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Childhood eating practices are relevant to ultra-processed food consumption in adulthood: results from the Nutritionists' Health Study

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Abstract

Studies on childhood feeding and current food consumption, according to the NOVA classification, in adults are scarce. The objective of this study was to evaluate the relationship between childhood dietary practices and the current consumption of different categories of processed foods in young adults using data from the Nutritionists' Health Study (NutriHS) cohort. A cross-sectional analysis was performed using data of 392 on nutrition undergraduate students or nutritionists aged ≥18 years. Current food consumption was assessed using a food frequency questionnaire and the NOVA classification. The investigated childhood eating practices included fruit and vegetable intake, exclusive breastfeeding, and other breastfeeding practices. Participants breastfed with introduction of solid, semi-solid or soft foods before 6 months had higher current consumption of processed foods than those who were not breastfed ($\beta = 4.30$; 95% confidence interval [CI] = 0.56–8.04) and those who did not have the habits of eating fruits and vegetables during childhood consumed less unprocessed and minimally processed foods in adulthood than those who ate fruits and vegetables during infancy ($\beta = -3.76$; 95% CI = −0.82 to −6.70). Further, later introduction of infant formula or other types of milk between 3 and 5 months of age had a lower current consumption of ultra-processed foods than those fed infant formula or other types of milk before 1 month age of life ($\beta = -3.09$; 95% CI = −6.12 to −0.06). In conclusion, childhood feeding practices were linked to food consumption in adult life in NutriHS cohort, highlighting that the first 1000 days of life seems to impact on food choices during adulthood, with potential to protect against nutrition-related diseases later in life.

Introduction

The types of food offered in the first 1000 days of life, especially breast milk, have an influence on food choices throughout life and protection against the development of cardiometabolic disorders,[1] a phenomenon known as metabolic programming.[2] This is because early exposure to certain environmental factors influences gene expression, thus affecting the emergence of chronic diseases in adulthood.[3] Human milk enables the child's first contact with real food and ensures that their nutrition is adequate to their needs in early life.[4] Its composition, in addition to nutrients essential for the baby, includes hormones, especially leptin, which plays an essential role in controlling food intake and consequent regulation of nutritional status.[5,6]

Infant formulas have a greater amount of protein, which may favor the deposition of fat in the first years of life due to the increase in insulin and Insulin Growth Factor 1 (IGF-1) secretion, unlike breastfeeding, as breast milk has a lower protein content, which contributes to optimal weight gain and fat deposition in childhood.[7] Its effective practice also restricts the intake of age-inappropriate foods, which are rich in sugars, sodium, and saturated fats. Moreover, breastfeeding allows for better control of the portions ingested according to the baby's own hunger and satiety signals due to hormones present in breast milk, which shapes long-term physiological processes responsible for maintaining energy balance; these hormones are absent in infant formulas.[8,9]

The recommendations of the World Health Organization (WHO) on the practice of exclusive breastfeeding (EBF) during the first 6 months and continued breastfeeding up to 2 years of age or over coincide with this critical period.[10] The global epidemiological analysis indicates that breastfeeding decreases as the child grows and its prevalence is higher in less developed regions, justified by the lower socioeconomic level and resulting restricted access to other types of food, making human milk the main food source in early life.[11] In contrast, babies from wealthier families have a higher consumption of infant formulas and other types of milk than breast milk, possibly due to their marketing at the national level.[12] In 2019, the global rates of EBF and continued breastfeeding was 42% and 65%, respectively, considering that there is a modest

improvement for EBF, with an increase of only 7% points, but has remained unchanged in certain geographical locations, such as Latin America, since 2005.[13] In the same year, following the trend of breastfeeding rates similar to those in Latin America, only 52.7% of Brazilian children under 6 months of age were on EBF and 53.1% of Brazilian children between 6 and 24 months, on complemented breastfeeding.[14]

The duration of breastfeeding is associated with food consumption throughout life.[15] For instance, in a study including 403 children aged 4–7 years, EBF for <4 months was associated with a lower consumption of fruits and vegetables, classified in the category of unprocessed and minimally processed foods. This was linked to the detrimental greater inclusion of ultra-processed foods;[16] both food groups were organized according to the NOVA classification, which considers the level of food processing for its categorization.[17]

