



Association of exclusive breastfeeding duration with consumption of ultra-processed foods, fruit and vegetables in Brazilian children

Poliana Cristina de Almeida Fonseca¹ · Sarah Aparecida Vieira Ribeiro² · Cristiana Santos Andreoli³ · Carolina Abreu de Carvalho^{4,5} · Milene Cristine Pessoa⁵ · Juliana Farias de Novaes⁶ · Silvia Eloisa Priore⁶ · Sylvia do Carmo Castro Franceschini⁶

Received: 3 January 2018 / Accepted: 2 October 2018
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Abstract

Background There has been little evidence of the influence of breastfeeding on childhood eating habits.

Aim To evaluate the association between duration of exclusive breastfeeding (EB) and consumption of ultra-processed foods, fruits and vegetables by Brazilian children.

Methods This is a cross-sectional study nested in a cohort of 403 children age 4–7 years. Food consumption was evaluated by three food records and the foods were grouped by the amount of processing involved (minimal, including fruit and vegetables to ultra-processed foods). Adjusted linear and multinomial regression models were proposed to evaluate the association of EB with children's food intake. Median duration of EB was 4.0 (2.0–6.0) months and the prevalence of EB of 4 months or more was 60.9%.

Results Mean energy consumption was 1536 kcal/day, 38% of energy was from ultra-processed foods. Mean intake of fruit and vegetables was 130 g/day. For each 1-month increase in duration of EB there was a 0.7% decrease in energy from ultra-processed foods (β : -0.7 ; 95% CI: -1.3 to 0.1 ; $p=0.038$). EB of less than 4 months was associated with the child being in the lowest tercile for consumption of fruit and vegetables (Adjusted OR: 1.8; 95% CI: 1.1–3.0; $p=0.030$) and the highest for consumption of ultra-processed foods (adjusted OR: 1.7; 95% CI: 1.1–2.9; $p=0.040$).

Conclusions In addition to other benefits of EB, we emphasize its importance for the formation of healthy eating habits, contributing to a higher consumption of fruit and vegetables and lower consumption of ultra-processed foods in childhood.

Keywords Children · Exclusive breastfeeding · Infant nutrition · Fruit · Vegetables · Ultra-processed foods

Introduction

Change in food patterns of the Brazilian population is notorious in the metropolitan areas of the country since 1980. Traditional diets are replaced by consumption of processed and highly processed foods [1–3]. This feeding behavior is

a risk factor for the increase in the prevalence of overweight and chronic noncommunicable diseases in the population [4].

A study with representative data of Brazilian children aged 2–5 years showed that 60% consumed fried foods, 82% consumed artificial juices and soft drinks at least 1 day a week, and 47.4% consumed cookies daily [5]. The consumption of snacks and sweets, from 1–3 times a week, was 39.4% and 37.8%, respectively, among children under 5 years of age [6]. On the other hand, daily intake was only 13.8% for leafy vegetables, 19.5% for vegetables and 43.8% for fruit [5]. Other authors have shown that the consumption of ultra-processed foods makes up 47% of the diet of children aged 2–10 years in Brazil [7]. These results indicate that the food consumption of children has been characterized by high intake of unhealthy foods, especially ultra-processed foods, and low frequency of fruit and vegetable consumption.

✉ Poliana Cristina de Almeida Fonseca
Polianafonseca.nutri@gmail.com

¹ Federal University of Maranhão (UFMA), São Luís, Brazil

² Federal University of Espírito Santo (UFES), Vitória, Brazil

³ Federal Institute of Ouro Preto (IFOP), Ouro Preto, Brazil

⁴ Federal Institute of Maranhão (IFMA), São Luís, Brazil

⁵ Department of Nutrition, School of Nursing, Federal University of Minas Gerais (UFMG), Belo Horizonte, Brazil

⁶ Federal University of Viçosa (UFV), Viçosa, Brazil

An already-established eating behavior in children and adults is difficult to change, and early-life dietary practices, including breastfeeding, are essential for the formation of healthy eating habits [8]. Studies demonstrate the positive impact of longer duration of breastfeeding on healthy eating habits, as assessed by fruit and vegetable consumption by children at later ages [8, 9]. Moller et al. [10] observed an association of exclusive breastfeeding (EB) duration with vegetable but not fruit intake by children of 5 years. In another study, vegetable consumption in the age group 4–7 years was associated with the duration of breastfeeding for 12 months or more [11]. However, other authors found no influence of EB on the higher frequency of fruit and vegetables in the diet of children 2–3 years and 4–7 years [11, 12].

