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Food consumption markers and minimum dietary diversity in different complementary feeding methods: a randomized clinical trial

Marcadores de consumo alimentar e diversidade alimentar mínima em diferentes métodos de introdução alimentar: um ensaio clínico randomizado

Abstract

Objective: To evaluate food consumption markers and minimum dietary diversity in 12-month-old infants exposed to different methods of food introduction. **Methods:** A randomized clinical trial with mother-infant pairs undergoing intervention on food introduction in three methods: Parent-Led Weaning (PLW), Baby-Led Introduction to SolidS (BLISS), and mixed (combination of the two techniques). Food consumption markers were evaluated by an online questionnaire at 12 months based on food consumed the previous day, using food consumption markers for children under 2 years of the Food and Nutrition Surveillance System. The study was approved by the ethics committee. **Results:** At 12 months, 136 children were evaluated: 45 allocated to PLW, 48 to BLISS, and 43 to mixed. The foods with the highest prevalence of consumption were breast milk 103 (75.7%), vegetables 122 (89.7%), meat 135 (99.3%), beans 115 (84.6%), rice, potatoes, or yam 135 (99.3%). Ultra-processed foods were present in the diet of infants, including hamburgers or sausages 3 (2.2%), sweetened beverages 2 (1.5%), instant noodles 4 (2.9%), and sandwich cookies 2 (1.5 %). No differences were found between the methods of introducing complementary feeding. The minimum dietary diversity was present in the diet of 22 infants (16.2%), being: 6 (13.3%) in the PLW, 8 (16.7%) in the BLISS, and 8 (18.6%) in the mixed ($p=0.793$). **Conclusion:** Breast milk, vegetables, meat, beans, and rice were present in the diet of most infants; however, the prevalence of minimal dietary diversity was low. The consumption of ultra-processed foods was also present in the diet of infants.

Brazilian Registry of Clinical Trials (ReBEC) identification RBR-229scm

Keywords: Infant Nutrition. Diet Healthy. Eating. Minimum Dietary Diversity. Complementary Feeding. Infant and Young Child Feeding. Child Nutrition. Food Intake Markers.

Resumo

Objetivo: Avaliar os marcadores de consumo alimentar e a diversidade alimentar mínima em lactentes de 12 meses de vida expostos a diferentes métodos de introdução alimentar. **Métodos:** Ensaio clínico randomizado com pares mãe-lactente submetidos à intervenção sobre introdução alimentar em três métodos: Método tradicional (MT), *Baby-led Introduction to SolidS* (BLISS) e misto (combinação das duas técnicas). Os marcadores de consumo alimentar foram avaliados por questionário online aos 12 meses com base nos alimentos consumidos no dia anterior, utilizando os marcadores de consumo alimentar para menores de 2 anos do Sistema de Vigilância Alimentar e Nutricional. O estudo foi aprovado no comitê de ética. **Resultados:** Aos 12 meses foram avaliadas 136 crianças: 45

alocadas no MT, 48 no BLISS e 43 no misto. Os alimentos com maior prevalência de consumo foram: leite materno 103 (75,7%), frutas, legumes e verduras 122 (89,7%), carnes ou ovos 135 (99,3%), feijão 115 (84,6%), cereais ou tubérculos 135 (99,3%). Alimentos ultraprocessados que estiveram presentes na dieta dos lactentes foram hambúrguer ou salsichas 3 (2,2%), bebidas açucaradas 2 (1,5%), macarrão instantâneo 4 (2,9%) e biscoito recheado 2 (1,5%). Não foram encontradas diferenças entre os métodos de introdução da alimentação complementar. A diversidade alimentar mínima esteve presente na alimentação de 22 lactentes (16,2%), sendo: 6 (13,3%) no MT, 8 (16,7%) no BLISS e 8 (18,6%) no misto ($p=0,793$). **Conclusão:** Leite materno, frutas, legumes e verduras, carne, feijão e arroz estiveram presentes na alimentação da maioria dos lactentes; no entanto, a prevalência de diversidade alimentar mínima foi baixa. O consumo de alimentos ultraprocessados também esteve presente na alimentação dos lactentes.

