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Mapping the Milk: Integrating Donor Human Milk into Infant Nutrition Systems

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Mapping the Milk: Integrating Donor Human Milk into Infant Nutrition Systems

A Thesis Presented

by

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Abstract

Acknowledgements

Abstract

A human milk diet is an important part of the health and survival of all infants. A human milk diet is especially crucial for the most vulnerable preterm infants as it promotes a healthy gut and protects from Necrotizing Enterocolitis (NEC). However, many preterm infants are unable to consume their mother's own milk due to breastfeeding challenges resulting from early delivery. Therefore, nutritional supplementation is often necessary for preterm infants and donor human milk (DHM) is highly superior to baby formula. DHM in the United States is processed at the 29 not-for-profit Human Milk Banking Association of North America (HMBANA) milk banks. Milk banks play a key role in providing optimal nutrition to vulnerable babies all over the country. Currently, there is a lack of research on the use of and access to DHM. The current thesis proposes a data repository to identify disparities in the use and access of DHM and look for correlations in the data. There are predicted links between low breastfeeding rates at 6 months and low access to DHM, high early formula use and low use of DHM, and a correlation between low access and low use. The proposed data repository would allow the landscape of milk banking to be better understood, and would create room for policy change, government funding and public health reforms that work to further integrate DHM into part of infant nutrition and care.

<u>Acknowledgments</u>

I would like to thank my first reader Dr. Elise Ferree for her thoughtful support and guidance through my thesis, as well as her willingness to listen to my silly stories about milk. Additionally, I would like to thank Dr. Lars Schmitz for reading my thesis and for all the long runs over the years in Claremont. I also thank my mentors and colleagues at Northwest Mothers Milk Bank who introduced me to the world of human milk banking and gave me a newfound passion during my gap year. Finally, I dedicate this thesis to milk donors across the country. The generosity of milk donors saves the lives of our most vulnerable populations, and I am inspired by their spirit and donations of love.

Introduction

History of breastfeeding in the United States

The practice of infant breastfeeding in the United States has changed throughout the past century, and is influenced by economic and cultural factors. Economic factors may involve the necessity of working outside the home and cultural factors may include education surrounding breastfeeding (Eidelman et al, 2012). In the colonial era, it was common for mothers to breastfeed their babies for the first two years of life. However, the late 1800s saw a shift to primarily feeding babies with cow's milk due to a mothers' need to work outside the home (Salmon, 1994; Wolf, 2003). The shift to cow's milk and artificial food was coupled with a high infant death rate due to diarrhea in the early 1900's (Wolf, 2003). Public health reforms in the 1910's advocated for infant feeding with pasteurized cow's milk. In the 1920's physicians around the United States started to strongly promote breastfeeding's importance as well as putting public health funding into breastfeeding education (Wolf, 2003). While physicians continued to inform people of the positive health benefits of breastfeeding for both mothers and babies, breastfeeding hit an all-time low in the 1970's in the United States. With only 24% of infants being breastfed at all before leaving the hospital, physicians and public health experts were concerned. Breastfeeding rates seemed to rise and surge following the 1970's (Wolf, 2003). The importance of breastfeeding and health benefits to both mother and baby are continuing to be discovered, and public health reforms work to match these discoveries.

While breastfeeding rates are significantly higher today than in the 70's, public health experts continue to campaign for breastfeeding education (Ryan, 1997). In 2017, the United States national percentage of babies that were ever breastfed (engaged in at least one breastfeeding session) was 84.1%, while the breastfeeding rate at 6 months was 58.3% (CDC,

2017). However, breastfeeding rates and feeding practices in general vary significantly across regions of the United States. This variation is likely due to economic and cultural factors. Additionally, there are a number of correlates to low breastfeeding rates including lack of breastfeeding education, low income, and employment outside of the home (Calnen, 2007; Heck et al, 2006). With about 2/3 of all new mothers returning to work in the first year after giving birth, there are many challenges to breastfeeding. The issue of a standardized maternity leave and lack of nationwide policies in place that support breastfeeding in the workplace are both factors that likely lead to the large range of breastfeeding rates across the country. Additionally, the education behind the importance of breastfeeding also varies across the country.

While the importance of breastfeeding should be emphasized for all babies, the practice is especially important for preterm infants that are born at or before 37 weeks gestation (Eidelman et al, 2012). Despite the great value of breastfeeding for preterm infants, the rates are lower for this population than for full term babies (Nyqvist, 2008). It is predicted that lower incidence of breastfeeding in preterm infants is due to feeding challenges related to establishing and maintaining a milk supply, and the transition from tube feeding in the hospital to breastfeeding (Callen & Pinelli, 2005). Given the difficulties in feeding for preterm infants, it is often necessary to supplement the diets of these infants while in the hospital. Common methods of nutritional supplementation are baby formula and donor human milk (DHM). DHM is pasteurized breast milk that is processed outside of the hospital, and highly regarded as the superior nutrition supplementation strategy when compared with infant formula (Abrams et al, 2017; Eidelman et al, 2012). While DHM is the best option for a nutritional supplement, there is a lack of research on the use and access of DHM (Updegrove, 2013). The current proposed study

hopes to survey DHM use and access in a way that indicates disparities, and promotes policy and public health reforms that integrate DHM into newborn nutrition and care.

Importance of a human milk diet

A human milk diet is important for the health and survival of all babies, especially for vulnerable and preterm infants. The American Academy of Pediatrics recommends that all preterm infants receive human milk over formula supplementation. Premature infants make up the largest and most vital group of donor milk recipients, because their own mother's milk is often not available in sufficient quantities (Abrams et al, 2017; Haiden & Ziegler, 2016). It has been shown that receiving human milk for vulnerable infants is incredibly important for preventing Necrotizing Enterocolitis (NEC) (Richard, 2017). NEC is a disease of an infant's intestinal tissue which can lead to bloodstream infections. NEC can make the infant unable to properly feed and move food through the digestive tract (NIH, 2022). Premature infants are especially at risk for NEC because of the immaturity of their immune and digestive systems.

