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Association of Prenatal COVID-19 Infection with Maternal Peripartum and Neonatal Complications in Gujarat India

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Short Report

Keywords: In-utero COVID-19 exposure, Neonatal Complication, Maternal peripartum complications, Prenatal COVID-19 infection

Posted Date: May 18th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9325039/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

The COVID-19 pandemic has intensified health risks across the population, particularly among vulnerable groups such as pregnant women & children. Pregnant women are considered most vulnerable due to physiological and immunological changes that may exacerbate disease severity as well as subsequent health outcomes. Empirical evidences showed possible links between prenatal COVID-19 infection and adverse maternal & neonatal outcomes. However, evidence from resource-constrained countries remains limited.

Methods

This study adopted a case-control design with the enrollment of a total of 593 mother-neonate pairs (191 COVID-positive and 402 COVID-negative) from two districts in Gujarat. Key variables analysed were maternal sociodemographic and clinical characteristics, pregnancy-related complications, delivery & neonatal health outcomes.

Results

Among the enrolled participants, 80.4% were aged ≤ 30 years, 74% resided in urban areas, and 58.2% were above the poverty line. Maternal peripartum and neonatal complications documented in 26.6% and 27.1% of cases, respectively. Prenatal COVID-19 infection was significantly associated with maternal peripartum complications in unadjusted logistic regression analysis (cOR = 1.49; 95% CI: 1.01–2.17; p = 0.042), but this was not sustained significant after adjustment (aOR = 1.25; 95% CI: 0.82–1.89; p = 0.295). Neonatal complications were significantly associated with prenatal COVID-19 infection in both unadjusted and adjusted logistic regression models (aOR = 1.87; 95% CI: 1.27–2.75; p = 0.008).

Conclusion

Prenatal COVID-19 infection was independently associated with neonatal complications, reinforcing the need for targeted monitoring and care during pregnancy & postpartum amid pandemics.

Introduction

Since its emergence in December 2019, the COVID-19 pandemic has profoundly affected humanity across social, economic, political, and health domains. Pregnant women have been identified as a particularly vulnerable group owing to unique physiological and anatomical changes that impact their disease progression, pathophysiology, pregnancy outcomes.[1–3] Although the COVID-19 infection rates are similar between pregnant and non-pregnant women, evidence shows that pregnant women face a heightened risk of severe symptoms, often requiring intensive care, ICU admission, mechanical ventilation, or even extracorporeal membrane oxygenation support.[4–8]

Recent studies have demonstrated that COVID-19 infection could be a risk factor for a range of pregnancy-related complications, leading to adverse outcomes for maternal, fetal, and neonatal. These complications may include hypertensive disorders during pregnancy, higher likelihood of cesarean delivery, increased rates of preterm birth, neonatal ICU admissions, and changes in breastfeeding practices.[2, 9, 10] Additionally, the presence of pre-existing comorbidities and socioeconomic factors, daily stressors, and limited access to adequate antenatal, Perinatal, and postpartum care can further exacerbate these adverse outcomes.[11]

In response to the increased vulnerability of pregnant women to severe outcomes, the scientific community actively began gathering data to better understand COVID-19's nature and medical impact on high-risk groups. This effort has led to the implementation of tailored policies and preventive measures like timely updates in COVID-19 vaccination and pre-delivery screening. Despite these advancements, evidence documented adverse impacts among these groups, especially in resource-constrained settings. Fully understanding COVID-19's impact on such populations remains an evolving area of research, especially region-specific. While the acute phase of the pandemic has subsided, new robust, context-specific insights are crucial for a comprehensive understanding of these impacts.[1, 2, 12] This study, therefore, aims to assess the impact of prenatal COVID-19 infection on maternal peripartum & neonatal Complications in Gujarat, India.

Methods

Study design: This study adopted a case control design, a part of a larger ambispective longitudinal study cohort in Gujarat India settings. The study considered the pandemic waves from March to October 2020 as the first wave, February to May 2021 as the second wave, and November 2021 to March 2022 as the third wave. A total of four follow-ups were conducted at six-month intervals of from the first contact. This study presents findings from the initial enrollment phase, capturing reproductive indicators, healthcare access, COVID-19 infection status during pregnancy, and peripartum maternal and neonatal complications. Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research**.**

Sample size & Sampling frame: We initially identified participants from public, private, and COVID-19-designated hospital databases with the key criteria of having pregnancy during the covid-19 pandemic & covid-19 infection during pregnancy. They were assessed for other eligibility per inclusion criteria and contacted for study participation through informed consent. The potential consented index participants were labelled as Covid diagnosed/positive participants and further followed for snowballing sampling to enhance the sample size. Simultaneously, a comparison group of women from the same region and the same period of pregnancy who tested negative for COVID-19 during pregnancy were identified, contacted, and recruited in a 1:2 ratio. They were labelled as COVID-19, not diagnosed/negative group of participants. The study included and assessed 593 mother-neonate pairs during the COVID-19 pandemic from selected study settings.