Registro Brasileiro de Ensaios Clínicos (ReBEC) identificação RBR-229scm

Palavras-chave: Nutrição do lactente. Dieta Saudável. Alimentação. Diversidade Alimentar Mínima. Alimentação Complementar. Alimentação de lactentes e crianças pequenas. Nutrição infantil. Marcadores de Consumo Alimentar.

INTRODUCTION

Appropriate feeding practices for children under two years of age include breastfeeding practice and timely healthy food introduction.^{1,2} The Ministry of Health of Brazil (MH) recommends that all food groups should be offered to children from the beginning of complementary feeding (CF), from the sixth month of life in the form of purees or porridge until the family consistency, at 12 months.³ In addition to the traditional method, also called Parent-Led Weaning (PLW), as it guides the provision of food by parents with the help of cutlery, there are other methods described in the literature, such as Baby Led Weaning (BLW)⁴ and Baby-led Introduction to SolidS (BLISS).⁵ Both methods recommend an approach to introducing solid foods that are based on the baby's developmental readiness to consume foods other than breast milk or formula. By allowing the child to decide when to start eating other foods, what to eat (from a selection of healthy foods), how quickly to eat, and how much to consume at once. In addition to allowing the child to control the pace at which they expand their diet and transition away from milk feeding.^{4,5} The BLISS method also recommends that an energy food, such as tubers, and a source of protein, such as meat and eggs, should be offered at every meal to avoid energy and iron deficiencies.⁵ The data available so far on the BLISS and BLW methods demonstrate that this type of diet is associated with lower consumption of saturated fat,⁶ greater food variety, and exposure to vegetables.^{6,7}

The diversity of foods to which the child is exposed in CF is important in meeting nutritional needs and contributing to the formation of healthy children's eating habits.^{3,8,9} To assess food consumption, the Food and Nutrition Surveillance System (SISVAN)¹⁰ provides the form "Markers of Food Consumption", which considers the consumption of fruits, vegetables, and beans as a marker of healthy eating; and unhealthy, the consumption of ultra-processed foods. In addition, minimum dietary diversity (MDD) is an indicator of diet quality that assesses the consumption of food groups that are important sources of nutrients for child growth and development in the 24 hours before the assessment.¹⁰ MDD is a good parameter to assess indirect micronutrient intake in children.¹¹ The low variety of foods in the diet is associated with growth restriction, worsening of the main micronutrient deficiencies, intellectual delay, weight gain, and, in the long term, the development of chronic non-communicable diseases.^{12,13}

Data available in Brazil demonstrate inadequate practices in traditional CF with the offer of non-recommended foods in the first year of life.^{12,14,15} Even with the growing popularity of CF methods and the promising results in food diversity⁷ and exposure to vegetables⁶ in infant feeding, there is a gap in the literature on whether such methods positively impact food variety and consequently the presence of MDD. Based on the importance of dietary variety in the diet of children in the first year of life and the evidence from CF methods, this study aimed to evaluate food intake markers and minimal dietary diversity in 12-month-old infants exposed to different methods of feeding food introduction.

METHODS

A randomized clinical trial involving three distinct groups of mothers and infants about the CF method: (A) PLW;³ (B) BLISS;⁵ and (C) Mixed method: a combination of the CF PLW and BLISS method, created especially for this study,¹⁶ based on the difficulties encountered by mothers in previous research¹⁷ on adherence to the BLISS method.

This is a non-probabilistic sample in which participants were recruited for the study through the Internet, both through social networks and through pages and groups aimed at mothers, in addition to posters posted in the corridors and waiting rooms of the Hospital de Clínicas de Porto Alegre (HCPA). The invitation letter contained a phone number and an email address where parents could leave a message if

they wished to participate. Once the inclusion criteria were verified, the subjects considered eligible received a standardized message explaining the details, risks, and benefits of the study, and their eventual questions were answered by the researchers by telephone or e-mail.

They were considered eligible to participate in the investigation of mothers residing in Porto Alegre or the metropolitan region, with single-term births, with birth weight $\geq 2,500$ g, and who had not yet started the introduction of food, with internet access. Children with medically certified dietary restrictions (such as congenital errors of metabolism and celiac disease), children with congenital malformations, and children with special needs were not considered eligible.

