

GUTIERREZ DOS SANTOS, BRUNA. Ph.D. Exploring the Demographic, Clinical, and Behavioral Attributes of Approved Milk Bank Donors in the United States and United Kingdom. (2023) Directed by Dr. Maryanne T. Perrin. 101 pp.

The World Health Organization and the American Academy of Pediatrics support that low and very-low-birth-weight infants receive pasteurized donor human milk (DHM) from established milk banks when there is limited or no access to mother's own milk. It is estimated that over 60 countries have operating milk banks, totalizing over 700 milk banks around the world and consequently, more than 800,000 infants receiving DHM annually. Although human milk banking continues to grow around the world, information about the individuals who donate their milk is limited. It is important to note that different milk banking models may have differing influences on donors. For example, the Human Milk Banking Association of North America (HMBANA) is a non-profit organization that currently has 31-member milk banks. In 2021, they had 13,000 donors and dispensed over 9 million ounces of milk. While the main focus of this research was the United States (US), we have included the United Kingdom (UK), another high-income geography, as a comparison for our study. The United Kingdom Association for Milk Banking (UKAMB) is also a non-profit organization and currently has 15 milk bank members.

In aim 1, we described and compared milk bank donors' demographic, clinical and lifestyle characteristics, and breastfeeding experiences in the US and UK. Donors were predominantly in their early 30s, White, married, educated, and identified as female. Donors from the UK were more frequently on maternity leave than donors from the US (32.6% vs 5.4%, $p < 0.001$). Moreover, more donors in the US reported pumping several times a day compared to donors in the UK (57% vs 36%, $p < 0.001$). Donors in the UK reported a longer average duration of breastfeeding a single child (21.2 vs. 13.3 months, $p < 0.001$) and lifetime milk production

(30.9 vs. 19.4 months, $p < 0.001$) compared to donors in the US. The most common primary reason reported for pumping milk among US donors was returning to work (34% vs 11%, $p < 0.001$ in the UK). While in the UK, the most common primary reason reported was related to breastfeeding difficulties (e.g., latching issues, sick infant) (45/187, 24.0%). Donors in both settings received information/assistance from more sources related to breastfeeding than to pumping (US – 2.8 vs 2.0 sources, UK – 2.8 vs 1.8 sources).

In aim 2, we described and compare enablers, barriers, and patterns of donation among milk bank donors in the US and UK. Donors in the US donated on average a higher lifetime volume of milk than UK donors (1126 vs 966 fl. oz, $p = 0.002$). Donors in both settings often reported participating in other forms of milk exchange including peer-to-peer milk sharing (51% of US donors and 39% of UK donors). The average number of information sources donors received about milk banks was relatively small in the US and UK (1.3 vs 1.2 sources, $p = 0.096$), where the most common source of information about milk banks was the internet/social media (US: 63% vs UK: 70%, $p = 0.112$), followed by information from healthcare providers (US: 41% vs UK: 30%, $p = 0.012$). The top reasons reported for donating were wanting to help others (UK 66%, US 51%) and having excess milk (UK 27%, US 43%) with statistical differences by geography ($p = 0.039$). In terms of donation barriers, 69-79% of donors reported encountering a barrier.

In aim 3, we identified factors that predict lifetime donation volume of milk bank donors in the US. Our backward elimination model started by considering 14 variables and resulted in a final six-factor model to predict lifetime milk bank donation volume of US donors ($R^2 = 0.327$). The significant predictors were: number of days since approved as a donor, number of milk types

donated (e.g., colostrum, mature milk), pumping frequency, milk sharing/selling practices, duration breastfeeding single child, and child's age at first donation.

In conclusion, we observed that US donors are less frequently on maternity leave than UK donors and they also started pumping breast milk earlier and more frequently. In addition, US donors donated more milk to milk banks and participated more frequently in peer-to-peer milk sharing. Both pumping frequency and milk sharing practices were identified as significant positive predictor variables of donation volumes in US donors. Factors that impact donation volume in other milk banking settings warrants further investigation.

EXPLORING THE DEMOGRAPHICS, CLINICAL AND BEHAVIORAL
ATTRIBUTES OF APPROVED MILK BANK DONORS IN THE
UNITED STATES AND UNITED KINGDOM

by

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CHAPTER I: INTRODUCTION

The World Health Organization (WHO) and the American Academy of Pediatrics support that low and very-low-birth-weight infants receive pasteurized donor human milk (DHM) from established milk banks when there is limited or no access to mother's own milk.^{1,2} The use of DHM in vulnerable infants has been shown to improve feeding tolerance, and decrease the risk of necrotizing enterocolitis (NEC) and infant mortality.^{3,4}

It is estimated that over 60 countries have operating milk banks, totalizing over 700 milk banks around the world⁵ and consequently, more than 800,000 infants receiving DHM annually.⁶ In 2021, the WHO issued a bulletin report about the need of developing milk banking global guidelines with the goal of establishing safe milk bank practices and targeting specific health needs of vulnerable infants.⁷ It is important to note that since there are no global guidelines for donor milk banking,^{7,8} different milk banking models may have differing influences on donors.

Individuals who have surplus milk are typically breastfeeding and expressing milk for their own infant, which results in extra milk. Women with surplus milk have options when it comes to what to do with their excess milk including: non-profit milk banks where donors are screened for diseases prior to donation and milk is pasteurized and tested for possible bacterial growth (referred to as donating)⁹; for-profit milk banks where donors are compensated for their donations and the milk is sold in bottles and as other human milk derived products, such as fortifiers (referred to as selling)¹⁰; and peer-to-peer milk sharing, where donors and recipients can connect in person and online and raw milk is exchanged without remuneration (referred to as sharing).^{11,12}

There is limited information about what influences an individual's decisions regarding whether they donate, sell, or share their excess breast milk, or whether individuals participate in multiple methods of human milk exchange. A recent study conducted in the US administered an online survey for individuals who participated in peer-to-peer milk sharing, with milk sharers (n=661) and milk recipients (n=206) and showed an overlap between milk sharers and milk donors, where 10% of milk sharers were also donating to a milk bank.¹³ Moreover, a small qualitative study in the United States of 27 peer-to-peer milk sharers (who had not donated to a milk bank) reported that most milk sharers did not receive information on milk exchange options and considerations from healthcare providers, suggesting a potential barrier to increasing donations to milk banks.¹⁴

Although human milk banking continues to grow around the world,^{15,16} information about the individuals who donate their milk is limited.¹⁷ The WHO report identified that motivations for donating human milk warrants further investigation.⁷ Obtaining more detailed information about the experiences and characteristics of milk bank donors will provide important insights regarding donor recruitment, allowing milk banks to strategically target new donors and address reported barriers for donation. Additionally, knowledge about milk bank donors may help inform the nutritional care of infants receiving donor human milk based on a better understanding of known donor attributes that influence milk composition (e.g., whether donors are predominantly term versus preterm, and donating early versus mature milk). Lactation is an energy-intensive biological process that may have maternal costs; therefore, it is important to gain a better understanding of the reasons that lactating women are pumping and amassing excess milk for donation. Long-term, this work will shed light on characteristics and experiences of milk bank

donors and contribute to a robust, global milk banking network that ensures donor human milk is available to the most vulnerable infants.

The focus of this research was divided into three specific aims. Aim 1: Describe and compare milk bank donors' demographic, clinical and lifestyle characteristics, and breastfeeding and pumping experiences in the US and UK; Aim 2: Describe and compare reasons, barriers, and patterns of donation among milk bank donors in the US and UK; Aim 3: Identify factors that predict lifetime donation volume in milk bank donors in the US.

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CHAPTER II: WHAT IS KNOWN ABOUT HUMAN MILK BANK DONORS AROUND THE WORLD: A SYSTEMATIC SCOPING REVIEW

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Introduction

The World Health Organization (WHO) recommends that low-birth-weight (LBW) infants receive donor human milk (DHM) when mother's own milk is not available due to evidence that it decrease the risk of necrotizing enterocolitis (NEC).^{1,2} Globally, DHM is typically produced by country-level milk banking networks that serve as a conduits between the recipient infants and the donors who provide the milk.³⁻⁵

Although the recommended recipient for DHM is primarily the preterm infant^{2,6}, a recent review reported that DHM is also being used in other populations including healthy term infants, and term infants with health risks. A 2020 report from a Virtual Communication Network of global milk banking leaders estimated that at least 800,000 infants receive DHM around the world annually.^{7,8}

To ensure the quality and safety of DHM, human milk banks use similar hazard analysis and critical control points, where protocols are used in every step of the process, from donors

screening until milk distribution.⁹ Holder pasteurization is the main processing technique used in milk banks, and although it inactivates virus such as HIV and cytomegalovirus, it also alters the milk composition.¹⁰ A recent review found over 40 studies that had evaluated the impact of Holder pasteurization on DHM, suggesting that this aspect of human milk banking has been well studied.¹⁰

While there are multiple reviews on DHM recipients and milk banking processes, the donors to milk banks have not been systematically studied. A recent report by the WHO noted that, “the motivations behind donating human milk remain under-researched”.¹¹ Other information about milk bank donors may provide important insights regarding donor recruitment and the nutritional care of infants receiving DHM. For example, a donor’s birth type (term vs preterm) and milk type (colostrum, transition, mature) would influence the composition of the milk being collected by the milk banks. Therefore, the aim of this review is to explore what is currently known about human milk bank donors globally and identify gaps for future research.

Methods

A systematic scoping review was conducted to investigate what is known about milk bank donors. The objective of a scoping review is to map and summarize the information available for a research topic and to identify gaps where more research is needed.¹² The Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used to guide this review. The databases used to identify original research articles were PubMed and Scopus. Search terms utilized for both databases included: “Milk bank*” AND “donors” NOT (composition OR pasteur* OR nutri*). Additional studies were located by hand-reviewing bibliographies of the studies identified through the primary search.

Original research articles about milk bank donors that were published before August 2020 were included in this review. Studies were excluded if they were: about donor milk composition and/or pasteurization only; about infant feeding practices and/or infant nutrition only; in languages that were not English; not original articles; or not about milk bank donors (e.g., peer-milk sharing only). Two researchers (BGS and MTP) independently evaluated all study titles, abstracts, and full papers for exclusion or inclusion criteria and differences were resolved after each review step by discussion.

Included studies were independently abstracted by two researchers (BGS and MTP) into a Microsoft Excel spreadsheet for the following information: study location, study design, study population, study objectives, data collection methods, outcome variables, results, and funding source. Studies that used multiple years of milk bank donor data were classified as semi-longitudinal study design since some donors may have appeared more than once in data that spanned several years. Abstracted data were reviewed by two researchers (BGS and MTP) and discrepancies were resolved by discussion. Data that were inconsistent/unclear and that could not be interpreted by the two reviewers were not reported.

To organize outcome variables, an iterative process was used by two researchers working together to develop and refine a classification system of main categories and sub-categories for study outcomes. Categories and sub-categories used to classify outcomes included: Donor Demographic (Demographics) which included Age, Marital Status, Race-Ethnicity, Education, and Employment Status; Donor Clinical Characteristics (Clinical) which included Birth History (e.g. number of children, parity, delivery term, NICU admissions), Diseases (e.g. donor health conditions), and Prenatal Care; Donor Lifestyle Characteristics (Lifestyle) which included Diet, Exercise, Legal Drug Use (e.g. nicotine, caffeine, and alcohol), and Illegal Drug Use; Lactation

and Breastfeeding Experience (Breastfeeding) which included Breastfeeding History (e.g. breastfeeding experience and problems), Clinical Support, Milk Expression Practices, and Beliefs About the Value Milk; Donor Experience and Beliefs (Experience/Beliefs) included Reasons/Enablers for Donation, Barriers for Donation and Donor Identity; Donation Patterns (Patterns) included Donation Volume, Donor Type (first-time or repeat), Milk Type (colostrum – 0-7 days, transition milk – 7-21 days, mature milk – over 21 days)¹³ and Donation Duration.

Results

A total of 181 studies were identified through Scopus, 84 through PubMed and 8 through hand review of bibliographies (Figure 1). After excluding duplicates (n=70), a total of 203 studies were screened. After a review of abstracts and titles, 154 articles were excluded leaving 49 articles for full text review. Twenty-one studies were excluded after full text review leaving 28 studies in this scoping review about human milk bank donors.¹⁴⁻⁴¹

Studies in this systematic review were published between 2003 and 2020 and included 2 to 4000 donors (Table 1). Eight studies were conducted in the United States (US), seven in Brazil, four in Spain, two in India, and individual studies were conducted in France, Norway, Poland, Italy, Taiwan, Korea, and China. A qualitative design was used in eight studies, which allows for rich exploration of the donors' lived experiences. Qualitative studies were predominantly conducted in the US and had a small sample size. Data collection methods used in the studies included interviews, questionnaires, chart reviews, and online content analysis. In most of the studies, donors were recruited from a single milk bank (n=16). The number of studies reporting outcome variable types included: Donor Demographics (n=19), Clinical Characteristics (n=20), Donor Experiences (n=16), Donation Patterns (n=16), Lifestyle Characteristics (n=4),

and Lactation/Breastfeeding History (n=8). Results by outcome category and sub-category are summarized in Tables 2-7.

Figure 1. Flow Diagram of the Literature Search Process Used to Identify Studies Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist

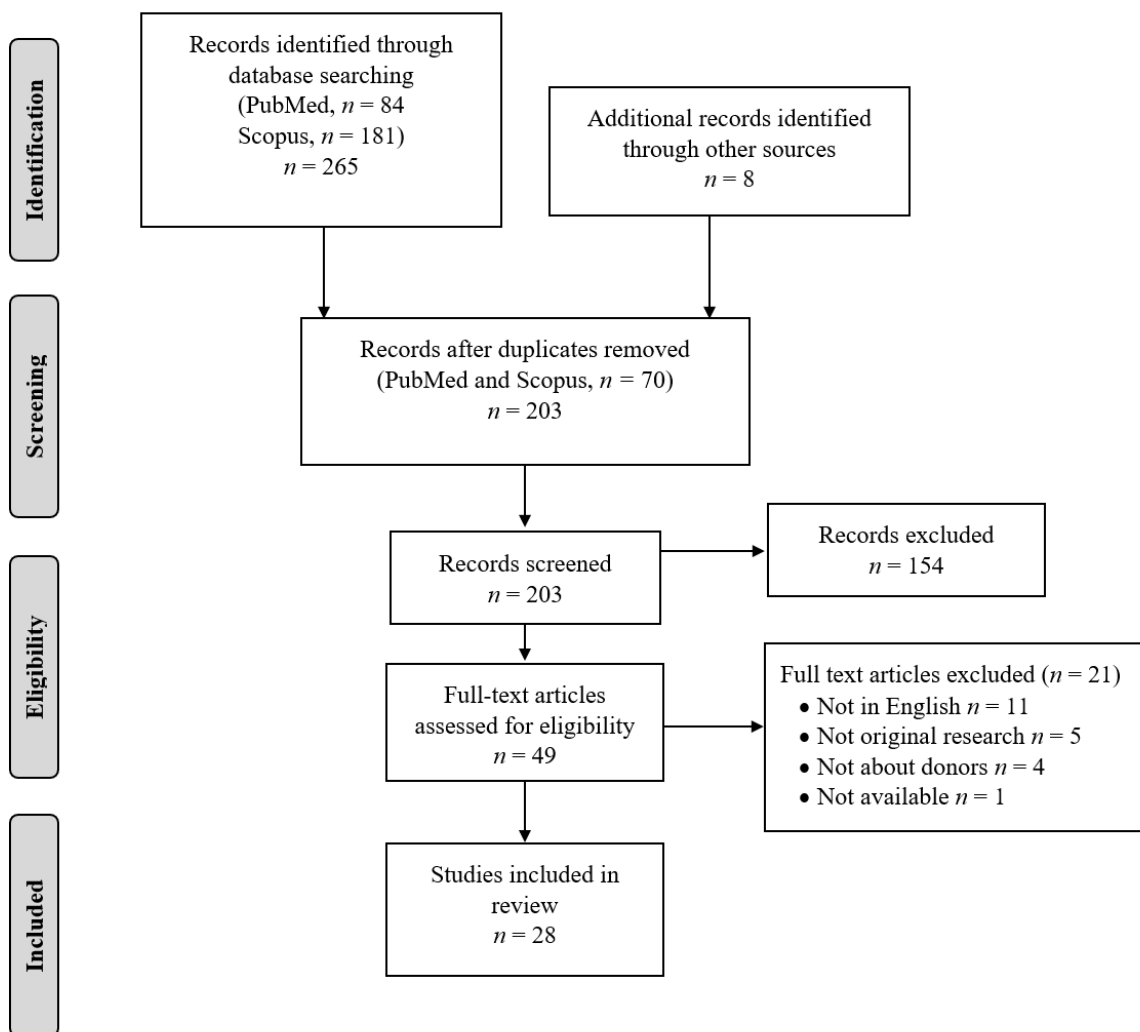


Table 1. Summary of Studies Included in the Systematic Scoping Review of Human Milk

