Understanding Women, Infant and Children Feeding Decisions in Emergencies: The Case of COVID-19 and the Formula Shortage

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Abstract
Background: The advantages of breastfeeding and its role in emergencies are undeniable. Studies show that many women in developed countries choose formula over breastmilk, even in emergencies. Nevertheless, no one knows if postpartum women under the Women, Infants and Children (WIC) program turned out to breastfeed or re-lactate their infants during these crises. This study aims to better understand WIC participants' perceptions about breastfeeding their babies in emergencies.

Methods: A chi-square test of independence was used to assess the association between breastfeeding choice and demographic characteristics and potential covariates of respondents. A post hoc analysis using Dunn's multiple comparisons test was adopted to identify specific group differences after employing the Kruskal-Wallis test. The logistic regression was likewise employed to examine the likelihood that respondents would prefer any of the three feeding choices (breast milk, formula, or both).

Results: Infant feeding choice during emergencies depends on age, education, ethnicity, race, breastfeeding knowledge, home duration, support during crisis, re-lactation, formula convenience, and breastfeeding status. However, it is independent of whether a study participant enrolled in a WIC program during pregnancy.

Conclusion: The study found a significant difference between the median breastfeeding rate before COVID-19 and the formula shortage. However, there was no significant difference between the median breastfeeding rate during COVID-19 and before COVID-19 as well as during COVID-19 and the formula Shortage. The study suggests that WIC programs should reinforce the benefits and convenience of breastfeeding, especially during emergencies, to reduce reliance on formula.

Keywords: *Breastfeeding, COVID-19, Formula Shortage, Women Infants and Children, Emergencies.*

DOI: 10.7176/JHMN/117-05

Publication date: December 30th 2024

1. Introduction

There is much evidence that breastfeeding is the best infant feeding method due to its health benefits. This is one of the reasons the World Health Organization (WHO) recommends the initiation of breastfeeding within the first hour after birth, exclusive breastfeeding for six months, and continuous breastfeeding for up to 2 years and beyond (Alzaheb, 2017). Breastmilk protects children from many infections that cause death. The WHO Collaborative group found that children not breastfed in their first few years had a high mortality rate due to infection and all causes (World Health Organization, 2000). In a recent review, Lee and Binns (2019) confirmed the role of breastfeeding in protecting against child infection by revealing that children under six months of age who are breastfed have a significantly at least 50% lower rate of diarrhoea and respiratory infection compared to children who are formula fed. Furthermore, breastfeeding lowers the risk of obesity, diabetes, and hypertension for children who have been breastfed later in life (Binns et al., 2016; Ip et al., 2007). In addition to the above, breastfeeding can prevent the negative effects of air pollution (Zielinska & Hamułka, 2019) and improve cognitive function (Hallal et al., 2015). The benefits of breastfeeding are not only limited to children. Many previous studies also show that breastfeeding provides advantages for mothers (Asci et al., 2021; Mufdlilah et al., 2022). In their meta-analysis study, Victora et al. (2016) indicated that breastfeeding lowers the risk of type 2 diabetes, ovarian cancer, and breast cancer and improves birth spacing in nursing mothers. Breastfeeding is also known to help postpartum women retain less weight (Doan et al., 2020). It is also beneficial for women who are obese, as proven by Sharma et al. (2014), whose study shows a weight loss of about 8 kilograms in obese mothers who exclusively breastfed for at least four months.

Although the multiple advantages of breastfeeding both for mothers and children, the rate is still low worldwide. Parasuraman et al. (2020) reported that the breastfeeding outcomes among WIC participants are mixed, although the Special Supplemental Nutrition Program for WIC is required to promote and support breastfeeding practices. The WIC program has always made efforts to promote breastfeeding among its participants. Strategies used by the WIC program to advocate and promote breastfeeding among pregnant and postpartum women are breastfeeding education, counselling, and face-to-face peer support. To help women think and decide about their infant feeding choices, WIC staff share all the benefits of breastfeeding, including how important it would be in emergencies. During the COVID-19 and the formula shortage crises, the importance of this message to WIC participants has been exacerbated. Unfortunately, less is known about the factors that affected WIC women's infant decisions during the COVID-19 pandemic and the formula shortage. A study showed that the breastfeeding rate of postnatal women dropped worldwide, particularly during the SARS-CoV-2 global pandemic, due to misinformation (Spatz et al., 2021). Another study among WIC participants demonstrated that the rate of breastfeeding during the pandemic was lower than before the pandemic (Koleilat et al., 2022). One of the factors that was found to explain the reduction in breastfeeding rate among WIC participants during the pandemic is the lack of lactation service due to the lockdown (Brown & Shenker, 2020). A particular aspect of the COVID-19 crisis is that it has created a shutdown that permitted people to stay home and work remotely. Doing so has allowed certain women to be with their babies. Studies show that a mother's separation from her baby for more than 4-hours per day is one factor affecting women's decision to breastfeed. A study by Rethy et al. (2019) published in the Lancet found that the most common reason WIC women participants choose formula feeding is returning to work or school. With that being the case, one can believe that many women would have breastfed their babies during the COVID-19 crisis. Also, with the fear of contracting the virus, many people were less likely to go out shopping. Consequently, breastfeeding should be the main infant feeding option for many women during that period. Similarly, postnatal women should have learned more about breastfeeding during the national formula shortage crisis.

Before the two emergency crises, no one could have predicted that formula feeding would still be WIC participants' first infant feeding choice. This is because, in nations such as low-income countries where formulas are not easily accessible and affordable, more women tend to breastfeed (Brink, 2018). One of the world breastfeeding reports reveals that breastfeeding in low- and middle-income populations is high because "Many families in low- and middle-income countries just cannot afford to buy it" (Howard, 2018). Similarly, Malik (2022) found that the inaccessibility of formula is one of the contributing factors to the high rate of breastfeeding among middle- and low-income populations. As such, one should have thought the same scenario would have happened among WIC participants during the national formula shortage crisis because of the high cost and scarcity of formulas. With the COVID-19 pandemic, different changes occurred, and countries worldwide experienced the consequences at different levels. In the United States, one of the impacts has been the shortage of infant formulas. Another impact was remote work and services that enable people to stay home close to their families. These two consequences combined can affect women's feeding decision choices and contribute to an increased breastfeeding rate in WIC postpartum women. This is one reason for this research to find if there is a statistically significant difference in the breastfeeding rate during COVID-19 and the formula shortage compared to the pre-COVID-19 among Virginia WIC participants. The second reason is to understand the factors that impacted their infant feeding decision during these emergencies. This study aims to better understand WIC participants' perceptions about breastfeeding their babies in emergencies. This will allow policymakers to formulate better strategies in the future to reduce not only the stress related to infant feeding in emergencies but also the associated economic burden. With that being the case, one can believe that many women would have breastfed their babies during the COVID-19 crisis.

