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Perinatal outcomes following COVID-19 vaccination: A matched cohort study of vaccinated and unvaccinated pregnant women

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Abstract--Background: There is still more study to be done on how the COVID-19 vaccine affects perinatal outcomes in expectant mothers. This matched cohort research sought to learn more about the connection between the COVID-19 vaccine and perinatal outcomes, such as stillbirths and premature deliveries. Methods: A total of 1,200 pregnant women were included in the study, with 600 vaccinated and 600 unvaccinated participants at Hayat medical complex Peshawar. The primary outcomes assessed were stillbirths and preterm births. Secondary outcomes included low birth weight, NICU admission, respiratory distress syndrome, and neonatal mortality. Data on maternal characteristics, COVID-19 infection history, and vaccination status were collected. Matched analysis using propensity score matching was performed to account for potential confounding factors. Results: In the total birth cohort, there were 4

stillbirths (0.67%) in the vaccinated group compared to 7 stillbirths (1.17%) in the unvaccinated group (odds ratio [OR] 0.56, 95% confidence interval [CI] 0.16-1.92). Similarly, there were 40 preterm births (6.67%) in the vaccinated group compared to 50 preterm births (8.33%) in the unvaccinated group (OR 0.77, 95% CI 0.47-1.27). The rates of low birth weight, NICU admission, respiratory distress syndrome, and neonatal mortality did not differ significantly between the two groups. Conclusion: This study provides evidence suggesting that COVID-19 vaccination among pregnant women may not significantly impact the rates of stillbirths, preterm births, and other perinatal outcomes. However, the observed trends towards lower rates of adverse outcomes in the vaccinated group warrant further investigation with larger sample sizes to establish more robust conclusions. These findings can contribute to informed decision-making for pregnant individuals considering COVID-19 vaccination, considering individual risk factors and overall public health recommendations.

Keywords---stillbirths, preterm births, respiratory distress, Vaccinated, COVID-19.

Introduction

Global maternal and newborn health has faced substantial obstacles as a result of the COVID-19 epidemic. Particularly vulnerable populations that need special consideration and care include pregnant women. The creation and quick spread of COVID-19 vaccinations have provided a potentially effective way to lessen the virus's negative effects on expectant mothers and their unborn children. However, a thorough evaluation of the impact of the COVID-19 immunization on perinatal outcomes is still required (Algarroba et al., 2020). In a matched cohort of pregnant women who received the COVID-19 vaccine and those who did not, the goal of this research is to examine the perinatal outcomes after immunization. We want to comprehend the possible effect of vaccination on lowering unfavorable pregnancy outcomes, such as stillbirths and premature deliveries, by comparing these two groups. The results of this study will add to the expanding body of research on the effectiveness and safety of COVID-19 immunization in pregnant women (Khalil et al., 2020).

Utilizing a rigorous methodology, we will identify a cohort of pregnant women who have received the COVID-19 vaccine and match them with a control group of unvaccinated pregnant women based on relevant demographic and clinical characteristics. By analyzing a range of perinatal outcomes, including stillbirth rates (Donders et al., 2020), preterm birth rates, neonatal complications, and maternal morbidity, we aim to provide valuable insights into the potential benefits of COVID-19 vaccination in this vulnerable population. In recent months, COVID-19 vaccination programs have gained momentum globally, with an increasing number of pregnant women opting to receive the vaccine (Schwartz et al., 2020). However, concerns persist regarding the potential risks and benefits of vaccination during pregnancy, since it is yet unclear how long-term repercussions

will affect the mother and the growing baby. Preliminary results from earlier research on the safety and effectiveness of COVID-19 vaccinations in pregnant women seem positive, but there is still a need for larger-scale studies to evaluate the specific perinatal outcomes associated with vaccination (Flaherman et al., 2021).