To date, limited studies have evaluated the association between early childhood eating practices and food consumption in adults, especially according to the NOVA classification, due to the need for longitudinal studies. Therefore, a cohort of young nutritionists and nutrition undergraduates can be advantageous since they are (or are training to become) health professionals who deal with dietary assessment on a daily basis and could apply their knowledge and expertise to improve memory biases of their mothers, consequently enhancing information precision on their early childhood nutrition. This information precision is essential for understanding how physiological processes can influence food consumption throughout life and help prevent associated diseases.

We hypothesized that events occurring in the first 1000 days of life have an influence on adequate food consumption during adulthood. Based on this, the present study aimed to evaluate the relationship between childhood eating practices and current consumption of unprocessed and minimally processed as well as processed and ultra-processed foods in young adults using data from the Nutritionists' Health Study (NutriHS) cohort.

Methods

Study design and population

The cross-sectional study used baseline data from the NutriHS conducted in Fortaleza, Ceará; the data were collected from 2018 to 2019. Volunteers signed the Free and Informed Consent Form, and the study was approved by the Ethics Committee of State University of Ceará (CAAE n° 95402618.3.0000.5534).

The NutriHS is a longitudinal study conducted with a cohort of undergraduates in nutrition and nutritionists graduated from three universities *campi* in Brazil (the University of São Paulo, in Sao Paulo city, the State University of Campinas, in Limeira city, and the University of Fortaleza/State University of Ceara, in Fortaleza city). Data on general health was collected through electronic and self-applied questionnaires (including sociodemographic data, current health, early life factors, childhood and current food consumption, and morbid personal and family history) via an online platform (http://www.fsp.usp.br/nutrihs).[18]

The minimum sample size for the NutriHS was previously estimated considering the detection of a correlation coefficient of ≥0.20 (alpha: 5% and beta: 20%), with an addition of 20% to cover for follow-up losses. Thus, a minimum of 233 volunteers were required for each center.[19,20] For the present study, the same parameters were considered for sample size estimation.
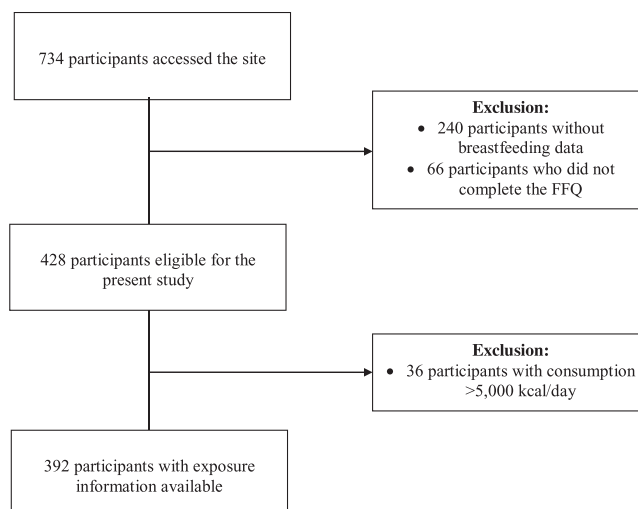
Figure 1. Flowchart of selection of participants included in the present study, Fortaleza, Brazil.

The recruitment for potential subjects was carried out by placing advertisements around campus and inviting students and alumni by email messages. From all the recruited subjects, it was estimated that 61% accessed the website and at least partially filled the self-applied questionnaire. All undergraduates in nutrition and newly graduated nutritionists, ageing 18 years or more at baseline were included, and those that were pregnant at baseline, with missing breastfeeding and FFQ data, or who presented a dietary energy intake above 5,000 kcal/day were excluded (Fig. 1), comprising 392 participants.