Study Settings: This study was carried out in two geographically distinct districts within the Indian state of Gujarat: Ahmedabad, an urban area, and Sabarkantha, a rural area. Furthermore, study participants were recruited from all seven zones of Ahmedabad and all blocks of Sabarkantha district.

Variables of Interest: Maternal peripartum complications and Neonatal Complications are the primary outcomes of interest.

Dependent Variables:

Maternal peripartum complications: This study considered the “Maternal peripartum complications” as shortly just before, during, and immediately after giving birth. we created a composite variable namely “Maternal peripartum complications” as a dichotomous dependent variable and defined as the occurrence of any of the following conditions: oligohydramnios, convulsions, sudden hike of blood pressure during labour, pre-eclampsia, eclampsia (a sudden complication of pre-eclampsia marked by seizure and required medical emergency), tachycardia during labour, pre-term labour, premature rupture of membranes (PROM), prolonged labour, lack of cervical dilation. All complications were identified through a review of maternal medical records and verified through structured verbal questionnaires, including questions related to the indication for cesarean delivery and any maternal complications experienced during labour.

Neonatal Complications: We created a composite variable namely “Neonatal Complications” as a dichotomous dependent variable and defined it as the occurrence of low birth weight or required NICU admission during 28 days of birth.

Independent variables

The independent variables related to maternal characteristics included socio-demographic factors such as age, district, religion, caste, education, and type of ration card (The ration card, issued by the state government based on socioeconomic status, served as a proxy for the participant's economic background) and reproductive history, which includes status of gravida, place of delivery, and type of delivery. Additional independent variables comprised pregnancy-related complications during antenatal periods (gestational hypertension, gestational diabetes, mild to moderate anaemia), as well as COVID-19 infection status during pregnancy.

For Neonates, it includes all maternal independent variables mentioned above, and an additional variable specific to the neonates was the sex of the child.

Patient and Public Involvement: The study did not involve patients or study participants in the design, conduct, reporting, or dissemination plans of this study. Recruitment strategies and study procedures were designed solely by the research team. Future dissemination of study findings will follow standard academic channels without direct patient or public co-production. However, it will be shared with the participants on a request basis for their reading & to know the study outcomes.

Statistical methods and modelling

Simple descriptive statistics using mean and median for continuous data and frequency for categorical data were used to gain an initial understanding of the data. To assess the association between maternal peripartum & neonatal complications (dependent variable) and prenatal COVID-19 infection (key predictor), a chi-square test of independence was performed. Subsequently, both unadjusted and adjusted binomial logistic regression models were applied to estimate the strength and direction of the association between the dependent and independent variables while accounting for potential confounders.

Many variables are record-based, so we observed missing data in our study. Observations with missing data were excluded from the logistic regression models; this represented a maximum of 4% of total observations. Statistical analyses were performed using JAMOVI (version 2.6.26).

Results

Table 1: Sociodemographic Profile (n=593)

Characteristics	**N**	**(%)**
Maternal Age (in years)		
≤ 30 years of age	477	80.4
> 30 years of age	116	19.6
Prenatal COVID-19 infection		
COVID (-)	402	67.8
Covid (+)	191	32.2
District		
Ahmedabad	439	74
Sabarkantha	154	26
Caste		
General	193	32.5
OBC/SC/ST*	400	67.5
Level of education		
No formal Education	61	10.3
Primary to H. Secondary	398	67.1
Graduation/above graduation	134	22.6
Ration card		
APL**	345	58.2
BPL**	128	21.6
Occupation		
Housewife	520	87.7
Working women	73	12.3
Child median age at enrollment (in months)	11 [11.7 – 12.7]	
Gender of the child		
Male	307	51.8
Female	286	48.2
Note: *OBC: Other Backwards Class, SC*: Scheduled Caste, ST*: Scheduled Tribes ** APL – Above poverty line, BPL: Below poverty line		

Table 1 presents a detailed overview of the demographic, socioeconomic, and health-related characteristics of the study population. A significant majority of the mothers are less than or equal to 30 years of age (80.4%), recruited from urban areas (74%), and above the poverty line (58.2%). Additionally, most of the recruited women belong to the OBC/ST/SC category (67.5%), have primary to higher secondary education (67.1%), and are from the above-poverty families (58.2%) as categorized by the Indian government to distribute the subsidized food grains.

