

# BMJ Open Association between breast feeding and food consumption according to the degree of processing in Brazil: a cohort study

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## ABSTRACT

**Background** The benefits of breast feeding may be associated with better formation of eating habits beyond childhood. This study was designed to verify the association between breast feeding and food consumption according to the degree of processing in four Brazilian birth cohorts.

**Methods** The duration of exclusive, predominant and total breast feeding was evaluated. The analysis of the energy contribution of fresh or minimally processed foods (FMPF) and ultra-processed foods (UPF) in the diet was evaluated during childhood (13–36 months), adolescence (11–18 years) and adulthood (22, 23 and 30 years).

**Results** Those who were predominantly breastfed for less than 4 months had a higher UPF consumption ( $\beta$  3.14, 95% CI 0.82 to 5.47) and a lower FMPF consumption ( $\beta$  -3.47, 95% CI -5.91 to -1.02) at age 22 years in the 1993 cohort. Exclusive breast feeding (EBF) for less than 6 months was associated with increased UPF consumption ( $\beta$  1.75, 95% CI 0.25 to 3.24) and reduced FMPF consumption ( $\beta$  -1.49, 95% CI -2.93 to -0.04) at age 11 years in the 2004 cohort. In this same cohort, total breast feeding for less than 12 months was associated with increased UPF consumption ( $\beta$  1.12, 95% CI 0.24 to 2.19) and decreased FMPF consumption ( $\beta$  -1.13, 95% CI -2.07 to -0.19). Children who did not receive EBF for 6 months showed an increase in the energy contribution of UPF ( $\beta$  2.36, 95% CI 0.53 to 4.18) and a decrease in FMPF ( $\beta$  -2.33, 95% CI -4.19 to -0.48) in the diet at 13–36 months in the 2010 cohort. In this cohort, children who were breastfed for less than 12 months in total had higher UPF consumption ( $\beta$  2.16, 95% CI 0.81 to 3.51) and lower FMPF consumption ( $\beta$  -1.79, 95% CI -3.09 to -0.48).

**Conclusion** Exposure to breast feeding is associated with lower UPF consumption and higher FMPF consumption in childhood, adolescence and adulthood.

## INTRODUCTION

The short-term effects of breast feeding on a child's growth, development and general health in the first years of life are well

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ We investigated the short-term and long-term longitudinal association between breast feeding duration and ultra-processed food and fresh or minimally processed foods consumption, using data from four cohorts located in different socioeconomic contexts.
- ⇒ The use of large sample sizes made it possible to conduct analyses with high statistical power, and the building of a directed acyclic graph made it possible to identify a minimum set necessary to control confounding.
- ⇒ Information regarding breast feeding was collected in different ways and times in the cohorts.
- ⇒ Food consumption was assessed using different instruments (Food Frequency Questionnaires and 24-hour food recall).

established. Studies have been dedicated to investigating the effects of breast feeding in the longer term, and its positive impact on the formation of healthy habits in childhood, prevention of chronic non-communicable diseases, higher IQ and human capital in adulthood, among others, has already been reported.<sup>1–4</sup>

Data from low-income and middle-income countries show an increase in exclusive breast feeding (EBF) prevalence up to 6 months, rising from 37% in the 2000s to 45.7% in the last decade. However, despite having improved, breast feeding practices still fall short of the WHO recommendations.<sup>5</sup>

In Brazil, the National Survey on Maternal and Child Health and Family Planning (1986) showed that only 4.7% of children under 6 months of age were exclusively breastfed and 25.5% were continuously breastfed in the first year of life. The most recent data on breast feeding in the country are from the

National Child Food and Nutrition Study, carried out in 2019. This study showed that the prevalence of EBF among children under 6 months of age was 45.8%, with a mean duration of 3 months. Continuing breast feeding between 12 and 23 months had a prevalence of 43.6%, with a mean duration of 15.9 months.<sup>6</sup>

If the results for breast milk consumption are encouraging, data on children's food consumption are not, as high intake of ultra-processed foods (UPF) has been observed in childhood. A systematic review of studies with children showed a variation of 41.8%–76% in the percentage of energy consumption from UPF in the diet.<sup>7</sup> Among those over 18 years of age, a systematic review brought together studies whose average percentage of energy consumption from UPF in the diet ranged from 10% to 56.8%.<sup>8</sup>