Health data

Volunteers who met the eligibility criteria were asked to complete questionnaires using the e-NutriHS system (http://www.fsp.usp.br/nutrihs), which were presented in blocks of questions. Sociodemographic data (age, sex, skin color, family income, and smoking status), events that occurred in the first 2 years of life, current food consumption and nutritional status through self-reported body weight and height for the calculation of body mass index (BMI), calculated by dividing weight (in kilograms) by height squared (in meters), were investigated and classified according to the World Health Organization cutoff values.[21] Previous studies indicate that self-reported weight and height are accurate for calculating BMI in adults.[22,23]

Past events data collection: first 2 years of life

Participants were asked to fill part of the e-NutriHS questionnaire with aspects concerning their first 2 years of life. To obtain the information in a more reliable way, the volunteers were instructed to consult their mothers or their birth cards. In particular, the following information was collected: breastfeeding practice and duration, introduction of infant formula or other types of milk, and consumption of fruits and vegetables during childhood.

The practice of breastfeeding regardless of duration was categorized as no or yes, and the duration of breastfeeding was categorized as <6 months of life, 6–24 months of life, and ≥24 months of life. Type of feeding during the first 6 months of life (main exposure) was classified as not breastfed, introduction of solid, semi-solid or soft foods before 6 months, and EBF. The

introduction of infant formula or other types of milk was categorized as follow: <1 month of life of life, 1–3 months of life of life, 3–5 months of life of life, and ≥6 months of life. The habit of eating fruits and vegetables during childhood was categorized as yes or no.

Current food consumption data

Current food consumption, the main outcome variable, was assessed using a previously validated quantitative food frequency questionnaire (FFQ).[24] The quantitative FFQ contemplates the eating habits of individuals over a period of 1 year, identifying the usual individual portion of 136 food items, with options for frequencies (0–10 times), time units (day, week, month, or year) and portions (described in homemade measures, grams, and millimeters). The data were processed in the Nutrition Data System for Research (Nutrition Coordinating Center, University of Minnesota, Minneapolis).[25]

Food consumption was assessed according to the NOVA classification, which categorizes foods into four groups according to their level of processing and their processing purpose – unprocessed and minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods.[26]

According to the FFQ, food items were classified into 74 unprocessed or minimally processed foods, 3 processed culinary ingredients, 19 processed foods, and 40 ultra-processed foods.

From this classification, the percentages of each group's contribution to the daily energy intake were calculated, based on previous studies.[27,28] Then, nutritional indicators were used to assess the relationship between current food consumption and the duration of EBF. The nutritional indicators chosen were carbohydrates, dietary fiber, added sugar, lipids, saturated fats, and proteins, based on the United States Department of Agriculture (USDA) National Nutrient Database for Standard Reference[25], and for which the WHO has established recommendations for the consumption for specific populations, which are independent of sex, age group, and physiological status.[29,30]

Data analysis

Descriptive variables are expressed as absolute and relative values or mean and standard deviation. For the association between childhood eating practices (dependent variable) and current food habits (independent variables) a multiple linear regression model was used, selection of co-variates was based on literature well-known confounding factors. The linear trend between food consumption and NOVA classification and EBF was assessed by using linear regression analysis after adjusting for sex, age, and BMI. The beta estimate and 95% confidence interval (95% CI) for the association between current energy consumption from the NOVA classification food groups and breastfeeding practice and eating practices in childhood were evaluated by linear regression analysis using an unadjusted model (crude) and a model adjusted for age (continuous, years), sex (men or women), BMI (continuous, kg/m^2), skin color/self-declared race (white or black/brown or others), use of dietary supplement (yes or no), family income (<1 or 1–5 or 6–10 or >10 Brazilian minimum wages – equivalent to 257 USD per month), and smoking habit (yes or no).

For multiple models only participants with no missing data for any of the variables were included.

Statistical analyses were performed using the Stata (version 12.0, 2011, StataCorp LP, College Station, TX). $P < 0.05$ was considered significant.

Results

Among the 392 participants (average age: 23.9 ± 5.9 years) with complete breastfeeding and FFQ data, 83.2% participants were women, 56.1% participants self-reported having black/brown skin color, and 60.5% participants had family income of 1–5 minimum wages. The mean BMI was 24.2 ± 4.1 kg/m^2, and 60.5% participants were classified as eutrophic. Regarding the events that occurred in the first 2 years of life, 87% participants were breastfed, and among them, 46.7% participants received EBF for 6 months (Table 1).