Table 2: Prevalence of Maternal Peripartum & Neonatal Complications (n=593)

Characteristics	N	Prevalence Rate [95% CI]
Maternal peripartum complications		
Yes	158	26.6 [23.2 - 30.4]
No	435	73.4 [69.6 - 76.8]
Neonatal Complication		
Yes	161	27.1 [23.7 - 30.9]
No	432	72.8 [69.1 - 76.3]
Note: Refer to the "Variables" section for details of Peripartum Maternal & Neonatal complications		

Table 2 provides the prevalence of maternal peripartum and neonatal complications among the study population, which is 26.6 % and 27.1 %, respectively, with a 95% confidence interval (CI). As shown in the table, the Neonatal complication is slightly higher than the maternal peripartum complication.

Bivariate Analysis of various predictors of interest on Maternal Peripartum & Neonatal Complications

The series of chi-square tests of independence was used to assess the association between various maternal characteristics and peripartum maternal and neonatal complications.

Table 3: Association of Maternal Characteristics with Maternal Peripartum and Neonatal Complications (N = 593)

Characteristics	Maternal Peripartum Complication			Neonatal Complications		
	No (n=435)	Yes (n=158)	p	No (n=432)	Yes (n=161)	p
District						
Ahmedabad	316 (72.6%)	123 (77.8%)	0.201	316 (73.1%)	123 (76.4%)	0.422
Sabarkantha	119 (27.4%)	35 (22.2%)		116 (26.9%)	38 (23.6%)	
Maternal Age						
≤ 30 years	363 (83.4%)	114 (72.2%)	0.002	348 (80.6%)	129 (80.1%)	0.906
> 30 years	72 (16.6%)	44 (27.8%)		84 (19.4%)	32 (19.9%)	
Caste						
Reserved*	303 (69.7%)	97 (61.4%)	0.058	295 (68.3%)	105 (65.2%)	0.478
General	132 (30.3%)	61 (38.6%)		137 (31.7%)	56 (34.8%)	
Education						
No formal Education	36 (8.3%)	10 (6.3%)	0.233	33 (7.6 %)	13 (8.1%)	0.757
Till high school	299 (68.7%)	99 (62.7 %)		298 (69.0%)	115 (71.4%)	
Graduation and above	91 (20.9%)	43 (27.2%)		101 (23.4%)	33 (20.5%)	
Wealth index measured by availability of Ration card						
APL	252 (57.9%)	93 (58.9%)	0.582	244 (56.5%)	101 (62.7%)	0.373
BPL	98 (22.5%)	30 (19.0%)		96 (22.2%)	32 (19.9%)	
None	85 (19.5%)	35 (22.2%)		92 (21.3%)	28 (17.4%)	
Occupation						
Housewife	382 (87.8%)	138 (87.3%)	0.760	379 (87.7%)	141 (87.6%)	0.673
Working	53 (72.6%)	20 (27.4%)		53 (12.3%)	20 (12.4%)	
COVID-19 infection during pregnancy						
COVID (-)	305 (70.1%)	97 (61.4%)	0.044	310 (71.8%)	92 (57.1%)	<.001
COVID (+)	130 (29.9%)	61 (38.6%)		122 (28.2%)	69 (42.9%)	
COVID-19 vaccination before delivery						
Yes	39 (12.2%)	15 (12.9%)	0.939	111 (25.7%)	46 (28.7%)	0.455
ANC visit as per guidelines						
No	17 (3.9%)	6 (3.8%)	0.951	15 (3.5%)	8 (5.0%)	0.401
Complications during pregnancy (antenatal period)						
Yes	85 (19.6%)	52 (33.1%)	<.001	89 (20.6%)	48 (30.0%)	0.017
Gravida status						
Primigravida	155 (35.6%)	54 (34.2%)	0.743	152 (35.2%)	57 (35.4%)	0.96
Multigravida	280 (64.4%)	104 (65.8%)		280 (64.8%)	104 (64.6%)	
Place of delivery						
Private	224 (51.9%)	80 (51.3%)	0.926	242 (56.4%)	62 (39.0%)	<.001
Public	208 (48.1%)	76 (48.7%)		187 (43.6%)	97 (61.0%)	
Type of delivery						

Vaginal	257 (59.1%)	68 (43.0%)	<.001	236 (54.6%)	89 (55.3%)	0.888
C-section	178 (40.9%)	90 (57.0%)		196 (45.4%)	72 (44.7%)	
Gender - Child						
Male	NA	NA	NA	232 (53.7%)	75 (46.6%)	0.123
Female	NA	NA		200 (46.3%)	86 (53.4%)	

As shown in Table 3, maternal peripartum complications were significantly associated with maternal age ($\chi^2 = 9.51$, $p = .002$), COVID-19 infection during pregnancy ($\chi^2 = 4.07$, $p = .044$), complications during pregnancy ($\chi^2 = 16.73$, $p < .001$), and type of delivery ($\chi^2 = 12.48$, $p < .001$). Post hoc standardized residuals indicated that the higher rates of complications among women with prenatal COVID-19 infection (residual = ±2.01), pregnancy-related complications during the antenatal period (±3.44), and higher maternal age (±3.07) reflect a non-random pattern, suggesting these factors may have a meaningful influence rather than representing chance variation. No significant associations were found with district, caste, education, wealth index, occupation, COVID-19 vaccination status, ANC visits, gravida status, or place of delivery.

