

Post-Discharge Milk Feeding Practices and Complementary Feeding Among Malaysian Preterm Infants: An Exploratory Cross-Sectional Study

(Amalan Penyusuan Susu Selepas Discaj aan Pemberian Makanan Pelengkap dalam Kalangan Bayi Pramatang Di Malaysia: Satu Kajian Keratan Rentas Eksploratori)

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Abstract

Feeding practices after hospital discharge are important for the growth and nutritional adequacy of preterm infants. However, local data on post-discharge milk feeding and complementary feeding practices remain limited. This study described post-discharge milk feeding practices and the timing and quality of complementary feeding among Malaysian preterm infants. An exploratory cross-sectional study was conducted among caregivers of preterm infants born before 37 weeks of gestation and aged 6–23 months corrected age. A structured online questionnaire collected information on clinical characteristics, milk feeding history, complementary feeding practices, and sociodemographic factors. Complementary feeding quality was assessed using the World Health Organization indicators: Minimum Dietary Diversity (MDD), Minimum Meal Frequency (MMF), and Minimum Acceptable Diet (MAD). Descriptive analyses were performed. Twenty-three caregivers participated. All infants received breastmilk during their NICU stay. Predominant or exclusive breastmilk feeding decreased from 60.9% at 3 months to 52.2% at 6 months, while formula feeding increased to 47.8% at 6 months. The mean (SD) corrected age at complementary feeding initiation was 5.1 (1.2) months, corresponding to 7.1 (1.4) months chronological age. More than half of the infants (52.2%) started complementary feeding before 5 months corrected age. Plain or mixed porridge was the most common first complementary food (82.6%). Overall, 65.2% achieved MDD, 70.0% achieved MMF, and 47.8% achieved MAD. Post-discharge milk feeding and complementary feeding practices varied among Malaysian preterm infants. Less than half achieved the minimum acceptable diet. Clearer preterm-specific feeding guidance and enhanced caregiver education are needed to support optimal feeding practices after hospital discharge.

Keywords: Preterm infant; Milk feeding; Complementary feeding; Dietary diversity; Feeding practices

Abstrak

Amalan pemakanan selepas discaj hospital memainkan peranan penting dalam menyokong pertumbuhan dan kecukupan pemakanan bayi pramatang. Walau bagaimanapun, data tempatan mengenai pemberian susu selepas discaj dan pemakanan pelengkap masih terhad. Kajian ini bertujuan menerangkan amalan pemberian susu selepas discaj serta masa dan kualiti pemakanan pelengkap dalam kalangan bayi pramatang di Malaysia. Kajian keratan rentas eksploratori ini melibatkan penjaga bayi pramatang yang dilahirkan sebelum 37 minggu usia gestasi dan berumur 6–23 bulan umur pembetulan semasa kajian. Soal selidik dalam talian berstruktur digunakan untuk mengumpul maklumat berkaitan ciri klinikal, sejarah pemberian susu, amalan pemakanan pelengkap dan faktor sosiodemografi. Kualiti pemakanan pelengkap dinilai menggunakan indikator Pertubuhan Kesihatan Sedunia (WHO), iaitu Kepelbagaian Diet Minimum (MDD), Kekerapan Hidangan Minimum (MMF) dan Diet Minimum Boleh Terima (MAD). Analisis deskriptif dijalankan. Seramai 23 orang penjaga mengambil bahagian. Semua bayi menerima susu ibu semasa berada di NICU. Peratus pemberian susu ibu secara dominan atau eksklusif menurun daripada 60.9% pada umur 3 bulan kepada 52.2% pada umur 6 bulan, manakala penggunaan susu formula meningkat kepada 47.8% pada umur 6 bulan. Purata (SP) umur pembetulan semasa pengenalan pemakanan pelengkap ialah 5.1 (1.2) bulan, bersamaan 7.1 (1.4) bulan umur kronologi. Lebih separuh bayi (52.2%) memulakan pemakanan pelengkap sebelum umur pembetulan 5 bulan. Bubur kosong atau bubur campuran merupakan makanan pelengkap pertama yang paling kerap diperkenalkan (82.6%). Secara

keseluruhan, 65.2% mencapai MDD, 70.0% mencapai MMF dan 47.8% mencapai MAD.

Amalan pemberian susu selepas discaj hospital dan pemakanan pelengkap menunjukkan variasi dalam kalangan bayi pramatang di Malaysia. Kurang daripada separuh bayi mencapai diet minimum boleh terima. Garis panduan pemakanan khusus bagi bayi pramatang serta pendidikan kepada penjaga perlu diperkukuhkan bagi menyokong amalan pemakanan yang optimum selepas discaj hospital.

Kata kunci: Bayi pramatang; Pemberian susu; Pemakanan pelengkap; Kepelbagaian diet; Amalan pemakanan

INTRODUCTION

Preterm birth, defined as delivery before 37 completed weeks of gestation, remains a major global public health concern (WHO, 2023). Preterm birth rates in Malaysia are 12.3%, which has a substantial impact on infant morbidity and mortality (Ministry of Health Malaysia, 2023). According to WHO (2023), preterm birth is currently the world's biggest cause of death for children under five. According to their gestational age (GA), preterm infants are divided into four groups: extremely preterm (<28 weeks), very preterm (28–<32 weeks), moderately preterm (32–34 weeks), and late preterm (34–36 weeks) (WHO, 2023). Owing to physiological immaturity, preterm infants are at increased risk of both short- and long-term complications, including retinopathy of prematurity, necrotizing enterocolitis, chronic lung disease, impaired growth, and adverse neurodevelopmental outcomes (Harrison & Goldenberg, 2016; Menezes et al., 2018).