The current average daily energy intake was 2565.6 ± 898.9 kcal, with 62% intake from unprocessed and minimally processed foods, 3.4% intake from processed culinary ingredients, 19.6% intake from processed foods, and 15.1% intake from ultra-processed foods (Table 1). No significant linear trend was observed between mean food consumption in adulthood among the categories of EBF practice (not breastfed, introduction of solid, semi-solid or soft foods before 6 months, and EBF) (Table 2).

Participants who did not have the habit of eating fruits and vegetables during their childhood consumed less unprocessed and minimally processed food ($\beta = -3.76$; 95% CI = −6.70 to −0.82) (Table 3) and more processed culinary ingredients ($\beta = 0.84$; 95% CI = 0.06–1.64) (Table 4) and processed foods ($\beta = 2.62$; 95% CI = 0.04–5.20) in adulthood (Table 5) than those who had the habit of eating fruits and vegetables during their childhood.

Among the breastfeeding practices evaluated in the present study, adults who were breastfed but started introduction of solid, semi-solid or soft foods before 6 months had a higher consumption of processed foods ($\beta = 4.30$; 95% CI = 0.56–8.04) than those who were not breastfed (Table 5). No difference was observed for other breastfeeding practices in relation to current consumption of unprocessed and minimally processed foods (Table 3), processed culinary ingredients (Table 4), and ultra-processed foods (Table 6).

Participants who were fed infant formula or other types of milk between 3 and 5 months of life had a lower current consumption of ultra-processed foods ($\beta = -3.09$; 95% CI = −6.12 to −0.06) than those who were fed infant formula or other types of milk before 1 month of life (Table 6).

Discussion

The present study is the first study to assess the relationship between early childhood eating practices and food consumption in adulthood, considering levels of food processing according to the NOVA classification.

We found that breastfed young adults who started introduction of solid, semi-solid or soft foods before 6 months of age had a higher average consumption of processed foods than those who were not breastfed. Participants who did not have the habits of eating fruits and vegetables during childhood consumed less unprocessed and minimally processed foods in adulthood than those who had the habit of eating fruits and vegetables during infancy. Volunteers fed infant formula or other types of milk between 3 and 5 months of age had a lower current consumption of ultra-processed foods than those fed infant formula or other types of milk before 1 month age of life.

In addition, we found that 34.7% energy intake was from processed and ultra-processed foods, with 15.1% intake from ultra-processed foods alone. According to the 2017–2018 Household Budget Survey, the percentage of consumption of ultra-processed foods was 14.8% in Brazil.[31] A comparison of our results with the

Table 1. Description of the sample of young adults from the NutriHS, Fortaleza, Brazil

Variables	Total (n = 392)***
Sample characterization	
Age, years*	23.9* (5.9)**
Sex. women, n (%)	326 (83.2)
Skin color/self-declared, n (%)	
White	157 (40.1)
Black/Brown	220 (56.1)
Others	15 (3.8)
Family income, 1–5 minimum wages, n (%)	237 (60.5)
Smoking, no, n (%)	383 (97.7)
BMI, kg/m²*	24.2 (4.1)
Previous data on early childhood	
Breastfeeding, n (%)	
No	51 (13.0)
Yes	341 (87.0)
Duration of Breastfeeding, months, n (%)	
<6 months of life	148 (40.3)
6–24 months of life	155 (42.2)
≥24 months of life	64 (17.4)
At how many months was formula or milk introduced, months, n (%)	
<1 month of life	47 (13.6)
1–3 months of life	53 (15.3)
3–5 months of life	78 (22.5)
≥6 months of life	168 (48.6)
Type of feeding during the first 6 months of life, n (%)	
Not breastfed	51 (13.0)
Introduction of solid, semi-solid or soft foods before 6 months	158 (40.3)
Exclusive breastfeeding	183 (46,7)
As a child, did you have a habit of eating fruits and vegetables?, n (%)	
No	115 (29.9)
Yes	270 (70.1)
Current food consumption*	
Energy, kcal/day	2,565.6 (898.9)
Carbohydrates, g/1000 kcal/day	119.2 (20.4)
Dietary fiber, g/1000 kcal/day	9.1 (3.1)
Addition sugar, g/1000 kcal /day	20.1 (11.7)
Lipids, g/1000 kcal/day	40.0 (6.2)
Saturated fats, g/1000 kcal/day	14.0 (2.8)
Proteins, g/1000 kcal/day	41.6 (8.5)
NOVA classification*	
Unprocessed and minimally processed, % total energy	62.0 (13.5)
Culinary ingredient, % total energy	3.4 (3.6)
Processed, % total energy	19.6 (11.8)
Ultra-processed, % total energy	15.1 (8.5)

