| Ocular Assessments of a Series of Newborns Gestationally Exposed to Maternal COVID-19 Infection  | 2021 | Kiappe        | DOI: 10.1001/jamaophthalmol.2021.1088 | Brazil           | 01/04/2020 | 30/11/2020 | Cohort       | 5 | 165    | 165  | 165    | 165  | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2 |
| Rooming-in, Breastfeeding and Neonatal Follow-up of Infants Born to Mothers with COVID-19  | 2021 | Brito         | DOI: 10.20344/amp.15441               | Portugal         | 01/04/2020 | 31/12/2020 | Cohort       | 5 | 77     | 77   | 77     | 77   | All pregnant women delivering during study period | PCR-confirmed SARS-CoV-2 |