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Maternal gestational, neonatal and nutritional factors of preterm newborn in the first 1000 days of life: pre-grow cohort

Fatores maternos gestacionais, neonatais e nutricionais dos recém-nascidos pré-termo nos primeiros 1000 dias de vida: coorte pré-crescer

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ABSTRACT

Objective

To describe maternal gestational, neonatal, and nutritional characteristics during hospitalization and after discharging up to 2 years of age.

Methods

This descriptive study of the "Pre-Grow Cohort" was conducted in a national institute with clinically stable preterm newborns and admitted between 2012 and 2016. Data on maternal characteristics (weight, body mass index, comorbidities), neonatal factors (weight, length, head circumference), and nutrition (use of human milk, infant formula, cow's milk, and introduction of solid foods) were collected. Data was stored in REDCap and analyzed using IBM®SPSS® with descriptive statistics. The study was approved by the Research Ethics Committee.

Results

The population was mostly composed of infants with adequate weight for gestational age (65.9%) and females (63.4%). Excessive gestational weight gain was observed in 49.3% of mothers with hypertension diagnosed in 30.5%. During hospitalization, 22 infants (26.8%) received exclusively human milk, while 60 infants (73.2%) were given infant formula. After discharge, only 2 infants (2.4%) received exclusively human milk, and among those who received infant formula (97.6%), some had added ingredients (45.1%), mostly sweetened flours (39,0%). The introduction of ultra-processed foods occurred before 11 months of corrected age, and the majority of infants (77.8%) received juice before 8 months of age.

Conclusion

The study identified important factors, such as excessive gestational weight gain, addition of sweetened flours, and early introduction of juice and ultra-processed foods, which may be modified through effective and early interventions.

Keywords: Breast feeding. Child nutrition. Gestational weight gain. Infant, premature.

RESUMO

Objetivo

Descrever as características maternas gestacionais, neonatais e nutricionais durante a internação e após a alta hospitalar até os 2 anos de idade.

Métodos

Estudo descritivo da "Coorte Pré-crescer" realizado em um Instituto Nacional com recém-nascidos pré-termo, clinicamente estáveis e admitidos entre 2012 e 2016. Foram coletados dados maternos (peso, IMC, comorbidades), neonatais (peso, comprimento, perímetro cefálico) e nutricionais (uso de leite humano, fórmula infantil, leite de vaca e introdução alimentar). Os dados foram armazenados no REDCap e analisados no IBM®SPSS® por estatística descritiva. Estudo aprovado pelo Comitê de Ética em Pesquisa.

Resultados

A população foi composta em sua maioria por bebês com peso adequado para a idade gestacional (65,9%) e sexo feminino (63,4%). As gestantes apresentaram excessivo ganho de peso durante a gestação (49,3%) e a hipertensão arterial foi diagnosticada em 30,5% das mulheres. Durante a internação 22 bebês (26,8%) receberam exclusivamente leite humano, a fórmula infantil foi ofertada para 60 bebês (73,2%). Após a alta, apenas 2 bebês (2,4%) receberam exclusivamente o leite humano e os bebês que receberam fórmula infantil (97,6%), tiveram algum ingrediente adicionado ao preparo do leite (45,1%), em sua maioria farinhas açucaradas (39,0%). A oferta de alimentos ultraprocessados aconteceu antes dos 11 meses de idade corrigida. A maior parte dos bebês (77,8%) recebeu suco antes dos 8 meses de idade

Conclusão

O estudo identificou fatores importantes, como excessivo ganho de peso gestacional, adição de farinhas açucaradas, introdução inadequada de sucos e alimentos ultraprocessados, que podem ser modificados por meio de ações efetivas e precoces.

Palavras-chave: *Aleitamento materno. Nutrição da criança. Ganho de peso na gestação. Recém-nascido prematuro.*

INTRODUCTION

The first 1,000 days of life, encompassing the period from conception to a child's second birthday, is recognized as a window of opportunity for early interventions and, simultaneously, a phase of vulnerability for child growth and development [1,2]. This period is characterized by significant brain plasticity [3,4] and is highly susceptible to environmental influences that affect health and disease trajectories both in the short and long term [5,6].

This phase is critical for all newborns, especially for preterm infants, who are considered a high-risk population for developing neurocognitive, behavioral, and motor impairments [7]. Additionally, prematurity may lead to clinical and feeding complications, high rates of hospitalization, and significant healthcare costs [8,9]. The challenges associated with preterm birth demand early intervention approaches and multidisciplinary support [10].

It is estimated that 1 in 10 infants is born before 37 weeks of pregnancy. In 2020 alone, more than 13 million Preterm Newborns (PTNBs) were born worldwide. Complications from prematurity are the leading causes of death among children under five years old [11].

In Brazil, prematurity is a significant public health issue. Data from the *Sistema de Informações sobre Nascidos Vivos* (SINASC, Live Birth Information System) indicates that approximately 11% of births in the country are preterm [12]. This high rate is associated with factors such as socioeconomic conditions and unequal access to prenatal care. Furthermore, complications related to prematurity are among the primary causes of neonatal morbidity and mortality in Brazil [13].

Supporting these findings, the 2023 World Health Organization report highlights that this number of preterm births remains a major challenge and has not significantly declined for several decades. Affecting multiple countries, it deserves greater attention on the global health agenda. The authors argue that, for countries to achieve Sustainable Development Goal 3 – ending preventable neonatal deaths and enhancing human capital throughout the life course – urgent action is required to prevent preterm births and improve the quality of care for preterm infants [9].

Improving care quality requires understanding the various factors influencing this process, including nutrition – a particularly challenging aspect because of the complexity and heterogeneity of preterm births and their impact on a child's metabolic programming [14].

To date, no studies have been identified that elucidate the nutritional characteristics of PTNBs during the first 1,000 days. This study aims to describe the maternal gestational, neonatal, and nutritional characteristics of these infants during hospitalization and after discharge, up to two years of age.

