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Donor and newborn profiles and their influence on donation volume and duration: a cross-sectional study in a Spanish human milk bank

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Abstract

Background Human milk banks are essential facilities to provide donated human milk (DHM) to preterm and term infants with health complications. Little is known regarding milk bank donors and how their characteristics may influence the particularities of the donation process. The present study aims to assess characteristics of donors and their newborns to identify associations with the amount of DHM and initiation and donation time, during the first and second year of the milk bank operation in Córdoba, Spain.

Methods This cross-sectional study was conducted in three periods: pre-opening of the milk bank (PRE) including all women who gave birth to a newborn between January – May 2017 and were hospital users; donors in the first year after the opening (Period 1 (P1): April 2019 – March 2020); and in the second year (P2: April 2020 – March 2021). For P1 and P2, DHM data were recorded. The relationships between donor and newborn characteristics and the donation process were examined using univariable and regression models.

Results From 391 women interviewed in the PRE period, 55 (14%) showed intention to donate. In P1 and P2, there were 51 and 25 human milk (HM) donors, respectively. Age, gestational age (GA) and parity were similar between periods. In P2, a higher proportion of donors had higher education (P1: 46%; P2: 70.8%, $p=0.045$). Around 40% of donors in both periods were on maternity leave. In P1, donors who had low birth weight infants (< 2500 g) donated more HM than those with infants weighing ≥ 2500 g ($p=0.020$). In P2, women whose GA was < 37 weeks donated a higher volume vs. those with ≥ 37 weeks ($p=0.002$). Maternity leave was linked to a shorter initiation time for donations in both periods (P1: $p=0.002$; P2: $p<0.001$).

Conclusions Data obtained from a Spanish human milk bank indicate that prematurity and low birth weight appear to influence the amounts of DHM. Employment status might be a decisive factor in initiating HM donation. Additional efforts are required to identify shared donor characteristics that influence the initiation and volume of donation.

Keywords Human milk donor, Milk bank, Donation, Gestational age, Prematurity, Birth weight

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Background

Breastfeeding is an important practice for public health, delivering benefits to both infants and their mothers, as well as to society at large [1]. It not only reduces infant morbidity and mortality, largely due to its protective effects against infectious diseases [1], but also offers long-term protection against metabolic diseases such as obesity [2]. Breastfeeding is unfortunately not possible in low birth weight and / or preterm infants because they have difficulties sucking milk from the mother's breast. In these cases, obtaining donated human milk (DHM) has become an increasingly common practice during hospitalization. It is considered the first alternative to milk coming from the infant's own mother according to the World Health Organization (WHO) [3]. In this context, the milk banks, as non-profit entities, have a major role to provide DHM to preterm and term infants facing medical challenges [1].

DHM preserves significant clinical advantages and nutritional properties for preterm infants in contrast to infant formulas. These benefits encompass shielding against necrotizing enterocolitis [4] and nosocomial infections, along with enhancing digestive tolerance [5]. Beyond its positive impact on infant health, milk banks offer economic and social advantages, including lowered healthcare expenses due to decreased necrotizing enterocolitis rates [6, 7].

Through the European Milk Bank Association (EMBA) guidelines, the operating system of the milk banks is increasingly developed and controlled, making all the DHM processing more secure and efficient. To obtain DHM voluntarily by lactating women is the first step to be developed and therefore an essential step in the process. Hence, to identify social and clinical patterns in donors could provide a useful overview to incorporating new donors. In addition, it is important to detect any challenges in order to facilitate the donation process. Furthermore, the COVID-19 pandemic might importantly have influenced, as it does in all fields, the milk bank procedure and the number of donors. However, there is little evidence on how it has influenced the profile of women who become human milk (HM) donors [8–11].

Based on a recent systematic review, ten studies have been conducted globally concerning donors and newborns factors that influence HM donation [12]. Among these studies, only two Spanish hospitals have examined donor characteristics [13–15], identifying common traits such as being around 30 years old and having a university education [13, 14]. Furthermore, two of these studies also explored the connection between donor profile and both the length [13] and volume [15] of their donations. However, it is worth noting that these data were reported nearly one decade ago, highlighting the need for more recent research findings to contribute establishing key donor patterns and their impact on HM donation characteristics.

The objectives of the current study were (1) to analyze the characteristics of the mothers who showed intention to become milk donors, prior to the opening of the milk bank; (2) to evaluate the milk donors' characteristics, the donation time and the DHM volume during the first and second year of its operation; and (3) to identify the social and clinical factors that influence the amount of DHM, as well as the initiation and duration of the donation, and to detect any distinct patterns within these associations due to the pandemic situation.