Human milk can be helpful to a preterm infant by enhancing intestinal motility, lowering gastric acidity and epithelial permeability and changing the composition of bacterial flora. Additionally, human milk provides bacteria that prevents pathogen adhesion and allows for gut colonization of beneficial microbes (Lyons et al, 2020). Human milk can be considered as having its own microbiome, which makes important probiotics for infant development (Lyons et al, 2020). Nutritional supplementation through formula does not provide the same benefits and protection against NEC. Infants who are fed over 50% of their own mother's milk in the first 2 weeks after birth are significantly less likely to suffer from NEC (Richard, 2017). When a mother's own milk is not available, DHM can be used as an alternative over formula. Declining rates of NEC can be linked to increasing use of DHM (Kantorowska et al, 2016). Due to the huge

benefits of supplementing with DHM, the use and access of DHM should be studied to promote the health of the most vulnerable infants.

Human milk banking and HMBANA

Donor human milk use is increasing in the United States with the growth of the Human Milk Banking Association of North America (HMBANA). Milk banks are the largest and safest providers of human donor milk (Haiden & Ziegler, 2016; Abrams et al, 2017; HMBANA, 2022). There are 29 not-for-profit HMBANA milk banks in the United States and two in Canada. The United States milk banks are shown on a map in figure 1.
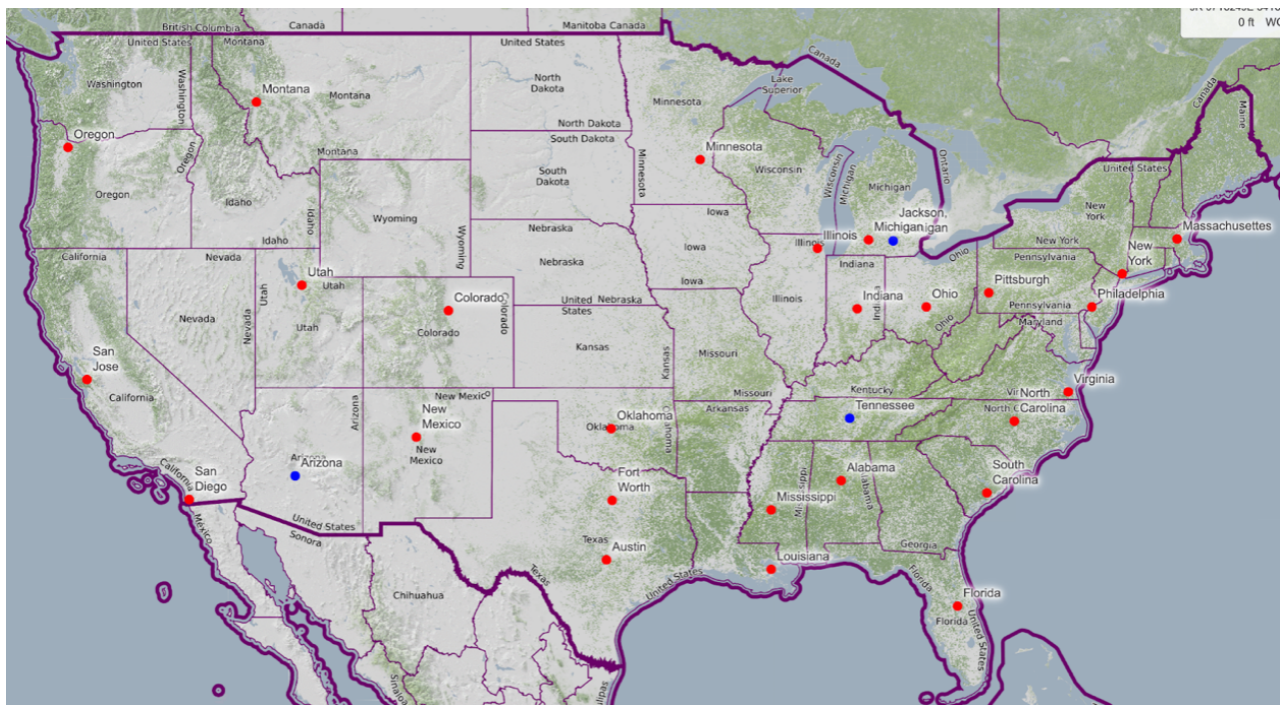

Figure 1. A map of the 29 not-for-profit HMBANA milk banks. The fully established milk banks are shown in red while the developing milk banks are shown in blue. This map does not show any milk banks that may be in the planning phase. Source: caltopo, HMBANA

All HMBANA milk banks are modeled after receiving milk from mothers who have an oversupply of milk for no payment or compensation other than the knowledge their donation is going to help babies in need. Donors are recruited through a variety of channels depending on the milk bank (HMBANA, 2022). Some milk banks provide written information to be left in general practitioners offices, hospitals to be shown to mothers during perinatal periods, volunteer and other organizations working in public health, and stores for new mothers and babies. Donors can also be found through direct referrals from other donors, staff in NICUs, pediatricians, childbirth educators, organizers or attendees of pre and/ or postnatal classes, breastfeeding mothers' groups, and organizations including La Leche League or the National Childbirth Trust. Some milk banks also recruit donors through marketing strategies such as placing advertisements in newspapers, newsletters, magazine articles, TV and radio ads (NICE, 2010). The method and necessity for recruitment of donors depends on a milk banks' need for raw milk. Additionally, the breastfeeding rates in any given region likely affects the need to actively recruit donors.

HMBANA milk banks are dedicated to providing safe, pasteurized breast milk to feed low birth weight and other at-risk infants whose mothers cannot produce an adequate supply. All donors go through a thorough health screening to meet the HMBANA donor criteria, and are given cleanliness guidelines for pumping. The screening process for milk donors is established by HMBANA, the U.S. Food and Drug Administration and the U.S. Centers for Disease Control and Prevention and is more stringent than blood donation standards (CHOP, 2014; HMBANA, 2022). Human milk donors are screened for HIV-1, HIV-2, human T-cell leukemia virus 1&2, hepatitis B, hepatitis C, and syphilis through a blood test. Donors use a mechanical breast pump or hand expression to acquire milk, and then freeze it to be shipped to a milk bank or dropped off at a milk drop site (Haiden & Ziegler, 2016; HMBANA, 2022). The extensive process of

screening for donors necessitates a certain level of breastfeeding knowledge, as well as having enough time to pump extra milk to donate.