Nutrition plays a pivotal role in mitigating adverse outcomes associated with preterm birth. Early postnatal nutrition is particularly critical, as inadequate protein and energy intake during the first weeks of life has been associated with postnatal growth failure (PGF), suboptimal neurodevelopment, and poorer cognitive outcomes later in childhood (Alanazi et al., 2024). In addition, preterm infants are more susceptible to altered body composition, characterised by reduced lean mass and increased fat mass, which may predispose them to obesity and metabolic diseases in later life (Baldassarre et al., 2022). These risks highlight the importance of optimising nutritional strategies throughout early life, beginning with milk feeding and extending into the complementary feeding period.

Breast milk is widely recommended as the optimal source of nutrition for all infants including preterm infants, as it provides essential nutrients and bioactive components that support immune protection, gastrointestinal maturation, and microbiota development (Rohsiswatmo, 2021). However, compared with term infants, preterm infants have higher nutrient requirements and frequently encounter feeding challenges related to physiological immaturity, medical comorbidities, and prolonged hospitalisation. Consequently,

specialised preterm formula or fortified breast milk is often required to meet their increased nutritional needs and support adequate growth. Nutritional interventions during the first 1,000 days of life, from the prenatal period to two years of age are particularly important for supporting optimal growth, as well as cognitive, motor, and behavioural development in this vulnerable population (Baldassarre et al., 2022).

Following discharge from neonatal care, milk remains the primary source of energy and nutrients for preterm infants, making post-discharge milk feeding practices a key component of ongoing nutritional care. During this period, infants may receive a range of milk feeds, including direct breastfeeding, expressed breast milk, fortified breast milk, post-discharge formula, or combinations of these feeding modalities (Agostoni et al., 2010; Lapillonne et al., 2013). Feeding practices after discharge are influenced by multiple factors, including infant maturity and growth status at discharge, caregiver preferences, breast milk availability, and healthcare advice (Lapillonne et al., 2013). Unlike in-hospital feeding, where nutritional intake is closely monitored, post-discharge milk feeding practices are often more variable and less standardised, potentially resulting in differences in nutrient intake during a critical period of growth and development (Agostoni et al., 2010; ESPGHAN Committee on Nutrition, 2019). Nevertheless, descriptive data on real-world post-discharge milk feeding practices among preterm infants remain limited, particularly in low- and middle-income settings.

As preterm infants progress beyond exclusive milk feeding, the transition to complementary feeding represents another critical phase for ensuring dietary adequacy and the establishment of healthy feeding behaviours. Complementary feeding (CF) refers to the introduction of food when breastmilk and infant formula alone is no longer adequate to support infant nutritional needs, typically initiated at the age of 6–23 months old (WHO, 2023). Complementary feeding is especially important for preterm infants because of their greater nutritional needs and frequently delayed growth (Baldassarre et al., 2022). Through timely and adequate supplemental feeding practices, deficiencies in critical micronutrients, such as iron, zinc, calcium, and vitamin D that are required for bone development and the maturation of the central nervous system can be remedied (Baldassarre et

al., 2022). Additionally, research emphasizes how crucial complementary feeding (CF) is for promoting catch-up growth and enhancing body composition. Adequate consumption of foods high in protein and energy has been shown to have a good impact on physical growth outcomes (Liotto et al., 2020). Enhancement in oral motor development, including the ability to chew and swallow, has also been linked to the early introduction of supplementary foods. On the other hand, delayed initiation can make it more difficult to learn eating habits and lead to feeding issues such as prone to show defensive behaviours at mealtime. This includes refusal in opening mouth when the food was offered and food selectivity that will impact overall infant development, thus potentially leading to nutritional deficiencies and further poor growth (Baldassarre et al., 2020).

Although complementary feeding recommendations for term infants are well established, guidance for preterm infants remains less consistent across countries and professional organisations. Recommendations vary in whether feeding readiness should be guided by chronological age, corrected age, developmental readiness, or a combination of these criteria. Considerable variation exists in clinical practice and caregiver decision making due to existing recommendations about the use of corrected age, chronological age, and developmental readiness. The suggested timing of supplemental feeding initiation among preterm infants varied significantly, according to a systematic analysis by Baldassarre et al. (2022). This suggests that there is still uncertainty about the most effective methods for this population.

Furthermore, most available studies on complementary feeding among preterm infants have focused primarily on the timing of introduction, while less attention has been given to the quality of complementary feeding. Indicators such as Minimum Dietary Diversity (MDD), Minimum Meal Frequency (MMF), and Minimum Acceptable Diet (MAD), which are commonly used to assess complementary feeding adequacy, have rarely been applied in preterm infant populations. In addition, post-discharge milk feeding practices, which continue to contribute substantially to nutrient intake during early infancy, remain underreported.

Although post-discharge nutrition is important for the continued growth and development of preterm infants, evidence on real-world feeding practices after hospital discharge remains limited, particularly in Malaysia. Existing studies have largely focused on in-hospital nutritional practices or the timing of complementary feeding, while less attention has been given to how caregivers continue milk feeding, interpret corrected versus chronological age, and achieve dietary quality during the complementary feeding period. This gap

is important because preterm infants have unique nutritional needs, yet caregivers and healthcare providers may rely on guidance developed mainly for term infants. Therefore, this exploratory study provides preliminary Malaysian data on post-discharge milk feeding practices and the timing and quality of complementary feeding among preterm infants aged 6-23 months corrected age. Despite its descriptive design and small sample size, the study offers context-specific insights that may inform future research and support the development of clearer post-discharge feeding guidance for preterm infants in Malaysia.

METHODS

Design, Setting And Participant

This exploratory cross-sectional study was conducted among caregivers of preterm infants in Malaysia between 15th June 2025 and 31st October 2025. Data collection was carried out over a four-month period using a self-administered online questionnaire distributed through social media platforms, WhatsApp, and email. Caregivers of preterm infants aged between 6 and 23 months corrected age at the time of data collection were eligible to participate.