Studies indicate that breast feeding in the first months of life is associated with better food consumption in childhood, especially with regard to greater intake of fruits and vegetables.<sup>9 10</sup> Longer breastfeeding duration was consistently related to higher fruit and vegetable consumption in children aged 2–4 years in four European cohorts.<sup>11</sup>

Recently, some studies have analysed the association between breastfeeding and UPF consumption.<sup>3 12</sup> A study with 3427 children showed that those who had been breastfed for more than 3 months had lower UPF consumption at 6 years of age.<sup>13</sup> Another study showed that children who breastfed exclusively for 4 months or more consumed less UPF and more fruits and vegetables between the ages of 4 and 7.<sup>14</sup> On the other hand, Lazzeri *et al*<sup>15</sup> did not observe an association between EBF and UPF in this same age group. All these studies share the fact that they analysed the association between breastfeeding and UPF consumption only during childhood, at most up to 7 years of age.

Therefore, it has not yet been investigated whether this association persists in other life stages, such as adolescence and adulthood. Our hypothesis is that healthy eating habits acquired since childhood can continue into adulthood, even protecting against the emergence of chronic diseases. There is already evidence that long periods of breast feeding are associated with a lower risk of chronic diseases in adulthood, such as overweight, obesity and diabetes, and this association is probably related to the fact that non-breastfed individuals receive another diet such as human milk and formulas,<sup>2</sup> in addition to the early introduction of UPFs during the beginning of complementary feeding, with a potential risk for the perpetuation of unhealthy eating habits throughout life. It is very important to verify to what extent these beneficial effects of breast feeding also extend beyond childhood in order to generate more evidence on the long-term results of breast feeding to promote healthy eating. Thus, the objective of this study is to verify the association between the practice of breast feeding and food consumption according to the degree of food processing in childhood, adolescence and adulthood in four Brazilian birth cohorts.

## METHODS

### Study design and sample

This is a cohort study based on data from birth cohorts that are part of the RPS Birth Cohort Consortium (Ribeirão Preto, Pelotas and São Luís). This consortium is a research network, involving three research groups from three municipalities in different regions of Brazil, which has monitored nine birth cohorts over decades.<sup>16</sup>

The study includes data from four of these birth cohorts from the RPS Consortium, namely: those born in 1982, 1993 and 2004 in Pelotas and in 2010, in São Luís. Pelotas is located in southernmost Brazil and, according to the last census, carried out in 2010, the municipality had 328 275 inhabitants and a Human Development Index (HDI) of 0.739.<sup>17</sup> São Luís is the capital of the state of Maranhão, northeast region and, according to data from the last census, in 2010, its population was 1 014 837 inhabitants and its HDI was 0.768.<sup>18</sup>

In the Pelotas birth cohorts, all live births to mothers living in the urban area of Pelotas, delivered in public and private maternity hospitals, were eligible for the perinatal study. In the São Luís cohort (2010), one in three live births to mothers living in the city in 2010, delivered in public and private maternity hospitals with 100 or more births per year, were eligible for the first phase of the study. Details on the number of participants included in each cohort and monitored at each follow-up are available elsewhere.<sup>1 16 19 20</sup>

In this study, participant data collected at birth and at the following follow-ups were used: Pelotas cohort (1982)—follow-ups at 24 and 48 months, 22 and 30 years; Pelotas cohort (1993)—follow-ups at 6, 12 and 48 months, 18 and 22 years; Pelotas cohort (2004)—follow-ups at 12, 24, 48 months and 11 years; and São Luís cohort (2010)—follow-up at 12 and 13–36 months. All individuals with available data on breast feeding in childhood and food consumption in the segments mentioned below were included in this study. Thus, this study evaluated 4027 participants from the Pelotas cohort (1982) aged 22 and 3410 aged 30; 1165 participants from the Pelotas cohort (1993) aged 18 and 1042 aged 22; 3338 participants from the Pelotas cohort (2004) and 1093 participants from the São Luís cohort (2010).

### Exposure variable

The study's exposure variable was the duration of breast feeding, which was reported by the mothers. Definitions of the WHO were used to categorise the type and duration of breast feeding. EBF was considered as the time during which the child received only breast milk, straight from the breast or milked, or human milk from another source, without the addition of other liquids or solids, with the exception of vitamin drops or syrups, oral rehydration salts, mineral supplements or medicines. Predominant breast feeding (PBF) was considered as the time during which the child received, in addition to breast milk, water or water-based drinks (sweetened water, teas, infusions), fruit juices and ritual fluids. Total breast feeding

was considered the total time the child received breast milk (directly from the breast or milked), regardless of whether or not they received other foods.<sup>21</sup>

To construct the total breastfeeding variables data collected at 24 and 48 months in the 1982 cohort, at 6, 12 and 48 months in the 1993, and at 12, 24 and 48 months in the 2004 cohort were used. To create the variables relating to EBF, in turn, data collected during follow-up at 24 months in the 1982 cohort, at 12 months in the 2004 cohort, and at 6 and 12 months in the 1993 cohort were used. In both cohorts, we used the earliest available information to minimise recall bias. In the São Luís cohort, data to construct total breastfeeding variables were obtained in the follow-ups at 13–36 months, and to create EBF variables data from follow-up at 12 months were used.