METHODS

The present study conducted a descriptive analysis of maternal gestational, neonatal, and nutritional data during the first 1,000 days of life of preterm newborns (PTNBs) participating in the "Pre-Grow Cohort" at the Instituto Nacional de Saúde da Mulher, da Criança e do Adolescente Fernandes Figueira (IFF/FIOCRUZ, National Institute of Women, Children and Adolescents Health Fernandes Figueira).

This cohort included newborns with a gestational age of less than 32 weeks or a birth weight below 1,500 g, clinically stable, without congenital malformations, genetic syndromes, or infections from the TORCHS group (toxoplasmosis, rubella, cytomegalovirus, herpes, and syphilis), Zika virus, or human immunodeficiency virus.

Those who developed intracranial hemorrhage grades III and IV, severe neurological impairment, necrotizing enterocolitis, bronchopulmonary dysplasia, patent ductus arteriosus with surgical indication, exclusive parenteral nutrition for more than 7 days, those who remained on nil by mouth for more than 5 days, gastrointestinal surgery, and Rh isoimmunization were excluded.

A convenience sample was used, and PTNBs were evaluated from birth and admitted to the Pre-Grow Cohort upon meeting the inclusion and exclusion criteria. All data were collected by a team of multidisciplinary researchers trained for the project's activities at every stage.

PTNBs admitted to the Pre-Grow Cohort between 2012 and 2016, with complete data, were included in the study. The selected variables were retrieved from medical records and clinical charts of the Pre-Grow Cohort. Data encompassed maternal characteristics during pregnancy, neonatal and nutritional characteristics during hospitalization, and after hospital discharge, up to 24 months of corrected age, as detailed in Figure 1.

Maternal variables included pre-pregnancy weight, pre-pregnancy body mass index, gestational weight gain, nutritional status according to the new Brazilian population curves [15],

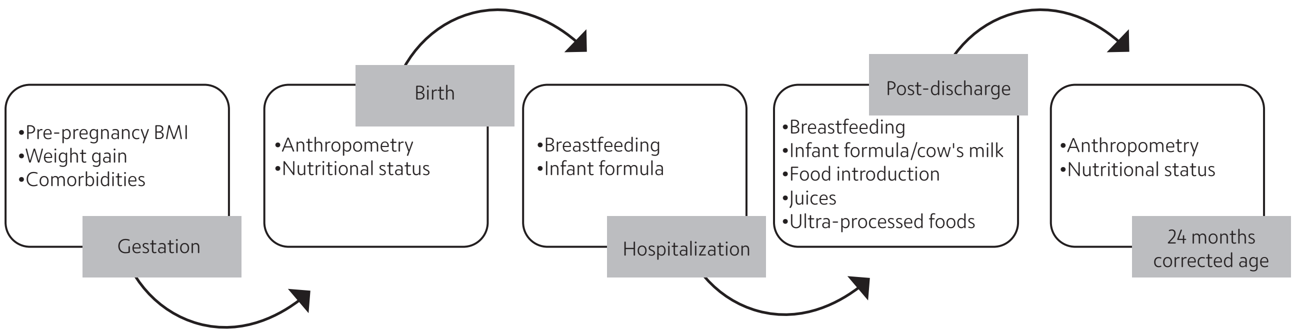

Figure 1 – Flowchart of study variables and their respective collection moments.

presence of multiple gestations, and gestational comorbidities such as hypertension and gestational diabetes mellitus.

Neonatal variables included birth weight, length, and head circumference at birth and 24 months of corrected age, along with their respective Z-scores, classification at birth, gestational age, and sex.

Birth weight was measured using a Filizola® scale with 5-gram precision. Length was measured using a specific ruler suited to the incubator and crib, and head circumference was measured with a non-stretchable measuring tape accurate to 1 mm, adjusted to the head anteriorly in the supraorbital region and posteriorly over the occipital prominence. Z-scores were calculated using Intergrowth curves [16]. Newborns were classified as Small for Gestational Age (SGA, birth weight less than the 10th percentile), Appropriate for Gestational Age (AGA, birth weight was greater than or equal to the 10th percentile and less than or equal to the 90th percentile), or Large for Gestational Age (LGA, birth weight was greater than the 90th percentile).

At 24 months, weight was measured using a high-precision scale (0.01 kg), length with a standardized anthropometric ruler, and head circumference with a non-stretchable millimeter tape. Corresponding Z-scores for age were calculated using WHO Anthro software [17].

Gestational age at birth was calculated based on first-trimester ultrasound or, in its absence, the date of the mother's last menstrual period. In addition, the Corrected Age (CA) was used, which is a measure used to assess the development and growth of premature babies, adjusting the baby's chronological age based on their prematurity, that is, it is the age the baby would have been if they had been born at 40 weeks. The CA is calculated by subtracting the number of weeks left to complete the gestation from the baby's chronological age. In the present study, the CA was adjusted up to 2 years of age.

Nutritional variables were collected from information recorded in the medical records by the attending physicians of the study. The selected variables referred to the beginning and the number of days of life that the baby received Human Milk (HM) and/or Infant Formula (IF), during hospitalization and after discharge, as well as the form of administration (breast, cup or bottle), the ingredients added (thickeners, sugary flours and fruits) to the preparation of IF and/or cow's milk and the maximum age at which the baby received any HM and stopped receiving IF.

Breastfeeding was defined as any human milk intake, whether from the mother or a milk bank. Exclusive breastfeeding was defined as receiving only human milk, regardless of the administration method.

