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Breastfeeding Characteristics and Duration of Feeding Human Milk in Infants With Congenital Heart Disease

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ABSTRACT

Background: Although infants with congenital heart disease (CHD) are able to breastfeed successfully, the factors that affect feeding human milk across the first year are not well established. **Purpose:** The objective of this study was to examine breastfeeding characteristics and their relationships to the exclusivity and duration of feeding human milk among infants with CHD. **Methods:** Breastfeeding characteristics data from a cohort of 75 infants with CHD enrolled in a study that examined relationships among milk type and infant growth in the first year of life were analyzed. **Results:** Infants whose mothers reported not having enough milk were exclusively fed human milk for a shorter duration than those who did not have this challenge ($P = .04$); however, the duration of feeding any human milk did not differ ($P = .18$). Average daily volume expressed at 1 month was positively related to the duration of exclusive human milk ($\beta = .07$, $P = .04$) and any human milk ($\beta = .07$, $P = .04$) feeding. **Conclusions:** Future efforts to support feeding human milk in infants with CHD should emphasize practices that support maximal human milk production.

Key Words: breastfeeding, congenital heart disease, duration, exclusivity, human milk

Human milk is considered the gold standard for infant nutrition, and it is recommended that infants receive human milk for the first 6 months of life followed by continued provision of human milk in addition to complementary foods through at least 12 months of age.[1–6] Longer duration of feeding human milk has been associated with a decreased incidence of adverse health outcomes including necrotizing enterocolitis, otitis media, and gastrointestinal, urinary, and respiratory infections.[7–9] Moreover, exclusively providing human milk for the first 6 months of life has been associated with lower infant mortality rates worldwide.[8]

Despite the well-documented nutrition and health benefits of human milk and recommendations to feed infants' human milk until at least 6 months of age,[5,6] only 25.6% of infants in the United States are exclusively breastfed at 6 months of age.[10] Parents of infants with serious health conditions face challenges feeding their infants. Challenges specific to breastfeeding include maternal anxiety, separation from the infant for medical reasons, infant fatigue and weak sucking due to medical conditions, lack of privacy in hospital settings, and lack of support from care teams knowledgeable in lactation.[11,12]

Research on breastfeeding and provision of human milk to infants with congenital heart disease (CHD) is limited. One study reported that 85% of infants were fed

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human milk during their neonatal intensive care unit (NICU) stay, with a downward trend of human milk feeding for those with a prolonged NICU stay.[13] Specific to infants with cyanotic heart defects, one study found that feeding readiness and oral-motor skill delays led to prolonged hospital stays and an increased risk of malnutrition.[14] Another study of infants younger than 6 months with CHD in a cardiac intensive care unit (CICU) reported that 89% of infants were fed human milk, with the majority (63%) by bottle feeding.[15] While mothers reported that they received support for breastfeeding from certified lactation consultants and breastfeeding resource nurses, barriers to breastfeeding were not examined.[15] Breastfeeding support is associated with a higher proportion of human milk provision, and early initiation of exclusive human milk feeding is associated with continued human milk feeding throughout hospitalization.[16]

A better understanding of breastfeeding challenges and the role of breastfeeding support in infants with complex CHD is needed to determine how best to promote human milk feeding in this population. Furthermore, it is important to longitudinally examine the provision of human milk, as there is a paucity of research on breastfeeding characteristics in these infants throughout the first year. The current study aimed to describe the course of breastfeeding in infants with CHD from birth to 12 months of age, with a focus on medical and breastfeeding characteristics and their relationship to the exclusivity and duration of feeding human milk.

MATERIAL AND METHODS

Study design

This study was a prospective cohort study of infant feeding practices and growth in the first year among infants with CHD.[17] Data on breastfeeding barriers and social support experienced by parents of infants with CHD were also collected. Aside from the enrollment visit, which was conducted in-person, subsequent visits were conducted by phone if the infant was no longer in the hospital or in-person if the infant was hospitalized.