2. Materials and Methods

2.1 Study design

The study design associated with this research was a cross-sectional comparative study method and an online survey method. The comparative approach aimed to determine the differences in breastfeeding rates across three distinct periods: pre-COVID-19, during COVID-19, and during the formula shortage. The online survey method was utilized to identify the factors influencing infant feeding decisions among Virginia WIC postpartum women during these periods.

2.2 Participants and Sample Size

Virginia postpartum WIC women are the research participants. The researcher selected the participants who were postpartum women from October 2017 to September 2022 within the 35 health districts of the Virginia Department of Health. No sample sizes were calculated for comparative study or the online survey. Nevertheless, the survey targeted WIC postpartum women who delivered their babies during the COVID-19 and formula shortage periods.

2.3 Inclusion and Exclusion Criteria

There were no inclusion and exclusion criteria for the secondary data analysis. The inclusion criteria of the online survey were a WIC postpartum woman who delivered during the COVID-19 pandemic and/or the formula shortage crisis and a WIC participant who delivered during emergencies and still participates in the WIC program. For the exclusion criteria, the following was considered: a WIC postpartum woman who delivered during these emergencies or crises but whose baby did not survive.

2.4 International Review Board Approval

Before implementing data requests and extraction, the researcher received International Review Board (IRB) approval from the Virginia Health Department Ethical Committee with ethics approval number 50290. An informed consent form was developed in English and Spanish for survey participants. The researcher writes the identity of the survey participants anonymously and maintains confidentiality using the RedCap survey tool. The Researcher decided to use the REDCap software to collect the data to protect participants' information and to ensure confidentiality. Thus, the survey was sent to the participants via email with an individual link for each participant to complete the survey.

2.5 Data Description

Secondary data was received from the Virginia Department of Health (VDH) data team to answer the research questions. Secondary data compares the breastfeeding rate in three periods: pre-COVID-19, during COVID-19, and formula shortage. For the pre-COVID-19 period, data from October 2017 to March 2020 was used; for the during-COVID-19 period, the WIC breastfeeding data from April 2020 to December 2021 was used; and for the formula shortage, WIC breastfeeding data from January 2022 to September 2022 was used. In this study, the COVID-19 period did not go beyond December 2021 because the researcher wanted to determine the breastfeeding results of COVID-19 independently from the formula shortage. Thus, 106920 WIC postpartum women made the data received for the pre-COVID-19, but 80471 were considered for the study. For the during-COVID-19, 72774 WIC postpartum women data was received. However, 53746 were considered for the study. For the Formula shortage, 32323 WIC postpartum women data was received, but 6000 made the count of the study. Some postpartum women from the original data were excluded because of incomplete information during the data cleaning. For the primary data, an online survey was conducted among WIC postpartum women in all 35 health districts in Virginia. The data was received encrypted and could only be opened using a code. Approximately 55,800 WIC postpartum women emails were provided. A convenience sampling method was used to ensure the time and cost-effectiveness of data collection. The survey was sent to the 55,800 participants whose contacts were provided. About 11, 044 women took the survey, but 6,000 completed all questions. The survey was developed in English and then translated into Spanish by two translators from VDH. To ensure the validity and reliability of the survey before its use online, both versions of the questions were submitted to the WIC staff in the Rappahannock Health District and the Danville Health District for review to identify any statements in the survey that were misleading, unclear, or highly sensitive. Revisions were made to the wording based on the comments received from the WIC staff.

2.6 Statistical Analyses

A statistical hypothesis test was used as a proxy to determine the difference in the rate of breastfeeding among Virginia WIC postpartum women. The Kruskal-Wallis rank test was adopted for this task due to the violation of homogeneity and normality assumptions. The Dunn (1964) Kruskal-Wallis multiple comparison test (p-values adjusted with the Holm method) was used to conduct a post hoc analysis (multiple comparison test). A chi-square test of independence (with Yates continuity correction) was also performed to assess the existence of an association or relationship between the demographic characteristics and covariates under consideration (age, level of education, ethnicity, race, knowledge of breastfeeding, home duration, support during crisis, factors influencing Breastfeeding, re-lactation, status of breastfeeding, WIC program during pregnancy, etc.) and breastfeeding choice of a respondent. An effect was adjudged statistically significant, with an associated p-value < 0.05. The logistic regression was also employed to examine the likelihood that respondents would prefer any of the three feeding choices (breast milk, formula, or both) with both breast milk and formula as the base outcome. All the statistical analyses were conducted using R-statistic software version 4.3.0 and IBM SPSS version 23.

2.7 Chi-Square Test of Independence

The chi-square test of independence was employed to assess the relationship between demographic characteristics/covariates and breastfeeding choice. The test statistic is given in (1) by:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \tag{1}$$

where O_i represents the observed frequencies and E_i represents the expected frequencies under the null hypothesis. A Yates continuity correction was applied to account for small sample sizes, with statistical significance set at $p < 0.05$.

2.8 Kruskal-Wallis Test

Due to violations of the normality and homogeneity assumptions, the Kruskal-Wallis test was used instead of ANOVA to compare the median breastfeeding rates across the three periods. The Kruskal-Wallis test statistic H is given in (2) by:

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} n_i \left(R_i - \frac{N+1}{2}\right)^2 \tag{2}$$

where N is the total number of observations, n_i is the number of observations in the group i, R_i is the rank sum of group i, and k is the number of groups. Large values of the test statistic H lead to the rejection of the null hypothesis of no significant median breastfeeding rates of the three distinct periods: pre-COVID-19, during COVID-19, and during the formula shortage. A post hoc analysis using Dunn's multiple comparisons test with Holm adjustment is then conducted to identify specific group differences after the null hypothesis is rejected.

2.9 Dunn's Multiple Comparisons Test with Holm Adjustment

To identify specific differences between the groups after the Kruskal-Wallis test, Dunn's multiple comparisons test was performed with Holm adjustment. The test statistic for Dunn's test is given in (3) by:

$$z = \frac{R_i - R_j}{\sqrt{\frac{N(N+1)}{12}\left(\frac{1}{n_i} + \frac{1}{n_j}\right)}} \tag{3}$$

where R_i and R_j are the rank sums for groups i and j respectively, and n_i and n_j are the number of observations in groups i and j. Holm's adjustment modifies the p-values to control for the family-wise error rate, ensuring that the overall Type I error rate remains below 0.05.

2.10 Multinomial Logistic Regression

To examine the likelihood of different feeding choices (breast milk, formula, or both), a multinomial logistic regression model was employed. The model estimates the relative risk ratios (RRR) for each predictor variable, with the probability P of choosing outcome j given in (4) by:

$$P(Y = j|X) = \frac{e^{X\beta_j}}{1 + \sum_{k=1}^{J-1} e^{X\beta_k}} \quad (4)$$

where X represents the vector of predictor variables and β_j represents the vector of coefficients for the outcome j and Y is the categorical outcome variable (feeding choice: breast milk, formula, or both).