Regarding the introduction of food, information was included on the first meal offered and its consistency, as well as the food groups present at lunch and dinner, the offer of juices and their presentation (natural or artificial) and the consumption of ultra-processed foods These data were collected by the multidisciplinary team of the specialized follow-up outpatient clinic for PTNB care and recorded in the medical record. The care protocol includes the assessment of feeding readiness and questions about feeding in the last 24 hours, as well as some specific foods, such as juices, sugars and ultra-processed foods. Routine post-discharge consultations were carried out at 1, 2, 4, 6, 9, 12, 18 and 24 months of corrected age.

The choice of information separated by food groups, juices and ultra-processed foods followed the Dietary Guidelines for Brazilian Children Under 2 Years of Age [18].

Data were stored using Research Electronic Data Capture (REDCap) software [19] and analyzed with IBM®SPSS® (version 22). For data analysis, a descriptive approach was used that provided a comprehensive view of the population characteristics and variables of interest. Continuous variables were analyzed using means and standard deviations, and categorical variables were expressed as frequencies and percentages.

The Pre-Grow Cohort was approved by the Human Research Ethics Committee of the Fernandes Figueira Institute, CAAE: 00754612.9.0000.5269. The Informed Consent Form was requested from the parents/guardians of the participants for their inclusion in the study. This study did not receive private or public funding.

RESULTS

Of the 93 infants eligible for the study, 82 had complete information in the database and medical records and were therefore included in the study.

The population consisted mostly of PTNB with appropriate weight for gestational age (AGA) (65.9%), female (63.4%), with a mean (minimum and maximum) birth weight of 1,287 g (675-2085 g), length of 38.6 cm (29-49 cm), head circumference of 27.5 cm (22-31.5 cm), and gestational age at birth of 30.5 weeks (25-35 weeks). At 24 months of age, the infants had adequate weight, length, and head circumference for their age, following a growth trajectory close to the expected one (Table 1).

Table 1 – Maternal gestational and neonatal characteristics of preterm newborns participating in the Pre-Grow Cohort, of the National Institute of Women, Children and Adolescents Health Fernandes Figueira (IFF)/FIOCRUZ, 2012-2016.

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Clinical Characteristics	N (%)
Maternal	
Classification of nutritional status	
Low weight	3 (4.3)
Eutrophic	40 (57.1)
Overweight	25 (35.7)
Obesity	2 (2.9)
Weight gain classification during pregnancy	
Insufficient	13 (18.8)
Adequate	22 (31.9)
Excessive	34 (49.3)
Singleton pregnancy	
Yes	28 (34.1)
No	54 (65.9)

Table 1 – Maternal gestational and neonatal characteristics of preterm newborns participating in the Pre-Grow Cohort, of the National Institute of Women, Children and Adolescents Health Fernandes Figueira (IFF)/FIOCRUZ, 2012-2016.

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Clinical Characteristics	N (%)
Hypertension during pregnancy	
Yes	25 (30.5)
No	57 (69.5)
Gestational diabetes during pregnancy	
Yes	6 (7.3)
No	76 (92.1)
Clinical Characteristics	Mean±(SD)
Pre-gestational BMI	24.2 (±3.95)
Preterm newborns	
Sex	
Male	30 (36.6)
Female	52 (63.4)
Birth classification	
SGA	28 (34.1)
AGA	54 (65.9)
Clinical Characteristics	Mean±(SD)
Gestational age at birth (weeks)	30.5 (±2.3)
Birth weight (g)	1287 (±302.0)
Birth weight z-score for age	0.3 (±1.6)
Birth length (cm)	38.6 (±3.4)
Birth length z-score for age	0.3 (±1.5)
Birth head circumference (cm)	27.5 (±2.2)
Birth head circumference z-score for age	-0.2 (±1.2)
Weight at 24 months (g)	11562.0 (±1779.9)
Weight at 24 months z-score for age	-0.4 (±1.2)
Length at 24 months (cm)	88.2 (±4.1)
Length at 24 months z-score for age	0.1 (±1.2)
Head circumference at 24 months (cm)	47.8 (±1.9)

Note: SGA: Small for Gestational Age; AGA: Appropriate for Gestational Age.

Maternal characteristics during pregnancy are presented in Table 1. Anthropometric data were available for 70 pregnant women, most of whom had adequate pre-pregnancy nutritional status (57.1%) and excessive weight gain during pregnancy (49.3%). Regarding comorbidities, most pregnant women did not develop gestational diabetes (92.1%) or hypertension (69.5%). A large number of twin pregnancies were observed (65.9%).

Table 2 presents the results regarding the intake of human milk and/or infant formula during hospitalization. Of the 82 PTNBs, all received human milk during hospitalization, however, 22 infants (26.8%) received exclusively human milk, and infant formula was offered to 60 PTNBs (73.2%) during their stay, starting at 33 weeks of corrected age.

Table 2 – Use of human milk and/or infant formula by PTNBs participating in the Pre-Grow Cohort during hospitalization, Neonatal Intensive Care Unit (NICU) of the National Institute of Women, Children and Adolescents Health Fernandes Figueira (IFF)/FIOCRUZ, 2012-2016.

Nutritional characteristics during hospitalization	Mean±SD	Min-max
Number of days of life with some HM	36.4 (±14.9)	
Number of days of life with exclusively HM	22.8 (±11.3)	
Corrected age at the start of IF (weeks)	33.1 (±2.6)	28- 33
Number of days of life with FI	26.6 (±18.5)	
Corrected age at hospital discharge (weeks)	36.5 (±3.8)	

Notes: HM: Human milk; IF: Infant formula; Min-max: minimum and maximum.

Table 3 presents the results regarding the intake of human milk and/or infant formula after hospital discharge. After hospital discharge, only 2 PTNBs (2.4%) continued to receive exclusively human milk until the introduction of complementary feeding, 25 babies (30.5%) received only IF, and 55 (67.1%) received mixed feeding (human milk and infant formula). The method of administration of IF chosen for most babies (96.3%) was the bottle, and IF was offered until 60 weeks of corrected age. Of these infants, 45.1% had some ingredient added to the preparation of the IF and/or cow's milk, and most of them were sugary flours (39.0%).

