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Human Milk Feeding Trajectories From Neonatal Intensive Care to Two Years and Their In-Hospital Predictors in Very and Extremely Low Birth Weight Infants: A Prospective Cohort Study

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Abstract

Background: Human milk protects very and extremely low birth weight (VLBW/ELBW) infants, but sustaining human milk feeding after neonatal intensive care unit (NICU) discharge is difficult, and the feeding trajectory and its in-hospital determinants are poorly quantified in China.

Methods: In this single-center prospective cohort of 77 infants (birth weight < 1500 g), the cumulative volumes of mother's own milk, donor human milk, and formula across the whole hospitalization were abstracted from system records, and the mother's own milk proportion of intake was derived. Maternal depression (EPDS), breastfeeding self-efficacy (BSES-SF) and social support (SSRS) were assessed and related to the in-hospital mother's own milk proportion. Feeding mode was recorded at discharge and at 1, 3, and 6 months corrected age (CA), and any human milk at 1 and 2 years. Distributions were tested with the Shapiro–Wilk test. Univariable and multivariable generalized estimating equations (GEE) modeled exclusive mother's own milk feeding across the four timepoints; logistic models examined any human milk feeding at 1 and 2 years. Covariates were multiply imputed (m = 20).

Results: Exclusive mother's own milk feeding fell from 49.3% at discharge to 15% at 6 months CA; any human milk feeding was 21.7% at 1 year and 10% at 2 years. A higher in-hospital proportion of mother's own milk independently predicted exclusive breastfeeding through 6 months CA (adjusted OR = 2, 95% CI [1.56, 2.57] per 10-percentage-point increase) and any human milk feeding at 1 year (adjusted OR = 1.38, 95% CI [1.07, 1.78]); the direction was consistent at 2 years. Higher maternal breastfeeding self-efficacy was positively correlated with a higher level of the mother's own milk production ratio during hospitalization (Spearman ρ = 0.55, p = 0.041).

Conclusions: Human milk feeding declined steeply after discharge in VLBW/ELBW infants and was rare by 1–2 years. A higher in-hospital proportion of mother's own milk predicted more sustained feeding, identifying a modifiable in-hospital target. The decline reflects intersecting family, workplace,

community, and policy inequities. Efforts to sustain human milk feeding should begin during the NICU stay—including support for maternal breastfeeding self-efficacy—and extend across the discharge transition.

Trial registration: Chinese Clinical Trial Registry (ChiCTR2400086610|http://www.chictr.org.cn/). Registered 8 July 2024.

Keywords: human milk; mother's own milk; preterm infant; very low birth weight; breastfeeding; feeding trajectory; health inequities; socioecological

Background

Preterm birth is a major global and Chinese public-health challenge, and China has among the highest numbers of preterm births worldwide [1,2]. As survival of very low birth weight (VLBW; < 1500 g) and extremely low birth weight (ELBW; < 1000 g) infants improves, the quality of long-term outcomes has become the priority, and human milk feeding is central to it.

For these infants, mother's own milk is a dose-dependent intervention that lowers the risk of necrotizing enterocolitis and late-onset sepsis and supports neurodevelopment [3–5]. Accordingly, the World Health Organization strongly recommends mother's own milk and exclusive breastfeeding for preterm and low-birth-weight infants, with donor human milk as the preferred supplement when mother's own milk is insufficient [6,7]. Throughout this article, "human milk feeding" denotes provision of mother's own milk by any route (direct breastfeeding or expressed milk), whereas "exclusive breastfeeding" follows the World Health Organization definition.

Sustaining human milk feeding in this population is nonetheless difficult. Prolonged NICU admission and mother–infant separation disrupt lactation: infrequent or ineffective breast emptying limits milk production, and the NICU environment is a potent psychological stressor that can undermine maternal confidence and milk supply [11,12,15]. In China, national progress is real but uneven—human milk feeding in NICUs rose from 23% in 2009 to 58.2% in 2018, yet in a national survey kangaroo care was widely available while only about one-fifth of units used donor human milk and about half routinely provided family-integrated care [8]. Among preterm infants specifically, exclusive breastfeeding has been reported at only about 41% during hospitalization, falling to roughly 19% after discharge [9].

Despite this, most evidence is cross-sectional or reports feeding rates at single timepoints; few studies from China characterize the full feeding trajectory—the balance of mother's own milk, donor human milk, and formula—from the NICU through the first two years, or identify in-hospital, potentially modifiable predictors of later feeding. Breastfeeding is, furthermore, shaped by interacting individual, family, community, health-system, and policy influences [10,15,16], which are rarely considered

together for preterm infants in the Chinese context, and which may generate marked inequities within this already vulnerable group. This study therefore aimed to (a) describe the human milk feeding trajectory of VLBW/ELBW infants from NICU discharge to two years, and (b) identify in-hospital factors associated with non-exclusive human milk feeding through six months corrected age (CA).