Donors

Year	Author	Study Location	Study Objectives	Population Studied	Study Design	Data Collection Method	Funding Source
2003	Azema ¹⁴	France	Examine characteristics of donors and attitudes towards donation	Donors to eight milk banks	Cross-sectional	Questionnaire	Information not available
2004	Lindemann ¹⁵	Norway	Evaluate donor characteristics and donation patterns	Donors to a single milk bank in 2001	Not identified	Not identified	Information not available
2007	Osbaldiston ¹⁶	United States	Compare donors and nondonors characteristics, experiences, motives and barriers to donation, and the relationship between donation experience and amount of milk donated	Donors to a single milk bank and nondonor controls	Case-control	Telephone survey that included VFI, PANAS, scale questions; chart review	Information not available
2008	Thomaz ¹⁷	Brazil	Identify factors that influenced or motivated donations	Donors to three milk banks	Cross-sectional	Questionnaire	Information not available
2009	Alencar ¹⁸	Brazil	Describe the behavior, beliefs, and feelings behind the donations	Donors to two milk banks	Cross-sectional	Structured and semi-structured face-to-face interviews	Information not available
2010	Alencar ¹⁹	Brazil	Characterize the behavior of donation and formal/informal support	Donors to two milk banks	Cross-sectional	Chart review	Information not available
2010	Cohen ²⁰	United States	Estimate the seroprevalence of hepatitis B and C, syphilis, HTLV-1 and 2 and HIV	Potential donors to a single milk bank from 2000-2005	Semi-Longitudinal	Structured and semi-structured face-to-face interviews	Information not available
2010	Koyashiki ²¹	Brazil	Evaluate the degree of exposure to lead of donors	Donors to a single milk bank	Cross-sectional	Face-to-face interview, questionnaire, milk sample, blood sample	Information not available
2012	Welborn ²²	United States	Examine the role of milk donation in the grieving process	Bereaved donors to two milk banks	Qualitative, Phenomenological	Semi-structured face-to-face and web-based interviews	No funding obtained
2013	Chang ²³	Taiwan	Evaluate donor characteristics and donation patterns	Donors to a single milk bank from 2005-2010	Semi-Longitudinal	Face-to-face and telephone interviews	Information not available
2013	Pineau ²⁴	United States	Describe how intensive motherhood and	Donors to a single milk bank,	Qualitative	Chart Review	Information not available

			social class influence milk donations	including 16 middle/upper income and 3 WIC recipients			
2014	Escuder-Vieco ²⁵	Spain	Validate the health questionnaire with respect to the presence of illegal drugs, nicotine, and caffeine in donor milk	Donors to a single milk bank	Cross-sectional	Questionnaire and milk samples	Spanish Health Research Funding
2014	Sierra-Colomina ²⁶	Spain	Compare the donors social and demographic characteristics with the volume of milk donated	Donors to a single milk bank from 2009-2013	Semi-Longitudinal	Questionnaire and chart review	SAMID (Spanish Collaborative Maternal and Children and Development) Research Network
2015	Machado ²⁸	Spain	Describe experiences, beliefs, motivations, and difficulties of donations	Donors to a single milk bank	Qualitative Phenomenological	Semi-structured interviews	Information not available
2016	Escuder-Vieco ²⁷	Spain	Determine levels of illegal drugs, nicotine, and caffeine in hair and breast milk	Donors to a single milk bank	Cross-sectional	Questionnaire; Hair and milk samples	Spanish Health Research Funding
2016	Jang ²⁹	Korea	Evaluate donor characteristics and donation patterns	Donors to a single milk bank from 2008-2015	Semi-Longitudinal	Chart Review using standardize form	Information not available
2016	Miranda ³⁰	Brazil	Investigate milk donor's representations of the donation experience	Donors to a single milk bank	Qualitative	Semi-structured interview	Universidade Federal de Ouro Preto
2017	Barbarska ³¹	Poland	Evaluate donor characteristics and donation patterns	Donors to a single milk bank from 2015-2016	Semi-Longitudinal	Chart review	Information not available
2017	Kupek ³²	Brazil	Estimate the seroprevalence of HIV, syphilis, and hepatitis B	Prospective donors to a single milk bank from 2005-2015	Semi-Longitudinal	Chart Review	No funding obtained
2017	Meneses ³³	Brazil	Estimate prevalence and factors associated with donation	Donors to nine milk banks and nondonors control	Case-control	Structured interviews	Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro - FAPERJ
2018	Candelaria ³⁴	United States	Examine donors' experiences donating to milk banks	Donors with infants in the NICU	Qualitative Phenomenological	Questionnaire and Semi-structured face-to-face interviews	No funding obtained
2018	Cole ³⁵	United States	Examine milk donation in the context of perinatal palliative care	Bereaved Donors	Qualitative Case Study	Questionnaire and telephone interview	No funding obtained
2018	Quitadamo ³⁶	Italy	Describe donation volume by donor	Donors to a single milk	Semi-Longitudinal	Chart Review	Information not available

			clinical characteristics	bank from 2010-2017			
2019	Liu ³⁷	China	Characterize milk bank donors and donation patterns	Donors to fourteen milk banks 2013-2016	Semi-Longitudinal	Content analysis of online donor testimonials	Guangdong provincial commission of health and family planning appropriate technology promotion project (2015-7 Guangdong)
2019	Oreg ³⁸	United States	Explore milk donation in times of loss to uncover mechanisms linking grief and loss to philanthropic giving	Bereaved donors	Qualitative Phenomenological	Chart review	Information not available
2019	Sachdeva ³⁹	India	Evaluate the status of milk banks	Donors to sixteen milk banks from 2015-2016	Semi-Longitudinal	Online questionnaire and on-site interview of milk bank personnel	Margaret A. Cargill Philanthropies to PATH
2020	Nangia ⁴⁰	India	Classify donors by demographics; Determine and compare milk volume donated by donor classifications.	Donors to a hospital milk bank from 2017-2019	Semi-Longitudinal	Chart review	No funding obtained
2020	Oreg ⁴¹	United States	Determine characteristics of the milk donor identity	Donors' online testimonials and images	Qualitative Phenomenological	Content analysis of online donor testimonials (n=95) and images (n=107)	Information not available

Table 2. Demographic Information about Milk Bank Donors

Sub-category	Country	Year	Subjects	Findings
Age	Brazil ¹⁷	2008	737 donors	Majority < 25 (18% < 18; 41% 18 to 24)
	Brazil ^{18,19}	2009, 2010	36 donors	Ranged from 14-33; mean age 25
	Brazil ²¹	2010	92 donors	Ranged from 16-45; mean age 21
	Brazil ³⁰	2016	12 donors	Ranged from 18-39; mean age 26
	Brazil ³²	2017	3,513 donors	Majority 20-35 (80%)
	China ³⁷	2019	2,680 donors	Majority 25-35 (82%); mean age 29
	France ¹⁴	2003	103 donors	Ranged from 20-42; mean age 31
	India ⁴⁰	2020	1,553 donors	Majority < 25 (88%)
	Korea ²⁹	2016	915 donors	Majority 30-39 (70%)
	Norway ¹⁵	2004	69 donors	Ranged from 21-45; mean age 34
	Poland ³¹	2017	45 donors	Ranged from 23-44; mean age 32
	Spain ²⁶	2014	391 donors	Median age of 34; IQR of 31-36

	Spain ²⁵	2014	63 donors	Ranged from 23-53; mean age 36
	Spain ²⁸	2015	7 donors	Ranged from 21-39; mean age 32
	Spain ²⁷	2016	36 donors	Ranged from 24-41; mean age 34
	Taiwan ²³	2013	816 donors	Ranged from 18-45; mean age 31
	USA ¹⁶	2007	87 donors	Majority 30-39 (73%)
	USA ³⁴	2018	12 donors	All < 40 (50% 21-29; 50% 30-39)
Marital Status	Brazil ¹⁷	2008	737 donors	Single (54%)
	Brazil ¹⁸	2009	36 donors	Married or in a partnership (78%)
	Brazil ³⁰	2016	12 donors	Married or in a partnership (75%)
	France ¹⁴	2003	103 donors	Married or in a partnership (97%)
	Spain ²⁸	2015	7 donors	Married (86%)
	USA ¹⁶	2007	87 donors	Married (91%)
	USA ³⁴	2018	12 donors	Married (100%)
Race-Ethnicity	Brazil ²¹	2010	92 donors	White (72%)
	USA ¹⁶	2007	87 donors	White (87%)
	USA ³⁴	2018	12 donors	White (100%)
Education	Brazil ¹⁷	2008	737 donors	Some college/higher education (5%)
	Brazil ¹⁸	2009	36 donors	Some college/higher education (36%)
	Brazil ²¹	2010	92 donors	Some college/higher education (48%)
	Brazil ³⁰	2016	12 donors	Completed high school (92%)
	China ³⁷	2019	2,680 donors	College/higher education (60%)
	Norway ¹⁵	2004	69 donors	College/higher education (73%)
	Spain ²⁸	2015	7 donors	College/higher education (majority)
	Taiwan ²³	2013	816 donors	College/higher education (81%)
	USA ¹⁶	2007	87 donors	College/higher education (83%)
Employment Status	Brazil ¹⁷	2008	737 donors	Unemployed (70%)
	Brazil ¹⁸	2009	36 donors	Worked outside the home (47%)
	Brazil ³⁰	2016	12 donors	Housewives (42%)
	China ³⁷	2019	2,680 donors	Worked outside the home (85%)
	France ¹⁴	2003	103 donors	Worked outside the home (51%)
	Korea ²⁹	2016	915 donors	Housewives (62%)
	Spain ²⁸	2015	7 donors	Worked outside the home (majority)
	Taiwan ²³	2013	816 donors	Worked outside the home (72%)
	USA ¹⁶	2007	87 donors	Worked outside the home (65%)

Table 3. Summary of Findings from Studies Assessing Donor Clinical Characteristics

Sub-category	Country	Year	Subjects	Finding
Birth History	Brazil ¹⁷	2008	737 donors	Delivered preterm (47%); had ≤ 3 children (94%)
	Brazil ¹⁸	2009	36 donors	Had 1 child (61%)
	Brazil ²¹	2010	92 donors	Had 1 child (67%)

	Brazil ³⁰	2016	12 donors	Primiparous (83%)
	Brazil ³²	2017	3,513 donors	Multiparous (94%)
	Brazil ³³	2017	51 donors; 644 nondonors	Donors less likely to have infant in NICU than non-donors
	China ³⁷	2019	2,680 donors	Delivered preterm (8%)
	France ¹⁴	2003	103 donors	Had 1 to 2 children (83%)
	India ⁴⁰	2020	1553 donors	Delivered preterm (53%); multiparous (57%); infant admitted to NICU (37%)
	Italy ³⁶	2018	659 donors	Delivered after 35 weeks gestational age (94%)
	Norway ¹⁵	2004	69 donors	Most donors were primiparous and delivered at term (% not provided)
	Poland ³¹	2017	45 donors	Delivered preterm (24%)
	Spain ²⁵	2014	63 donors	Delivered preterm (21%); primiparous (62%)
	Spain ²⁶	2014	391 donors	Delivered preterm (23%); primiparous (56%); infant admitted to NICU (37%)
	Spain ²⁸	2015	7 donors	Had 1 to 2 children (100%)
	Spain ²⁷	2016	36 donors	Delivered preterm (17%)
	Taiwan ²³	2013	816 donors	Delivered preterm (8%); primiparous (69%)
	USA ¹⁶	2007	87 donors	Had 1 to 2 children (80%)
	USA ³⁴	2018	12 donors	Primiparous (50%); had infant in NICU (100%)
Disease	Brazil ³²	2017	3,513 donors	HIV prevalence decreased to 0%, syphilis increased to 1.8%, and acute hepatitis B increased to 3% over 10 years.
	Poland ³¹	2017	45 donors	Had chronic disease not contraindicated to donation (24%)
	USA ²⁰	2010	1091 donors	3.3% rejected for abnormal serological screening
Prenatal Care	Brazil ¹⁸	2009	36 donors	Attended 3-30 prenatal health care visits (100%)
	Brazil ³⁰	2016	12 donors	Attended 7-12 prenatal health care visits (100%)

Table 4. Lifestyle Characteristic Information about Milk Bank Donors

Sub-category	Country	Year	Subjects	Finding
Diet	USA ¹⁶	2007	87 donors	Self-reported always/nearly always eating healthy food (56%)
Exercise	USA ¹⁶	2007	87 donors	Self-reported exercising 3+ times/week (64%)
Legal Drug Use	Brazil ²¹	2010	92 donors	Self-reported never having smoked (82%)
	USA ¹⁶	2007	87 donors	Self-reported alcohol consumption \leq 1 time/month (77%)
	Spain ²⁵	2014	63 donors	Presence of caffeine (45% of milk samples); Presence of nicotine (0.3% of milk samples)
	Spain ²⁷	2016	36 donors	Presence of caffeine (50% of milk and 78% of hair samples); presence of nicotine (0% of milk and 3% of hair samples at threshold of active smoker)
Illegal Drug Use	Spain ²⁵	2014	63 donors	Presence of illegal drugs (0% of milk samples)
	Spain ²⁷	2016	36 donors	Presence of illegal drugs (0% of milk and 0% of hair samples)

Table 5. Lactation and Breastfeeding Experience Information about Milk Bank Donors

Sub-category	Country	Year	Subjects	Finding
Breastfeeding History	France ¹⁴	2003	103 donors	Excellent/good breastfeeding experience (97%);
	USA ³⁴	2018	12 donors	Exclusive breastfeeding (100%)
Clinical Support	Brazil ³³	2017	51 donors; 644 nondonors	Clinical support associated with being a donor included: (1) receiving in-hospital help with breastfeeding; (2) receiving information about milk expression
Milk Expression Practices	Brazil ¹⁹	2010	36 donors	Expressed manually (61%); Expressed milk 1+ times per day (72%); Factors influencing expression included beliefs about impact of diet (47%), availability of time (28%), and negative emotions (28%).
	USA ¹⁶	2007	87 donors; 19 nondonors	Expressed with personal electrical pump (75%); Donors reports fewer problems with pumping than nondonors
Beliefs About the Value of Milk	Brazil ³⁰	2016	12 donors	Major theme: Importance of breastfeeding for both the baby and the mother
	Spain ²⁸	2015	7 donors	Major theme: benefits of breastfeeding
	USA ²⁴	2013	19 donors	Major themes: breast milk being a cure for everything, a gift with expiration date, majority of middle- and upper-income donors expressed an interest of receiving compensation

Table 6. Donor Experience Information about Milk Bank Donors

Sub-category	Country	Year	Subjects	Findings
Reasons/Enablers to Donation	Brazil ¹⁷	2008	737 donors	Encouraged by a health professional (61%), received information in the hospital (50%)
	Brazil ¹⁸	2009	36 donors	Altruism (92%), excess milk production (61%), to avoid waste (47%), information provided by healthcare professionals and media (47%)
	Brazil ¹⁹	2010	36 donors	Received support from family (89%) and institution (58%)
	Brazil ³⁰	2016	12 donors	Major themes: Altruism, avoid waste, institutional and family support
	Brazil ³³	2017	51 donors; 644 nondonors	Donors were significantly more likely to be encouraged to donate milk at the hospital than nondonors
	China ³⁷	2019	2,680 donors	The internet was the most popular source of information regarding donations (33%)
	France ¹⁴	2003	103 donors	Having excess milk (57%), desire to help others (41%)
	Korea ²⁹	2016	915 donors	Obtained information about donation online (76%)
	Spain ²⁸	2015	7 donors	Major themes: Information received about milk banks and perceived approval of family and friends, having excess milk, altruism, empathy, support from family and milk bank
	USA ¹⁶	2007	87 donors	To help others, having excess milk (% not

				provided)
	USA ²²	2012	21 donors	Major themes: Physical and emotional meanings of pumping, finding meaning in perinatal loss, importance of healthcare providers addressing lactation with bereaved mothers
	USA ²⁴	2013	19 donors	Major theme: deriving value from the physical and emotional labor of pumping
	USA ³⁴	2018	12 donors	Major themes: Hope of donation helping others, act of donating was nurturing for the donor, importance of support from healthcare staff, desire to share their stories
	USA ³⁵	2018	2 donors	Major themes: Milk donation as a mean of processing perinatal loss and doing something helpful with their milk
	USA ⁴¹	2020	95 donor testimonials	Major theme: having excess milk
Barriers for Donation	Brazil ¹⁸	2009	36 donors	Main reasons to cease donation included returning to work and reduction in milk production
	Brazil ³⁰	2016	12 donors	Major theme: Limited information provided prenatally
	Spain ²⁸	2015	7 donors	Major themes: Lack of healthcare provider knowledge, distance from milk bank, no support at work, decrease of milk production
	USA ¹⁶	2007	87 donors	Finding time to pump, transporting milk to the bank, problems getting blood test (% not provided)
	USA ³⁵	2018	2 donors	Major theme: Frequent pumping was difficult
Donor Identity	USA ²²	2012	21 donors	Major themes: Identifying as a bereaved mother/grieving the loss of motherhood
	USA ³⁸	2019	80 donors	Major themes: A temporal donor identity allowed bereaved mothers opportunity to process loss and reconstruct maternal/female identity
	USA ⁴¹	2020	95 donors	Major themes: donors had complex and fluid identity including being a woman, a mother, healthcare professional and prior recipient of milk donation

Table 7. Donation Patterns Information about Milk Bank Donors

Sub-category	Country	Year	Subjects	Findings
Donation Volume	China ³⁷	2019	2,680 donors	1.9L (mean)
	India ³⁹	2019	70-4000 donors	0.64L (median)
	India ⁴⁰	2020	1,553 donors	0.27L (mean); significantly higher volumes were donated by mothers with infants in the NICU versus postnatal wards
	Italy ³⁶	2018	659 donors	2.9L (mean) for term donors and 11.7L (mean) for preterm donors
	Korea ²⁹	2016	915 donors	11.8L (mean)
	Norway ¹⁵	2004	69 donors	29L (mean)
	Poland ³¹	2017	45 donors	0.65-32L (range)
	Spain ²⁶	2014	391 donors	3.1L (median), 0.04-174L (range); donation volume was significantly higher with donors:

				whose infants were hospitalized, had lower gestational age at birth, lower infant age at time of donation and were previously milk bank donors
	Taiwan ²³	2013	816 donors	17L (mean)
	USA ¹⁶	2007	87 donors	30L (mean)
Donor Type	Brazil ¹⁸	2009	36 donors	First time donors (83%)
	Brazil ³⁰	2016	12 donors	First time donors (92%)
	China ³⁷	2019	2,680 donors	Repeat donors (donated more than 3 times) (55%)
	France ¹⁴	2003	103 donors	First time donors (72%)
	Korea ²⁹	2016	915 donors	First time donors (51%)
	Taiwan ²³	2013	816 donors	First time donors (97%)
Milk Type	Brazil ¹⁸	2009	36 donors	Started donating within 3 weeks after delivery (colostrum/transition milk) (47%)
	Brazil ²¹	2010	92 donors	Majority of donations were mature milk (83%)
	China ³⁷	2019	2,680 donors	Started donating after 1 month postpartum (77%) (mature milk)
	Korea ²⁹	2016	915 donors	Majority of donations were from 1-3 months postpartum (mature milk)
	Norway ¹⁵	2004	69 donors	Started donating on average when infant was 7 weeks old. Range of infant age at start was 1-21 weeks (transition and mature milk)
	Poland ³¹	2017	45 donors	Started donating on average when infant was 14 weeks old. Range of infant age at start was 1-44 weeks (transition and mature milk)
	Spain ²⁶	2014	391 donors	Started donating on average when infant was 12 weeks old. Range of infant age at start was 0-28 months old (colostrum to mature milk)
	Spain ²⁵	2014	63 donors	Majority of donations were mature milk (91%)
	Taiwan ²³	2013	816 donors	Majority of donors (97%) began donating \geq 1 month postpartum (mature milk)
Donation Duration	Brazil ¹⁸	2009	36 donors	From 1 to 4 months
	Norway ¹⁵	2004	69 donors	From <1 to 13 months
	Poland ³¹	2017	45 donors	From 2-26 weeks
	USA ³⁵	2018	2 donors	From 6-8 weeks

Discussion

Despite reports that there are now over 600 milk banks operating around the world,⁴² and over 800,000 infants annually who receive DHM⁷, only 28 studies were identified that studied the donors to milk banks. Moreover, what is known about milk bank donors in different geographies is often limited to a single study, with significant heterogeneity in the outcome variables reported.