The results of studies on this topic are still controversial. Further studies are needed to investigate whether exclusive breastfeeding influences the construction of healthy eating patterns at later ages in childhood [8, 13]. In addition, there have been few studies investigating the influence of breastfeeding on the consumption of markers of unhealthy diet. So far, we have found no study that investigated the association of EB duration with ultra-processed food consumption by children.

In this context, the objective of this study was to evaluate the association between duration of EB and consumption of fruit, vegetables and ultra-processed foods by Brazilian children aged 4–7 years. Our hypothesis is that a shorter duration of EB contributes to formation of eating habits that pose risk to children's health.

Methods

It is a cross-sectional study nested in a cohort of children followed up in the first 6 months of life and re-evaluated at ages 4–7 years. The children were born in the maternity hospital in Viçosa, Minas Gerais, Southeast Brazil, and were monitored by the Lactation Support Program (LSP), part of the Extension Program of the Federal University of Viçosa (UFV). This program aims to promote breastfeeding with guidelines for mothers in the postpartum period and for nutritional monitoring each month during the first year of the child's life [14, 15]. All information regarding this follow-up of mothers and infants is recorded in LSP medical records.

All the LSP medical records containing information on the location of the children and date of birth compatible with the ages of 4–7 years at the time of the study were selected. A total of 669 medical records were selected for the recruitment of children by telephone contact and at least three attempts were made to arrange a home visit. Some children were not located because of change in address (176), parents did not agree to participate or did not complete all stages of

the study (75), had health problems that made participation impossible (8) or were excluded because they had no data on food consumption (7). Thus, there was a sample loss of 266 children (39.8%) and the final sample comprised 403 children in 2016 (Fig. 1).

Information on the duration of EB [16] was collected from the LPS medical records. EB was categorized into up to 4 months or more. A semi-structured questionnaire was applied to investigate sociodemographic variables of children aged 4–7 years such as gender and age of the child, age and education of parents, family and per-capita income. Screen time (television, mobile, computer, tablet, and video game) spent by children in hours/day was also investigated.

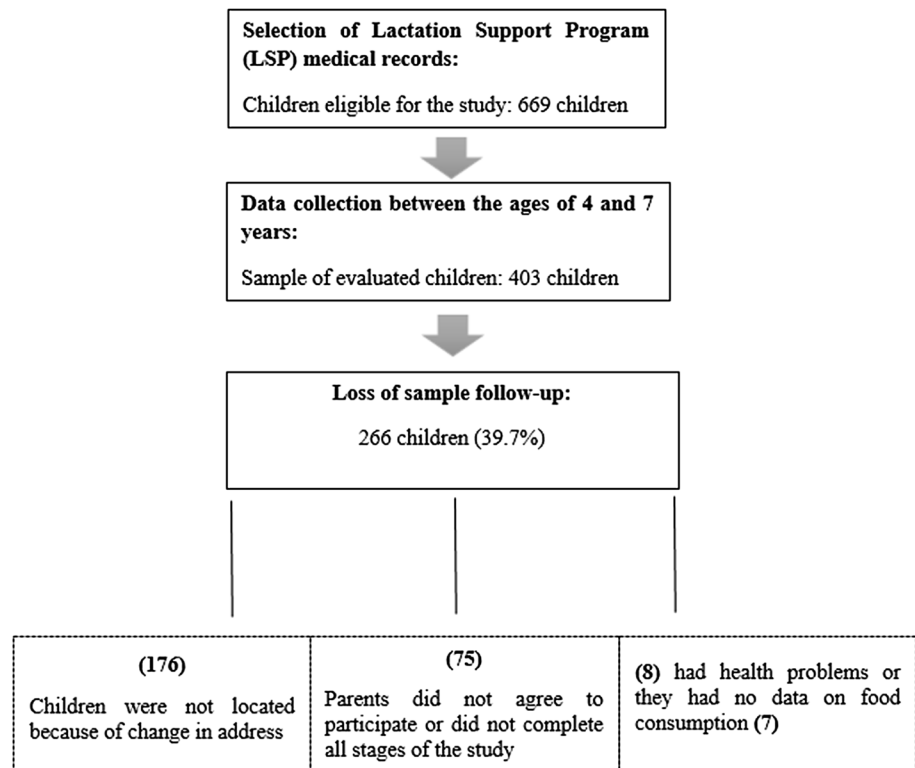
To assess the nutritional status of children, weight and height measurements were taken according to recommendations by the World Health Organization (WHO) [17]. Weight was measured using an electronic digital scale, with maximum capacity of 150 kg and accuracy of 50 g. Height was measured with a 2 m wall-mounted stadiometer, in centimeters divided and subdivided into millimeters. Body Mass Index (BMI)-for-age z-score was calculated using the Who-Anthro software version 2.0.1. Values greater than one standard deviation of BMI/A were considered as overweight [17].

