Factors influencing breast milk donation to a human milk bank in Iran: implications for policymakers and planners

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Abstract

Background The World Health Organization (WHO) actively promotes breastfeeding as the optimal source of nourishment for infants and young children. However, not all newborns have access to breast milk, leading to deprivation of its nutritional benefits or incurring financial burdens from alternative feeding options. Establishing Human Milk Banks (HMBs) can help ensure equitable access to donated human milk. However, several factors may hinder breast milk donation. This study aims to identify the factors influencing milk donation to HMBs in Iran.

Methods We conducted a case-control study involving mothers who had given birth at least one year prior to the study. The study included 51 cases (mothers who donated their milk to HMBs) and 153 controls. Data were collected using a questionnaire designed to gather retrospective information on individual health, social networks, and other relevant factors. Logistic regression analysis was performed to examine the relationships between breast milk donation and these factors. Additionally, qualitative data were collected through face-to-face interviews with HMB senior staff and mothers. Thematic analysis was employed to identify perspectives on factors influencing milk donation.

Results Family factors, social influences, individual social welfare scores, and breast milk adequacy were significantly associated with increased milk donation. Among these, family support emerged as one of the strongest predictors of milk donation.

Conclusion To establish HMBs and promote human milk donation, health policymakers and planners should implement strategies that motivate mothers to donate. Evidence-based training and motivational programs for mothers and their families, which address barriers to milk donation, are essential to achieving this goal.

Keywords Milk donation, Milk bank, Human milk, Breastfeeding, Health policy and systems research, Public health

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Background

Breastfeeding, also known as nursing, provides significant health benefits for both mother and infant, and its importance is well-recognized in low- and middle-income countries (LMICs) [1]. Mother's milk is the ideal source of nutrition for both term and preterm infants, offering vital nutritional and immunological benefits while also providing economic advantages for families [1–3]. Research demonstrates that breast milk positively impacts the cognitive development of preterm infants [4–6]. The United Nations International Children's Emergency Fund (UNICEF) and the World Health Organization (WHO) underscore the critical role of breastfeeding in achieving the Sustainable Development Goals (SDGs). Breastfeeding contributes to improved child nutrition (SDG 2), reduced child mortality and lower risks of noncommunicable diseases (SDG 3), and enhanced cognitive development, which supports quality education (SDG 4) [7].

Despite breastfeeding's crucial role in infant health and development, not all infants have access to breastfeeding or their own mother's milk due to various reasons, including health-related issues, maternal death, or separation. According to WHO, donated breast milk is one of the best alternatives for infants who cannot access their biological mother's milk [8]. While donated breast milk may have slightly reduced nutritional value compared to biological mother's milk, it is far more beneficial than powdered formula, particularly for preterm or high-risk neonates [9–11]. However, the direct use of donor milk for preterm infants is sometimes restricted due to the risks of bacterial or viral contamination [12]. Human Milk Banks (HMBs) address these challenges by recruiting breast milk donors and ensuring the safe collection, processing, screening, storage, and distribution of donated human milk. Operating for over a century, HMBs are now an established part of global healthcare systems, helping to ensure equitable access to donor milk [13, 14]. More than 600 HMBs have been established across over 60 countries, with the majority located in Europe, the United States, Asia, and Brazil [7].

In Iran, breast milk donation has deep historical roots but is not widely practiced due to cultural and religious considerations. For instance, potential donor mothers must have a close relationship with the infant's family, and donors are often regarded almost as surrogate mothers, a role that some biological mothers may find difficult to accept. Additionally, the donor's children are considered siblings of the milk recipient, which prohibits future marriages between them under religious law [15]. Recognizing these cultural sensitivities and the proven benefits of donated breast milk, Iran's health leadership took steps to formalize milk donation. In 2016, the country established its first HMB, *Al-Zahra*, affiliated with Tabriz University of Medical Sciences, following a visit by Ministry of Health officials to an HMB in the Netherlands. By 2021, Iran had expanded its network to ten HMBs, making it the leader in the Middle East in terms of HMB infrastructure.