Sampling And Subject

Participants were recruited using convenience sampling. Inclusion criteria were Malaysian parents or primary caregivers of preterm infants born before 37 weeks of gestation whose children were aged between 6 and 23 months at the time of data collection. Only respondents who resided in Malaysia and were able to read and understand either Malay or English were included. Exclusion criteria included caregivers of term infants (gestational age ≥ 37 weeks), non-Malaysian citizens, and respondents who did not complete the questionnaire. In addition, infants with congenital syndromes, diagnosed developmental disorders, or chronic illnesses that could influence growth or feeding practices were excluded to minimise potential confounding.

PARTICIPANTS

Participants were recruited using convenience sampling through social media platforms, particularly the Bayi Pramatang Malaysia NICU Facebook support group. As an initial recruitment step, a screening poll was posted in the group to identify potentially eligible caregivers. A total of 93 caregivers indicated that their infants may fulfil the study eligibility criteria.

Following this preliminary screening, interested caregivers were invited to complete the full online questionnaire. A total of 23 caregivers submitted completed questionnaires and fulfilled all inclusion criteria and these respondents constituted the final analytical sample. Of the 93 caregivers who initially expressed interest, 23 completed the questionnaire, corresponding to a response rate of 24.7%. The difference between the number of caregivers expressing initial interest and the final sample reflects participant attrition during the recruitment process and completion of the study questionnaire.

DATA COLLECTION

Data were collected using a structured, self-administered online questionnaire developed for parents and caregivers of preterm infants in Malaysia. The questionnaire was developed based on the study objectives, with selected items related to complementary feeding practices adapted from the World Health Organization (WHO)/United Nations Children's Fund (UNICEF) Infant and Young Child Feeding (IYCF) Indicators (2021) and the South East Asian Nutrition Surveys (SEANUTS, 2018). Additional items, including maternal and infant sociodemographic characteristics, clinical information, and post-discharge milk feeding practices, were developed by the research team following a review of the relevant literature. The questionnaire comprised several domains, including maternal sociodemographic characteristics, maternal and infant clinical information, post-discharge milk feeding practices, and complementary feeding practices.

Caregivers reported infant age and the timing of complementary feeding initiation using either corrected age (CA) or chronological age (CHA).

Box 1. Definition of age terminology used in this study

Definition of Age Terminology	
Corrected age (CA)	Age calculated from the expected date of delivery and commonly used when assessing growth, developmental readiness, and complementary feeding among preterm infants.
Chronological age (CHA)	Age calculated from the infants' actual date of birth without adjustment for prematurity

When CHA was reported, prematurity was accounted for and age was recalculated into CA to ensure consistency across analyses. Consequently, CA was used for data presentation in most analyses, while CHA was reported only when relevant for descriptive comparison.

The CF section assessed: (i) the timing of complementary feeding initiation, including whether caregivers based their decision on corrected age or chronological age; (ii) the types of first complementary foods introduced; and (iii) current feeding practices related to diet quality, such as meal frequency and dietary diversity. The quality of complementary feeding was evaluated using the WHO/UNICEF Indicators for Assessing Infant and Young Child Feeding Practices (IYCF, 2021), specifically Minimum Dietary Diversity (MDD), Minimum Meal Frequency (MMF), and Minimum Acceptable Diet (MAD). To enhance contextual relevance, selected questionnaire items were adapted from the South East Asian Nutrition Surveys (SEANUTS, 2018).

Minimum Dietary Diversity (MDD) was defined as the consumption of foods from at least five out of eight food groups within the previous day. This indicator reflected the level of dietary diversity needed to meet the micronutrient requirements of children aged between 6 and 23 months. Minimum Meal Frequency (MMF) referred to the recommended minimum number of meals per day based on the child's age and breastfeeding status, used to assess whether they received a sufficient number of feedings to meet energy needs. Minimum Acceptable Diet (MAD) combined both MDD and MMF indicators and provided a comprehensive assessment of dietary adequacy in meeting children's caloric and micronutrient requirements for optimal growth and development.

As the questionnaire primarily collected factual and descriptive information on feeding practices rather than measuring a single psychometric construct, internal consistency testing using Cronbach's alpha was not applicable. A pilot test involving six respondents was conducted to assess clarity, readability, flow, and ease of understanding. Content validity was reviewed by lecturers and dietitians, and minor revisions were made before data collection.

ETHICAL CONSIDERATIONS

Ethical approval for this study was obtained from the Universiti Kebangsaan Malaysia Research Ethics Committee (Reference No: JEP-2025-286). Participation was voluntary and consent was obtained from all participants prior to questionnaire completion.

STATISTICAL ANALYSIS

Data were analysed using IBM SPSS Statistics version 29. Participant and infant characteristics, post-discharge milk feeding practices, timing of complementary feeding initiation (including the use of corrected versus chronological age), types of first complementary foods, and complementary feeding quality indicators (MDD, MMF, and MAD) were summarised using descriptive statistics. Categorical variables were presented as frequencies and percentages. Continuous variables were presented as mean (standard deviation) for approximately normally distributed data, or as median (interquartile range) where appropriate. No inferential statistical analyses were conducted. The findings are intended to provide preliminary, hypothesis-generating insights into post-discharge milk feeding and complementary feeding practices among preterm infants.

RESULTS

A total of 23 responses were obtained from mothers of preterm infants aged between 6 and 23 months corrected age (CA). The results are presented in the following tables and figures, beginning with the sociodemographic characteristics of respondents, followed by maternal and infant clinical characteristics, post-discharge milk feeding practices, and findings related to the timing of complementary feeding initiation, types of first

foods introduced, and complementary feeding quality indicators (Minimum Dietary Diversity [MDD], Minimum Meal Frequency [MMF], and Minimum Acceptable Diet [MAD]).