Donor Demographics

Age was the most commonly reported demographic variable, with some initial geographic differences observed.^{14–19,21,23,25–32,34,37,40} Specifically, donors were predominantly in their early- to mid-twenties in Brazil and India (based on mean donor age or prevalence of donors by age group),^{18,19,21,30,32,40} while donors were predominantly in their early-thirties in France, Korea, Norway, Poland, Spain, Taiwan, and the US.^{14–16,23,25–29,31} There were also geographic differences in education levels among donors, with studies conducted in Brazil reporting that the majority of donors were not college educated compared to mostly college-educated donors in China, Norway, Spain, Taiwan and US.^{17,18,21,23,37} Across all geographies, donors were predominantly married or living with a partner.^{14,16–18,28,30,34} Limited information was available on race-ethnicity, which was self-reported.^{16,21,34} No information was collected about gender in any of the studies. Given the growing understanding of gender as a non-binary variable, future studies on milk bank donors should collect gender information instead of assuming that all donors identify as female.

Donor Experiences and Beliefs

The most common donor experience outcome variable studied was reasons/enablers for donation.^{14,16–19,22,24,28–30,33,35,37,41} Common reasons for donation included altruism, having excess milk, and avoiding waste.^{14,16,18,28,30,34,35,41} Common enablers for donation were being encouraged to donate and receiving information about milk banks from healthcare providers.^{17–19,22,28–30,33,34,37} Health care providers were reported as a major source of information in Brazil, while online sources were reported as major sources of information in Korea and China.^{17–19,29,37} Barriers for donation were only assessed in 3 countries and included: finding time to pump, reduced milk production, limited information provided prenatally, returning to work, distance

from milk bank, and no support at work.^{16,18,28,30,35} Qualitative studies that explored donor identity were all conducted in the US and found that while the act of donating influenced mother's identity, it had a special meaning for bereaved mothers.^{22,35,38}

Donation Patterns

There was a wide range of reported donation volumes per donor (mean-median:0.64-30L and range 0.04-174L).^{15,16,23,26,29,31,36,37,39,40} The wide range could be attributed to the differences in milk banking requirements. For example, in Brazil, there is not a minimum donation volume,⁴³ while in the US some milk banks require a minimum donation of 100 ounces.⁴⁴ In India and Spain, donors with infants in the NICU/hospitalized donated significantly higher volumes than donors without hospitalized infants.^{26,40} Donor type was mostly first-time (versus repeat) in all regions, although it was not widely reported.^{14,18,23,29,30} The type of milk commonly donated was mature milk, as the donations started mostly after one month postpartum.^{15,18,23,25,26,29,31,37} This suggests that donors are frequently providing milk that is likely lower in protein than the colostrum and transition milk that would normally be provided by an infant's own mother in the early postpartum period. There was limited information about donation duration (range: 2 weeks to 13 months).^{15,18,31,35} No studies collected information regarding whether donors provided their milk elsewhere, including either selling it or sharing with a peer.

Donor Clinical Characteristics

Birth history outcomes frequently included a donor's number of children. Results varied by geographies, with some studies reporting that donors were predominantly primiparous and others predominantly multiparous.^{14-18,21,23,25-28,30-34,36,37,40} The percentage of donors that had preterm births were in the minority in most studies (8-24%),^{23,25-27,31,37} though two studies in India and Brazil reported the approximately half of donors gave birth preterm.^{17,40} This suggests

that if donors predominantly gave birth term, their milk composition will likely be lower in some nutrients, including protein, fat and free amino acids, than the milk that would normally be provided by a preterm infant's own mother.⁴⁵ Information regarding donor's diseases/conditions^{20,31,32} and prenatal clinical care was limited.^{18,30}

Lactation and Breastfeeding Experience

Donors reported similar beliefs about the importance of breastfeeding and breast milk across three geographies.^{24,28,30} Donors' beliefs in value of their milk was only explored in one study, with many donors expressing the desire for compensation. Information about donors' breastfeeding history, clinical support for lactation, and milk expression practices was limited to one or two studies, suggesting this is an important area for future research to better understand the donor's path to having excess milk for donation.

Donor Lifestyle Characteristics

There is limited research regarding donors' lifestyle characteristics including diet, exercise, legal and illegal drug use, that does not allow for any type of synthesis across regions. While all milk banks screen donors to ensure they are healthy, lifestyle information could be valuable, as factors associated with maternal diet and lifestyle may influence what is being transferred in the milk.

Conclusion and Future Direction

Although donor human milk banking continues to grow around the world^{46,47}, information about the individuals who donate their milk is scarce. Some demographic characteristics were commonly reported across regions, while other, including gender and race were infrequently explored, suggesting the need to incorporate these demographic variables

when studying donors in a region. Although donors' experiences related to donations were frequently reported, enablers and barriers for donation differ among regions studied and not enough is known about what motivates donors to donate.

Additionally, factors that could influence the nutritional profile of DHM, including birth timing (term or preterm), type of milk donated (colostrum, transition, or mature), and donor diet should be more frequently collected. Other factors that have not been widely studied include: donor lactation and breastfeeding history, including factors that influence why donors are pumping and amassing surplus milk; and donation patterns, including whether donors are also selling milk to corporations or sharing milk with peers.

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CHAPTER III: CHARACTERISTICS AND BREASTFEEDING AND PUMPING
EXPERIENCES OF MILK BANK DONORS IN THE UNITED STATES AND UNITED
KINGDOM

Abstract

According to the World Health Organization (WHO), pasteurized donor human milk (DHM) is the recommended feeding strategy for low-birth-weight infants when there is no access to or insufficient amounts of mothers' own milk (MOM). Although human milk banking continues to grow around the world, information about the individuals who donate their milk is limited. The purpose of this study is to describe and compare milk bank donors' demographic, clinical and lifestyle characteristics, and breastfeeding experiences in a variety of geographic settings. A cross-sectional online survey was conducted from August 2022 to December 2022 with approved milk bank donors (n=556) from three milk banks in the United States (US), and one milk bank in the United Kingdom (UK). Donors in all settings were predominantly in their early 30s, White, married, educated, identified as female. More donors in the UK reported being on maternity leave, breastfeeding a single child longer, exclusively breastfeeding directly at the breast, and had a longer lifetime milk production than US donors. Significantly more US donors than UK donors reported receiving information/assistance from a healthcare provider about breastfeeding and about pumping. US donors also reported pumping more frequently than UK donors. Factors that are not directly related to milk banking practices (e.g., maternity leave, breastfeeding/pumping support) may have an impact on how donors feed their children and ultimately on their milk donation pattern. The impact of donor characteristics and feeding practices on donation patterns warrants further investigation.

Introduction

According to the World Health Organization (WHO), pasteurized donor human milk (DHM) is the recommended feeding strategy for low-birth-weight infants when there is no access to or insufficient amounts of mothers' own milk (MOM).¹ A 2020 report estimated there are now over 700 milk banks operating around the world and that approximately 800,000 infants receive DHM annually.² Although human milk banking continues to grow around the world,^{3,4} information about the individuals who donate their milk is limited, as summarized in a 2021 scoping review.⁵

Donor's demographics characteristics that have been more frequently explored include age, marital status, and education level, where donors are typically described to be in their early thirties, married or living with a partner, and college educated. However, some geographic differences were noted. For example, donors in Brazil and India were commonly reported to be in their early to mid-twenties, and donors in Brazil were often not college educated compared to other geographies.⁵⁻¹¹ There is limited information about donors race-ethnicity, gender and household income.

Clinical characteristics that have been reported about milk bank donors primarily relate to their birth history. Results suggests that in most milk banking geographies, donors typically give birth at term,^{6,12-16} which implies that the milk donated might be lower in some nutrients, compared to what preterm infants would receive from MOM.¹⁷ Only one study in India reported that most donors delivered preterm.¹¹ Some studies reported that most donors were primiparous,^{10,14-16,18} and only two studies reported that the majority of donors were multiparous.^{11,19} Information about donors' diseases or medical conditions, as well as prenatal clinical care have not been widely explored.

Based on the current literature, donor's lifestyle characteristics such as diet and exercise patterns, and medication use have not been frequently explored. A single study from Osbaldiston et al. conducted an interview with 87 donors in the United States, where the majority self-reported always/nearly always eating healthy foods and exercising 3+/times a week.²⁰ Better understanding donor lifestyle characteristics may provide insights into some components in milk influenced by diet and supplement use.

Lactation and breastfeeding experience was only explored in 2 studies, where most donors reported having an excellent/good experience with breastfeeding and exclusively breastfeeding their babies.^{21,22} Clinical support for breastfeeding was described by Meneses et al. and included that donors received assistance with breastfeeding at the hospital and information about milk expression.²³ Milk expression practices were discussed in 2 studies, where the primary milk expression method reported by donors in Brazil was manual expression, while the primary milk expression method reported by donors in the US was with an electric pump.^{8,20} Beliefs about breast milk were explored in 3 small studies, where major themes included the importance and benefits of breastfeeding, and breast milk as cure for everything.^{10,24,25}

To address these knowledge gaps about milk bank donors the purpose of this study is to describe and compare milk bank donors' demographic, clinical and lifestyle characteristics, and breastfeeding experiences in a variety of geographic settings. We hypothesize that donor characteristics and breastfeeding and pumping experiences may differ between geographies due to cultural and healthcare system differences.

Methods

Study Design

This cross-sectional online survey was conducted from August 2022 to December 2022 with approved milk bank donors from three milk banks in the United States (US), and one milk bank in the United Kingdom (UK). A convenience sample of donors (n=556) was obtained from the four geographies. Milk banks in the US were selected based on geographic diversity (Oregon, Texas, and Florida) and having a large number of donors. A milk bank in the UK was selected for the convenience of being an English-speaking country that could use the same survey instrument, and to provide a global perspective to the study. The present study was approved by the Institutional Review Board at University of North Carolina at Greensboro.

Subject Recruitment

Approved milk bank donors were invited to participate in the survey through milk bank partners. Milk bank partners included were Northwest Mother's Milk Bank (Portland, OR, US), Mother's Milk Bank of North Texas (Benbrook, TX, US), Mother's Milk Bank of Florida (Orlando, Florida, US), and Hearts Milk Bank (Hertfordshire, England, UK). The recruitment goal was to obtain 100 survey responses per geography. Donors received an email from their respective milk banks containing a link to the online questionnaire. The survey included an online consent form before donors started the survey. Eligibility was explored with 2 screening questions. Participants were excluded from the study if they had never pumped/expressed breast milk or if they had not been approved or donated to a milk bank. Participants were also excluded if they had an incomplete survey (<75% of questions answered). To encourage participation, donors were offered the opportunity to enter a drawing with the chance of winning US\$25 gift cards.

Survey Development

The current survey (Appendix A) was developed based on gaps identified in a systematic scoping review about milk bank donors around the world.⁵ Six domains were included in the survey: (i) Experiences with feeding their own child(ren); (ii) Experiences expressing/pumping breast milk; (iii) Breastfeeding information and support received; (iv) Beliefs about breastfeeding; (v) Demographic, clinical, and lifestyle characteristics; (vi) Experiences as a milk bank donor. The focus of this chapter is information from domains i-v. Domain vi will be discussed in the next chapter.

Experiences with feeding your own child(ren) – Domain i

Questions about how a donor fed their own child were based on a study by O’Sullivan et al. that developed nuanced questions about infant feeding modes²⁶ (the Questionnaire of Infant Feeding – QIF). QIF includes questions about the age of a child when they were first fed directly at the breast, were first fed pumped/expressed milk, and first fed formula. We created an additional question, where based on the first 3 months of their child’s life, participants were asked to characterize their primary feeding mode. Two questions about breastfeeding duration were informed by a survey developed by Palmquist et al.²⁷ that obtained information about lactation history, among other topics, from milk sharers and milk recipients in the US. The questions refer to the longest duration in months that they breastfed or expressed milk for a single child and the lifetime duration in months that their body produced milk.

Experiences expressing/pumping breast milk – Domain ii

Two questions about pumping/expressing practices and frequency were informed by O’Sullivan’s QIF.²⁶ A question about how old their child was when they first started pumping/expressing milk was modified to frame the question related to the donor’s most recent

child. A question regarding the frequency of pumping/expressing milk from QIF was also included. The Infant Feeding Practices Study II (IFPS II)²⁸ is a longitudinal survey that was developed to obtain information about maternal feeding practices in the US. It collects information about breastfeeding and pumping/expressing practices. Based on a question from IFPS II, participants were asked about the most frequent way used for pumping/expressing milk. A question about the primary reason for pumping/expressing milk was asked by providing common reasons identified in previous studies in milk sharing communities.²⁹⁻³¹

Breastfeeding information and support received – Domain iii

The IFPS II also collects data about where mothers received information about or assistance with breastfeeding and breast pumps.²⁸ Based on that, a question about breastfeeding support was adapted by collapsing possible responses into the following options: information/assistance received from healthcare professionals, relatives or friends, breastfeeding support groups, and other sources such as books and internet. To assess for the support donors received during their infant's first month of life, we used a modified Hughes' Exclusive Breastfeeding Social Support scale (EBFSS).³² We used three questions from each main category of support – instrumental, emotional, and informational -- which are measured using a 3-point Likert scale, including the options “as much as I would like” = 2, “less than I would like” = 1, and “no help at all” = 0. Therefore, overall support scores could range from 0 to 18, with 0 being no support and 18 being fully supported.

Beliefs about breastfeeding – Domain iv

Beliefs about breastfeeding were assessed using the Beliefs About Breastfeeding Questionnaire (BAB-Q)³³, which was developed to assess maternal beliefs about breastfeeding to predict breastfeeding behaviors. The questionnaire contains 8 constructs related to the “benefits”

and “efforts” of breastfeeding that were measured using a 5-point Likert scale. Scores could range from -16 to 16, with a positive score being more benefit than effort, a negative score being more effort than benefit, and 0 being equal amounts of benefit and effort. To measure participants’ overall breastfeeding experience, a question using a 5-point Likert scale (from negative to positive experience) was included.

Demographic, Clinical, and Lifestyle Characteristics – Domain v

Donor age, gender, marital status, race, education level, employment status, household income, gestation duration and age of most recent child, number of children, medication use for chronic health conditions, height and weight were collected. Stress levels were assessed using the Perceived Stress Scale 4³⁴. Scores range from 0 to 16, with 0 being less stress and 16 being more stress. Diet patterns were assessed by using a modified REAP screener³⁵ that focused on the constructs: consumption of fruits, vegetables, and fish, and the use of prenatal/multivitamins. Exercise patterns was measured by the frequency that participants exercise in a week, based on a modified question from the book: *Designing Quality Survey Questions*.³⁶ To further explore donors’ background, additional information collected regarding participants include if they ever had a child in an Intensive Care Unit, had a pregnancy of multiples (e.g. twins, triplets), and if they ever lost a child.

Survey validation and configuration

To assess for internal and external validity, the survey was reviewed by experts in the area, including milk banking and breastfeeding experts, International Board-Certified Lactation Consultant (IBCLC) and members from the target population.

The survey was closed after 3 weeks in Oregon, Texas, and the UK. In Florida, the survey closed after 4 weeks, due to the email invitations being sent across multiple days.

Not all survey questions required a response, due to the sensitive content (e.g., income). Range of responses for all questions was 89% or higher.

Survey data was reviewed and updated as follows. Questions that had an 'Other' option that allowed open responses were discussed by two researchers to determine if they fit into an existing category within the question or if a new category was needed. To determine how long a participant had been a milk bank donor, the month/year that participants were approved as a donor was converted to the 15th of the month (e.g., may/2022 converted to 05/15/2022) and subtracted from survey completion date to compute the number of days that the participant had been an approved donor. Additional variables that were calculated from survey responses included: BMI; intensity of information sources for breastfeeding, pumping, and milk banking was computed by summing the number of information sources reported by each participant; intensity of milk exchange was computed by summing the number of places milk was provided.

The final survey was configured using Qualtrics software, Version 2021.

