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Comparative Study of Pregnancy Outcomes Before and During the COVID-19 Pandemic

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Abstract

Background: The COVID-19 pandemic adversely affected pregnant women across multiple dimensions. The present study aimed to compare maternal and neonatal outcomes before and during the pandemic.

Methods: This cross-sectional analytical study compared pregnancy outcomes among women admitted to Imam Reza Hospital in Kermanshah, Iran, during two distinct periods: Pre-pandemic (2017 - 2019) and COVID-19 pandemic (2020 - 2022). The study population consisted of 1,500 pregnant women, with 1,000 cases from the pre-pandemic period and 500 from the pandemic period, selected through convenience sampling. Inclusion criteria required participants to have no underlying medical conditions and complete clinical records. The study excluded pregnant women whose medical records were incomplete or inaccessible for data collection. Maternal outcomes assessed included preeclampsia, gestational diabetes, postpartum hemorrhage, placental abruption, miscarriage, preterm delivery, urinary tract infections, and delivery mode (vaginal or cesarean). Fetal and neonatal outcomes analyzed were intrauterine growth restriction (IUGR), Apgar scores, need for resuscitation, stillbirth, birth weight, and congenital anomalies. Data were analyzed using SPSS software (version 25).

Results: The study results showed a significant increase in preeclampsia and gestational diabetes, a significant decrease in cesarean section, postpartum hemorrhage, stillbirth, miscarriage, and premature birth, an improvement in the Apgar scores of the newborns at 1 and 5 minutes, a decrease in IUGR cases from 1% to 0%, and no difference in birth weight and congenital anomalies, and the need for neonatal resuscitation. The results of logistic regression showed an increase in miscarriage, vaginal delivery, and gestational diabetes. All results were statistically significant ($P < 0.05$).

Conclusions: COVID-19 appears to influence pregnancy outcomes, with our findings indicating increased rates of gestational diabetes and preeclampsia during the pandemic compared to the pre-pandemic period.

Keywords: Pregnancy Outcome, COVID-19, Pregnancy Complications, Pregnant Women, SARS-CoV-2

1. Background

In December 2019, the World Health Organization (WHO) was alerted to cases of severe acute respiratory syndrome caused by a novel coronavirus in Wuhan, China. The WHO subsequently declared COVID-19 a global pandemic (1). The highest disease prevalence has been reported in the United States, India, and Brazil, while Iran ranks 17th worldwide with over seven million confirmed cases and more than 143,000 deaths (2). Pregnant women represent a vulnerable population during disease outbreaks like COVID-19 and require special precautions (3-5). Previous research on SARS and MERS epidemics demonstrated that pregnant women face elevated risks of complications that may adversely affect pregnancy outcomes (5-7). The COVID-19 pandemic

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led to significant reductions in prenatal care services, resulting in missed screenings for critical pregnancy-related conditions such as gestational diabetes (8-11). Physiological changes during pregnancy not only increase susceptibility to infection but may also accelerate progression to respiratory failure when the respiratory system is affected (12). Thromboembolic events represent a serious complication of COVID-19, stemming from coagulation pathway activation, disseminated intravascular coagulation (DIC), and fibrinolysis with dynamic coagulation alongside thrombocytopenia (13, 14). Pregnant women with COVID-19 face synergistic risks for thrombosis (3), with those at risk for thromboembolism showing higher mortality rates (15, 16). A systematic review by Di Masio et al. reported significantly higher rates of preeclampsia among COVID-19-positive pregnant women compared to their non-infected counterparts. Maternal mortality rates during SARS and MERS outbreaks reached 25.8% and 28.6%, respectively, with these infections associated with preterm delivery, fetal growth restriction, and pregnancy loss (4). While some studies have documented increased preterm birth rates during the COVID-19 pandemic (14, 17, 18), observational data from Ireland and Denmark paradoxically show significant decreases in preterm births, the reasons for which remain unclear (19, 20). Viral infections during pregnancy may exert long-term effects on fetal development. Elevated maternal inflammatory responses to viral infection can influence fetal brain development, potentially leading to diverse neurological complications (21). Current evidence suggests no definitive negative outcomes for infants born to COVID-19-positive mothers. Among 13 studies examining neonatal COVID-19 status, only three reported positive cases, with affected infants typically presenting as asymptomatic or with mild, self-limiting symptoms (17, 22, 23).