Analysis of food consumption

The children's food intake was evaluated through a food record. The mothers completed three food records on non-consecutive days of the week, including one day at the weekend. All foods and quantities consumed were recorded in household measures, as well as the time and place of meals.

Mothers were instructed to complete the forms and received written guidance. Because the children spend at least part of the day or, in some cases, the whole day at school or day care, a form has been handed out to record the food consumed in these places. The staff responsible for the distribution of food were also advised on how to complete the records. To reduce filling errors, the forms were reviewed by nutritionists along with the children's mothers.

Food records were analyzed with the Dietpro® software version 5.1, using preferably the Brazilian Food Composition Table (TACO) in addition to the Brazilian Food and Nutrition Composition Tables of the Brazilian Institute of Geography and Statistics (IBGE) and food facts labels when necessary. In case of unavailability of the food information in national tables, we used the US table (United States Department of Agriculture—USDA). The food portions were expressed as grams or milliliters and kilocalories (kcal), and the total energetic value of the diet was calculated considering the mean of the three records per child. The consumption of food and food groups in grams or milliliters were expressed per 1000 calories, aiming at the minimum adjustment of consumption by the total energy of the diet.

Fig. 1 Flowchart of the cohort study sample**Table 1** Definition and examples of the NOVA classification

| Food Groups | Examples |
|---|--|
| Natural or minimally processed foods | |
| Natural foods are all foods of vegetable or animal origin for consumption, which have not undergone changes after being removed from nature. When natural foods are submitted to processes that do not include the addition of substances, they are considered minimally processed | Fruit and vegetables packed, portioned, refrigerated or frozen; dried fruits and fruit juices without added sugar or other substances; white or whole rice; other cereals; roots and tubers; all types of beans, chickpeas and lentils; chestnuts, walnuts, and peanuts (no salt or sugar); meat, poultry and fish (fresh, chilled or frozen); fresh or pasteurized milk, yoghurt (without added sugar); eggs; teas, coffees and water; others |
| Processed foods | |
| They are foods made with the addition of salt, sugar, oil or other culinary ingredient making them durable, more palatable and attractive. The processes involved in the manufacture of these products may involve various methods of preservation and cooking | Canned vegetables, nuts added with salt or sugar, salted meats, fish preserved in oil or salt, fruits in syrup, cheeses and breads; others |
| Ultra-processed foods | |
| They are industrialized products made with five or more ingredients. These ingredients can be oil, hydrogenated fat, sugar, modified starch, colorants, flavorings, flavor enhancers and various additives that make the products more attractive. These products have little or no amount of natural or minimally processed foods in the composition | Soft drinks and other sugar-sweetened drinks; packet snacks (chips); ice creams, chocolates, candies and sweets in general; breads, hotdog or hamburger; sweet breads, biscuits, cakes and cake mixes; morning cereals and cereal bars; energetic drinks; mayonnaise and other sauces ready; infant formulas; ready-to-heat products; pizzas; breaded type nuggets; sausage; hamburger; others |