The relative risk ratio for a predictor variable X_i is given in (5) by:

$$\boldsymbol{RRR = e^{\beta_i}} \quad \textbf{(5)}$$

where β_i is the coefficient estimate for the predictor variable X_i. The RRR indicates the change in the relative risk of choosing a particular outcome category over the reference category for a one-unit increase in the predictor variable. The multinomial logistic regression model can be represented by (6) as:

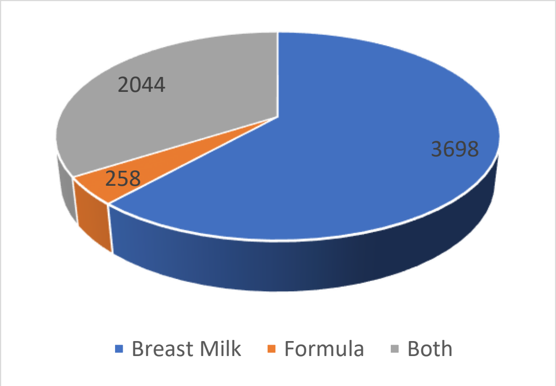
$$\log\left(\frac{P(Y = j)}{P(Y = \text{reference})}\right) = \beta_{0j} + \beta_{1j}X_1 + \beta_{2j}X_2 + \cdots + \beta_{pj}X_p \quad (6)$$

where β_{0j} is the intercept for category j, and $\beta_{1j}, \beta_{2j}, \ldots, \beta_{pj}$ are the coefficients for the predictor variables $X_1, X_2, \ldots, X_p$ for category j.

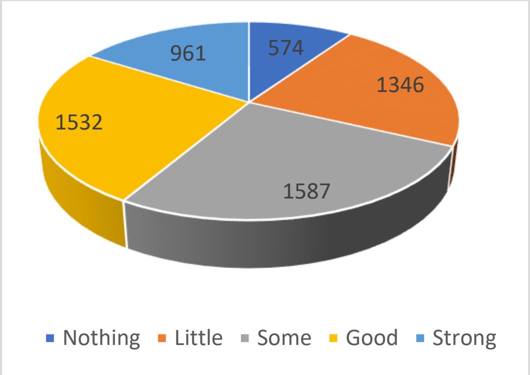
In this study, the base outcome was set as the combined choice of both breast milk and formula. The model was used to estimate the likelihood of choosing either breast milk or formula relative to the base outcome, with significant predictors identified based on their associated p-values.

3. Results

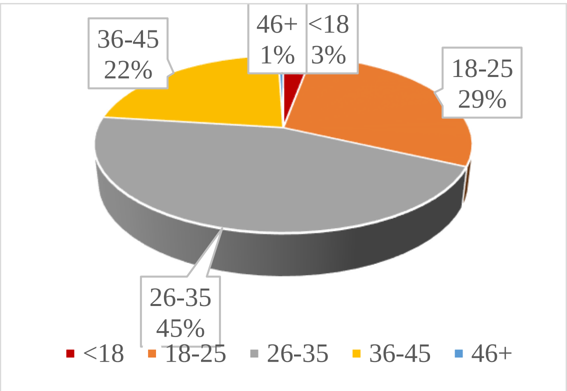
In this section, we present the results of the findings of the study.



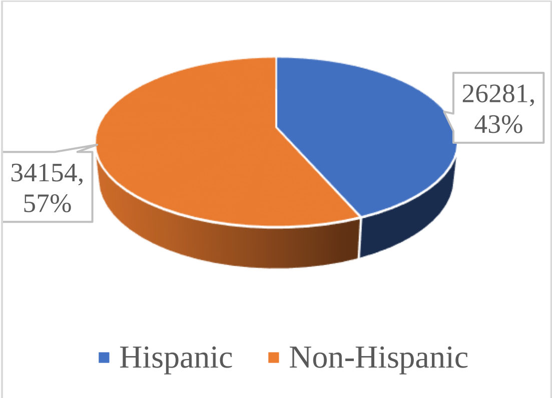
(a) Distribution of feeding choice.



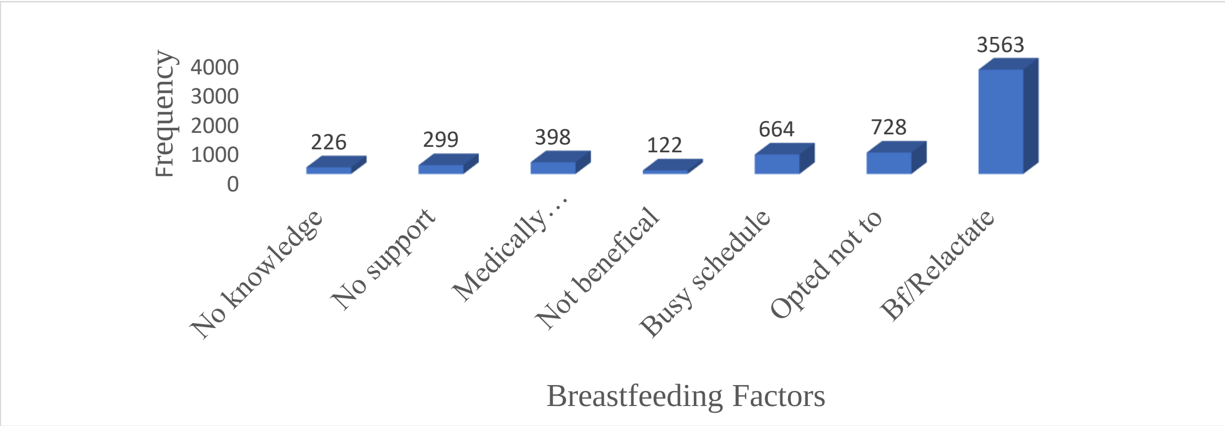
(b) Knowledge of breastfeeding.



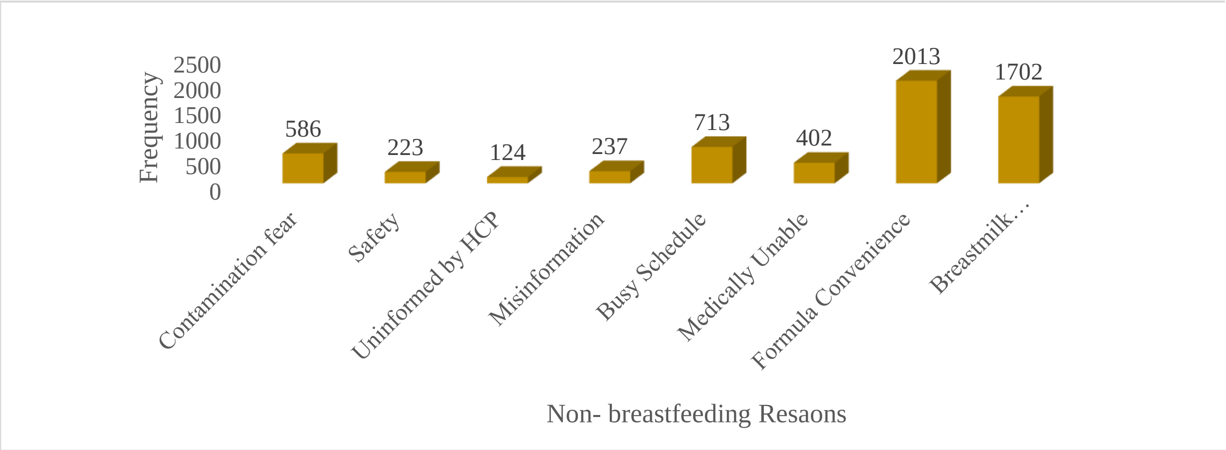
(c) Distribution of Age Group.