Neonatal complications were significantly associated with maternal COVID-19 infection/in utero covid-19 exposure ($\chi^2 = 14.14$, $p < .001$), complications during pregnancy ($\chi^2 = 5.70$, $p = .017$), and place of delivery ($\chi^2 = 14.15$, $p < .001$). Post hoc standardized residuals showed that higher complication rates among neonates of mothers with prenatal COVID-19 infection (residual = ±3.39), pregnancy complications (±2.39), and deliveries in public health facilities (±3.75) also reflect a non-random pattern, suggesting these associations are unlikely due to chance alone. No significant associations were observed with maternal age, caste, education, wealth index, occupation, vaccination status, ANC visits, gravida, type of delivery, or child's gender.

Independent Predictors of Maternal Peripartum & Neonatal Complications: Logistic Regression

To further examine the strength and direction of association between prenatal COVID-19 infection and maternal peripartum & Neonatal complications while adjusting for potential confounders, a binomial logistic regression analysis was conducted. Before performing the analysis, the validity of the logistic regression model was ensured by assessing key statistical assumptions.

Model Fit: A stepwise logistic regression approach was used to assess the association between prenatal COVID-19 infection and Peripartum maternal and neonatal complications. Variables with a p-value ≤ 0.30 in bivariate analysis were included in the adjusted models to control for potential confounding. Model 1 included only the main predictor (prenatal COVID-19 infection), Model 2 added sociodemographic variables, and Model 3 further adjusted for reproductive and clinical factors. Model fit improved across stages, with a decrease in deviance and AIC, and an increase in McFadden's R^2 (from 0.008 to 0.057 for maternal and from 0.012 to 0.048 for neonatal models), indicating better explanatory power in the fully adjusted models.

As shown in Figure 1, the final adjusted logistic regression model examined the association between prenatal COVID-19 infection and maternal peripartum complications. The model included the following control variables based on theoretical relevance and bivariate significance ($p \leq 0.30$): maternal age (reference: younger group), education level (reference: no formal education), caste (reference: General category), district of residence (reference: Ahmedabad), and presence of pregnancy-related complications during antenatal period (reference: no complications).

After adjusting for all covariates, the odds of experiencing maternal peripartum complications were higher among women with prenatal COVID-19 infection; however, this association was no longer statistically significant after controlling for other maternal characteristics, indicating that the effect of prenatal COVID-19 infection was confounded with other maternal characteristics. Other covariates including education, caste, and district of residence also did not show significant associations in the fully adjusted model.

Notably, pregnancy-related complications and increasing maternal age remained significant independent predictors of peripartum complications after adjusting for all other variables.

As shown in Figure 2, the final adjusted logistic regression model assessed the association between prenatal COVID-19 infection and neonatal complications. Similar to the maternal peripartum complications model, variables were selected based on theoretical relevance and bivariate significance, including pregnancy-related complications, place of delivery (Private hospital) and gender of the baby (female). After adjustment, prenatal COVID-19 infection, complications during pregnancy, and delivery in public health facilities were significantly associated with higher odds of neonatal complications. In contrast, the gender of the baby did not show a significant

association. Notably, prenatal COVID-19 infection and pregnancy-related complications remained independent predictors of neonatal complications after controlling for all other covariates.

Discussion

This community-based analysis of 593 mother–neonate pairs initially showed a borderline significant increase in the odds of maternal peripartum complications; this association weakened and lost statistical significance after adjusting for other explanatory variables. This decline could be attributed to the non-significant association between COVID-19 infection and pre-term labour, a key outcome/event included in our composite index of maternal peripartum complications. However, our study reported a non-significant association between pre-term labour; it was commonly observed to be significantly associated with COVID-19 infection in many earlier studies.[3,13–15] In contrast, many other studies reported similar or unclear results about the incidence in the pre-term.

For Neonatal complications, prenatal COVID-19 infection remained a significant independent predictor. Higher odds of having neonatal complications were observed with neonates born to COVID-19-positive mothers, and this was consistent even after adjusting for other maternal characteristics. Most of the complications observed in our analysis were not isolated incidents; several previous studies have similarly reported associations between COVID-19 infection and neonatal complications.[16–22] De Medeiros et al.'s findings aligned with the higher rates of neonatal complications (higher NICU admission & Low birth weight) [23,24], and a study done by Norman et al found that these findings were consistent even after adjusting for other maternal characteristics [25]. In contrast, Wilkinson et al. observed no statistically significant differences.[26] Additionally, neonatal complications were more likely among offspring born to mothers who experienced pregnancy complications, pre-term births, and deliveries in public healthcare facilities.