A systematic review by Doshmangir et al. [11] found that key facilitators of milk donation include surplus milk production, altruism, and the desire to help other babies. Conversely, religious and cultural concerns are significant barriers. The review also highlighted that countries with established HMBs must continually adapt and refine strategies to attract donors and ensure sustainable operations. Such strategies should address individual, social, and systemic factors while being tailored to the specific cultural context of each country [11]. The participation of mothers in milk donation programs is critical for the successful operation of HMBs. However, without appropriate training and efforts to address barriers specific to mothers, participation rates may decline, compromising the effectiveness of these programs [16]. Despite the increasing number of HMBs in Iran, no prior studies, to the best of our knowledge, have investigated the barriers and facilitators affecting human milk donation in this context. This study aims to fill this gap by exploring the factors influencing milk donation at Iran's longest-operating HMB, *Al-Zahra*.

Methods

Study design and setting

We conducted a mixed-method study that incorporated both quantitative and qualitative approaches during data collection and analysis. Purposeful data integration provided a comprehensive understanding of the research topic, allowing us to examine the phenomenon of milk bank donation from multiple perspectives. The results from the quantitative and qualitative components were combined during the interpretation stage of the study.

The HMB is located at Al-Zahra Women's Tertiary Referral University Hospital, affiliated with Tabriz University of Medical Sciences. Established in 2015, it is the largest HMB in northwest Iran. At Al-Zahra HMB, the privacy and anonymity of both milk donors and recipients are strictly maintained.

Quantitative component

We employed a case-control design and recruited eligible participants from mothers admitted to Al-Zahra Hospital. Cases were defined as mothers who visited the hospital for postpartum health services and participated in the donor milk program, as documented in hospital records. Controls were mothers who visited the hospital for routine health services but had no prior history of milk donation.

Given that the typical breastfeeding duration in Iran is one year, participants in both groups were mothers who had given birth at least one year before the study. Participants were recruited using convenience sampling from those visiting the hospital or milk bank. Data were collected through face-to-face structured interviews using a standardized questionnaire.

Data collection tool

Participants (cases and controls) completed a Persian-language questionnaire with pre-coded questions designed to collect retrospective data on their health and socio-economic status, social networks, beliefs, and cultural factors. These questions also assessed the characteristics of the participants' closest family members and friends.

The questionnaire content was informed by a comprehensive literature review and interviews with healthcare experts ($n = 17$) from various sectors, including health services management, epidemiology, nursing, and pediatrics. Questions were grouped into domains addressing individual, family and friends, health system, community, and social welfare factors related to human milk donation.

- Individual Questions: Focused on the mother's perception of milk quality, frequency of breastfeeding, experiences of breast pain, and perceived physical and mental effects of milk donation.
- Family and Friends Questions: Examined the attitudes of the participant's mother, husband, in-laws, and closest friends towards milk donation.
- Health System Questions: Investigated access to milk banks, training for health volunteers, availability of educational materials on milk donation, and access to milking machines.
- Cultural and Social Questions: Addressed perceptions of milk donation as a form of altruism, beliefs about milk-sibling relationships and incest, the perceived benefits of milk donation, and the role of media in raising awareness.

The questionnaire's content validity was reviewed by ten health experts using the content validity ratio (CVR) and content validity index (CVI). The CVR assessed the necessity of each question, while the CVI evaluated the simplicity, relevance, and clarity of the questions. The overall CVR and CVI scores were 93% and 92%, respectively.

To ensure reliability, test-retest reliability was assessed by administering the questionnaire twice to 20 potential participants, with a two-week interval between tests. Inter-class correlation (ICC) coefficients with 95% confidence intervals were calculated for each item. The overall ICC was 0.98, and Cronbach's alpha was 0.76, indicating good reliability.

Interviews

Face-to-face semi-structured interviews were conducted with breastfeeding mothers ($n = 7$), non-breastfeeding mothers ($n = 7$), and HMB experts ($n = 7$) in East Azerbaijan Province, Iran. Breast milk donors were selected through convenience sampling, while HMB staff were recruited using purposive sampling. The criteria for selecting HMB experts included prior experience working in an HMB, involvement in establishing HMBs, or participation in planning or policymaking related to HMBs.

Researchers conducting the interviews spent at least two months familiarizing themselves with the research setting, which included the HMB and the hospital's newborn intensive care unit. All interviews were digitally recorded and transcribed verbatim. Interviews continued until data saturation was achieved. Following each interview, participants reviewed and confirmed the transcribed content to ensure accuracy.