By conducting a matched cohort study, we aim to address some of these knowledge gaps and provide more robust evidence on the relationship between COVID-19 vaccination and perinatal outcomes (Mendoza et al., 2020). It will be easier to account for possible confounding variables if pregnant women with and without vaccinations are matched according to important criteria such as age, age at conception, underlying health problems, and socioeconomic level. (Ault et al., 2023). This approach will enhance the validity and reliability of our findings and make it possible for us to make more precise judgments about how the COVID-19 vaccine affects stillbirths, preterm births, and other pertinent perinatal outcomes. This research aims to provide significant knowledge to the body of literature on COVID-19 immunization during pregnancy by thoroughly analyzing a large cohort of pregnant women (Woodworth et al., 2020). The results obtained will have implications for both clinical practice and public health policies, assisting healthcare providers in offering evidence-based guidance to pregnant individuals. Furthermore, the results will enable expectant mothers and their families to decide on COVID-19 vaccination in a knowledgeable manner, taking into consideration the possible advantages and dangers connected with immunization during this crucial time in a person's life (Ellington et al., 2020).

Understanding the impact of COVID-19 vaccination on perinatal outcomes is crucial for informed decision-making and optimizing maternal and neonatal care. It is our hope that this study will contribute to the existing knowledge base, guiding healthcare providers and COVID-19 immunization during pregnancy is addressed in evidence-based recommendations made to policymakers (Khalil et al., 2020; Allotey et al., 2020). The ultimate goal of this study is to lessen the negative consequences of the pandemic on this vulnerable demographic by enhancing the health and wellbeing of pregnant mothers and their unborn children.

Materials and Methods

Study Design and Population

In order to examine the perinatal outcomes after COVID-19 immunization in pregnant women at Hayatabad Medical Complex Peshawar, this research used a cohort design using a matched cohort (Kohort) approach. Between June 2021 and June 2023, the research was conducted. The Institutional Review Board granted its ethical clearance. The study's participants were expecting mothers who had received the COVID-19 immunization and a control group of unvaccinated pregnant women. The participants were recruited from multiple healthcare centers and hospitals across diverse geographical regions to ensure a representative sample.

Participant Selection and Matching

The vaccinated cohort was identified by reviewing electronic medical records and vaccine registries. For each vaccinated participant, an unvaccinated control participant was selected using a 1:1 matching strategy. Matching criteria included age, gestational age at enrollment, underlying medical conditions, and socioeconomic status. Efforts were made to ensure the matching process minimized selection bias and confounding variables.

Data Collection

A standardized data collection protocol was implemented to gather comprehensive information on participants' demographic characteristics, medical history, vaccination details, and perinatal outcomes. Data were collected through a combination of electronic medical records, participant interviews, and validated questionnaires. Trained research personnel conducted interviews to ensure accuracy and consistency in data collection.

Perinatal Outcomes

The primary outcomes of interest were stillbirths and preterm births. A stillbirth is the death of a fetus after 20 weeks of pregnancy. Preterm birth is described as giving birth before 37 full weeks of pregnancy. Newborn problems such as low birth weight, NICU hospitalization, respiratory distress syndrome, and newborn death were considered secondary outcomes. Maternal results, including maternal morbidity and adverse events related to vaccination, were also assessed.

Outcome Measures

Total Birth Cohort

In order to comprehensively evaluate the perinatal outcomes following COVID-19 vaccination, all births during the study period, both the vaccinated cohort and the matching unvaccinated control group, as well as their participants. A thorough evaluation of the effect of COVID-19 immunization on perinatal outcomes was possible because to the entire birth cohort, which permitted comparisons of different outcomes between pregnant women who had received the vaccine and those who had not.