Statistical Methods

Analysis from this study were performed in SPSS. Descriptive statistics were used to characterize categorical variables (prevalence) and numerical variables (mean, SD, median, range) of donors' demographic, clinical and lifestyle characteristics, and breastfeeding experiences. Results for all US milk banks were combined in order to compare geographical differences between US and UK donors. Differences in categorical variables were assessed using Chi-square tests. Numerical variables were assessed using a Kruskal Wallis test for nonparametric data and ANOVA for normally distributed data.

Results

A total of 586 approved milk bank donors agreed to participate in this study. A total of 30 participants were excluded from the analysis: 7 participants did not meet the inclusion criteria and 23 participants had an incomplete survey, leaving a total of 556 participants in the study. Of those, 89 participants were from the Oregon milk bank, 141 from the Texas milk bank, 139 from the Florida milk bank, and 187 from the UK milk bank.

Donors in all settings were predominantly in their early 30s, White, married, educated, and identified as female. More donors in the UK reported living with a partner and being on maternity leave ($p < .001$). More donors in the US reported being in a higher household monthly income bracket ($p < .001$). Donor demographics are summarized in Table 8.

Table 8. Demographic Characteristics of Milk Bank Donors

	Oregon (n=89)	Texas (n=141)	Florida (n=139)	Total US (n=369)	UK (n=187)	<i>p</i> value ^b
Maternal age (years) ^a	33.9 (3.7)	32.5 (3.9)	33.0 (4.3)	33.0 (4.0)	34.9 (4.9)	<.001
Gender: # (%)						0.471
Female	89 (100)	140 (99)	138 (99)	367 (100)	187 (100)	
Male	0 (0)	1 (1)	0 (0)	1 (0)	0 (0)	
Non-binary	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Other/ Prefer not to say	0 (0)	0 (0)	1 (1)	1 (0)	0 (0)	
Marital Status: # (%)						<.001
Married	88 (99)	133 (94)	127 (91)	348 (94)	140 (75)	
Living with a partner	1 (1)	7 (5)	5 (4)	13 (3)	37 (20)	
Divorced/Separated	0 (0)	0 (0)	2 (1)	2 (1)	4 (2)	
Never Married	0 (0)	1 (1)	5 (4)	6 (2)	6 (3)	
Race/Ethnicity: # (%)						0.024
White	81 (91)	118 (84)	118 (85)	317 (86)	168 (90)	
Black	1 (1)	3 (2)	2 (1)	6 (2)	8 (4)	
Asian	3 (3)	10 (7)	8 (6)	21 (6)	5 (3)	
Mixed	3 (3)	3 (2)	6 (4)	12 (3)	6 (3)	
Other/Prefer not to answer	1 (1)	7 (5)	5 (4)	13 (4)	0 (0)	
Education: # (%)						0.165
< HS graduate	0 (0)	1 (1)	1 (1)	2 (1)	0 (0)	
HS graduate	9 (10)	15 (11)	22 (16)	46 (13)	35 (19)	
Undergraduate degree	40 (45)	55 (39)	60 (43)	155 (42)	75 (40)	
Graduate degree	40 (45)	70 (50)	56 (40)	166 (45)	77 (41)	
Employment status: # (%)						<.001
On maternity leave	7 (8)	6 (4)	7 (5)	20 (5)	61 (33)	
Not on maternity leave	72 (81)	97 (69)	101 (73)	270 (73)	103 (55)	
Unemployed	10 (11)	38 (27)	31 (22)	79 (21)	23 (12)	
Household monthly income: # (%)						<.001
< 1,000 \$/ £	0 (0)	4 (3)	1 (1)	5 (1)	2 (1)	
1,000 to 5,000 \$/ £	17 (19)	24 (17)	48 (35)	89 (25)	97 (52)	

5,001 to 10,000 \$/ £	39 (44)	61 (43)	55 (40)	155 (43)	57 (30)	
> 10,000 \$/ £	33 (37)	51 (36)	31 (22)	115 (32)	28 (15)	
Unless noted, data represent frequency (percentage). ^a Data represents mean (standard deviation) of normally distributed data evaluated using ANOVA. ^b P-value reflects comparison between Total US and UK groups.						

In all milk bank setting, donors had on average slightly less than 2 children, and predominantly gave birth at term. Age of donors' most recent child was older in the UK compared to the US. More donors in the UK had an infant in a NICU and reported higher levels of stress than US donors. Other clinical and lifestyle differences between donors (UK and US) were related to exercise patterns, consumption of fish, intake of multi-vitamins, and having a child that received DHM (Table 9).

Table 9. Clinical and Lifestyle Characteristics of Milk Bank Donors

	Oregon (n=89)	Texas (n=141)	Florida (n=139)	US Total (n=369)	UK (n=187)	p value ^b
Maternal BMI (kg/m ²) ^a	25.6 (24.7) 18.3-40.2	25.7 (24.7) 17.4-56.5	25.0 (23.9) 17.6-47.9	25.4 (24.5) 17.4-56.5	25.3 (23.7) 17.6-46.9	0.571
Number of children ^a	1.8 (2.0) 1-5	1.7 (1.0) 0-6	1.6 (2.0) 0-3	1.7 (2.0) 0-6	1.9 (2.0) 1-4	<.001
Most recent child age (months) ^a	11.0 (10.0) 2.0-31.0	8.9 (8.0) 0.0-28.0	12.9 (12.0) 0.0-31.0	10.9 (10.0) 0.0-31.0	21.3 (15.0) 0.0-73.0	<.001
Gestational age at birth: # (%)						0.079
Term	78 (88)	122 (87)	119 (86)	319 (86)	151 (81)	
Preterm	11 (12)	19 (14)	20 (14)	50 (14)	36 (19)	
Special scenarios: # (%)						
Had infant in NICU	24 (27)	28 (20)	31 (22)	83 (23)	61 (33)	0.010
Had a multiple pregnancy	5 (6)	5 (4)	4 (3)	14 (4)	11 (6)	0.262
Child received DHM	23 (26)	35 (25)	13 (9)	71 (19)	11 (6)	<.001
Bereaved donor	1 (1)	5 (4)	6 (4)	12 (3)	5 (3)	0.709
Food consumption patterns: # (%)						
Fruits						0.439
Almost never	7 (8)	11 (8)	13 (9)	31 (8)	22 (12)	
Sometimes	31 (35)	77 (55)	64 (46)	172 (47)	83 (44)	
Almost always	51 (57)	53 (38)	62 (45)	166 (45)	82 (44)	
Vegetables						0.198
Almost never	7 (8)	13 (9)	14 (10)	34 (9)	10 (5)	
Sometimes	39 (44)	68 (48)	61 (44)	168 (46)	86 (46)	
Almost always	43 (48)	60 (43)	64 (46)	167 (45)	91 (49)	
Fish						0.033
Almost never	47 (53)	66 (47)	68 (49)	181 (49)	80 (43)	
Sometimes	29 (33)	56 (40)	56 (40)	141 (38)	69 (37)	
Almost always	13 (15)	19 (14)	15 (11)	47 (13)	38 (20)	
Prenatal/Multivitamins						<.001
Almost never	9 (10)	13 (9)	21 (15)	43 (12)	63 (34)	
Sometimes	12 (14)	18 (13)	17 (12)	47 (13)	54 (29)	
Almost always	68 (76)	110 (78)	101 (73)	279 (76)	70 (37)	
Exercise patterns: # (%)						0.007
<1 day/week	34 (38)	42 (30)	52 (37)	128 (35)	44 (24)	

1-3 days/week	33 (37)	70 (50)	60 (43)	163 (44)	91 (49)	
4 or more days/week	22 (25)	29 (21)	27 (19)	78 (21)	52 (28)	
Uses medication for chronic health condition: # (%)	14 (16)	22 (16)	17 (12)	53 (14)	20 (11)	0.227
Perceived stress ^a	5.2 (5.0) 0-15	7.0 (7.0) 2-16	4.6 (4.0) 0-13	5.6 (6.0) 0-16	8.8 (9.0) 1-13	<.001
Unless noted, data represent frequency (percentage). ^a Data represents –mean, (median) and range evaluated using Kruskal-Wallis Test. ^b P-values reflect comparison between Total US and UK groups.						

There were numerous differences in the breastfeeding and lactation experiences of UK and US donors (Table 3). Donors in the UK breastfed a single child longer and had a longer lifetime milk production than US donors ($p < .001$). How donors fed their child also differed, with UK donors most frequently reporting exclusively breastfeeding directly at the breast (96/197; 51%), while US donors reported a combination of at-the-breast and pumped milk feedings (177/369; 48%). When a donor first fed their infant at the breast and with expressed milk differed between the US and UK donors with more US donors reporting earlier at-the-breast and expressed milk feedings than UK donors. Regarding breastfeeding social support, US donors reported slightly higher emotional and informational support than UK donors. Additionally, significantly more US donors than UK donors reported receiving information/assistance from a healthcare provider about breastfeeding (94% vs 88%, respectively) and about pumping (60% vs 45%, respectively). UK donors had higher breastfeeding belief scores than US donors. In terms of pumping practices, most donors (70% or more in all settings) reported beginning to pump within the first week after birth. More US donors reported pumping as a result of separation from infant due to work (125/369, 34%) compared to UK donors (20/187, 11%). US donors also reported pumping more frequently than UK donors with 57% of US donors pumping several times per day compared to 36% of UK donors. Breastfeeding and pumping experiences are summarized in Table 10.

Table 10. Breastfeeding and Lactation Experiences of Milk Bank Donors

	Oregon (n=89)	Texas (n=141)	Florida (n=139)	US Total (n=369)	UK (n=187)	p value ^b
Maximum duration of breastfeeding a single child (months) ^a	14.1 (13.0) 3.5-39.0	12 (12.0) 1.0-30.0	14.1 (13.0) 4.0-41.0	13.3 (12.0) 1.0-41.0	21.2 (18.0) 1.0-72.0	<.001
Lifetime duration producing milk (months) ^a	21.8 (17.0) 3.5-82.0	17.9 (14.0) 1.5-125.0	19.3 (15.5) 4.0-60.0	19.4 (15.0) 1.5-125.0	30.9 (26.0) 2.5-110.0	<.001
Breastfeeding experience: # (%)						0.039
Negative	13 (15)	35 (25)	25 (18)	73 (20)	26 (14)	
As expected	13 (15)	32 (23)	20 (14)	65 (18)	28 (15)	
Positive	63 (71)	74 (52)	94 (68)	231 (63)	133 (71)	
Breastfeeding information/assistance: # (%)						
Healthcare professionals	85 (96)	130 (94)	128 (93)	343 (94)	162 (88)	0.022
Relatives/Friends	46 (52)	74 (53)	74 (54)	194 (53)	88 (48)	0.252
Birthing class/Breastfeeding group	38 (43)	70 (50)	51 (37)	159 (43)	99 (54)	0.022
Internet/Social media	59 (66)	86 (62)	87 (63)	232 (63)	117 (64)	0.964
Other sources	28 (32)	34 (24)	34 (25)	96 (26)	56 (30)	0.299
Number of information sources about breastfeeding ^a	2.9 (3.0) 1.0-5.0	2.8 (3.0) 1.0-5.0	2.7 (3.0) 1.0-5.0	2.8 (3.0) 1.0-5.0	2.8 (3.0) 1.0-5.0	0.784
Breastfeeding support						
Instrumental	4.2 (1.6)	4.1 (1.8)	4.4 (1.6)	4.3 (1.7)	4 (1.7)	0.172
Emotional	5 (1.3)	5.2 (1.3)	5 (1.4)	5.1 (1.3)	4.8 (1.5)	0.027
Informational	4.3 (1.8)	4.4 (1.8)	4.3 (1.6)	4.3 (1.7)	4 (1.9)	0.046
Breastfeeding beliefs: # (%)						0.207
More benefits	63 (71)	113 (80)	109 (78)	285 (77)	157 (84)	
More effort	21 (24)	21 (15)	22 (16)	64 (17)	19 (10)	
Neutral	5 (6)	7 (5)	8 (6)	20 (5)	11 (6)	
Breastfeeding beliefs ^a	3.5 (3.0) -5.0-16.0	4.1 (4.0) -8.0-15.0	3.5 (3.0) -11.0-15	3.7 (4.0) -11.0-16.0	4.8 (5.0) -6.0-16.0	0.007
First fed at breast: # (%)						0.012
Within 24h after birth	72 (81)	117 (83)	111 (82)	300 (82)	142 (76)	
Within first week	11 (12)	8 (6)	18 (13)	37 (10)	15 (8)	
Within first month	2 (2)	8 (6)	2 (2)	12 (3)	12 (6)	
Beyond 1 month	2 (2)	3 (2)	2 (2)	7 (2)	8 (4)	
Never	2 (2)	5 (4)	3 (2)	10 (3)	10 (5)	
First fed pumped/expressed milk: # (%)						<.001
Within 24h after birth	24 (27)	23 (16)	30 (22)	77 (21)	37 (20)	
Within first week	25 (28)	51 (36)	53 (39)	129 (35)	43 (23)	
Within first month	15 (17)	36 (26)	18 (13)	69 (19)	29 (16)	
Beyond 1 month	24 (27)	26 (18)	27 (20)	77 (21)	42 (23)	
Never	1 (1)	5 (4)	8 (6)	14 (4)	36 (19)	
First fed formula: # (%)						0.342
Within 24h after birth	6 (7)	10 (7)	17 (13)	33 (9)	15 (8)	
Within first week	13 (15)	24 (17)	29 (21)	66 (18)	21 (11)	
Within first month	1 (1)	5 (4)	3 (2)	9 (3)	5 (3)	
Beyond 1 month	5 (6)	3 (2)	12 (9)	20 (6)	32 (17)	
Never	64 (72)	99 (70)	75 (55)	238 (65)	114 (61)	
Feeding way first 3 months: # (%)						<.001
Exclusively fed at the breast	28 (32)	36 (26)	39 (29)	103 (28)	96 (51)	
Exclusively fed expressed/pumped milk	9 (10)	20 (14)	27 (20)	56 (15)	24 (13)	
Mixed feedings (at the breast and pumped milk)	45 (51)	73 (52)	59 (43)	177 (48)	53 (28)	
Mixed feedings (formula and breast milk)	7 (8)	12 (9)	10 (7)	29 (8)	14 (8)	
Exclusively fed formula	0 (0)	0 (0)	1 (1)	1 (1)	0 (0)	
Day started pumping/expressing milk: # (%)						0.229
Before birth	9 (10)	14 (10)	7 (5)	30 (8)	47 (25)	

Within 24h after birth	28 (32)	38 (27)	44 (32)	110 (30)	45 (24)	
Within first week	30 (34)	53 (38)	60 (43)	143 (39)	37 (20)	
Within first month	13 (15)	27 (19)	18 (13)	58 (16)	29 (16)	
Beyond 1 month	9 (10)	9 (6)	10 (7)	28 (8)	29 (16)	
Expressing due to induced lactation	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Pumping method: # (%)						0.599
Electric breast pump	73 (82)	116 (82)	111 (80)	300 (81)	138 (74)	
Manual breast pump	2 (2)	2 (1)	3 (2)	7 (2)	21 (11)	
Passive milk collection	7 (8)	9 (6)	8 (6)	24 (7)	14 (8)	
Combination electric and battery-operated breast pump	6 (7)	14 (10)	17 (12)	37 (10)	10 (5)	
By hand (without using a pump)	1 (1)	0 (0)	0 (0)	1 (0)	4 (2)	
Pumping frequency: # (%)						<.001
Rarely	0 (0)	2 (1)	4 (3)	6 (2)	9 (5)	
Once or twice a week	5 (6)	5 (4)	2 (1)	12 (3)	23 (12)	
Most days of the week	15 (17)	19 (14)	20 (14)	54 (15)	50 (27)	
Once or twice every day	26 (29)	30 (21)	30 (22)	86 (23)	37 (20)	
Several times every day	43 (48)	85 (60)	83 (60)	211 (57)	68 (36)	
Pumping reason: # (%)						<.001
Separation from infant due to work (current or future)	33 (37)	46 (33)	46 (33)	125 (34)	20 (11)	
To store breast milk for other planned or unplanned separations besides work	6 (7)	11 (8)	14 (10)	31 (8)	17 (9)	
To maintain or increase breast milk supply	8 (9)	20 (14)	16 (12)	44 (12)	17 (9)	
To gauge breast milk supply	0 (0)	0 (0)	0 (0)	0 (0)	3 (2)	
To manage an oversupply of milk	18 (20)	18 (13)	18 (13)	54 (15)	20 (11)	
To allow other individuals to participate in infant feeding	7 (8)	13 (9)	10 (7)	30 (8)	13 (7)	
To provide milk to another person or entity	4 (5)	9 (6)	10 (7)	23 (6)	43 (23)	
Other	13 (15)	24 (17)	25 (18)	62 (17)	54 (29)	
Pumping information/assistance: # (%)						
Healthcare professionals	64 (76)	70 (53)	74 (57)	208 (60)	73 (45)	0.001
Relatives/Friends	32 (38)	49 (37)	54 (42)	135 (39)	60 (37)	0.670
Birthing class/Breastfeeding group	16 (19)	34 (26)	19 (15)	69 (20)	35 (22)	0.666
Internet/Social media	44 (52)	88 (67)	93 (72)	225 (65)	103 (64)	0.751
Other sources	12 (14)	16 (12)	19 (15)	47 (14)	26 (16)	0.461
Number of information sources about pumping ^a	2.0 (2.0) 1.0-5.0	1.9 (2.0) 1.0-5.0	2.0 (2.0) 1.0-5.0	2.0 (2.0) 1.0-5.0	1.8 (2.0) 1.0-5.0	0.163
Unless noted, data represent frequency (percentage). ^a Data represents –mean, (median) and range evaluated using Kruskal-Wallis Test. ^b P-values reflect comparison between Total US and UK groups.						