Data analysis
Quantitative analysis
Continuous variables were expressed as means with 95% confidence intervals (95% CI), and percentages were calculated for categorical variables. Independent t-tests were used to compare continuous variables between the case and control groups, while chi-squared tests were applied for categorical variables. Fisher's exact test was employed when the expected frequency in any cell of a 2×2 table was less than 5. Odds ratios (OR) with 95% CIs for factors influencing milk donation were calculated using bivariate logistic regression models. Statistical significance was set at $P < 0.05$, and all analyses were performed using SPSS version 23 (IBM Corp., Armonk, NY, USA).

Qualitative analysis
All qualitative interviews were conducted by an academic with extensive experience in qualitative research and holding an associate professor title. Qualitative data were analyzed using a thematic analysis approach. After transcription, interview transcripts were reviewed multiple times to identify main and general concepts. Semantic units were examined on a word-by-word basis, and initial codes were extracted. Duplicate codes were removed to reduce data. Codes with similar meanings were grouped into broader categories, which eventually formed central themes. Themes extracted from the interviews were reviewed and validated by an external expert familiar

with qualitative research methodology to ensure accuracy and reliability [17, 17].

Quantitative findings

Cases and controls

Individual factors

A total of 204 subjects participated in the study, including 51 cases and 153 controls. The mean age of participants in both groups was 30 years. The majority of participants in both the case and control groups had a parity of 1 or 2, but the distribution was significantly different ($P = 0.016$). Most participants were housewives (cases: $n = 48$, 91.3%; controls: $n = 129$, 84.4%) and had attained either a diploma or a bachelor's degree or higher (cases: $n = 37$, 72.5%; controls: $n = 137$, 89.5%). Regarding occupational status, 17.5% ($n = 14$) of mothers in the case group and 10.5% ($n = 16$) in the control group were employed outside the home ($P < 0.01$). Additional participant characteristics are presented in Table 1.

Regarding perceptions of human milk donation, mothers in the case group more frequently reported having excess milk after breastfeeding and agreed that regular milk expression enhances milk production compared to mothers in the control group (both $P < 0.001$; Table 2). Cases also believed that donating milk provided both physical and mental benefits and noted that donated milk could benefit other babies, significantly more so than controls ($P < 0.001$).

Family and friends factors

Family and friends' attitudes toward human milk donation also differed between cases and controls (Table 3). Cases reported significantly stronger support for milk donation from their spouses and family members than controls (both $P < 0.001$). However, encouragement from friends to donate milk to an HMB was low in both groups, particularly among controls ($P < 0.001$).

Health system-associated factors

Table 4 highlights health system-associated factors influencing milk donation. Approximately half of these factors significantly differed between cases and controls. Compared to controls, cases were more likely to have visited an HMB, received non-financial incentives from health workers to donate milk, agreed that access to a breast pump made milk donation more convenient, and reported exposure to advertisements about human milk donation (all $P < 0.001$). Despite these differences, most participants in both groups stated that they received education about milk donation during childbirth at the hospital.

Cultural and social factors

Cultural and social factors influencing human milk donation varied significantly between cases and controls (Table 5). Mothers in the case group were more likely than controls to believe that milk donation does not create a familial bond between the donor and recipient, that it helps others, and that it brings divine reward. Cases were also more informed about milk donation through mass media compared to controls.

Bivariate regression analysis

Bivariate regression analysis showed that mothers in the case group had significantly higher levels of milk sufficiency than those in the control group ($P < 0.001$).