Methods

This cross-sectional study was carried out in three different periods in a third level center, Reina Sofia University Hospital in Córdoba, Spain. The milk bank of this hospital was established on 17 April 2019. For the first period (pre-opening of the milk bank (PRE)), data were prospectively collected from all women who gave birth to a newborn in our hospital between January and May 2017, without considering any exclusion criterion. Four successive surveys were conducted (see Additional file 1): at hospital discharge, one month postpartum, four months postpartum, and nine months postpartum. These postpartum stages were chosen based on their possible relevance in the decision to donate. The first survey was conducted in person, while the other three were via telephone. Women who answered affirmatively at all the postpartum stages regarding their intention to donate HM if a milk bank were to be established in the hospital, were considered as potential candidates to become donors. After the opening of the milk bank, data from donor women were retrospectively collected for the first two years of its operation (Annual Period 1 (P1): April 2019 – March 2020; Annual Period 2 (P2): April 2020 – March 2021).

Since the opening of the milk bank, a screening process has been implemented following international recommendations [16] to ensure that women meet the inclusion criteria to become donors. The last criterion has been removed as it was incorrect. We also accept donations of colostrum and intermediate milk, which refers to milk collected during the first days and weeks postpartum. They must be healthy women, free of infectious disease transmissible through HM (confirmed by a serological test), have well-established lactation and have met their child's nutritional needs. Women are excluded from donating HM if they have active infectious disease, breast skin infections, or are carriers of hepatitis B surface antigen. Positive markers for hepatitis C, syphilis, HIV-1, HIV-2, HTLV-1, HTLV-2, Trypanosoma cruzi, or any current or past sexually transmitted infections also disqualify donors. Other exclusions include having had

risky sexual intercourse, current use of drugs, alcohol, tobacco, or consuming two or more caffeine-containing drinks per day. History of heroin use, use of medications or herbal products that contraindicate breastfeeding, and supplementation of vitamins A, C, B6, or E in megadoses are also disqualifying factors. Women following a vegan diet without adequate B12 supplementation during pregnancy and lactation are excluded, as are those with chronic or systemic debilitating diseases, transmissible spongiform encephalopathies, or exposure to radiopharmaceuticals.

Donor women are provided with sterile equipment, breast pumps (if needed) and detailed instructions on best practices for expressing and collecting milk. DHM is collected using sterile single-use milk collection kits and stored in sterile glass bottles with secure lids. HM can be expressed either in the lactation room of the milk bank at Reina Sofia University Hospital or at home. Once collected at home, HM should be stored at -20 °C until it is brought to the milk bank. Upon arrival, the milk remains stored at -20 °C until it undergoes pasteurization. A minimum volume of HM is not required to become a donor; women contribute whatever amount of milk they consider possible. For all periods, sociodemographic data including donor age, place of residence, educational level (categorized as "no studies / basic studies" or "higher education" for post-secondary school studies such as vocational training and university education), employment situation and maternity leave, as well as obstetric and clinical information (gestational age (GA), parity, newborn birth weight, prematurity and newborn hospitalization) were collected. All mothers were included as users of the Reina Sofia University Hospital, regardless of their place of residence.

For P1 and P2, we asked donors via what means they knew of the milk bank and the reasons that caused the cessation of the donation (should this have occurred). DHM data were collected from each milk donor, encompassing the volume donated per day, the total volume and the length of donation time for each post-opening period. In addition, the time that elapsed between the birth and commencement of milk donations was calculated. The number and characteristics of the lactating women who, in the end, did not start donations were also collected.

All clinical and sociodemographic information was retrospectively extracted from the donor's medical records and kept confidential by numerical codification. The study was conducted following the standards of the Declaration of Helsinki and was approved by the Ethics Committee of the Reina Sofia University Hospital.

Statistical analysis

Data are presented as mean±standard deviation (SD) or median (interquartile range, IQR) for continuous variables. Normality of all continuous variables was assessed using Q-Q plots and histograms. None of the variables showed a normal distribution except the donor age. Total volume and total donation time were log10 transformed to mitigate substantial dispersion in the data. However, data are presented as untransformed values to ensure a clear understanding. To explore the period differences, the U Mann-Whitney test was used for those variables where a log10 transformation did not normalize the data. For the donor age, Student-t test was applied. Several continuous variables were categorized to enhance the understanding of their relationship with the outcome variables based on specific cutoffs: donor age was classified into three categories (<30 years, 30–35 years, and ≥36 years), GA into two categories (<37 weeks (prematurity), ≥ 37 weeks (term birth)), and birth weight into two categories (<2500 g (low birth weight), ≥ 2500 g). Categorical variables are expressed as counts (*n*, %) and the differences between periods were tested by X^2 test. Univariable general linear models (GLM) were performed to examine the association of donor and newborn characteristics (as explanatory categorized variables) with the donation volume, starting time of donation and length of donation time (outcome variables). Linear regression models were employed when the independent variables were continuous. As the length of donation time strongly influences the DHM volume, analyses for this outcome were adjusted to account for this covariate. Furthermore, two extreme values (>3 lengths away from Q3) that belonged to "length of donation time" and "total DHM volume" variables from two donors (P1: 1 value; P2: 1 value) were removed. All models were evaluated by model control (investigating linearity of effects on outcome(s), normality of residuals and variance homogeneity). Tests were done using a two-sided 5% significance level, and all statistical analyses were carried out using SPSS software version 25 (SPSS Inc., Chicago, IL, USA).