(d) Distribution of Ethnicity



(e) Factors affecting feeding choices.



(f) Reasons for non-breastfeeding.

Figure 1: Pie and Bar charts showing the distribution of survey characteristics, Breastfeeding and Non-Breastfeeding choices.

Figure 1 gives pie and bar charts showing the distribution of survey characteristics. Figure 1a, the distribution of feeding choice showed that approximately 3698 (61.6%) of the participants preferred breast milk, followed by 2044 (34.1%) with Formula preference and the rest, 258 (4.3%), preferring both formula and breast alternative infant feeding mechanism. From Figure 1b, it is observed that the distribution of breastfeeding knowledge indicates that 1587 (26.5%) had some knowledge of breastfeeding at the time of the survey, 1532 (25.5%) of the research participants had good knowledge of breastfeeding, whereas 1346 (22.4%) had little knowledge of breastfeeding. Surprisingly, a small sample size of 961 (16.0%) has a strong knowledge of breastfeeding mechanisms, while the remaining 574 (9.6%) do not know about breastfeeding. From Figure 1c and Figure 1d, the percentile distribution of age group and ethnicity can be inferred accordingly. From Figure 1e, the frequency distribution of feeding factors showed that most of the survey respondents 3563 (59.4%) either breastfed or re-lactated during the formula shortage. 728 (12.1) research participants opted not to breastfeed during the formula shortage. The busy schedule of 664 (11.1%) made it difficult for them to breastfeed their infants during the same period. Approximately 398 (6.6%) indicated that they were not in a better position medically to breastfeed during the formula shortage. 299 (5.0%) and 226 (3.8%) responded that they had no support and knowledge of breastfeeding respectively while 122 (2.0%) believed that it was not beneficial for them to either breastfeed or re-lactate during the formula shortage. Figure 1f, the frequency distribution of reasons for non-breastfeeding during the COVID-19 pandemic showed that most of the survey respondents 2013 (33.6%) did not breastfeed during the COVID-19 pandemic due to formula convenience. 1702 (28.4%) research participants opted not to breastfeed during the COVID-19 pandemic because of breastmilk convenience. The busy schedule of 713 (11.8%) made it difficult for them to breastfeed their infants in the wave of the COVID-19 pandemic. Approximately 536 (9.8%) respondents indicated that they were afraid to contaminate their baby with the virus if they got sick with the COVID-19 virus during the same period. 402 (6.7%) participants responded that they were medically unable to breastfeed their infants, and 237 (3.9%) respondents attributed it to misinformation. 223 (3.7%) believed that it was not safe for them to breastfeed their babies during the COVID-19 era while the remaining 124 (2.1%) respondents did not breastfeed their infants due to inadequate information provided by their healthcare providers.

Table 1 presents the bivariate correlation analysis of the various variables under consideration. A statistically significant result is indicated with a p-value less than 0.05 placed in brackets under the value of the correlation coefficient. Significant correlations are flagged with ** in Table 1. The sign before the correlation coefficient shows the direction (either positive or negative) in which the two variables are related.

Table 1: Bivariate correlation analysis between the variables under consideration

	Bf Status	Bf Knowledge	Bf Choice	Bf Duration	Home Duration	Formula Shortage	Crisis Support	WIC	Age	Education	Ethnicity	Race
Bf Status	1.000											
Bf Knowledge	-0.054 (.000**)	1.000										
Bf Choice	0.070 (.000**)	-1.000 (.000**)	1.000									
Bf Duration	-0.159 (.000**)	0.089 (.000**)	-0.103 (.000**)	1.000								
Home Duration	-0.032 (.014**)	0.043 (.001**)	-0.034 (.009**)	0.159 (.000**)	1.000							
Formula Shortag	-0.042 (.001**)	0.091 (.000**)	-0.201 (.000**)	0.079 (.000**)	0.019 (.140**)	1.000						
Crisis Support	0.016 (.206)	0.023 (.074)	0.009 (.508)	-0.028 (.033**)	-0.035 (.006**)	0.066 (.000**)	1.000					
WIC Program	-0.009 (.467)	-0.024 (.068)	-0.011 (0.413)	-0.001 (.960)	-0.018 (.171)	-0.034 (.009**)	0.036 (.000**)	1.000				
Age	-0.031 (.016**)	0.165 (.000**)	-0.102 (.000**)	0.030 (.019**)	-0.022 (.090**)	0.056 (.000**)	0.071 (.000**)	-0.014 (.288)	1.000			
Education	-0.050 (.000**)	-0.055 (.000**)	-0.064 (.000**)	0.018 (.155)	0.003 (.802)	0.071 (.000**)	-0.039 (.000**)	0.056 (.000**)	0.206 (.000**)	1.000		
Ethnicity	0.044 (.001**)	-0.005 (.690)	0.060 (.000**)	-0.053 (.000**)	-0.008 (.515)	-0.014 (.288)	-0.074 (.000**)	-0.028 (.027)	0.041 (.002**)	0.127 (.000**)	1.000	
Race	-0.043 (.001**)	-0.048 (.000**)	0.008 (.555)	-0.044 (.001**)	-0.043 (.001**)	0.001 (.941)	0.048 (.000**)	0.043 (.001**)	-0.059 (.000**)	-0.080 (.000**)	-0.266 (.000**)	1.000

Table 2: Distribution of Feeding Choice by demographic characteristics and potential covariates of respondents.