The key strength of this study is that it is a community-based primary data study, and the data are mainly from the first two waves of the pandemic, where young populations were at higher risk; hence, it would represent the real-time scenario for the outcome of interest. Secondly, it contains the controlled arm, which allows it to be compared to women without COVID-19 infection.

Several limitations also need to be acknowledged. Firstly, the study excluded pregnant women with SARS-CoV-2 who weren't screened for any of the reasons, and potential asymptomatic COVID-19 in the community. Secondly, although most of the COVID-19-positive participants were mildly to moderately infected, it's worth presenting the outcome of interest according to the severity of the infection. However, due to the limited sample size for COVID-positive, too much stratification is not possible; hence, it is missing in our findings. Thirdly, while the study provides valuable insights into COVID-19 infection status and management, it limited the scope to present data on stillbirth and neonatal mortality due to the ongoing pandemic and challenges in securing community permission.

Conclusion

Our study provides compelling region-specific evidence of increased odds of peripartum maternal and significant neonatal complications associated with prenatal COVID-19 infection and in-utero exposure to the infection. This consistent association underscores the potential biological and systemic impact of in-utero exposure to maternal COVID-19 infection. These findings can offer robust evidence for public health strategies, particularly in pandemics and health crises. To get better insights, further in-depth exploration of biological mechanisms and health system factors that may mediate these outcomes is recommended.

Declarations

Acknowledgement: We would like to express our sincere gratitude to all the enrolled study participants who generously shared their valuable support and share the required information. We are also thankful to our colleagues Dr. Monali Patel and Dr. Shailee Patil for their assistance in data collection. Our heartfelt thanks go out to the Deputy Health Officers of the respective zonal health offices, Medical Officers at the Urban health centres, and the dedicated Anganwadi workers from all the respective AWCs for providing invaluable support during the field data collection. The successful completion of this study would not have been possible without the unwavering support of the Ahmedabad Municipal Corporation and the Private and public health providers in Ahmedabad and Sabarkantha districts. We thank all these stakeholders for their crucial contributions to our research/study.

Funding: The study was initiated under the Action Against Stunting Hub, funded by UKRI GCRF. However, Funder had no direct involvement in the design, conduct & dissemination of findings.

Competing interests: The authors declare that they have no competing interests

Data Availability statement: The datasets used/analysed in this study will be made accessible upon request from the Principal Investigator at ddeepak72@iiphg.org.

Ethics approval and consent to participate: Ethics approval was granted by the institutional ethics committees of the Indian Institute of Public Health Gandhinagar (IIPHG) (Referenace no: SHSRC/2021/2185) and London School of Hygiene and Tropical Medicine (LSHTM) (reference no: 72848). Informed consent was obtained through fingerprint or signature on a pre-structured form that provided detailed information about the project and withdrawal policy. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and relevant national and institutional guidelines.

Clinical trial number: Not Applicable

Consent for publication: Not Applicable

Author Contribution

All authors contributed equally to the development of this study. DS, KS, CF, and MJ participated in the study's conception and design. FM was responsible for data collection, analysis, and drafting the initial version of the manuscript. FKM assisted in data cleaning & writing the first draft of manuscript. DS, KS, CF, NT, AS, and TP critically reviewed the manuscript. All authors read and approved the final manuscript.Abbreviations: DS – Deepak Saxena; KS – Komal Shah; CF – Claire Heffernan; MJ – Modou Jobarteh; FM – Farjana Memon; FKM: Fatimakhatun Memon, NT – Nandan Thakkar; AS – Anish Sinha; TP – Tapasvi Puwar