Mothers and children who met the inclusion criteria were placed on a list by a researcher not responsible for recruitment and selection and were given an identification number. The identification number has been entered on the website <http://www.randomization.com> and the pair is allocated to one of three intervention groups.

At five and a half months of age, the mothers underwent a 45-minute intervention, which consisted of a food introduction workshop in a private nutrition clinic equipped with an experimental kitchen, in which four nutritionists who were members of the research team previously trained mothers taught these mothers to start CF appropriately, depending on the group to which they were randomized. A speech therapist, previously trained to standardize the guidelines to be provided, also guided the prevention and management of choking in a 15-minute session. The workshop was offered to groups of four to seven mothers and could be accompanied by a family member or professional responsible for caring for the child, on a previously agreed date, according to the age of the infants. Participants and nutritionists prepared sample meals together, in real-time, in the experimental kitchen. During the COVID-19 pandemic, from March 2020 to March 2021, the intervention took place online and synchronously.

Regardless of the method, those responsible were instructed to offer breast milk exclusively for six months, and in a complementary way, for two years or more, to limit the supply of industrially processed foods (such as canned and preserved foods), not to offer ultra-processed foods and foods sweetened foods and pay attention to basic hygiene care in food preparation, such as washing hands and utensils before preparation, using filtered or boiled water and storing food under refrigeration.

In addition to the oral instructions, those responsible received support material created especially for this study, according to the randomization group, as described below.

(A) PLW Method

Those responsible were instructed to start offering complementary feeding from the sixth month of life, with the slow and gradual introduction of food carried out by the adult with a spoon. Complementary foods (cereals, tubers, meats, legumes, fruits, and vegetables) should be offered three times a day, without rigid schedules and respecting the child's appetite; the consistency should be initially pasty and gradually progress to the consistency of the family's diet at 12 months, with a variety of colors and food groups at every meal, without blending or sieving.

(B) BLISS method

The infant should be encouraged to feed independently, although always assisted by an adult and participating in family mealtimes. The consistency of foods offered from six months of age onwards should be in nature, in formats that would allow the infant to hold with their own hands, cut into elongated formats, such as strips or sticks, which facilitate the pinching movement and prevent choking. They were instructed to

avoid rushing the infant, respect their time to explore flavors and textures; offering at least three types of food at each meal: a food source of iron, a food source of energy, and a food source of fiber.⁵

(C) Mixed Method

The method proposed by our research group, where those responsible were instructed to apply the PLW and BLISS technique in the same meal, offering part of the food mashed by spoon and part in nature cut into safe formats such as strips and sticks, from six months of age life.

At nine months of the infant's life, those responsible received a home visit by a member of the team previously trained to reinforce the guidelines on CF provided during the first intervention in the family environment, such as the importance of maintaining the food supply according to the method, breastfeeding and food quality.

The choice of home visit at nine months aimed not to burden the family with travel to the clinical research center (CRC), located at the HCPA.

During the COVID-19 pandemic, from March 2020 to March 2022, counseling took place over the Internet through a messaging application.

Upon entering the survey, mothers answered a sociodemographic questionnaire. Information on total family income, schooling, parity, self-reported race/ethnicity, sex of the infant, cohabitation, maternal employment, and daycare were obtained through the online questionnaire.

At 12 months of age, those responsible received an online questionnaire to assess food consumption markers, according to the parameters established by SISVAN.¹⁰ Food consumption markers for children under 2 years of age are: breast milk, milk other than breast milk, porridge with milk, yogurt, vegetables (do not consider those used as seasonings, nor potatoes and yams), orange-colored vegetable or fruit (pumpkin, carrot, papaya, mango) or dark green leaves (kale, *caruru*, purslane, *bertalha*, spinach, mustard), leafy vegetables (lettuce, chard, cabbage), meat (beef, chicken, fish, pork, offal, others) or egg, liver, beans, rice, potato, yam, cassava, flour or pasta (other than instant), hamburger and/or sausages (ham, bologna, salami, sausage), sweetened beverages (soda, juice box, juice powder, boxed coconut water, guarana/currant syrups, fruit juice with added sugar), instant noodles, packaged snacks or crackers, and sandwich cookies, sweets or treats (candy, lollipops, gum, caramel, gelatin).