	Choice of feeding				
	Breast Milk	**Formula**	**Both**		
Variable	**n (%)**	**n (%)**	**n (%)**	**Total (%)**	**P-value**
Age					
Less than 18	38 (69.1)	5 (9.1)	12 (21.8)	55 (0.9)	**.000****
18-25	726 (52.6)	76 (5.5)	579 (41.9)	1381 (23.0)	
26-35	2173 (62.9)	136 (3.9)	1146 (33.2)	3455 (57.6)	
36-45	740 (68.5)	39 (36)	301 (27.9)	1080 (18.0)	
46 and above	21 (72.4)	2 (6.9)	6 (20.7)	29 (0.5)	
Educational Status					
Less than HS Diploma	282 (66.2)	29 (6.8)	115 (27.0)	426 (7.1)	**.000****
HS Diploma	1067 (56.4)	86 (4.5)	739 (39.1)	1892 (31.5)	
Some College	1055 (61.4)	56(3.3)	606 (35.3)	1717 (28.6)	
Associate College	396 (59.6)	37 (5.6)	231 (34.8)	664 (11.1)	
Undergraduate College	546 (67.8)	26 (3.2)	233 (28.9)	805 (13.4)	
Graduate College	352 (71.0)	24 (4.8)	120 (24.2)	496 (8.3)	
Ethnicity					
Hispanic	1154 (66.3)	63 (3.6)	523 (30.1)	1740 (29.0)	**.000****
Non- Hispanic	2544 (59.7)	195 (4.6)	1521 (35.7)	4260 (71.0)	
Race					
AIAN	130 (67.4)	14 (7.3)	49 (25.4)	193 (3.2)	**.000****
Asian	274 (72.7)	9 (2.4)	94 (24.9)	377 (6.3)	
BAA	1262 (58.4)	107 (4.9)	793 (36.7)	2162 (36.0)	
NHPI	53 (59.6)	9 (10.1)	27 (30.3)	89 (1.5)	
White	1979 (62.3)	119 (3.7)	1081 (34.0)	3179 (53.0)	
Bf Status					
Yes	3622 (62.40	222 (3.8)	1959 (33.8)	5803 (96.7)	**.000****
No	76 (38.6)	36 (18.3)	85 (43.1)	197 (3.3)	
Bf Knowledge					
Nothing	320 (55.7)	37 (6.4)	217 (37.8)	574 (9.6)	**.000****
Little	758 (56.3)	66 (4.9)	522 (38.8)	1346 (2.4)	
Some	949 (59.8)	64 (4.0)	574 (36.2)	1587 (26.5)	
Good	989 (64.6)	66 (4.3)	477 (31.3)	1532 (25.5)	
Strong	682 (71.0)	25 (2.6)	254 (26.4)	961 (16.0)	

Source: Survey data, 2023

NB: HS: High School; Bf: Breast Feeding; AIAN: American Indian or Alaskan Native; BAA: Black or African American; NAPI: Native Hawaiian or Pacific Islands

Table 2 Cont'd: Distribution of Feeding Choice by demographic characteristics and potential covariates of respondents.

	Choice of feeding				
	Breast Milk	Formula	Both		
Variable	n (%)	n (%)	n (%)	Total (%)	P-value
Bf Factors					
No knowledge	107 (47.3)	18 (8.0)	101 (44.7)	226 (3.8)	**.000****
No support	159 (53.2)	20 (6.7)	120 (40.1)	299 5.0)	
Medically reasons	203 (51.0)	31 (7.8)	164 (41.2)	398 (6.6)	
Not beneficial	48 (39.3)	15 (12.3)	59 (48.4)	122 (2.0)	
Busy schedule	342 (51.5)	22 (3.3)	360 (45.2)	664 (11.1)	
Opted not to	325 (44.6)	66 (9.1)	337 (46.3)	728 (12.1)	
Breastfed or lactate	2514 (70.6)	86 (2.4)	963 (27.0)	3563 (59.4)	
Home Duration					
Less than one month	51 (47.7)	11 (10.3)	45 (42.1)	107 (1.8)	**.000****
2 – 4 months	930 (56.8)	79 (4.8)	628 (38.4)	1637 (27.3)	
5 – 11 months	870 (62.1)	50 (3.6)	481 (34.3)	1401 (23.4)	
One year and above	1769 (64.7)	115 (4.2)	851 (31.1)	2735 (45.6)	
No home stay	78 (65.0)	3 (2.5)	39 (32.5)	120 (2.0)	
Crisis Support					
COVID-19	1041 (66.5)	49 (3.1)	975 (30.4)	1565 (26.1)	**.000****
Formula shortage	719 (54.1)	63 (4.7)	547 (41.2)	1329 (22.2)	
None	1938 (62.4)	146 (4.7)	1021 (32.9)	3106 (51.8)	
Re-lactation					
Yes	2409 (64.2)	131 (3.5)	1210 (32.3)	3750 (62.5)	**.000****
No	1289 (57.3)	127 (5.6)	834 37.1)	2250 (37.5)	
WIC Program					
Yes	3075 (61.5)	208 (4.2)	1720 (34.4)	5003 (83.4)	**.297**
No	623 (62.5)	50 (5.0)	324 (32.5)	997 (16.6)	
Bf Duration					
Less than one month	130 (38.8)	41 (12.2)	164 (49.0)	335 (5.6)	**.000****
2 – 4 months	933 (46.8)	120 (6.0)	942 (47.2)	1995 (33.3)	
5 – 11 months	1180 (64.8)	45 (2.5)	596 (32.7)	1821 30.4)	
One year and above	1455 (78.7)	52 (2.8)	342 (18.5)	1849 (30.8)	

NB: WIC: Women, Infants and Children.

3.1 Sample characteristics

Presented in Table 2 above are the demographic characteristics of the 6000 participants who took part in the survey for the study. The 6000 participants included in the study completed all fields of the survey questionnaire resulting in a 100% response rate. The participants were mostly between 26 to 35 years, 3455 (57.6%), followed by participants in the age bracket 18 to 25, 1381 (23.0%) and fewer participants who were 45 years and older, 29 (0.5%). In the study population, non-Hispanics were more prevalent, 4260 (71.0%), compared to 1740 (29.0%) Hispanic. The study participants comprised 1892 (31.5%) individuals whose level of education is a high school diploma, 1717 (28.6%) participants who have some college instruction, 805 (13.4%) undergraduate college participants, 664 (11.1%) and 496 (8.3%) individuals who have attained respective associate and graduate degree respectively. 426 (7.1%) respondents have attained a degree less than a high school diploma which is the least represented level of education the survey recorded. The race category which was most represented is the White, with a population of 3179 corresponding to 53.0%, followed in second by the Black or African American race 2162 (36.0), with Native Hawaiian or Pacific Island race category 896 (1.5%) being the least represented race category. Of the 600 participants who took part in the research, most of the respondents, 3698 61.6%) prefer breast milk as a means of breastfeeding, 2044 (34.1%) prefer both breast milk and formula as a breastfeeding mechanism, while the rest 258 (4.3%) prefer formula as a breastfeeding choice. During the COVID-19 crisis, 1565 (26.0%) received support, and 1329 (22.2%) received some form of support during the formula shortage. However, to our dismay, most of the research participants, 3106 (51.8%) received no support during the COVID-19 and formula shortage period.