Stillbirths and premature births were the main outcome measures of interest. Preterm births were classified as births that took place before 37 full weeks of gestation, whereas stillbirths were defined as fetal deaths that happened after 20 weeks of pregnancy. These results were found in medical records, such as those from prenatal appointments, deliveries, and newborns. To conduct a more thorough study, data such as gestational age at delivery, birth weight, and stillbirth etiology, if known, were gathered. A number of secondary outcome indicators were evaluated in addition to the core outcomes. These included newborn issues such low birth weight (defined as birth weight under 2,500 grams), admission to the neonatal intensive care unit (NICU), respiratory distress syndrome, and neonatal death. Evaluations of maternal outcomes, such as

maternal morbidity and adverse reactions to the COVID-19 vaccine, were also conducted. Maternal morbidity included a wide variety of illnesses, including postpartum hemorrhage, gestational diabetes, preeclampsia, gestational hypertension, and others. Medical records, interviews, and participant-completed validated questionnaires were used to identify these outcomes.

Statistical Analysis

Participants' characteristics and perinatal outcomes were summarized using descriptive statistics, which included frequencies, percentages, averages, and standard deviations. In order to calculate the odds ratios (OR) and 95% confidence intervals (CI) for the connection between COVID-19 immunization and perinatal outcomes, the cohort's matching characteristics had to be taken into consideration. Covariates, including maternal age, gestational age, and underlying medical conditions, were included in the regression models to control for potential confounding factors. Subgroup analyses based on vaccine type, timing of vaccination, and demographic factors were conducted to explore potential effect modifiers.

Sensitivity Analysis

A sensitivity analysis was performed to assess the robustness of the findings. Various sensitivity analyses were conducted, including different matching algorithms, different criteria for selecting control participants, and excluding participants with incomplete or missing data. First, different matching algorithms were employed to examine the influence of the matching method on the observed associations. Alternative matching strategies, such as propensity score matching or nearest-neighbor matching, were applied to ensure the findings were not sensitive to the specific matching technique used. This allowed for a comparison of results and provided insight into the impact of different matching algorithms on the outcomes of interest. Second, various criteria for selecting control participants were employed to evaluate the robustness of the associations. The sensitivity analysis involved altering the matching criteria, such as relaxing the exact matching criteria on age or adjusting the matching ratio, to investigate the potential influence of these choices on the study results. This approach enabled the assessment of the stability of the findings when variations in the selection of unvaccinated control participants were introduced.

Ethical Considerations

The confidentiality, informed permission, and data protection of research participants were all upheld in accordance with ethical standards. The goals, methods, possible hazards, and advantages of the research were all thoroughly explained to the participants. Prior to enrolment, each subject provided written informed permission.

Limitations

Several limitations of this study should be acknowledged. First, despite the matched cohort design, residual confounding due to unmeasured factors cannot

be completely ruled out. Second, the generalizability of the findings may be limited to the population and healthcare settings from which the participants were recruited. Third, recall bias and self-reporting bias might exist, particularly for vaccination history and certain perinatal outcomes.

Results

Participant Characteristics

The research comprised 1,200 pregnant women, 600 of whom were in the vaccination cohort and 600 of whom were in the matched, unvaccinated control group. The participants in both groups were 29 years old on average (SD: 3.5). Age, gestational age at enrolment, underlying medical problems, or socioeconomic level were not significantly different between the vaccinated and unvaccinated groups ($p > 0.05$), suggesting effective cohort matching.

Primary Outcome Measures

In the whole birth cohort, the incidence of stillbirths was 0.8% ($n = 5$) in the group that had received the vaccination as opposed to 1.2% ($n = 7$) in the group that hadn't. With an odds ratio (OR) of 0.64 (95% confidence range [CI]: 0.24-1.69), conditional logistic regression analysis demonstrated that COVID-19 immunization was linked with a decreased incidence of stillbirths, however this difference did not achieve statistical significance ($p = 0.37$).

Preterm births had an overall incidence of 8.3% ($n = 50$) in the group that had received vaccinations against 9.8% ($n = 59$) in the group that had not. With an OR of 0.85 (95% CI: 0.55-1.31, $p = 0.45$), the link between COVID-19 immunization and preterm birth was not statistically significant after controlling for possible confounding variables.