Methods

Study design and setting

This single-center, prospective longitudinal cohort study was conducted in the NICU and high-risk infant follow-up clinic of Peking University Shenzhen Hospital, a tertiary center in Shenzhen, China, and is reported per the STROBE guideline. It was registered with the Chinese Clinical Trial Registry on 8 July 2024(ChiCTR2400086610|http://www.chictr.org.cn/) and approved by the hospital Ethics Committee (No. 2024[103]); mothers gave written informed consent.

Participants: eligibility and exclusions

Mother–infant dyads were eligible if the infant was born with a birth weight below 1500 g, was admitted to the NICU of the study hospital, and was anticipated to require an NICU stay of at least 14 days, and if the mother was at least 18 years of age, intended to provide breast milk, and gave written informed consent. Infants were excluded if they had a major congenital anomaly, died before discharge, had an NICU stay shorter than 14 days, or were transferred to another hospital or withdrawn from treatment for any reason before discharge; dyads were also excluded if the mother had a contraindication to lactation or declined to participate.

Participant flow should be reported as follows: of 103 infants with birth weight below 1500 g screened during the study period, 2 were excluded because of an NICU stay shorter than 14 days, 5 because of transfer to another hospital, 1 because of a major congenital anomaly, and 1 because of death before discharge; a further 17 dyads were excluded because the mother declined. The final analytic sample comprised 77 infants (32 extremely low birth weight and 45 very low birth weight); the participant flow is shown in Figure 1.

Feeding exposure and outcomes

The principal in-hospital exposure was feeding composition across the entire hospital stay, abstracted from routine nursing feeding records as the cumulative volumes (mL) of mother's own milk, donor human milk, and formula; from these, the proportion of total enteral intake provided as mother's own milk (mother's own milk %) was derived. In this unit, donor human milk is provided only until an infant reaches 2 kg; consequently donor human milk contributes to the in-hospital feeding composition but does not appear as a separate category at discharge or in post-discharge follow-up. The primary

outcome was feeding mode—exclusive mother's own milk, mixed (human milk and formula), or exclusive formula—ascertained at discharge and at 1, 3, and 6 months CA; for longitudinal modeling it was dichotomized as non-exclusive human milk feeding (mixed or formula) versus exclusive mother's own milk. Any human milk feeding (yes/no) was recorded at 1 and 2 years. Covariates included gestational age, birth weight, sex, mode of birth, multiple birth, small-for-gestational-age status, maternal age, length of stay, day of full enteral feeds, direct breastfeeding in hospital, and major morbidities (feeding intolerance, necrotizing enterocolitis, bronchopulmonary dysplasia, sepsis, retinopathy of prematurity). In the sample of mothers, three validated self-report scales were administered at enrolment: the Edinburgh Postnatal Depression Scale (EPDS; total 0–30, higher = more depressive symptoms), the Breastfeeding Self-Efficacy Scale–Short Form (BSES-SF; total 14–70, higher = greater self-efficacy), and the Social Support Rating Scale (SSRS; higher = more support).

Statistical analysis

The distribution of continuous variables was examined with the Shapiro–Wilk test. Most continuous variables (including gestational age, length of stay, day of full enteral feeds, discharge weight, feeding volumes, and mother's own milk %) departed significantly from normality ($p < 0.05$); accordingly, continuous variables were summarized as median [interquartile range, IQR] and non-parametric methods were used, while categorical variables were summarized as counts (percentages), with denominators reported at each timepoint because of missing data.

We analyzed three feeding outcomes. First, exclusive mother's own milk feeding (vs. mixed or formula) across discharge and 1, 3, and 6 months CA was modeled with generalized estimating equations (GEE; binomial family, logit link, exchangeable working correlation, robust standard errors), with timepoint entered as a categorical variable; a single-timepoint logistic model at 6 months CA was also fitted. Second and third, any human milk feeding (vs. none) at 1 year and at 2 years were each modeled with logistic regression. For each outcome, all candidate predictors were first assessed univariably (the GEE outcome adjusted for timepoint only). Pre-specified, parsimonious multivariable models were then fitted: for exclusive mother's own milk feeding, gestational age (per week), in-hospital mother's own milk % (per 10 percentage points), direct breastfeeding in hospital, and maternal age (per year); for the 1- and 2-year outcomes, given the small number of events, only in-hospital mother's own milk % and gestational age. Odds ratios above 1 therefore indicate higher odds of (continued) breastfeeding. Missing covariate data (8%–13%) were addressed by multiple imputation by chained equations ($m = 20$) under a missing-at-random assumption, combined by Rubin's rules; feeding outcomes were analyzed using all available observations. Sensitivity analyses used complete cessation of human milk (exclusive formula vs. any human milk), complete-case data, and a single-timepoint logistic model at 6 months CA. Odds ratios (OR) with 95% confidence intervals

(CI) are reported. In the sample of mothers, scale scores were summarized descriptively and their association with the in-hospital mother's own milk proportion was examined using Spearman correlation. Analyses used Python 3.12 (statsmodels, scikit-learn); two-sided $p < 0.05$ was significant. Given the exploratory nature and modest sample size, findings are hypothesis-generating.