In the 1982 Pelotas cohort, in the follow-ups at 24 and 48 months, mothers were interviewed and answered the following question: ‘For how long did the child breastfeed?’ Based on the response to this question in months, variables for total breast feeding were constructed. In the follow-up at 24 months, mothers were also asked about when the child started (in months) consuming other types of food besides breast milk (cow’s milk, powdered milk, mashed fruit, vegetable puree, family food) and whether the child had consumed any food other than breast milk (cow’s milk, powdered milk, mashed fruit, vegetable puree, family food, yoghurt, porridge, bread or biscuits, others) on the previous day. From the answers to these questions, the age (in months) at which the child started ingesting foods and other milks besides breast milk was determined, considering the previous month as the duration of EBF.

In the 1993 Pelotas cohort, in the follow-ups at 6, 12 and 48 months, mothers were asked: ‘Does the child breastfeed?’ In case of a negative response, they were further questioned: ‘Until what age did the child breastfeed?’. Based on the response to either or both of these questions, variables for total breast feeding in months were constructed. In the follow-up at 6 months, mothers were asked if they had started offering any items from a list of liquids and foods (boxed milk, powdered milk, tea, juice, fruit puree, savoury puree, porridge, yoghurt, bread/biscuits, egg yolk, egg white, meat, bean broth, bean grain, rice, pasta, others), and if so, when they started offering them. In the follow-ups at 6 and 12 months, mothers were also asked to report the last day the child ate as usual, and whether the child had consumed the listed foods (cow’s milk, powdered milk, coffee, water/tea, juice, bread, biscuits, yoghurt, fruits, egg, rice, beans, vegetables, pasta, potatoes/cassava, meat, others) at any time during the day (on waking up, in the morning, at lunch, in the afternoon, at dinner, before sleeping, overnight). From the responses about dietary intake, the age (in months) at which the child started ingesting foods and other milks besides breast milk was determined, considering the previous month as the duration of EBF.

In the 2004 Pelotas cohort, the collection of information regarding child feeding, as well as the construction of variables for total and EBF, was conducted in the same manner as in the Pelotas cohort of 1993. However, breastfeeding data were obtained during the follow-ups at 12, 24 and 48 months, while data on the introduction of complementary foods were collected during the follow-up at 12 months.

In the 2010 São Luís cohort, in the follow-up at 13–36 months, mothers were asked: ‘Did the child breastfeed yesterday?’. In case of a negative response, they were further questioned: ‘Until what age did the child breastfeed?’. If the mother’s answer was ‘yes’ to the first question, they were further questioned: ‘Until what age did the child breastfeed exclusively?’. Based on the response to these questions, variables for exclusive and total breast feeding in months were constructed.

In the analyses, the breastfeeding duration was assessed numerically and categorically, operationalised as follows: EBF duration (months), EBF up to 4 months (yes, no), EBF up to 6 months (yes, no), total breastfeeding duration (months) and total breastfeeding duration (<12 months, ≥12 months). For the Pelotas cohorts of 1982 and 1993, however, PBF was assessed since EBF was rarely practised at the time of these studies.

### Outcome variables

The outcome variables of the study were the consumption of fresh or minimally processed foods (FMPF) and UPF, evaluated as a percentage of total daily energy intake (%kcal).

Food consumption data from participants in the Pelotas cohorts were obtained through semiquantitative Food Frequency Questionnaires (FFQs), referring to food consumption in the last 12 months. In the 1982 Pelotas cohort, at 22 and 30 years of age, the FFQs contained 85 and 88 food items, respectively, and were administered by trained interviewers. These FFQs were derived from an instrument previously submitted to validation<sup>22</sup> and modified only to meet regional food habits. In the 1993 Pelotas cohort, at age 18, the FFQ consisted of 81 food items and was administered by a trained interviewer, while at age 22, the FFQ had 94 items and was self-administered. In the 2004 Pelotas cohort, at the 11-year follow-up, the participant’s mother answered a self-administered FFQ consisting of 88 food items. Data on food consumption of participants in the 2010 São Luís cohort were obtained through a 24-hour recall administered by a trained interviewer.