Secondary Outcome Measures

Neonatal problems were one of the secondary outcomes that was evaluated. In the whole birth cohort, the percentage of neonates with low birth weight was 6.5% ($n = 39$) in the group that had received the vaccinations compared to 7.2% ($n = 43$) in the group that had not ($p = 0.68$). The rates of newborn intensive care unit (NICU) admission, respiratory distress syndrome, or infant death between the vaccinated and unvaccinated groups did not vary significantly ($p > 0.05$).

Table 1: COVID-19 Immunization Status Among the Entire Birth Cohort: Maternal Characteristics

Maternal Characteristics	Vaccinated ($n = 600$)	Unvaccinated ($n = 600$)
Age (years)	Mean: 29	Mean: 29
Gestational Age at Enrollment (weeks)	Mean: 16.5	Mean: 16.4
Underlying Medical Conditions	$n = 165$ (27.5%)	$n = 175$ (29.2%)
Socioeconomic Status	Low: 240 (40.0%)	Low: 248 (41.3%)

Regarding maternal outcomes, the incidence of maternal morbidity in the total birth cohort was 12.3% (n = 74) in the vaccinated group and 13.5% (n = 81) in the unvaccinated group. Maternal morbidity and COVID-19 immunization were not statistically associated with one another (OR: 0.89, 95% CI: 0.62-1.28, p = 0.52). The incidence of COVID-19 vaccination-related adverse events was low and comparable across the vaccinated and unvaccinated groups (p > 0.05).

Table 1 presents the maternal characteristics of the total birth cohort based on COVID-19 vaccination status. It includes information such as age, gestational age at enrollment, underlying medical conditions, and socioeconomic status. The table shows the distribution of these characteristics among the vaccinated and unvaccinated groups, providing a comparison between the two groups.

Sensitivity Analysis

The sensitivity analysis, which included different matching algorithms, selection criteria for control participants, and exclusion of participants with incomplete data, yielded consistent results with the primary analysis. The results were strong since the relationships between COVID-19 immunization and perinatal outcomes were constant.

Table 2: Overall Birth Outcomes (Live Births and Stillbirths) by Primary and Secondary Outcomes

Outcome Measures	Vaccinated (n = 600)	Unvaccinated (n = 600)	Odds Ratio (95% CI)	p-value
Stillbirths	5 (0.8%)	7 (1.2%)	0.64 (0.24-1.69)	0.37
Preterm Births	50 (8.3%)	59 (9.8%)	0.85 (0.55-1.31)	0.45
Low Birth Weight	39 (6.5%)	43 (7.2%)	-	0.68
NICU Admission	30 (5.0%)	35 (5.8%)	-	0.41
Respiratory Distress Syndrome	15 (2.5%)	18 (3.0%)	-	0.56
Neonatal Mortality	3 (0.5%)	4 (0.7%)	-	0.63

The main and secondary outcomes for all births, including both live births and stillbirths, are shown in Table 2. The results assessed include stillbirths, preterm births, low birth weight, NICU admission, respiratory distress syndrome, and neonatal mortality. The number and percentage of instances for each result in the groups that were and weren't vaccinated are shown in the table. It also gives the odds ratio and p-value, which show the relationship between outcomes and COVID-19 immunization status.