Results

Assessment of profiles of mothers interviewed before the opening of the milk bank and mothers who became HM donors

Table 1 describes the demographic and clinical characteristics of the women and their newborns in PRE, P1 and P2. From 391 lactating women interviewed in the PRE period, 55 (14%) showed intention to donate at all postpartum stages evaluated. These women were considered as potential candidates to be HM donors. Their mean age was similar to the donors of both post-opening periods, as well as the GA. The percentage of first-time mothers ranged from 54% (PRE) to 66% (P2). The majority of women in all periods were of Spanish nationality (PRE: $n=55$, P1: $n=49$, P2: $n=25$) and from the province of Córdoba (PRE: $n=54$, P1: $n=48$, P2: $n=25$). Regarding

Table 1 Profile and characteristics of lactating women with intention to donate (PRE), donors (P1, P2) and their infants

	PRE (*n* = 55)		**P1 (*n* = 51)**		**P2 (*n* = 25)**		***P*-value***
Women's characteristics	n		n		n		
Age (years)	55	32.6 ± 4.9	51	33.57 ± 5.51	25	32.52 ± 5.4	0.438
< 30	15		9		9		0.369
30–35	26		20		8		
≥ 36	14		22		9		
Gestational age (weeks)	55	40 (1)	51	39 (3)	25	39 (3)	0.450
< 37	3		7		4		0.791
≥ 37	52		44		21		
First-time mother	30		29		16		0.475
Educational level	*n* = 55		*n* = 50		*n* = 24		
No studies / basic studies	15		27		7		**0.045**
Higher education	40		23		17		
Occupational activity			*n* = 50		*n* = 22		
Homemaker	25		7		1		0.643
Untrained work	NA		17		8		
Trained work	30		25		12		
Student	NA		1		1		
Working situation at starting donation			*n* = 37		*n* = 16		
Maternity leave	-		15		7		0.927
Leave of absence	-		3		2		
Unemployed	-		7		3		
Active:	-		12		4		
Full-time	-		8		4		0.182
Part-time	-		4		-		
Infant's characteristics			*n* = 51		*n* = 25		
Birth weight (g)	55	3275 (600)	49	3220 (690)	23	3000 (910)	0.236
Birth weight < 2500 g	2		6		5		0.296
Very preterm infant[†]	-		4		1		0.525
Hospitalization after birth	-		2		3		0.182

Given that not all women responded to all questions, the count (*n*) for each variable is provided alongside the total count. Continuous variables are presented as mean ± SD or median (IQR), and period differences were assessed via Student-t or U Mann-Whitney test, respectively. Categorical variables are expressed as counts, and differences between periods were evaluated using X^2 test. *GA* gestational age, *HO* holidays, *mo* months, *NA* non-available, *PRE* pre-opening phase of the milk bank, including all women who gave birth to a newborn between January and May 2017 and were users of the hospital, *P1* annual period 1 (April 2019 – March 2020), encompassing donors from the first year after opening, *P2* annual period 2 (April 2020 – March 2021) encompassing donors from the second year of operation. [†] < 33 GA and/or < 1500 g. * P1 vs. P2, significant differences in bold ($p < 0.05$)

the educational level, a high proportion of women with higher education was especially observed in PRE and in P2 periods.

Regarding the infant characteristics, most of them had a birth weight exceeding 2500 g and were born at full term.

Comparison of the donor profiles in the two post-opening periods

Significant differences were not observed in donor age, GA, or parity between the post-opening periods (Table 1). However, differences were detected in the educational level, with a homogeneous distribution in P1 period, while in P2 a higher proportion of donors had higher education ($n = 17$, 70.8%, $p = 0.045$). Regarding the occupation and the working situation at the starting time of donation, no significant differences were observed between the post-opening periods. Eighteen (40.5%) in P1 and seven donors (43.8%) in P2 were on maternity leave. However, it should be noted that a considerable proportion of donors were actively working when they started the donation (P1: $n = 12$, 32.4%; P2: $n = 4$, 25%), and a large part of them, especially in P2, at full-time (P1: $n = 8$, 66.7%; P2: $n = 4$, 100%).