Table 1 Socio-demographic characteristics of cases and controls

Demographic characteristics	Category	Case (N = 51)	Control (N = 153)	P-value	OR*	95% CI
		n (%)	*n* (%)			
Number of confirmed pregnancies (parity)	One	27 (52.9)	59 (38.6)	0.016	Ref	
	Two	21 (41.2)	70 (45.8)		0.66	0.34–1.28
	Three	3 (5.9)	20 (13.1)		0.33	0.09–1.20
	Four and more	0 (0.0)	4 (2.6)		-	-
Occupation	Employed	14 (27.4)	16 (10.5)	< 0.001	Ref	
	Housewife	37 (72.5)	137 (89.5)		0.31	0.14–0.69
Educational status	Under diploma	13 (25.5)	37 (24.2)	0.580		
	Diploma	22 (43.1)	56 (36.6)		1.12	0.50–2.49
	Tertiary education	16 (31.4)	60 (38.2)		0.76	0.33–1.76
Owning a personal car	Yes	40 (78.4)	92 (60.1)	0.012	0.42	0.20–0.87
	No	11 (21.5)	61 (39.8)		Ref	
Owning dishwasher machine	Yes	22 (43.1)	45 (29.4)	< 0.001	0.32	0.16–0.61
	No	22 (56.9)	108 (70.6)		Ref	
Age	(mean ± sd)	30.12 (4.9)	30.65 (4.8)	0.501		
Weight	(mean ± sd)	67.22 (10.3)	71.55 (10.6)	0.010		
Height	(mean ± sd)	162.94 (4.4)	159.75 (5.3)	< 0.001		

Note: sd - Standard deviation; OR – odd ratio; ref- reference category, *: dependent variable = Milk donation; Ref – reference category

Table 2 Perceptions regarding human milk donation

Item	Category	Case (*N* = 51)	Control (*N* = 153)	*P*-value	OR*	95%CI
		n (%)	n (%)			
Do you have remaining milk after breastfeeding your baby?	Rarely	1 (1.9)	66 (43.1)	< 0.001	Ref	
	Sometimes	3 (21.9)	34 (22.2)		5.82	0.58–58.13
	Usually	14 (27.4)	33 (21.5)		28.00	3.53-222.19
	Most of the times	22 (43.1)	11 (7.2)		132.00	16.11-1081.40
	Always	11 (21.5)	9 (5.9)		80.67	9.28-701.11
In addition to breastfeeding, does frequent milking increase the production of your breast milk?	Yes	44 (81.3)	54 (35.3)	< 0.001	11.52	4.86–27.33
	No	7 (18.7)	99 (64.7)		Ref	
Does filling your breasts make it painful?	Yes	28 (54.9)	61 (39.9)	0.044	1.84	0.97–3.48
	No	23 (45.1)	92 (60.1)		Ref	
Is donating breast milk physically beneficial for you?	There is no harm	11 (21.6)	82 (9.1)	< 0.001	Ref	
	Neither harm nor benefit	7 (13.7)	58 (43.8)		0.90	0.33–2.46
	There is benefit	21 (41.2)	9 (5.9)		17.39	6.38–47.42
	There is a lot of benefit	12 (23.5)	2 (1.3)		44.73	8.82-226.89
	I do not know	0 (0.0)	2 (1.3)		-	
Is donating breast milk mentally beneficial for you?	There is no harm	10 (19.6)	16 (10.4)	< 0.001	Ref	
	Neither harm nor benefit	5 (9.8)	53 (34.6)		0.15	0.05–0.51
	There is benefit	9 (17.6)	10 (6.5)		1.44	0.43–4.77
	There is a lot of benefit	22 (43.1)	11 (7.2)		3.20	1.10–9.34
	I do not know	5 (9.8)	62 (40.5)		0.13	0.04–0.42

Note: * dependent variable = Milk donation; Ref – reference category

Table 3 Family and friends' attitude towards human milk donation

Item	Categories	Case (*n* = 51)	Control (*n* = 153)	*P*-value	OR*	95% CI
		n (%)	n (%)			
Does your husband agree with your milk donation to HMB?	No	5 (9.8)	64 (41.8)	< 0.001	Ref	
	Yes	40 (78.4)	17 (11.1)		30.118	10.31–88.03
	I do not know	6 (11.8)	72 (47.1)		1.067	0.31–3.66
Does your family agree with your milk donation to HMB?	No	6 (11.8)	57 (37.2)	< 0.001	Ref	
	Yes	37 (72.5)	12 (7.8)		58.58	15.48-221.75
	I do not know	8 (15.7)	84 (54.9)		2.49	0.66–9.32
Until now, do your friends encourage you to donate your milk to HMB?	No	33 (64.7)	136 (88.9)	< 0.001	Ref	
	Yes	18 (35.3)	17 (11.1)		4.36	2.03–9.37

Note: * dependent variable = Milk donation; Ref – reference category

Additionally, no statistically significant differences in demographic characteristics were observed between the two groups. Individual, family, social, and health system factors were all positively and significantly associated with milk donation (*P* < 0.001 for all).