Those responsible answered structured questions as follows: "Did the child consume breast milk yesterday?" With the answer option yes, no, or don't know.

The prevalence of MDD was assessed by the consumption on the previous day of the six food groups: breast milk, other kinds of milk or yogurt; fruits, vegetables, and greens; orange-colored vegetables or fruits and dark green leaves; meat and eggs; bean; and cereals and tubers.¹⁰

The database was created using Statistical Package for the Social Sciences (SPSS®), version 21.0, with double typing and later validation. Numerical nonparametric variables were described by the median and interquartile range and categorical variables were described by percentage and absolute number.

Pearson's chi-square or Fisher's exact test was used to detect differences between proportions and the ANOVA test with Tukey's post hoc, Mann Whitney, or Kruskal Wallis with Dunn's post hoc test was used to detect differences between medians.

The project was approved by the Research Ethics Committee of the Hospital de Clínicas de Porto Alegre under the number 2019-0230 (CAAE: 1537018500005327) and registered in the Brazilian Registry of Clinical

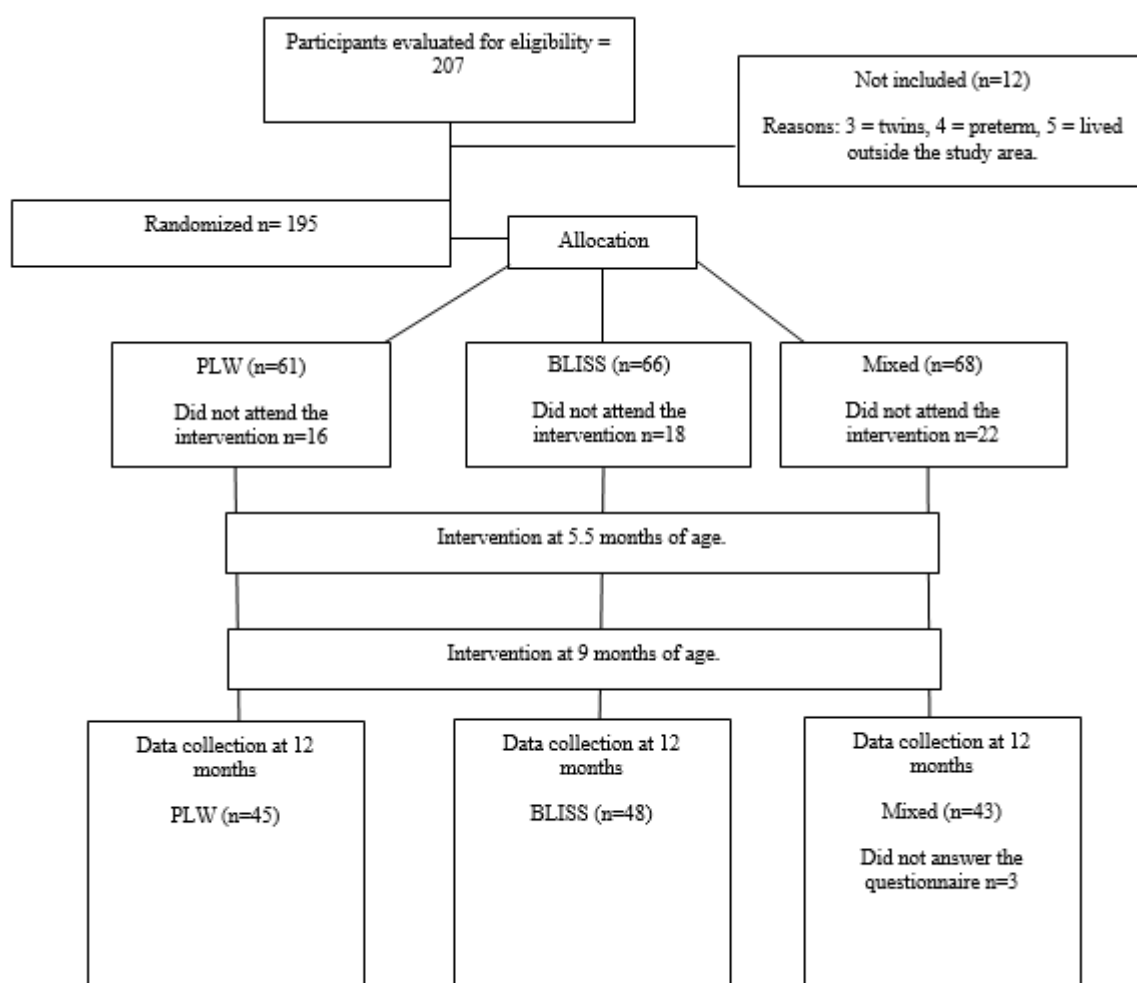
Trials (ReBEC) under the identification RBR-229scm. The present study respects the bioethical aspects, according to Resolution No. 466, of December 12, 2012, of the National Health Council.