Infants exhibited similar median birth weights between periods (P1: 3220 g; P2: 3000 g), with no statistically significant differences observed in the counts of low birth weight (< 2500 g) or prematurity. In both periods, a small proportion of women delivered infants who required hospitalization (P1: $n = 2$, 3.9%; P2: $n = 3$, 12%) or were very preterm infants (P1: $n = 4$, 7.8%; P2: $n = 1$, 4%) (Table 1).

A total of 13 (20.3%) women in P1 and five (16.7%) women in P2 initially registered as potential donors for the milk bank, but ultimately did not initiate the donation process. The women's average age was 31.9 years,

Table 2 Volume of DHM and donation times for each period

	P1 ($n=51$)	P2 ($n=25$)	*P*-value
Donated volume / day (mL)	90 (55)	90 (48)	0.626
Total volume (mL)	3378.55 ± 7445.79	4339.52 ± 11025.45	0.758
Time elapsed after childbirth (weeks)	19 (35.9)	8.7 (31.4)	**0.047**
Total donation time (weeks)	4.71 ± 6.60	4.83 ± 8.07	0.996

Variables are presented as mean ± SD or median (IQR), and period differences were assessed via Student-t or U Mann-Whitney test, respectively. *P1* annual period 1 (April 2019 – March 2020), encompassing donors from the first year after opening, *P2* annual period 2 (April 2020 – March 2021), encompassing donors from the second year of operation. Total volume and total donation time were log10 transformed for the analyses. Significant differences in bold ($p<0.05$)

and their infant's average GA was 38.5 weeks. Out of these, ten were first-time mothers, while 11 had a higher educational level and engaged in trained work. Only one woman had given birth to a low-weight infant, and four had experienced preterm deliveries. The reasons for not proceeding with the donation were as follows: withdrawal (72.2%), insufficient milk production (11.1%), COVID-19 (5.6%), mastitis (5.6%), and change of residence (5.6%).

Distribution of DHM volume and donation times

Table 2 shows the volumes of DHM and donation times. The range of total volume for both periods was remarkably wide (P1: 125–52,900 L; P2: 333–56,535 L). There were no significant differences observed in the daily or annual volume between periods, nor in the total donation time, which was very similar. However, significant differences were identified in the time that women took to initiate HM donation after the day of delivery, with a longer duration in P1 (median: 19 vs. 9 weeks, $p=0.047$). Donors in P1 took almost five months to initiate donation after giving birth, while in P2, it took around two months.

Figure 1 displays the volume of DHM per month for both post-opening periods. A higher amount of DHM was collected in P2 than in the first year of the milk bank, despite having a smaller number of donors. May and July showed a higher DHM reception in both periods, with July 2020 having the highest volume of DHM (40 L). However, in both periods, the volume significantly decreased in August and then increased again in September. In October of P1, the volume remains similar to September, while in P2, it drops by 50%, and in November, it drops by 100% compared to September. There is a turning point in October, where the graph reverses, and the monthly received volume is higher in P1.

Relationship between donor characteristics and DHM volume

Table 3 shows the association between donor profiles, their infants, and the total volume of DHM in each post-opening period. Results for GA showed a relationship with the donation volume in P2, with an additional three L donated by donors whose GA was <37 weeks vs. those with ≥37 weeks (4.73 L vs. 1.80 L, $p=0.002$).

Regarding the infant weight, donors from P1 with low birth weight infants donated more liters of milk compared with those whose infants had appropriate weight, regardless of the donation time ($p=0.020$). However, in P2, this factor was not related to the donated volume.

No significant associations were observed between the starting time of donation and the total donated volume in either of the periods (Table 3).