Most milk banks pool milk from multiple donors to achieve an even distribution of calories and protein. Donor milk is heat treated through pasteurization. Pasteurization has been found to eliminate harmful bacteria and viruses such as *Escheria coli, Staphylococcus aurous,* and *Salmonella spp* from the milk (Moro et al, 2019). Additionally, the most important nutritional benefits of human milk survive the process of pasteurization. Specifically, bioactive milk components including oligosaccharides, lactose, glucose, gangliosides, vitamins A, D, E, and B12, folic acid, and some growth factors are preserved (Moro et al, 2019). These biological components are especially important in protecting the preterm infant from NEC (Arslanoglu et al, 2013). Additional testing is performed following pasteurization to ensure there are no bacteria present in the milk (Haiden & Ziegler, 2016; Abrams et al, 2017). The process of pasteurization works to ensure that milk is both bacteria and virus free while maintaining the huge nutritional benefits of human milk.

Methods of pasteurization vary across milk banks but the most common method across HMBANA banks is holder pasteurization (Haiden & Ziegler, 2016). Holder pasteurization places bottles of refrigerated pooled milk into a shaking water bath, and brings the milk up to a temperature between 62.5 c and 64.5 c, holding the bottles in that temperature range for 30 minutes. The milk is then rapidly cooled down to be labeled and then frozen before being shipped out. This method of holder pasteurization is generally found to be an acceptable balance of maintaining the nutritional quality and safety of the milk. Some milk banks have more advanced methods of pasteurization that potentially lead to less nutrient loss and are more efficient (Haiden & Ziegler, 2016). For example, some milk banks have used high pressure

automatic milk pasteurizers. However, technology on these pasteurizers is still being developed. Most milk banks are able to hold frozen, processed milk for one year after the pump date.

Most milk from HMBANA milk banks are sent to hospitals in the region of the bank to be used in neonatal intensive care units (NICUs). DHM in NICUs is ordered to supplement preterm infants who are unable to get sufficient nutrition from their own mother's milk (Abrams et al, 2017; HMBANA, 2022). If milk banks have enough milk to fulfill the orders of their hospitals, they will be able to sell milk to outpatients. Outpatient families can apply to purchase milk if they do not have a way to supply their baby their own mother's milk.

Part of HMBANA's mission focuses on identifying appropriate use of and access to donor milk. However, with no data repository on where all of the milk is going, there are no concrete ways to identify disparities in access to donor milk. Table 1 below shows the most recent version (2015) of the HMBANA bylaws section 2 which is relevant to understanding the purpose of the organization.

Table 1: Section 2 of the 2015 HMBANA bylaws outlines the purpose "to create a coalition of donor human milk banks and others interested in supporting not-for-profit donor human milk banking in North America and to provide a forum for":

1. Supporting the practice of providing a safe, accessible source of human milk for those who need it;
2. developing and maintaining donor human milk banking standards;
3. fostering development of scientific research which supports and facilitates donor human milk banking;
4. fostering development of scientific research which supports the use of screened donor human milk in clinical situations where it is indicated;
5. functioning as a clearinghouse for information about the availability, benefits and appropriate uses of human milk on a regional, national, and North American continental level;
6. acting as a liaison between member institutions and governmental regulatory agencies;
7. fostering optimal public health by promoting, protecting and supporting breastfeeding for families and infants.

While it is known that DHM is an important part of providing care to babies across the country when mothers own milk is not available, there is a lack of data and research on the use and access of DHM (Brownell et al, 2014; Updegrove, 2013). Because DHM is such a vital resource, the current proposed study hopes to survey the use and access of DHM in the United States. This survey will allow disparities in access to DHM to come to the surface and call for an adjustment in the landscape of HMBANA to ensure that all vulnerable babies can experience the benefits of DHM. Specifically, development of HMBANA milk banks and donor outreach

should be increased in areas of the country that are found to have lower levels of use and access to DHM. The current research shows that each HMBANA milk bank collects data on the DHM it collects and sells, but there is not yet a centralized data repository. The Food and Drug Administration detailed a need for a centralized data repository for HMBANA milk banks in 2010, but no such system has been created at this point (Updegrove, 2013) . HMBANA sets standards for its member milk banks, facilitates the formation of new banks, and advocates for breastfeeding, appropriate use of donor milk, research on donor milk and movements that will increase access to donor milk (HMBANA, 2022). To best enforce movements to increase access to DHM, it is important that HMBANA have a centralized data system to identify gaps in access.

The current grant proposal hopes to pool data from the CDC Maternity Practices in Infant Nutrition and Care (mPINC) survey as well as collecting data from each individual HMBANA milk bank to create a data system that will identify disparities in access and use of human donor milk. The CDC mPINC survey looks at the breastfeeding rates and feeding practices throughout the country. The proposed data repository would identify any links between breastfeeding rates and use of DHM.

Current breastfeeding rates

Breastfeeding rates and culture surrounding infant feeding vary around the country (Eidelman et al, 2012). Breastfeeding rates in any given region likely affect the amount of people who donate their surplus milk and the culture surrounding milk donation and donor milk. Every two years, the CDC comes out with a Breastfeeding Report Card in the United States. The report is generated from the results of CDC's national mPINC survey which assesses maternity care practices that affect how babies are fed. Some of these practices include policies affecting newborn feeding, feeding education and support, staff skills, and discharge support. The

American Academy of Pediatrics recommends infants are exclusively breastfed for about the first 6 months of life with continued breastfeeding while introducing complementary foods for at least 1 year (Eidelman et al, 2012; Abrams et al, 2017; CDC, 2021). However, breastfeeding gets significantly harder if the mother has to return to work in the first year after giving birth.