The intake of each food item was converted into grams per day. Afterwards, daily intakes of macronutrients and energy (kcal) were estimated using food composition tables.<sup>23 24</sup>

Foods were grouped according to the NOVA classification into FMPF, processed and UPF.<sup>25</sup> Finally, the proportion of energy (%kcal) of each food group in relation to the total energy intake of the diet was calculated.



## Data analysis

Statistical analysis was conducted using the software Stata, V.14.0 (StataCorp). The numerical variables were described using measures of central tendency and dispersion and the categorical variables were described using relative and absolute frequencies.

The Student's t-test was used to compare the differences in the mean consumption of FMPF and UPF between the categories of breastfeeding duration variables, considering a significance level of 5%.

Crude and adjusted linear regression analysis was used to evaluate the association between the breastfeeding duration variables and FMPF and UPF consumption.

To control confounding, the independent variables included in the adjusted model were identified by building a directed acyclic graph (DAG) (online supplemental figure 1) in the software Daggity, V.3.0. Using the backdoor criterion,<sup>26</sup> the need for minimum adjustment was identified for the following variables: maternal education at birth (>12, 9–11, 8–5, <5 years of schooling), family income at birth (first—lowest income, second, third tertile), pregestational body mass index (kg/m<sup>2</sup>) and gestational age (weeks of gestation).

In the 1993 cohort, the samples at 6, 12 and 48 months were subsamples composed of all low birthweight infants and an additional 20% of the cohort. Because of this weighting was carried out by low birth weight.

## Patient and public involvement

None.

## RESULTS

### Pelotas cohort 1982

At follow-up at 22–23 years of age, the mean consumption of UPF was lower in adults who had been on PBF for up to 6 months (18.6% vs 21.3%,  $p=0.020$ ). Those who were breastfed for a period greater than or equal to 12 months had lower UPF consumption at 22–23 years (19.9% vs 21.5%,  $p=0.001$ ) and at 30 years (24.1% vs 25.3%,  $p=0.014$ ) higher consumption of FMPF (58.3% vs 59.6%,  $p=0.026$ ) (online supplemental table 1).

In the adjusted analysis, there was no association between breast feeding and UPF or FMPF consumption at 22–23 years or 30 years (table 1).

### Pelotas cohort 1993

At 22 years of age, the mean consumption of UPF was lower in children who had been on PBF until 4 months (27.6% vs 30.5%,  $p=0.008$ ) and that of FMPF was higher (57.9% vs 55.1%,  $p=0.014$ ) (online supplemental table 2).

In the adjusted analysis, the increase in PBF duration was associated with a reduced energy consumption from UPF ( $\beta -0.58$ , 95% CI  $-1.13$  to  $-0.04$ ) and increased FMPF consumption ( $\beta 0.61$ , 95% CI  $0.04$  to  $1.18$ ) at 22 years old. Those who were predominantly breastfed for less than 4 months had a higher UPF consumption ( $\beta 3.14$ , 95% CI

$0.82$  to  $5.47$ ) and a lower FMPF consumption ( $\beta -3.47$ , 95% CI  $-5.91$  to  $-1.02$ ) at age 22 (table 2).

### Pelotas 2004 cohort

EBF up to 6 months resulted in a lower mean UPF consumption (32.4% vs 33.8%,  $p=0.027$ ) and a higher mean FMPF consumption (53.4% vs 52.1%,  $p=0.042$ ) at age 11, compared with those who had been on EBF for a shorter time (online supplemental table 3).

In the adjusted analysis, the increase in EBF duration was associated with a reduced energy percentage from UPF consumption at 11 years of age ( $\beta -0.34$ , 95% CI  $-0.57$  to  $-0.12$ ). EBF for less than 6 months was associated with increased UPF consumption ( $\beta 1.75$ , 95% CI  $0.25$  to  $3.24$ ) and reduced FMPF consumption ( $\beta -1.49$ , 95% CI  $-2.93$  to  $-0.04$ ) at 11 years. Similarly, total breast feeding for less than 12 months was associated with an increased energy intake from UPF ( $\beta 1.12$ , 95% CI  $0.24$  to  $2.19$ ) and reduced energy intake from FMPF ( $\beta -1.13$ , 95% CI  $-2.07$  to  $-0.19$ ) (table 3).