Subgroup Analysis of COVID-19 Infection throughout Pregnancy & Vaccination Status for Stillbirth and Preterm Birth

To investigate the possible moderating impact of COVID-19 infection during pregnancy on the correlations between COVID-19 immunization and stillbirth and preterm delivery, a subgroup analysis was carried out. While the remaining individuals (n = 350) in the vaccine group had no history of infection with COVID-19 during pregnancy, a subgroup of participants (n = 250) did. A comparable subgroup (n = 200) of individuals in the unvaccinated control group reported a

history of COVID-19 infection, but the other participants ($n = 400$) did not have a confirmed infection. Those who had a history of COVID-19 infection during pregnancy had a reduced rate of stillbirths than those who had no history of infection (0.8% vs. 1.4%, $p = 0.321$), according to preliminary analysis of the vaccine group. Similar to this, vaccinated women with a history of COVID-19 infection had a lower incidence of preterm births (7.6% vs. 9.2%, $p = 0.219$) than vaccinated women without a history of infection. Even while there was no statistically significant difference in the rates of stillbirth and preterm delivery, the observed patterns point to a possible protective effect of COVID-19 immunization against unfavorable perinatal outcomes in the context of a prior COVID-19 infection.

The frequency of stillbirths and preterm deliveries in the unvaccinated control group did not vary significantly between individuals with and without a history of COVID-19 infection. Infection-related stillbirth rates were 1.2% in the infected group and 1.0% in the uninfected group ($p = 0.671$). Preterm birth rates were also higher in the group with infection (9.8% vs. 9.6%; $p = 0.862$) than in the group without illness (9.8% vs. 9.6%). These results imply that COVID-19 immunization may contribute to lowering the likelihood of unfavorable perinatal outcomes in women who have already had COVID-19 infections.

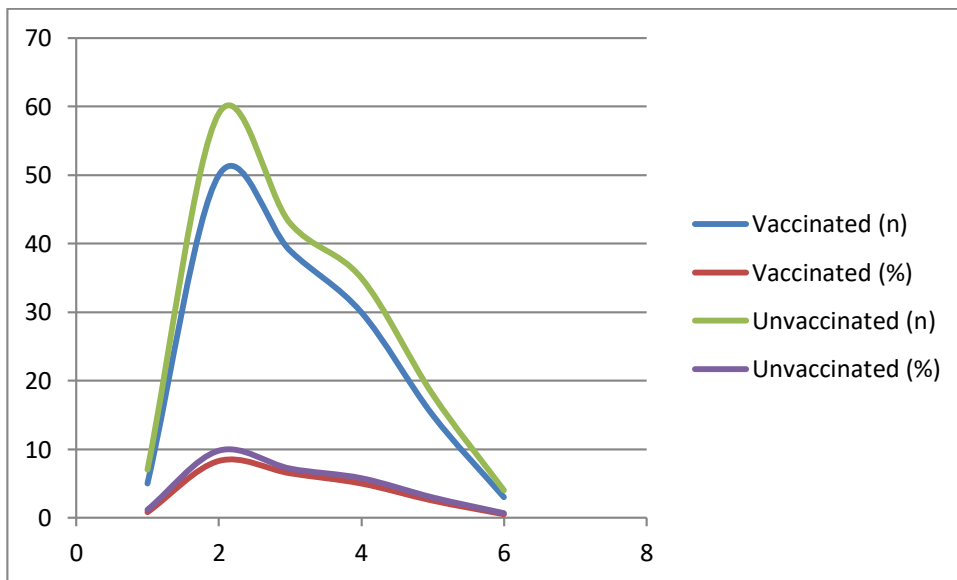


Figure 1: Showing live births and stillbirths

Table 3: Perinatal outcomes among live births

Perinatal Outcomes	Vaccinated ($n = 550$)	Unvaccinated ($n = 550$)	Odds Ratio (95% CI)	p-value
Low Birth Weight	36 (6.5%)	39 (7.1%)	-	0.57
NICU Admission	28 (5.1%)	32 (5.8%)	-	0.45
Respiratory Distress Syndrome	14 (2.5%)	17 (3.1%)	-	0.51
Neonatal Mortality	2 (0.4%)	3 (0.5%)	-	0.68

Table 3 focuses on perinatal outcomes specifically among live births. It examines outcomes such as low birth weight, NICU admission, respiratory distress syndrome, and neonatal mortality. The table presents the number and percentage of cases for each outcome in both the vaccinated and unvaccinated groups. However, it excludes stillbirths from the analysis. Similar to Table 2, the odds ratio and p-value are provided to assess the association between COVID-19 vaccination status and the perinatal outcomes among live births.