A chi-square test of independence (with Yates continuity correction) was performed to assess the existence of an association or relationship between the demographic characteristics and covariates under consideration (age, level of education, ethnicity, race, knowledge of breastfeeding, home duration, support during crisis, factors influencing breastfeeding, re-lactation, status of breastfeeding, WIC program during pregnancy, etc.) and breastfeeding choice of a respondent. An effect is adjudged statistically significant, with an associated p-value < 0.05. With p-value < 0.05, age, education, ethnicity, race, knowledge of breastfeeding, home duration, breastfeeding duration, support during crisis, factors influencing breastfeeding, re-lactation, and breastfeeding status were associated with breastfeeding choice in the cross-tabulation results presented in Table 2. This shows the dependency between the above-listed variables (age, education, ethnicity, race, knowledge of breastfeeding, home duration, breastfeeding duration, support during crisis, factors influencing breastfeeding, re-lactation, and breastfeeding status) and breastfeeding choice. However, the WIC program (whether women were enrolled in WIC program during pregnancy or not) was the only non-statistically significant variable with a p-value > 0.05. In conclusion, feeding choice depends on age, education, ethnicity, race, knowledge of breastfeeding, home duration, breastfeeding duration, support during crisis, factors influencing breastfeeding, re-lactation, and breastfeeding status. However, it is independent of whether a study participant enrolled in a WIC program during pregnancy.

3.2 Kruskal-Wallis rank sum test of medians

The normality and homoscedasticity assumptions were violated, so we could not use Analysis of Variance (ANOVA) to test the differences between the three groups (breastfeeding before COVID-19, during COVID-19 and Formula Shortage) but rather the Kruskal-Wallis rank sum test.

At the 5% significance level, since the p-value of the Kruskal-Wallis rank sum test (0.0117) with a test statistic of 21.915 was less than 0.05, we reject the null hypothesis and conclude that there is a statistically significant difference between the median breastfeeding rates of breastfeeding participants before COVID-19, during COVID-19 and Formula Shortage. We therefore conduct a post hoc analysis (multiple comparison test) to identify the group(s) that differ(s) significantly from the others. The Dunn (1964) Kruskal-Wallis multiple comparison test (p-values adjusted with the Holm method) was used.

Table 3: Duncan Multiple comparison test for breastfeeding type

Comparison	Z - Statistic	P unadjusted	P adjusted
BreastfedDUR – BreastfedFS	2.9173	0.1758	**0.3516**
BreastfedDUR – BreastfedPRE	-2.0981	0.4858	**0.4858**
BreastfedFS – BreastfedPRE	-4.6241	0.0093	**0.0076**

Key: BreastfedPRE = Breastfeeding before COVID-19; BreastfedDUR = Breastfeeding during COVID-19; BreastfedFS= Breastfeeding during Formula Shortage.

From Table 3, it can be observed that there is no statistically significant difference between the median breastfeeding rate of breastfeeding participants during COVID-19 and the Formula Shortage with a p-value (0.3516) greater than 0.05. Likewise, there is a noticeable non-statistically significant difference between the median breastfeeding rate of breastfeeding participants before COVID-19 and during COVID-19 with an adjusted p-value (0.4858) greater than 0.05. On the contrary, at the 5% significance level, with an adjusted p-value (0.0076) less than 0.05, it is observed that there is a statistically significant difference between the median breastfeeding rate of breastfeeding participants before COVID-19 and the Formula Shortage.

3.3 Predictors of Infant feeding choices

Using multinomial logistic regression, several factors were examined to determine the likelihood that respondents would prefer any of the three feeding choices (breast milk, formula, or both) with both breast milk and formula as the base outcome. Model parameters were obtained using maximum likelihood estimation. As an evaluation of the goodness of fit, a likelihood ratio test (LRT), Akaike information criterion (AIC), and Bayesian information criterion (BIC) were used. P-values were used as an indicator to assess the significance of the various attributes, which was established by the prior result. An effect is statistically significant, with an associated p-value less than or equal to a 5% significance level. At the 95% confidence interval, all the coefficients have their anticipated signs. As a result, the signs of the estimates have an impact on the feeding choice. The model contained thirteen (13) independent variables (as evident in Table 4). The complete model containing all predictors was statistically significant, $\chi^2\ (26, N = 6000) = 561.42,\ p < .05$, indicating that the model fits the data well. Likewise, the model can distinguish between respondents who prefer any of the three feeding choices. From the Goodness of fit test, a p-value of 0.242 indicat support for the use of our proposed multinomial logistic model.

From Table 4, we observe two logistic regression models (the first being breast milk relative to both breast milk and formula as base outcome while the second model being formula relative to both breast milk and formula as base outcome). For the first logistic model, nine (9) of the thirteen independent variables in the logistic regression model made a unique statistically significant contribution to the model (namely breast feeding status, knowledge on breast feeding, duration of breast feeding, formula shortage, re-lactation, breast feeding factors, age, education and ethnicity) with p-values $< .05$ while the remaining four (home duration, crisis support, WIC program and race) did not have any statistically significant contribution to the model with p-values > .05. For the second logistic model, five (5) of the thirteen independent variables in the logistic regression model made a unique statistically significant contribution to the model (namely breast feeding status, duration of breast feeding, formula shortage, breast feeding factors, and race) with p-values $< .05$ while the remaining eight (knowledge on breast feeding, home duration, re-lactation, crisis support, WIC program, age, education and ethnicity) are not significant predictors of breast feeding choices with p-values > .05. In both logistic models, breast feeding status, duration of breast feeding, formula shortage and breastfeeding factors are significant predictors of breastfeeding choice.

Table 4: Parameter estimates of Multinomial logistic regression model of Feeding choices with both breast milk and formula as base outcome.

						95% CI for RRR	
Variables	**Coefficient**	**Std. Error**	**Wald(Z)**	**P-value**	**RRR**	**Lower**	**Upper**
Breast Milk							
Bf Status	-0.368	0. 167	-2.20	**.028****	0.692	0.498	0. 960
Bf Knowledge	0.089	0. 024	3.64	**.000****	1.093	1.042	1.146
Bf Duration	0.455	0.129	3.52	**.000****	1.577	1.224	2.031
Home Duration	0.262	0.219	1.20	**.231**	1.300	0.846	1.998
Formula Shortage	0.823	0.063	13.07	**.000****	2.278	2.013	2.577
Re-lactation	-0.357	0.062	-5.74	**.000****	0.670	0.619	0.790
Bf Factors	0.051	0.018	2.92	**.004****	1.053	1.017	1.089
Crisis Support	-0.048	0.034	-1.40	**.162**	0.953	0.891	1.109
WIC program	0.102	0.078	1.29	**.196**	1.106	0.949	1.289
Age	0.227	0.044	5.21	**.000****	1.255	1.152	1.367
Education	0.057	0.021	2.66	**.008****	1.059	1.015	1.104
Ethnicity	-0.332	0.066	-5.01	**.000****	0.717	0.629	0.817
Race	-0.023	0.025	-0.91	**.360**	0.977	0.931	1.026
Constant	-1.995	0.589	-3.38	**.001****	0.136	0.042	0.432
Formula							
Bf Status	1.068	0.222	4.89	**.000****	2.962	1.917	4.578
Bf Knowledge	-0.013	0.058	-0.23	**.815**	0.987	0.881	1.104
Bf Duration	-0.445	0.207	-2.14	**.032****	0.641	0.426	0.962
Home Duration	-0.437	0.360	-1.21	**.225**	0.646	0.319	1.309
FS Shortage	0.398	0.146	2.72	**.006****	1.489	1.118	1.984
Re-lactation	0.127	0.141	0.90	**.370**	1.135	0.861	1.497
Bf Factors	-0.102	0.036	-2.83	**.005****	0.903	0.841	0.969
Crisis Support	0.134	0.084	1.59	**.111**	1.143	0.970	1.347
WIC program	0.250	0.172	1.45	**.147**	1.283	0.916	1.798
Age	-0.069	0.102	-0.68	**.496**	0.933	0.765	1.139
Education	0.029	0.051	0.57	**.566**	1.030	0.932	1.138
Ethnicity	-0.060	0.160	-0.38	**.706**	0.941	0.688	1.289
Race	-0.133	0.057	-2.31	**.021****	0.876	0.723	0.980
Constant	-1.607	1.054	-1.52	**.127**	0.201	0.025	1.582
Number of Obs.	6000						
Prob > F	**.0000****						
AIC	9099.786						
BIC	9287.373						