Qualitative findings

The findings from the qualitative and quantitative components of the study were generally consistent. Both sets of results indicated that societal attitudes and beliefs, training, motivation, and accessibility were among the most influential factors for mothers donating milk to Human Milk Banks (HMBs). While the quantitative data did not reveal a significant relationship between physiological factors and milk donation, the qualitative findings highlighted their importance from the mothers' perspectives.

The factors influencing milk donation to HMBs were categorized into four main themes—physiological factors, societal attitudes and beliefs, training and motivators, and accessibility—and 14 sub-themes (Table 6). Details of the interview participants are provided in Appendix 1. Among the 21 interviewees, seven had experience with milk donation, seven did not, and the remaining participants included the hospital manager and HMB health workers.

Physiological factors

Participants identified several physiological factors as crucial for influencing breastfeeding and milk donation

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Table 4 Health system factors related to a human milk donation

Item	Category	Case (*n* = 51)	Control (*n* = 153)	*P*-value	OR*	95% CI
		n (%)	n (%)			
How much is it possible for you to go to the milk bank?	Very low	7 (13.7)	72 (47.0)	0.001<	Ref	
	Low	14 (27.4)	44 (28.7)		3.27	1.23–8.74
	Moderate	21 (41.2)	15 (9.8)		14.40	5.19–39.95
	Much	8 (15.7)	3 (1.9)		27.43	5.90-127.58
	Very much	0 (0.0)	1 (0.6)		-	
	I do not know	1 (1.9)	18 (11.7)		0.57	0.07–4.95
Have community health workers (in your health centres) taught you about the possibility to donate milk donation?	No	34 (66.6)	120 (78.4)	0 0.056	Ref	
	Yes	17 (33.3)	33 (21.5)		1.82	0.90–3.65
Have your paediatrician taught you about milk donation?	No	36 (70.6)	137 (89.5)	0.002	Ref	
	Yes	15 (29.4)	16 (10.4)		3.57	1.61–7.89
Have you been taught to donate milk during pregnancy by the health centre' midwives?	No	38 (74.5)	135 (88.2)	0.019	Ref	
	Yes	13 (25.5)	18 (11.7)		2.566	1.15–5.70
Have you been taught to donate milk during childbirth at the hospital?	No	5 (9.8)	27 (17.6)	0.066	Ref	
	Yes	46 (90.2)	126 (82.3)		2.52	0.84–7.58
Have you ever been offered a non-financial incentive to donate milk from the milk bank?	No	11 (21.5)	146 (95.4)	0.001<	Ref	
	Yes	40 (78.4)	7 (4.57)		75.84	27.62-208.26
Does offering a milking machine by HMB make the milk donation easier for you?	No	6 (11.7)	22 (14.38)	0.001<	ref	
	Yes	39 (76.4)	26 (17.0)		38.08	4.85-299.15
	I do not know	6 (11.7)	105 (68.6)		1.05	0.12–9.41
Have you ever seen an advertisement about donating milk?	No	15 (29.4)	129 (84.3)	0.001<	Ref	
	Yes	36 (70.6)	24 (15.7)		12.90	6.13–27.13

Note: * dependent variable = Milk donation; Ref – reference category

Table 5 Cultural and social factors related to human milk donation

Item	Category	Case (*n* = 51)	Control (*n* = 153)	*P*-value	OR*	95% CI
		n (%)	n (%)			
Do you see milk donation as a kind of help to others?	No	1 (2.0)	61 (39.9)	< 0.001	Ref	
	Yes	50 (98.0)	92 (60.1)		33.15	4.46-246.37
Does milk donation to HMB cause a family relation?	No	41 (80.4)	42 (27.4)	< 0.001	Ref	
	Yes	5 (9.8)	39 (25.5)		0.13	0.05–0.37
	I do not know	5 (9.8)	72 (47.1)		0.07	0.03–0.19
Do you believe that milk donation has a God's reward?	No	8 (5.9)	60 (39.0)	< 0.001	Ref	
	Yes	48 (64.1)	93 (60.8)		10.32	3.08–34.64
Have you ever heard about milk donation in the media?	No	32 (62.7)	137 (89.5)	< 0.001	Ref	
	Yes	19 (37.2)	16 (10.4)		5.08	2.36–10.96
In your workplace, can you take time off to go to HMB and donate milk?	No	8 (15.7)	11 (7.7)	0.140	Ref	
	Yes	7 (13.7)	5 (3.7)		1.92	0.44–8.33
	Not applicable	36 (70.6)	137 (89.5)		-	