The most recent data on breastfeeding rates that has been released from the CDC is from 2017. Breastfeeding rates for the infants born in 2017 come from the US National Immunization Surveys (NIS) 2018 and 2019. In the United States, 84.1% of infants started breastfeeding, but only 58.3% of infants were still breastfeeding at 6 months. Looking at the breastfeeding rates for 6 months is important in determining the likelihood for a person to become a milk donor, because based on HMBANA donor screening standards, a person would need to have a significant surplus of pumped milk to be able to become a donor (HMBANA, 2022). Additionally, 19.2% of infants were supplemented with formula before 2 days of age. This rate of early formula use has gone up over 2% from 2016 (CDC, 2021). If available, DHM would be an excellent alternative during the first week of life as opposed to a hospital offering a new baby formula.

When considering breastfeeding rates through the lens of milk banking and human milk donors, looking at the rate of breastfeeding at 6 months can be an important gauge (Fig 2). Based on Figure 2, the states with the lowest rates of breastfeeding at 6 months are Alabama (38.5%), Mississippi (38.6%), and Louisiana (41%)(CDC, 2021). It is expected that the states with the lowest breastfeeding rates will have lower rates of donation to milk banks. Rates of milk donation also depend on the general knowledge of milk banking in a specific region. The general knowledge could hinge on if a state has a milk bank and how well advertised the process of milk donation is.

Additionally, the rate of infants that were supplemented with formula before 2 days of age is also relevant. Sometimes it takes some time for mother's milk to come in, and thus nutritional supplementation is necessary. Based on APA guidelines and considering the background earlier discussed on the massive benefits of an exclusive human milk diet in early life, DHM would be a great alternative in cases where one's own mother's milk is not available. The rates of early formula use throughout the country will be important in determining what areas need to increase the access to or use of DHM. Based on figure 3, the states with the highest formula supplementation before 2 days of age were Illinois (26.2%), Arizona (24.9%), and New York (24.9%)(CDC, 2021). It is expected that the states with higher rates of early formula supplementation use have lower rates of using DHM.
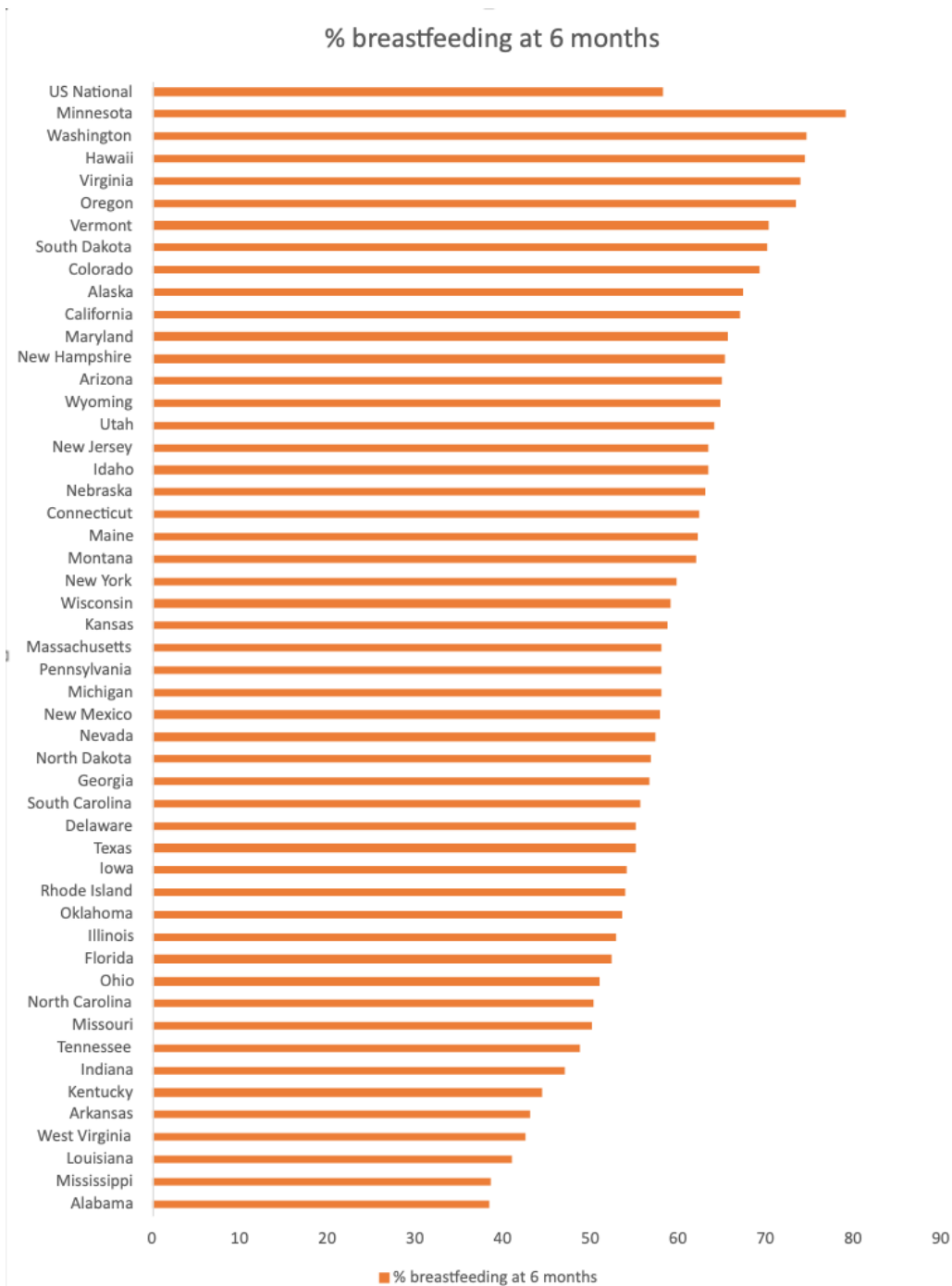
% breastfeeding at 6 months