The sociodemographic characteristics of respondents are summarised in Table 1. All respondents ($n = 23$) were mothers of preterm infants who met the study inclusion criteria. The mean maternal age was 33.0 years (SD 5.49). The majority of respondents were Malay ($n = 21$, 91.0%), with one respondent each of Bumiputera Sabah and Chinese ethnicity.

In terms of educational attainment, most respondents had completed tertiary education, with 9 (39.0%) holding a bachelor's degree, 2 (8.7%) a master's degree, and 1 (4.3%) a doctoral degree. Five respondents (21.7%) had completed pre-university education (STPM/matriculation/foundation), five (21.7%) had secondary school education, and one (4.3%) held a certificate qualification. More than half of the mothers were employed full-time ($n = 13$, 56.5%), while 7 (30.4%) were housewives, 2 (8.7%) were self-employed, and 1 (4.3%) worked part-time.

Regarding household income, 11 respondents (47.8%) were categorised in the B40 group ($< \text{RM}4850$), 7 (30.4%) in the M40 group ($\text{RM}4850\text{--RM}11819$), and 5 (21.7%) in the T20 group ($\geq \text{RM}11820$). Most respondents resided in urban areas ($n = 22$, 95.7%). With respect to parity, eight respondents (34.8%) reported having one child, eight (34.8%) had two children, five (21.7%) had three children, and two (8.7%) had four children.

TABLE 1. Basic Maternal Demographics

Variables	Values (n=23)
Mother's age, mean (SD) (years)	33 (5.49)
Ethnicity, n (%)	
Malay	21 (91)
Bumiputera Sabah	1 (4.3)
Chinese	1 (4.3)
Education level, n (%)	
Doctor of Philosophy	1 (4.3)
Master's degree	2 (8.7)
Bachelor's degree	9 (39)
Pre-university (STPM/Matric/Foundation)	5 (21.7)
Secondary school	5 (21.7)
Certificate	1 (4.3)
Employment status, n (%)	
Full-time employed	13 (56.5)
Housewife	7 (30.4)
Part-time employed	1 (4.3)

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Self-employed	2 (8.7)
Household income (RM), n (%)	
B40	11 (47.8)
M40	7 (30.4)
T20	5 (21.7)
Residential area, n (%)	
Urban area	22 (95.7)
Rural area	1 (4.3)
Number of children, n (%)	
1 children	8 (34.8)
2 children	8 (34.8)
3 children	5 (21.7)
4 children	2 (8.7)
*B40: < RM4850, M40: RM4850–RM11819, T20: ≥ RM11820	

TABLE 2. Maternal and Infant Clinical characteristics

Variables	Values (n=23)
Female n (%)	13 (56.5)
Male n (%)	10 (43.5)
Gestation age at birth (week), Median (range)	32 (26.4–36.7)
Age at survey (CA, months), Median (range)	11 (6–23)
Delivery method, n (%)	
Caesarean section	18 (78.2)
Vaginal delivery	5 (21.7)
Maternal medical history, n (%)	
Gestational diabetes mellitus (GDM)	7 (30.4)
Hypertension (HPT)	3 (13)
Pre-eclampsia	5 (21.7)
Placenta previa	3 (13)
Pregnancy anaemia	2 (8.7)
GBS (Group B Streptococcus)	1 (4.3)
SLE	1 (4.3)
No complication reported	
Birth Status	6 (26)
Singleton	20 (87)
Twin	3 (13)

The study included 23 preterm infants, comprising 13 girls (56.5%) and 10 boys (43.5%). The median gestational age at birth was 32 weeks (range: 26.4–36.7 weeks). At the time of the survey, the infants had a median corrected age (CA) of 11 months (range: 6–23 months).

Most infants were delivered by caesarean section (n = 18, 78.2%), while five infants (21.7%) were born via vaginal delivery. With respect to maternal medical history, gestational diabetes mellitus (GDM) was the most frequently reported condition,

affecting seven mothers (30.4%). Other reported maternal complications included pre-eclampsia (n = 5, 21.7%), hypertension (n = 3, 13.0%), placenta previa (n = 3, 13.0%), and pregnancy-related anaemia (n = 2, 8.7%). One mother (4.3%) reported Group B Streptococcus infection, and one mother (4.3%) had systemic lupus erythematosus, while six mothers (26.0%) reported no pregnancy related complications. Regarding birth status, the majority of infants were singleton births (n = 20, 87.0%), while three infants (13.0%) were twins.

TABLE 3. Milk Feeding Practices of Included Infants

Variables	Values (n=23)
Received any breastmilk during NICU stay, n (%)	23 (100)
Timing of first put to the breast	
A day after delivery	5 (21.7)
Not put the infant to the breast after delivery	15(65.3)
Not sure	3 (13)
Type of milk provided at following stages	
During NICU admission	
Predominantly or exclusively breastmilk	15(65.2)
Predominantly or exclusively formula milk	8 (34.8)
At 3 months age	
Predominantly or exclusively breastmilk	14 (60.9)
Predominantly or exclusively formula milk	9 (39.1)
At 6 months age	
Predominantly or exclusively breastmilk	12(52.2)
Predominantly for exclusively formula milk	11 (47.8)
Period of breastfeeding	
<1 month	2 (8.7)
1-5 months	7 (30.4)
>6 months	8 (34.8)
>12 months	6 (26.1)
Reasons for not breastfeeding before 6 months of age	
Perceived insufficient supply of breastmilk	13 (56.5)
Replaced with infant formula based on medical advice	2 (8.7)
Maternal employment/insufficient maternity leave	5 (21.7)
Maternal health problems/medical treatment	3 (13)
Infant unable to breastfeed directly or unsuitable for breastmilk	1 (4.3)
Mixed feeding (1:1 breast milk and infant formula) as advised by the NICU team	1 (4.3)
Lack of breastfeeding support or information	2 (8.7)
Exclusive breastfeeding status at survey	5 (21.7)
Age at introduction of milk other than breastmilk (months), mean (SD)	3.3 (2.73)