Source: Monteiro et al. (2010) [2]; BRASIL (2014) [20]; Monteiro et al. (2016) [3]

The foods were grouped according to the NOVA classification into the categories natural or minimally processed, processed, and ultra-processed. Table 1 shows the definition

and examples of foods of the three groups. The percentage contribution to energy intake of each group was calculated in relation to the total energetic value of the children's diet.

Statistical analyses

The power of the study was 98%, considering the difference in prevalence among children exposed (EB for < 4 months) and non-exposed (EB for 4 months or more). This calculation was performed by the Web-based software OpenEpi.

Statistical analyses were carried out using the Stata 14.0 software, with a significance level of 5%. To characterize the sample, the categorical variables were presented as frequencies and the continuous variables as means and standard deviations or medians and interquartile ranges (percentiles 25 and 75). Means of total energy were compared with food consumption and food groups according to the terciles of the percentage contribution to energy of ultra-processed foods using the analysis of variance (ANOVA) with the post-hoc Bonferroni test.

Crude and adjusted linear regression models were proposed to analyze the influence of EB (explanatory variable) on the changes in food consumption by children using the beta coefficient (β) and 95% confidence interval. The dependent variables were the percentage contributions to energy of the food groups (NOVA classification) and the consumption of fruit and vegetables. To analyze whether the EB duration (explanatory variable) of less than 4 months was associated with the children's food consumption, crude and adjusted multinomial regression models were used to calculate the Odds Ratio (OR). The percentage contribution to energy of the food groups (NOVA classification) and the fruit and vegetable intake were categorized into tertiles (dependent variables). The confounding variables for the statistical adjustment were sex and age of the child, screen time, occurrence of overweight, maternal schooling and income per capita.

Ethical aspects

This study was approved by the Research Ethics Committee with Human Beings of the Federal University of Viçosa (Ref. no. 892476/2014). The children participated in the study after the parents or guardians have signed the Term of Free and Informed Consent.

Results

In this study, we evaluated a total of 403 children aged 4–7 years, 55.1% male, with a mean age of 71.8 ± 12.0 months. The mothers' median educational level was 11.0 (2.0–18.0) years and the per-capita income was 340.0 (67.7–2500.0) BRL. The median screen time was 3.0 (2.0–5.0) h and the prevalence of overweight among the children was 25.6%. The median duration of EB was

4.0 (2.0–6.0) months, and 60.9% of the infants were exclusively breastfed for 4 months or more.

The mean total energy value of the diet was 1536 ± 366 kcal/day, 38% (± 14) from ultra-processed foods alone, 43% (± 14) from processed and ultra-processed foods taken together, and 46% (± 13) from natural or minimally processed foods (Table 2). Of the natural or minimally processed foods, the mean consumption of fruit and vegetables was 130 (± 107) g/day. We observed an increase in total energy intake and a decrease in the mean intake of coffee and teas, milk, rice, beans, eggs, red meat, fruit and vegetables with the increase in the percentage contribution to energy of ultra-processed foods (Table 3).

The adjusted linear regression showed an association between the duration of EB and the percentage contribution of ultra-processed foods to total energy intake. For each 1-month increase in EB duration, there was a decrease in ultra-processed food consumption by children (β : -0.7 ; 95% CI: -1.3 to -0.1 ; p value: 0.038) (Table 4).

In the adjusted multinomial regression analysis, EB of less than 4 months increased the probability of being in the lowest tercile for consumption of fruit and vegetables (OR: 1.8; 95% CI: 1.1–3.0; p value: 0.030) and increased the chance of being in the highest tercile for % energy from ultra-processed foods (OR: 1.7, 95% CI: 1.1–2.9, p value: 0.040) (Table 5). There was no association between EB and the percentage contribution to energy of fresh or minimally processed foods.