All participants consented to participate in the research and signed the informed consent form (ICF), initially online and later physically during the first intervention.

RESULTS

Sample recruitment took place between March 2019 and March 2020. During this period, 207 mothers showed interest in participating in the research, 195 met the inclusion criteria, and were randomized (n=61 for the PLW method, n=66 for the BLISS method, and n=68 for the mixed method). Between April 2019 and April 2020, 139 mothers attended the intervention, 16 of them online during the COVID-19 pandemic. At 12 months of age, between November 2019 and November 2020, 136 mothers completed the online questionnaire on food consumption markers. Figure 1 shows the flowchart of the survey with mothers who showed interest, those who met the eligibility criteria, and who were randomized. The number of participants who did not attend the intervention was similarly distributed between the intervention groups (16 in the PLW method, 23 in the BLISS, and 25 in the mixed method). Data on sample characterization are presented according to the intervention groups in Table 1

Figura 1. Fluxograma de seleção da amostra.



Legend: BLISS – Baby-Led Introduction to SolidS; PLW - Parent-Led Weaning.

Table 1. Characterization of the sample according to the food introduction group. Porto Alegre-RS, 2019

	Food Introduction Method			
	PLW (n=45)	BLISS (n=48)	Mixed (n=43)	Total (n=136)
Maternal characteristics				
	Median [P25 - P75]			
Age (years)	34 [27 - 37]	35 [32 - 38]	33 [29 - 36]	34 [29 - 37]
Monthly family income (reais)	5000 [3850 - 10000]	8000 [4000 - 13000]	6000 [4000 - 10000]	6,000 [4000 - 10000]
Education (years)	16.5 [13 - 20]	18 [15.3 - 20]	18 [16 - 20]	18 [15 - 20]
	n (%)			
Race/ethnicity				
White	37 (84.1)	41 (85.4)	38 (88.4)	116 (85.9)
Not white	7 (15.9)	7 (14.6)	5 (11.6)	19 (14.1)
Parity				
Primiparous	35 (77.8)	37 (77.1)	38 (88.4)	110 (80.9)
multiparous	10 (22.2)	11 (22.9)	5 (11.6)	26 (19.1)
Infant characteristics				
	n (%)			
Sex				
Male	20 (44.4)	22 (45.8)	22 (51.2)	62 (47.1)
Female	25 (55.6)	26 (54.2)	21 (48.8)	72 (52.9)
Lactation				
maternal at 12				
Months				
Yes	37 (82.2)	36 (75.0)	30 (69.8)	103 (75.7)
No	8 (17.8)	12 (25.0)	13 (30.2)	33 (24.3)

Legend: BLISS – Baby-Led Introduction to SolidS; PLW – Parent-Led Weaning; P – percentile

Table 2. presents the prevalence of consumption on the previous day of each marker of food consumption and minimum diversity. Breast milk 103 (75.7%), vegetables 122 (89.7%), meat or egg 135 (99.3%), beans 115 (84.6%), rice, potatoes, or yams 135 (99.3%) were the most consumed foods in the previous day. Green leaves 29 (21.3%), yogurt 14 (10.3%), and porridge 7 (5.1%) were the least consumed foods on the previous day. No statistically significant differences were found between the groups introducing CF

Table 2. Food consumption markers for children under two years of age in infants submitted to three methods of introducing complementary feeding. Porto Alegre-RS, 2019.