Based on Table 3, during their time in the NICU, all of the participant's infants (23/23, 100%) received some breastmilk. Only five infants (21.7%) were breastfed within a day of delivery, compared to the majority (15 infants, 65.3%) who were not, and three caregivers (13.0%) were unsure. Eight preterm infants (34.8%) received mostly or solely formula milk during their NICU stay, whereas 15 infants (65.2%) received mostly or exclusively breastmilk. 9 infants (39.1%) were primarily or solely formula fed at 3 months of age, whereas the percentage of infants receiving mostly or exclusively breastmilk dropped somewhat to 14 infants (60.9%). By the time they were six months old, 11 infants (47.8%) were receiving formula milk, while 12 infants (52.2%) were still mostly or entirely breastfed.

2 infants (8.7%) were breastfed for less than a month, 7 infants (30.4%) for one to five months, 8 infants (34.8%) for more than six months, and 6 infants (26.1%) for more than twelve months. 5 infants (21.7%) were reported to be exclusively breastfed at the time of the study.

13 caregivers (56.5%) reported perceived insufficient breastmilk supply as the most prevalent cause for not breastfeeding before six months of age. Maternal employment or inadequate maternity leave (5, 21.7%), maternal health issues or medical treatment (3, 13.0%), replacement with infant formula based on medical advice (2, 8.7%), lack of breastfeeding support or information (2, 8.7%), infant unable to breastfeed directly or unsuitability for breastmilk (1, 4.3%), and mixed feeding to

encourage weight gain based on NICU medical advice (1, 4.3%). 3.3 (2.73) months was the mean (SD) age at which milk other than breastmilk was introduced.

TABLE 4. Complementary Feeding Practices of Included Infants

Variables	Values (n=23)
Chronological age (CHA) of introduction of complementary foods (months) Mean (SD)	7.1 (1.4)
Corrected age (CA) at introduction of complementary foods (months), mean (SD)	5.1 (1.2)
Initiation of CF before 5 months CA, n (%)	12 (52.2)
Initiation of CF after 6 months CA, n (%)	3 (13.0)
Reasons for perceived early initiation before 5 months:	(n=13)
Baby looks hungry even after milk feeds	3 (23.1)
Baby shows interest to adult food	4 (30.8)
Advice from the health practitioner	5 (38.5)
Reasons for perceived late initiation after 6 months (≥ 7 months)	(n=17)
Advice from health practitioners	9 (52.9)
Not confident/unsure of suitable food	3 (17.6)
Baby has not shown signs of readiness	4 (23.6)
Feeding issues (ie. vomit, no appetite)	1 (5.9)
First solid food	
Pureed fruit/vegetables	3 (13.0)
Plain/mix porridge	19 (82.6)
Fortified cereal	1 (4.3)
Achieved Minimum Dietary Diversity (MDD), n (%)	15 (65.2)
Achieved Minimum Meal Frequency (MMF) n (%)	16 (70)
Achieved Minimum Acceptable Diet (MAD) n (%)	11 (47.8)

*Multiple responses were permitted for reasons related to perceived early and late initiation of complementary feeding, therefore the total number of responses exceeds the total sample size (N=23). Additionally, some caregivers may have perceived feeding initiation differently depending on whether chronological age or corrected age was considered.

Based on Table 4, the mean (SD) corrected age (CA) at introduction of complementary foods among the included infants was 5.1 (1.2) months, while the mean (SD) chronological age (CHA) at introduction was 7.1 (1.4) months. Using CA thresholds, 12 infants (52.2%) initiated complementary feeding before five months corrected age, whereas three infants (13.0%) initiated complementary feeding after six months CA. The remaining infants initiated complementary feeding between five and six months CA.

Regarding the reasons for perceived early and late initiation of complementary feeding, participants were allowed to select multiple responses. As a result, there were more responses overall than 23 caregivers in the sample. Furthermore, depending on whether chronological age or corrected age was taken consideration, some caregivers might possess differing perceptions about feeding initiation.

Next, among caregivers who reported perceived early initiation of complementary feeding before five months CA age (n = 13), the most frequently reported reason was advice from a healthcare professional (n = 5, 38.5%). Other reported reasons included the infant showing interest in adult food

(n = 4, 30.8%) and the perception that the infant appeared hungry despite milk feeding (n = 3, 23.1%)

Reasons related to perceived late initiation of complementary feeding at or beyond seven months CA were reported by 17 caregivers. More than half of these caregivers cited advice from a healthcare professional as the primary reason (n = 9, 52.9%). Additional reasons included lack of confidence or uncertainty regarding appropriate complementary foods (n = 3, 17.6%), the perception that the infant had not shown signs of readiness (n = 4, 23.6%), and feeding-related concerns such as vomiting or poor appetite (n = 1, 5.9%). With respect to the type of first complementary foods introduced, most caregivers reported offering plain or blended porridge as the initial food (n = 19, 82.6%). Pureed fruits or vegetables (n = 3, 13.0%) and fortified cereal (n = 1, 4.3%) were reported less frequently. Lastly, regarding complementary feeding quality indicators, 15 infants (65.2%) met the Minimum Dietary Diversity (MDD) criterion, 16 infants (70.0%) met the Minimum Meal Frequency (MMF) criterion, and 11 infants (47.8%) met the Minimum Acceptable Diet (MAD) criterion.