Abbreviations: Bf, Breast Feeding; RRR, Relative Risk Ratio; Obs, Observations; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; CI, Confidence Interval; Std, Standard.

4. Discussion

The breastfeeding rate among VA WIC participants during COVID-19 was higher than that of breastfeeding before COVID-19. One reason that could explain their decisions might have been that they might have believed that breastmilk can protect their babies from the virus (Aşcı et al., 2021; Mufdlilah et al., 2022; Radwan & Sapsford, 2016). Previous studies indicated that in countries where the formula is less accessible, women tend to breastfeed more (Aros-Vera et al., 2021; Brink, 2018). Our study showed the same effect among WIC postpartum women during the formula shortage. Breastfeeding support during the crisis was seen in the COVID-19 period than in the formula shortage. This study indicated that more than half of the participants received no support for breastfeeding during the COVID-19 and formula shortage emergencies. This finding is similar to the one of Costantini et al. (2021), who found that breastfeeding during COVID-19 decreased from 57% to 40% in the United Kingdom due to the lockdown. Infant feeding choice during emergencies depends on age, education, ethnicity, race, knowledge of Breastfeeding, home duration, support during crisis, re-lactation, formula convenience, and breastfeeding status. However, it is independent of whether a study participant enrolled in a WIC program during pregnancy. Our study revealed that survey participants with graduate college degrees have the highest breastfeeding choice, followed by undergraduate college participants. This result is not different from many other studies that found that the higher a mother's education level, the higher the chance of her breastfeeding. In their study, Lio et al. (2021) observed that the proportion of breastfed women increased with increasing educational levels in the general population. Another study by Laksono et al. (2021) also shows a strong association between the education level of mothers with the rate of exclusive Breastfeeding in Indonesian women. A possible explanation by (Yang et al., 2014; Webb et al., 2009) for our study's results is that mothers who are more educated have an increased likelihood of sick medical advice and use health services that include lactation (Menon, 2002). Breastfeeding rate increased among VA WIC postpartum women during COVID-19 and the formula shortages emergencies. The increase was higher in the formula shortage crisis because of the high number of participants who re-lactated their infants compared to the COVID-19 crisis. Infant feeding choice during emergencies depends on age, education, ethnicity, race, knowledge of Breastfeeding, home duration, support during crisis, re-lactation, formula convenience, and breastfeeding status. However, it is independent of whether a study participant enrolled in a WIC program during pregnancy. WIC staff should continue to emphasize the convenience of breastmilk over formula to decrease its participants' belief in the convenience of formula. This will set a firm ground for emergencies where women depend more on breast milk to feed their infants than formula. Also, VA WIC needs to reexamine its strategies so that many women receive support for breastfeeding mothers in future situations. This study provided scope to understand the factors influencing VA WIC postpartum women's infant feeding decisions during COVID-19 and the formula shortage.

5. Conclusion

This study explored the breastfeeding choices and factors influencing infant feeding decisions among Virginia WIC postpartum women during the COVID-19 pandemic and the subsequent formula shortage. The findings highlight significant shifts in breastfeeding rates and underscore the importance of demographic factors, knowledge, and support systems in shaping these decisions. Key findings indicate that while breastfeeding rates increased during both the COVID-19 pandemic and the formula shortage, the formula shortage period saw a higher increase due to re-lactation efforts. Factors such as age, education, ethnicity, race, breastfeeding knowledge, home duration, and support during crises were significantly associated with feeding choices. Interestingly, enrollment in the WIC program during pregnancy did not significantly influence breastfeeding choices. Despite the increased breastfeeding rates, a considerable number of participants reported insufficient support for breastfeeding during emergencies, emphasizing the need for enhanced support strategies. Higher educational levels were consistently associated with a higher likelihood of breastfeeding, aligning with global trends that link maternal education to breastfeeding practices. In the light of this research, breast cancer diagnosis should be a core priority (Agbota et al, 2024). The study used a large survey size from all 35 health districts of VDH. It also used the RedCap tool to collect and manage the survey data. However, the study would have been more informative if a focus group discussion had been associated with the online survey. This would have allowed us to detect other factors that the online survey would not reveal. Future studies should consider the examination of the perception of WIC postpartum women after COVID-19 and the breastfeeding rates with the inclusion of focus group discussions.

Ethics Approval

This study was approved by the International Review Board (IRB) of the Virginia Department of Health (VDH) Ethical Committee with ethics approval number 50290.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Funding

The study did not receive any funding.

Acknowledgement

The authors thank all members of the Virginia Department of Health (VDH) for their enormous assistance and the Virginia State WIC Office for providing the necessary data for this research.

REFERENCES

Agbota, L., Agyemang, E., Kissi-Appiah, P., Moshood, L., Osei-Nkwantabisa, A., Agbenyeavu, V., Nsiah A. & Adjei, A. (2024). Enhancing Tumor Classification Through Machine Learning Algorithms for Breast Cancer Diagnosis. *Computer Engineering and Intelligent Systems*, *15*(1), 71.

Alzaheb, R. A. (2017). A review of the factors associated with the timely initiation of breastfeeding and exclusive breastfeeding in the Middle East. *Clinical medicine insights: pediatrics*, *11*, 1179556517748912.

Aros-Vera, F., Chertok, I. R. A., & Melnikov, S. (2021). Emergency and disaster response strategies to support mother-infant dyads during COVID-19. *International Journal of Disaster Risk Reduction*, *65*, 102532. https://doi.org/10.1016/j.ijdrr.2021.102532

Aşcı Ö, Demirgöz Bal M., Ergin A. (2021). The breastfeeding experiences of COVID-19- positive women: A qualitative study in Turkey. *Japan Journal of Nursing Science* 19(1), e12453.