Results

Sample characteristics and in-hospital feeding composition

The 77 infants had a median gestational age of 30.1 weeks [IQR 27.7, 31.1] and a median birth weight of 1150 g [IQR 950, 1300]; 41.6% were extremely low birth weight and 93.5% were born by cesarean (Table 1). The median length of stay was 53 days. Across the whole hospitalization, mother's own milk provided a median of 60.3% [IQR 22.9, 88.6] of enteral intake, donor human milk 6.6% [2.7, 22.8], and formula 26.1% [4.8, 52.1]; any human milk made up a median of 73.9% of intake.

Missing data

Gestational age and birth weight were complete; other covariates had 8%–13% missing values (maternal age 6/77, 8%; length of stay, in-hospital mother's own milk proportion, direct breastfeeding, and each morbidity 10/77, 13%; day of full enteral feeds and small-for-gestational-age status 6–7/77). Feeding-outcome data were available for 67/77 infants (87%) at discharge, 63/77 (82%) at 1 month, and 60/77 (78%) at 3 months, 6 months, 1 year, and 2 years; the remaining infants had not yet reached, or did not attend, the corresponding follow-up visit. Covariate missingness was handled by multiple imputation as described, and feeding outcomes were analyzed using all available observations.

Human milk feeding trajectory

Exclusive mother's own milk feeding declined progressively from 49.3% (33/67) at discharge to 39.7% at 1 month, 21.7% at 3 months, and 15% (9/60) at 6 months CA, while exclusive formula feeding rose from 23.9% to 75% (Table 2). Any human milk feeding was reported in only 21.7% (13/60) of infants at 1 year and 10% (6/60) at 2 years.

Predictors of exclusive mother's own milk feeding (GEE)

In the GEE model for exclusive mother's own milk feeding, the odds of exclusive breastfeeding fell steeply over time relative to discharge (3 months CA: OR = 0.12, 95% CI [0.03, 0.4]; 6 months CA: OR = 0.06, 95% CI [0.02, 0.24]), quantifying the trajectory in Table 2. A higher in-hospital proportion of mother's own milk was the only factor independently associated with exclusive breastfeeding: each 10-percentage-point increase roughly doubled the odds (univariable OR = 2.04, 95% CI [1.59, 2.62]; adjusted OR = 2, 95% CI [1.56, 2.57], $p < .001$; Table 3). Gestational age (adjusted OR = 1.13), direct

breastfeeding in hospital (adjusted OR = 1.78), and maternal age (adjusted OR = 0.91) were not significantly associated, and no other candidate predictor reached significance in univariable analysis (Table 3). In the single-timepoint logistic model at 6 months CA, in-hospital mother's own milk proportion remained associated with exclusive breastfeeding (OR = 1.39, 95% CI [1.01, 1.92]). These associations are summarized in Figure 2, a forest plot of the adjusted odds ratios: each point is the adjusted OR and the horizontal line its 95% CI, the dashed vertical line marks OR = 1 (no association), and points falling to the right of this line indicate higher odds of exclusive breastfeeding. Only in-hospital mother's own milk proportion lies clearly to the right, its confidence interval excluding 1, whereas the intervals for the other predictors cross the line.

Predictors of any human milk feeding at 1 and 2 years

A higher in-hospital proportion of mother's own milk was also associated with any human milk feeding at 1 year (univariable OR = 1.35, 95% CI [1.06, 1.73]; adjusted OR = 1.38, 95% CI [1.07, 1.78] per 10-percentage-point increase, p = 0.014; Table 4). At 2 years the association was in the same direction but did not reach significance (adjusted OR = 1.2, 95% CI [0.9, 1.6]), consistent with the small number of infants still receiving any human milk (6/60). Gestational age was not significantly associated with either outcome. Because only 13 and 6 infants received any human milk at 1 and 2 years, respectively, these estimates are imprecise and should be regarded as exploratory.

Maternal psychosocial characteristics

In the sample of mothers who completed the scales, the median EPDS score was 9 [IQR 5.5, 10.5], with 36/77 (46.8%) scoring at or above 10 and 10/77 (13.0%) at or above 13, indicating a substantial burden of depressive symptoms. The median BSES-SF score was 52 [IQR 47, 55.5] and the median SSRS score 32 [IQR 27, 35.5] (Table 5). In analysis, higher breastfeeding self-efficacy was associated with a higher in-hospital proportion of mother's own milk (Spearman ρ = 0.55, p = .041), whereas depressive symptoms (ρ = 0.12, p = 0.689) and social support (ρ = 0.31, p = 0.285) were not significantly associated.