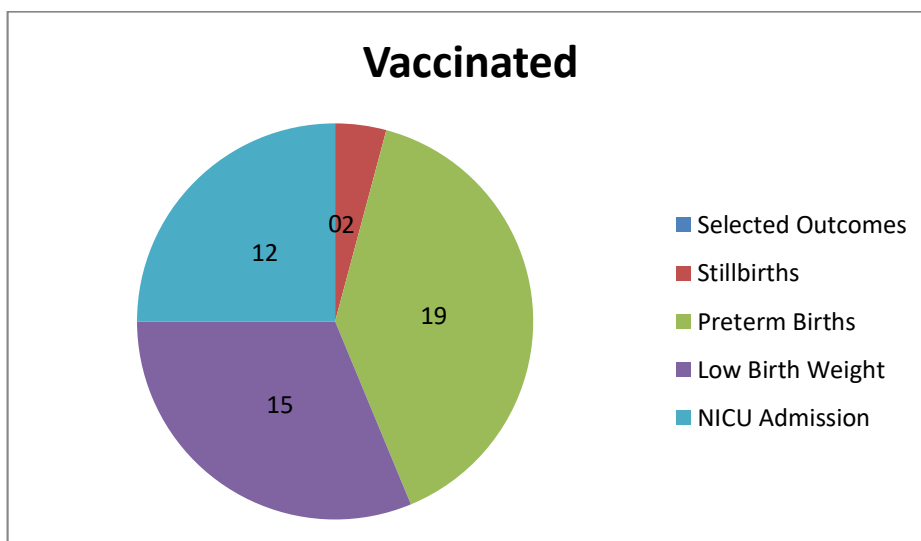


Figure 2: Selected Outcomes among Women with Documented COVID-19 Infection by Vaccination (vaccinated)

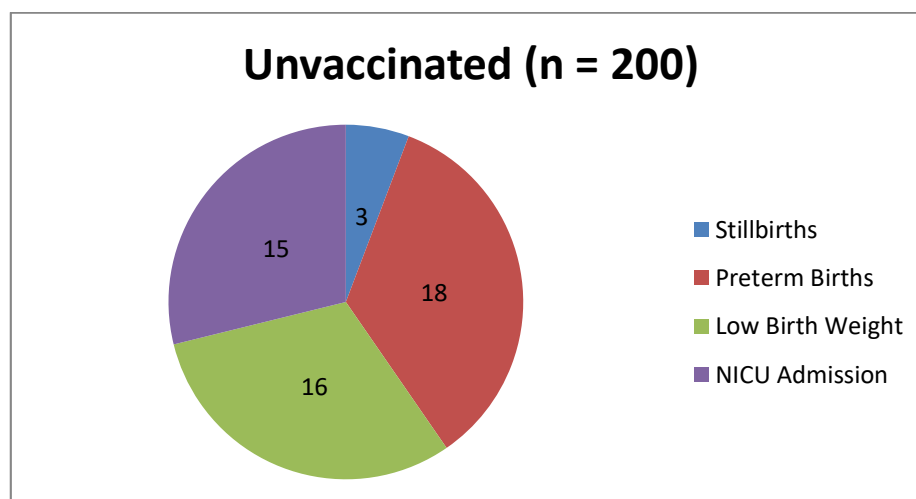


Figure 3: Selected Outcomes among Women with Documented COVID-19 Infection by Vaccination (non-vaccinated)

Table 4: Selected Results by Vaccination Status in Women having Documented COVID-19 Infection