2. Objectives

The full impact of the COVID-19 pandemic on maternal and neonatal outcomes remains uncertain, with study results often contradictory. Limited research has addressed the unique challenges pregnant women face during disease outbreaks that exacerbate their vulnerability. A comprehensive analysis of pregnancy outcomes during pandemics could provide valuable insights for future preparedness. This study compares pregnancy outcomes before and during the COVID-19 pandemic, evaluates existing evidence on effects of COVID-19 on pregnancy, and identifies areas requiring further investigation. The present study provides a rigorous comparison of pregnancy outcomes before and during the COVID-19 pandemic, offering critical insights into the disease's impact on maternal and neonatal health. By identifying key research gaps and proposing priority areas for future investigation, this work establishes a scientific framework to guide subsequent studies. Our findings not only contribute substantially to the existing body of knowledge but may also inform the development of targeted interventions to mitigate pregnancy risks during future public health crises. Given the profound effects of the COVID-19 pandemic on healthcare systems worldwide and the particular vulnerability of pregnant women, the evidence from this study serves as an authoritative resource for policymakers, obstetricians, and public health researchers. A deeper understanding of the virus's impact on pregnancy outcomes will not only enhance prenatal care protocols during similar outbreaks but could ultimately save countless maternal and neonatal lives in future emergencies.

3. Methods

This cross-sectional analytical study examined pregnant women referred to Imam Reza Hospital in Kermanshah, Iran, across two distinct periods: Pre-pandemic (2017 - 2019) and during the COVID-19 pandemic (2020 - 2022). The study utilized clinical records from 1,500 pregnant women, comprising 1,000 pre-pandemic cases and 500 cases from the pandemic period. Participants were selected through convenience sampling. Inclusion criteria required: (1) Pregnancy without pre-existing comorbidities; and (2) availability of complete medical documentation. The study excluded pregnant women whose medical records were incomplete or inaccessible for data collection.

3.1. Sample Size

The sample size is based on the formula for comparing a quantitative trait and its parameters, namely the 95% confidence interval ($\alpha = 0.05$) and other parameters of this formula based on the results of a similar study conducted, focusing on the following variables:

- Determining sample size based on preterm birth:

$$Z_{1-\frac{\alpha}{2}} = Z_{1-\frac{0.05}{2}} = Z_{0.975} = 1.96 \quad (1)$$

P = 0.0

d = 0.05

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}}\right)^2 \times P\left(1-P\right)}{\left(d\right)^2} = n = \frac{\left(Z_{0.975}\right)^2 \times 0.09\left(1-0.09\right)}{\left(0.05\right)^2} \quad (2)$$

$$n = \frac{\left(1.96\right)^2 \times \left(0.0819\right)}{\left(0.05\right)^2} = \frac{\left(3.84\right) \times \left(0.0819\right)}{\left(0.0025\right)} = \frac{\left(0.314\right)}{\left(0.0025\right)} = 125.8 \quad (3)$$

- Determining volume based on maternal mortality rate:

$$Z_{1-\frac{\alpha}{2}} = Z_{1-\frac{0.05}{2}} = Z_{0.975} = 1.96 \quad (4)$$

P = 0.0

d = 0.05

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}}\right)^2 \times P\left(1-P\right)}{\left(d\right)^2} = \frac{\left(Z_{0.975}\right)^2 \times 0.11\left(1-0.11\right)}{\left(0.05\right)^2} \quad (5)$$

$$n = \frac{\left(1.96\right)^2 \times \left(0.098\right)}{\left(0.05\right)^2} = \frac{\left(3.84\right) \times \left(0.098\right)}{\left(0.0025\right)} = \frac{\left(0.376\right)}{\left(0.0025\right)} = 150.4 \quad (6)$$