Discussion

In this cohort of VLBW/ELBW infants followed to two years, human milk feeding declined steeply after NICU discharge: exclusive mother's own milk feeding more than halved between discharge and 6 months CA, most infants received exclusive formula by 6 months, and any human milk was uncommon by 1–2 years. A higher in-hospital proportion of mother's own milk independently predicted more sustained human milk feeding, robust across outcome definitions and complete-case analysis.

The steep post-discharge decline is consistent with Chinese data showing exclusive breastfeeding of

preterm infants falling from about 41% in hospital to roughly 19% after discharge [9], and with longitudinal work identifying the post-discharge period as a point of particular vulnerability [10,12]. Our central finding accords with evidence that early milk supply and breastfeeding self-efficacy underpin continuation: in a recent NICU cohort, higher breastfeeding self-efficacy predicted greater milk output and a preference for breastfeeding [13], and insufficient supply is a leading reason for cessation among mothers of preterm infants [12]. The very low 6-month levels we observed also contrast with the emphasis on non-separation, kangaroo care and family-integrated care that is unevenly implemented across Chinese NICUs [8], suggesting that care-model and post-discharge support factors, rather than infant biology alone, drive much of the loss. Because in-hospital mother's own milk may partly reflect maternal intention and circumstances, this association should be interpreted as such rather than as proof of causation.

Breastfeeding is embedded in a socioecological system, and the decline we observed is unlikely to have a single cause. At the individual level, milk supply, breastfeeding self-efficacy, and postpartum distress shape continuation [12,13]; consistent with this, in our study higher breastfeeding self-efficacy correlated with a higher in-hospital mother's own milk proportion, and nearly half of mothers screened positive for depressive symptoms, although the sample was small. At the family level, partner and family support, household income, and maternal plans strongly influence self-efficacy and duration [10,13,16]; in China, spouses and grandparents often play a decisive role in feeding decisions, and the perception of formula as convenient or high-status can favor early formula introduction [13]. Qualitative work with mothers of VLBW infants describes lactation as something that can feel "taken away" in the NICU, underscoring the emotional and structural barriers of the separation and transition home [11,15].

Critically, these influences are not distributed equally, and the post-discharge decline is in part a story of breastfeeding inequity within an already marginalized group. Determinants such as low household income, rural residence, limited family support, and precarious or early return to employment cluster in the least-resourced families and predict lower breastfeeding self-efficacy and shorter duration [15,16]. At the health-system level, uneven access to kangaroo care, family-integrated care, donor human milk, and skilled post-discharge lactation support compounds these gaps [8]. At the policy and structural level, maternity-leave provisions matter: for preterm infants, a long hospital stay—here a median of nearly eight weeks—can consume much of a mother's leave, so that return to work coincides with the fragile early post-discharge period, an effect likely to fall hardest on lower-income mothers with less flexible employment. Framed this way, sustaining human milk feeding after NICU discharge is a question of equity as much as of clinical care.

Existing research has strengthened breastfeeding outcomes for preterm infants on several fronts. In-hospital, kangaroo mother care, family-integrated care, non-separation, and structured lactation education have been widely adopted in Chinese NICUs and are associated with higher human milk feeding [8], and interventions that build maternal breastfeeding self-efficacy have been shown to extend breastfeeding duration and exclusivity [13,17]. National guidance prioritizing mother's own milk, together with the expansion of human milk banks, has helped raise in-hospital human milk feeding rates over the past decade [8,9].

Several gaps remain, however, that our data bring into focus. First, gains have been concentrated during the hospital stay, whereas the post-discharge period—where we observed the steepest decline—has received far less structured support; where post-discharge programs have been trialed, effects have been limited, for example, a Chinese online education program improved knowledge but not self-efficacy[18], indicating that the optimal content, intensity, and delivery of post-discharge support are still unresolved. Second, provision remains uneven: donor human milk is used by only about one-fifth of Chinese level-3 NICUs and family-integrated care by only about half [8], so many families do not receive the very practices shown to help. Third, the family, socioeconomic, workplace, and policy determinants that shape post-discharge feeding have rarely been measured or targeted together, and interventions engaging partners and grandparents, or addressing maternity-leave and return-to-work pressures, are largely untested in this group [10,15,16]. Future efforts should therefore extend support across the discharge transition and into the community, standardize access to kangaroo/family-integrated care and donor human milk, and design and rigorously evaluate multi-level, equity-oriented interventions—spanning the family, the workplace, and policy—so that the in-hospital gains already achieved are not lost after discharge.