*Value expressed in average.
**Value expressed in standard deviation.
***Sample reduction due to missing information (Duration of Breastfeeding: $n = 367$; At how many months was formula or milk introduced: $n = 346$; As a child, did you have a habit of eating fruits and vegetables?: $n = 385$).

Table 2. Association between food consumption and type of feeding during the first 6 months of life in young adults from the NutriHS, Fortaleza, Brazil

| Current food consumption* | Type of feeding during the first 6 months of life | | | |
| | Not breastfed | Introduction of solid, semi-solid or soft foods before 6 months | Exclusive breastfeeding | |
	(*n* = 51)	(*n* = 158)	(*n* = 183)	p-trend*
Energy, kcal/day	2543.2 (884.8)	2508.5 (866.7)	2621.2 (930.9)	0.44
Carbohydrates, g/1000 kcal/day	119.8 (20.6)	119.5 (20.7)	118.7 (20.3)	0.587
Dietary fiber, g/1000 kcal/day	9.3 (3.5)	9.1 (3.1)	9.0 (3.0)	0.39
Addition sugar, g/1000 kcal/day	19.9 (11.4)	21.2 (12.7)	19.3 (10.8)	0.527
Lipids, g/1000 kcal/day	39.6 (6.3)	40.0 (6.4)	40.1 (6.1)	0.551
Saturated fat, g/1000 kcal/day	13.7 (2.9)	14.1 (2.8)	14.0 (2.7)	0.444
Proteins, g/1000 kcal/day	42.3 (9.6)	41.3 (8.6)	41.7 (8.2)	0.904
NOVA classification*				
Unprocessed and minimally processed, % total energy	64.4 (14.0)	60.6 (13.1)	62.6 (13.7)	0.782
Culinary ingredient, % total energy	2.8 (2.6)	3.6 (4.5)	3.3 (2.9)	0.743
Processed, % total energy	16.7 (11.8)	21.1 (11.5)	19.1 (11.9)	0.578
Ultra-processed, % total energy	16.2 (9.2)	14.7 (8.1)	15.1 (8.7)	0.637

*Linear regression model adjusted for sex, age, and BMI. Values are expressed as mean and standard deviation.

Table 3. Association between current energy consumption from unprocessed and minimally processed foods and the practice of breastfeeding and childhood eating experiences in young adults from the NutriHS, Fortaleza, Brazil

| Breastfeeding practice and childhood eating experiences | Current energy consumption from unprocessed and minimally processed food (% of total energy) | |
| | Gross model | Adjusted model* |
	Beta (95% CI)	Beta (95% CI)
Breastfeeding	*n* = 392	*n* = 392
Yes	Reference	Reference
No	2.70 (−1.29 to 6.69)	2.82 (−1.15 to 6.79)
Type of feeding during the first 6 months of life	*n* = 392	*n* = 392
Not breastfed	Reference	Reference
Introduction of solid, semi-solid or soft foods before 6 months	−3.78 (−8.06 to 0.49)	−3.75 (−8.00 to 0.50)
Exclusive breastfeeding	−1.77 (−5.97 to 2.43)	−2.00 (−6.19 to 2.19)
p-trend	0.942	0.819
Breastfeeding duration, months, n (%)	*n* = 367	*n* = 367
<6 months of life	Reference	Reference
6–24 months of life	−1.50 (−4.60 to 1.60)	−1.71 (−4.81 to 1.39)
≥24 months of life	−1.14 (−5.18 to 2.90)	−1.75 (−5.80 to 2.29)
p-trend	0.452	0.299
At how many months was formula or milk introduced, months, n (%)	*n* = 346	*n* = 346
<1 month of life	Reference	Reference
1–3 months of life	1.37 (−4.04 to 6.78)	1.40 (−4.01 to 6.82)
3–5 months of life	−0.27 (−5.26 to 4.71)	−0.30 (−5.29 to 4.70)
≥6 months of life	2.18 (−2.27 to 6.64)	1.60 (−2.87 to 6.08)
p-trend	0.524	0.332
As a child, did you have a habit of eating fruits and vegetables?	*n* = 385	*n* = 385
Yes	Reference	Reference
No	**−4.01 (−6.95 to −1.06)**	**−3.76 (−6.70 to −0.82)**