Discussion

This is the first study investigating the influence of EB duration on childhood food consumption considering the level of food processing according to the NOVA classification [4]. We observed that there was an inverse association between the EB duration and the consumption of ultra-processed foods by children. The practice of EB for less than 4 months was associated with low intake of fruit and vegetables and high consumption of ultra-processed foods, even after adjusting for other variables that also influence childhood feeding. In addition, we highlight that almost half of the

Table 2 Energy consumption and percentage contribution to energy of food groups in relation to the total energetic value (TEV) of children's diet

| Foods | Energy (kcal/day) | % TEV |
|--------------------------------|-------------------|-------|
| Natural or minimally processed | 700 | 46 |
| Processed | 81 | 5 |
| Ultra-processed | 597 | 38 |

Viçosa, Minas Gerais, 2016. The percentage contribution of culinary ingredients was 10%

Table 3 Mean energy-adjusted food intake (g or mL) according to tertiles of the percentage contribution to total energy intake of ultra-processed foods consumed by children

| | Contribution of ultra-processed to dietary energy (%) | | | <i>p</i> value |
|-------------------------------------|---|-----------------------------------|----------------------------------|-------------------|
| | First tertile (4.7% – 31.2%) | Second tertile (31.3% – 44.2%) | Third tertile (44.5% – 82.6%) | |
| Total energy and foods/1000 kcal | | | | |
| Total Energy (kcal/day) | 1417 ^a | 1534 ^b | 1656 ^c | < 0.001 |
| Natural or minimally processed food | | | | |
| Coffee and teas (mL) | 41 ^a | 25 ^{bc} | 16 ^{bc} | < 0.001 |
| Milk (mL) | 200 ^a | 172 ^a | 125 ^b | < 0.001 |
| Rice (g) | 93 ^a | 73 ^b | 54 ^c | < 0.001 |
| Bean (g) | 95 ^a | 65 ^b | 52 ^c | < 0.001 |
| Eggs (g) | 6 ^{ab} | 8 ^a | 5 ^b | 0.005 |
| White meat (g) | 18 | 17 | 15 | 0.209 |
| Red meat (g) | 18 ^a | 16 ^a | 11 ^b | 0.002 |
| Pork meat (g) | 6 | 8 | 6 | 0.123 |
| Fruit and vegetables (g) | 98 ^a | 85 ^{ab} | 72 ^b | 0.005 |

Viçosa, Minas Gerais, 2016. ANOVA (post-hoc test: Bonferroni); values in bold and different letters on the same line indicate statistical difference ($P < 0.05$)

Table 4 Association between exclusive breastfeeding duration (months) and consumption of food groups by children. Viçosa, Minas Gerais, 2016

| Foods | Crude analysis | <i>p</i> value | Adjusted analysis ^a | |
|--|---------------------|----------------|--------------------------------|----------------|
| | β (CI 95%) | | β (CI 95%) | <i>p</i> value |
| Natural or minimally processed (% of energy) | 0.4 (–0.2 to 1.0) | 0.163 | 0.4 (–0.2 to 1.0) | 0.149 |
| Fruit and vegetables (g)/1000 kcal | 1.8 (–1.1 to 4.8) | 0.221 | 2.0 (–1.0 to 4.9) | 0.194 |
| Ultra-processed (% of energy) | –0.6 (–1.3 to –0.0) | 0.046 | –0.7 (–1.3 to 0.1) | 0.038 |

CI Confidence interval

^aMultiple linear regression adjusted by sex and age of the child, overweight, screen time, maternal schooling and per-capita income; bold values indicate statistical difference ($p < 0.05$)

total energetic value (43%) of the children's food came from processed and ultra-processed foods taken together.