It might be assumed that advances in obstetric and neonatal care will progressively reduce the number of very small, very preterm infants who require this support. The evidence points, if anything, in the opposite direction at the extreme end of prematurity: refinements in perinatal care have lowered the threshold of viability toward 22–23 weeks and increased both the proportion of extremely preterm infants offered active treatment and their survival to discharge [19,20]. Although antenatal interventions may prevent some preterm births, the net effect has been that more—not fewer—VLBW and ELBW infants survive the neonatal period and are discharged home, so the population that stands to benefit from sustained human milk feeding is unlikely to shrink and may grow. This reinforces the need to build durable systems for supporting these families after discharge.

Our findings also expose the limited adequacy of long-term follow-up for these infants. In our cohort, most infants were followed to about 1 year, with attendance falling sharply thereafter, and

neurodevelopmental assessment was inconsistent in both instrument and timing—problems that are widely reported: ensuring follow-up attendance even before 12 months corrected age is a recognized challenge, loss to follow-up is patterned by social disadvantage, and surveillance practices vary across services [21]. Strengthening follow-up is therefore both a clinical and an equity priority. Community-oriented models may help close these gaps: integrating anticipatory guidance and family education before discharge with home-based services, telehealth, and flexible, family-centered scheduling has been proposed to reduce logistical barriers and improve attendance at developmental follow-up for high-risk infants [22], and embedding lactation and peer support within such follow-up could simultaneously protect breastfeeding and developmental surveillance for the least-resourced families.

Implications for clinical practice

Efforts to sustain human milk feeding should begin during the NICU stay. Maximizing the in-hospital proportion of mother's own milk—through early and frequent expression support, protection of supply, kangaroo mother care and reduced separation, and facilitation of direct breastfeeding before discharge—may improve later continuation [3,8,13]. The abrupt post-discharge decline identifies the discharge transition as a priority window for structured, teach-back lactation education, early proactive follow-up contact, and clear pathways to community lactation and peer support [17,18].

Implications for public health, policy and equity

At the population level, sustaining human milk feeding in preterm infants requires action beyond the bedside, targeted to reduce disparities. Health systems should scale kangaroo mother care and family-integrated care, expand access to donor human milk—used by only about one-fifth of Chinese level-3 NICUs [8]—and embed lactation and peer support into preterm follow-up, prioritizing under-resourced families. Maternity-leave and workplace-lactation policy should be strengthened, and for hospitalized preterm infants, allowing leave to begin at discharge rather than birth would directly address the return-to-work pressure our data imply. Community programs offering accessible, culturally attuned support that engages partners and grandparents could counter family- and community-level drivers of early formula use [13,16]. These are public-health and equity interventions, likely necessary to change the trajectory we observed.

Strengths and limitations

Strengths include the prospective design, the use of whole-hospitalization system-record feeding volumes to quantify feeding composition rather than feeding rates alone, follow-up to two years, formal testing of distributional assumptions, and robustness of the key association across univariable, multivariable, multiply imputed, complete-case, and alternative-outcome analyses.

Several limitations should be emphasized. First, the study was single-center with a modest sample size. Infants with birth weight below 1500 g are relatively uncommon at any single center, which inherently constrains the achievable sample and, with few infants still exclusively or partially breastfed at later timepoints (exclusive mother's own milk feeding, 9/60 at 6 months; any human milk, 13/60 at 1 year and 6/60 at 2 years), limits statistical power. Consequently, several covariates showed sizeable but non-significant adjusted odds ratios—for example, direct breastfeeding in hospital (OR 1.78) and gestational age (OR 1.13)—for which the wide confidence intervals and the small number of events indicate a substantial risk of type II error rather than true absence of effect; these associations may be clinically meaningful but were underpowered, and larger studies are needed to test them. The single significant predictor, in-hospital mother's own milk proportion, should likewise be interpreted as an observational association that may be confounded by maternal intention rather than proof of causation, and multiple imputation was applied to covariates only.

Second, long-term follow-up was incomplete, mirroring a well-recognized challenge in this field: loss to follow-up in very preterm cohorts is common, increases over time, and is associated with social disadvantage, which can bias outcome estimates [21]. In our cohort, follow-up data were most complete to 1 year and became sparse thereafter, and few infants had complete two-year clinic follow-up. In addition, neurodevelopmental assessment was performed with different instruments and at inconsistent ages across infants, so these data could not be pooled or analyzed uniformly and are not reported here; this heterogeneity of developmental surveillance is itself a documented problem that hampers comparison across studies and services [3,21]. These outcomes will be examined as follow-up matures and as assessment is standardized. Finally, single-center recruitment and the specific care model of this unit may limit generalizability, and the family, socioeconomic, workplace, community, and policy factors discussed above were not measured directly, so the inequities interpretation draws on external evidence and motivates dedicated study.