Sample and setting

Infants with CHD who were admitted to the Cardiac Intensive Care Unit (CICU) at Children's Hospital of Philadelphia between 2015 and 2018 were recruited to participate in this study. Children's Hospital of Philadelphia is an urban hospital with a 30-bed CICU for critically ill children pre- and post-surgery. At the time of the study, there were 207 neonatal cardiac admissions and 157 neonatal cardiac surgical procedures. Inclusion criteria required infants to be born full term (37-42 weeks of gestation at birth), singleton, appropriate size for gestational age, diagnosed with CHD, between 0 and 21 days old at enrollment, and to have had or planned to have neonatal corrective or palliative cardiac surgery prior to discharge. Additionally, mothers were required to be 18 years and older, English-speaking, and planning to breastfeed their infants (either by direct breastfeeding or expressed human milk). Infants were excluded if they had other physical, neurological, or physiological anomalies that are known to affect feeding and nutrition (eg, cleft palate or inborn errors of metabolism). A feeding protocol for neonates in the CICU undergoing cardiac surgery is part of routine care in this population. This protocol includes feeding on demand and parenteral nutrition until maternal lactogenesis II occurs and the infant demonstrates adequate human milk intake. All hospitalized infants are also eligible for pasteurized donor milk per parental request. The study was approved by the Institutional Review Boards of both the Children's Hospital of Philadelphia and University of Delaware and written informed consent was obtained from all participants.

Data collection

A registered dietitian nutritionist (RDN), who is also an International Board Certified Lactation Consultant (IBCLC) in the CICU, approached eligible parents regarding the study. The study involved 9 total contacts: the first took place when the infant was 0 to 21 days of age (enrollment), and the remaining contacts occurred at 1, 2, 3, 4, 6, 8, 10, and 12 months of age. Information on infant feeding, breastfeeding challenges, and breastfeeding support was collected using a standard list of questions. The questions were adapted from the Infant Feeding Practices Study questionnaires.[18]

At study enrollment, data on infant sex, ethnicity, race, maternal and paternal age, maternal marital status, education level, employment status, number of other children, birth order, breastfeeding initiation, breastfeeding challenges, breastfeeding sources of support, maternal milk expression, feeding type, and pasteurized donor milk use were determined by self-report; type of cardiac defect was abstracted from the electronic health record. To assess breastfeeding challenges and sources of support, parents were presented with a discrete list of items to select from as well an "other" option with a field to provide descriptive information. Feeding type was assessed using the following discrete list of response items: exclusive human milk feeding, human milk fortified with powder cow's milk infant formula, human milk feedings plus infant formula feedings, or infant formula only. At each study visit after enrollment (months 1, 2, 3, 4, 6, 8, 10, and 12), parents were asked whether their infant had been hospitalized in the past

month and, if so, the number of days the infant was hospitalized, sources of breastfeeding support they had received over the past month, feeding type, maternal milk expression, and pasteurized donor milk use.

Data analysis

Duration of "exclusive human milk" and "any human milk" feeding was calculated at each time point, as a continuous variable (months). Exclusive human milk refers to infants feeding human milk (either maternal milk or pasteurized donor milk) as a sole source of nutrition with no supplementation with infant formula. Any human milk refers to infants feeding any human milk (maternal or donor), either as a sole source of nutrition or in combination with infant formula, including fortified human milk (human milk with added infant formula powder) or partial human milk feeding (both human milk feedings and infant formula feedings). Finally, given recommendations to exclusively feed human milk for 6 months, infants were further categorized as being fed exclusive human milk for less than 6 months or 6 months or longer and as being fed any human milk for less than 6 months or 6 months or longer.

Shapiro-Wilk tests were conducted on all outcome variables to evaluate normality. For descriptive statistics, continuous variables were reported as means (SD) if normally distributed, as well as medians and interquartile ranges (IQRs) if not normally distributed. Categorical variables were reported as frequencies and percentages. Associations between participant characteristics and duration and exclusivity of feeding human milk (see Table 1) were determined by χ^2 or Fisher's exact tests, depending on sample size. The Mann-Whitney U test was used to compare continuous variables between groups, while associations were examined using general linear models. Statistical analyses were performed using IBM SPSS Statistics for Windows version 27 (IBM Corp, Armonk, New York), and statistical significance was set at $P \leq .05$.

RESULTS

Dyad characteristics

A total of 75 mother-infant dyads were enrolled. Baseline characteristics for 74 dyads (1 dyad dropped prior to data collection) and stratification by duration of human milk feeding are shown in Table 1. Seventy-two infants were able to be characterized for duration of feeding human milk (<6 months or ≥6 months). A total of 69 mother-infant dyads completed all visits. The majority of infants were male, non-Hispanic, and White (see Table 1). A similar percentage of infants had single and biventricular defects. Nearly 75% of infants were rehospitalized at least once during the study. Those fed only or any human milk for 6 months or longer had a higher percentage of mothers with a college education. Forty-three (58%) households had at least 1 other child.