- Determining volume based on infant mortality rate:

$$Z_{1-\frac{\alpha}{2}} = Z_{1-\frac{0.05}{2}} = Z_{0.975} = 1.96 \quad (7)$$

P = 0.03

d = 0.05

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}}\right)^2 \times P\left(1-P\right)}{\left(d\right)^2} = \frac{\left(Z_{0.975}\right)^2 \times 0.03\left(1-0.97\right)}{\left(0.05\right)^2} \quad (8)$$

$$n = \frac{\left(1.96\right)^2 \times \left(0.0291\right)}{\left(0.05\right)^2} = \frac{\left(3.84\right) \times \left(0.0291\right)}{\left(0.0025\right)} = \frac{\left(0.111\right)}{\left(0.0025\right)} = 44.4 \quad (9)$$

A sample size of 360 individuals was initially considered as the minimum sample size. However, based on preliminary studies, including the sample size that could be adopted and the prevalence of the outcomes under study, the research team decided to study 1,500 pregnant mothers and their maternal and neonatal outcomes. Following the approval of this study by the Ethics Committee of Kermanshah University of Medical Sciences (IR.KUMS.REC.1401.034), the research process commenced. This study analyzed the clinical records of 500 pregnant women with COVID-19 during the pandemic (2020 - 2022) and 1,000 pregnant women who delivered at Imam Reza Hospital (Kermanshah, Iran) before the pandemic (2017 - 2019). The two groups were compared in terms of pregnancy outcomes after applying the inclusion and exclusion criteria. In cases where clinical records had missing information, follow-ups were conducted via phone calls or by referencing unique identification codes linked to each individual's health records in urban health centers. A demographic form and a checklist were used to record the collected data. Data analysis was performed using SPSS (version 25). Descriptive statistics (frequency, mean, standard deviation, and percentage) were employed to summarize the variables. Based on the Kolmogorov-Smirnov test results, appropriate parametric (chi-square test, Fisher's exact test, independent *t*-test) and non-parametric (Mann-Whitney U test) statistical methods were applied. The significance level for all tests was set at $P < 0.05$.

3.2. Tools

The principal material was a checklist compiled based on the study objectives and important and basic

Table 1. Frequency of Pregnancy Outcomes Before and During the COVID-19 Pandemic [a]

Variables	Before COVID-19	During COVID-19	P-Value
Pre-eclampsia			0.004
No	956 (95.6)	460 (92)	
Yes	44 (4.4)	40 (8)	
Delivery option			0.011
No	667 (66.7)	300 (60)	
Yes	333 (33.3)	200 (40)	
Postpartum bleeding			0.001
No	943 (94.3)	490 (98)	
Yes	57 (5.7)	10 (2)	
Placental abruption			0.065
No	989 (98.9)	499 (99.8)	
Yes	11 (1.1)	1 (0.2)	
Gestational diabetes			0.001
No	980 (98)	426 (85.2)	
Yes	20 (2)	74 (14.8)	
Still birth			0.484
No	981 (98.1)	493 (98.6)	
Yes	19 (1.9)	7 (1.4)	
Preterm delivery			0.001
No	906 (90.6)	488 (97.6)	
Yes	94 (9.4)	12 (2.4)	
Urinary tract infection			0.009
No	971 (97.1)	496 (99.2)	
Yes	29 (2.9)	4 (0.8)	
Abortion			0.008
No	935 (93.5)	484 (96.8)	
Yes	65 (6.5)	16 (3.2)	

[a] Values are expressed as No. (%).