Future research

Larger multicenter cohorts should confirm these associations and directly measure socioeconomic, family, occupational, community, and policy determinants, enabling explicit analysis of disparities. Because our quantitative data establish the magnitude and timing of the decline but not its reasons, we are conducting a qualitative study of mothers' experiences of, and barriers to, sustaining human milk feeding after discharge, with attention to under-resourced families. Intervention studies targeting in-hospital mother's own milk, kangaroo mother care, the discharge transition, and workplace support are warranted, and future work should integrate maternal psychosocial factors and long-term neurodevelopment.

Conclusions

Human milk feeding in VLBW/ELBW infants declined steeply after NICU discharge and was rare by 1–2 years. A higher in-hospital proportion of mother's own milk predicted more sustained feeding, identifying a modifiable in-hospital target. Reversing the decline will require a socioecological, equity-focused response spanning the NICU, the family, the workplace, the community, and policy.

Declarations

Ethics approval and consent to participate: Approved by the Ethics Committee of Peking University Shenzhen Hospital (No. 2024[103]); written informed consent obtained from all participating mothers.

Trial registration: Chinese Clinical Trial Registry (ChiCTR2400086610), registered 8 July 2024, https://www.chictr.org.cn/.

Consent for publication: Not applicable.

Availability of data and materials: The data that support the findings of this study are available from the corresponding author upon reasonable request. The contact information of the corresponding author is Wanxiang He, hewanxiang@pkuszh.com.cn, and the first author Yuying Mo, moyy9@alumni.sysu.edu.cn.

Competing interests: The authors declare no competing interests.

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Authors' contributions: WH conceived and designed the study and supervised the project. YM designed the study, collected and curated the data, performed the statistical analysis, and drafted the manuscript. XLL, ZY and FZ contributed to data collection and data curation. XJL contributed to the study design and data collection and sorting. WH acquired funding and administered the project. All authors critically revised the manuscript for important intellectual content, and read and approved the final manuscript.

Table 1. Sample characteristics (N = 77)

Characteristic	Value
Infant characteristics	
Gestational age, weeks — Mdn [IQR]	30.1 [27.7, 31.1]
Birth weight, g — Mdn [IQR]	1150 [950, 1300]
Extremely low birth weight (< 1000 g) — n (%)	32 (41.6)
Very low birth weight (1000–1499 g) — n (%)	45 (58.4)
Male sex — n (%)	35 (49.3)
Multiple birth — n (%)	17 (23.9)
Small for gestational age — n (%)	22 (31)
Cesarean birth — n (%)	72 (93.5)
Clinical course	
Length of hospital stay, days — Mdn [IQR]	53 [43, 70]
Day of full enteral feeds — Mdn [IQR]	12 [8, 16]
Discharge weight, g — Mdn [IQR]	2570 [2285, 2805]
Direct breastfeeding established in hospital — n (%)	10 (14.9)
Feeding intolerance — n (%)	26 (38.8)
Necrotizing enterocolitis — n (%)	2 (3)
Bronchopulmonary dysplasia — n (%)	14 (20.9)
Sepsis — n (%)	11 (16.4)
Retinopathy of prematurity (any stage) — n (%)	19 (28.4)
Maternal characteristic	
Maternal age, years — Mdn [IQR]	33 [30, 36]
In-hospital feeding composition (cumulative, whole hospitalization)	
Mother's own milk, mL — Mdn [IQR]	6563 [2590, 10082]
Donor human milk, mL — Mdn [IQR]	825 [372, 2177]
Formula, mL — Mdn [IQR]	3451 [632, 5896]
Mother's own milk, % of intake — Mdn [IQR]	60.3 [22.9, 88.6]
Donor human milk, % of intake — Mdn [IQR]	6.6 [2.7, 22.8]
Formula, % of intake — Mdn [IQR]	26.1 [4.8, 52.1]
Any human milk, % of intake — Mdn [IQR]	73.9 [47.9, 95.2]

MOM mother's own milk; IQR interquartile range. Feeding volumes are cumulative over the whole hospitalization. Denominators vary due to missing data.

Table 2. Human milk feeding-mode trajectory from discharge to two years

Timepoint	n	Excl. MOM, n (%)	Mixed, n (%)	Formula, n (%)
Discharge	67	33 (49.3)	18 (26.9)	16 (23.9)
1 month CA	63	25 (39.7)	17 (27)	21 (33.3)
3 months CA	60	13 (21.7)	14 (23.3)	33 (55)
6 months CA	60	9 (15)	6 (10)	45 (75)
Any human milk, 1 year	60	13 (21.7)	—	—
Any human milk, 2 years	60	6 (10)	—	—

MOM mother's own milk; CA corrected age. Donor human milk is provided in hospital only until 2 kg and does not appear as

a post-discharge category.