Breastfeeding characteristics

Characteristics of breastfeeding at enrollment are shown in Table 2. For over three-quarters of participants, 3 days or more elapsed before maternal milk came in. Most infants were able to feed at the breast by study enrollment. With respect to pasteurized donor milk use (data not shown), 28 infants (38%) were receiving donor milk at enrollment. Of these, 9 infants (35%) received donor milk by 1 day of life and 17 infants (65%) between 2 and 6 days of life; the day donor milk was received was missing for 2 participants. The majority of these infants ($n = 23$, 92%) received donor milk for 4 days or less, while the remaining infants ($n = 2$, 8%) received donor milk for 7 days or more.

Challenges with breastfeeding reported at enrollment are shown in Table 3. Nearly all participants reported having a breastfeeding challenge. Of those who reported at least one challenge, the most common ($n = 26$, 38%) was that the baby had trouble latching, followed by the infant not waking regularly enough to breastfeed, and the mother reporting overfull or engorged breasts. Fourteen participants (20%) reported experiencing 4 or more challenges.

Sources of support for breastfeeding received in the first 6 months are shown in Table 4; it should be noted that some participants received support from multiple sources within the same visit. Most of the support was received early in lactation and no support was reported from 8 months onward. With respect to expressing maternal milk (data not shown), at the enrollment visit, 66 participants (90%) reported that they initiated pumping within the first 6 hours after birth, 4 (5%) initiated within the first 24 hours, and 4 (5%) initiated within the first 48 hours. At 1 month, 66 participants (90%) reported to have expressed maternal milk approximately 6 times per day (mean (SD) 5.95 (1.9) times per day); the average daily volume expressed for those who reported expressing maternal milk was approximately 25 oz/day (mean (SD) 724.6 (360.8) mL per day).

Duration and exclusivity of human milk feeding

The percentage of infants exclusively fed human milk or any human milk throughout the first year of life are shown in Figure 1. At baseline, all infants (100%; $n = 74$) were exclusively feeding human milk. At 6 months ($n = 71$), 22 (31%) infants were exclusively feeding human milk, and 41 (57%) were feeding any human milk. At 12 months ($n = 69$), 11 (15%) infants were

Table 1. **Dyad characteristics at enrollment**[a]

		Duration and exclusivity of feeding human milk ($n = 72$)			
		Fed human milk exclusively		Fed any human milk	
	All ($n = 74$) *n* (%)	<6 mo ($n = 55$) *n* (%)	≥6 mo ($n = 17$) *n* (%)	<6 mo ($n = 31$) *n* (%)	≥6 mo ($n = 41$) *n* (%)
Infant characteristics[b]					
Gender					
Male	54 (73)	43 (78)	10 (59)	25 (81)	28 (68)
Female	20 (27)	12 (22)	7 (41)	6 (19)	13 (32)
Ethnicity[c]					
Hispanic or Latino	4 (5)	3 (6)	1 (6)	2 (7)	2 (5)
Non-Hispanic or Latino	69 (95)	51 (94)	16 (94)	28 (93)	39 (95)
Race					
White	60 (81)	43 (78)	15 (88)	25 (81)	33 (81)
Black or African American	8 (11)	8 (15)	0 (0)	4 (13)	4 (10)
≥2 races	5 (7)	3 (5)	2 (12)	1 (3)	4 (10)
Other	1(1)	1 (2)	0 (0)	1 (3)	0 (0)
CHD defect					
Single ventricle	41 (55)	31 (56)	8 (47)	19 (61)	20 (49)
Biventricular	33 (45)	24 (44)	9 (53)	12 (39)	21 (51)
Rehospitalization					
Ever rehospitalized	54 (73)	43 (78)	11 (65)	24 (77)	30 (73)
Never rehospitalized	20 (27)	12 (22)	6 (35)	7 (23)	11 (27)
Parental characteristics[b]					
Maternal education					
11-12 y of high school	5 (7)	5 (9)[c]	0 (0)[c]	5 (16)[c]	0 (0)[c]
1-4 y of trade school	1 (1)	1 (2)[c]	0 (0)[c]	1 (3)[c]	0 (0)[c]
1-4 y of college	45 (61)	37 (67)[c]	7 (41)[c]	18 (58)[c]	26 (63)[c]
>4 y of college	23 (31)	12 (22)[c]	10 (59)[c]	7 (23)[c]	15 (37)[c]
Maternal employment					
Employed	51 (69)	38 (69)	12 (71)	20 (65)	30 (73)
Unemployed	23 (31)	17 (31)	5 (29)	11 (35)	11 (27)
Paternal education[d]					
12 y of high school	11 (15)	10 (16)	1 (6)	5 (16)	6 (15)
1-4 y of trade school	4 (6)	4 (7)	0 (0)	2 (6)	2 (5)
1-4 y of college	40 (56)	31 (56)	7 (41)	17 (55)	21 (51)
>4 y of college	17 (24)	9 (16)	8 (47)	7 (23)	10 (24)
Maternal marital status					
Single	15 (20)	15 (27)[c]	0 (0)[c]	10 (32)	5 (12)
Married	58 (78)	39 (71)[c]	17 (100)[c]	21 (68)	35 (85)
Divorced	1 (1)	1 (2)[c]	0 (0)[c]	0 (0)	1 (2)
Widowed	0 (0)	0 (0)[c]	0 (0)[c]	0 (0)	0 (0)