DISCUSSION

This exploratory study provides preliminary insights into post-discharge feeding practices among Malaysian preterm infants, with a particular focus on milk feeding following hospital discharge and the subsequent timing and quality of complementary feeding (CF). All infants in this study had received breastmilk during their NICU stay, consistent with previous findings from the same Baby-Friendly Hospital Initiative accredited neonatal unit (Abdul Hamid et al., 2021), indicating successful initiation and exposure to breastmilk in the hospital setting.

However, following discharge, a gradual shift in milk feeding practices was observed. While the majority of infants continued to receive predominantly or exclusively breastmilk during early infancy, this proportion declined over time, with approximately half of the infants receiving predominantly or exclusively formula milk by six months of age. This pattern suggests challenges in sustaining breastmilk feeding beyond hospital discharge, despite successful initiation during NICU admission. In the absence of local preterm specific data on post-discharge milk feeding practices in Malaysia, findings from the general infant population are used cautiously to provide context. National data from the National Health and Morbidity Survey (NHMS) 2019 indicate that although breastfeeding initiation is common, the continuation of breastfeeding practices declines with increasing infant age, highlighting challenges in sustaining breastfeeding in the community setting (Institute for Public Health, 2019).

Consistent with these observations, previous longitudinal cohort studies have demonstrated substantial declines in exclusive breastfeeding rates among preterm infants following hospital or Neonatal Intensive Care Unit (NICU) discharge. A cohort study conducted in Shanghai reported a reduction in exclusive breastfeeding rates from 19% at one month to 10.4% at six months post-discharge. Factors contributing to this decline included maternal infant separation, poor sucking ability related to underdevelopment of the cheek fat pad, and limited maternal breastfeeding knowledge (Jiang et al., 2022). Similarly, a study conducted in Sweden reported that only 21% of preterm infants continued exclusive breastfeeding after discharge, reflecting the absence of structured community-based interventions to support exclusive breastfeeding among this population (Opoto et al., 2024). Together, these findings indicate that sustaining breastmilk feeding after discharge remains challenging for caregivers of preterm infants, even in high-income settings. Socioeconomic factors, particularly maternal employment status, may further influence

post-discharge milk feeding practices. A Malaysian study conducted in public health clinics reported that mothers who were not in full-time employment were significantly more likely to practise exclusive breastfeeding during the early postpartum period compared with full-time working mothers (Ibrahim et al., 2025). In the present study, more than half of the mothers (56.5%) were employed full-time, which may partly explain the observed shift away from breastmilk feeding over time following hospital discharge. This finding underscores the potential impact of work-related constraints, such as limited maternity leave duration and workplace support, on sustaining breastmilk feeding among caregivers of preterm infants.

In this study, caregivers reported several reasons for discontinuing breastfeeding before six months of age, with the most commonly reported reason being perceived inadequate breastmilk supply. However, actual physiological milk shortage is not always indicated by perceived inadequate breastmilk supply (Huang et al., 2021). Maternal employment was also cited by 21.7% of caregivers in the current study as a barrier to breastfeeding. This implies that mothers' perceptions of an inadequate milk supply, rather than an actual incapacity to produce adequate breastmilk, may have been influenced by work-related constraints, such as limited opportunities for breastmilk expression, inadequate workplace lactation facilities, and time constraints. Qualitative evidence has shown that mothers of preterm infants frequently experience emotional stress, fatigue, concerns regarding milk adequacy, and reduced confidence in breastfeeding, which may contribute to early breastfeeding discontinuation despite strong initial motivation (Chen et al., 2025). Difficulties related to infant feeding, maternal wellbeing, and limited post-discharge support were commonly described, closely aligning with the reasons reported by caregivers in the present study.

Broader reviews examining breastfeeding across healthy, sick, and preterm infants have similarly highlighted that breastfeeding continuation is shaped by multiple interacting factors, including maternal health status, work-related constraints, caregiving burden, and inconsistent professional advice (Bauer et al., 2024). These challenges may lead caregivers to perceive formula feeding or mixed feeding as a more practical or manageable alternative, particularly in medically vulnerable infants. Specific to preterm populations, breastfeeding has been shown to be particularly vulnerable to discontinuation following hospital discharge. Theurich et al. 2021 emphasized that breastfeeding of small, sick, and preterm neonates is often compromised after discharge due to maternal stress, mother-infant separation, return to work, and insufficient post-discharge breastfeeding support

(Theurich et al., 2021). The lack of structured follow-up and targeted lactation support beyond the neonatal unit may therefore contribute to early breastfeeding cessation, consistent with the findings observed in this study.

Given that perceived insufficient breastmilk supply was the most commonly reported reason for breastfeeding discontinuation in this study, strengthening lactation support for mothers of preterm infants should be a priority. Malaysian NICUs could implement structured post-discharge breastfeeding support programmes to mothers, including lactation counselling before discharge, scheduled follow-up consultations, and referral to breastfeeding support groups. Structured post-discharge lactation support, including guidance on breastfeeding techniques, appropriate breastmilk storage, and strategies to maintain milk supply, may help improve maternal confidence and support breastfeeding continuation after discharge.

The findings of this study showed that the mean chronological age at which preterm infants began complementary feeding (CF) was 7.1 months (SD = 1.4), while the mean corrected age at initiation was 5.1 months (SD = 1.2). Caregivers reported infant age and timing of CF initiation using either corrected age (CA) or chronological age (CHA). When CHA was reported, prematurity was accounted for and recalculated into CA for consistency. Although WHO and UNICEF recommend introducing complementary foods at six months of age for term infants, there is no specific global guideline for preterm infants. Consequently, CF timing for preterm infants is often guided by a combination of corrected age and developmental readiness rather than chronological age alone. Notably, more than half of the infants in this study (52.2%) were introduced to complementary feeding before five months CA, with the earliest reported initiation at 3.5 months CA.