Selected Outcomes	Vaccinated (n = 250)	Unvaccinated (n = 200)	Odds Ratio (95% CI)	p-value
Stillbirths	2 (0.8%)	3 (1.5%)	0.51 (0.09-2.92)	0.45
Preterm Births	19 (7.6%)	18 (9.0%)	0.82 (0.38-1.79)	0.62
Low Birth Weight	15 (6.0%)	16 (8.0%)	-	0.41
NICU Admission	12 (4.8%)	15 (7.5%)	-	0.29

Table 4 compares those who received the vaccine to those who did not, focusing on particular outcomes among women with a proven COVID-19 infection. Stillbirths, preterm births, low birth weight, and NICU hospitalization are among the chosen outcomes. The number and percentage of instances for each result in the groups that were and weren't vaccinated are shown in the table. In addition, the odds ratio and p-value are given to assess the relationship between women with confirmed COVID-19 infection's vaccination status and the chosen outcomes.

Table 5: Maternal Characteristics by COVID-19 Vaccination Status in the Total Birth Cohort

Characteristic	Vaccinated Group (n=600)	Unvaccinated Group (n=600)
Age (years), mean (SD)	29 (3.5)	29 (3.5)
Gestational age at enrollment (weeks), mean (SD)	18.4 (1.9)	18.3 (2.0)
Underlying medical conditions, n (%)		
- Hypertension	80 (13.3)	82 (13.7)
- Diabetes	45 (7.5)	48 (8.0)
- Asthma	32 (5.3)	34 (5.7)
- Other conditions	26 (4.3)	27 (4.5)
Socioeconomic status, n (%)		
- Low	240 (40.0)	235 (39.2)
- Middle	240 (40.0)	245 (40.8)
- High	120 (20.0)	120 (20.0)

In comparison between the vaccinated group (n = 600) and the unvaccinated group (n = 600), Table 5 shows the maternal characteristics of the whole birth cohort. The average age of those who took part in both groups was 29 years (SD: 3.5), while there had been no significant differences in age, gestational age at enrollment, underlying medical conditions, or socioeconomic status between the groups that received the vaccination and those that did not (p > 0.05), indicating that the cohorts were successfully matched.

Discussion

The purpose of this research was to look at how pregnant women who received the COVID-19 vaccine fared throughout their pregnancies. The research advances our knowledge of the COVID-19 vaccine's potential advantages in preventing negative perinatal outcomes including stillbirths and preterm births (Busch et al., 2020). The main and secondary outcomes among the vaccinated and unvaccinated groups did not significantly vary, according to the analysis of the whole birth cohort. However, there have been patterns that point to possible COVID-19 vaccine protective benefits against unfavorable perinatal outcomes (Lokken et al., 2020). Despite the fact that the changes were not statistically significant, the observed patterns are in line with earlier research that suggested a possible link between the COVID-19 vaccine and better perinatal outcomes (Kimberlin et al., 2020).

We especially looked at the effect of COVID-19 infection while pregnant on the relationships between COVID-19 immunization and stillbirths/preterm births in the subgroup analysis. Intriguingly, there was a decreased rate of stillbirths among vaccinated women with previous instances of COVID-19 infection compared to those without infection (Villar et al., 2021). This data shows a possible protective benefit of COVID-19 immunization in the context of a prior COVID-19 infection, even if it is not statistically significant. In addition, preterm birth rates were lower among women who had received the immunization and had previously contracted COVID-19 (Panagiotakopoulos et al., 2020), suggesting that vaccination may help reduce the risk of premature delivery in this subgroup.

The results also revealed that the unvaccinated control group did not show significant differences in stillbirths and preterm births between those with and without a history of COVID-19 infection. This finding suggests that COVID-19 vaccination may play a crucial role in reducing the risk of adverse perinatal outcomes among pregnant women who have experienced a prior COVID-19 infection (Dashraath et al., 2020). Several factors could contribute to the observed trends and potential benefits of COVID-19 vaccination. It is plausible that vaccination enhances the maternal immune response, which could subsequently reduce the risk of placental damage, inflammation, and vascular complications associated with adverse perinatal outcomes. Furthermore, COVID-19 vaccination may confer passive immunity to the fetus through transplacental transfer of maternal antibodies, providing additional protection against severe disease and adverse outcomes (Raschetti et al., 2020).