Abbreviation: CHD, congenital heart disease.

[a]Dyad characteristics ($n = 74$) were collected at enrollment (mean infant age 14.3 ± 4.2 days). Durations of human milk feeding were available for 72 mother-infant dyads (1 dyad that dropped out early, while the infant was still consuming human milk, and could not be categorized; 1 dyad had insufficient data and could not be categorized; 2 dyads that dropped out <6 months had already transitioned to infant formula at the time of dropout and could thus be categorized for "exclusive human milk" and "any human milk" duration).

[b]χ^2 test or Fischer's exact test used to assess for difference in infant or parental characteristics by duration or exclusivity of feeding human milk.

[c]Significant difference ($P < .05$) between being fed "human milk exclusively" or "any human milk" for <6 months and ≥6 months.

[d]$n = 72$ due to 2 nonresponses.

exclusively feeding human milk and 22 (31%) were feeding any human milk. Over the first year of life, the mean duration of exclusive human milk consumption was 3.2 (4.4) months (median 0.5, IQR 0.5-4 months), and the mean duration of any human milk consumption was 6.4 (4.5) months (median 6, IQR 1-12 months).

With respect to challenges with breastfeeding, having any challenge with breastfeeding (yes/no) was not associated with duration of either exclusive human milk consumption or any human milk consumption. However, when examining each individual challenge, infants who had trouble sucking were exclusively fed human milk for a longer duration ($n = 11$, mean (SD)

Table 2. **Characteristics of breastfeeding at enrollment**

Characteristic	*n* (%)
Fed human milk by enrollment	74 (100)
Held infant skin-to-skin	46 (62)
When milk came in	
≤1 d	2 (3)
2 d	13 (18)
3 d	30 (41)
4 d	23 (31)
>4 d	6 (8)
Ever fed at the breast at enrollment	58 (78)
How long after delivery breastfeeding initiated[a]	
<1 h	8 (14)
1-12 h	9 (16)
12-24 h	7 (12)
24-36 h	13 (22)
48-72 h	6 (10)
>72 h	14 (24)
Location breastfeeding initiated	
Special delivery unit (SDU)[b]	5 (9)
Cardiac intensive care unit (CICU)	47 (81)
Birth hospital	4 (7)
Other	2 (3)

[a] $n = 1$ subject with no response.
[b] An SDU is a delivery floor with a group of clinicians skilled in the delivery room care of infants with known congenital birth defects.

Table 3. **Challenges with breastfeeding reported at enrollment ($n = 74$)**

Problem reported	*n* (%)
No problem	5 (7)
Yes, had a problem[a]	69 (93)
My baby had trouble latching	26 (38)
My baby would not wake up to breastfeed regularly enough	20 (29)
My breasts were overfull (engorged)	19 (28)
My nipples were sore, cracked, or bleeding	15 (22)
My baby was not interested in breastfeeding	14 (20)
I had a plugged milk duct	12 (17)
My baby had trouble sucking	11 (16)
I did not have enough milk	7 (10)
My baby choked	6 (9)
My baby did not gain enough weight	6 (9)
My baby got distracted	4 (6)
My breasts leaked too much	3 (4)
I had trouble getting the milk flow to start	3 (4)
My breasts were infected or abscessed	2 (3)
I had some other problem	2 (3)
My baby breastfed too often	1 (1)
My baby lost too much weight	1 (1)
It took too long for my milk to come in	1 (1)

[a] Mothers were provided a discrete list of challenges to select from as well an "other" option with a field to provide additional information. Mothers could report one or more problems.

