DOI: 10.7860/JCDR/2026/82167.22739

Original Article

Paediatrics Section

Association of SARS-CoV-2 Serology in Cord Blood with Maternal COVID-19 Vaccination Status: A Prospective Cohort Study

SANOBER WASIM[1], SANA GUPTA[2], RAKESH KUMAR[3], GIRISH GUPTA[4], GARIMA MITTAL[5]

ABSTRACT

Introduction: Maternal vaccination against Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) offers an opportunity to protect both pregnant women and their newborns. Understanding how vaccine timing and dosing influence transplacental antibody transfer is essential for optimising perinatal immunisation strategies.

Aim: To assess the SARS-CoV-2 Immunoglobulin G (IgG) status and its association with maternal Coronavirus Disease 2019 (COVID-19) vaccination status.

Materials and Methods: A prospective observational cohort study was conducted at the Department of Neonatology, Paediatrics, Swami Rama Himalayan University, Dehradun, Uttarakhand, India, from October 2021 to January 2022. The study included all 200 mothers who delivered during the study period and their neonates. Maternal SARS-CoV-2 infection and vaccination status were recorded on admission. Umbilical cord blood was collected at birth and IgG was assessed. Neonates born to mothers with confirmed infection underwent polymerase chain reaction testing. Primary analysis compared Cord blood IgG concentrations across vaccination subgroups and examined associations with the number of doses, interval since vaccination, and gestational age at delivery. The Kruskal-Wallis test was used to determine statistically significant differences between groups. A two-tailed p-value<0.05 was considered statistically significant.

Results: The mothers had a mean age of 27.1±4.3 years (median 26 years; range 18-45years) with a mean gestational age at delivery of 37.64±2.39 weeks (median 38 weeks; range 26-41weeks), and neonatal birth weight was 2.72±0.60 kg. Cord blood IgG concentrations were markedly higher in neonates of vaccinated mothers than in those of unvaccinated mothers (p-value=0.001). Titers did not differ between one-dose and two-dose recipients. Antibody concentrations declined as the interval between the final vaccine dose and delivery lengthened, within nine months of vaccination (76.72±10.64 AU/mL; n=52), at 9-12 months (10.65±7.73 AU/mL; n=10), and at 12-14 months (6.92±6.07 AU/mL; n=8; p-value=0.016), while later gestational age at birth was associated with higher titers.

Conclusion: Maternal SARS-CoV-2 vaccination, particularly when administered close to delivery, enhances passive antibody transfer to the newborn, whereas immunity acquired through infection alone is less effective. These findings support the use of universal vaccination during pregnancy and suggest that a booster dose in late pregnancy may maximise neonatal protection.

Keywords: Antibody titers, Coronavirus disease 2019, Immunoglobulin G, Maternal serostatus, Neonatal immunity, Severe acute respiratory syndrome coronavirus 2, Vaccine

INTRODUCTION

Population seroprevalence surveys are critical for guiding Coronavirus Disease 2019 (COVID-19) policy. Serologic testing for antibodies against SARS-CoV-2 can identify prior exposure and may help predict clinical outcomes [1,2]. However, implementing large-scale surveys remains challenging in resource-limited settings. Umbilical cord blood, however, is collected routinely at birth without discomfort to the infant, and its antibody profile mirrors maternal serostatus [2-4]. Cord blood seroprevalence studies could therefore monitor infection trends among pregnant women and inform public health interventions [5,6].

Maternally derived antibodies provide a newborn's first line of passive immunity. IgG crosses the placenta, whereas immunoglobulin M (IgM) does not. Perinatal SARS-CoV-2 transmission (via the placenta, exposure to infected secretions during delivery, postnatal respiratory droplets, or breast milk) appears to be uncommon, with reported neonatal infection rates ranging from 3.1% to 9.1% [3,4]. Although passive transfer of anti-SARS-CoV-2 antibodies has been documented, their protective effect and duration remain uncertain [6-9].

There have been several studies regarding the COVID-19 vaccination status of mothers and related immune response in the neonate, but the result of active immunisation of mothers in pregnancy and its yield has not been studied quantitatively [4-6]. Measuring these antibodies in cord blood and following newborns prospectively could clarify the impact of maternal infection and the potential benefits of maternal vaccination. Therefore, the present study was conducted to assess anti-SARS-CoV-2 IgG in umbilical cord blood and its association with maternal COVID-19 vaccination status was assessed.

MATERIALS AND METHODS

A prospective observational cohort study was conducted in the Department of Neonatology, Paediatrics, at the Himalayan Institute of Medical Sciences (HIMS), Dehradun, from October 2021 to January 2022. The Institutional Review Board ethical committee at study Institute approved the study design (Approval No. SRHU/HIMS/ETHICS/2021/114). A thorough written consent was taken from all the participating mothers.

Inclusion criteria: The cohort comprised all healthy neonates delivered at HIMS during the study period and their mothers, irrespective of gestational age, irrespective of maternal vaccination status or history of previous COVID-19 infection in the mother.

Exclusion criteria: Any neonate with congenital malformation and mother who did not give consent for the study were excluded.

Sample size calculation: Sample size has been calculated by using the formula [10]:

$n=(Z)^2\ pq/(e)^2$

n=Sample size; Z=1.96 for 95% CI; p=0.14; e=0.05 and q=1-p

$Z^2=3.8416$, $e^2=0.0025$, q=0.86, pq=0.1204

Minimum (185.0115) 185 samples are required for the study.

α=critical value of the normal distribution i.e., 95%, alpha value is 0.05 and critical value is 1.96;

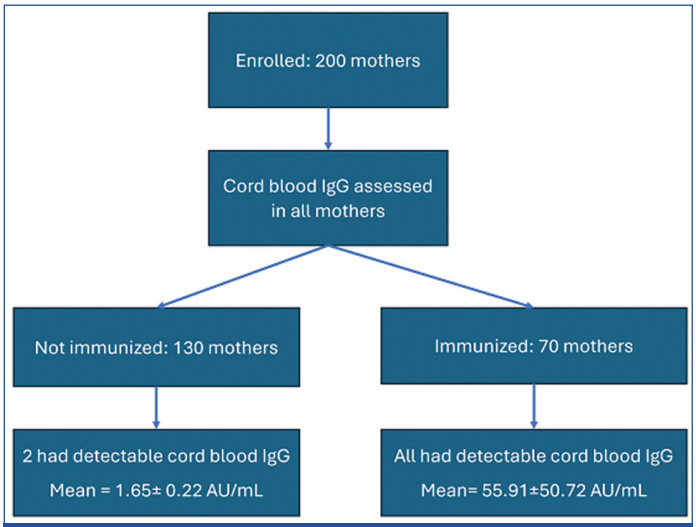
p= expected prevalence or proportion; q: 100 – p; e: margin of error

Study Procedure

Pregnant women were screened for SARS-CoV-2 on admission for delivery by collecting Nasopharyngeal (NP) and Oropharyngeal (OP) samples and performing either a qualitative rapid antigen test or Reverse-Transcription Polymerase Chain Reaction (RT-PCR; covipath COVID-19 RT-PCR kit, approved by the Indian Council of Medical Research, Conformité Européenne in-vitro diagnostic, and the United States Food and Drug Administration). Maternal test results were recorded prospectively.

Immediately after delivery, umbilical cord blood was collected from each neonate. Anti-SARS-CoV-2 IgG antibodies directed against the receptor-binding domain of the spike protein using an enzyme-linked fluorescent assay (Vidas, biomérieux, Marcy-l'Étoile, France) were measured. All newborns received standard clinical evaluation and management according to unit protocols.

Maternal demographic data, obstetric history, details of COVID-19 exposure or infection, and vaccination status were entered into a structured proforma and recorded neonatal demographic and clinical variables in the same manner. The COVID-19 vaccine received by the mothers enrolled in the study was either the adenoviral vectored vaccine ChAdOx1 nCoV-19 (Covishield, Serum Institute of India, Pune, India) or the inactivated whole virion vaccine BBV152 (Covaxin, Bharat Biotech, Hyderabad, India). This data was collected as a part of the case record form, maximum mothers could themselves tell which COVID-19 vaccine they received. The primary outcome was the presence of anti-SARS-CoV-2 IgG in cord blood. A flow diagram of the study population is provided [Table/Fig-1].



[Table/Fig-1]: Participant flow diagram.

STATISTICAL ANALYSIS

The collected data were entered into Microsoft Excel (Microsoft Corp., Redmond, WA) and analysed with IBM Statistical Package for Social Sciences (SPSS) Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY). Normality was assessed with the one-sample Kolmogorov–Smirnov test. Categorical variables were reported as frequencies and percentages, and continuous variables as descriptive statistics. Associations between categorical variables were evaluated using the χ^2 test and relationships between continuous variables were examined using the Pearson correlation. The Kruskal-Wallis test was used to determine statistically significant differences between groups. A two-tailed p-value<0.05 was considered statistically significant.

RESULTS

A total of 200 mother-infant pairs were enrolled. The mothers had a mean age of 27.1±4.34 years (median 26; range 18-45). The mean gestational age at delivery was 37.64±2.39 weeks (median 38; range 26-41). Neonatal birth weight averaged 2.72±0.60 kg, with a median of 2.75 kg and a range of 0.99-4.32 kg [Table/Fig-2]. Cord blood IgG titers were markedly lower in the two infants born to unvaccinated mothers (1.65±0.22 AU/mL) than in those whose mothers received a COVID-19 vaccine dose (56.05±71.81 AU/mL (p-value=0.001).

Demographic information		n (%)
Age group (years)	18-25	77 (38.50%)
	26-35	113 (56.50%)
	36-45	10 (5%)
	Mean±SD	27.12±4.34
History of COVID-19 infection	Yes	7 (3.50%)
	No	193 (96.50%)
COVID-19 vaccine received	Yes	70 (35%)
	No	130 (65%)
Gravida	Gravida 1	110 (55%)
	Gravida 2	60 (30%)
	Gravida 3	20 (10%)
	Gravida >3	10 (5%)
Gestational age	<28	1 (0.50%)
	28-32	8 (4%)
	32-34	11 (5.50%)
	35-36	22 (11%)
	37-40	153 (76.50%)
	≥41	5 (2.50%)
	Mean±SD	37.64±2.39
Blood group	A+ve	47 (23.50%)
	A-ve	2 (1%)
	B+ve	63 (31.50%)
	B-ve	1 (0.50%)
	O+ve	50 (25%)
	O-ve	5 (2.50%)
	AB+ve	30 (15%)
	AB-ve	2 (1%)
Birth weight (kg)	<1.5 kg	6 (3%)
	1.5-2.5 kg	63 (31.50%)
	2.51-3.35 kg	117 (58.50%)
	>3.5 kg	14 (7%)
	Mean±SD	2.72±0.60
AGA/LGA/SGA	AGA	175 (87.50%)
	LGA	2 (1%)
	SGA	23 (11.50%)

[Table/Fig-2]: Basic demographic and clinical characteristics of the study population.
COVID-19: Coronavirus disease 2019; AGA: Appropriate for gestational age; LGA: Large for gestational age; SGA: Small for gestational age.

Among vaccinated women, 30 had received a single dose (54.90±67.49 AU/mL) and 40 had received two doses (56.92±75.72 AU/mL); this difference was not significant (p-value=0.251). There was no significant difference in the antibody titers according to the number of doses of the COVID-19 vaccine received by the mother [Table/Fig-3].

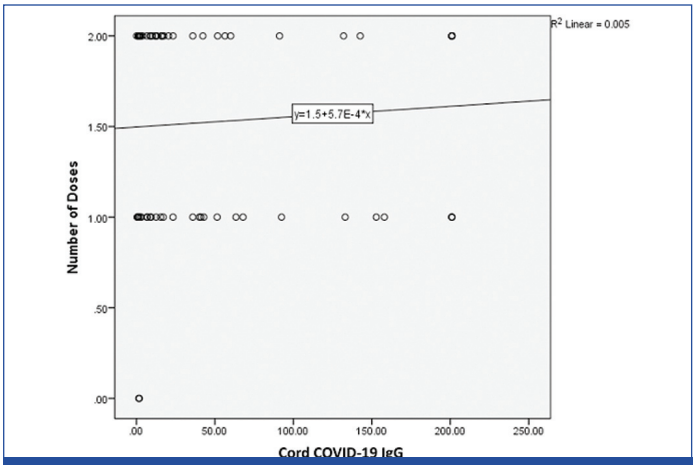
Number of doses	n (%)	Mean±SD	Mean rank	Kruskal-Wallis test	p-value*
1 Dose	30 (42.85%)	54.9±67.4	36.0	2.762	0.251
2 Dose	40 (57.14%)	56.9±75.7	36.4		
Total	70 (100%)	--	--		

[Table/Fig-3]: Correlation of number of doses received by the mother to antibody titer in cord blood.
SD: Standard Deviation; *Kruskal–Wallis H test comparing median cord blood IgG titers among mothers who received 0, 1, or 2 vaccine doses.

A positive correlation between the dose number and IgG concentration (Spearman ρ=0.056) is depicted in [Table/Fig-4]. A line diagram depicting the trend of antibody titers according to the number of doses is shown in [Table/Fig-5].

Spearman's rho		Cord COVID-19 IgG
Number of doses	Correlation Coefficient	0.056
	p-value	0.645
	N	70

[Table/Fig-4]: Correlation of number of doses received and IgG titres.
IgG: Immunoglobulin G.



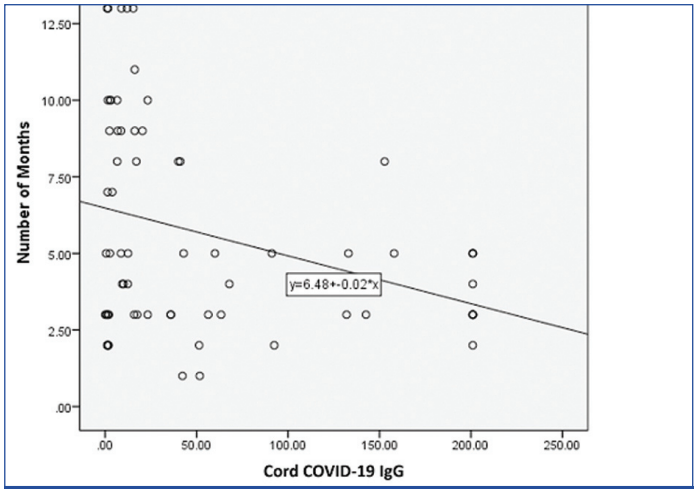
[Table/Fig-5]: Relationship between Cord blood SARS-CoV-2 IgG concentration and number of maternal vaccine doses.

IgG titers also declined as the interval between the final vaccine dose and delivery lengthened. Mean titers remained high when birth occurred within nine months of vaccination (76.72±10.64 AU/mL; n=52), dropped at 9-12 months (10.65±7.73 AU/mL; n=10), and were lowest at 12-14 months (6.92±6.07 AU/mL; n=8; p-value=0.016) [Table/Fig-6,7].

Time gap vaccine	N (%)	Mean±SD	Mean rank	Kruskal-Wallis test	p-value*
<9 months	52 (74.2%)	76.72±10.64	39.4	8.259	0.016
9-11 months	10 (14.2%)	10.65±7.73	27.3		
12-14 months	8 (11.4%)	6.92±6.07	20.0		
15-17 months	0	NA	NA		
18-21 months	0	NA	NA		
Total	70 (100%)	NA	NA		

[Table/Fig-6]: Mean IgG titers and months from COVID-19 vaccine.
NA: not applicable; *Kruskal–Wallis H test comparing median cord blood IgG titres across categories of time elapsed since maternal vaccination (<9 months, 9-11 months, 12-14 months).

Gestational age modulated antibody transfer. Neonates delivered at later gestations exhibited the highest IgG titers, indicating that transplacental transfer peaks during the third trimester [Table/Fig-8].



[Table/Fig-7]: Relationship between cord blood SARS-CoV-2 IgG concentration and months elapsed since maternal vaccination.

Gestational age (weeks)	Total, (N)	Present	Mean±SD	Mean rank	Kruskal-Wallis Test	p-value
<28	1	1	10.1±0.0	28.0	8.130	0.049
28-31	8	5	45.9±86.9	31.1		
32-34	11	5	34.0±66.5	24.0		
35-36	22	6	36.8±80.6	21.0		
37-40	153	52	57.3±68.9	38.2		
≥41	5	1	201.0±0.0	65.5		
Total	200	70	54.5±71.3	NA		

[Table/Fig-8]: Mean IgG titers in neonates by gestational age.

DISCUSSION

Antenatal vaccination against SARS-CoV-2 primarily protects pregnant women from COVID-19; however, the optimal schedule (i.e., dose number and timing) remains unsettled [11]. In the present study cohort, maternal vaccination before or during pregnancy generated anti-SARS-CoV-2 IgG that crossed the placenta; cord blood titers rose with each additional dose, and transfer efficiency peaked in the third trimester, consistent with previous kinetic studies [12,13]. Neonates delivered at later gestations, therefore, showed the highest IgG concentrations.

The findings from the current study align with data from Rottenstreich A et al., who observed a robust antibody response when vaccination occurred early in the third trimester, although their analysis excluded doses given in the first two trimesters or before conception [14]. Cord blood titers also declined as the interval between the final vaccine dose and delivery lengthened (p-value=0.016), suggesting that a booster late in pregnancy may maximise neonatal protection.

Vaccination outperformed natural infection. Mean cord blood IgG titers were significantly lower after maternal infection alone than after vaccination, echoing results from Bordt EA et al., who reported stronger maternal and neonatal humoral responses following vaccination than following infection [15]. Martínez-Quezada R et al., proved in their study that antibodies are detectable in mothers and their neonates even after 12 months of immunisation [16], so COVID-19 vaccination before or during pregnancy exerts a robust immune response in both mothers and babies. Shook LL et al., compared the cord blood titres of vaccinated mothers from the infected mothers and found a significant difference between the cord titers after vaccination 2.17±, 0.50 vs natural infection 1.00±0.83 with a p-value of <0.001 [17]. These observations support current recommendations that even previously infected pregnant individuals should be vaccinated to enhance immunity [18,19].

The protection conferred by passive antibodies is transient. In the present study, neonatal titers were not serially tracked (which is a limitation of

this study), but Proto A et al., recently documented a steady postnatal decline, underscoring the urgency of defining when infant vaccination should begin [20]. The current study did not compare titers by trimester of vaccination, as Rottenstreich A et al., did [14]; nevertheless, the gestational-age gradient we observed indicates that placental transfer intensifies late in pregnancy. Variations across trimesters likely reflect differences in vaccine-to-delivery interval, the maturation of placental transport mechanisms, and antibody half-life [21].

Limitation(s)

Cord blood IgG titers were measured only once and no paired maternal serum samples were available, which prevented the calculation of transfer ratios or assessment of antibody waning after birth. Also, the outcome of the babies born to mothers participating in the present study was not assessed. The observational design also left residual confounding possible, particularly because vaccination status, interval from vaccination to delivery, and circulating viral variants were not randomised. Additionally, relatively few women received their first vaccine dose in the first or second trimester, making the study underpowered to compare transfer efficiency by trimester.

CONCLUSION(S)

Cord blood IgG titers correlated positively with maternal COVID-19 vaccination status and dose number and inversely with the time elapsed since the last dose. These data confirm that placental transfer provides newborns with short-term passive immunity, highlighting the third trimester as the window of maximal antibody transfer. Universal vaccination during pregnancy, including boosters for those vaccinated early or previously infected, should remain a public health priority while further research clarifies the durability of neonatal protection and the optimal timing of infant immunisation. There has been enough evidence supporting the administration of the COVID-19 vaccine to pregnant females, whereas more research needs to be done on how long the titer remains above the beneficial value in newborns and when the neonate should be vaccinated and whether the neonate should be or not.

REFERENCES

[1] Flannery DD, Gouma S, Dhudasia MB, Mukhopadhyay S, Pfeifer MR, Woodford EC, et al. Assessment of Maternal and Neonatal Cord Blood SARS-CoV-2 Antibodies and Placental Transfer Ratios. JAMA Pediatrics [Internet]. 2021;175(6):594. Available from: https://jamanetwork.com/journals/jamapediatrics/fullarticle/2775945.

[2] Paul G, Chad R. Newborn antibodies to SARS-CoV-2 detected in cord blood after maternal vaccination – A case report. BMC Pediatrics. 2021;21(1):138.

[3] Liu F, Nguyen M, Vijayakumar P, Kaplan A, Meir A, Dai Y, et al. Newborn Dried Blood Spots for Serologic Surveys of COVID-19. Pediatric Infectious Disease Journal. 2020;39(12):e454-e456.

[4] Kubiak J, Murphy E, Yee J, Cagino K, Friedlander RL, Glynn SM, et al. Severe acute respiratory syndrome coronavirus 2 serology levels in pregnant women and their neonates. American Journal of Obstetrics and Gynecology. 2021;225(1):73.e1-e7.

[5] Edlow AG, Li JZ, Collier AY, Atyeo C, James KE, Boatin AA, et al. Assessment of maternal and neonatal SARS-CoV-2 viral load, transplacental antibody transfer, and placental pathology in pregnancies during the COVID-19 pandemic. JAMA Network Open. 2020;3(12):e2030455.

[6] Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, et al. Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: A retrospective review of medical records. The Lancet [Internet]. 2020;395(10226):809-15. Available from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30360-3/fulltext.

[7] Zeng H, Xu C, Fan J, Tang Y, Deng Q, Zhang W, et al. Antibodies in infants born to mothers with COVID-19 pneumonia. JAMA [Internet]. 2020 Mar 26; Available from: https://jamanetwork.com/journals/jama/fullarticle/2763854.

[8] Kotlyar AM, Grechukhina O, Chen A, Popkhadze S, Grimshaw A, Tal O, et al. Vertical transmission of coronavirus disease 2019: A systematic review and meta-analysis. American Journal of Obstetrics and Gynecology [Internet]. 2021;224(1):35-53.e3. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7392880/.

[9] Amaral WND, Moraes CL, Rodrigues APDS, Noll M, Arruda JT, Mendonça CR: Maternal coronavirus infections and neonates born to mothers with SARS-CoV-2: A systematic review. Healthcare (Basel). 2020;8:511. Doi: 10.3390/healthcare8040511.

[10] Hanafi M. Ultrasound diagnosis of adenomyosis, leiomyoma, or combined with histopathological correlation. Journal of Human Reproductive Sciences [Internet]. 2013 [cited 2022 Apr 3];6(3):189-93. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3853875/.

[11] Amihai R, Gila Z, Oiknine-Djian E, Olesya V, Zigron R, Geffen K, et al. Kinetics of maternally derived anti–Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) antibodies in infants in relation to the timing of antenatal vaccination. Clinical infectious diseases/Clinical infectious diseases (Online University of Chicago Press). 2022;76(3):e274-e279.

[12] Kachikis A, Englund JA. Maternal immunization: Optimizing protection for the mother and infant. Journal of Infection. 2016;72:S83-S90.

[13] Maertens K, Orije MRP, Van Damme P, Leuridan E. Vaccination during pregnancy: Current and possible future recommendations. European Journal of Pediatrics. 2020;179(2):235-42.

[14] Rottenstreich A, Zarbiv G, Oiknine-Djian E, Vorontsov O, Zigron R, Kleinstern G, et al. Timing of SARS-CoV-2 vaccination during the third trimester of pregnancy and transplacental antibody transfer: A prospective cohort study. Clin Microbiol Infect. 2022;28(3):419-25.

[15] Bordt EA, Shook LL, Atyeo C, Pullen KM, De Guzman RM, Meinsohn MC, et al. Maternal SARS-CoV-2 infection elicits sexually dimorphic placental immune responses. Science Translational Medicine. 2021;13(617):eabi7428.

[16] Martínez-Quezada R, Miguel-Rodríguez CE, Ramírez-Lozada T, Valencia-Ledezma OE, Acosta-Altamirano G. Placental transfer efficiency of neutralizing antibodies on SARS-CoV-2 vaccination before and after pregnancy in Mexican women. International Journal of Molecular Sciences [Internet]. 2024;25(3):1516. Available from: https://pubmed.ncbi.nlm.nih.gov/38338795/.

[17] Shook LL, Atyeo CG, Yonker LM, Fasano A, Gray KJ, Alter G, et al. Durability of anti-spike antibodies in infants after maternal COVID-19 vaccination or natural infection. JAMA [Internet]. 2022;327(11):1087-89. Available from: https://jamanetwork.com/journals/jama/fullarticle/2788986.

[18] Krammer F, Srivastava K, Alshammary H, Amoako AA, Awawda MH, Beach KF, et al. Antibody responses in seropositive persons after a single dose of SARS-CoV-2 mRNA vaccine. N Engl J Med. 2021;384:1372-74.

[19] ACOG and SMFM Recommend COVID-19 Vaccination for Pregnant Individuals [Internet]. www.acog.org. Available from: https://www.acog.org/news/news-releases/2021/07/acog-smfm-recommend-COVID-19-vaccination-for-pregnant-individuals.

[20] Proto A, Agliardi S, Pani A, Renica S, Gazzaniga G, Giossi R, et al. COVID-vaccines in pregnancy: Maternal and neonatal response over the first 9 months after delivery: Biomolecules (2218-273X). Biomolecules (2218-273X) [Internet]. 2024;14(4):435. [cited 2024 May 27]. Available from: https://eds.p.ebscohost.com/eds/pdfviewer/pdfviewer?vid=1&sid=b72afea4-6ad1-4846-90c3-240405be6992%40redis.

[21] Lopez PA, Nziza N, Chen T, Shook LL, Burns MD, Demidkin S, et al. Placental transfer dynamics and durability of maternal COVID-19 vaccine-induced antibodies in infants. iScience. 2024;27(3):109273-73.

PARTICULARS OF CONTRIBUTORS:

1. Professor, Department of Paediatrics, Swami Rama Himlayan University, Dehradun, Uttrakhand, India.
2. Senior Resident, Department of Paediatrics, Swami Rama Himlayan University, Dehradun, Uttrakhand, India.
3. Associate Profesor, Department of Paediatrics, Himalayan Institute of Medical Sciences, Dehradun, Uttrakhand, India.
4. Professor, Department of Paediatrics, Himalayan Institute of Medical Sciences, Dehradun, Uttrakhand, India.
5. Professor, Department of Microbiology, Himalayan Institute of Medical Sciences, Dehradun, Uttrakhand, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Sana Gupta,
B17/11, SRHU Campus, Dehradun-248016, Uttrakhand, India.
E-mail: sana.gupta46@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Jul 30, 2025
- Manual Googling: Dec 22, 2025
- iThenticate Software: Dec 24, 2025 (3%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jul 19, 2025**
Date of Peer Review: **Sep 24, 2025**
Date of Acceptance: **Dec 26, 2025**
Date of Publishing: **Apr 01, 2026**