	Food Introduction Method				P
	PLW (n=45)	BLISS (n=48)	Mixed (n=43)	Total (n=136)	
Foods are eaten the day before					
	n (%)				
Breast milk	37 (82.2)	36 (75.0)	30 (69.8)	103 (75.7)	0.391
Other kinds of milk	24 (53.3)	18 (37.5)	18 (41.3)	60 (44.1)	0.389
Porridge with milk	3 (6.7)	4 (8.3)	0 (0.0)	7 (5.1)	0.170
Yogurt	7 (15.6)	3 (6.2)	4 (9.3)	14 (10.3)	0.325
Vegetables	39 (86.7)	43 (89.6)	40 (93.0)	122 (89.7)	0.561
Orange or dark green vegetable	41 (91.1)	43 (89.6)	40 (93.0)	124 (91.2)	0.846
Green leaves	8 (17.8)	10 (20.8)	11 (25.6)	29 (21.3)	0.667
Meat or egg	45 (100.0)	47 (97.9)	43 (100.0)	135 (99.3)	0.397
Bean	35 (77.8)	42 (87.5)	38 (88.4)	115 (84.6)	0.304
Rice, potato, yam	45 (100.0)	47 (97.9)	43 (100.0)	135 (99.3)	0.397
Hamburger or sausages	2 (4.4)	1 (2.1)	0 (0.0)	3 (2.2)	0.364
Sweetened drinks	1 (2.2)	0 (0.0)	1 (2.3)	2 (1.5)	0.574
Instant noodles	2 (4.4)	1 (2.1)	1 (2.3)	4 (2.9)	0.765
Sandwich cookie	2 (4.4)	0 (0.0)	0 (0.0)	2 (1.5)	0.128
Minimum dietary diversity	6 (13.3)	8 (16.7)	8 (18.6)	22 (16.2)	0.793

Legend: BLISS – Baby-Led Introduction to SolidS; PLW - Parent-Led Weaning
Pearson's Chi-square test.

MDD was present in 22 (16.2%) of the infants, 6 (13.3%) in the PLW group, 8 (16.7%) in the BLISS group, and 8 (18.6%) in the mixed group. There was no difference between the groups ($p=0.793$).

The infant's sex ($p = 0.811$), attending kindergarten ($p = 0.695$), being breastfed at 12 months ($p = 0.709$), living with the infant's father ($p = 0.340$), maternal grandmother ($p = 0.109$), or paternal grandmother ($p = 0.299$), parity (p

= 0.776) and maternal race/ethnicity ($p = 0.734$) and the mother working outside the home ($p = 0.543$) were not associated with the presence of MDD. In addition, maternal schooling ($p = 0.502$), total family income ($p = 0.774$), and maternal age ($p = 0.770$) did not differ between infants with or without MDD.

DISCUSSION

This study found a high prevalence of consumption of breast milk, vegetables, meat and eggs, beans and cereals, or tubers in infants at 12 months who underwent three different methods of introducing complementary feeding. MDD was not prevalent in the population and, despite not being very prevalent, the consumption of ultra-processed foods was identified. The methods of introducing complementary feeding were not associated with the consumption of the food groups present in the food consumption markers, nor with the MDD and consumption of ultra-processed foods.

Previous studies have shown that the introduction of complementary feeding using BLISS and BLW methods favors exposure to vegetables and proteins⁷ and contributes to greater acceptance of fruits and vegetables,⁶ however, no difference was observed between the groups in terms of exposure to these foods.

The low diversity of food for children between six and 23 months is worrying. It is estimated that less than one in three children has MDD, according to UNICEF data.¹⁸ Research carried out in Brazil shows a similar scenario, the prevalence ranged from 31.8% in children between six and 23 months¹⁸ to 41.3%¹⁹ in children aged 12 months. The lack of food diversity in this age group can compromise the supply of nutrients necessary for growth and development,²⁰ when associated with the consumption of foods that have a high energy density, fat, sugar, sodium, and little fiber,³ in the early stages of development, harm the health of infants in the long term, predisposing them to the development of chronic diseases in adulthood.^{1,13} A food survey, answered by parents of children under three years old from public schools in the south of the country, showed that only a third of them consumed six food groups daily and none of them had MDD at the beginning of the CF.²¹

Food consumption in childhood is influenced by several factors,¹⁷ such as being born in a public or private network,²⁰ age (children between six and eight months are more likely not to consume the minimum recommended groups),⁷ maternal knowledge about nutrition,²² exposure to programs focused on food,²³ and social class.²⁴ Previous studies show income as a determining factor for the quality of food,^{24,25} demonstrating that children from families with lower incomes are more likely to have a less diversified diet.²⁵ The income and education of the present sample differed from the Brazilian average,⁶ however, even in a population with higher education and income, the prevalence of MDD was below the desired level.