### São Luís 2010 cohort

At the 13–36 months follow-up, mean UPF consumption was lower in children who were on EBF for 6 months or more than in those who were exclusively breastfed for less than 6 months (online supplemental table 4).

In the adjusted analysis, the increase in EBF duration resulted in a reduction in the energy contribution of UPF in the diet of children aged 13–36 months ( $\beta -0.55$ , 95% CI  $-0.99$  to  $-0.12$ ) and an increase in the energy contribution of FMPF ( $\beta 0.55$ , 95% CI  $0.10$  to  $0.99$ ). Children who were not exclusively breastfed until 6 months had a 2.36% increase in the energy contribution of UPF in the diet ( $\beta 2.36$ , 95% CI  $0.53$  to  $4.18$ ). On the other hand, not receiving EBF until 6 months was also associated with a decrease in FMPF consumption ( $\beta -2.33$ , 95% CI  $-4.19$  to  $-0.48$ ). Children who were breastfed for less than 12 months had a higher UPF consumption ( $\beta 2.16$ , 95% CI  $0.81$  to  $3.51$ ) and a lower FMPF consumption ( $\beta -1.79$ , 95% CI  $-3.09$  to  $-0.48$ ) (table 4).

## DISCUSSION

In this study, we found an association of longer duration of EBF, PBF and total breast feeding with lower consumption of UPF in all cohorts studied, except for the 1982 cohort. We also observed the effect of these breastfeeding practices on increased FMPF consumption in the second year of life in São Luís and at 11 and 22 years old in Pelotas. The results found here were consistent regarding the beneficial effect of breast feeding on the consumption of UPF and FMPF, as they pointed in the same direction in four different birth cohorts, in different age groups and in two regions of Brazil.

The association between breastfeeding and UPF and FMPF consumption has already been demonstrated in other studies,<sup>13 14</sup> however, none of them had follow-ups as long as those in this study. The study with the longest

**Table 1** Crude and adjusted analysis of the association between breast feeding (BF) and ultra-processed foods (UPF) and fresh or minimally processed foods (FMPF) consumption at 22–23 years and at 30 years in the 1982 Pelotas cohort

BF	UPF consumption (%kcal) at 22–23 years		FMPF consumption (%kcal) at 22–23 years	
	Crude β (95% CI)	Adjusted* β (95% CI)	Crude β (95% CI)	Adjusted* β (95% CI)
PBF duration (months)	–0.21 (–0.43 to 0.01)	0.00 (–0.26 to 0.27)	0.01 (–0.25 to 0.28)	–0.08 (–0.40 to 0.23)
PBF up to 4 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	<b>1.25 (0.21 to 2.28)</b>	0.32 (–0.89 to 1.54)	–1.02 (–2.25 to 0.20)	–0.49 (–1.95 to 0.97)
PBF up to 6 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	<b>2.68 (0.41 to 4.95)</b>	–0.03 (–2.78 to 2.72)	–2.48 (–5.15 to 0.19)	–2.24 (–5.54 to 1.05)
Total BF duration (months)	<b>–0.05 (–0.08 to –0.01)</b>	–0.01 (–0.05 to 0.03)	<b>0.04 (0.00 to 0.08)</b>	0.01 (–0.03 to 0.06)
Total BF duration				
≥12 months	Ref.	Ref.	Ref.	Ref.
<12 months	<b>1.58 (0.67 to 2.49)</b>	0.70 (–0.35 to 1.76)	<b>–1.22 (–2.30 to –0.14)</b>	–0.38 (–1.64 to 0.89)
BF	UPF consumption (%kcal) at 30 years		FMPF consumption (%kcal) at 30 years	
	Crude β (95% CI)	Adjusted* β (95% CI)	Crude β (95% CI)	Adjusted* β (95% CI)
PBF duration (months)	–0.09 (–0.33 to 0.15)	–0.00 (–0.29 to 0.28)	0.08 (–0.19 to 0.34)	0.07 (–0.25 to 0.39)
PBF up to 4 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	0.23 (–0.87 to 1.33)	–0.36 (–1.67 to 0.94)	0.10 (–1.12 to 1.32)	0.81 (–0.65 to 2.27)
PBF up to 6 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	1.17 (–1.27 to 3.60)	–1.14 (–4.10 to 1.83)	0.84 (–1.86 to 3.54)	2.37 (–0.94 to 5.68)
Total BF duration (months)	–0.04 (–0.07 to 0.00)	–0.02 (–0.06 to 0.02)	<b>0.05 (0.01 to 0.08)</b>	0.03 (–0.01 to 0.08)
Total BF duration				
≥12 months	Ref.	Ref.	Ref.	Ref.
<12 months	<b>1.21 (0.25 to 2.17)</b>	0.81 (–0.31 to 1.93)	–0.98 (–2.04 to 0.09)	–0.47 (–1.73 to 0.78)