Note: * dependent variable = Milk donation; Ref – reference category

to HMBs. These included maternal health, the quantity and quality of breast milk produced, and the infant's health. One participant stated:

> *"A mother who has enough milk herself and produces more milk than her baby needs and has no difficulty in breastfeeding has more motivation for milk donation." (Senior HMB Manager 3).*

Societal attitudes and beliefs

Family and spousal attitudes were found to have a significant impact on mothers' decisions regarding milk donation. For example, one mother shared her reasons for not donating:

> *"Even though I have much milk, my mother-in-law is against donating breast milk, and her attitude affects my husband; that is why he is also against donating milk." (Mother 8).*

Table 6 Themes and subthemes related to factors influencing milk donation to HMBs

Themes	Subthemes
Physiological factors	• Breastfeeding problems • The amount of breast milk • Treatment of breast pain after breastfeeding
Societal attitudes and beliefs	• Knowledge of mothers and others • Altruism and humanity • Cultural roots and origins • Donors' culture
Training and motivators	• Individual motivators • Substantial motivators • Incentive mechanisms • Advertising for donation
Accessibility	• Number of HMBs • Facilities to milk bank • Time interval to reach the milk bank • Equipping the milk bank with the most modern equipment and devices

Note: HMB, human milk bank

Cultural, societal, religious, and spiritual beliefs were identified as influential factors. Motivators such as divine reward, altruism, helping others, and making other parents happy were frequently mentioned. One mother explained:

"I vowed that if my baby were born healthy, my baby would eat half of my milk, and I would give the other half to other babies." (Mother 4).

Conversely, some participants highlighted religious beliefs, such as concerns about consanguinity and kinship, as barriers to milk donation:

"I believe that if a mother breastfeeds a child, that child will become consanguineous with her children, and they should not marry each other in the future." (Mother 12).

Training and motivators
Several mothers mentioned that they were not informed about milk donation by community health workers, pediatricians, or midwives during pregnancy. Suggested motivators for encouraging milk donation included providing necessary equipment, such as milk pumps, offering incentives, such as recognition certificates, diapers, or free health checks, educating mothers in neonatal intensive care units (NICUs) about the benefits of breastfeeding and human milk donation and advertising through mass media, Friday prayers, women's meetings, and informative posters.

A senior staff member highlighted the importance of NICUs in motivating milk donation:

"Generally, our donors are those who are in the neonatal and newborn intensive care unit section, and they are dealing with the process of donating milk. Therefore, they understand the need for donated milk, and the internal advertising is done by influential people such as the head nurse."

A junior staff member also emphasized the role of training:

"When mothers are trained how to donate their milk, it encourages them to donate."

Accessibility
Barriers related to accessibility included long travel distances, the lack of HMBs in many cities, and the absence of efficient milk collection systems in smaller towns. One mother explained her reasons for not donating:

"There is only one milk bank, and it is situated in the center of the province. If the donor is in the township, she must go to the center of the province by using a vehicle, which is why so many mothers prefer not to donate their milk." (Mother 7).

Discussion
HMBs rely on donor milk and cannot thrive without a robust breastfeeding culture [16]. Our findings highlight the critical role of family and community support, along with counseling, in promoting human milk donation to HMBs. To address these needs, governments should establish and implement welfare programs that provide comprehensive support to mothers for human milk donation.

The perceptions of family and friends were identified as significant factors influencing mothers' decisions to donate human milk. Disagreement from husbands was shown to significantly deter donations to HMBs. Successful milk donation often requires collaboration among key family members, including senior female relatives and husbands [18]. Evidence suggests that such challenges can be mitigated by conducting educational programs for fathers and raising awareness about HMB activities, goals, and the benefits of milk donation for both mothers and children [19–21]. An adequate supply of milk was another key factor influencing human milk donation. Mothers who had surplus milk after feeding their infants were more inclined to donate. Azema (2003) reported that 40–60% of mothers cited having an excess supply of milk and a desire to help others as the primary motivations for donating milk [22]. Similarly, Gribble (2014) found that among 97 donors, surplus milk and the desire to avoid waste were prominent reasons for human milk donation [23].