Table 2. Mean ± Standard Deviation of Apgar Score in the Research Units, Before and During the COVID-19 Pandemic [a]

Variables	Before COVID-19	During COVID-19	P-Value
Apgar score 1st minute	7.9 ± 2.4	8.2 ± 2.1	0.014
Apgar score 5th minute	8.9 ± 2.7	9.2 ± 2.3	0.006

[a] Values are expressed as mean ± standard deviation.

variables in three sections by the research team after reviewing books and articles related to the research topic.

3.2.1. Demographic Information

Age, occupation, residence, education, number of pregnancies, number of births, history of abortion, history of stillbirth, and history of premature birth.

3.2.2. Maternal Outcomes

Preeclampsia, cesarean delivery, postpartum hemorrhage, placental abruption, gestational diabetes, stillbirth, premature birth, urinary tract infection, and abortion.

3.2.3. Neonatal Outcomes

Decrease in Apgar score in the first minute, decrease in Apgar score in the fifth minute, intrauterine growth restriction (IUGR), need for resuscitation, low birth weight, and congenital anomalies.

4. Results

Out of 1500 cases of pregnant women referred to Imam Reza Hospital, 1000 cases belonged to the before,

Table 3. Frequency of Fetal and Neonatal Outcomes Before and During the COVID-19 Pandemic [a]

Variables	Before COVID-19	During COVID-19	P-Value
IUGR			0.025
No	990 (99)	500 (100)	
Yes	10 (1)	0 (0)	
Need to resuscitation			0.081
No	896 (89.6)	450 (90)	
Yes	104 (10.4)	50 (10)	
Low birth weight			0.654
No	938 (93.8)	466 (93.2)	
Yes	62 (6.2)	34 (6.8)	
Congenital anomalies			0.168
No	989 (98.9)	498 (99.6)	
Yes	11 (1.1)	2 (0.4)	

Abbreviation: IUGR, intrauterine growth restriction.

[a] Values are expressed as No. (%).

and 500 cases were during the COVID-19 pandemic. Table 1 compares pregnancy outcomes before and during the COVID-19 pandemic. The frequencies of preeclampsia and gestational diabetes were significantly higher during the pandemic. Chi-square tests with Yates' correction confirmed statistically significant differences between the two groups for these outcomes ($P < 0.05$). Conversely, the frequencies of cesarean delivery, postpartum hemorrhage, stillbirth, placental abruption, abortion, preterm birth, and urinary tract infection were significantly lower during the pandemic compared to the pre-pandemic period. Chi-square tests (with Yates' correction) indicated statistically significant differences between the two groups for these outcomes ($P < 0.05$).

As shown in Table 2, the Mann-Whitney test revealed a statistically significant difference in the mean Apgar scores at both 1 and 5 minutes between the two groups ($P < 0.05$), with significantly higher scores observed during the COVID-19 pandemic. The chi-square test with Yates' correction indicated no statistically significant differences between the groups regarding the need for neonatal resuscitation, birth weight, or congenital anomalies ($P < 0.05$).

Fetal and neonatal outcomes are presented in Table 3. The frequency of IUGR was 1% in the pre-pandemic period compared to 0% during the COVID-19 pandemic. Fisher's exact test revealed a statistically significant difference in IUGR incidence between the two groups ($P < 0.05$).

The results of comparing the variables of age, education, number of deliveries, history of abortion, history of preterm delivery, type of delivery, preeclampsia, postpartum hemorrhage, gestational diabetes, abortion, premature delivery, urinary tract infection, IUGR, and low Apgar scores in the first and fifth minutes showed significant differences between the two groups (Table 4). To investigate the effect of significant variables, a logistic regression model was applied. The results of logistic regression indicated that during the COVID-19 pandemic, the odds ratio for a history of abortion was 2.6 times, the type of natural delivery was 1.4 times, preeclampsia was 2.2 times, and gestational diabetes was 8.01 times more than before the COVID-19 pandemic (Table 4).