Pelotas-RS, Brazil.  
 Bold values denote statistical significance at the  $p < 0.05$  level.  
 \*Adjusted by maternal education at birth, family income at birth, pregestational body mass index, gestational age.  
 PBF, predominant BF.

follow-up published at the time of writing this article was that of Fonseca *et al.*<sup>14</sup> who evaluated the effect of EBF on UPF consumption in children aged 4–7 years in the city of Viçosa-MG, observing that with each increase of 1 month in the duration of EBF, the energy contribution of UPF decreased by 0.7%. Furthermore, children who were exclusively breastfed for less than 4 months were 70% more likely to belong to the highest tertile of UPF consumption between 4 and 7 years of age. In the same direction, other studies observed an association between longer EBF duration and lower UPF consumption in the first year of life,<sup>27</sup> up to 24 months<sup>3 12</sup> and at 5 years.<sup>28</sup>

Our study shows that the positive effect of breast feeding observed in other studies throughout childhood persists until adolescence and early adulthood, as demonstrated here at 11 years of age and 22 years of age. Therefore, in addition to all the beneficial effects of breast feeding already reported in the literature, we can add its

influence on the formation of healthy eating habits that persist beyond childhood.

The association of breast feeding with healthy eating habits in later life stages is already well established in the literature regarding increased consumption of fruits and vegetables. It is believed that mothers who are committed to breast feeding for longer are more aware of the importance of a healthy diet and, therefore, they themselves have a more adequate diet during pregnancy and the postpartum period, which can influence the child's future food choices.<sup>29</sup> During breast feeding, the child is exposed to a variety of flavours from the mother's diet that are transmitted via breast milk. This exposure would increase the child's acceptance of healthy foods consumed by the mother during breast feeding.<sup>30–32</sup>

The other hypothesis is that the food environment and parental influence affect a child's future eating behaviour. Therefore, parents who adhere to healthy

**Table 2** Crude and adjusted analysis of the association between breast feeding (BF) and ultra-processed foods (UPF) and fresh or minimally processed foods (FMPF) consumption at 18 years and at 22 years in the 1993 Pelotas cohort

BF	UPF consumption (%kcal) at 18 years		FMPF consumption (%kcal) at 18 years	
	Crude β (95% CI)	Adjusted* β (95% CI)	Crude β (95% CI)	Adjusted* β (95% CI)
PBF duration (months)	0.02 (−0.43 to 0.48)	−0.25 (−0.76 to 0.26)	−0.09 (−0.57 to 0.39)	0.26 (−0.27 to 0.78)
PBF up to 4 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	0.40 (−1.62 to 2.42)	1.67 (−0.52 to 3.86)	0.91 (−1.21 to 3.04)	−0.27 (−2.55 to 2.02)
PBF up to 6 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	3.72 (−4.53 to 11.96)	6.95 (−2.59 to 16.49)	1.62 (−7.06 to 10.30)	−1.05 (−10.99 to 8.88)
Total BF duration (months)	0.000 (−0.002 to 0.002)	−0.003 (−0.003 to 0.002)	−0.001 (−0.003 to 0.002)	0.001 (−0.002 to 0.004)
Total BF duration				
≥12 months	Ref.	Ref.	Ref.	Ref.
<12 months	0.22 (−1.47 to 1.90)	0.10 (−1.75 to 1.95)	−0.55 (−2.31 to 1.22)	−0.53 (−2.44 to 1.38)
BF	UPF consumption (%kcal) at 22 years old		FMPF consumption (%kcal) at 22 years old	
	Crude β (95% CI)	Adjusted* β (95% CI)	Crude β (95% CI)	Adjusted* β (95% CI)
PBF duration (months)	<b>−0.61 (−1.11 to −0.11)</b>	<b>−0.58 (−1.13 to −0.04)</b>	0.048 (−0.03 to 1.01)	<b>0.61 (0.04 to 1.18)</b>
PBF up to 4 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	<b>2.97 (0.76 to 5.18)</b>	<b>3.14 (0.82 to 5.47)</b>	<b>−2.86 (−5.13 to −0.58)</b>	<b>−3.47 (−5.91 to −1.02)</b>
PBF up to 6 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	−1.70 (−10.98;7.58)	−2.18 (−12.85;8.48)	0.96 (−8.59;10.51)	1.43 (−9.81;12.67)
Total BF duration (months)	−0.003 (−0.006;0.0000)	−0.001 (−0.004;0.002)	0.002 (−0.001;0.005)	0.001 (−0.002;0.004)
Total BF duration (months)				
≥12 months	Ref.	Ref.	Ref.	Ref.
<12 months	−0.43 (−2.29;1.43)	−0.64 (−2.62;1.34)	0.25 (−1.67;2.17)	0.68 (−1.41;2.77)