Figure 2. A representation of the rate of breastfeeding at 6 months in all 50 states. This data was

gathered from the CDC National Immunization Survey (NIS) 2018-2019 among 2017 births.
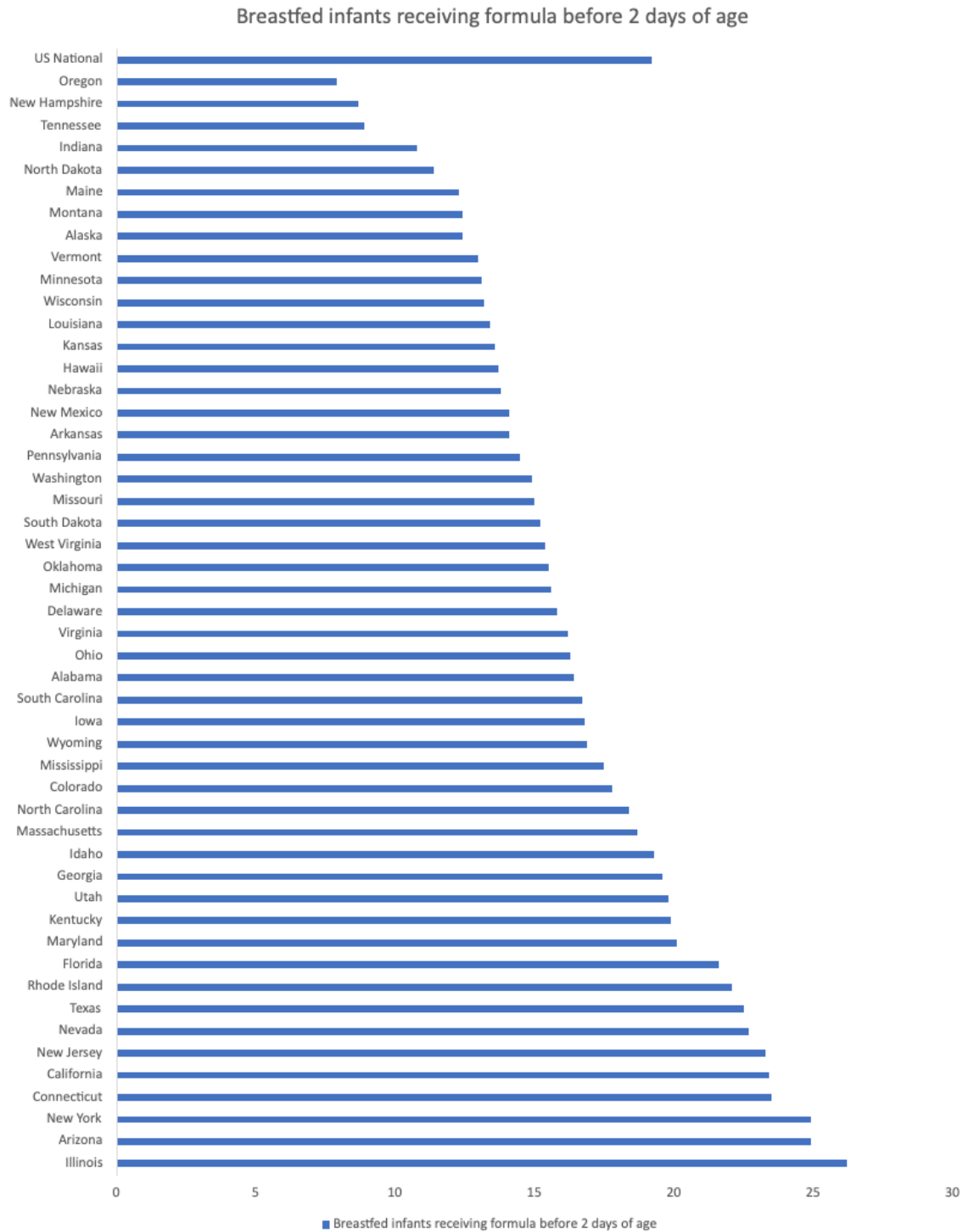
Figure 3. A representation of the rate of infants receiving formula before the first 2 days of life, calculated among breastfed infants. This data was gathered from the CDC National Immunization Survey (NIS) 2018-2019 among 2017 births.

It is the goal of the proposed data repository to determine what states fall short in both the use and access to DHM. Data from HMBANA milk banks will be collected and synthesized to determine the access to DHM. Based on Figure 2, it can be predicted that the states that have lower rates of breastfeeding at 6 months will also have lower rates of milk donors, and therefore less access to DHM for babies in need. Data from the CDC's Maternity Practices in Infant Nutrition and Care Survey (mPINC) survey will be used to determine use of DHM in hospitals. Based on Figure 3, it can be predicted that states that have higher rates of early formula supplementation have lower rates of use of DHM supplementation in hospitals. Creating this data repository to determine the disparities in access to and use of DHM would be useful in understanding what regions need more funding, support, and education surrounding the benefits of DHM for the most vulnerable babies.

Proposed Methods

To acquire data and create a repository on both access to and use of human donor milk in hospitals across the United States, human milk can be surveyed from both the perspective of collection at milk banks and in hospital use. The current thesis proposes a data collection system on where milk is sent from all HMBANA milk banks, as well as pulling data from the CDC's Maternity Practices in Infant Nutrition and Care Survey (mPINC) on hospitals.

Use of DHM

The mPINC survey is conducted biannually by the CDC, inviting all eligible hospitals to complete the survey and assesses maternity care practices. Results of the survey can be used to provide feedback and encourage hospitals to make improvements and support breastfeeding. The CDC submits a report to every hospital to show specific areas where breastfeeding and infant

feeding support can be improved. States can also utilize mPINC data to make policy changes.

Report cards are made from mPINC data on a state and national level. There are two questions

on the most updated mPINC survey that have to do with the use of donor human milk (Fig 4).

Additionally, there are a variety of questions on the mPINC that assess formula use in hospitals

and overall supplementation outside of breastfeeding. This data will be used to calculate a use of

DHM score.

A:10) Among breastfed newborns who are supplemented and not in a special care nursery or

neonatal intensive care unit, how many receive donor human milk?

Not offered at our hospital	Few (0-19%)	Some (20-49%)	Many (50-79%)	Most (80% +)
☐	☐	☐	☐	☐

B:5) How many infants receive donor human milk at any time while cared for in your

hospital's SCN/ NICU?