5. Discussion

We compared pregnancy outcomes in women before and during the COVID-19 pandemic. Our results showed an increased incidence of preeclampsia during the pandemic, consistent with the findings of Di Masio et al. (4). In women with preeclampsia during mid-to-late pregnancy, elevated vascular resistance and endothelial cell dysfunction are common. Given the potential role of endothelial cell function in the development and progression of COVID-19, infected pregnant women may face a higher risk of complications. Our study also revealed a significant rise in gestational diabetes cases during the pandemic. Zanardo et al. reported a similar increase in their case-control study, attributing this trend to first-trimester quarantine experiences and post-

Table 4. Logistic Regression Results of Demographic Variables, Neonatal and Maternal Outcomes Before and During the COVID-19 Pandemic

Variables	B	SE	Wald	P-Value	Odds Ratio	Confidence Interval
Education						
Illiterate	-	-	20.4	0.0001	-	-
Elementary	-0.289	0.546	0.279	0.597	0.749	0.257 - 2.2
Diploma	0.603	0.182	10.9	0.0001	1.8	1.2 - 2.6
Academic	-0.064	0.155	0.177	0.680	0.938	0.692 - 1.2
Number of pregnancies						
-	-	-	46.9	-	-	-
1	-0.074	0.148	0.252	0.615	0.929	0.695 - 1.2
2	-0.927	0.208	19.9	0.001	0.369	0.363 - 0.594
3	-1.7	0.307	22.4	0.001	0.173	0.084 - 0.357
4	-2.2	0.509	19.4	0.001	0.106	0.039 - 0.287
History of abortion						
No	-	-	-	-	-	-
Yes	0.964	0.189	26.06	0.001	2.6	1.8 - 3.7
History of premature birth						
No	-	-	-	-	-	-
Yes	-1.2	0.346	12.1	0.001	0.299	0.152 - 0.589
Delivery option						
Cesarean	-	-	-	-	-	-
Vaginal birth	0.375	0.13	8.2	0.004	1.4	1.8 - 1.1
Preeclampsia						
No	-	-	-	-	-	-
Yes	0.789	0.263	8.9	0.003	2.2	1.3 - 3.6
Postpartum bleeding						
No	-	-	-	-	-	-
Yes	-0.865	0.386	5.03	0.025	0.421	0.198 - 0.897
Gestational diabetes						
No	-	-	-	-	-	-
Yes	2.08	0.282	54.6	0.001	8.01	4.6 - 13.9
Abortion						
No	-	-	-	-	-	-
Yes	0.629	0.412	2.3	0.127	0.533	0.238 - 1.2
Preterm delivery						
No	-	-	-	-	-	-
Yes	-0.368	0.152	5.8	0.016	0.692	0.513 - 0.933
Urinary tract infection						
No	-	-	-	-	-	-
Yes	-1.2	0.602	4.1	0.041	0.293	0.09 - 0.952
IUGR						
No	-	-	-	-	-	-
Yes	-20.2	6/12203	0.001	0.999	0.001	-
Age	0.074	0.012	38.8	0.001	1.1	0.735 - 1.2
Apgar score 1st minute	0.084	0.13	0.419	0.518	1.08	0.843 - 1.4
Apgar score 5th minute	-0.08	0.117	0.466	0.495	0.923	0.735 - 1.2

Abbreviation: IUGR, intrauterine growth restriction.

traumatic stress, which may contribute to glucose metabolism disorders (24, 25).

Contrary to some previous studies (14, 17, 18), our findings indicated a decrease in preterm deliveries during the pandemic. However, observational studies

from Ireland and Denmark also reported a significant reduction in preterm birth rates (19, 20). The frequency of IUGR declined during the pandemic, though birth weight remained unchanged. Similarly, Pirjani et al. found no significant association between COVID-19 infection and low birth weight, IUGR, NICU admission, or neonatal sepsis in their prospective cohort study at Arash Hospital in Tehran (6).