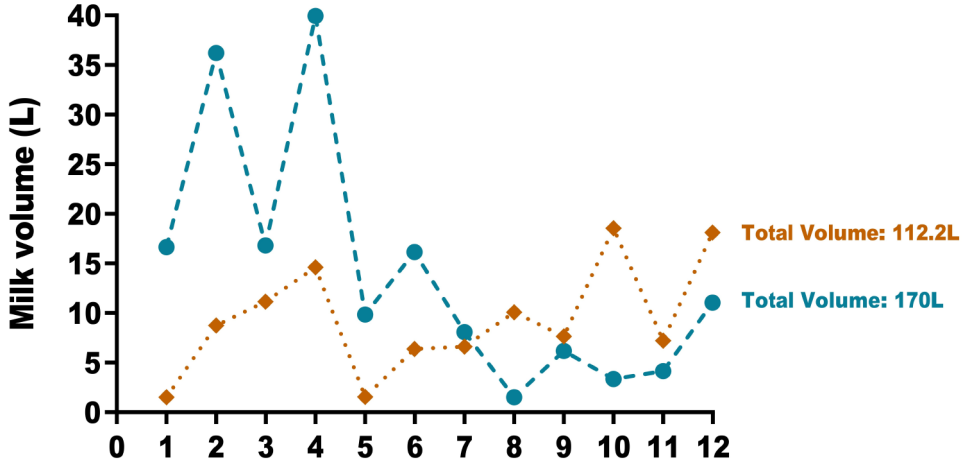

Fig. 1 Volume of DHM per month throughout the two post-opening periods. Orange diamonds: P1 (April 2019 – March 2020); Blue circles: P2 (April 2020 – March 2021). X-axis represents every month starting from April (P1: 2019, P2: 2020) until March (P1: 2020, P2: 2021)

Table 3 Association between donor characteristics (and their infants) and the total DHM volume in each post-opening period

	P1 (*n* = 51)		P2 (*n* = 25)	
	Total donated volume (L)	**Model *P*-value**	**Total donated volume (L)**	**Model *P*-value**
Donor's characteristics				
*Mother age (years)**	-0.020 (0.024)	0.393†	0.004 (0.025)	0.866†
≤ 30	2.31 ± 2.15	0.712†	1.41 ± 1.02	0.169†
30–35	2.26 ± 2.27		1.84 ± 1.09	
≥ 36	2.53 ± 2.58		3.04 ± 2.58	
*Gestational age (weeks)**	-0.058 (0.042)	0.174†	-0.082 (0.051)	0.122†
< 37	4.29 ± 4.13	0.080†	4.73 ± 3.36	**0.002**†
≥ 37	2.12 ± 1.82		1.80 ± 1.31	
Deliveries				
First-time mother	2.12 ± 2.33	0.375†	1.98 ± 1.54	0.754†
Not first-time mother	2.65 ± 2.40		1.74 ± 0.98	
Time elapsed after childbirth (weeks)*	-0.020 (0.011)	0.078	-0.010 (0.021)	0.628
Total donation time (weeks)*	0.670 (0.040)	**< 0.001**	0.794 (0.056)	**< 0.001**
Educational level				
No studies / basic studies	2.22 ± 1.95	0.166†	1.20 ± 1.47	0.680†
Higher education	2.48 ± 2.80		2.63 ± 1.94	
Working situation at starting donation				
Maternity leave	3 ± 2.79	0.061†	2.31 ± 2.95	0.712†
Leave of absence	1.66 ± 2.13		0.62 ± 0.30	
Unemployed	1.92 ± 1.51		2.37 ± 2.60	
Active	2.05 ± 1.89		2.58 ± 1.54	
Infant's characteristics				
*Birth weight (g)**	-0.358 (0.191)	0.068	-0.002 (0.221)	0.993
Birth weight < 2500 g	4.70 ± 4.40	**0.020**†	2.27 ± 1.59	0.171†
Birth weight ≥ 2500 g	2 ± 1.78		2.21 ± 2	
Hospitalization	3 ± 2.56	0.385†	4.53 ± 5.19	0.157†
No hospitalization	2.36 ± 2.37		1.95 ± 1.40	

*Linear regression models (data expressed as β (standard error))

Categorical variables were analyzed using univariate general linear models (data expressed as mean ± SD). *P1* annual period 1 (April 2019 – March 2020), encompassing donors from the first year after opening, *P2* annual period 2 (April 2020 – March 2021), encompassing donors from the second year of operation. † Models adjusted for total donation time

Relationship between donor and newborn characteristics and time elapsed after childbirth to initiate donation

Neither the women's age nor the GA showed a relationship with the starting time of donation in either period. Furthermore, neither being a first-time mother nor educational level were decisive factors in starting to donate (data not shown). However, in P2, first-time mothers tended to initiate donation later than non-first-time mothers did (22.63 ± 19.50 vs. 7.14 ± 11.14 weeks, $p = 0.051$).

The employment status showed an association with the time that women took to initiate the donation, both in P1 and P2. Specifically, in P1, women on maternity leave took less time (13.82 ± 11.74 weeks) to start donating compared to women who were actively working (42.72 ± 34.22 weeks, $p = 0.002$). During P2, unemployed women and women on maternity leave took significantly fewer weeks (15 ± 16.73; $p = 0.006$; and 7.82 ± 9.05 weeks; $p < 0.001$, respectively) to initiate donation after giving birth than women who were working at that time (46.82 ± 16.85 weeks). Additionally, differences were found between women on maternity leave and women on leave of absence, who took an average of 30.5 ± 10 weeks to initiate donation ($p = 0.049$).