Very few studies have investigated the consumption of ultra-processed foods by children, and the negative effects on health due to excessive intake of these products are still underestimated. The findings with children shows a percentage of ultra-processed consumption ranging from 19.7% [19] to 47% [7] of the total energetic value of the diet, in some children almost half of their total energy intake. We found average consumption of 38% of energy intake from ultra-processed foods alone in the diet of children from 4 to 7 years in Brazil. This percentage is considered high and is worrying because these products are rich in saturated and trans fats, sugar, and sodium and poor in fiber, protein, and micronutrients [20, 21]. We observed that a greater contribution of ultra-processed foods was associated with an increase in total energy of the children's diet. In addition, there was less consumption of some fresh or minimally processed foods important in the protection from chronic noncommunicable diseases, for instance, the combination of rice and beans and the group of fruit and vegetables. We emphasize

that the consumption of coffee and tea in the studied age range is not recommended and should be discouraged. In this sense, we consider beneficial the decrease in the consumption of coffee and tea by the children.

It is known that the consumption of ultra-processed foods is associated with poor dietary quality of diet both in children [20] and the general population [1, 22], higher prevalence of obesity in all age groups [23], increased risk of hypertension in adults [24], metabolic syndrome in adolescents [25], and lipid profile in children [26]. Due to this evidence, the Food Guide for the Brazilian Population and a number of studies have strongly recommended to avoid excess of these products [1, 21]. In this sense, it is important to take constructive measures to encourage healthy eating habits from the beginning of childhood, to contribute to the lower intake of ultra-processed foods.

We found that for each month of EB, there was a decrease of about 1% in the consumption of ultra-processed foods in the diet. Moreover, children breastfed for less than 4 months consumed fewer fruit and vegetables and more ultra-processed foods at preschool and school ages than those

Table 5 Crude and adjusted odds ratio of the association between the practice of exclusive breastfeeding for <4 months compared to 4 months or more and the consumption of food groups by children. Viçosa, Minas Gerais, 2016

| Foods | Crude analysis | | Adjusted analysis ^a | |
|--|-----------------------------|----------------|--------------------------------|----------------|
| | EB <4 months OR (CI 95%) | <i>p</i> value | EB <4 months OR (CI 95%) | <i>p</i> value |
| Natural or minimally processed (% of energy) | | | | |
| First tercile | 1.0 (0.6–1.7) | 0.875 | 0.9 (0.6–1.6) | 0.839 |
| Second tercile | 1.2 (0.7–2.0) | 0.480 | 1.2 (0.7–2.0) | 0.495 |
| Third tercile | Ref | | Ref | |
| Fruit and vegetables (g)/1000 kcal | | | | |
| First tercile | 1.7 (1.1–2.9) | 0.032 | 1.8 (1.1–3.0) | 0.030 |
| Second tercile | 1.5 (0.9–2.5) | 0.125 | 1.5 (0.9–2.6) | 0.098 |
| Third tercile | Ref | | Ref | |
| Ultra-processed (% of energy) | | | | |
| First tercile | Ref | | Ref | |
| Second tercile | 1.3 (0.8–2.1) | 0.348 | 1.5 (0.9–2.5) | 0.151 |
| Third tercile | 1.6 (0.9–2.6) | 0.083 | 1.7 (1.1–2.9) | 0.040 |

OR odds ratio, CI confidence interval, Ref reference

^aMultinomial regression adjusted by sex and age of the child, overweight, screen time, maternal schooling and per-capita income; bold values indicate statistical difference ($p < 0.05$)

breastfed for longer. These findings reveal that, in addition to all known EB benefits, we observed its influence on the formation of healthy eating habits in childhood. It is important to emphasize that the reduction in the consumption of ultra-processed foods can contribute to reduce excess weight and associated comorbidities in the current and future life of these children.

Similar results were found by other authors who evaluated the beneficial association of a longer breastfeeding duration with a greater intake of fruit and vegetables [8, 9], or only vegetables [10, 11, 13] or only fruits [27], because these are foods considered markers of a healthy diet. On the other hand, other authors found no such relationship [12]. Most studies have reported the positive impact of longer breastfeeding duration on increased consumption of fruit and vegetables in childhood. Therefore, we highlight the importance of recommending EB as well as continuing breastfeeding alongside complementary feeding in the formation of healthy habits for children and consequent prevention of diseases related to food.