References

1. Ferrara A, Hedderson MM, Zhu Y, Avalos LA, Kuzniewicz MW, Myers LC et al. Perinatal Complications in Individuals in California With or Without SARS-CoV-2 Infection During Pregnancy. JAMA Intern Med [Internet]. 2022 May 1 [cited 2024 Nov 10];182(5):503–12. Available from: https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2790318
2. Saban A, Haleluya NL, Geva Y, Geva N, Hershkovitz R. Perinatal outcomes among pregnant patients with peripartum coronavirus disease 2019 infection. Arch Gynecol Obstet [Internet]. 2024 Aug 1 [cited 2024 Nov 10];310(2):793. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC11258051/
3. Zaigham M, Andersson O. Maternal and perinatal outcomes with COVID-19: A systematic review of 108 pregnancies. Acta Obstet Gynecol Scand [Internet]. 2020 Jul 1 [cited 2024 Sep 4];99(7):823–9. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/aogs.13867
4. Smith ER, Oakley E, Grandner GW, Rukundo G, Farooq F, Ferguson K, et al. Clinical risk factors of adverse outcomes among women with COVID-19 in the pregnancy and postpartum period: a sequential, prospective meta-analysis. Am J Obstet Gynecol. 2023;228(2):161–77.
5. Pregnancy. and COVID-19: What are the risks? - Mayo Clinic [Internet]. [cited 2024 Aug 25]. Available from: https://www.mayoclinic.org/diseases-conditions/coronavirus/in-depth/pregnancy-and-covid-19/art-20482639
6. Briller JE, Aggarwal NR, Davis MB, Hameed AB, Malhamé I, Mahmoud Z et al. Cardiovascular Complications of Pregnancy-Associated COVID-19 Infections. JACC Advances [Internet]. 2022 Aug 1 [cited 2024 Aug 24];1(3). Available from: https://pubmed.ncbi.nlm.nih.gov/35967591/
7. Muñoz-Chápuli Gutiérrez M, Prat AS, Vila AD, Claverol MB, Martínez PP, Recarte PP et al. Post-COVID-19 condition in pregnant and postpartum women: a long-term follow-up, observational prospective study. EClinicalMedicine [Internet]. 2024 Jan 1 [cited 2024 Aug 24];67. Available from: https://pubmed.ncbi.nlm.nih.gov/38274115/
8. COVID-19. Overview of pregnancy issues - UpToDate [Internet]. [cited 2024 Aug 24]. Available from: https://www.uptodate.com/contents/covid-19-overview-of-pregnancy-issues
9. Greenberg GC, Vishwakarma N, Tirupattur MP, Sprague HM, Katwa LC. Implications of COVID-19 Pandemic on Pregnancy: Current Status and Controversies. COVID 2023, Vol 3, Pages 859–873 [Internet]. 2023 May 26 [cited 2024 Oct 31];3(6):859–73. Available from: https://www.mdpi.com/2673-8112/3/6/62/htm
10. Metz TD, Clifton RG, Hughes BL, Sandoval GJ, Grobman WA, Saade GR et al. Association of SARS-CoV-2 Infection With Serious Maternal Morbidity and Mortality From Obstetric Complications. JAMA [Internet]. 2022 Feb 22 [cited 2024 Sep 5];327(8):748–59. Available from: https://jamanetwork.com/journals/jama/fullarticle/2788985