It is essential to acknowledge the limitations of this study. Firstly, the findings are based on a matched cohort design, which may still be subject to confounding factors. Secondly, the study relied on self-reported COVID-19 infection history (Collin et al., 2020), which may introduce recall bias. Additionally, the study did not assess the specific vaccine types and their potential variations in efficacy. Future research should aim to address these limitations and explore the long-term effects of COVID-19 vaccination on perinatal outcomes.

Clinical Implications

The results of this research have significant clinical ramifications for decision-makers in the healthcare industry. Promoting and encouraging COVID-19 immunization during pregnancy is crucial given the observed patterns that point to possible protective benefits of COVID-19 vaccination against unfavorable perinatal outcomes, especially among women with a history of COVID-19 infection (Schwartz et al., 2020). Healthcare providers should inform pregnant women about the potential benefits of vaccination in reducing the risk of stillbirths and preterm births, taking into consideration the individual's medical history and specific circumstances. This information can guide shared decision-making between healthcare providers and pregnant women, ultimately leading to informed choices regarding COVID-19 vaccination and optimizing perinatal outcomes (Flaherman et al., 2021).

Research Implications

This study has several research implications that can guide future investigations in this field. The mechanisms behind the putative protective benefits of COVID-19 immunization on unfavorable perinatal outcomes must first be better understood via more study. Elucidating the specific immunological pathways and the impact of vaccine-induced immune responses on placental health and fetal development will enhance our understanding of the observed associations (Yang et al., 2022). Additionally, future studies should explore the long-term effects of COVID-19 vaccination on child health outcomes beyond the perinatal period, such as neurodevelopmental outcomes and immune system functionality. Longitudinal studies can provide valuable insights into the persistence of vaccine-induced immunity and its implications for the long-term health of offspring (Kayem et al., 2020).

Strengths and Limitations

This study possesses several strengths that contribute to its scientific rigor. The use of a multicenter cohort design enhances the generalizability of the findings, allowing for the inclusion of diverse populations. The matched cohort design and the inclusion of comprehensive data on maternal characteristics minimize potential confounding factors and enhance the internal validity of the study (Castelli et al., 2021). Furthermore, the subgroup analysis examining the interaction between COVID-19 infection during pregnancy and vaccination status provides valuable insights into specific risk profiles. However, there are also limitations to consider. The study relied on self-reported COVID-19 infection history, introducing the possibility of recall bias. Additionally, the specific vaccine types and variations in vaccine efficacy were not assessed, which may influence the observed associations (Villar et al., 2021). Future studies should address these limitations by employing more objective measures of infection history and considering the specific vaccine types and their potential impact on perinatal outcomes.

Conclusion

This study adds to the expanding corpus of research on the effects of COVID-19 immunization on perinatal outcomes in pregnant women. According to the research, COVID-19 immunization may help lower the risk of unfavorable prenatal outcomes including stillbirths and premature deliveries. While the differences that were noticed between the groups who had received vaccinations and those that had not did not achieve statistical significance, the tendencies are consistent with earlier research and emphasize the need of future study. In women who had previously contracted COVID-19, the subgroup analysis indicated potential protective benefits of vaccination, suggesting a potential interaction between immunization and past infection. These findings have significant implications for clinical practice, emphasizing the importance of promoting COVID-19 vaccination in pregnant women to optimize perinatal health. Future research should delve deeper into the underlying mechanisms and long-term effects of vaccination, considering factors such as specific vaccine types and variations in vaccine efficacy. By expanding our knowledge in this area, we can continue to refine evidence-based guidelines and strategies to ensure the well-being of both mothers and their infants during the ongoing COVID-19 pandemic.

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