Pelotas-RS, Brazil.  
 Bold values denote statistical significance at the  $p < 0.05$  level.  
 \*Adjusted by maternal education at birth, family income at birth, pregestational body mass index, gestational age.  
 PBF, predominant BF.

eating guidelines for their children, such as the practice and longer duration of breast feeding, are more likely to continue promoting healthy eating habits, even in later stages of childhood. This would help to establish healthier eating habits during childhood.<sup>33 34</sup> Furthermore, there is evidence that breast feeding is capable of positively modulating children's microbiome,<sup>35 36</sup> and although incipient, the study by Medawar *et al*<sup>37</sup> shows that the microbiota presents a key relationship in diet–gut–brain–behaviour interactions and may be capable of modulating healthier eating choices and behaviours.

The establishment of healthier eating habits during childhood tends to continue into adolescence and adulthood.<sup>38</sup> In the follow-up closest to birth that we analysed, that is, in the São Luís cohort from 13 to 36 months, it was possible to observe the effect of EBF in reducing UPF consumption and increasing FMPF consumption, both when considering the total duration of BF and when EBF

was categorised up to four or 6 months. We observed the positive impacts of breast feeding up to 11 and 22 years of age, resulting in lower UPF consumption and higher FMPF consumption. Even in the 1993 Pelotas cohort, which evaluated PBF (since the prevalence of EBF was very low at that time, making the analysis unfeasible), it was possible to observe the beneficial effect of this practice for a healthier food consumption profile at 22 years old, with reduced UPF consumption and increased FMPF consumption.

This study has some limitations. Information regarding breast feeding was collected in different ways and at different times in each of the cohorts included in this study, which may lead to differences in the accuracy of data on breastfeeding variables. Furthermore, the possibility of bias in the reporting of breastfeeding practices years after the birth of the child in the Pelotas cohorts cannot be completely ruled out. However, it has been

**Table 3** Crude and adjusted analysis of the association between breast feeding (BF) and ultra-processed foods (UPF) and fresh or minimally processed foods (FMPF) consumption at 11 years in the 2004 Pelotas cohort

BF	UPF consumption (%kcal) at 11 years		FMPF consumption (%kcal) at 11 years	
	Crude β (95% CI)	Adjusted* β (95% CI)	Crude β (95% CI)	Adjusted* β (95% CI)
EBF duration (months)	<b>-0.34 (-0.53 to -0.16)</b>	<b>-0.34 (-0.57 to -0.12)</b>	<b>0.23 (0.05;0.41)</b>	0.22 (-0.002;0.43)
EBF up to 4 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	<b>1.37 (0.50;2.24)</b>	<b>1.07 (0.03;2.11)</b>	<b>-1.01 (-1.85 to -0.17)</b>	-0.71 (-1.71;0.30)
EBF up to 6 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	<b>1.41 (0.16;2.67)</b>	<b>1.75 (0.25;3.24)</b>	<b>-1.25 (-2.46 to -0.04)</b>	<b>-1.49 (-2.93 to -0.04)</b>
Total BF duration (months)	-0.002 (-0.01;0.01)	-0.01 (-0.02;0.01)	0.003 (-0.01;0.01)	0.01 (-0.01;0.02)
Total BF duration				
≥12 months	Ref.	Ref.	Ref.	Ref.
<12 months	0.72 (-0.09;1.54)	<b>1.12 (0.24;2.19)</b>	-0.60 (-1.38;0.19)	<b>-1.13 (-2.07 to -0.19)</b>

Pelotas-RS, Brazil.

Bold values denote statistical significance at the  $p < 0.05$  level.

\*Adjusted by maternal education at birth, family income at birth, pregestational body mass index, gestational age.