4.6 (4.7) months; median 3, IQR 1-10 months) than those who did not face this problem ($n = 63$, mean (SD) 2.9 (4.4) months; median 0.5, IQR 0.5-4 months, $P = .027$; Mann-Whitney). Participants who reported not having enough milk exclusively fed their infant human milk for a shorter duration ($n = 7$, mean (SD) 0.79 (1.4) months; median 0.5, IQR = 0-0.5 month) than those who did not report this problem ($n = 67$, mean (SD) 3.5 (4.5) months; median 0.5, IQR 0.5-6 months, $P = .035$; Mann-Whitney). Receiving support (yes/no) was not associated with the duration of exclusive human milk or any human milk ($P = .91$ and $P = .67$, respectively; Mann-Whitney) feeding. The highest percentage of support occurred in the first month after birth and dropped off quickly thereafter (see Table 4). The following breastfeeding characteristics were not associated ($P > .05$) with the duration of exclusive human milk or any human milk consumption: holding the infant skin-to-skin, time until milk came in, how long after delivery the infant first breastfed, where breastfeeding was initiated, timing of human milk expression initiation, and times expressed per day, number of children, and birth order. However, average daily volume expressed at 1 month was positively associated with the duration of feeding both exclusive human milk (® = 0.07, $P = .04$; general linear model) and any human milk (® = 0.07, $P = .04$; general linear model).

DISCUSSION

This study found that parents of infants with CHD requiring corrective or palliative cardiac surgery within the first 3 weeks of life were able to successfully feed their infants human milk despite facing breastfeeding and medical challenges. Having a sufficient milk supply and milk volume expressed were the 2 most salient factors influencing exclusivity and duration of human milk feeding.

The World Health Organization recommends initiating breastfeeding within the first hour, as early initiation reduces infant mortality and promotes and supports maternal milk production.[19,20] We found that of those infants who were able to feed at the breast at enrollment ($n = 58$, 78%), only 14% ($n = 8$) were able to do so within 1 hour of birth and 16% ($n = 9$) were able to feed at the breast within 1 to 12 hours of birth. Seventy-eight percent of participants were eventually able to nurse their infants at the breast, which underscores the ability and commitment of these mothers to breastfeed. Worldwide, 48% of mothers achieve early initiation of maternal milk.[20] Of note, 89% of participants in our study had initiated maternal milk expression within the first 6 hours after birth, a practice that supports milk production. Our findings on maternal milk expression

Table 4. **Sources of support received for breastfeeding in the first 6 months**

Support reported[a]	Enrollment ($n = 74$) *n* (%)	1 mo ($n = 73$) *n* (%)	2 mo ($n = 72$) *n* (%)	3 mo ($n = 70$)[b] *n* (%)	4 mo ($n = 70$)[b] *n* (%)	6 mo ($n = 70$)[b] *n* (%)
No support	24 (32)	64 (88)	66 (92)	67 (96)	67 (96)	69 (99)
Yes, received support	50 (68)	9 (12)	6 (8)	3 (4)	3 (4)	1 (1)
IBCLC	38 (76)	8 (89)	4 (67)	3 (100)	3 (100)	1 (100)
Registered nurse	31 (62)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Family	5 (10)	1 (11)	1 (17)	0 (0)	0 (0)	0 (0)
Physician	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Friend	1 (2)	1 (11)	0 (0)	0 (0)	0 (0)	0 (0)
Midwife	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other	3 (6)	1 (11)	1 (17)	0 (0)	0 (0)	0 (0)

Abbreviation: IBCLC, International Board Certified Lactation Consultant.
[a]Mothers were queried about sources of support over the past month; some mothers received support from multiple sources.
[b]$n = 70$ due to 3 participants who dropped out prior to 6 months and 1 participant with nonresponse.

initiation are similar to those of a previous study in this population.[13] Importantly, we found a positive correlation, although weak to moderate, between average daily volume expressed and duration of exclusive or any human milk feeding.