For the characteristics of the newborns, there were no significant associations with the starting time of donation (data not shown).

Relationship between donor and newborn characteristics and donation times

Neither the donor age nor the GA showed a relationship with the total donation time in any of the post-opening periods (data not shown). Regarding educational level, there is a trend towards longer donation time in women with higher education during P2 (No studies / basic studies: 2.04 ± 1.40 vs. higher education: 3.93 ± 2.32 weeks, $p = 0.061$). The employment status at the starting time of the donation did not influence the length of donation

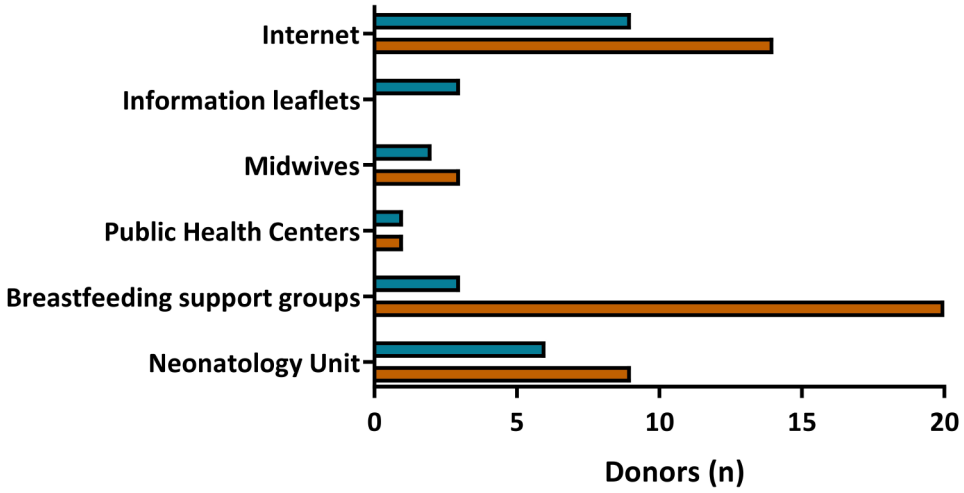

Fig. 2 Sources of information for promoting the milk bank. Orange bars: P1 (April 2019 – March 2020, total $n=47$); Blue bars: P2 (April 2020 – March 2021, total $n=24$)

time either (data not shown). Furthermore, although birth weight did not have a significant relationship, there was a trend to donate for a longer time in women whose infants had low birth weight in period P1 (birth weight < 2500 g: 6.14 ± 4.20 vs. birth weight ≥ 2500 g: 3.47 ± 2.99 weeks, $p=0.058$). Regarding the condition of newborn hospitalization, no association was detected with the duration of donation time (data not shown).

The starting time of donation also did not have a relationship with the total time women spent donating (data not shown).

Dissemination media of the milk bank

Figure 2 shows all the information sources that have disseminated information about the milk bank and the possibility of becoming donors. Significant differences were observed between the two post-opening periods ($p=0.048$). Breastfeeding support groups played a significant role in promoting awareness of the milk bank during its inaugural year ($n=20$, 42.6%). However, in P2, the dissemination of information regarding HM donation through these groups dropped to 12.5% ($n=3$), which aligned with the COVID-19 restrictions. In turn, the proportion of women who discovered the milk bank through the internet was higher during P2 ($n=9$, 37.5%) compared with P1 ($n=14$, 29.8%).

Reasons for ceasing donation

Reasons why women discontinued donation did not show significant differences between periods. One of the most common was lack of time (P1: $n=12$, 32.4%; P2: $n=5$, 31.3%). In P2, the end of breastfeeding was the most important factor ($n=6$, 37.5%). It is worth noting that in total, only one mother (who belonged to P1) decided to stop donating due to difficulties in the procedure, although for half of them, in both periods, it was an effort to come to the hospital to donate.

Discussion

Currently, there is a high demand for DHM, especially for premature infants and other newborns facing various medical issues [17]. In our area, the neonatology units and the health-care staff made an important effort to disseminate the need for establishing a milk bank in the province of Córdoba. To evaluate this requirement and the possibilities of a milk bank, mothers who had given birth in the hospital between January and May 2017 were interviewed to assess whether they would be potential candidates to become HM donors. Fifty-five (14%) mothers expressed their intention to donate part of their HM at all the postpartum stages studied. In a cross-sectional survey conducted in two Chinese hospitals involving 1078 women, 28.3% of participants indicated their willingness to consistently donate HM [18]. Although our data indicate a somewhat lower percentage, these results underscored the presence of potential donors, facilitating the establishment of a milk bank within our hospital. Indeed, the number of potential candidates aligns with the number of mothers who donated during the first year of the milk bank's operation, and also corresponds to those from various hospitals worldwide [19, 20].