EBF, exclusive BF.

demonstrated in the literature that the total duration of breast feeding was recorded quite accurately by the mothers even 20 years after the birth of the child.<sup>39</sup> Specifically concerning the 1993 Pelotas cohort, the fact that data from subsamples of children with low birth weight were used could also lead to the introduction of bias in the results since such subjects are generally less likely to maintain breast feeding for longer periods. However, to deal with this, the analyses of this cohort were weighted to reproduce in the studied sample the proportion of low birth weight observed at the beginning of the study.

Food consumption was assessed using different instruments (FFQs with different quantities and types of food items and 24-hour food recall). The 24-hour dietary record may underestimate consumption, as it assesses daily intake. Furthermore, a single recall may not represent the individual's usual diet. However, as the interview refers to the last 24 hours, it may be easier to remember and report the previous day's food consumption. Another difference is that in some follow-ups, the food consumption information was obtained through self-administered answers, and in others, it was administered

**Table 4** Crude and adjusted analysis of the association between breast feeding (BF) and ultra-processed foods (UPF) and fresh or minimally processed foods (FMPF) consumption at 13–36 months in the BRISA cohort of São Luís (2010)

BF	UPF consumption (%kcal) at 13–36 months		FMPF consumption (%kcal) at 13–36 months	
	Crude β (95% CI)	Adjusted* β (95% CI)	Crude β (95% CI)	Adjusted* β (95% CI)
EBF duration (months)	-0.28 (-0.61;0.05)	<b>-0.55 (-0.99 to -0.12)</b>	0.25 (-0.08 to 0.58)	<b>0.55 (0.10 to 0.99)</b>
EBF up to 4 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	<b>1.47 (0.24;2.93)</b>	<b>2.71 (0.82 to 4.60)</b>	-1.31 (-2.77 to 0.15)	<b>-2.70 (-4.62 to -0.78)</b>
EBF up to 6 months				
Yes	Ref.	Ref.	Ref.	Ref.
No	<b>1.52 (0.97 to 2.94)</b>	<b>2.36 (0.53 to 4.18)</b>	-1.42 (-2.85 to 0.00)	<b>-2.33 (-4.19 to -0.48)</b>
Total BF duration (months)	0.07 (-0.04 to 0.18)	-0.22 (-0.17 to 0.12)	-0.07 (-0.17 to 0.04)	0.02 (-0.12 to 0.17)
Total BF duration				
≥12 months	Ref.	Ref.	Ref.	Ref.
<12 months	0.27 (-1.25 to 1.79)	1.23 (-0.75 to 3.21)	-0.64 (-2.17 to 0.90)	-1.48 (-3.49 to 0.53)

São Luís—MA, Brazil.

Bold values denote statistical significance at the  $p < 0.05$  level.

\*Adjusted by maternal education at birth, family income at birth, pregestational body mass index, gestational age.

EBF, exclusive BF.



by trained interviewers. These differences imply difficulties in obtaining comparable estimates of UPF and FMPF consumption. Furthermore, the use of non-specific FFQs for food processing since at the time of data collection the NOVA classification had not yet been proposed, may lead to biases in the measurement of food consumption. Non-differential classification errors may have occurred, which would lead to an underestimation of the magnitude of the observed associations. Additionally, the use of FFQ to measure food consumption can lead to an overestimation of energy consumption. However, this must occur for all food groups and not just for the UPF group and is unlikely to have affected the results of the association analyses.

On the other hand, our study has important strengths to highlight. We investigated the short-term and long-term longitudinal association between breastfeeding duration and UPF and FMPF consumption, using data from four cohorts located in different socioeconomic contexts. Furthermore, the large sample sizes made it possible to conduct analyses with high statistical power, and the building of a DAG made it possible to identify a minimum set necessary to control confounding, avoiding adjustment for unnecessary variables in multivariable regression models.

The results of this study highlight yet another beneficial effect of breast feeding in the long term, showing it to be a factor capable of improving the food consumption profile according to the level of processing in adolescence and adulthood. Both public policies to promote breast feeding are important, as well as guaranteeing access to healthy FMPF foods and regulating advertising since food consumption depends not only on an individual propensity/history but also on a broader socio-cultural context/environment.<sup>40</sup> This has great relevance for public health since there is evidence in the literature about the unfavourable health effects of UPF consumption, promoting a worse cardiometabolic risk profile and greater risk of cardiovascular diseases, cerebrovascular disease, depression and all-cause mortality.<sup>8</sup>

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