A survey commissioned by the MH to assess the effectiveness of the Amamenta Brazil Network in three capital cities showed no difference in the consumption of vegetables between the group that participated in a six-hour workshop on the 10 steps to healthy complementary feeding and the group that did not. participated in the workshop. In both intervention groups, less than 20% of the sample had consumed this food group.²⁶ In this study, despite the participants being advised of the importance of consuming all food groups, the prevalence of consumption of orange-colored vegetables or fruits and dark green leaves presented a value similar to that found in the aforementioned study. The group of green leaves was the least consumed the day before, this finding is likely associated with the degree of difficulty of offering leafy vegetables to children under one year old. However, this group has high amounts of fiber and micronutrients, and their consumption should be encouraged to meet nutritional needs to promote adequate growth and development.^{17,27} In contrast, insufficient amounts of micronutrients during CF may reflect the onset of child malnutrition, significantly contributing to the high incidence of malnutrition in children under five years of age.²⁸ In addition, inadequate intake of micronutrients and fiber in children under two years of age can also result in growth deficit, delay in sexual maturation, delay in cognitive and

intellectual development, and compromised immune system,¹⁷ in addition to initiating subclinical biological processes that lead to the expression of the disease in later years.¹³

The unsatisfactory result of the intervention in promoting MDD may be alert for the opportune moment to provide such guidelines. A cross-sectional survey carried out in Indonesia showed that counseling during prenatal care was positively associated with MDD.²⁹ These results may indicate that interventions made during the first months of the infant's life are not able to increase the diversity of food offered and that the ideal moment may be pregnancy. The first few months of a child's life are a period of concern for parents regarding the success of breastfeeding and the organization of infant care.

This study has some limitations, such as the sample selection bias, as those responsible who showed interest in taking part in the research are probably more concerned with food, which can influence the results. The higher level of schooling and family income of the sample than the Brazilian population, in general, prevents the generalization of the findings. However, the novelty of this work, as it is the first randomized clinical trial to evaluate MDD in Brazil using CF methods, provides important results on the quality of the diet of infants, especially vegetables and leaves. One of the strengths of this work was that the intervention was carried out in a nutrition clinic, allowing the subjects to practice in loco the dietary preparations involving the important food groups for infants. During this study, some modifications were implemented due to the declaration of the COVID-19 epidemic. The counseling sessions that used to take place in a private nutrition clinic were replaced by synchronous online counseling sessions. Although the content covered remained the same, we cannot disregard the possibility that this change may have affected the results.

In conclusion, the prevalence of MDD in infants at 12 months of age was low, with less than 20% of the sample having consumed six food groups the day before the interview. Food introduction methods were not associated with diet quality from the DAM perspective. More studies are needed on this topic with a representative sample of the country's socio-economic conditions and with an assessment of the quality of the diet

AGRADECIMENTOS

To the graduate students of the Jordana Fuhr research group, Christy Hanna Sanini Belin and Renata Oliveira Neves for all their support and collaboration, in addition to the scientific initiation students, fathers, mothers, and children participating and for the financial support from the Fundação de Apoio à Universidade do Rio Grande do Sul (FAURGS), Brazil, to the National Development Council Scientific and Technological Institute (CNPq), Brazil and the Research and Events Incentive Fund (FIPE) of Hospital de Clínicas de Porto Alegre, Brazil.

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Contributors

Moreira PR: statistical analysis, data interpretation, and article writing; Vargas BO: data collection, interpretation of results, and writing of the article; Nunes LM: research coordination, study conception and design, critical review of the article, and approval of the final version; Gomes E: a critical review of the article and approval of the final version; Bernardi JR: research coordination, study conception, and design, critical review of the article and approval of the final version.

Conflict of Interest: The authors declare no conflict of interest.

Received: June 3, 2022

Accepted: June 26, 2023