Discussion

In this observational study of 556 milk bank donors from the US and UK, we report significant differences in infant feeding and pumping practices between US and UK donors that may be related to differences in maternity leave. In our convenience sample, milk bank donors from the UK were more frequently on maternity leave than donors from the US (61/187, 32.6% vs 20/369, 5.4%, $p < 0.001$). A relationship between maternity leave and breastfeeding practices has been described by others.³⁷ Our data suggest potential differences including how donors fed their own child and the timing, frequency, and motivations for pumping.

How donors feed their own child

Over 90% of donors in the UK and the US reported exclusively feeding their child with human milk during the first 3 months of life, though the form of human milk feedings differed. In the UK, most donors exclusively breastfed their infant directly at the breast (96/187, 51%), while in the US, the most common method was a combination of at-the-breast and expressed milk feedings (177/369, 48%). Additionally, most donors in the US first fed their infants pumped milk earlier (within the first week postpartum) than donors in the UK (within the first month postpartum). Osbaldiston et al. described breastfeeding and pumping problems encountered by donors and nondonors in the US, however details about how they fed their infants was not reported.²⁰

Donors in the UK reported a longer average duration of breastfeeding a single child (21.2 vs. 13.3 months, $p < .001$) and lifetime milk production (30.9 vs. 19.4 months, $p < .001$) compared to donors in the US. Interestingly, the rates of infants who are breastfed at 12 months in the US and UK are 35.9 and 0.5%, respectively.^{38,39} Therefore, milk bank donors may breastfeed their children longer and have an increased lifetime milk production when compared to the average population of lactating women.

Pumping Experiences

We observed some similarities in donor pumping practices among geographies. Most donors in the US (283/369, 77%) and the UK (129/187, 69%) started pumping milk within the first week postpartum. Additionally, the majority of donors reported using an electric breast pump in both settings. Weisband et al. studied the pumping intentions of non-donor postpartum

women in the US, found that 98% of the sample intended to feed their infants pumped milk, and 69% of participants were planning on starting to pump within weeks after birth.⁴⁰ In our study, 77% of US donors reported pumping within the first week postpartum, which is in line with the findings of Weisband et al. There is limited information about how early UK women start pumping. Crossland et al. conducted a qualitative study in the UK with pregnant/postpartum women, healthcare professionals and other health related professionals. They reported that many participants were unsure about when postpartum women should start pumping. Many also reported believing that women should wait 4-6 weeks after birth before start pumping and some reported considering breast pumps as part of the items that needed to be acquired before birth (percentages not provided).⁴¹

In our sample, pumping reasons and frequency differed between settings. The most common primary reason reported for pumping milk among US donors was returning to work (125/369, 34% vs 20/187, 11%, $p < .001$ in the UK). While in the UK, the most common primary reason reported was related to breastfeeding difficulties (e.g., latching issues, sick infant) (45/187, 24%). Moreover, more donors in the US reported pumping several times a day compared to donors in the UK (211/369, 57% vs 68/187, 36%, $p < .001$). Felice et al. evaluated how pumping reasons and frequency are related to duration of human milk feeding in a population of mother-infant dyads (not milk bank donors) in the US. They found that women who pumped for elective reasons (e.g., to have milk stored for unplanned situations) had a longer duration of feeding human milk than women who pumped for non-elective reasons (e.g., to keep milk supply when away from the baby). Additionally, studies have shown that women who pumped more frequently were also more likely to feed their infant with human milk for a shorter

period.^{42,43} In our sample, we observed similar trends, where US donors reported pumping more frequently than UK donors, and also breastfeeding a single child for a shorter duration than UK donors.

Breastfeeding and Pumping Support

In our study, we observed that donors in both settings received information/assistance from more sources related to breastfeeding than to pumping (US – 2.8 vs 2.0 sources, UK – 2.8 vs 1.8 sources). More donors in the US than in the UK received information/assistance about breastfeeding (94% vs 88%, respectively; $p=0.022$) and about pumping (60% vs 45%, respectively; $p<.001$) from healthcare professionals. In contrast, the most popular source of pumping information/assistance was the internet/social media in the US and the UK (65% vs 64%, $p=0.751$). Our findings related to breastfeeding and pumping information sources agree with findings from Chen et al.⁴⁴ They conducted a secondary data analysis of US women from the IFPS II study, where participants reported having more breastfeeding education sources than breast pump education. Approximately 60% of participants reported receiving breastfeeding education from various healthcare professionals (e.g., physicians, nurses, IBCLCs). The media was also a popular source of breastfeeding information (64%) for IFP II participants. Conversely, only 11-31% of IFP II participants reported receiving breast pump education from various healthcare professionals, and the most popular source of breast pump education was the media (38%).

Donors' perceptions of the breastfeeding support they received during their infant's first month of life was assessed using a scale that intended to gauge the types of social support: (1)

instrumental (e.g., cooking, doing the laundry), (2) emotional (e.g., showing concern about physical condition and mental health), and (3) informational (e.g., gave advice about how to exclusively breastfeed). Donors in the US reported receiving significantly more emotional and informational breastfeeding support than UK donors ($p < 0.05$), while differences in instrumental support did not differ. Generally, we observed relatively high breastfeeding social support scores in our sample of donors from high income settings compared to support reported in low-income settings using the same scale.³² No studies using this social support instrument were identified in high income settings.

Clinical and lifestyle characteristics

It was interesting to note that more UK donors had an infant in the NICU (19% vs 6%, $p < .001$), which is the recommended population to receiving DHM, yet more US donors had an infant that received donor milk (33% vs 23%, $p = 0.01$). Possible reasons for higher DHM use in the US, despite the lower number of NICU infants, might be related to the high use of DHM in US maternity settings^{45,46}, as well as the growing tendency of DHM use beyond the NICU population.⁴⁷

Moreover, donors in the UK reported a higher perceived stress score than donors in the US (8.8/16 vs 5.6/16, $p < .001$). Bonacquisti et al. evaluated mental health conditions of mothers who had a child at the NICU and reported that having an infant in the NICU was related to increased maternal stress levels.⁴⁸ Therefore, the higher maternal stress levels that we observed in UK donors might be associated with having an infant at the NICU.

In our sample, over 80% of donors in the US and UK reported consuming fruits and vegetables “sometimes/almost always”, however fish consumption was reported less frequently. In addition, more donors in the US reported “almost always” consuming prenatal/multivitamins than donors in the UK (279/369, 76% vs 70/187, 37%, $p < .001$). Maternal diet and supplement use has been previously linked with milk composition, in particular fatty acids (e.g., DHA, EPA), fat-soluble vitamins, micronutrients (e.g., choline, calcium) and vitamins B₁ and C.⁴⁹ Therefore, differences in supplement use among donor populations may contribute to differences in milk composition. In terms of physical activity, most donors in our sample reported exercising less than the recommendations for postpartum women of 150 minutes a week.⁵⁰ Osbaldistion et al. previously described US donors' food consumption patterns and physical activity, where the majority of donors self-reported always/nearly always consuming healthy foods and exercising 3+/times a week.²⁰ However, types of healthy foods included in the criteria were not reported. The present study was the first to collect more specific details about donors' food consumption and supplement use patterns.

Demographics

Our study explored demographic characteristics of milk bank donors that have not frequently been reported including gender and income. The majority of donors in our study (554/556, 99.6%) reported identifying as female. While we are not aware of studies that assessed gender in milk bank donors, Palmquist et al. surveyed peer-to-peer milk sharers in the US and reported that most milk sharers (99.7%) identified as female,²⁷ which is similar to our findings.

In our sample, more US donors reported being in the higher household income brackets. Palmquist et al. study showed that peer-to-peer milk sharers reported a significant higher median income than milk recipients. Although we haven't identified studies that collected donor income in the US and the UK, our sample showed that donors in the US and UK have different household income patterns, yet income might not be comparable between settings due to differences in economies.

Our findings about other donor's demographics characteristics are consistent with the literature about donors in other high-income settings.⁵ In both setting, donors were predominantly in their early/mid 30s, married, White and educated.

Limitations

Limitations of our study included using a convenience sample, where donors who had a positive experience with milk banks may have been more likely to participate. The survey and consent form were distributed digitally, which may have influenced the comfort of donors who were willing to share their experiences, resulting in a sample different from the actual donor population.

Our sample included four different milk banks, with three banks in distinct regions in the US and one bank in the UK. Although our sample illustrated differences in milk bank settings, our findings cannot be generalized to all milk bank populations.

Conclusion

Donors' characteristics and infant feeding practices have similarities and differences between settings. Factors that are not directly related to milk banking practices (e.g., maternity

leave, breastfeeding/pumping support) may have an impact on how donors feed their children and ultimately on their milk production and donation patterns. The impact of donor characteristics and feeding practices on donation patterns warrants further investigation.

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CHAPTER IV: DONATION EXPERIENCES, BARRIERS, AND ENABLER OF MILK BANK DONORS IN THE UNITED STATES AND UNITED KINGDOM

Abstract

The World Health Organization and The American Academy of Pediatrics (AAP) encourages that very low birth weight infants who do not have access to their mother's milk receive pasteurized donor human milk (PDHM). More specifically, the AAP recommends the use of PDHM acquired through established human milk banks. Although the use of PDHM continues to increase, little is known about the experiences of milk bank donors. The aim of this study is to describe and compare enablers, barriers, and patterns of donation among milk bank donors in different geographic settings. A cross-sectional online survey was conducted from August 2022 to December 2022 with approved milk bank donors (n=556) from three milk banks in the United States (US), and one milk bank in the United Kingdom (UK). To our knowledge, this was the first study about milk donors that collected information about their milk sharing/selling practices, where 46% of donors reported giving milk through additional channels than just milk banks. Our findings of top reasons for donating to a milk bank agree with those reported in other settings. In terms of donation barriers, 69-79% of donors reported encountering barriers. Whether participation in other forms of milk exchange influences donation volumes is an important area of future research. Donors' sources of milk bank information were relatively low, with the internet and healthcare professionals being the primary sources reported. A combination of the desire to help others and having excess milk may be the biggest motivator of milk donors, while barriers to donate milk might setting-specific and related to milk bank processes and requirements.

Introduction

The World Health Organization and The American Academy of Pediatrics (AAP) encourages that very low birth weight infants who do not have access to their mother's milk receive pasteurized donor human milk (PDHM) due to evidence of health benefits for the infant, including the decreased risk of necrotizing enterocolitis.^{1,2} More specifically, the AAP recommends the use of PDHM acquired through established human milk banks. Although the use of PDHM continues to increase^{1,2}, little is known about the experiences of milk bank donors.³ Understanding the donor experience is important to support mothers, infants, and milk banks.

Donor's reasons and enablers to donate milk have been explored in studies from six different countries.⁴⁻¹⁸ Common reasons for donating included helping others, having excess milk and avoiding waste.^{4,6,8,9,11,16-18} Enablers for donation included receiving support/information from health professionals, institutions, and family members.^{5-7,9,11,12,14,16} Moreover, the internet/media was noted to be one of the most popular sources for obtaining information about milk banks in some settings.^{6,10,13}

Barriers for donation were previously explored in 5 studies with small sample sizes (n=2 to 87) and included having limited information about milk banks, decrease of milk production related to returning to work and infrequent pumping, and issues with donation processes (e.g. distance from milk bank, transporting milk, blood testing).^{4,6,9,11,17}

Frequency of donation was identified in five studies, where most participants were first time donors^{6,8,10,11,19} and a single study reported that most donors have donated multiple times.¹³ While the type of milk most frequently donated was mature milk (defined as > 4 weeks postpartum), donation of colostrum and transition milk have also been reported.^{6,10,13,19-24}

Additionally, the donation duration was reported in 4 studies, where the donation period ranged from 2 weeks to 13 months.^{6,17,21,22}

There is limited information about what influences an individual's decisions regarding whether to donate milk to a milk bank, share their excess breast milk with a peer, sell their milk, or whether individuals participate in multiple methods of human milk exchange. An online survey of peer-to-peer milk sharers in the United States (n=661) reported that 10% of participants also donated their milk to a milk bank.²⁵ A small qualitative study in the United States of 27 peer-to-peer milk sharers (who had not donated to a milk bank) reported that most milk sharers did not receive information on milk exchange options from healthcare providers, suggesting a potential barrier to increasing donations to milk banks.²⁶ Additionally, a single study explored beliefs regarding financial compensation for milk donation and reported that most middle- and upper-income donors viewed compensation favorably.¹⁵

Milk banks are organized in different ways around the world, and there are currently no global guidelines.^{27,28} The aim of this study is to describe and compare enablers, barriers, and patterns of donation among milk bank donors in different geographic settings. We hypothesize that donation enablers will be similar within geographies; donation barriers will differ within geographies due to variation in milk bank donation processes; donation volumes will vary within geographies due to milk bank requirements; and milk sharing practices will differ within geographies due to cultural reasons.

Methods

Study Design

This cross-sectional online survey was conducted from August 2022 to December 2022 with approved milk bank donors from three milk banks in the United States (US), and one milk

bank in the United Kingdom (UK). A convenience sample of donors (n=556) was obtained from the four geographies. Milk banks in the US were selected based on geographic diversity (Oregon, Texas, and Florida) and having a large number of donors. A milk bank in the UK was selected for the convenience of being an English-speaking country that could use the same survey instrument, and to provide a global perspective to the study. The present study was approved by the Institutional Review Board at University of North Carolina at Greensboro.

Subject Recruitment

Approved milk bank donors were invited to participate in the survey through milk bank partners. Milk bank partners included were Northwest Mother's Milk Bank (Portland, OR, US), Mother's Milk Bank of North Texas (Benbrook, TX, US), Mother's Milk Bank of Florida (Orlando, Florida, US), and Hearts Milk Bank (Hertfordshire, England, UK). The recruitment goal was to obtain 100 survey responses per geography. Donors received an email from their respective milk banks containing a link to the online questionnaire. The survey included an online consent form before donors started the survey. Eligibility was explored with 2 screening questions. Participants were excluded from the study if they had never pumped/expressed breast milk or if they had not been approved or donated to a milk bank. Participants were also excluded if they had an incomplete survey (<75%). To encourage participation, donors were offered the opportunity to enter a drawing with the chance of winning US\$25 gift cards.

Survey Development

The current survey (Appendix A) was developed based on gaps identified in a systematic scoping review about milk bank donors around the world.³ Six domains were included in the survey: (i) Experiences with feeding your own child(ren); (ii) Experiences expressing/pumping breast milk; (iii) Breastfeeding information and support received; (iv) Beliefs about

breastfeeding; (v) Demographic, clinical, and lifestyle characteristics; (vi) Experiences as a milk bank donor. The focus of this chapter is information from domains vi. Domains i-v were discussed in the previous chapter.

Experiences as a milk bank donor – Domain vi

To explore how donors learned about milk banks, a question from The Infant Feeding Practices Study II (IFPS II) was adapted by collapsing possible responses into the following options: information/assistance received from healthcare professionals, relatives or friends, breastfeeding support groups, and other sources such as books and internet. Participants were asked if they ever provided their own breast milk in the following scenarios: given to a relative or friend; given to unknown person; sold to an individual, in-person; sold to an individual remotely; sold to a corporation. The previous question was informed by O’Sullivan’s the Questionnaire of Infant Feeding (QIF)²⁹. A question about reasons for donating to a milk bank was informed by research conducted by Gribble³⁰, Perrin³¹ and Osbaldiston⁴ et al. that described enablers for donating/sharing milk. A question about the primary perceived barrier in milk donations was informed by the procedures utilized by the Human Milk Association of North America (HMBANA) in the donation process.³² A question about the month and year that a participant was first approved as a donor was created to assess how long they had been a donor. A question about donation intensity was developed to identify if donors were donating for the first time, had donated several times for one pregnancy or donated multiple times across multiple pregnancies. A question about participants’ life-time volume of milk donated to milk banks was informed by volumes found in research conducted by Perrin et al.²⁶ (often above 100 ounces) and Palmquist et al.²⁵ (mean volume = 1356.5 ounces). We developed two questions about how old participants’ child was when they started donating to a milk bank and about the type of milk (by

lactation stage) participant donated, to obtain information about the type of milk that was being donated (e.g., colostrum vs. mature milk).

Survey validation and configuration

To assess for internal and external validity, the survey was reviewed by experts in the area, including milk banking and breastfeeding experts, International Board-Certified Lactation Consultant (IBCLC) and members from the target population.

The survey was closed after 3 weeks in Oregon, Texas, and the UK. In Florida, the survey closed after 4 weeks, due to the email invitations being sent across multiple days.

Survey data was reviewed and updated as follows. Questions that had an 'Other' option that allowed open responses were discussed by two researchers to determine if they fit into an existing category within the question or if a new category was needed. To determine how long a participant had been a milk bank donor, the month/year that participants were approved as a donor was converted to the 15th of the month (e.g., may/2022 – 05/15/2022), subtracted from survey completion date to compute the number of days that the participant had been an approved donor. Additional variables that were calculated from survey responses included: BMI; number of information sources for breastfeeding, pumping, and milk banking was computed by summing the number of information sources reported by each participant; total types of milk sharing/selling scenarios was computed by summing the number of places milk was provided.

Not all survey questions required a response, due to the sensitive content (e.g., income). Range of responses for all questions was 89% or higher.

The final survey was configured using Qualtrics software, Version 2021.

Statistical Methods

Analysis from this study were performed in SPSS. Descriptive statistics were used to characterize categorical variables (prevalence) and numerical variables (mean, SD, median, range) of donors' experiences, donation history, enablers and barriers to donating milk. Results from all US milk banks were combined in order to compare geographical differences between US and UK donors. Differences in categorical variables were assessed using Chi-square tests. Numerical variables were assessed using a Kruskal Wallis test for nonparametric data and ANOVA for normally distributed data.

Results

A total of 586 approved milk bank donors agreed to participate in this study. A total of 30 participants were excluded from the analysis: 7 participants did not meet the inclusion criteria and 23 participants had an incomplete survey, leaving a total of 556 participants in the study. Of those, participants were from the following milk banks: 89 participants from Oregon, 141 from Texas milk bank, 139 from Florida milk bank, and 187 from the UK milk bank. A summary of the demographic of participants can be found in Table 8 (Chapter III).