Table 3 – Use of human milk and/or infant formula by PTNBs participating in the Pre-Grow Cohort after hospital discharge, monitored in the follow-up clinic of the National Institute of Women, Children and Adolescents Health Fernandes Figueira (IFF)/FIOCRUZ, 2012-2016.

Nutritional characteristics after hospital discharge	N (%)	Min-max.
Type of breastfeeding		
HM exclusively until FI	2 (2.4)	
IF exclusively	25 (30.5)	
Mixed (HM and IF)	55 (67.1)	
Form of administration of the IF		
Cup	1 (1.2)	
Baby bottle	79 (96.3)	
Not applicable	2 (2.4)	
Addition of ingredient in the preparation of IF/Cow's milk		
Yes	37 (45.1)	
No	45 (54.9)	
Ingredient added to the preparation of IF/Cow's milk		
Thickeners	0 (0.0)	
Sweetened flours	32 (39.0)	
Fruits	5 (6.1)	
No	45 (54.9)	
	Mean±SD	
Corrected age at which some HM was consumed (weeks)	34.7 (±27.7)	2-137
Corrected age at which IF was no longer consumed (weeks)	60.9 (±23.0)	14-124

Notes: HM: Human Milk; IF: Infant Formula; FI: Food Introduction; Min-max: minimum and maximum.

Cow's milk and/or dairy products were used by most infants (91.3%) and started at a mean corrected age of 48 weeks (5 to 103 weeks).

Table 4 presents the results of the introduction of complementary feeding which occurred at 6.1 (±1.9) months of corrected age. All infants were attended and guided by the study's pediatric team at the IFF/FIOCRUZ follow-up outpatient clinic.

Table 4 – Characteristics of the introduction of food to PTNBs participating in the Pre-Grow Cohort, monitored in the follow-up clinic of the National Institute of Women, Children and Adolescents Health Fernandes Figueira (IFF)/FIOCRUZ, 2012-2016.

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Characteristics of food introduction	N (%)	Min-max
First meal offered at FI		
Fruits	73 (89.0)	
Lunch/dinner	9 (11.0)	
Consistency of the first food offered		
Liquified	25 (30.9)	
Puree	56 (69.1)	

Table 4 – Characteristics of the introduction of food to PTNBs participating in the Pre-Grow Cohort, monitored in the follow-up clinic of the National Institute of Women, Children and Adolescents Health Fernandes Figueira (IFF)/FIOCRUZ, 2012-2016.
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Characteristics of food introduction	N (%)	Min-max
Consistency of the first food offered		
Coarsely mashed	0 (0.0)	
Slices	0 (0.0)	
Foods offered at lunch and dinner		
Vegetables	35 (42.6)	
Meat/eggs	15 (18.3)	
Cereals	3 (3.7)	
Legumes	9 (11.0)	
All groups above	47 (57.3)	
Consistency of food offered at lunch and dinner		
Liquified	2 (2.5)	
Puree	78 (96.3)	
Coarsely mashed	1 (1.2)	
Slices	0 (0.0)	
Juice offer		
Yes	63 (77.8)	
No	18 (22.2)	
Presentation of juices		
Natural	47 (58.0)	
Artificial	7 (8.6)	
Not informed/Not consumed	27 (33.3)	
Consumption of ultra-processed foods before 24 months		
Yes	76 (93.8)	
No	5 (6.2)	
	Mean±SD	
Corrected age at onset of AI (months)	6.1 (±1.9)	1-12
Corrected age at onset of lunch (months)	7.1 (±1.4)	3-12
Corrected age at onset of dinner (months)	8.4 (±1.5)	6-13
Corrected age at onset of juice consumption (months)	7.6 (±3.6)	1-24
Corrected age at onset of UPF consumption (months)	10.7 (±5.6)	1-24

Note: FI: Food Introduction; UPF: Ultra-processed foods; Min-max: minimum and maximum.

The first food offered was fruit (89.0%) and in the form of puree (69.1%). The age for starting lunch and dinner was after 7 and 8 months of corrected age, respectively, and most (57.3%) started offering with all food groups present in the meal. The offer of ultra-processed foods to infants occurred before 11 months of corrected age. Most infants (77.8%) received juice before 8 months of corrected age, with 58.0% being natural juice.

DISCUSSION

This study highlighted significant findings in the first 1000 days of life of PTNBs that are amenable to intervention to prevent current and future diseases, such as excessive maternal weight gain during pregnancy, reduced duration of HM provision, and inadequate introduction of certain foods.

Regarding maternal variables during pregnancy, our study revealed results that differed from recent data presented by the *Sistema de Vigilância Alimentar e Nutricional* (SISVAN, Food and Nutrition Surveillance System), which showed that more than half of pregnant women receiving primary care presented overweight or obesity [20]. In the present study, most pregnant women were classified as eutrophic, but they presented weight gain above recommendations, as observed in another study with more than 700 pregnant women in the city of São Paulo [21]. Studies have shown that excess weight during pregnancy is a risk factor for excess weight and adiposity in infants during childhood and for increased chances of developing other chronic non-communicable diseases, such as obesity, in later years of life [22,23]. There is a great interest in research in this area to understand epigenetic modifications, metabolic programming mechanisms, and the determinants of the adult phenotype [6]. Metabolic programming is an adaptation process that occurs early in life, where the maternal environment during pregnancy is influenced by environmental factors [24,25] and excessive weight gain in women during pregnancy makes the maternal environment suboptimal and is a strongly associated environmental factor with the increased risk of age-related diseases [26].

For Lackovic et al., excessive gestational weight gain is related to adverse pregnancy outcomes, such as hypertensive disorders, gestational diabetes, and affects early motor development in infants [27].