Table 3. Predictors of exclusive mother's own milk feeding through 6 months CA (GEE, univariable and multivariable, multiply imputed)

Predictor	Univariable OR (95% CI)	p	Multivariable OR (95% CI)	p
Timepoint (ref. discharge; multivariable model)				
1 month CA	—	—	0.45 (0.19, 1.05)	0.066
3 months CA	—	—	0.12 (0.03, 0.4)	< 0.001
6 months CA	—	—	0.06 (0.02, 0.24)	< 0.001
Infant, clinical and maternal factors				
In-hospital mother's own milk (per 10%)	2.04 (1.59, 2.62)	< 0.001	**2 (1.56, 2.57)**	< 0.001
Gestational age (per week)	1.01 (0.84, 1.21)	0.911	1.13 (0.94, 1.36)	0.193
Direct breastfeeding in hospital	2.79 (0.83, 9.46)	0.099	1.78 (0.53, 5.95)	0.352
Maternal age (per year)	0.93 (0.84, 1.04)	0.197	0.91 (0.82, 1.02)	0.105
Length of hospital stay (per day)	0.98 (0.96, 1)	0.035	Not included	—
Birth weight (per 100 g)	1.08 (0.89, 1.3)	0.438	Not included	—
Day of full enteral feeds (per day)	1.01 (0.95, 1.08)	0.659	Not included	—
Feeding intolerance	1.17 (0.48, 2.86)	0.723	Not included	—
Small for gestational age	0.69 (0.28, 1.67)	0.408	Not included	—
Bronchopulmonary dysplasia	0.77 (0.25, 2.36)	0.653	Not included	—
Sepsis	0.53 (0.17, 1.67)	0.278	Not included	—

OR odds ratio; CI confidence interval; GEE generalized estimating equations; CA corrected age. Outcome: exclusive mother's own milk feeding (vs. mixed or formula) at discharge and 1, 3, 6 months CA. OR > 1 indicates higher odds of exclusive breastfeeding. Univariable models adjusted for timepoint only. "Not included" = not in the pre-specified parsimonious multivariable model.

Table 4. Predictors of any human milk feeding at 1 and 2 years (logistic regression, multiply imputed)

Predictor	1 year — Univariable OR	1 year — Multivariable OR	2 years — Univariable OR	2 years — Multivariable OR
In-hospital mother's own milk (per 10%)	1.35 (1.06, 1.73)	**1.38 (1.07, 1.78)**	1.18 (0.89, 1.56)	**1.2 (0.9, 1.6)**
Gestational age (per week)	1.08 (0.81, 1.45)	1.17 (0.85, 1.6)	1.12 (0.75, 1.68)	1.17 (0.78, 1.75)
Maternal age (per year)	0.94 (0.8, 1.1)	—	1.12 (0.92, 1.37)	—
Length of hospital stay (per day)	0.98 (0.94, 1.01)	—	0.98 (0.94, 1.03)	—

OR odds ratio (95% CI). Outcome: any human milk feeding (vs. none). OR > 1 indicates higher odds of continued human milk feeding. Multivariable models included in-hospital mother's own milk % and gestational age only, given the small number of events (any human milk: 1 year, 13/60; 2 years, 6/60).

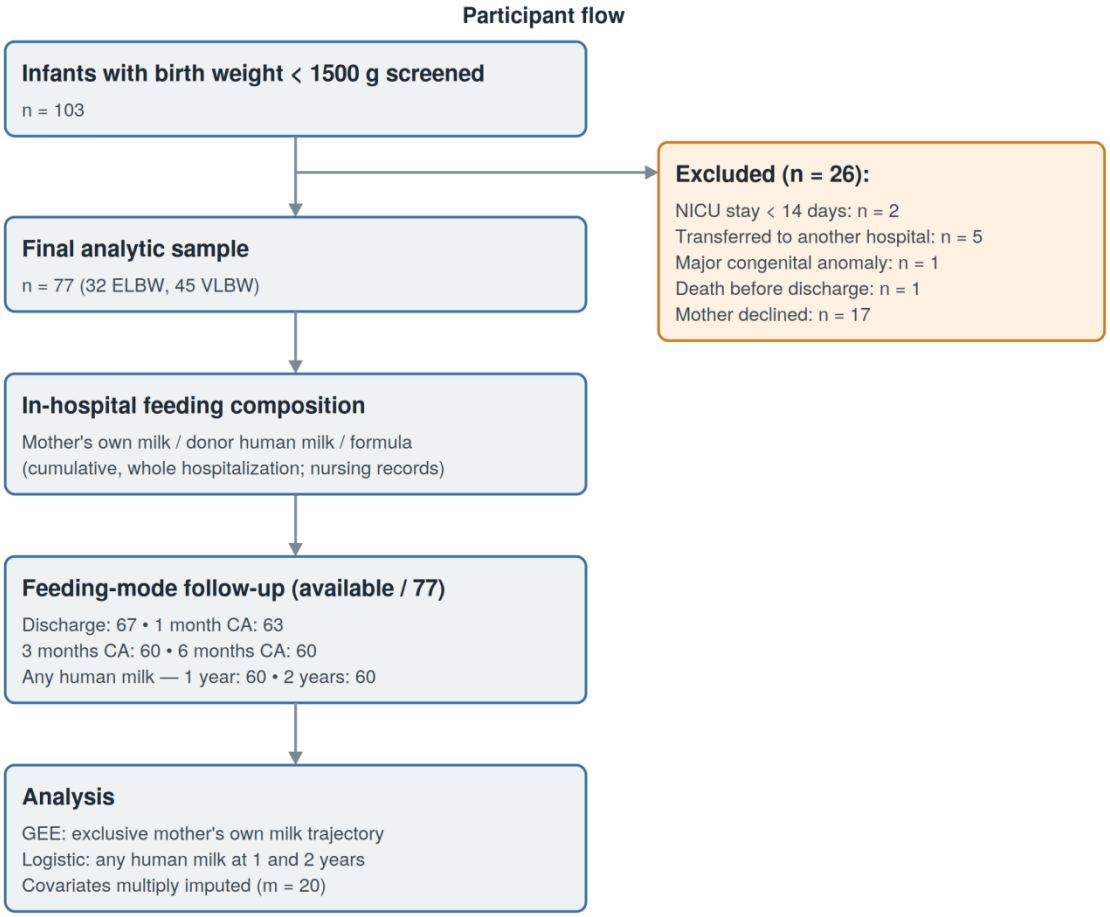
Table 5. Maternal psychosocial characteristics in the sub-sample (n = 77)