11. Kim MK, Lee SM, Bae SH, Kim HJ, Lim NG, Yoon SJ et al. Socioeconomic status can affect pregnancy outcomes and complications, even with a universal healthcare system. Int J Equity Health [Internet]. 2018 Jan 5 [cited 2024 Aug 26];17(1):2. Available from: https://equityhealthj.biomedcentral.com/articles/10.1186/s12939-017-0715-7
12. Engjom HM, Ramakrishnan R, Vousden N, Bunch K, Morris E, Simpson N et al. Perinatal outcomes after admission with COVID-19 in pregnancy: a UK national cohort study. Nature Communications 2024 15:1 [Internet]. 2024 Apr 15 [cited 2024 Nov 10];15(1):1–9. Available from: https://www.nature.com/articles/s41467-024-47181-z
13. Dileep A, ZainAlAbdin S, AbuRuz S. Investigating the association between severity of COVID-19 infection during pregnancy and neonatal outcomes. Sci Rep [Internet]. 2022 Dec 1 [cited 2024 Sep 5];12(1):3024. Available from: https://research.uaeu.ac.ae/en/publications/investigating-the-association-between-severity-of-covid-19-infect
14. Metz TD, Clifton RG, Hughes BL, Sandoval GJ, Grobman WA, Saade GR et al. Association of SARS-CoV-2 Infection With Serious Maternal Morbidity and Mortality From Obstetric Complications. JAMA [Internet]. 2022 Feb 22 [cited 2024 Sep 5];327(8):748–59. Available from: https://pubmed.ncbi.nlm.nih.gov/35129581/
15. Wei SQ, Bilodeau-Bertrand M, Liu S, Auger N. The impact of COVID-19 on pregnancy outcomes: a systematic review and meta-analysis. CMAJ [Internet]. 2021 Apr 19 [cited 2024 Sep 5];193(16):E540–8. Available from: https://pubmed.ncbi.nlm.nih.gov/33741725/
16. Vidal MJ, Martínez-Solanas È, Mendoza S, Sala N, Jané M, Mendioroz J, et al. Impact of SARS-CoV-2 infection in pregnant women and their babies: clinical and epidemiological features. Gac Sanit. 2023;37:102332.
17. Martinez-Perez O, Prats Rodriguez P, Muner Hernandez M, Encinas Pardilla MB, Perez Perez N, Vila Hernandez MR et al. The association between SARS-CoV-2 infection and preterm delivery: a prospective study with a multivariable analysis. BMC Pregnancy Childbirth [Internet]. 2021 Dec 1 [cited 2024 Sep 5];21(1). Available from: https://pubmed.ncbi.nlm.nih.gov/33794829/
18. Wei SQ, Bilodeau-Bertrand M, Liu S, Auger N. The impact of COVID-19 on pregnancy outcomes: a systematic review and meta-analysis. CMAJ [Internet]. 2021 Apr 19 [cited 2024 Sep 5];193(16):E540–8. Available from: https://pubmed.ncbi.nlm.nih.gov/33741725/
19. Gomez UT, Francisco RPV, Baptista FS, Gibelli MABC, Ibidi SM, de Carvalho WB et al. Impact of SARS-CoV-2 on pregnancy and neonatal outcomes: An open prospective study of pregnant women in Brazil. Clinics (Sao Paulo) [Internet]. 2022 Jan 1 [cited 2024 Sep 5];77. Available from: https://pubmed.ncbi.nlm.nih.gov/35797767/
20. Knight M, Bunch K, Vousden N, Morris E, Simpson N, Gale C et al. Characteristics and outcomes of pregnant women admitted to hospital with confirmed SARS-CoV-2 infection in UK: national population based cohort study. BMJ [Internet]. 2020 Jun 8 [cited 2024 Sep 4];369. Available from: https://www.bmj.com/content/369/bmj.m2107
21. Di Mascio D, Khalil A, Saccone G, Rizzo G, Buca D, Liberati M et al. Outcome of coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. Am J Obstet Gynecol MFM [Internet]. 2020 May 1 [cited 2024 Sep 4];2(2). Available from: https://pubmed.ncbi.nlm.nih.gov/32292902/
22. Villar J, Ariff S, Gunier RB, Thiruvengadam R, Rauch S, Kholin A et al. Maternal and Neonatal Morbidity and Mortality Among Pregnant Women With and Without COVID-19 Infection: The INTERCOVID Multinational Cohort Study. JAMA Pediatr [Internet]. 2021 Aug 1 [cited 2024 Sep 5];175(8):1. Available from: /pmc/articles/PMC8063132/
23. Allotey J, Stallings E, Bonet M, Yap M, Chatterjee S, Kew T et al. Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: living systematic review and meta-analysis. BMJ [Internet]. 2020 Sep 1 [cited 2024 Sep 5];370. Available from: https://www.bmj.com/content/370/bmj.m3320
24. de Medeiros KS, Sarmento ACA, Costa APF, Macêdo LT, de Silva A, de Freitas LAS. CL, Consequences and implications of the coronavirus disease (COVID-19) on pregnancy and newborns: A comprehensive systematic review and meta-analysis. International Journal of Gynecology & Obstetrics [Internet]. 2022 Mar 1 [cited 2024 Sep 4];156(3):394–405. Available from: https://onlinelibrary.wiley.com/doi/full/10.1002/ijgo.14015
25. Norman M, Navér L, Söderling J, Ahlberg M, Hervius Askling H, Aronsson B et al. Association of Maternal SARS-CoV-2 Infection in Pregnancy With Neonatal Outcomes. JAMA [Internet]. 2021 May 25 [cited 2024 Sep 5];325(20):2076–86. Available from: https://jamanetwork.com/journals/jama/fullarticle/2779586
26. Wilkinson M, Johnstone ED, Simcox LE, Myers JE. The impact of COVID-19 on pregnancy outcomes in a diverse cohort in England. Sci Rep [Internet]. 2022 Dec 1 [cited 2024 Sep 4];12(1). Available from: https://pubmed.ncbi.nlm.nih.gov/35042979/