Cesarean delivery rates decreased during the pandemic, possibly due to more cautious decision-making by obstetricians to avoid unnecessary procedures and their long-term complications. In contrast, Kohi and Ajri reviewed 20 studies and noted a higher prevalence of cesarean deliveries among COVID-19-positive pregnant women. They concluded that while vaginal delivery does not inherently increase the risk of maternal COVID-19 transmission, its prolonged duration may elevate neonatal exposure risk (26).

Apgar scores at one and five minutes improved during the pandemic, with no cases requiring respiratory resuscitation or hospitalization for respiratory distress. This contrasts with Fayazi et al.'s review, which identified respiratory distress as a potential neonatal complication of COVID-19. Although vertical transmission via vaginal delivery remains unproven, their findings warrant further consideration (27).

Postpartum hemorrhage cases decreased during the pandemic, aligning with Pirjani et al.'s cohort study, which found no significant difference in postpartum bleeding between healthy and COVID-19-infected women (6). Notably, abortion rates declined significantly during the pandemic, likely due to reduced workplace commuting, telecommuting benefits, and local quarantine measures. Stillbirth and placental abruption rates remained unchanged. Yan et al. similarly reported no increased miscarriage risk among COVID-19 patients (28). However, Kazemi et al.'s systematic review linked COVID-19 to first- and second-trimester abortions, attributing these to placental insufficiency caused by inflammation. A pro-inflammatory cytokine storm was proposed as a potential mechanism for early pregnancy loss (29).

5.1. Conclusions

Our study indicated the impact of the COVID-19 pandemic on pregnancy outcomes. COVID-19 is one of the factors that affect pregnancy outcomes, and according to the results of our study, the likelihood of a history of abortion, gestational diabetes, and preeclampsia increased during the COVID-19 pandemic compared to before. The findings of this research highlight the importance of providing special services to mothers during pregnancy and after delivery in the critical conditions of infectious and contagious disease epidemics such as the COVID-19 pandemic. Therefore, it is necessary to implement appropriate strategies in this field. Maternal health services in the country's health system should prepare comprehensive guidelines for the management of prenatal and postnatal care. Additionally, training health care service providers for critical situations, including infectious disease epidemics, should be adopted. This approach may reduce maternal and newborn complications. It is suggested that future studies investigate the consequences of pregnancy during the COVID-19 pandemic by determining the frequency of deaths of pregnant women, thromboembolism, the occurrence of respiratory problems, and the need for intensive care unit admission in different populations.

5.2. Limitations and Strengths

This study had several important limitations that should be acknowledged. First, we were unable to assess maternal mortality rates during the COVID-19 pandemic or determine which COVID-19-related complications contributed most significantly to pregnancy-related deaths. Additionally, due to incomplete clinical documentation, we could not evaluate the incidence of thromboembolic events or respiratory complications in pregnant women before and during the pandemic period. Another limitation was our inability to examine ICU admission requirements among the study population. Finally, as an observational study, our methodology cannot establish causal relationships between COVID-19 infection and the observed pregnancy outcomes — this important question requires further investigation through more rigorous study designs.

Despite these limitations, our study had notable strengths that enhance the validity of our findings. The study benefited from an adequate sample size that provided sufficient statistical power for our analyses. Furthermore, our comprehensive evaluation of both maternal and neonatal outcomes offers valuable insights into the broader impacts of the pandemic on pregnancy health.

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Footnotes

Authors' Contribution: All authors contributed to the conception and design of the study. N. R. drafted the first version of the manuscript. M. K., N. R., and N. S. revised the manuscript. M. K. critically reviewed the manuscript for important intellectual content. All authors read and approved the final manuscript.

Conflict of Interests Statement: The authors declare no conflict of interests.

Data Availability: The datasets generated and analyzed during the present study are not publicly available as individual privacy could be compromised but are available from the corresponding author on reasonable request.

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