Binns, C. W., Lee, M., & Low, W. Y. (2016). The Long-Term Public Health Benefits of Breastfeeding. *Asia-Pacific Journal of Public Health*, *28*(1), 7–14. https://doi.org/10.1177/1010539515624964

Brink, S. (2018, July 13). *Why the Breastfeeding vs. formula debate is especially critical in poor countries*. NPR. Retrieved November 3, 2022, from https://www.npr.org/sections/goatsandsoda/2018/07/13/628105632/is-infant-formula- ever-a-good-option-in-poor-countries

Brown, A., & Shenker, N. (2020). Experiences of Breastfeeding during COVID-19: Lessons for future practical and emotional support. *Maternal & Child Nutrition*, *17*(1). https://doi.org/10.1111/mcn.13088

Costantini, C., Joyce, A., & Britez, Y. (2021). Breastfeeding experiences during the COVID-19 lockdown in the United Kingdom: an exploratory study into maternal opinions and emotional states. *Journal of Human Lactation*, *37*(4), 649–662. https://doi.org/10.1177/08903344211026565

Doan, T. H., Binns, C. W., Pham, N. M., Zhao, Y., Dinh, T. H., Bui, T. H., Tran, T. T., Nguyen, X. V., Giglia, R., Xu, F., & Lee, A. H. (2020). Improving Breastfeeding by empowering mothers in Vietnam: a randomized controlled trial of a mobile app. *International Journal of Environmental Research and Public Health*, *17*(15), 5552. https://doi.org/10.3390/ijerph17155552

Hallal, P. C., De Mola, C. L., & Victora, C. G. (2015). Breastfeeding and intelligence: a systematic review and meta-analysis. Acta Paediatrica, 104, 14–19. https://doi.org/10.1111/apa.13139

Howard, J. (2018, May 10). *The countries where 1 in 5 children are never breastfed*. CNN. Retrieved November 1, 2022, from https://www.cnn.com/2018/05/09/health/breastfeeding-unicef-study-parenting-without-borders-intl/index.html

Ip, S., Chung, M., Raman, G., Chew, P., Magula, N., DeVine, D., ... & Lau, J. (2007). Breastfeeding and maternal and infant health outcomes in developed countries. *Evidence report/technology assessment*, (153), 1-186.

Koleilat, M., Whaley, S. E., & Clapp, C. (2022). The impact of covid-19 on breastfeeding rates in a low-income population. *Breastfeeding Medicine*, *17*(1), 33–37. https://doi.org/10.1089/bfm.2021.0238

Laksono, A. D., Wulandari, R. D., Ibad, M., & Kusrini, I. (2021). The effects of mother's education on achieving exclusive Breastfeeding in Indonesia. *BMC Public Health*, *21*(1). https://doi.org/10.1186/s12889-020-10018-7

Lee, M., & Binns, C. W. (2019). Breastfeeding and the risk of infant illness in Asia: a review. *International Journal of Environmental Research and Public Health*, *17*(1), 186.

Lio, R. M. S., Maugeri, A., La Rosa, M. C., Cianci, A., M, P., Giunta, G., Agodi, A., & Barchitta, M. (2021). The Impact of Socio-Demographic Factors on Breastfeeding: Findings from the "Mamma & Bambino" Cohort. *Medicina-lithuania*, *57*(2), 103. https://doi.org/10.3390/medicina57020103

Malik, S. (2022, May 18). *What are babies fed in countries where infant formula isn't available? (best alternatives & dont's!)*. 1happykiddo. Retrieved November 2, 2022, from https://1happykiddo.com/what-are-babies-fed-in-countries-where-infant-formula-isnt-available/

Menon, S. T. (2002). Toward a model of psychological health empowerment: implications for health care in multicultural communities. *Nurse education today*, *22*(1), 28-39.

Mufdlilah M., Ernawati D., Ambarwati D. M. (2022). Effectiveness of husband and care provider support of exclusive breastfeeding in nursing mothers: A systematic literature review. *Brunei International Medical Journal*, 18(1), 24–31. https://bimjonline.org

Parasuraman, S., Lebrun-Harris, L., & Jones, J. (2020). Breastfeeding initiation, duration, and exclusivity among wic-eligible populations. *Health Services Research*, *55*(S1), 30–31. https://doi.org/10.1111/1475-6773.13366

Radwan, H., & Sapsford, R. (2016). Maternal perceptions and views about breastfeeding practices among Emirati mothers. *Food and Nutrition Bulletin*, *37*(1), 73-84.

Rethy, J. A., Gallo, S., Doig, A. C., Brady, J., & Goodfriend, D. (2019). Sociodemographic predictors of exclusive breastfeeding among low-income women attending a special supplemental nutrition program for women, infants, and children (WIC) programme. *Public Health Nutrition*, *22*(09), 1667–1674. https://doi.org/10.1017/s1368980019000119

Sharma, A. J., Dee, D. L., & Harden, S. M. (2014). Adherence to breastfeeding guidelines and maternal weight 6 years after delivery. *Pediatrics*, *134*(Supplement_1), S42– S49. https://doi.org/10.1542/peds.2014-0646h

Spatz, D. L., Davanzo, R., Müller, J. A., Powell, R., Rigourd, V., Yates, A., Geddes, D. T., van Goudoever, J. B., & Bode, L. (2021). Promoting and protecting human milk and breastfeeding in a COVID-19 world. *Frontiers in Pediatrics*, *8*. https://doi.org/10.3389/fped.2020.633700

Victora, C. G., Bahl, R., Barros, A. J. D., De França, G. V. A., Horton, S., Krasevec, J., Murch, S., Sankar, M. J., Walker, N., & Rollins, N. (2016). Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. *The Lancet*, *387*(10017), 475–490. https://doi.org/10.1016/s0140-6736(15)01024-7

Webb, A. L., Sellen, D. W., Ramakrishnan, U., & Martorell, R. (2009). Maternal years of schooling but not academic skills is independently associated with infant-feeding practices in a cohort of rural Guatemalan women. *Journal of Human Lactation*, *25*(3), 297-306.

World Health Organization. (2000). Effect of breastfeeding on infant and child mortality due to infectious diseases in less developed countries: a pooled analysis. *The Lancet*, *355*(9197), 451-455.

Yang, S., Platt, R. W., Dahhou, M., & Kramer, M. S. (2014). Do population-based interventions widen or narrow socioeconomic inequalities? The case of breastfeeding promotion. *International journal of epidemiology*, *43*(4), 1284-1292.

Zielinska, M. A., & Hamułka, J. (2019). Protective effect of breastfeeding on the adverse health effects induced by air pollution: Current evidence and possible mechanisms. *International Journal of Environmental Research and Public Health*, *16*(21), 4181. https://doi.org/10.3390/ijerph16214181