Infants whose mothers reported not having enough milk had a shorter duration of exclusive human milk feeding, and consistent with this, we found that volume expressed at 1 month was positively associated with duration of exclusive and any human milk feeding. In another study of infants with CHD, the 2 most common reasons for cessation of exclusive breastfeeding were CHD-related complications and not having enough milk.[21] In the general population, not having enough milk is a commonly reported reason for breastfeeding cessation.[22,23] In the CICU setting specifically, it is common to experience challenges with maternal milk expression and as such practices that promote sufficient milk supply should therefore be a focus of care for both the general population and mother-infant dyads affected by CHD.[24]

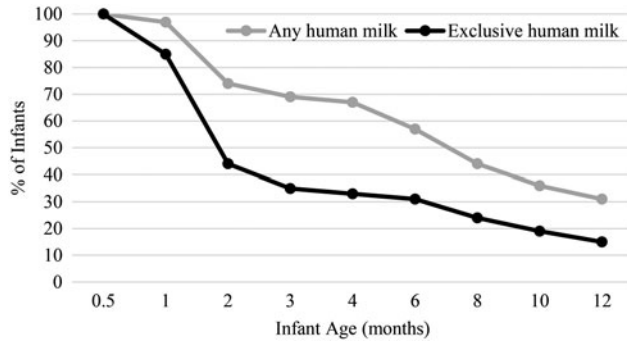

Figure 1. Percentage (%) and duration of feeding any human milk and exclusive human milk by infant age (0.5 months: $n = 74$; 1 month: $n = 73$; 2 months: $n = 72$; 3, 4, and 6 months: $n = 71$; 8 months: $n = 70$; and 10 and 12 months: $n = 69$).

It is recommended that all infants be held skin-to-skin after birth to help initiate and promote breastfeeding.[25–27] Over half of the participants in this study ($n = 46$, 62%) were able to have skin-to-skin contact with their infants at some point after birth. Although there is no national data on the number of infants with CHD receiving skin-to-skin contact, the Centers for Disease Control and Prevention (CDC) reports that 67% of all US infants receive skin-to-skin contact with their mothers after birth.[28] In our study, skin-to-skin contact was not correlated with the length of breastfeeding.

We found that the 3 most common challenges parents reported were infant having trouble latching, infant not waking up regularly enough to breastfeed, and mother having overfull or engorged breasts. An additional challenge reported, infants having trouble sucking, surprisingly resulted in a longer duration of exclusive human milk feeding compared with infants who did not have this problem. However, 73% ($n = 8$) of participants who reported this problem also reported their infants were both tube and bottle fed in addition to being breastfed, and the remaining 27% ($n = 3$) reported bottle feeding in addition to breastfeeding, suggesting that having alternative means of providing human milk may increase duration of feeding human milk. Although this study did not collect data on challenges faced throughout the entire first year, it is possible that challenges persist as barriers to breastfeeding, as it has been shown that human milk provision decreases as hospital length of stay increases.[16]

In our study, the support parents received from lactation consultants (IBCLC) and registered nurses occurred early in lactation, and all but one participant reported receiving help with breastfeeding. In the general

population, providing support increases breastfeeding exclusivity and duration.[29] Additionally, receiving support has been shown to increase the proportion of infants with surgical anomalies that are fed human milk, to levels that surpass that of the general population.[30,31] Regarding infants with CHD specifically, those who received prenatal lactation education were more likely to initiate and continue breastfeeding their infants with CHD.[15,32] Therefore, pre- and postnatal breastfeeding support for vulnerable populations, including parents of infants with CHD, should continue to be a focus of care.

In this study, the duration of feeding any human milk was longer than that of exclusive human milk feeding. The proportion of infants exclusively fed human milk or any human milk was similar to that of the general population. Data from the CDC's Breastfeeding Report Card indicate that 58% and 35% of infants feed any human milk at 6 and 12 months, respectively[10]; our study found similar percentages, with 57% and 31% receiving any human milk at 6 and 12 months, respectively. Furthermore, nationally, 25.6% of infants were exclusively fed human milk at 6 months, compared with 31% of infants in this sample. These proportions are lower than the Healthy People 2030 breastfeeding targets of 42.4% at 6 months and 54.1% at 12 months.[33,34] Common barriers to exclusivity and duration of human milk feeding include issues with milk supply/lactation, returning to work or lack of parental leave, and cultural norms or lack of family support,[32] underscoring the importance of ongoing breastfeeding support.