In general, women with intention to donate HM showed a similar profile to donors that belonged to the first (P1) and second year (P2) of the milk bank: age mean between 32 and 33 years, GA around 38 weeks, both first-time mothers and with previous parities, mostly Spanish. Based on the evidence reported so far, this average of donor age might be a common characteristic in Europe [13, 14, 19, 21, 22]. In relation to educational level, most of mothers interviewed before the opening

of the milk bank had completed post-secondary studies, similar to donors of P2 (around 70%). As already reported in previous studies, it is expected that women with this academic profile are more sensitive to the needs of a milk bank and have a deeper knowledge about the importance of breastfeeding [8, 13, 23, 18]. Nevertheless, donors belonging to P1 showed a similar proportion between no / basic studies and higher education. In this context, it is important to highlight the key role of breastfeeding support groups in promoting the milk bank in diverse profiles of mothers. Regarding the length of donation time, a trend towards larger donations was observed in P2 among women with higher education. In contrast, in P1, the duration of donation was fairly similar across different educational levels, as noted previously in both a Spanish [13] and an Italian milk bank [21]. Meanwhile, another study reported that women with a higher educational level had a greater likelihood of donation recurrence [24]. Hence, the influence of this factor on the length of donation time seems to remain unclear. Our data suggest that during the pandemic, women with higher educational level may be more inclined to make larger donations, potentially due to their positive attitude towards milk donation even in challenging circumstances such as a global pandemic.

In 2020, the number of donors decreased by 50% (P1: 51 vs. P2: 25) due to the COVID-19 restrictions policy for donors coming to the hospital. During the lockdown periods of 2020, donors came exclusively from the hospital, including both staff members and mothers who had utilized the Maternity and Neonatology Units. That might explain that donors in P1 took almost five months to initiate donation after giving birth, while those in P2 took around two months. Despite a reduced number of donors in P2, the total volume of DHM was not different between periods. This fact contrasts with how the COVID-19 pandemic affected the operation in both other hospitals in Spain [11] and European and non-European countries [8, 10]. In fact, during the initial months of P2 coinciding with the onset of the lockdown, the volume donated remained consistently high. This mainly occurred because one woman who started donating in May 2020 provided large amounts of HM due to high production. Interestingly, while July was a month with a considerable amount of DHM in both periods, the volume decreased considerably in August. The sharp decrease in the volume of DHM during both periods in Córdoba can likely be attributed to the high temperatures typically experienced during this month (average maximum temperatures ranging between 34 and 36 °C over the past five years [25]) coupled with the impact of summer holidays. A turning point was observed in October, where the trend reversed, and the volume received per month was higher in P1. This can be largely attributed to the resurgence of COVID-19 cases during the winter of 2020–21.

Regarding the starting time of donation, 40% of women in both periods began donating during their maternity leave. Sierra-Colomina et al. previously documented comparable findings at the 12 Octubre University Hospital [13], where 54% of their donors were on maternity leave. Moreover, our findings revealed that women on maternity leave took less time to start donating compared to those who were actively working. This underscores that the employment status of donors played a significant role in their decision to initiate donation, since unemployed women also initiated HM donation earlier in P2. Donors from a Spanish hospital have already reported that incomprehension and lack of support at their workplace were obstacles to remaining a donor [14]. Returning to work is actually considered as a contributing factor that complicates donation-related processes, such as HM extraction [26]. Balancing HM donation with work responsibilities poses a significant challenge for many mothers. Limited break times and the lack of suitable facilities for expressing milk can hinder the ability to maintain a consistent and adequate milk supply for donation. Actually, the cessation of donation was largely attributed to time constraints in both periods. This draws attention to the need for supportive policies and workplace accommodations that enable mothers to continue their milk donation efforts while effectively managing their work obligations. Moreover, offering milk expression facilities in more health centers across various metropolitan areas and villages could reduce the time women need to spend on donation. Nevertheless, it is crucial to mention the considerable proportion of women (P1: 32%; P2: 25%) who were actively working, most of them at full-time and the 50% involved with trained work. At the 12 Octubre University Hospital, approximately 30% of women were working while being donors [13], and over two-thirds of them did so on a full-time basis. This fact highlights the remarkable level of altruism and dedication shown by HM donors, as they likely had a limited timeframe to carry out the donation. Furthermore, maternal age, GA, and educational level did not influence the time that mothers took to start donating in any post-opening period. First-time mothers tended to initiate donating HM later in P2. This could be because first-time mothers may have more fears about the consequences of the pandemic compared to those with more experience in motherhood.