	Not available	Few (0-19%)	Some (20-49%)	Many (50-79%)	Most (80% +)
Infants < 1500 grams	☐	☐	☐	☐	☐
Infants ≥ 1500 grams	☐	☐	☐	☐	☐

Figure 4. The two questions that reference DHM use as presented in the mPINC survey. This

survey is completed by hospitals across the United States every other year. (CDC, 2021)

Use of DHM score

With the data on DHM and formula use from the mPINC survey, a USE* of DHM score

will be calculated. USE* will equal the amount of DHM infants received in the hospital divided

by the total amount of supplementation received in the hospital (adding DHM and formula

together). A use score closer to 1 would indicate a high level of use of DHM, while a use score

closer to 0 would indicate a low use of DHM in comparison to formula supplementation.

Access to DHM

To look at the milk bank's point of view, data would be collected from each HMBANA milk bank in the United States. The survey in table 2 would be given to the shipping coordinator and donor coordinator or other appropriate employee at each milk bank through an interview format.

Table 2. This is the proposed survey to be given to shipping coordinators at all HMBANA milk banks. It would gather information each year on milk orders received and fulfilled, as well as donors.

	Milk Bank: _____ **State:**_____ **Date of interview:**_____ **Employee name:**_____ **Employee position:**_____	**#**
1)	How many milk donors total donated milk this year? How many new donors were screened this year?	
2)	What is the number of ounces of raw milk intake this year?	
3)	What is the number of ounces of milk sold total for this year?	
4)	What is the number of ounces sold to another milk bank?	
5)	What is the number of ounces of milk ordered from any hospital in the state of the milk bank?	
6)	What is the total number of ounces of milk that was fulfilled through hospital orders in the home state?	
7)	What is the total number of ounces sold to any hospital in a state outside the milk bank's home state?	
8)	What is the total number of ounces of milk that was fulfilled through hospital orders outside of the home state?	
9)	What is the number of ounces that were ordered by a hospital or outpatient that weren't able to be fulfilled by the milk bank OR the milk bank had to purchase from another milk bank?	

Access to DHM score

One of the products of the data repository would be an ACCESS* score for each milk bank. The results of the interview style survey (Table 2) could be used to calculate an access score for DHM both in state and out of state for each milk bank. For the in-state access score, the reported response to question 6 would be divided by question 5. For the out of state access score, the reported response to question 8 would be divided by question 7. A score closer to 1 for either category would indicate a higher level of access to DHM. The access scores could be used to indicate what state's milk banks struggle more to fulfill the needs of the hospitals they serve, and use this information to support these milk banks through more funding and development to meet these needs.

Studying the data for correlations

The data repository would be built using the data collected from the CDC's mPINC survey and Breastfeeding Report Card, as well as the HMBANA survey. The goal of the repository would be to rank the states that have less access to DHM from a HMBANA perspective, and the states who are on average using less DHM in hospitals. The repository would also be used to look for correlations between breastfeeding rates and early formula use and the access to and use of DHM (Figure 5). It should be determined if states are using formula over DHM in hospitals because there is a lack of access to DHM from their local milk bank, or if the hospital is failing to order it. In other words, does low access to DHM correlate with low use of DHM?
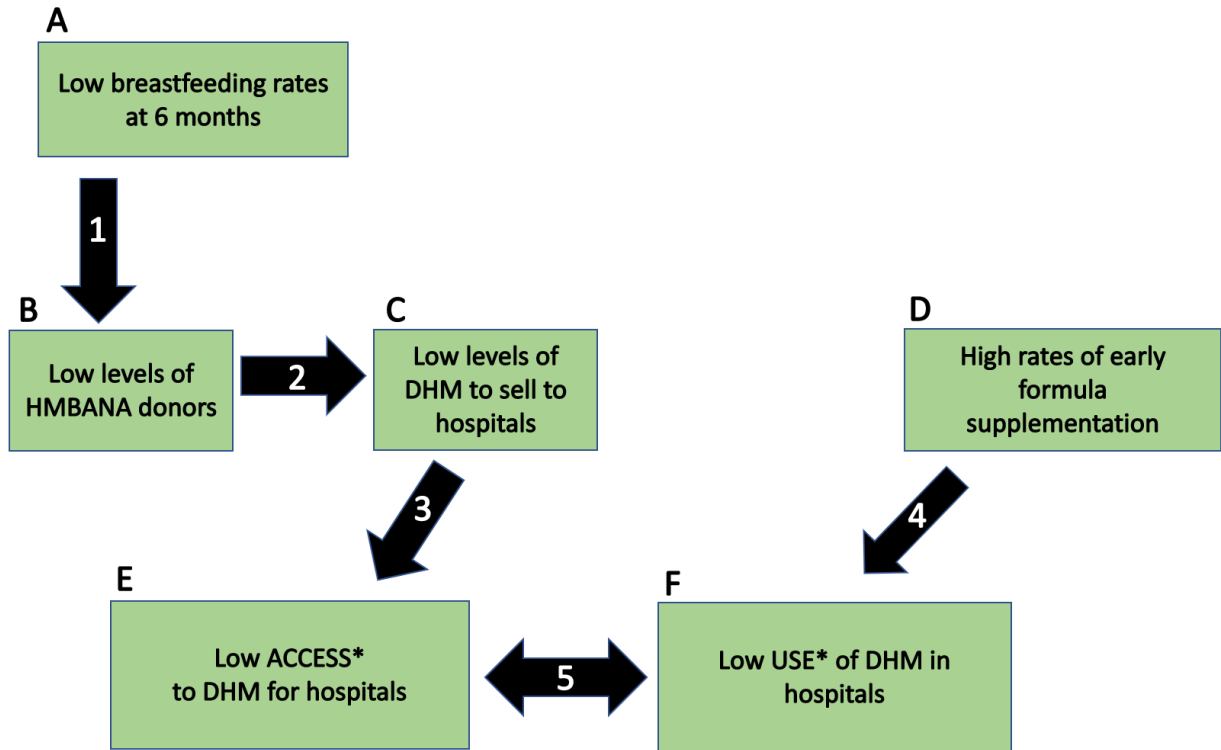
Figure 5. This shows a flowchart of the data and possible correlations of interest for the data repository. Numbers 1-5 on the chart are predicted correlations between factors that could be seen in the data repository. One shows a predicted link between a low breastfeeding rate at 6 months and low levels of HMBANA donors. Two shows a predicted link between low levels of HMBANA donors and low levels of DHM to sell to hospitals. Three shows a predicted link between low levels of HMBANA donors and low levels of DHM to sell to hospitals and low access to DHM for hospitals. Four shows a predicted link between high rates of early formula supplementation and low use of DHM in hospitals. Five shows a predicted link between low access to DHM in hospitals and low use of DHM in hospitals.