Figures

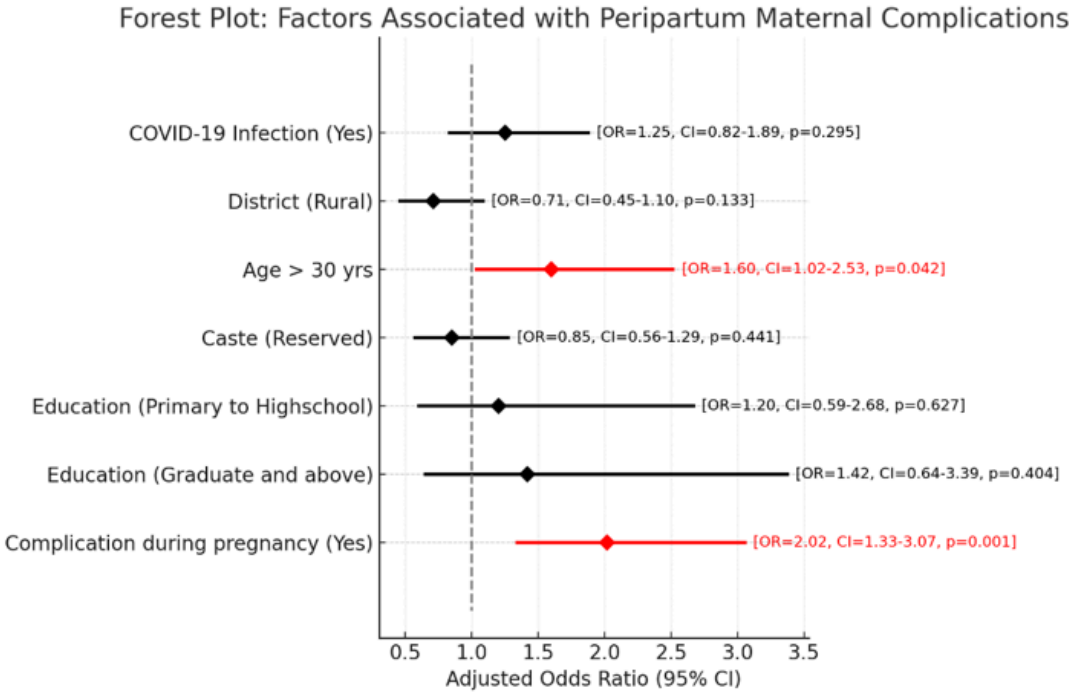


Figure 1

Adjusted logistic regression of prenatal COVID-19 infection and Maternal Peripartum complications

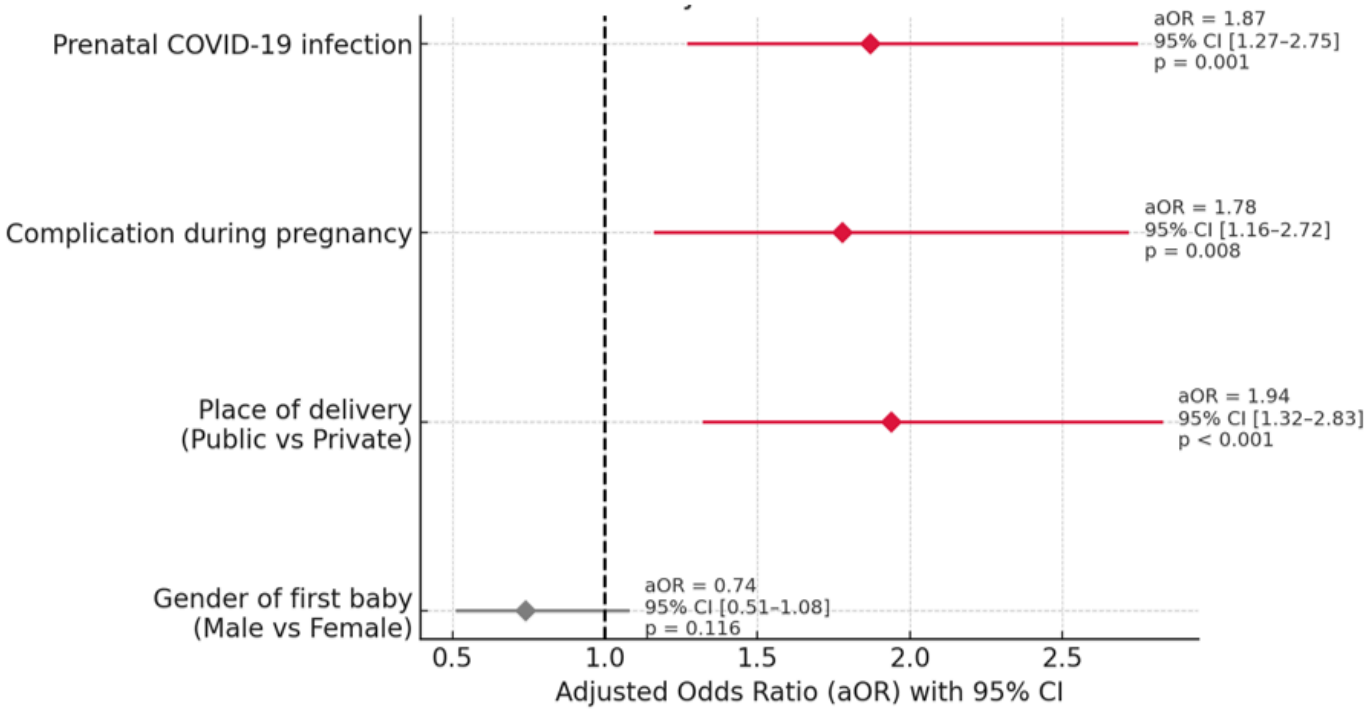


Figure 2

Adjusted logistic regression of prenatal COVID-19 infection and Neonatal Complications: