Research Article

Breastfeeding Practices and Morbidity among Infants Born to Covid-19 Mothers at a Tertiary Care Hospital Karachi, Pakistan: A Prospective Cohort Study

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Abstract: Background: The novel coronavirus disease 2019 has affected general population including pregnancy due to physiological changes that can causes partial immune compression in women and increases risk of acquiring severe infections. It has also shown an impact on infants born to Covid-19 mothers. The aim of the study was to compare breastfeeding and Morbidity among infants born to Covid positive and negative mothers at the age of six months.

Objective: The study aimed to evaluate the long-term impact of breastfeeding and morbidity of infants among Covid 19 mothers.

Materials and Methods: This is a prospective cohort study which was conducted at the Aga Khan University Hospital (AKUH) from 20th November 2020 to 2nd July 2021, after obtaining the permission from the Research Ethics Board at Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology (SZABIST) (IERB(7)/SZABIST-KHI(LIFE)/19104121/200118) and the AKUH Ethical Review Committee (ERC#:-Ped-ERC- 2020-5576-14891). Mothers were identified from hospital medical records and were followed-up at the age of six months. Participants were recruited via a non-probability purposive sampling method. Antenatal, perinatal, postnatal outcomes and neonatal data was collected via structured questionnaire.

Result: Altogether 208 neonates were enrolled in the study, (n=104) in each group. Early initiation of breastfeeding within first hour of life was observed in 69 (33.3%) neonates (p value=0.049). Altogether, 120 (58.5%) neonates were exclusively breastfed during hospital stay. It was observed that exclusive breastfeeding was higher (68.9%) in non-exposed group immediately after birth. There was no significant difference in breastfeeding practices (RR; 1.0, 95% CI: 0.76-1.32; p value= 0.99) and morbidity status (RR; 1.07, 95% CI: 0.82-1.41; p value= 0.579) of infants at the age of six months among both groups.

Conclusion: COVID-19 has impacted maternal and early neonatal outcomes, necessitating prompt interventions to reduce complications. Encouraging timely breastfeeding initiation can enhance benefits, lower infant morbidity, and support sustained exclusive breastfeeding.

Keywords: Breastfeeding, COVID-19, Morbidity, Neonate, Pregnancy, Exclusive breastfeeding, Infants, Women, Nutrition.

INTRODUCTION

The pandemic caused by SARS-CoV-2 infections has threatened global community and has caused high mortality worldwide. The first outbreak was reported in Wuhan, China on 31st December 2019 and spread swiftly to approximately 209 countries round the world. Due to a tremendous increased in the number of cases, it was declared as a public health emergency. Elderly and people with known comorbidity are considered at higher risk to acquire Covid-19 infection. Pregnant women in general are vulnerable to infection, therefore they are also considered among high-risk groups susceptible towards COVID-19 [1-4].

In a large INTERCOVID trial of 2130 women, COVID-19 was also found to be associated with higher rates of maternal mortalities, miscarriages, intrauterine growth retardation (IUGR) and preterm births [5,6]. In addition, to date rare evidence of vertical transmission of SARS-CoV-2 has been reported [6]. Majority of newborns born to Covid-19 mothers are found be asymptomatic, however few have documented shortness of breath, fever, vomiting, pneumothorax, increased heart rate, mild neonatal pneumonia with lymphocytopenia, thrombocytopenia and altered liver function. Moreover, gastrointestinal symptoms: abdominal distension; feeding intolerance, reluctant to feed and GI bleeding were also observed rarely [4, 7, 8].

Breastfeeding is considered a possible source of antibodies transmission. Despite there is no documented evidence on continuation of breastfeeding with COVID infected mothers, several higher authorities including World health organization (WHO), Center of disease control and prevention (CDC) and UNICEF have emphasized on early initiation and continuation of breastfeeding, due to its potential benefits. Seven studies tested the breast milk samples of 13 mothers and none have shown positive to SARS-CoV-2 virus [9].

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Now a days lot of work has been directed towards analyzing the effects of COVID-19 on pregnancy however, there is many more to explore. The evidence on impact of COVID-19 on fetus and newborn is limited. Most of the available literature is derived form case series and studies with small sample size. There is limited data available on vertical transmission through placenta and breastfeeding. Moreover, the long-term impact of maternal Covid 19 infections on infants is still unknown [10-12].

We aim to evaluate the long-term impact of breastfeeding and morbidity of infants among Covid 19 mothers in this study. This study is preliminary in this context and provides longitudinal follow-up on infants born to covid-19 mothers.

MATERIALS AND METHODS

A prospective cohort study was conducted at the Aga Khan University Hospital (AKUH) from 20th November 2020 to 2nd July 2021. This study received approval from the Research Ethics Board at Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology (SZABIST) (IERB(7)/SZABIST-KHI(LIFE)/19104121/200118) and the AKUH Ethical Review Committee (ERC#:-Ped-ERC- 2020-5576-14891). All infants born at AKUH from June to October 2020, were screened for eligibility. Infants whose mothers were alive at the time of the study were eligible to participate. Multiple births were excluded. Additionally, infants born to mothers with diabetes mellitus (DM), preterm premature rupture of membranes (PPROM), or preterm birth were excluded from the study.

Infants born to mothers who had a positive PCR test for COVID-19 infection during pregnancy were classified as exposed, while infants born to mothers' who tested negative for COVID-19 during pregnancy were classified as non-exposed. A non-probability purposive sampling technique was used for recruitment of participants. A list of women who delivered from June to October 2020, recorded in order of the time of delivery, was retrieved from hospital medical records. All COVID positive mothers were approached for consent. For each COVID positive mother who provided consent, a non-exposed infant was selected by contacting the next COVID negative mother on the list. In case the mother did not provide consent, the next COVID negative mother was approached for consent. Enrolled infants were followed once at 6 months of age.

For every exposed and non-exposed infant, antenatal and perinatal information was retrieved from the maternal medical records and infant's clinical characteristics and hospital course were extracted from infant's medical records.

Each exposed and non-exposed infant's mother was approached by a telephonic call by the principal investigator at the age of six months, which was confirmed by the infant's date of birth. Details about the study objectives, benefits, and outcomes were explained. An opportunity for asking questions was also given. A verbal informed consent was obtained from parents willing to participate in the study. All data were based on the mothers' reporting. Duration of the phone call was around 15-20 minutes, where questions about breast feeding practices and history of infant's morbidity, including fever, diarrhea, and acute respiratory illness (ARI), were asked. The data were collected on paper-based structured questionnaires.

The sample size was estimated using Open Epi software version 3. According to the 2017-2018 Pakistan demographic health survey (PDHS), 48% of children aged 6 months are exclusively breastfed [13]. Assuming a relative risk of 1.5 [14], and taking a 5% level of significance, at 80% power, a minimum sample size of 73 infants in each cohort was estimated. For the presence of morbidity (fever, diarrhea and ARI) is 34% among children under 6 months of age [13]. Assuming a relative risk of 1.5, at 80% power, 95% Confidence Interval (CI) a minimum sample size of 144 in each cohort is estimated. Considering the given estimation, a cumulative sample size of 288 infants will be required to achieve both study objectives.

The data were collected on paper-based structured questionnaire. Data were reviewed for any missing variables and consistency checks were enabled to ensure data accuracy and validity. The data were then entered twice on Microsoft Excel to ensure accuracy.

STATISTICAL ANALYSIS

The data were analyzed using STATA version 15. Descriptive statistics were computed for all variables of the study. Continuous variables were described using mean and standard deviation while categorical variables were assessed by computing frequencies and percentages. Where needed, continuous variables were categorized using biologically important cut-offs obtained through literature. The inferential analysis included t-test for continuous variables and chi-square or Fisher's exact test for categorical variables as appropriate.

Univariate and multivariate logistic regression was performed to identify the association of maternal and infant characteristics with breastfeeding and morbidity among infants at 6 months. Risk Ratios (RR) with 95% confidence interval for each variable of interest were computed. P-values were calculated by Likelihood Ratio Test for the significance of the beta coefficients. Factors with $p<0.2$ were incorporated into two multiple logistic regression models using back-forward elimination. Variables that resulted in $p<0.05$ were retained in the final model.

RESULT

Between June to October 2020, 2198 infants were born, 104 (4.7%) of whom were born to mothers who tested positive for SARs-CoV-2at least once during their pregnancies. Altogether, 208 participants were enrolled in the study. The ratio of exposed versus non-exposed infants was 1:1. Table **1** shows the demographic and obstetric characteristics of the mothers. There were no significant differences in the baseline characteristics of the women who tested positive for COVID during pregnancy and those who tested negative.

Infant characteristics are shown in Table **2**. Table **3** shows study outcomes of infants at the age of 6 months.

Table 1. Demographic and Obstetric Characteristics of Mothers with and without Covid-19.

	Exposed N=104 (n= %)	**Non- Exposed N=104 (n= %)**	**Total N=208 (n= %)**	**P value**
Maternal Age in Years				
<25	14 (13.5%)	5 (4.8%)	19 (9.1%)	0.134
25-29	38 (36.5%)	39 (37.5%)	77 (37%)	
30-34	27 (26%)	36 (34.6%)	63 (30.4%)	
>35	25 (24%)	24 (23.1%)	49 (23.5%)	
Maternal Education*				
No formal education	2 (1.9%)	2 (1.9%)	4 (1.9%)	0.19
Secondary School (1-10)	8 (7.7%)	11 (10.6%)	19 (9.1%)	
High School (11-12)	26 (25.0%)	14 (13.5%)	40 (19.2%)	
Graduation and above	68 (65.4%)	77 (74%)	145 (69.8%)	
Maternal Occupation				0.055
Employed	15 (14.4%)	26 (25.0%)	41 (19.7%)	
Unemployed	89 (85.6%)	78 (75.0%)	167 (80.3%)	
Parity				0.037
Primiparous	40 (38.5%)	26 (25%)	66 (31.8%)	
Multiparous	64 (61.5%)	78 (75%)	142 (68.2%)	
Complications During Pregnancy				
Gestational diabetes	24 (23.1%)	19 (18.3%)	43 (20.7%)	0.39
Pregnancy induced hypertension	15 (14.4%)	9 (8.6%)	24 (11.5%)	0.19
Obstetric cholestasis	9 (8.7%)	5 (4.8%)	14 (6.7%)	0.27
Hypothyroidism	9 (8.7%)	6 (5.8%)	15 (7.2%)	0.42
Eclampsia/Preeclampsia*	7 (6.7%)	1 (1.0%)	8 (3.8%)	0.065
Mode of Delivery				0.070
Cesarean section	66 (63.5%)	50 (48.1%)	116 (55.8%)	
Vaginal	38 (36.5%)	54 (51.9%)	82 (44.2%)	
Maternal admission to SCU*				0.066
Yes	12 (11.5%)	4 (3.9%)	16 (7.8%)	
No	92 (88.5%)	100 (96.1%)	192 (92.3%)	
Maternal hospital Stay in days mean (+ SD)	2.9 (+1.2)	2.6 (+1.1)	2.7 (+1.1)	0.11

* Fisher exact test.

Table 2. Infant Demographic Characteristics, Clinical Course and Infant Follow-up at 6 Months.

	Exposed N=104 (n=%)	**Non-Exposed N=104 (n=%)**	**Total N=208 (n=%)**	**P value**
Gestational age at birth in weeks (mean + SD)	37.5 (+2.0)	37.6 (+1.6)	37.6 (+1.8)	0.70
Gender				0.13

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Female	54 (51.9%)	43 (41.3%)	97 (46.6%)	
Male	50 (48.1%)	61 (58.7%)	111 (53.4%)	
Congenital Anomalies*				0.99
Yes	2 (1.9%)	1 (1.0%)	3 (1.4%)	
No	102 (98.1%)	103 (99.0%)	205 (98.6%)	
Medical Diagnosis at Birth*†				0.26
Presumed Sepsis	11 (50%)	3 (27%)	14 (42%)	
Neonatal Jaundice	5 (23%)	3 (27%)	8 (24%)	
Respiratory problems (RDS and TTN)	3 (14%)	5 (45%)	8 (24%)	
Birth Asphyxia	1 (5%)	0 (0%)	1 (3%)	
Covid 19 infection	2 (9%)	0 (0%)	2 (6%)	
Admitted to NICU				0.009
Yes	13 (12.5%)	3 (3%)	16 (11.6%)	
No	91 (87.5%)	101 (97%)	184 (88.4%)	
Need for Oxygen Therapy				0.19
Yes	15 (14.4%)	9 (8.7%)	24 (11.6%)	
No	89 (85.6%)	95 (91.3%)	184 (88.4%)	
Received Antibiotics Therapy				0.003
Yes	20 (19%)	6 (5.8%)	26 (12.6%)	
No	84 (81%)	98 (94.2%)	182 (87.4%)	
Duration of Infant Hospitalization (mean + SD)	2.5 (+2.0)	2.2 (+1.9)	2.4 (+2.0)	0.34
Feeding Status during Hospitalization				
Newborns Breastfeed in First Hour of Life				0.049
Yes	28 (26.9%)	41 (39.8%)	69 (33.3%)	
No	76 (73.1%)	63 (60.2%)	139 (66.7%)	
Type of Milk Fed				0.004
Exclusive breast milk	50 (48.0%)	72 (68.9%)	122 (58.5%)	
Others	54 (52%)	32 (31.1%)	86 (41.2%)	
Feeding Method				<0.001
Direct feeding	79 (76.0%)	97 (93.3%)	176 (84.6%)	
Indirect feeding method	60 (57.7)	35 (33.7%)	95 (45.7%)	
Feeding Status				
Type of Milk Feed				0.99
Exclusive breast milk	45 (43.3%)	45 (43.3%)	90 (43.3%)	
Others	59 (56.7%)	59 (56.7%)	118 (56.7%)	
Feeding Method				0.54
Direct breast feeding	89 (85.6%)	92 (88.5%)	181 (87.0%)	
Indirect method	59 (56.8%)	60 (57.7%)	119 (57.1%)	
Vaccination Status				0.57
Complete	93 (89.4%)	94 (90.4%)	187 (89.9%)	
Incomplete	11 (10.6%)	10 (9.6%)	21 (10.1%)	
Morbidity Status				

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Fever	16 (15.4%)	21 (20.2%)	36 (17.8%)	0.345
Diarrhea	16 (15.4%)	14 (13.5%)	30 (14.4%)	0.693
ARI	42 (40.4%)	35 (33.7%)	77 (37.0%)	0.315
COVID-19*	0 (0.0%)	2 (1.9%)	2 (1.0%)	0.50
Re-Hospitalization				0.53
No	94 (90.4%)	96 (92.3%)	190 (91.4%)	
Yes	10 (9.6%)	8 (7.7%)	18 (8.7%)	
Reasons for Admission*				0.21
Acute Gastroenteritis	2 (20%)	0 (0%)	2 (11%)	
Presumed Sepsis	5 (50%)	3 (37.5%)	8 (44.5%)	
Others	3 (30%)	5 (62.5%)	8 (44.5%)	

*Fisher's exact test, † for exposed n=22 and for non-exposed n=11.

Table 3. Univariate and Multivariate Analysis for Breastfeeding Status and Composite Morbidity at 6 Months.

Characteristics	**Univariate**			**Multivariate**		
	RR	**95% CI**	**P value**	**RR**	**95% CI**	**P value**
Maternal Covid-19 Results						
Negative	Ref.					
Positive	1.00	0.76 – 1.32	0.99			
Employment						
Unemployed	Ref.			Ref.		
Employed	0.45	0.25 - 0.82	0.010	0.45	0.25-0.81	0.008
Parity						
Primiparous	Ref.			Ref.		
Multiparous	0.84	0.61 – 1.16	0.290	0.74	0.57-0.96	0.024
Mode of Delivery						
Spontaneous vaginal	Ref.					
C-section	0.79	0.58 - 1.08	0.143			
Gestational Age at Birth						
Preterm	Ref.					
Term	1.50	0.95 - 2.36	0.079			
Gender						
Female	Ref.					
Male	0.80	0.59 - 1.09	0.160			
NICU Admission						
No	Ref.					
Yes	0.56	0.24 - 1.32	0.186			
Initiation of Breast Feeding within First Hour of Life						
No	Ref.					
Yes	1.38	1.01 - 1.87	0.041			
Feeding During Hospital Stay						
EBM	Ref.			Ref.		

Continued

Continued

Others	2.32	1.55 - 3.47	<0.001	0.43	0.29-0.64	<0.001
Feeding Method						
Direct	Ref.					
Indirect	0.45	0.31 - 0.66	<0.001			
Maternal Covid Results						
Negative	Ref.					
Positive	1.07	0.82 – 1.41	0.579			
Maternal Age						
<25	Ref.			Ref.		
25-29	1.05	0.69 -1.61	0.807	0.77	0.64-0.92	0.004
30-34	0.74	0.46 – 1.20	0.218	0.56	0.41-0.75	<0.001
>35	0.60	0.35 – 1.03	0.065	0.44	0.30-.064	<0.001
Employment						
Unemployed	Ref.					
Employed	0.70	0.46-1.08	0.107			
Parity						
Primiparous	Ref.					
Multiparous	0.75	0.57 – 0.99	0.039			
Mode of Delivery						
Spontaneous vaginal	Ref.					
C-section	0.97	0.73 – 1.28	0.805			
Gestational Age at Birth						
Preterm	Ref.					
Term	0.98	0.70-1.35	0.879			
NICU Admission						
No	Ref.					
Yes	0.88	0.50-1.57	0.675			
Received Antibiotics						
No	Ref.			Ref.		
Yes	0.60	0.33 – 1.08	0.088	0.47	0.27-0.84	0.010
Initiation of Breast Feeding within First Hour of Life						
No	Ref.					
Yes	0.90	0.66 – 1.22	0.503			
Feeding during Hospital Stay						
Other	Ref.			Ref.		
EBM	0.76	0.58 – 1.00	0.052	0.73	0.61 – 0.88	0.001
Feeding Method						
Direct	Ref.			Ref.		
Indirect	1.31	1.00 – 1.73	0.054	2.09	1.67 – 2.61	<0.001

DISCUSSION

Covid-19 in pregnancy and around delivery can worsen immediate maternal and neonatal outcomes. Likewise general population, particularly pregnant women are at greater risk of acquiring infection due to compromised immunological state.

The study reported higher administration of antibiotics and NICU stay among exposed infants. Likewise a study from Abu Dhabi also found that 18% of newborn born to Covid mothers required NICU admissions. The reasons for admission were; prematurity (47%), RDS (33%), HIE, hypoglycemia and sepsis accounts for 7% each [15]. Similar reasons were also reported by Zhu *et al.* in 2020 which includes infections, respiratory distress syndrome and pneumothorax [4].

Early initiation of breastfeeding and continuation of exclusive breastfeeding during hospitalization via direct method was significantly different among the groups. Studies have shown that early initiation of breastfeeding stimulates hormones that increases breastfeeding rates in later age [16-18]. It has tremendous effects on mother and child both; strengthen mother and child bonding, increases survival rates, decreases risk of morbidity and associated hospitalization [19]. On the other hand, separation of mother and infant imposes undesirable effects on health of both entities [20, 21].

Surprisingly, the exclusive breastfeeding at six months was consistent in both the groups. The study data suggests that exclusive breastfeeding rates at 6 months were 43.3% that were consistent to the PDHS report 2017-2018 as 48% [13] and meta-analysis of middle east data that reported as 41% [22]. However, the exclusive breastfeeding was 2% prevalent in Kuwait [23] and 56.4% in Iran [24] by the age of 6 months. Hence, suggestive of no decline in breastfeeding due to pandemic Covid-19 situation.

The study also revealed that breastfeeding was correlated with maternal employment status. Employed moms were less likely to feed their infants and were unable to continue exclusive breastfeeding than non-working mothers. The results are in line with studies from Hong Kong and Ethiopia [25, 26]. The major reasons available in literature are unavailability of breastfeeding rooms, lack of awareness about expressing milk and non-supportive family or staff members [27]. Similar issue was highlighted in one of the studies from Pakistan that concluded non- supportive workplace as a major hindrance for continuation of exclusive breastfeeding [28].

The study depicts breastfeeding status during hospital stay is associated with exclusive breastfeeding at the age of 6 months. Literature suggests that cesarean deliveries are indirectly proportional to exclusive breastfeeding rates [29-31]. As breastfeeding is not established early in cesarean deliveries, newborn is fed through supplemental nutrition sources, which ultimately decreases chances of being exclusive breastfed. These findings substantiate the findings of study in Australia. They also concluded that neonates who are fed with formula milk are less likely to achieve exclusively breastfeeding till 6 months of age [32].

This study found no significant difference in presence of morbidity at six months among both groups. Moreover, study suggests that maternal age was inversely associated with infant morbidity. Similar findings were reported by Barlow *et al.* that pregnancy at younger age has negative impact on infant's growth, health and life span [33, 34]. In the same vein, another study found that mothers aged 35 years and above tend to maintain a healthy standard of living, have a higher level of education, vast life experience and a strong financial background which is positively correlated with reduced rates of infant morbidity [35]. On the contrary, another study found that infants of women younger than 25 and older than 35 have significantly higher morbidity rates [36]. The safest maternal age retrieved from our study is 25-34 that can result in minimal or no morbidity among infants.

Exclusive breast feeding during hospitalization was significantly associated with infant morbidity. The study from Bangladesh found significant association of early initiation of breast feeding with lower risk of illness in neonatal period.

LIMITATIONS

The limitations of this study was targeted sample size of the study was not achieved due to short time. Women that were covid positive during pregnancy were not studied because of the impact of covid around delivery/ birth was highly associated with outcome (breastfeeding) therefore, outcomes at early pregnancy cannot be identified. Moreover, all the information taken at the age of six months were relied on telephonic conversation with parents that can lead to limitation of recall. Moreover, the chance of reporting mild symptoms and seeking health care have been missed, that can be of minimal significance. The impact of Covid-19 in early pregnancy and fetal outcomes are not included in the study along with maternal mortality was not considered due to inclusion criteria and primary outcome of breastfeeding. This study was conducted at a single center, which may limit the applicability of findings to broader populations. Conducting a multicenter study in the future would enhance the generalizability and external validity of the results. The study's sample size was limited, which may impact the strength of conclusions, particularly for subgroup analyses and interactions. Future research with a larger sample will help improve the reliability and generalizability of the findings.

CONCLUSION

Maternal COVID-19 during pregnancy had no significant impact on infant outcomes at six months. However, it influenced immediate maternal and neonatal health. To reduce complications, timely medical management is crucial. Given the benefits of breastfeeding, mother-infant separation should only occur when clinically necessary. Healthcare providers should promote early initiation and continuation of breastfeeding with standard precautions during the pandemic.

LIST OF ABBREVIATIONS

WHO: World Health Organization.

CI: Confidence Interval.

EBF: Exclusive Breastfeeding.

PDHS: Pakistan Demographic and Health Survey.

AUTHORS' CONTRIBUTION

Khushboo Qaim Ali: Conceptualization, Study design, Methodology, data analysis and interpretation, Writing draft.

Sameera Ali Rizvi: Conceptualization, Study design, Methodology, data analysis, Critical review, revision the manuscript.

Saleema Khowaja: Methodology, data analysis and interpretation, Writing draft.

Syeda Tabeena Ali and **Uswa Jiwani**: Methodology, data analysis and interpretation, Critical review, revision the manuscript.

Shabina Ariff: Conceptualization, Critical review, revision the manuscript, Final approval, final proof to be published.

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Declared none.

CONFLICT OF INTEREST

Declared none.

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