Scale	Value
EPDS total — Mdn [IQR]	9 [5.5, 10.5]

EPDS ≥ 10 — n (%)	7 (46.7)
EPDS ≥ 13 — n (%)	2 (13.3)
BSES-SF total — Mdn [IQR]	52 [47, 55.5]
SSRS total — Mdn [IQR]	32 [27, 35.5]

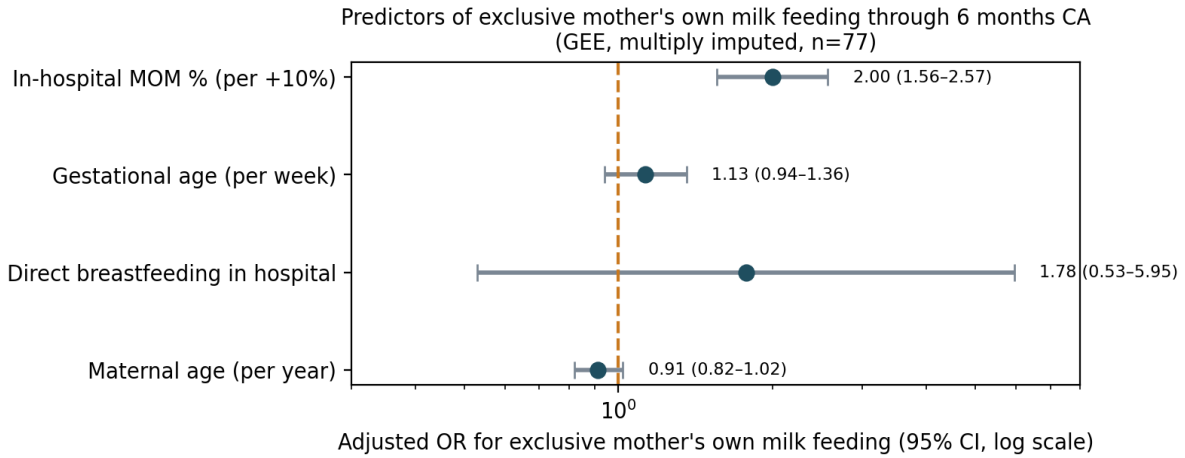
EPDS Edinburgh Postnatal Depression Scale; BSES-SF Breastfeeding Self-Efficacy Scale–Short Form; SSRS Social Support Rating Scale; IQR interquartile range. Exploratory sub-sample analysis; SSRS scoring should be confirmed against the local convention.

Figure 1. Participant flow



CA corrected age; ELBW extremely low birth weight; VLBW very low birth weight; GEE generalized estimating equations.

Figure 2. Adjusted odds ratios for exclusive mother's own milk feeding through 6 months CA



Odds ratios (95% CI) from the multiply imputed multivariable GEE model for exclusive mother's own milk feeding across discharge and 1, 3, and 6 months CA. The dashed line marks OR = 1 (no association); points to the right indicate higher odds of exclusive breastfeeding. A higher in-hospital mother's own milk proportion is associated with roughly twice the odds of exclusive breastfeeding per 10-percentage-point increase, while the other factors show no significant association.

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