Hypertensive disorders occur in 5 to 15% of pregnancies and represent one of the major causes of maternal morbimortality [28]. In the present study, hypertension was diagnosed in 30.5% of pregnant women, a result similar to that found by Guida et al. [29], in a multicenter study conducted in Brazil, where the prevalence of this disorder among women with premature births was 28.2%. These higher values may be due to the fact that the study populations were exclusively with PTNBs. It is known that changes in blood pressure values during pregnancy are a risk factor for premature births, besides adverse neonatal outcomes, such as babies with low birth weight and small for gestational age [28,30,31]. These data reinforce the importance of strategies for early detection and management of arterial hypertension during pregnancy.

Another environmental factor that has an effect on the infant's metabolic programming is breastfeeding. HM provides unique nutrients and bioactive compounds that are crucial for the growth of preterm newborns, in addition to reducing sepsis, necrotizing enterocolitis, and improving neurodevelopment. Initiating breastfeeding early in the Neonatal Intensive Care Unit (NICU) with strategies such as skin-to-skin contact enhances these benefits [32,33].

In the present study, during hospitalization, 26.8% of infants received exclusive human milk, a value higher than that found by Oliveira and Volkmer [34] in a cohort conducted in a NICU in the southern region of the country, which was 16.1%, and by Dias et al. [35] in a cross-sectional study, which found that only 2.4% of infants received exclusive human milk until discharge. A retrospective study in a hospital in the Brazilian Federal District with infants admitted to the NICU found that 3.0% of PTNBs received exclusive human milk during hospitalization [36]. The care profile of IFF, which belongs to the Baby-Friendly Hospital Initiative, with actions aimed at promoting breastfeeding and the presence of a human milk bank, may reflect the higher values found in the present study.

After hospital discharge, IF was offered to 80 (97.6%) infants, of which 55 received mixed feeding (human milk and infant formula) and 25 received infant formula only. Only 2 received exclusive breastfeeding until the introduction of complementary foods. These findings are consistent with other studies in the literature that show a marked decrease in exclusive breastfeeding rates after hospital discharge [37,38] and the difficulty of maintaining breastfeeding in PTNBs, whether because of low maternal milk production resulting from preterm birth (stress, hospitalization, complications) or difficulties of the PTNB itself (morbidities, immaturity for sucking, poor weight gain, increased nutritional needs) [38,39].

Public policies [40] aimed at promoting breastfeeding have become increasingly prevalent, as breast milk is considered the most suitable food for any newborn. The American Academy of Pediatrics [41] acknowledges the benefits of breast milk for PTNBs, because of its balanced chemical composition and easy absorption, reduced risk of complications, and improved cognitive development, among other factors. Therefore, human milk is recommended in neonatal intensive care units, both milks extracted from the mother and immediately offered to the newborn, and that obtained from human milk banks.

Current data on breastfeeding practices in Brazil show that the prevalence of exclusive breastfeeding up to six months of age in full-term infants and continued breastfeeding in the first year of life are still below the values recommended by the World Health Organization [42]. According to the *Estudo Nacional de Alimentação e Nutrição Infantil* (ENANI, Brazilian National Survey on Child Nutrition) [43], the prevalence of exclusive breastfeeding in infants under six months in Brazil was 45.8% and continued breastfeeding in the first year of life was 43.6%. The median duration of exclusive breastfeeding was 3 months and of any breastfeeding was 15.9 months.

Since 2010, Brazil has implemented the National Policy for the Promotion, Protection, and Support of Breastfeeding, a fundamental pillar of child health. This policy aims to foster strategic actions to encourage and monitor breastfeeding. Among the existing actions, we can highlight the implementation of rooming-in in public hospitals with the Kangaroo Method, the creation of Human Milk Banks, the Baby-Friendly Hospital Initiative, and the *Norma Brasileira para Comercialização de Alimentos para Lactentes* (Norm for Marketing of Breast-milk Substitutes). These initiatives are justified by the complexity of interventions aimed at breastfeeding and the need to guarantee the right to breastfeed [44].

However, the maintenance of breastfeeding remains a challenge for both term and preterm infants. There is a need to strengthen the debate on this topic and to reinforce effective actions to encourage breastfeeding [43].

Furthermore, it is noteworthy that in the present study, nearly half of the children received IF and/or cow's milk supplemented with some ingredient, most commonly sugary flours. The early introduction of sugar into the infant diet, as well as ultra-processed foods, promotes excessive intake of calories, salt, fat, and food additives, which may be an important factor for excessive weight gain, and also increase the risk of future diseases, tooth decay, and decreased interest in whole or minimally processed foods during a critical period for the development of taste preferences [18,45,46].

The age at which complementary feeding was introduced to the PTNBs in this study aligns with current recommendations [18,46], which consider both the infant's readiness and a corrected gestational age of 6 months. It is important to note that these recommendations are still under debate, as PTNBs constitute a heterogeneous population and there is limited evidence available on the optimal age for introducing solid foods and its implications for health [47,48].

A multicenter clinical trial conducted by Gupta et al. [49] compared PTNBs with early introduction of complementary feeding at 4 versus 6 months corrected gestational age. According to the authors, the rate of hospital admission was higher in the 4-month group (2.5 episodes per 100 infant-months in the 4-month group versus 1.4 episodes per 100 infant-months in the 6-month group, p=0.03). The introduction of solids for these infants should consider their distinct nutritional needs, organ immaturity, increased risk of rehospitalization, and motor development delays [50].

Current recommendations suggest that the first main meal should be introduced in the sixth month of a baby's life, and the second main meal should be introduced in the seventh month [18,45,46]. In the present study, we found that these were introduced after the seventh and eighth months of corrected age, respectively. The foods that make up the main meals should be offered in accordance with the recommendations for increasing the variety and presentation of new foods, adequate evolution of consistency, and the provision of nutrients that complement milk, which are necessary for the baby's satisfactory development [18]. Delaying this offer is associated with food selectivity [51] and the potential development of food allergies [52].