Currently, there are several studies that have examined the relationship between demographic and clinical characteristics of donors and their infants with the volume of DHM [15, 21, 22, 26–28]. As previously reported in Spain [15], maternal age was not found to be a determining factor in the volume of DHM. However, studies conducted

at a milk bank in Italy by Quitadamo et al. (2018) [22] and in the United States by Osbaldiston et al. (2007) [28] showed direct and inverse associations, respectively. For instance, at the Mothers' Milk Bank in Austin (Texas), younger mothers were found to donate higher amounts of HM. However, it is important to note that the duration of donation was not considered. In terms of number of childbirths, there is limited available evidence thus far. Based on our study along with the two mentioned above [15, 21], the fact of being a first-time mother was not an influential factor in donating greater or lesser amounts of HM. Concerning the newborns' profiles, data from our hospital exhibited comparability to data reported by other milk banks worldwide [8, 15, 18, 29]. Most of the donors from our hospital delivered at term and children had a birth weight ≥ 2500 g. Still, mothers who had infants born preterm or with a low birth weight provided a larger HM volume compared with those who had an infant at full-term or with higher birth weight (≥ 2500 g), regardless of the donation time. Several prior studies have likewise reported that mothers of preterm infants donated larger volumes than those with term infants [15, 21, 29]. Additionally, our findings in P1 align with the study by Quitadamo et al. involving 90 donors [22], which reported a negative correlation between infant birth weight and the volume of DHM. All these facts are possibly due to their heightened awareness of the importance of providing adequate nutrition to infants with these neonatal conditions [24]. The understanding of the nutritional needs and challenges faced by their low birth weight or preterm infants may motivate them to contribute a greater DHM quantity to milk banks. This trend reflects their commitment to ensuring that their infants receive the necessary nourishment for healthy growth and development during this critical stage of early life.

Study limitations

This study had some limitations. Firstly, it is important to consider that the variable "working situation at starting donation" contained a considerable amount of missing data, which could potentially affect the robustness of the statistical analyses. Similarly, this was observed for the variable "reasons for ceasing donation" (missing data: P1: 14; P2: 9). Secondly, exploring how the family dynamics influence the process of HM donation, with inquiries into maternal breastfeeding experiences, including whether mothers were breastfed themselves and if they breastfed their prior children, could have offered valuable insights. Furthermore, these data belong to the period before the milk bank's opening and the two years following its operation. Consequently, more evidence is needed to establish common patterns among HM donors and identify the factors that influence donation characteristics. Nevertheless, this study contributes to the body of research, providing valuable insights for recruiting new donors to milk banks and implementing programs to improve donor retention.

Conclusions

While milk banks continue to proliferate globally, information regarding the women who generously donate their milk is still limited, and particularly within our own country. In Europe, some factors appear be common, such as women age and term birth. The working situation is shown to be a decisive factor to initiate the HM donation and probably is related to the lack of supportive policies to the workplace to facilitate breastfeeding and therefore the donation. Furthermore, in spite of the number of donors affected by the COVID-19 pandemic, the amount of DHM was not reduced. HM donors play a vital role in ensuring adequate nutrition for infants with neonatal complications. Therefore, additional efforts are required to identify shared donor characteristics that affect the initiation and duration of donation.

Abbreviations

DHM	Donor Human Milk
EMBA	European Milk Bank Association
GA	Gestational Age
GLM	General Linear Model
HM	Human Milk
PRE	Pre-Opening
P1	Annual Period 1
P2	Annual Period 2
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1

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Author contributions

KFR and BPV conceived the study idea. KFR, MGC and BPV designed the study. ILP and MJPQ conducted the data curation after being extracted from the medical records. BPV undertook the statistical analysis and visualization. KFR, MGC and BPV drafted the manuscript. All authors critically revised, read and approved the final manuscript.

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Data availability

Data supporting the conclusions of this work are included within the article. Information labeled as data not shown can be supplied by the corresponding author. However, the datasets analyzed during the current study are not publicly available to ensure that the individual privacy of all donors from our hospital is safeguarded.

Declarations

Ethics approval and consent to participate

All clinical and sociodemographic information was retrospectively extracted from the medical records and kept confidential by numerical codification. The study was conducted following the standards of the Declaration of Helsinki and was approved by the Ethics Committee of the Reina Sofia University Hospital (ref. 1592-N-23).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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