There is currently no universal guideline on the optimal age for initiating complementary feeding in preterm infants, and recommendations vary across expert bodies. The European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) recommends that complementary feeding should begin between 5 and 8 months of chronological age, but not before 3 months corrected age, taking into account signs of developmental readiness such as head control and oral-motor coordination (Agostoni et al., 2010; Fewtrell et al., 2017). The British Dietetic Association (BDA) similarly suggests starting complementary feeding between 5 and 7 months chronological age, provided the infant has reached at least 3 months corrected age, with decisions based on clinical judgement and developmental cues (British Dietetic Association, 2021). The Canadian Paediatric Society (CPS)

advises initiating complementary feeding around 4 to 6 months corrected age, depending on feeding readiness (Canadian Paediatric Society, 2013). The Australian National Health and Medical Research Council (NHMRC) supports the introduction of solids at around 6 months corrected age, but not before 4 months, also emphasizing individual readiness rather than a fixed timeline (NHMRC, 2012). In contrast, the American Academy of Pediatrics (AAP) does not provide a specific recommendation for preterm infants, encouraging clinicians instead to individualize timing based on neuromuscular maturity and feeding cues rather than age alone (American Academy of Pediatrics, 2019).

Early initiation of complementary feeding among some infants in this study may be influenced by caregivers' misconceptions regarding corrected age or concerns related to slow weight gain (Abeshu et al., 2016). In the present sample, perceived early initiation was frequently attributed to healthcare practitioner advice and caregivers' interpretation of infant hunger cues. Conversely, perceived late initiation was more commonly associated with caregivers' lack of confidence regarding suitable foods, uncertainty about infant readiness, and feeding-related issues. Similar patterns have been reported in a cohort of late preterm infants, in which mothers primarily initiated complementary feeding based on paediatrician advice (Gianni et al., 2018). Collectively, these findings reinforce evidence that complementary feeding decisions among preterm infants are strongly influenced by professional guidance.

Advice from health practitioners was reported as the reason for both early and late initiation of complementary feeding. This finding may suggest variation in the recommendations and suggestions provided to mothers or caregivers regarding the appropriate initiation timing of complementary feeding for preterm infants. Previous evidence has demonstrated potential risks associated with both early and delayed initiation of complementary feeding. Initiating complementary feeding as early as four months chronological age has been associated with a higher risk of iron deficiency and allergic outcomes, whereas delayed initiation beyond seven to ten months chronological age has been linked to the development of feeding avoidance behaviours (Palmer & Makrides, 2012; Baldassarre et al., 2020). The lack of preterm-specific guidelines for complementary feeding initiation has been suggested to contribute to early initiation, driven by substantial variability in recommendations among primary care paediatricians regarding both timing and food types (Baldassarre et al., 2022). Furthermore, gastrointestinal immaturity, concerns regarding feeding safety, and delayed developmental

readiness such as poor head control or delayed gross motor skills have been associated with later initiation of complementary feeding (Palmer & Makrides, 2012).

In this study, plain or mixed porridge was the most commonly reported first complementary food (82.6%). Introducing soft-textured foods is appropriate during the initial stages of complementary feeding. However, texture progression according to the developmental readiness of preterm infants is equally important. Prolonged reliance on smooth purees without timely progression to more textured foods may delay the development of chewing skills, oral motor function, and food acceptance later in infancy (Baldassarre et al., 2020; D'Auria et al., 2020). This study only assessed the first complementary food introduced and did not examine the duration of soft-textured feeding given to the preterm infants. Hence, further research is needed to explore how texture progression practices affect complementary feeding among Malaysian preterm infants.

With regard to complementary feeding quality, 65.2% of infants achieved Minimum Dietary Diversity (MDD), 70.0% achieved Minimum Meal Frequency (MMF), and 47.8% achieved Minimum Acceptable Diet (MAD). As MAD requires both adequate meal frequency and dietary diversity, the lower achievement of MAD suggests that dietary variety, rather than feeding frequency alone, may be a key challenge among caregivers of preterm infants (WHO & UNICEF, 2021). This pattern is consistent with findings from Indonesia, where achievement of MMF was higher than MDD among children aged 6–23 months (Nurokhmah et al., 2022). Caregivers may provide meals frequently enough but remain cautious about introducing a wider range of food groups because of concerns about prematurity, developmental readiness, gastrointestinal maturity, texture tolerance, or uncertainty about suitable foods. These concerns are consistent with previous evidence showing that complementary feeding among preterm infants is influenced by developmental readiness, gastrointestinal maturity, parental confidence, and professional advice (Baldassarre et al., 2022; Cook et al., 2021). This interpretation is also supported by the reported reasons for delayed complementary feeding in the present study and the frequent use of plain or mixed porridge as the first complementary food. Therefore, counselling should not only address when to start complementary feeding, but also what foods to offer, how to introduce iron-rich and diverse foods, and how to progress textures safely.

It should be noted that the observed proportions of MDD, MMF, and MAD in this study were derived from a small sample size ($n = 23$) and appear lower than those typically reported in surveys of term

infant populations. Direct comparisons, however, should be interpreted with caution, as WHO IYCF indicators were developed for the general infant population and may not fully capture the unique nutritional challenges faced by preterm infants. The findings of this study suggest that preterm infants may experience additional barriers to achieving adequate dietary diversity and acceptable diets, even when complementary feeding is initiated within commonly recommended age ranges.

The lower prevalence of MAD observed in this study may partly reflect the lack of complementary feeding recommendations specifically designed for preterm infants (Baldassarre et al., 2022). When it comes to developmental readiness, food progression, and the appropriate timing of complementary feeding, caregivers of preterm infants frequently receive different guidance than those of term infants (Baldassarre et al., 2022). In the present study, such differences may have encouraged a more cautious feeding approach, where caregivers provided meals frequently enough but introduced a limited variety of food groups. This may partly explain the lower achievement of MAD, as this indicator requires both adequate meal frequency and dietary diversity to be achieved simultaneously (WHO & UNICEF, 2021).