Regarding feeding practices, it is worth noting that most babies consumed natural and/or artificial juice and ultra-processed foods before their first year of life. These data are in line with those presented by SISVAN for children aged 6 to 23 months, where 44% had already consumed ultra-processed products, 29% sugary drinks, 25% sandwich cookies, sweets and treats, and 21% instant noodles, crackers and packaged snacks, which can increase the risk of excess weight and nutritional deficiencies in all children, both those born at term and prematurely [20].

According to the Dietary Guidelines for Brazilian Children Under 2 Years of Age, juice should only be introduced after the first year of life and in limited quantities. This is because juice does not promote chewing, is low in fiber when strained, is often sweetened, and may replace water as the child's primary beverage. Ultra-processed foods are not recommended for children in this age group [18].

The study results should be interpreted considering some limitations, as they originated from an original cohort (*Pré-crescer* Project) and information such as dietary intake during pregnancy and family income were not prioritized, but followed the institution's protocol, which is based on the recommendations of the Dietary Guidelines for Brazilian Children Under 2 Years of Age [18].

Although participants were attended to in the public health system, presumably from a different social and financial condition than private network patients, the results found are similar to those of national studies.

As a strength of the work, there is a reinforcement of knowledge in the description of such a heterogeneous and vulnerable population, such as PTNBs, who, until now, have few national studies exploring nutritional aspects in the first 1000 days of life [35,53-55]. The possibility of intervention comes with visibility. The findings evidence the need for investments in continuous nutritional education in prenatal care, breastfeeding, and complementary feeding for PTNBs, in order to contribute to the promotion of maternal health and child development.

CONCLUSION

The identification of maternal, neonatal, and nutritional factors in early life is increasingly relevant, as it allows for early monitoring and the development of prevention strategies. Factors identified in the present study, such as excessive gestational weight gain, the addition of sugary flours to infant formula, and the inappropriate introduction of juices and ultra-processed foods, can be modified through effective and early interventions. This study contributes to clinical practice by providing evidence to assist healthcare professionals in counseling and nutritional guidance for pregnant women and PTNBs, a population particularly vulnerable to growth and neurodevelopmental deviations. In the field of study, the work offers a basis for future research on interventions and care practices in the first 1000 days of life, a critical phase for healthy development, enabling the refinement of health policies and the strengthening of preventive actions to minimize long-term risks.

REFERENCES

1. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, et al. What works? Interventions for maternal and child undernutrition and survival. Lancet. 2008;371(9610):417-40. doi: https://doi.org/10.1016/S0140-6736(07)61693-6
2. Mulcaire-Jones G, Scanlon R. The first thousand days of life. Issues Law Med. 2022;37(2):249-56.
3. Cunha AJLA, Leite ÁJM, Almeida IS. The pediatrician's role in the first thousand days of the child: the pursuit of healthy nutrition and development. J Pediatr. 2015;91(6):S44-S51. doi: https://doi.org/10.1016/j.jped.2015.07.002
4. Martorell R. Improved nutrition in the first 1000 days and adult human capital and health. Am J Hum Biol. 2017;29(2):101002. doi: https://doi.org/10.1002/ajhb.22952
5. Agosti M, Tandoi F, Morlacchi L, Bossi A. Nutritional and metabolic programming during the first thousand days of life. Pediatr Med Chir. 2017;39(2):157. doi: https://doi.org/10.4081/pmc.2017.157
6. Casirati A, Somaschini A, Perrone M, Vandoni G, Sebastiani F, Montagna E, et al. Preterm birth and metabolic implications on later life: a narrative review focused on body composition. Front Nutr. 2022;15(9):978271. doi: https://doi.org/10.3389/fnut.2022.978271
7. Ottolini KM, Andescavage N, Keller S, Limperopoulos C. Nutrition and the developing brain: the road to optimizing early neurodevelopment: a systematic review. Pediatr Res. 2020;87(2):194-201. doi: https://doi.org/10.1038/s41390-019-0508-3
8. Vogel JP, Chawanpaiboon S, Moller AB, Watananirun K, Bonet M, Lumbiganon P. The global epidemiology of preterm birth. Best Pract Res Clin Obstet Gynaecol. 2018;52:3-12. doi: https://doi.org/10.1016/j.bpobgyn.2018.04.003
9. World Health Organization. Preterm birth. Geneva: WHO; 2018 [cited 2022 Feb 25]. Available from: https://www.who.int/news-room/fact-sheets/detail/preterm-birth
10. Koletzko B, Cheah FC, Domellöf M, Goudoever JB, Poindexter BB, Vain N. Scientific basis and practical application of nutritional care for preterm infants. World Rev Nutr Diet. 2021;122:13-5.
11. World Health Organization. Preterm birth. Geneva: WHO; 2023 [cited 2023 May 30]. Available from: https://www.who.int/news-room/fact-sheets/detail/preterm-birth
12. Ministério da Saúde (Brasil). Painel de Monitoramento de Nascidos Vivos. Brasília: SINASC; 2022 [cited 2022 Feb 8]. Available from: https://svs.aids.gov.br/daent/centrais-de-conteudos/paineis-de-monitoramento/natalidade/nascidos-vivos/
13. Silva RM, Lima RM, Costa JS. Complicações associadas à prematuridade: dados epidemiológicos e desafios no Brasil. Arq Pediatr. 2022;26(3):152-60.
14. Mozetic RM, Silva SDC, Ganen AP. A importância da nutrição nos primeiros mil dias. REAS. 2016;8(2):876-84.
15. Ministério da Saúde (Brasil). Caderneta da Gestante. Brasília: Ministério da Saúde; 2022 [cited 2023 Feb 23]. Available from: https://bvsms.saude.gov.br/bvs/publicacoes/caderneta_gestante_versao_eletronica_2022.pdf
16. Villar J, Cheikh Ismail L, Victora CG, Ohuma EO, Bertino E, Altman DG, et al. International standards for newborn weight, length, and head circumference by gestational age and sex: the Newborn Cross-Sectional Study of the INTERGROWTH-21st Project. Lancet. 2014;384(9946):857-68. doi: https://doi.org/10.1016/S0140-6736(14)60932-6
17. World Health Organization. WHO Anthro for mobile devices version 2, 2007: software for assessing growth and development of the world's children. Geneva: WHO; 2007.
18. Ministério da Saúde (Brasil). Guia alimentar para crianças brasileiras menores de 2 anos. Brasília: Ministério da Saúde; 2019.
19. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap): a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009;42(2):377-81.
20. Ministério da Saúde (Brasil). Situação alimentar e nutricional de crianças na Atenção Primária à Saúde no Brasil. Brasília: Ministério da Saúde; 2022 [cited 2023 Feb 23]. Available from: https://bvsms.saude.gov.br/bvs/publicacoes/situacao_alimentar_nutricional_criancas_atencao.pdf