There have been very few studies evaluating the relationship between EB duration and consumption of markers of unhealthy diet. A study on Australian children aged 2–8 found no association between breastfeeding and two unhealthy eating patterns [28]. However, it found a positive association with the healthy eating pattern, characterized by the intake of vegetables, fruit, brown bread, and red meat [28]. According to Perrine et al. (2014), the consumption of

sugary beverages by 6 year old children was inversely associated with EB duration [9]. Another study looked into the beneficial effect of longer breastfeeding duration on weight gain of Brazilian preschool children and the harmful impact of sugary beverages on weight [29]. Other studies have also demonstrated the protective role of breastfeeding and the risk of consumption of sugary beverages to childhood obesity [30, 31]. Some authors point out that the association between EB and diet in childhood is an important aspect to be considered in the relationship between breastfeeding and obesity and chronic noncommunicable diseases [9, 28].

There are various hypotheses that explain the relationship between EB duration and children's diet years later. One of the explanations is that when breastfed, children are exposed to a wide diversity of flavors through the breast milk. This facilitates the acceptance of a greater variety of foods later and favors the formation of healthy eating habits from childhood [13, 28, 32]. Grimm et al. (2014) argues that the intake of fruit and vegetables less than once a day in the first year is associated with lower consumption of these foods at the age of 6 years [33]. This suggests that when exposed early on, children establish preferences and familiarity with fruit and vegetables [33]. Another explanation is that mothers who breastfeed properly usually have a healthier lifestyle and tend to follow the recommendations of a healthy diet for their children [8, 10]. Parents' eating behavior, evaluated by fruit and vegetable consumption, has also been shown to be an important predictor of children's ingestion of these foods [27]. Unfortunately, we do not have food consumption data of parents to control the association between breastfeeding and the later diet of children, which is a limitation of our study. However, our findings take account of parents' schooling and income. It is evident in the literature [7] that parents' socioeconomic status influences their child's eating pattern, due to the important role of the family environment in this context.

This study has other limitations to consider. Due to the lack of information about the mother's diet and the introduction of complementary feeding, we were not able to use these variables in the statistical adjustment. However, previous studies have demonstrated that these variables did not exclude the specific and independent effect of breastfeeding on the consumption of fruit and vegetables by children [8, 9]. In addition, Grimm et al. (2014) observed that the age of introduction of fruit and vegetables was not associated with the consumption of these foods by children [33], but other authors have shown that age of introduction is important [34].

We evaluated the prevalence of EB up to 4 months, similar to other authors [11–13], due to the low prevalence (30.8%) of this practice up to 6 months in our sample, since many mothers return to work 4 months after giving birth. We have shown the positive impact of EB for 4 months or

more on children's eating habits. However, we emphasize the importance of complying with the WHO recommendation [35] of EB until 6 months, whose benefits are many to the health of the child in the short and long term [16].

The strengths of this study need to be emphasized, such as its sample power of 98%. The food record to evaluate the children's consumption was applied for 3 days, one at the weekend, reducing the intra-individual variability and better reflecting the habitual intake of the children. We highlight that data on EB duration were collected from the medical records of children followed in the first months of life. This avoiding of the memory bias that may have occurred if this variable was self-reported by mothers during the data collection of children aged 4–7 years. This study is a pioneer in the field by demonstrating the relationship between EB and fruit and vegetable intake in Brazilian children, being the first to investigate this relationship with the consumption of ultra-processed foods.

Conclusion

In conclusion, Brazilian children aged 4–7 years with less than 4 months of EB showed lower intake of fruit and vegetables and greater consumption of ultra-processed foods in the diet than children EB for 4 months or longer. This is the first study to demonstrate such an association. Thus, it is worthwhile to reinforce the importance of the practice of EB for health and for the formation of healthy eating habits in childhood, aiming at the prevention of obesity and associated comorbidities in childhood and in later life.

Acknowledgements We thank the mothers of the children who participated in our study and the hospital staff who collaborated with the data collection. Thanks also to all data collection team.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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