Several differences were noted in milk banking related practices of US and UK donors (Table 2). Regarding donation patterns, donors in the UK had been approved as a donor longer than US donors (705 vs 309 days, $p < .001$). Donors in the US donated on average a higher lifetime volume of milk than UK donors (1126 vs 966 fl. oz, $p = 0.002$). More donors in the US than the UK reported knowing an estimate of their lifetime milk production (297/369, 80% vs 116/187, 62%). We also noted differences in early milk donation patterns, with a greater percentage of US donors reporting donating milk collected before 1 month postpartum (191/369, 53% vs 61/187, 33%). When observing donation reasons, the top reasons reported for donating

were wanting to help others (UK 66%, US 51%) and having excess milk (UK 27%, US 43%) with statistical differences by geography (p=0.039).

In terms of milk sharing/selling practices, more donors in the US reported participated in any form of milk sharing/selling than UK donors (185/369, 51% vs 73/187, 39%, p=0.009). The most common milk sharing scenario in both settings was sharing milk with a person that the donor did not know (34% in US, 33% in UK, p = 0.983). More donors in the US reported giving milk to relatives/friends compared to donors in the UK (117/369, 32% vs 20/187, 11%, p<.001). Additionally, more donors in the US favored receiving financial compensation for their milk (88/369, 24% vs 23/187, 12%, p<0.001), and for their time and supplies (167/369, 47% vs 53/187, 29%, p<0.001) compared to donors in the UK.

Related to barriers to donating milk, most donors reported encountering a barrier (UK - 79% vs US - 69%). Moreover, the most common source of information related to milk banking in each setting was the internet (UK – 126/187, 70% vs US – 228/369, 63%, p=0.112). However, more US donors reported getting milk banking info from healthcare providers than UK donors (148/369, 41% vs 53/187, 30%, p=0.012). (Table 11)

Table 11. Donor Characteristics and Experiences Related to Milk Bank Donation

	Oregon (n=89)	Texas (n=141)	Florida (n=139)	US Total (n=369)	UK (n=187)	p value ^b
Days since approved as a donor ^a	345 (164) 10-2080	260 (120) 11-2617	338 (207) 51-1877	309 (164) 10-2617	705 (599) 5-2609	<.001
Lifetime milk donation (fl. ounces) ^a	991 (500) 100-10000	1161 (500) 44-15000	1171 (600) 50-12000	1126 (530) 44-15000	966 (338) 51-33814	0.002
Child's age at first donation: # (%)						0.051
Less than 1 month old	4 (5)	9 (6)	7 (5)	20 (6)	10 (5)	
1 month to less than 3 months old	20 (23)	41 (29)	26 (19)	87 (24)	69 (37)	
3 months to less than 6 months old	39 (46)	48 (34)	51 (38)	138 (38)	56 (30)	
6 months to less than 12 months old	19 (22)	30 (21)	40 (30)	89 (25)	36 (19)	
12 months or older	3 (3)	13 (9)	10 (7)	26 (7)	15 (8)	
Donor type: # (%)						0.005
First time donor	38 (45)	68 (48)	79 (59)	185 (51)	104 (56)	
Repeat donor (across single child)	33 (39)	48 (34)	39 (29)	120 (33)	66 (36)	
Repeat donor (across multiple children)	14 (17)	25 (18)	17 (13)	56 (15)	16 (9)	

Milk bank information: # (%)						
Healthcare professionals	48 (55)	58 (42)	42 (31)	148 (41)	53 (30)	0.012
Relatives/Friends	9 (10)	22 (16)	14 (10)	45 (13)	22 (12)	0.982
Birthing class/Breastfeeding group	6 (7)	11 (8)	8 (6)	25 (7)	12 (7)	0.891
Internet/Social media	48 (55)	92 (67)	88 (65)	228 (63)	126 (70)	0.112
Other sources	7 (8)	1 (1)	15 (11)	23 (6)	0 (0)	<.001
Number of information sources about milk bank ^a	1.4 (1.0) 1.0-4.0	1.3 (1.0) 1.0-4.0	1.2 (1.0) 1.0-5.0	1.3 (1.0) 1.0-5.0	1.2 (1.0) 1.0-3.0	0.096
Donation reasons: # (%)						0.039
I wanted to help others	38 (43)	77 (55)	69 (51)	184 (51)	124 (66)	
I had excess milk	45 (51)	56 (40)	54 (40)	155 (43)	50 (27)	
I was encouraged by healthcare professional	1 (1)	0 (0)	1 (1)	2 (1)	1 (1)	
I was encouraged by family member/friend	0 (0)	0 (0)	0 (0)	0 (0)	5 (3)	
Other	4 (5)	8 (6)	11 (8)	23 (6)	7 (4)	
Donation barriers: # (%)						0.073
Completing the preliminary donor screening process	11 (13)	14 (10)	15 (11)	40 (11)	9 (5)	
Completing blood work during the donor screening process	13 (15)	29 (21)	16 (12)	58 (16)	41 (22)	
Following milk bank lifestyle practices for milk donation	6 (7)	4 (3)	1 (1)	11 (3)	3 (2)	
Following milk bank hygiene practices for milk collection	1 (1)	5 (4)	1 (1)	7 (2)	14 (8)	
Collecting enough milk to be eligible to donate	2 (2)	3 (2)	6 (4)	11 (3)	37 (20)	
Having enough space to store the collected milk	14 (17)	20 (14)	26 (19)	60 (17)	32 (17)	
Delivering/sending milk to the milk bank	17 (20)	20 (14)	27 (20)	64 (18)	6 (3)	
No barriers	21 (25)	46 (33)	43 (32)	110 (31)	44 (24)	
Milk type donated: # (%)						
Collected from < 7 days after birth (colostrum)	6 (7)	24 (17)	20 (15)	50 (14)	14 (8)	0.054
Collected from 1-4 weeks after birth (transition milk)	29 (34)	58 (41)	54 (40)	141 (39)	47 (25)	0.003
Collected from 1 month to 6 months after birth (mature milk)	78 (92)	110 (78)	102 (76)	290 (81)	131 (70)	0.014
Collected from more than 6 months after birth (mature milk)	39 (46)	51 (36)	59 (44)	149 (41)	83 (45)	0.571
Participated in milk sharing/selling: # (%)	45 (51)	77 (55)	63 (47)	185 (51)	73 (39)	0.009
Milk sharing/selling practices: # (%)						
Given to relative/friend	33 (37)	43 (31)	41 (30)	117 (32)	20 (11)	<.001
Given to unknown person	29 (33)	50 (36)	45 (33)	124 (34)	62 (33)	0.983
Sold milk in person	2 (2)	3 (2)	3 (2)	8 (2)	3 (2)	0.661
Sold milk remotely	2 (2)	2 (1)	1 (1)	5 (1)	3 (2)	0.808
Sold to a business/corporation	0 (0)	2 (1)	1 (1)	3 (1)	3 (2)	0.756
Total types of milk sharing/selling scenarios ^a	0.7 (1.0) 0-4.0	0.7 (1.0) 0-4.0	0.7 (0.0) 0-3.0	0.7 (1.0) 0-4.0	0.5 (0.0) 0-4.0	0.002
Interest in financial compensation: # (%)						
For their milk						<.001
Disagree	43 (51)	46 (33)	41 (31)	130 (36)	106 (57)	
Neutral	29 (34)	61 (43)	52 (39)	142 (39)	57 (31)	
Agree	13 (15)	34 (24)	41 (31)	88 (24)	23 (12)	
For their time and supplies						<.001
Disagree	24 (28)	31 (22)	26 (19)	81 (23)	74 (40)	
Neutral	26 (31)	41 (29)	43 (32)	110 (31)	59 (32)	
Agree	35 (41)	69 (49)	65 (49)	169 (47)	53 (29)	
Unless noted, data represent frequency (percentage). ^a Data represents –mean, (median) and range evaluated using Kruskal-Wallis Test. ^b P-values reflect comparison between Total US and UK groups.						

Discussion

In this cross-sectional study of 556 milk bank donors in the US and UK who were recruited through a convenience sample we provide detailed insights into milk exchange practices, motivation and barriers for donation to milk banks, and donation patterns.

Milk Sharing/Selling Practices

To our knowledge, this was the first study about milk donors that collected information about their milk sharing/selling practices. In our sample, donors in both settings provided milk to places other than milk banks (51% of US donors and 39% of UK donors). Palmquist et al. conducted an online survey between 2013-2014 of individuals in the United States participating in peer-to-peer milk sharing and reported that 10% of peer-to-peer milk sharers also donated their milk to a milk bank.³³ Our sample showed that a large number of milk bank donors in the UK and US are participating in milk sharing/selling. Thus, further research is needed to evaluate whether high participation in other forms of milk exchange influences donation volumes.

There is limited information about milk bank donors' opinions related to financial compensation for their milk. Overall, in our study most donors did not favor compensation for milk (though rates differed between geographies) and more donors in both settings favored compensation for time and supplies. In a small qualitative study in the US, Pineau et al. characterized how income level influences donations to milk banks (n=19), and observed that most middle/upper income donors reported having an interest in receiving financial compensation.¹⁵ We observed a similar pattern related to income and compensation beliefs in the US, where most US donors reported being in the higher income brackets and were neutral/favorable on receiving financial compensation for their milk, time and supplies. In

contrast, donors in the UK reported being in lower income brackets than US donors and were neutral/disagreed on receiving financial compensation for their milk, time and supplies.

Milk Bank Information, Donation Reasons and Barriers

Despite the fact that milk banking continues to grow around the world²⁸, we noted in our sample that the average number of information sources donors received about milk banks was relatively small in the US and UK (1.3 vs 1.2 sources, $p=0.096$). Moreover, the most common source of information about milk banks was the internet/social media (US: 63% vs UK: 70%, $p=0.112$), followed by information from healthcare providers (US: 41% vs UK: 30%, $p=0.012$). Two studies with milk donors in Asia identified that the most common source of information about milk banks was online, which supports our findings that donors often get milk banking information from the internet.^{10,13} Additionally, we observed a similar trend in a 2007 US study, where the internet was reported being a more popular source of milk bank information (17%) than healthcare providers (14%).⁴ In contrast, we noted a different pattern in a 2008 study of milk bank donors in Brazil ($n=737$), where 61% of donors were encouraged by a healthcare professional to donate. Brazil is the global leader in milk banking, where milk banks are inserted in the healthcare system, which may be related to the higher involvement of healthcare professionals with milk banks.³⁴ In 2020, the number of milk bank donors in Brazil was over 10-times greater than the number of donors in the US/Canada (181,000 versus 14,000).^{35,36} Therefore, healthcare professionals referral to milk banks might play an important role in donor recruitment.

Our findings of top reasons for donating to a milk bank agree with those reported in other settings. Donors from South and North America, Europe, and Asia reported that major donation reasons included the desire to help others/altruism, having excess milk, and being

encouraged/receiving information from health professionals, family members and the internet.³

The motivation of milk donors to give their milk may be similar to the motivation of women who participate in peer-to-peer milk sharing. A study with peer-to-peer milk sharers in the US reported that major reasons for sharing their milk included believing in the high value of breast milk, having an oversupply of breast milk, sources of information about milk sharing and helping and connecting with other mothers.²⁶

In terms of donation barriers, 69-79% of donors reported encountering a barrier. The top three barriers reported by US donors were delivering/sending milk to the milk bank, having enough space to store collected milk, and completing blood work during the screening process. In the UK, top three barriers included completing blood work during the screening process, collecting enough milk to be eligible to donate, and having enough space to store collected milk. We found some overlap in donation barriers reported in other studies of US donors, where major barriers included transporting milk to the milk bank, issues with the blood work, and finding time to pump milk.³ Studies that observed donation barriers in the UK were not identified. Understanding setting-specific donation barriers might allow milk banks to identify and address barriers early in the donation process.

Donation Patterns

Donation volumes widely vary across the world, which could be related to differences in milk bank models and requirements. In the US, milk banks often require a minimum donation volume of 100 oz and allow donations from infants of all ages³⁷, while in the UK, minimum volumes are around 68 oz and donors are often allowed to donate up until infant is 12 months.^{38,39} A study conducted in the US reported that the mean donation volume was 1014 ounces, which is similar to our finding of 1126 ounces from US donors.⁴ Although we haven't

identified studies in the UK that specifically reported donation volumes, studies in countries that are part of EMBA reported mean/median donation volumes of 98-981 ounces.³ The higher end of donation average was similar to what we observed in UK donors from our sample (966 oz).

There were no studies conducted in the US or UK that collected milk type information (e.g., colostrum vs transition vs mature milk). In our sample, more US donors donated milk collected from 1-4 weeks after birth than UK donors (141/369, 39% vs 47/187, 25%, $p=0.003$). More frequent donation of transition milk (defined as being collected before 4 weeks postpartum) among US donors might be related to feeding differences previously described in Chapter III including US donors pumping milk earlier in the postpartum period and more frequently.

Limitations

Limitations of our study included using a convenience sample, where donors who had a positive experience with milk banks may have been more likely to participate. The survey and consent form were distributed digitally, which may have influenced the comfort of donors who were willing to share their experiences, resulting in a sample different from the actual donor population.

Our sample included four different milk banks, with three banks in distinct regions in the US and one bank in the UK. Although our sample illustrated differences in milk bank settings, our findings cannot be generalized to all milk bank populations.

Conclusion

We observed that many milk bank donors in the US and UK are also participating in milk sharing/selling. Whether participation in other forms of milk exchange influences donation volumes is an important area of future research. Donors' sources of milk bank information were

relatively low, with the internet and healthcare professionals being the primary sources reported. A combination of the desire to help others and having excess milk may be the biggest motivator of milk donors, while barriers to donate milk might setting-specific and related to milk bank processes and requirements.

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CHAPTER V: FACTORS THAT PREDICT LIFETIME DONATION VOLUME IN UNITED STATES MILK BANK DONORS

Abstract

To ensure low-birth-weight infants receive an exclusive human milk diet, pasteurized donor human milk is the recommended feeding option when mother's own milk is unavailable. The Human Milk Banking Association of North America currently has 31-member milk banks, with 28 banks located in the United States (US). However, little is known about what factors predict a higher donation volume from donors in the US. The aim of this study is to identify factors that predict lifetime donation volume of milk bank donors in the US. A subsample of 297 participants reported knowing an estimate of their lifetime milk bank donation volume. To test for predictors of lifetime donation volume, we used a backward elimination model. Our model started by considering 14 variables and resulted in a final six-factor model to predict lifetime milk bank donation volume of US donors ($R^2=0.327$). To our knowledge, this was the first study to analyze donors' breastfeeding and pumping experiences, and milk sharing/selling practices as predictors of milk bank donation volume. We have observed logical predictors of lifetime milk donation related to time, including duration since approved as a donor (as a positive predictor), and age of child when first donated (as a negative predictor). A key finding was that greater participation in different forms of sharing/selling was a significant predictor of higher donation volumes. Therefore, collaboration with milk sharing communities might be a valuable strategy for reaching potentially high-volume donors that may have received limited information about milk banking. Excessive milk production beyond what is needed for a donor's infant may have biological, social, and emotional costs for donors and is an important area of future research.

Introduction

To ensure low-birth-weight (LBW) infants receive an exclusive human milk diet, pasteurized donor human milk is the recommended feeding option when mother's own milk (MOM) is unavailable.¹ A recent report disclosed that over 60 countries have operating human milk banks, with over 700 milk banks around the world.² More specifically, the Human Milk Banking Association of North America (HMBANA) currently has 31-member milk banks, with 28 banks located in the United States (US).³ In 2021, HMBANA had 13,000 donors and dispensed nearly 272,000L of milk.⁴ However, little is known about what factors predict a higher donation volume from donors in the US.

Three non-US studies observed that having an infant in the neonatal intensive care unit (NICU) and preterm birth are predictors of donating a higher volume of milk. Bocci et al. conducted a study in Italy with milk donors (n=304) to evaluate donors characteristics and identify factors that predict donation volume and length of donation. Donation volume had a significant relationship with gestational age and length of donation, where donors with preterm births donated higher amounts of milk compared to donors with term births. Additionally, other donors characteristics such as employment status, nationality, education level, type of labor and parity were analyzed, but did not reach significance.⁵

Similarly, Quitadamo et al. conducted a study in Italy with milk bank donors (n=659) to evaluate the contribution of donations from donors with infants of gestational age <35 weeks. Donors who gave birth to preterm infants donated a statistically higher volume compared to donors who gave birth to term infants.⁶

Nangia et al. conducted a study in India with milk bank donors (n=1,553) to evaluate the profile of low- and middle-income donors. Donors who had an infant in the NICU donated a

significantly higher volume of milk compared to those who were in postnatal care ward donors. Additionally, gestational age and birth weight were also analyzed, but were not statistically significant.⁷

Sierra-Colomina et al. evaluated Spanish donors and infants' characteristics and the relationship with donation volumes. Donors that had previously been involved with milk banks and made the first donation with a younger infant were identified as predictors of higher donation volumes. Other donors' demographic and clinical characteristics were analyzed, but did not predict higher donation volumes.⁸

Osbaldiston et al. explored factors that influenced donation volumes in the US, where problems with breastfeeding, donation reasons and barriers, and demographic and lifestyle characteristics were analyzed, however, no significant relationships were observed.⁹

Importantly, factors such as breastfeeding beliefs and support, pumping practices, and milk sharing/selling practices have not been previously studied as predictors of donation volume.

The aim of this study is to identify factors that predict lifetime donation volume of milk bank donors in the US. We hypothesize that having a positive breastfeeding experience, pumping frequently, donating multiple times, and not participating in other forms of milk exchange including milk sharing and selling will predict lifetime donation volume.