21. Fonseca MRCC, Laurenti R, Marin CR, Traldi MC. Ganho de peso gestacional e peso ao nascer do concepto: estudo transversal na região de Jundiaí, São Paulo, Brasil. Ciênc Saúde Coletiva. 2014;19(5):1401-7. doi: https://doi.org/10.1590/1413-81232014195.17022013

22. Mameli C, Mazzantini S, Zuccotti GV. Nutrition in the first 1000 days: the origin of childhood obesity. Int J Environ Res Public Health. 2016;13(9):E838. doi: https://doi.org/10.3390/ijerph13090838

23. Nehab SRG, Villela LD, Soares FVM, Abranches AD, Gomes Junior S-C, Moreira MEL. Body composition at 4 to 7 years of age in children born <32 weeks gestational age or 1500 g: a cohort study. Early Hum Dev. 2022;173:105659. doi: https://doi.org/10.1016/j.earlhumdev.2022.105659

24. Puche-Juarez M, Toledano JM, Ochoa JJ, Diaz-Castro J, Moreno-Fernandez J. Influence of adipose tissue on early metabolic programming: conditioning factors and early screening. Diagnostics. 2023;13(9):1510. doi: https://doi.org/10.3390/diagnostics13091510

25. Seneviratne SN, Rajindrajith S. Fetal programming of obesity and type 2 diabetes. World J Diabetes. 2022;13(7):482-97. doi: https://doi.org/10.4239/wjd.v13.i7.482.

26. Godfrey KM, Reynolds RM, Prescott SL, Nyirenda M, Jaddoe VWV, Eriksson JG, et al. Influence of maternal obesity on the long-term health of offspring. Lancet Diabetes Endocrinol. 2017;5(1):53-64. doi: https://doi.org/10.1016/S2213-8587(16)30107-3

27. Lackovic M. Jankovic M, Mihajlovic S, Milovanovic Z, Rovcanin M, Mitic N, et al. Gestational Weight Gain, Pregnancy Related Complications and the Short-Term Risks for the Offspring. J Clin Med. 2024;13(2):445. doi: https://doi.org/10.3390/jcm13020445

28. Teng H, Wang Y, Han B, Liu Y, Wang J, Zhu X, et al. Gestational systolic blood pressure trajectories and risk of adverse maternal and perinatal outcomes in Chinese women. BMC Pregnancy Childbirth. 2021;21(1):155. doi: https://doi.org/10.1186/s12884-021-03599-7

29. Guida JPS, Dias TZ, Lajos GJ, Nomura ML, Pacagnella RC, Tedesco RP, et al. Hypertensive disorders during pregnancy as a major cause of preterm birth and adverse perinatal outcomes: findings from a Brazilian National Survey. Einstein. 2024;22:eA00514. doi: https://doi.org/10.31744/einstein_journal/2024AO0514

30. Townsend R, O'Brien P, Khalil A. Current best practice in the management of hypertensive disorders in pregnancy. Integr Blood Press Control. 2016;9:79-94. doi: https://doi.org/10.2147/IBPC.S77344

31. Garovic VD, Dechend R, Easterling T, Karumanchi SA, Baird SM, Magee LA, et al. Hypertension in Pregnancy: diagnosis, blood pressure goals, and pharmacotherapy: a scientific statement from the American Heart Association. Hypertension, 2022;79(2):21-41. doi: https://doi.org/10.1161/HYP.0000000000000208

32. Gordillo CIG, Carpinteyro DA, Vazquez HZ, Gaudiano AP. Support breastfeeding in premature infants in the neonatal intensive care unit. J Pediatr. 2024;14(2):119-21. doi: https://doi.org/10.15406/jpnc.2024.14.00552

33. Lugonja N, Marinković V, Pucarević M, Miletić S, Stojić N, Crnković D, et al. Human milk: the biofluid that nourishes infants from the first day of life. Foods. 2024;13(9):1298. doi: https://doi.org/10.3390/foods13091298

34. Oliveira MG, Valle Volkmer DF. Factors associated with breastfeeding very low birth weight infants at neonatal intensive care unit discharge: a Single-Center Brazilian experience. J Hum Lact. 2021;37(4):775-83. doi: https://doi.org/10.1177/0890334420981929

35. Dias ALPO, Hoffmann CC, Cunha MLC. Breastfeeding of preterm newborns in a neonate hospitalization unit. Rev Gaúcha de Enferm. 2023;44:e20210193. doi: https://doi.org/10.1590/1983-1447.2023.20210193.en

36. Reis RS, Araújo DSL, Santos AP, Fortes RC. Perfil nutricional e clínico de recém-nascidos prematuros internados em uma unidade de terapia intensiva de um hospital particular do Distrito Federal. Brasília Med. 2021;58:1-6. doi: http://dx.doi.org/10.5935/2236-5117.2021v58a55

37. Sassá AH, Schmidt KT, Rodrigues BC, Ichisato SMT, Higarashi IH, Marcon SS. Bebês pré-termo: aleitamento materno e evolução ponderal. Rev Bras Enferm. 2014;67(4):594-600. doi: https://doi.org/10.1590/0034-7167.2014670415.