Data to synthesize for correlations

All of the boxes in Figure 5 indicate groups of data that will be collected and synthesized in the repository and tested for the above correlations. The data for A will be collected from the CDC's data as represented in Figure 2. The data for B and C will be collected from the interviews with HMBANA milk banks as presented in Table 2. The data for D will be collected from the CDC's data as represented in Figure 3. The data for E would be synthesized from the information collected in interviews with HMBANA milk banks as represented in Table 2. The data for F would be collected from the two questions about DHM in the CDC's mPINC survey as sent to hospitals shown in Figure 4.

Expected Results

The proposed data repository is intended to identify states with low access to and use of DHM, look for correlations between breastfeeding rates and early formula use, and ultimately create a plan to further the use and access of DHM in regions that are lacking. Figure 5 shows the predicted links for the factors that may affect the use and access of DHM in different states.

Access to DHM

It is predicted that lower breastfeeding rates at 6 months will lead to fewer HMBANA donors and therefore less raw milk for the milk banks to process and sell to hospitals. Considering the ACCESS* scoring system outlined in the methods section, it is also predicted that states with lower breastfeeding rates at 6 months will have lower access scores. By gathering data on milk volumes processed from the HMBANA milk banks through an interview method as represented in Table 2, the data repository will be able to determine which states have less access to DHM. It is predicted there will be a correlation of states with lower breastfeeding rates at 6

months and less access to DHM in hospitals in that state. If this were correct and shown in the data repository, the states at the bottom of Figure 2 with the lowest breastfeeding rates such as Alabama (38.5%), Mississippi (38.6%), and Louisiana (41%) would have the lowest access to DHM in hospitals. While all states could likely work to improve access to DHM as a vital resource to the most vulnerable babies, information from the proposed data repository would be used to support the states that struggle the most with access to DHM.

While the current study proposes a fairly simple correlation of lower breastfeeding rates at 6 months to less access to DHM, the results of the data repository may show a more complicated picture. For example, the presence of a milk bank in a given state could reflect the level of access to DHM. Some states have more than one milk bank and some states have no milk bank (Figure 1). Hospitals in states without a milk bank buy milk from a bank in neighboring states. Additionally, donors are able to donate to their nearest HMBANA milk bank if there is not a milk bank in the state they live in. HMBANA milk banks have milk drop locations throughout the region they are in and in neighboring states, and also have options for donors to overnight ship them milk at no cost. However, it is possible that even though there are high breastfeeding rates in a region, there are still very few people choosing to donate milk if there is not a nearby milk bank simply because of a geographic barrier to donation.

Additionally, the level of marketing for the process of milk donation by a given milk bank also likely affects the number of recruited donors and therefore the access to DHM in a given state. For example, if there was a very high breastfeeding rate in a state, but the knowledge of milk banking was small through lack of marketing to potential donors, there could still be low ACCESS* to DHM. Some HMBANA milk banks have budgets for recruiting donors, and others rely on word of mouth and memos in physicians' offices to find donors. In some states, such as

Oregon, the milk bank has not needed to spend any money on donor marketing and recruitment. The director of Northwest Mothers Milk Bank in Oregon credits the surplus of raw milk donated with little to no budget for marketing to the "positive breastfeeding culture in the Pacific Northwest" (NWMMB, 2022). However, the need for DHM is continuing to grow in 2022, and many HMBANA milk banks that have previously not had a budget for donor recruitment are starting to work harder to find more donors to keep up with growing needs for DHM.

While the data repository will look for the predicted link between low breastfeeding rates and low access to DHM, the level of access to DHM is likely complicated by the factors described above. Future studies should look into these factors to understand how to best support milk banks and provide the best access to the most vulnerable babies across the country.

Use of DHM

It is predicted that states with high early formula use (Figure 3) can be linked to low USE* of DHM in hospitals in that state. While nutritional supplementation in the hospital is likely to be necessary at similar rates due to mothers' milk taking a while to come in or babies needing supplementation in the neonatal intensive care unit (NICU), supplementation strategies may vary across states when considering formula or DHM. As shown in figure 3, the states with the highest rates of formula supplementation before 2 days are Illinois (26.2%), Arizona (24.9%), and New York (24.9%). If the correlation between high early formula rate and low use of DHM in hospitals is true, then these states and the following states that show the highest rates on Figure 3 should receive the most focus for public health measures to increase the use of DHM in hospitals.

In a similar nature to the access question of DHM, the proposed correlation of high early formula use and low use of DHM in hospitals could be more complicated. It is possible that

while a certain state uses more formula supplementation in the first 2 days, they use more DHM following the first two days. However, it has been shown that the first days of life are the most important time for babies to consume human milk (HMBANA, 2022), and thus early formula supplementation should be replaced with DHM whenever possible.

t is possible that in some states, there is little need for supplementation due to high early breastfeeding rates Of course, breastfeeding and consuming one's own mother's milk is the best early nutrition for babies without complications (Haiden & Ziegler, 2016; HMBANA 2022). If breastfeeding alone can cover an infant's nutrition, and DHM is not needed, that is the best-case scenario.