Methods

Study Design

This cross-sectional online survey was conducted from August 2022 to December 2022 with approved milk bank donors from three milk banks in the US. A convenience sample of donors (n=369) was obtained from the three geographies. Milk banks were selected based on geographic diversity (Oregon, Texas, and Florida) and having a large number of donors. The

present study was approved by the Institutional Review Board at University of North Carolina at Greensboro.

Subject Recruitment

Approved milk bank donors were invited to participate in the survey through milk bank partners. Milk bank partners included Northwest Mother's Milk Bank (Portland, OR, US), Mother's Milk Bank of North Texas (Benbrook, TX, US), and Mother's Milk Bank of Florida (Orlando, Florida, US). The recruitment goal was to obtain 100 survey responses per geography. Donors received an email from their respective milk banks containing a link to the online questionnaire. The survey included an online consent form before donors started the survey. Eligibility was explored with 2 screening questions. Participants were excluded from the study if they had never pumped/expressed breast milk or if they had not been approved or donated to a milk bank. Participants were also excluded if they had an incomplete survey (<75% of questions answered). To encourage participation, donors were offered the opportunity to enter a drawing with the chance of winning US\$25 gift cards.

Survey Development

The current survey (Appendix A) was developed based on gaps identified in a systematic scoping review about milk bank donors around the world.¹⁰ Six domains were included in the survey: (i) Experiences with feeding their own child(ren); (ii) Experiences expressing/pumping breast milk; (iii) Breastfeeding information and support received; (iv) Beliefs about breastfeeding; (v) Demographic, clinical, and lifestyle characteristics; (vi) Experiences as a milk bank donor.

Experiences with feeding your own child(ren) – Domain i

Questions about how a donor fed their own child were based on a study by O’Sullivan et al. that developed nuanced questions about infant feeding modes¹¹ (the Questionnaire of Infant Feeding – QIF). QIF includes questions about the age of a child when they were first fed directly at the breast, were first fed pumped/expressed milk, and first fed formula. We created an additional question, where based on the first 3 months of their child’s life, participants were asked to characterize their primary feeding mode. Two questions about breastfeeding duration were informed by a survey developed by Palmquist et al.¹² that obtained information about lactation history, among other topics, from milk sharers and milk recipients in the US. The questions refer to the longest duration in months that they breastfed or expressed milk for a single child and the lifetime duration in months that their body produced milk.

Experiences expressing/pumping breast milk – Domain ii

Two questions about pumping/expressing practices and frequency were informed by O’Sullivan’s QIF.¹¹ A question about how old their child was when they first started pumping/expressing milk was modified to frame the question related to the donor’s most recent child. A question regarding the frequency of pumping/expressing milk from QIF was also included. The Infant Feeding Practices Study II (IFPS II)¹³ is a longitudinal survey that was developed to obtain information about maternal feeding practices in the US. It collects information about breastfeeding and pumping/expressing practices. Based on a question from IFPS II, participants were asked about the most frequent way used for pumping/expressing milk. A question about the primary reason for pumping/expressing milk was asked by providing common reasons identified in previous studies in milk sharing communities.¹⁴⁻¹⁶

Breastfeeding information and support received – Domain iii

The IFPS II also collects data about where mothers received information about or assistance with breastfeeding and breast pumps.¹³ Based on that, a question about breastfeeding support was adapted by collapsing possible responses into the following options: information/assistance received from healthcare professionals, relatives or friends, breastfeeding support groups, and other sources such as books and internet. To assess for the support donors received during their infant's first month of life, we used a modified Hughes' Exclusive Breastfeeding Social Support scale (EBFSS).¹⁷ We used three questions from each main category of support – instrumental, emotional, and informational -- which are measured using a 3-point Likert scale, including the options “as much as I would like” = 2, “less than I would like” = 1, and “no help at all” = 0. Therefore, overall support scores could range from 0 to 18, with 0 being no support and 18 being fully supported.

Beliefs about breastfeeding – Domain iv

Beliefs about breastfeeding were assessed using the Beliefs About Breastfeeding Questionnaire (BAB-Q)¹⁸, which was developed to assess maternal beliefs about breastfeeding to predict breastfeeding behaviors. The questionnaire contains 8 constructs related to the “benefits” and “efforts” of breastfeeding that were measured using a 5-point Likert scale. Scores could range from -16 to 16, with a positive score being more benefit than effort, a negative score being more effort than benefit, and 0 being equal amounts of benefit and effort. To measure participants' overall breastfeeding experience, a question using a 5-point Likert scale (from negative to positive experience) was included.

Demographic, Clinical, and Lifestyle Characteristics – Domain v

Donor age, gender, marital status, race, education level, employment status, household income, gestation duration and age of most recent child, number of children, medication use for

chronic health conditions, height and weight were collected. Stress levels were assessed using the Perceived Stress Scale 4¹⁹. Scores range from 0 to 16, with 0 being less stress and 16 being more stress. Diet patterns were assessed by using a modified REAP screener²⁰ that focused on the constructs: consumption of fruits, vegetables, and fish, and the use of prenatal/multivitamins. Exercise patterns was measured by the frequency that participants exercise in a week, based on a modified question from the book: *Designing Quality Survey Questions*.²¹ To further explore donors' background, additional information collected regarding participants include if they ever had a child in an Intensive Care Unit, had a pregnancy of multiples (e.g. twins, triplets), and if they ever lost a child.

Experiences as a milk bank donor – Domain vi

To explore how donors learned about milk banks, a question from IFPS II was adapted by collapsing possible responses into the following options: information/assistance received from healthcare professionals, relatives or friends, breastfeeding support groups, and other sources such as books and internet. Participants were asked if they ever provided their own breast milk in the following scenarios: given to a relative or friend; given to unknown person; sold to an individual in person; sold to an individual that never met; sold to a corporation. The previous question was informed by O'Sullivan's QIF survey¹¹. A question about reasons for donating to a milk bank was informed by research conducted by Gribble¹⁵, Perrin²² and Osbaldiston²³ et al. that described enablers for donating/sharing milk. A question about the primary perceived barrier in milk donations was informed by the procedures utilized by HMBANA in the donation process.²⁴ A question about the month and year that a participant was first approved as a donor was created to assess how long they had been a donor. A question about donation intensity was developed to identify if donors were donating for the first time, had donated several times for

one pregnancy or donated multiple times across multiple pregnancies. A question about participants' life-time volume of milk donated to milk banks was informed by volumes found in research conducted by Perrin et al.¹⁴ (often above 100 ounces) and Palmquist et al.¹² (mean volume = 1356.5 ounces). We developed two questions about how old participants' child was when they started donating to a milk bank and about the type of milk (by lactation stage) participant donated, to obtain information about the type of milk that was being donated (e.g., colostrum vs. mature milk).

Survey validation and configuration

To assess for internal and external validity, the survey was reviewed by experts in the area, including milk banking and breastfeeding experts, International Board-Certified Lactation Consultant (IBCLC) and members from the target population.

The survey was closed after 3 weeks in Oregon, and Texas. In Florida, the survey closed after 4 weeks, due to the email invitations being sent across multiple days.

Not all survey questions required a response, due to the sensitive content (e.g., income). Range of responses for all questions was 89% or higher.

Survey data was reviewed and updated as follows. Questions that had an 'Other' option that allowed open responses were discussed by two researchers to determine if they fit into an existing category within the question or if a new category was needed. To determine how long a participant had been a milk bank donor, the month/year that participants were approved as a donor was converted to the 15th of the month (e.g., may/2022 converted to 05/15/2022) and subtracted from survey completion date to compute the number of days that the participant had been an approved donor. Additional variables that were calculated from survey responses included: BMI; number of information sources for breastfeeding, pumping, and milk banking

was computed by summing the sources of information reported by each participant; number of milk exchange was computed by summing the number of places milk was exchanged that was not a milk bank.

The final survey was configured using Qualtrics software, Version 2021.

Statistical Methods

Analysis from this study were performed in SPSS. Descriptive statistics were used to characterize categorical variables (prevalence) and numerical variables (mean, SD, median, range) of donors' demographic, clinical and lifestyle characteristics, breastfeeding experiences, and milk banking related experiences. Differences in categorical variables were assessed using Chi-square tests. Numerical variables were assessed using a Kruskal Wallis test for nonparametric data and ANOVA for normally distributed data.

To test for predictors of lifetime milk donation volume in US donors, we first performed a bivariate analysis to identify potentially significant variables ($p < 0.1$). We then used a backward elimination modeling approach to identify the most significant predictors of lifetime donation volume.²⁵ All variables identified in the bivariate analysis ($p \leq 0.1$) were initially included in the full model. Then the least significant variable was removed from the model and the model was re-run. We continued to remove the least significant variable and re-run the model until only significant variables were left ($p < 0.05$).

Results

A total of 369 approved milk bank donors agreed to participate in this study, and 297 participants reported knowing an estimate of their lifetime milk bank donation volume. Of those, participants were from the following milk banks: 67 participants from Oregon, 115 from Texas,

and 115 from Florida. The demographic characteristics of participants that reported knowing their lifetime milk bank donation volume can be found in Table 12.

Table 12. Demographic Characteristics of Donors that Reported Lifetime Milk Bank Donation Volume

	Oregon (n=67)	Texas (n=115)	Florida (n=115)	Total US (n=297)
Maternal age (years) ^a	33.9 (3.4)	32.6 (3.9)	33.0 (4.0)	33.0 (3.9)
Gender: # (%)				
Female	67 (100)	114 (99)	115 (100)	296 (100)
Male	0 (0)	1 (1)	0 (0)	1 (0)
Non-binary	0 (0)	0 (0)	0 (0)	0 (0)
Other/ Prefer not to say	0 (0)	0 (0)	0 (0)	0 (0)
Marital Status: # (%)				
Married	66 (99)	109 (95)	106 (92)	281 (95)
Living with a partner	1 (2)	5 (4)	4 (4)	10 (3)
Divorced/Separated	0 (0)	0 (0)	2 (2)	2 (1)
Never Married	0 (0)	1 (1)	3 (3)	4 (1)
Race/Ethnicity: # (%)				
White	61 (91)	99 (86)	101 (88)	261 (88)
Black	1 (2)	2 (2)	2 (2)	5 (2)
Asian	2 (3)	7 (6)	5 (4)	14 (5)
Mixed	2 (3)	2 (2)	5 (4)	9 (3)
Other/Prefer not to answer	1 (2)	5 (4)	2 (2)	8 (3)
Education: # (%)				
< HS graduate	0 (0)	1 (1)	1 (1)	2 (1)
HS graduate	8 (12)	10 (9)	14 (12)	32 (11)
Undergraduate degree	27 (40)	43 (37)	53 (46)	123 (41)
Graduate degree	32 (48)	61 (53)	47 (41)	140 (47)
Employment status: # (%)				
On maternity leave	6 (9)	6 (5)	5 (4)	17 (6)
Not on maternity leave	55 (82)	78 (68)	86 (75)	219 (74)
Unemployed	6 (9)	31 (27)	24 (21)	61 (21)
Household monthly income: # (%) (n=294)				
< 1,000 \$	0 (0)	3 (3)	0 (0)	3 (1)
1,000 to 5,000 \$	11 (16)	19 (17)	40 (36)	70 (24)
5,001 to 10,000 \$	31 (46)	51 (44)	45 (40)	127 (43)
> 10,000 \$	25 (37)	42 (37)	27 (24)	94 (32)
Unless noted, data represent frequency (percentage). ^a Data represents mean (standard deviation) of normally distributed data evaluated using ANOVA.				

A bivariate analysis was performed with variables related to demographic and clinical characteristics, breastfeeding and pumping practices, and milk banking experiences, that we identified as potential predictors of lifetime donation volume. Variables included in the analysis, and p-values for potential significant relationships with lifetime milk bank donation volume are summarized in Table 13.

Table 13. Summary of Variables Tested as Potential Predictors of Lifetime Milk Bank Donation Volume of US Milk Bank Donors

Potential predictor variable	Data type	Description	P-value
Demographics			
Maternal age	Numerical	Maternal age in years	0.559
Marital Status	Categorical	1 = married 0 = not married	0.650
Race	Categorical	1 = White 0 = not White	0.302
Education	Categorical	1 = at least college degree 0 = less than college degree	0.577
Income	Categorical	1 = \$5,001 or more 0 = \$5,000 or less	0.763
Employment status	Categorical	1 = working full time, not on maternity leave 0 = not working full time	0.729
Clinical and Lifestyle			
Maternal BMI	Numerical	Maternal BMI	0.285
Gestational age	Categorical	1 = preterm 0 = not preterm	0.228
Children number	Numerical	Donors number of children	0.002*
Lifetime duration producing milk	Numerical	Estimate of donors' lifetime duration production milk in months	<.001*
Perceived stress	Numerical	Scores from perceived stress scale ranging from 0 to 16, with higher scores related to more stress	0.271
NICU infant	Categorical	1 = ever had an infant at the NICU 0 = never had an infant at the NICU	0.790
Received donor milk	Categorical	1 = had an infant that received donor milk 0 = did not have an infant that received donor milk	0.201
Pregnancy of multiples (e.g., twins)	Categorical	1 = ever had a pregnancy of multiples 0 = never had a pregnancy of multiples	0.509
Bereaved donors	Categorical	1 = ever had a child that passed away 0 = never had a child that passed away	0.589
Breastfeeding and Lactation			
Breastfeeding beliefs	Numerical	Scale related to "benefits" and "efforts" of breastfeeding, scores could range from -16 to 16, with a positive score being more benefit than effort, a negative score being more effort than benefit, and 0 being equal amounts of benefit and effort	0.726
Breastfeeding experience	Categorical	1 = positive experience 0 = not positive experience	0.893
Duration breastfed a single child (months)	Numerical	Longest duration of breastfeeding a single child in months	<.001*
Information sources about breastfeeding	Numerical	Number of sources donors received information about breastfeeding	0.014*
Feeding method first 3 months	Categorical	1 = predominantly mixed human milk feedings (at the breast and pumped milk) 0 = other feeding ways	0.047*
Day started pumping/expressing milk	Categorical	1 = within first week postpartum 0 = after one week postpartum	0.134
Pumping method	Categorical	1 = mainly electric breast pump 0 = mainly other pumping methods	0.850
Pumping frequency	Categorical	1 = several times a day 0 = less than several times a day	0.041*
Pumping reason	Categorical	1 = separation due to work 0 = other pumping reasons	0.559

Information sources about pumping	Numerical	Number of sources donors received information about pumping	0.012*
Milk banking			
Days since approved	Numerical	Number of days since approved as a milk bank donor	<.001*
Donor type	Categorical	1 = first time donor 0 = not first-time donor	<.001*
Child's age at first donation	Numerical	Donors' infant age in months when first donation was made to a milk bank	<.001*
Primary donation barrier	Categorical	1 = any barrier 0 = no barrier	0.485
Primary donation reason	Categorical	1 = to help others 0 = other reason	0.236
Milk types donated	Numerical	Number of types of milk donated, collected across different lactation stages	<.001*
Number of information sources about milk banks	Numerical	Number of sources donors received information about milk banks	0.460
Milk sharing/selling practices	Numerical	Number of milk sharing/selling scenarios donors participated in (range:0-5 sources)	<.001*
Financial compensation milk	Categorical	1 = agree on financial compensation for milk 0 = not agree on financial compensation for milk	0.041*
Financial compensation time and supplies	Categorical	1 = agree on financial compensation for time and supplies 0 = not agree on financial compensation for time and supplies	0.046*
*P-value reflects results of bivariate analysis between potential predictor variable and lifetime milk bank donation volume. Variable with p <0.1 were considered in multi-variable regression model			

Our backward elimination model started by considering 14 variables and resulted in a final six-factor model to predict lifetime milk bank donation volume of US donors ($R^2=0.327$). The significant predictors were: number of days since approved as a donor, number of milk types donated (e.g., colostrum, mature milk), pumping frequency, milk sharing/selling practices, duration breastfeeding single child, and child's age at first donation. Standardized beta-coefficients of the final model are summarized in table 14.

Table 14. Final six-factor model of predictors of lifetime donation volume in US donors created using a backward elimination modeling technique.

Variable name	P-value	Standardized B-coefficient
Number of days since approved	<.001	0.308
Number of milk types donated	<.001	0.197
Pumping frequency	<.001	0.169

Milk sharing/selling practices	0.001	0.166
Duration breastfed single child (months)	0.033	0.124
Child's age at first donation	<.001	-0.184
Significant p-value <0.05; R²=0.327		

Discussion

To our knowledge, this was the first study to analyze donors' breastfeeding and pumping experiences, and milk sharing/selling practices as predictors of milk bank donation volume.¹⁰

In our sample, duration since approved as a donor was the strongest predictor of lifetime donation volume, where being a donor for a longer period was associated with higher donation volumes. Our findings agree with a similar study by Bocci et al. in Italy that identified that length of donation as a predictor of donation volume. Although the measurements used in our sample (days since approved) and in Bocci et al. study (length of donation in months) differed, a longer period of involvement with a milk bank may be related to higher donation volumes.

We observed other donation volume predictors that were related to time, including duration of breastfeeding a single child (as a positive predictor), and age of child when first donated (as a negative predictor). Our findings agree with a similar study conducted in Spain that reported that donors who made the first donation with a younger child donated higher amounts of milk.⁸ Thus, recruiting donors earlier and continuing to promote breastfeeding practices might result in high volume donors.

Pumping milk more frequently and donating more types of milk (e.g., colostrum, transition, mature milk) had a positive relationship with donation volumes (standardized β of 0.169 and 0.197, respectively, $p < .001$). Although pumping more frequently and earlier in the

postpartum period might be logical predictors of higher donation volumes, we noted in our sample that donors reported receiving fewer sources of information/assistance related to pumping than to breastfeeding (described in chapter III). Therefore, the frequent pumping practices may also be an indication of the low pumping support reported by US donors. While the availability of DHM is important for the care of preterm infants who do not have access to MOM, ethical treatment and lack of exploitation of milk bank donors is also required.²⁶ Excessive milk production beyond what is needed for a donor's infant may have biological, social, and emotional costs for donors and is an important area of future research.