Healthcare providers, including physicians, nurses, and health workers, play a pivotal role in educating and motivating mothers to donate milk [24]. Research shows that training programs led by healthcare professionals build trust among parents and positively influence milk donation rates [10, 25]. Mackenzie et al. (2013) highlighted that healthcare professionals are a vital source of information for milk donors [26]. Pimenteira et al. (2008) emphasized that multiple strategies initiated by health professionals such as providing information during hospitalization for childbirth can encourage milk donation [27].

In our study, we found a significant relationship between physician involvement and milk donation. However, training by other health workers was not significantly associated with donation. This may be attributed to the novelty of HMBs in Iran and their limited integration into the healthcare system. Furthermore, healthcare providers and volunteers may lack sufficient knowledge about HMBs and the importance of milk donation.

We also observed no significant relationship between training provided during childbirth and milk donation. However, advertising in hospital wards, such as neonatal intensive care units (NICUs), and health centers was significantly associated with human milk donation. The limited impact of training during childbirth could be due to factors such as the mother's postpartum condition or the poor quality of hospital training programs. To address this, evidence-based and updated training materials could improve the effectiveness of these programs.

Our findings suggest that educational programs during pregnancy could have a significant impact on milk donation rates. Expectant mothers should receive training on nutrition, breastfeeding, and the benefits of human milk donation. Carroll et al. (2014) underscored the importance of educating pregnant mothers and providing healthcare support for milk donors, particularly those who have experienced child loss. Furthermore, organizing case management for mothers facing difficulties accessing HMBs or breastfeeding could enhance milk donation [28].

The establishment of HMBs in predominantly Muslim countries can present unique challenges due to religious concerns. Some families may decline donated human milk due to cultural or religious beliefs [29–31]. Grol et al. (2014) found that 36.3% of respondents viewed milk banking as problematic for religious reasons, and 28.9% expressed concerns about potential social and moral issues [32]. However, in Iran, religious objections appear to be less prominent, and accurate information dissemination can effectively address these concerns.

Finally, the lack of breastfeeding information provided to mothers remains a major concern. Carroll et al. (2014) demonstrated that education for pregnant mothers and

professional support for milk donors are critical factors influencing donation decisions [28]. Improving mothers' access to HMBs and enhancing public awareness could significantly boost milk donation rates in Iran and other countries.

Limitations
The study had some limitations. First, due to the characteristics of Iranian society, the findings are locally valuable but difficult to generalize to other milk banks, though they may be beneficial for Iranian women immigrants in other countries. For future research, it would be interesting to explore the connection between donor characteristics, donation timing, and the volume donated.

The findings of a multi-center study conducted in countries with characteristics similar to Iran could provide more valuable insights into donor behaviors. Such results would help promote milk donation in these regions.

Conclusion
A central policy of Iran's healthcare system is to develop evidence-based training and motivational programs for families that address barriers to milk donation. Training programs should target all members of society, including breastfeeding mothers, their spouses, family members, and close friends where necessary. Information campaigns should utilize diverse mass media platforms, healthcare professionals, and social and religious organizations. Maternal education during pregnancy is a pivotal and influential factor in preparing mothers for future milk donation.

Our study highlights two key areas for further research. The first is the investigation of strategies to maintain the health and microbial safety of HMBs, and the second is exploring the barriers that prevent mothers without milk from accessing donated milk from HMBs.

Appendix 1) Characteristics for women who participated in the interviews

Participants	*N*=21
MoHME officers	2
Hospital manager	1
Milk bank officers	2
Faculty member	2
Mothers with experience of donation	7
Mothers with no experience of donation	7

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Data availability
The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Before starting the interview, the interviewees were fully explained about the importance, aims and research methods. The written consent form was obtained from the participants. The ethics committee of Tabriz University of Medical Sciences approved the project (Approval No: IR.TBZMED. REC.1398.1241). The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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