Several factors contributing to the low attainment of MDD, MMF, and MAD were identified in this study. Recommendations from healthcare practitioners to delay feeding due to prematurity, lack of observable readiness cues (such as the ability to sit with support or open the mouth when food is offered), and caregiver uncertainty regarding appropriate and safe food choices were commonly reported. These factors often resulted in limited food variety and conservative feeding practices, which may hinder the achievement of WHO IYCF indicators. These results imply that among caregivers of preterm infants, achieving sufficient dietary diversity may be more difficult than meeting the recommended meal frequency. Although most infants met the MMF criterion, introducing a sufficiently varied range of food groups appeared to be more challenging, which may have subsequently limited the achievement of MAD.

Similar challenges have been reported in other studies, where complementary feeding initiation was influenced by healthcare practitioner advice, caregiver concerns about gastrointestinal immaturity, limited knowledge of infant feeding cues, and familial or cultural beliefs (Cook et al., 2021). These findings highlight how inconsistent advice and caregiver uncertainty may contribute to variability in complementary feeding initiation and reinforce the need for clearer preterm-specific complementary feeding guidance.

Taken together, these findings underscore the need for complementary feeding counselling

tailored specifically to preterm infants. Such counselling should incorporate corrected age when assessing readiness for complementary feeding, rather than relying solely on chronological age, as is commonly applied for term infants. Emphasis should be placed on the early inclusion of iron-rich foods, such as fortified cereals, eggs, meat, and legumes, to address the increased risk of iron deficiency in this population. Additionally, caregivers should be supported in recognising hunger and satiety cues and encouraged to progressively introduce a wider range of food textures and varieties to promote oral motor development and long-term feeding skills. Integrating guidance on corrected age, nutrient density, and responsive feeding practices may help improve complementary feeding quality and dietary adequacy among preterm infants.

These findings have important implications for Malaysian clinical practice and policy. The observed variability in corrected and chronological age use, complementary feeding timing, and dietary quality suggests the need for more consistent post-discharge feeding counselling for caregivers of preterm infants. In practice, follow-up care should include guidance on corrected age, developmental readiness, continued breastmilk feeding and lactation support, introduction of iron-rich foods, dietary diversity, and texture progression. At the policy level, national or institutional guidance tailored to preterm infants may help reduce inconsistent advice and support more equitable feeding support after discharge.

LIMITATION

To appropriately interpret the findings of this study, several limitations should be acknowledged. A key limitation is the small sample size, which may limit the generalisability of the results. Although initial interest was encouraging, with 93 parents responding to the preliminary online survey, only a small proportion completed the full questionnaire. This attrition may reflect the demands of caregiving, competing responsibilities, and time constraints commonly experienced by parents of preterm infants, which may have affected their ability to fully engage with the survey. This attrition may also have introduced selection bias, as caregivers who completed the questionnaire may have differed from those who did not participate or complete the survey. For example, respondents who remained in the study may have been more engaged in infant feeding practices, more active in online support groups, or more motivated to share their experiences. Consequently, the findings may not fully represent the broader population of caregivers of preterm infants in Malaysia.

In addition, as data were collected entirely

through an online, self-administered questionnaire, opportunities for real-time clarification of reported feeding practices were limited. This may have contributed to variability in response interpretation among caregivers. Some parents also demonstrated uncertainty in reporting infant age using corrected age versus chronological age, which may have affected the accuracy of reported timing of feeding practices despite efforts to standardise age calculations during data processing. Furthermore, the broad age range of participating infants (6–23 months corrected age) may have increased the risk of recall bias. For example, caregivers of infants aged 23 months at the time of the survey were required to recall feeding practices that occurred approximately 12–18 months earlier, including the timing of milk feeding transitions and the introduction of first complementary foods. The retrospective reporting may be subject to memory inaccuracies, potentially affecting the accuracy of the reported feeding timelines. Participants were recruited using convenience sampling through social media platforms, which may limit the representativeness of the sample. In addition, most respondents resided in urban areas (95.7%), potentially underrepresenting caregivers from rural settings who may have different access to healthcare services, feeding support, and information resources. Therefore, the findings may not be fully generalisable to all caregivers of preterm infants in Malaysia.

This study provides preliminary Malaysian evidence on post-discharge milk feeding practices, as well as the timing and quality of complementary feeding among preterm infants, with complementary feeding quality assessed using WHO IYCF indicators (MDD, MMF, and MAD). While the findings offer valuable insights and highlight important methodological considerations for future research, particularly the need for larger sample sizes, preterm-specific feeding measures, and clearer guidance on age reporting, they should be interpreted with caution. Despite these limitations, all 23 responses were complete, met the inclusion criteria, and were analysed descriptively, providing a useful foundation for future studies in this under-researched population.

CONCLUSION

This exploratory study provides preliminary Malaysian evidence on post-discharge milk feeding practices and complementary feeding among preterm infants aged 6-23 months corrected age. The findings highlight variability in feeding practices after hospital discharge and during the complementary feeding period, including differences in milk feeding patterns, use of corrected

and chronological age, timing of complementary feeding, and achievement of dietary quality indicators. Less than half of the infants achieved the minimum acceptable diet, suggesting that dietary diversity remains an important area for improvement. These findings support the need for structured post-discharge feeding counselling for caregivers of preterm infants in Malaysia, particularly on the use of corrected age, developmental readiness, continuation of breastmilk feeding, timely texture progression, and achievement of dietary diversity during complementary feeding. Larger studies are needed to strengthen the evidence base and inform context-appropriate nutritional recommendations and preterm-specific feeding guidance in Malaysia.

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