38. Lima APE, Castral TC, Leal LP, Javorski M, Sette GCS, Scochi CGS, Vasconcelos MGL. Aleitamento materno exclusivo de prematuros e motivos para sua interrupção no primeiro mês pós-alta hospitalar. Rev Gaúcha Enferm. 2019;40 doi: https://doi.org/10.1590/1983-1447.2019.20180406

39. Lapillonne A. Feeding the preterm infant after discharge. In: Koletzko B, Poindexter B, Uauy R, editors. Nutritional care of preterm infants: scientific basis and practical guidelines. S Karger AG; 2014. p. 264-77. doi: https://doi.org/10.1159/000358475

40. Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Ações Programáticas Estratégicas (Brasil). Política Nacional de Atenção Integral à Saúde da Criança: orientações para implementação. Brasília: Ministério da Saúde; 2018 [cited 2023 Feb 18]. Available from: https://portaldeboaspraticas.iff.fiocruz.br/wp-content/uploads/2018/07/Pol%C3%ADtica-Nacional-de-Aten%C3%A7%C3%A3o-Integral-%C3%A0-Sa%C3%BAde-da-Crian%C3%A7a-PNAISC-Vers%C3%A3o-Eletr%C3%B4nica.pdf

41. American Academy of Pediatrics. Breastfeeding and the use of human milk. Pediatrics. 2012;129(3):827-41. doi: https://doi.org/10.1542/peds.2011-3552

42. World Health Organization. Global breastfeeding scorecard, 2019: increasing commitment to breastfeeding through funding and improved policies and programmes. Geneva: WHO; 2019 [cited 2023 Feb 2]. Available from: https://iris.who.int/handle/10665/326049

43. Universidade Federal do Rio de Janeiro. Estado nutricional antropométrico da criança e da mãe: prevalência de indicadores antropométrico de crianças brasileiras menores de 5 anos de idade e suas mães biológicas. Rio de Janeiro: ENANI; 2019.

44. Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Ações Programáticas Estratégicas (Brasil). Bases para a discussão da Política Nacional de Promoção, Proteção e Apoio ao Aleitamento Materno. Brasília: Ministério da Saúde; 2017.

45. Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Atenção Básica (Brasil). Saúde da criança: aleitamento materno e alimentação complementar. Brasília: Ministério da Saúde; 2015 [cited 2023 Feb 4]. (Cadernos de Atenção Básica; vol. 23). Available from: https://bvsms.saude.gov.br/bvs/publicacoes/saude_crianca_nutricao_aleitamento_alimentacao.pdf

46. Sociedade Brasileira de Pediatria, Departamento de Nutrologia. Manual de Alimentação: orientações para alimentação do lactente ao adolescente, na escola, na gestante, na prevenção de doenças e segurança alimentar. 4th ed. São Paulo: SBP; 2018.

47. Vissers KM, Feskens EJ, van Goudoever JB, Janse AJ. The timing of complementary feeding in preterm infants and the effect on overweight: study protocol for a systematic review. Syst Rev. 2016;5(1):149. doi: https://doi.org/10.1186/s13643-016-0324-3

48. Liotto N, Cresi F, Beghetti I, Roggero P, Menis C, Corvaglis L, et al. Complementary feeding in preterm infants: a systematic review. Nutrients. 2020;12(6):1843. doi: https://doi.org/10.3390/nu12061843

49. Gupta S, Agarwal R, Aggarwal KC, Chellani H, Duggal A, Arya S, et al. Complementary feeding at 4 versus 6 months of age for preterm infants born at less than 34 weeks of gestation: a randomised, open-label, multicentre trial. Lancet Glob Health. 2017;5(5):e501-e511. doi: https://doi.org/10.1016/s2214-109x(17)30074-8

50. Palmer DJ, Makrides M. Introducing solid foods to preterm infants in developed countries. Ann Nutr Metab. 2012; 60(2):31-38. doi: https://doi.org/10.1159/000335336

51. Emmett PM, Hays NP, Taylor CM. Antecedents of picky eating behaviour in young children. Appetite. 2018;130(1):163-73. doi: https://doi.org/10.1016/j.appet.2018.07.032

52. Fleischer DM, Chan ES, Venter C, Spergel JM, Abrams EM, Stukus D, et al. A consensus approach to the primary prevention of food allergy through nutrition: guidance from the American Academy of Allergy, Asthma, and Immunology; American College of Allergy, Asthma, and Immunology; and the Canadian Society for Allergy and Clinical Immunology. J Allergy Clin Immunol Pract. 2021;9(1):22-43. doi: https://doi.org/10.1016/j.jaip.2020.11.002

53. Brusco TR, Delgado SE. Caracterização do desenvolvimento da alimentação de crianças nascidas pré-termo entre três e 12 meses. Revista CEFAC. 2014;16(3):917-28. doi: https://doi.org/10.1590/1982-021620145313

54. De Freitas BAC, Lima LM, Carlos, CFLV, Priore SE, Franceschini SCC. Duration of breastfeeding in preterm infants followed at a secondary referral service. Rev Paul Pediatr. 2016;34(2):189-96. doi: https://doi.org/10.1016/j.rpped.2015.10.005

55. Godinho APK, Conceição AO, Rodrigues EL, Siqueira IMBJ, Taconeli CA, Crispim SP, et al. Padrões alimentares e fatores associados de crianças menores de dois anos nascidas prematuramente. Rev Paul Pediatr. 2022;40:e2021177. doi: https://doi.org/10.1590/1984-0462/2022/40/2021177IN

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