Limitations

This study had limitations. The level of parental education in our sample (most had a college degree or higher) exceeds the US national average education of the general US population. We focused on the occurrence of early breastfeeding challenges rather than duration of these challenges, and as such we are unable to determine whether later challenges affected the duration of human milk feeding. Future studies should examine breastfeeding challenges throughout the entire course of breastfeeding and their relation to breastfeeding cessation. The small sample size and very specific population of infants with CHD requiring surgery during the first weeks of life limits the generalizability of the findings. Only data on number of other children were collected, but information on parity, which may influence breastfeeding outcomes, was not collected. Moreover, these data were based on self-reported information and parents completed questionnaires at a single time point each month, which limits the precision of the human milk feeding duration estimate.

CONCLUSION

The findings herein provide preliminary insights into the breastfeeding experiences of mother-infant dyads with complex CHD. Despite additional challenges faced by this population, the proportion of participants who were able to feed their infants human milk was similar to the US national average, demonstrating that breastfeeding infants with CHD is possible and successful, especially when encouraged and supported by healthcare providers. Finally, insufficient supply of maternal milk was related to decreased exclusivity of feeding human milk. Therefore, practices that support maternal milk production and expression should be emphasized when caring for infants with CHD.

References

1. Eidelman AI, Schanler RJ. Breastfeeding and the use of human milk. *Pediatrics*. 2012;129(3):e827–e841. doi:10.1542/peds.2011-3552.
2. Walker A. Breast milk as the gold standard for protective nutrients. *J Pediatr*. 2010;156(2):S3–S7. doi:10.1016/j.jpeds.2009.11.021.
3. The World Health Organization. Breastfeeding. http://www.who.int/nutrition/topics/exclusive_breastfeeding/en/. Published 2018.
4. James DC, Lessen R. Position of the American Dietetic Association: promoting and supporting breastfeeding. *J Am Diet Assoc*. 2009;109(11):1926–1942. doi:10.1016/j.jada.2009.09.018.
5. National Institutes of Health. What are the recommendations for breastfeeding? https://www.nichd.nih.gov/health/topics/breastfeeding/conditioninfo/recommendations. Published 2017.
6. United States Department of Health and Human Services. *The Surgeon General's Call to Action to Support Breastfeeding*. Washington, DC: United States Department of Health and Human Services, Office of the Surgeon General; 2011.
7. Gertosio C, Meazza C, Pagani S, Bozzola M. Breastfeeding and its gamut of benefits. *Minerva Pediatr*. 2016;68(3):201–212.
8. Grummer-Strawn LM, Rollins N. Summarising the health effects of breastfeeding. *Acta Paediatr*. 2015;104(467):1–2. doi:10.1111/apa.13136.
9. Ip S, Chung M, Raman G, et al. Breastfeeding and maternal and infant health outcomes in developed countries. *Evid Rep Technol Assess (Full Rep)*. 2007;(153):1–186.
10. Centers for Disease Control and Prevention. Breastfeeding Report Card. https://www.cdc.gov/breastfeeding/data/reportcard.htm. Published 2020.
11. Lambert JM, Watters NE. Breastfeeding the infant/child with a cardiac defect: an informal survey. *J Hum Lact*. 1998;14(2):151–155. doi:10.1177/089033449801400221.
12. Barbas KH, Kelleher DK. Breastfeeding success among infants with congenital heart disease. *Pediatr Nurs*. 2004;30(4):285–289.
13. Jadcherla SR, Vijayapal AS, Leuthner S. Feeding abilities in neonates with congenital heart disease: a retrospective study. *J Perinatol*. 2009;29(2):112–118. doi:10.1038/jp.2008.136.
14. Demirci JR, Davis J, Glasser M, Brozanski B. Prevalence and patterns of gestational parent's own milk feeds among infants with major congenital surgical anomalies in the NICU. *J Perinatol*. 2021;41(12):2782–2788. doi:10.1038/s41372-021-01176-6.