Giving birth preterm and having an infant in the NICU were previously identified as predictors of donation volume in other countries.⁵⁻⁷ In the present study, preterm birth and having an infant in the NICU were not identified as predictors of donation volume. However, most participants in our sample reported giving birth term and not having an infant in the NICU (data reported in Chapter III). Thus, different milk banking models might have unique drivers that predict higher donation volumes.

Surprisingly, our findings did not support the hypothesis that donors who participate in milk sharing/selling activities would donate lower amounts of milk. In 2015, HMBANA and the European Milk Banking Association (EMBA) issued a joint statement expressing concern that participating in peer-to-peer milk sharing would have a negative impact on milk bank donations.²⁷ Our findings showed the opposite relationship, where greater participation in different forms of sharing/selling was a significant predictor of higher donation volumes ($\beta=0.166$, $p=0.001$). Moreover, Perrin et al. explored the reasons why lactating women who participated in peer-to-peer milk sharing ($n=27$) had not donated to a milk bank. Major reasons reported included misconceptions about the costs related to milk banks (e.g., believing that milk

banks profit from donor milk), and the lack of information provided by health care professionals about giving milk. Our findings suggest that milk banks may benefit from collaborating with milk sharing communities as a strategy for reaching potentially high-volume donors that may have received limited information about milk banking.

Limitations

Limitations of our study included using a convenience sample, where donors who had a positive experience with milk banks may have been more likely to participate. The survey and consent form were distributed digitally, which may have influenced the comfort of donors who were willing to share their experiences, resulting in a sample different from the actual donor population. Lifetime donation volume was based on donor's memory, however, a study in the US using chart reviews reported similar donation volumes.

Our sample included three different milk banks in the US. Although our sample illustrated predictors of lifetime donation volume, our findings cannot be generalized to all milk bank populations.

Conclusion

We observed logical predictors of lifetime milk donation related to time, including duration since approved as a donor (as a positive predictor), and age of child when first donated (as a negative predictor), which were supported by previous findings in the literature.^{5,8} Different drivers might predict donation volumes in different settings.

A key finding of our study was that greater participation in different forms of sharing/selling was a significant predictor of higher donation volumes. Therefore, collaboration with milk sharing communities might be a valuable strategy for reaching potentially high-volume donors that may have received limited information about milk banking. Milk banks might benefit

from identifying high-volume donors early in the donation process, however ethical treatment and lack of exploitation of milk bank donors is also required.²⁶ Excessive milk production beyond what is needed for a donor's infant may have biological, social, and emotional costs for donors and is an important area of future research.

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CHAPTER VI: EPILOGUE

Conclusion

We observed that factors that are not directly related to milk banking practices (e.g., maternity leave, breastfeeding/pumping support) may have an impact on how donors feed their children and ultimately on their milk production and donation patterns. A high percentage of milk bank donors in the United States (US) and United Kingdom (UK) are involved in other milk exchange practices (e.g., peer-to-peer milk sharing). Donors' sources of milk bank information were relatively low, with the internet and healthcare professionals being the primary sources reported. A combination of the desire to help others and having excess milk may be the biggest motivator of milk donors, while barriers to donate milk might setting-specific and related to milk bank processes and requirements. Specifically to US donors, we noted logical predictors of lifetime milk donation related to time, including duration since approved as a donor (as a positive predictor), and age of child when first donated (as a negative predictor). However, different drivers might predict donation volumes in distinct settings. A key finding of our study was that greater participation in different forms of sharing/selling was a significant predictor of higher donation volumes, suggesting that US milk banks may benefit from forming collaborations with milk sharing networks.

Challenges

The original idea for this project was to have Brazil as one of the countries studied. Brazil is currently the global leader in milk banking and also my home country. Despite many efforts being made, the timeline of this project did not allow Brazil to be included. However, we were able establish a partnership with the UK and include a different international site to this project.

Chapters III, IV and V were created based on the donor survey developed for this dissertation. A scoping review was conducted to identify gaps in the literature related to milk banks donors. Creating a robust and comprehensive questionnaire to address several gaps in the donor literature, while attempting to lessen the burden of participants, was a major challenge.

An additional challenge was related to the data cleaning. Some questions of the survey were created with “check all the apply” answers, and questions that required numerical responses were created with text entry response boxes. These types of responses required extra steps in the data cleaning process.

Information about milk banks donors is limited to a few geographies, where findings are often not generalizable. While we were able to compare our findings to some studies in the US, hardly any studies were identified about milk donors in the UK. Therefore, we decide to also include information available about peer-to-peer milk sharers to expand our work.

Implications for Future Research

Chapter III and IV data highlight the importance of exploring different characteristics, experiences and behaviors of milk bank donors, including factor that may or may not be directly related to milk banking practices. Learning about the profile of donors in different settings may allow milk banks to understand how donors feed their children, their needs, and ultimately how that is related to their milk production and donation patterns. In addition, expanding the support donors receive by healthcare professionals may be a strategy to address donation barriers.

In chapter V, we observed that participating in milk exchange practices in addition to donating to milk banks, was a predictor of donating higher volumes of milk. Thus, collaborating with milk sharing communities might be a valuable strategy for reaching potentially high-volume donors that may have received limited information about milk banking. While milk banks might

benefit from identifying high-volume donors early in the donation process, ethical treatment and lack of exploitation of milk bank donors is also required.¹ Excessive milk production beyond what is needed for a donor's infant may have biological, social, and emotional costs for donors and is an important area of future research.

Closing Remarks

The findings presented in this study provide new insights into the human milk donor literature that have been unexplored and/or unfrequently explored, and how those characteristics are related to donation patterns.

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APPENDIX A: MILK BANK DONORS SURVEY

Question #	Question text	Answers
Q1S	What scenario best describes your most recent experience with pumping/expressing breast milk?	a. I was pumping/expressing breast milk as the result of a pregnancy with my own child b. I was pumping/expressing breast milk as the result of a surrogate pregnancy c. I was pumping/expressing breast milk as a result of inducing lactation d. I have never pumped/expressed breast milk
Q2S	What scenario best describes your experience as a donor to a milk bank?	a. I have previously donated my expressed breast milk to a milk bank b. I have been approved to donate to a milk bank but have not yet made a donation c. I have not been approved or donated to a milk bank
Q3S	Have you fed your breast milk to your own child?	a. No b. Yes
Q1	If day 0 is the day your most recent child was born, how old were they when they first fed directly from your breast?	a. Day 0 (within 24h after birth) b. Within the first week (between days 1-7) c. Within the first month (between days 8-30) d. Beyond 1 month e. My child has never been fed directly at the breast
Q2	If day 0 is the day your most recent child was born, how old were they when they were first fed your pumped or expressed breast milk?	a. Day 0 (within 24h after birth) b. Within the first week (days 1-7) c. Within the first month (days 8-30) d. Beyond 1 month e. My child has never been fed pumped or expressed breast milk
Q3	If day 0 is the day your most recent child was born, how old were they when they were first fed infant formula, even one time?	a. Day 0 (within 24h after birth) b. Within the first week (days 1-7) c. Within the first month (days 8-30) d. Beyond 1 month e. My child has never been fed infant formula
Q4	Thinking about the first 3 months of your most recent child's life, what best describes the way they were fed?	a. Exclusively fed at the breast b. Exclusively fed expressed/pumped breast milk c. Mixed feedings of at the breast and pumped breast milk d. Mixed feedings of formula and breast milk e. Exclusively fed formula
Q5	What was the longest duration in months that you breastfed/expressed milk for a single child (in months)?	Text entry

Q6	What is the duration across your lifetime (in months) that your body has produced breast milk?	Text entry
Q7	If day 0 is the day you gave birth, what was the day that you started pumping or hand expressing breast milk?	<ul style="list-style-type: none"> a. Before I gave birth b. Day 0 (within 24h after birth) c. Within the first week (between days 1-7) d. Within the first month (between days 8-30) e. Beyond 1 month f. I am currently expressing milk because I induced lactation, not because I gave birth
Q8	What is the most common way that you have pumped or expressed milk?	<ul style="list-style-type: none"> a. Electric breast pump b. Manual breast pump (no batteries, no cord to plug in) c. Passive milk collection (e.g., drip cup, Haakaa milk collector) d. Combination electric and battery-operated breast pump e. By hand (without using a pump)
Q9	There are many reasons to pump/express breast milk. Please select the primary reason that describes why you pump/express milk.	<ul style="list-style-type: none"> a. Because of separation from infant due to work (current or future) b. To store breast milk for other planned or unplanned separations besides work c. To maintain or increase breast milk supply d. To gauge breast milk supply e. To manage an oversupply of milk f. To allow other individuals to participate in infant feeding g. To provide milk to another person or entity (e.g. friend, milk bank, milk company) h. Other
Q10	For this next question, please pick the option that best describes your experience with pumping or hand expressing your breast milk.	<ul style="list-style-type: none"> a. I rarely did it b. I did it once or twice a week c. I did it on most days of the week d. I did it once or twice every day e. I did it several times every day
Q11a	<p>Have you ever obtained information about or assistance with breastfeeding from any of the following sources? Check all that apply.</p> <p>Healthcare professional (e.g., doctor, physician assistant, nurse, dietitian, lactation consultant, etc.)</p> <p>Relatives or friends</p> <p>Birthing/baby care class or breastfeeding support group</p>	<ul style="list-style-type: none"> a. No b. Yes

	Internet/social media	
	Other sources (e.g., books, telephone support helpline)	
Q11b	Have you ever obtained information about or assistance with breast pumps from any of the following sources? Check all that apply.	a. No b. Yes
	Healthcare professional (e.g., doctor, physician assistant, nurse, dietitian, lactation consultant, etc.)	
	Relatives or friends	
	Birth/baby care class or breastfeeding support group	
	Internet/social media	
	Other sources (e.g., books, telephone support helpline)	
Q12	Please describe the amount of support you received in each of the following areas during the first month of your most recent child's life.	a. No help at all b. Less than I would like c. As much as I would like
Q12.A	Someone did tasks I would normally do so that I could exclusively breastfeed	
Q12.B	Someone prepared meals	
Q12.C	Someone did laundry	
Q12.D	Someone told me I was doing well caring for my baby	
Q12.E	Someone approved of me exclusively breastfeeding my baby	
Q12.F	Someone showed concern about my own physical condition and mental health	
Q12.G	Someone gave me advice and suggestions about how to exclusively breastfeed	

Q12.H	Someone told me where I could get help if I had questions about breastfeeding or caring for my baby	
Q12.I	Someone taught me how to take care of myself	
Q13	Please rate each of the statements from “strongly disagree” to “strongly agree”.	a. Strongly disagree b. Somewhat disagree c. Neither agree nor disagree d. Somewhat agree e. Strongly agree
Q13.A	Breastfeeding provides many health benefits for babies	
Q13.B	Breastfeeding develops a close bond between mother and baby	
Q13.C	Breastfeeding saves time and money	
Q13.D	Breastfeeding is rewarding for mothers	
Q13.E	Breastfeeding is exhausting	
Q13.F	The lifestyle changes mothers make for breastfeeding are inhibiting	
Q13.G	Breastfeeding is emotionally draining	
Q13.H	Breastfeeding means mothers can't leave their babies	
Q14	How would you rate your overall breastfeeding experience?	a. Much more negative than anticipated. b. A little more negative than anticipated. c. As expected. d. A little more positive than anticipated. e. Much more positive than anticipated.
Q15	How old are you?	Text entry
Q16	What is your gender?	a. Female b. Male c. Non-binary d. Other e. Prefer not to answer

Q17	What is your current marital status?	<ul style="list-style-type: none"> a. Married b. Living with a partner c. Divorced d. Separated e. Widowed f. Never married
Q18	What do you consider to be your race?	<ul style="list-style-type: none"> a. White b. Black or African American c. American Indian or Alaska Native d. Asian e. Native Hawaiian or Other Pacific Islander f. Mixed g. Prefer not to answer
Q19	What is the highest level of education you have completed?	<ul style="list-style-type: none"> a. Less than high school graduate b. High school graduate c. Bachelor's degree d. Master's degree e. PhD or higher
Q20	What is your current employment status?	<ul style="list-style-type: none"> a. Employed full-time and on maternity leave b. Employed full-time and not on maternity leave c. Employed part-time and on maternity leave d. Employed part-time and not on maternity leave e. Not employed
Q22	In what category does your monthly household income fall into?	<ul style="list-style-type: none"> a. Less than \$1,000 b. \$1,000 to \$3,000 c. \$3,001 to \$5,000 d. \$5,001 to \$8,000 e. \$8,001 to \$10,000 f. more than \$10,000
Q23	How many weeks of gestation was your most recent child born?	<ul style="list-style-type: none"> a. < 28 weeks b. 28 to < 32 weeks c. 32 to < 37 weeks d. 37 to 40 weeks e. > 40 weeks f. I am lactating because I induced lactation, not because I gave birth
Q24	How old is your most recent child in months? (If your child is less than 1 month old, please enter zero. If it does not apply to you, please enter n/a).	Text entry
Q25	Please answer whether the following scenarios have ever applied to you.	<ul style="list-style-type: none"> a. No b. Yes
Q25.A	I have had a child in the Intensive Care Unit after they were born	

Q25.B	My child has received donor milk	
Q25.C	I have had a pregnancy with multiple infants (i.e., twins, triplets, etc.)	
Q25.D	I have lost a child shortly after they were born	
Q26	How many children do you have?	Text entry
Q27	Do you regularly take prescription medications for any chronic health conditions (e.g., diabetes, high blood pressure, high cholesterol)?	a. No b. Yes
Q28	The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by selecting how often you felt or thought a certain way.	
Q28.A	In the last month, how often have you felt that you were unable to control the important things in your life?	a. Never b. Almost Never c. Sometimes d. Fairly Often e. Very Often
Q28.B	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	
Q28.C	In the last month, how often have you felt confident about your ability to handle your personal problems?	
Q28.D	In the last month, how often have you felt that things were going your way?	
Q29	In terms of your diet patterns, in a typical week, how often do you:	a. Almost never b. Sometimes c. Almost always
Q29.A	Eat 2-3 servings or more of fruit a day? (Serving = ½ cup or 1 med. fruit or 4 oz. 100% fruit juice)	
Q29.B	Eat 3-4 servings or more of vegetables a day? (Serving = ½ cup vegetables, or 1 cup leafy raw vegetables)	

Q29.C	Eat 2 or more servings of fish a week?	
Q29.D	Take prenatal vitamin or multivitamin each day?	
Q30	In a typical week, how many times do you exercise? (Exercise is defined as physical activity with a duration of at least 30 minutes).	a. I do not typically exercise b. Less than 1 day per week c. 1-2 day per week d. 3 days per week e. 4-5 days per week f. More than 6 days per week
Q31	What is your height in inches? (i.e., 5 feet = 60 inches)	Text entry
Q32	What is your weight in pounds?	Text entry
Q33	Did you get information about human milk banks from any of the following?	a. No b. Yes
	Healthcare professional (e.g., doctor, physician assistant, nurse, dietitian, lactation consultant, etc.)	
	Relatives or friends	
	Birthing/baby care class or breastfeeding support group	
	Internet/social media	
	Other sources (e.g., books, telephone support helpline)	
Q34	Have you ever provided your own breast milk under any of the following scenarios?	a. No b. Yes
Q34.A	Given to a relative, a friend or other person you knew?	
Q34.B	Given to somebody you do not know personally?	
Q34.C	Sold to an individual and met with them to exchange the milk?	
Q34.D	Sold to an individual who you never met?	
Q34.E	Sold to a corporation/business?	

Q35	There are many reasons why people donate breast milk to a human milk bank. What was the primary reason that you initially began donating to a milk bank?	<ul style="list-style-type: none"> a. I wanted to help others b. I had excess milk c. I was encouraged by healthcare professional d. I was encouraged by family member/friend e. Other
Q36	Some steps in donating to a milk bank may be more time-consuming or difficult than other steps. Please identify the primary step that you considered a barrier for donating.	<ul style="list-style-type: none"> a. Completing the preliminary donor screening process b. Completing blood work during the donor screening process c. Following milk bank lifestyle practices for milk donation (e.g., alcohol intake) d. Following milk bank hygiene practices for milk collection e. Collecting enough milk to be eligible to donate f. Having enough space to store the collected milk g. Delivering/sending milk to the milk bank h. I did not encounter any barriers to donating
Q37	When were you first approved as a milk bank donor? (Month/year)	Text entry
Q38	Please select the scenario that best applies to you regarding donating to a milk bank.	<ul style="list-style-type: none"> a. This is my first time donating to a milk bank b. I have donated multiple times to a milk bank across a single child c. I have donated multiple times to a milk bank across multiple children
Q39a	Do you know the approximate life-time volume of milk you have donated to milk banks (in ounces)?	<ul style="list-style-type: none"> a. No b. Yes
Q39b	If yes, please enter the approximate life-time volume of milk you have donated to milk banks (in ounces).	Text entry
Q40	Please rate the following statement from “strongly disagree” to “strongly agree”.	<ul style="list-style-type: none"> a. Strongly disagree b. Somewhat disagree c. Neither agree nor disagree d. Somewhat agree e. Strongly agree
Q40.A	I believe human milk donors should receive financial compensation for their milk	
Q40.B	I believe human milk donors should receive financial compensation for their time and supplies	
Q41	How old was your child when you first started donating to a milk bank?	<ul style="list-style-type: none"> a. Less than 1 month old b. 1 month to less than 3 months old c. 3 months to less than 6 months old d. 6 months to less than 12 months old e. 12 months or older

Q42	The milk that I have donated to a milk bank includes milk collected from the following time periods: (check all that apply)	a. No b. Yes
	Collected from < 7 days after birth (colostrum)	
	Collected from 1-4 weeks after birth (transition milk)	
	Collected from 1 month to 6 months after birth (mature milk)	
	Collected from more than 6 months after birth (mature milk)	