Correlation between use and access to DHM

As shown in Figure 5, the current study shows a predicted link in the data repository for low level of ACCESS* to DHM and low levels of USE* of DHM. However, it is possible that this link is not as simple as predicted. A state could have a very high level of access to DHM with large amounts of processed milk produced at a milk bank, but a low level of use if hospitals are not ordering and using the DHM. It is possible that states with high access to DHM are selling the milk to hospitals in other states that have higher levels of use. Looking for possible correlations between access and use is an important process to understand how to best support measures that increase both factors.

Discussion and Recommendations

       It is predicted that breastfeeding rates affect the access to DHM in a region. It is also predicted that use of formula in a hospital affects the use of DHM in that region and that the access to and use of DHM are directly correlated. The proposed data repository could be used to assess these predictions, as well as to identify states that need the most support on a public health level to work to increase the access and use of DHM in hospitals.

       The information garnered from the proposed repository could be used to promote investment by the government to promote, protect, and support breastfeeding, as well as supporting the human milk bank system, especially in areas of the country that score lower in access and use to DHM. To best support the most vulnerable infants, human milk banking should become an integrated component of breastfeeding support and early feeding and newborn care. Figure 6 outlines the ways that the government can engage to integrate human milk banking and promote a human milk diet. The federal government should put extra funding towards states who have low USE* and ACCESS* of DHM scores to support efforts to increase the integration of DHM into infant nutrition in these states. This funding should go towards the HMBANA milk banks in these states or the development of new milk banks in regions without them. In addition, federal government funding should be issued to support breastfeeding education in states that see low breastfeeding rates. Policy on a state and federal level should support breastfeeding in the workplace, as well as emphasize breastfeeding education in regions with low breastfeeding rates.
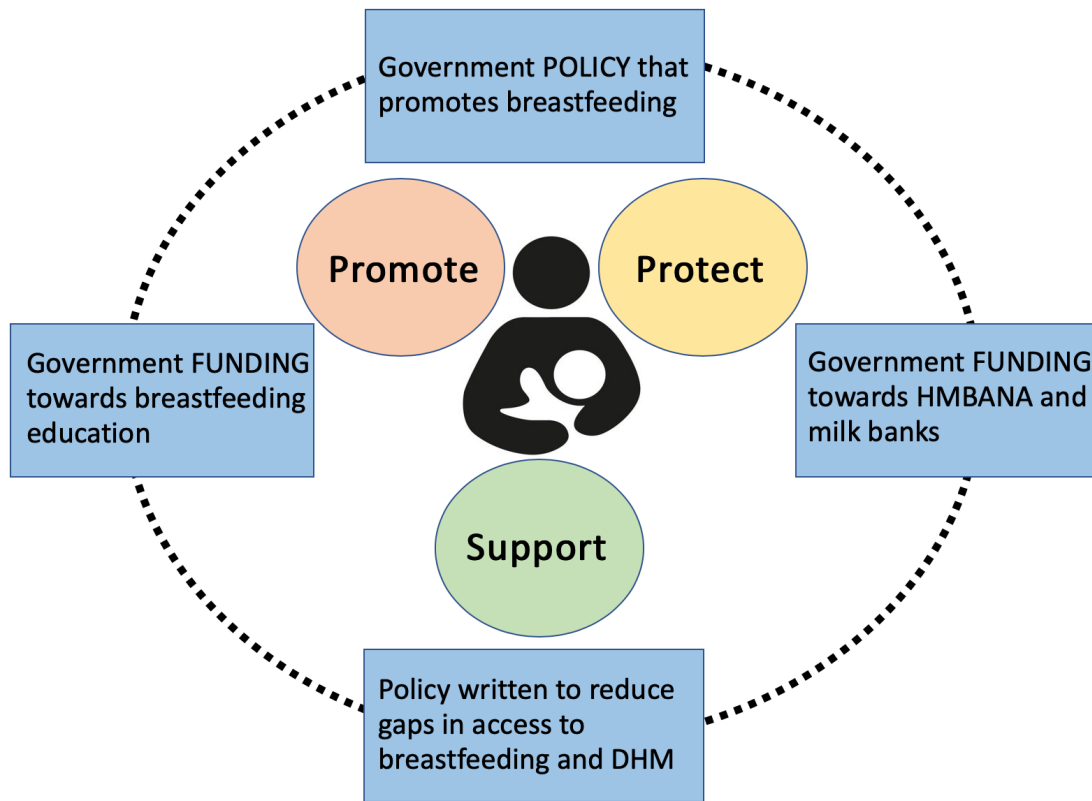
Figure 6: Goal outcomes of measures following proposed data repository. The government should work on both a state and national level to establish policies and fund efforts that promote, protect, and support a human milk diet for infants whenever possible.

The proposed data repository will identify regions of the country that have the lowest levels of use and access to DHM, as well as any possible correlations between DHM use and access, breastfeeding rates and early formula use. As Figure 6 outlines, the promotion, protection, and support of a human milk diet for all infants should be a strong governmental commitment. The data repository will allow the government to focus funding on specific regions of the country that need the most support. Policies that promote breastfeeding should involve hospital level policies that indicate considerable lactation support, as well as workplace policies that allow mothers to feed or pump at work. Additionally, government funding for breastfeeding

education and the creation of a positive culture surrounding breastfeeding through lactation rooms in public places would promote a human milk diet. Considering the data, additional government funding should be used to support the work of the not-for-profit HMBANA milk banks, especially the milk banks in the regions of the country that score the lowest for ACCESS* and USE* of DHM. Additionally, there should be governmental support to form new milk banks in low scoring regions without a bank. Finally, there should be policies in place to address gaps in breastfeeding and access to donor human milk. In the region of the country with the lowest breastfeeding rates and access to DHM, there should be additional efforts to support the growth of a human milk diet for infants.

The importance of a human milk diet for the health and survival of babies, especially when born preterm, is well understood and supported and supported by healthcare providers, physicians and public health experts (Hair et al, 2018; Underwood, 2013). However, the place of milk banks and DHM in the picture of ideal infant nutrition should be better understood and supported. The proposed data repository would be an important resource in identifying gaps in the use and access of DHM, and would allow for an understanding of how to grow the landscape of milk banking to increase the access of a human milk diet for all infants.

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