15. Torowicz DL, Seelhorst A, Froh EB, Spatz DL. Human milk and breastfeeding outcomes in infants with congenital heart disease. *Breastfeed Med*. 2015;10(1):31–37. doi:10.1089/bfm.2014.0059.
16. Davis JA, Glasser M, Spatz DL, Scott P, Demirci JR. First feed type is associated with birth/lactating parent's own milk use during NICU stay among infants who require surgery. *Adv Neonatal Care*. 2022;22(6):578–588. doi:10.1097/anc.0000000000000981.
17. Trabulsi J, Lessen R, Siemienski K, et al. Relationship between human milk feeding patterns and growth in the first year of life in infants with congenital heart defects [published online ahead of print October 25, 2022]. *Pediatr Cardiol*. doi:10.1007/s00246-022-03023-7.
18. Centers for Disease Control and Prevention. Questionnaires: Breastfeeding and Infant Feeding Practices. https://www.cdc.gov/breastfeeding/data/ifps/questionnaires.htm. Published 2019.
19. The World Health Organization. Early initiation of breastfeeding to promote exclusive breastfeeding. https://www.who.int/elena/titles/early_breastfeeding/en/. Published 2019.
20. The World Health Organization. Infant and young child feeding. https://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding#:~:text=WHO%2520and%2520UNICEF%2520recommend%253A,years%2520of%2520age%2520or%2520beyond. Published 2020.
21. Goulart MR, Lima J, Ahlert M, Barbiero S, Schuh DS, Pellanda L. Prevalence of breastfeeding and its obstacles in patients with CHD in southern Brazil. *Cardiol Young*. 2020;30(10):1417–1421. doi:10.1017/S1047951120002115.
22. Odom EC, Li R, Scanlon KS, Perrine CG, Grummer-Strawn L. Reasons for earlier than desired cessation of breastfeeding. *Pediatrics*. 2013;131(3):e726–e732. doi:10.1542/peds.2012-1295.
23. Li R, Rock VJ, Grummer-Strawn L. Changes in public attitudes toward breastfeeding in the United States, 1999-2003. *J Am Diet Assoc*. 2007;107(1):122–127. doi:10.1016/j.jada.2006.10.002.
24. Fernández Medina IM, Fernández-Sola C, López-Rodríguez MM, et al. Barriers to providing mother's own milk to extremely preterm infants in the NICU. *Adv Neonatal Care*. 2019;19(5):349–360. doi:10.1097/ANC.0000000000000652.
25. Moore ER, Anderson GC, Bergman N, Dowswell T. Early skin-to-skin contact for mothers and their healthy newborn infants. In: Moore ER, ed. *Cochrane Database of Systematic Reviews*. Chichester, England: John Wiley & Sons, Ltd; 2012. doi:10.1002/14651858.CD003519.pub3.
26. Cleveland L, Hill CM, Pulse WS, DiCioccio HC, Field T, White-Traut R. Systematic review of skin-to-skin care for full-term, healthy newborns. *J Obstet Gynecol Neonatal Nurs*. 2017;46(6):857–869. doi:10.1016/j.jogn.2017.08.005.
27. The World Health Organization. Protecting, promoting, and supporting breastfeeding in facilities providing maternity and newborn services. https://www.who.int/publications/i/item/9789241550086. Published 2021.
28. Centers for Disease Control and Prevention. Maternity Practices in Infant Nutrition and Care. https://www.cdc.gov/breastfeeding/data/mpinc/index.htm. Published 2018.
29. McFadden A, Gavine A, Renfrew MJ, et al. Support for healthy breastfeeding mothers with healthy term babies. *Cochrane Database Syst Rev*. 2017;2(2):CD001141. doi:10.1002/14651858.CD001141.pub5.
30. Spatz DL, Froh EB. Human milk and breastfeeding outcomes in infants with myelomeningocele. *Adv Neonatal Care*. 2019;19:376–382. doi:10.1097/ANC.0000000000000653.
31. Spatz DL, Froh EB, Bartholomew D, et al. Lactation experience of mothers and feeding outcomes of infants with congenital diaphragmatic hernia. *Breastfeed Med*. 2019;14(5):320–324. doi:10.1089/bfm.2019.0011.
32. Centers for Disease Control and Prevention. Breastfeeding: Why do mothers stop breastfeeding early. https://www.cdc.gov/breastfeeding/data/facts.html. Updated August 3, 2022.
33. The US Department of Health and Human Services. Healthy People 2030 Increase the proportion of infants who are breastfed exclusively through age 6 months. https://health.gov/healthypeople/objectives-and-data/browse-objectives/infants/increase-proportion-infants-who-are-breastfed-exclusively-through-age-6-months-mich-15.
34. The US Department of Health and Human Services: Healthy People 2030. Increase the proportion of infants who are breastfed at 1 year—MICH-16. https://health.gov/healthypeople/objectives-and-data/browse-objectives/infants/increase-proportion-infants-who-are-breastfed-1-year-mich-16.

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