*Linear regression model adjusted for age, sex, BMI, skin color/self-declared race, use of dietary supplement, family income, and smoking status.
Values in bold indicate significant coefficients. 95% CI: 95% confidence interval.

Table 4. Association between energy consumption from culinary ingredient foods and breastfeeding practice and childhood eating experiences in young adults from the NutriHS, Fortaleza, Brazil

Breastfeeding practice and childhood eating experiences	Energy consumption from culinary ingredient foods (% of total energy)	
	Gross model	Adjusted model*
	Beta (95% CI)	Beta (95% CI)
Breastfeeding	n = 392	n 392
Yes	Reference	Reference
No	−0.61 (1.67 to 0.45)	−0.71 (−1.77 to 0.35)
Type of feeding during the first 6 months of life	n = 392	n = 392
Not breastfed	Reference	Reference
Introduction of solid, semi-solid or soft foods before 6 months	0.81 (−0.33 to 1.94)	0.91 (−0.22 to 2.04)
Exclusive breastfeeding	0.44 (−0.68 to 1.56)	0.53 (−0.59 to 1.65)
p-trend	0.829	0.754
Breastfeeding duration, months, n (%)	n = 367	n = 367
<6 months of life	Reference	Reference
6–24 months of life	0.67 (−0.02 to 1.50)	0.81 (−0.03 to 1.65)
≥24 months of life	0.42 (−0.66 to 1.51)	0.46 (−0.63 to 1.55)
p-trend	0.265	0.211
At how many months was formula or milk introduced, months, n (%)	n = 346	n = 346
<1 month of life	Reference	Reference
1–3 months of life	−0.22 (−1.68 to 1.24)	−0.32 (−1.78 to 1.15)
3–5 months of life	−0.43 (−1.78 to 0.91)	−0.49 (−1.84 to 0.86)
≥6 months of life	−0.65 (−1.85 to 0.56)	−0.62 (−1.83 to 0.59)
p-trend	0.243	0.304
As a child, did you have a habit of eating fruits and vegetables?	n = 385	n = 385
Yes	Reference	Reference
No	**0.88 (0.09 to 1.66)**	**0.84 (0.06 to 1.64)**

*Linear regression model adjusted for age, sex, BMI, skin color/self-declared race, use of dietary supplement, family income, and smoking status.
Values in bold indicate significant coefficients. 95% CI: 95% confidence interval.

nationally representative data revealed that the daily intake of ultra-processed foods in the study population was similar that in the Brazilian population. As our study cohort included Nutrition Course undergraduates and recent graduated nutritionists, it was expected that the consumption of ultra-processed foods would be lower as they tended to a follow diet in greater agreement with the Food Guide recommendations for the Brazilian Population[32] due to their greater knowledge about the health impacts of nutrition. However, the average of 15.1% does not represent a high consumption of ultra-processed foods.

Our results showed that breastfed volunteers who were started introduction of solid, semi-solid or soft food before 6 months of life had a higher consumption of processed foods in young adulthood than those who were not breastfed. In a birth cohort study in Pelotas, located in Brazil's South, children who started introducing food before 4 months of life consumed more snacks and treats, predominantly coffee and bread, at 6 years of age than those who started food after 4 months of life.[33] Acknowledging that the present study chose to work with different reference categories for breastfeeding practices, the Pelotas cohort study findings

suggest that introduction of solid, semi-solid or soft foods before recommended starts with the supply of processed foods, such as dairy products and bread,[34,35] even in a region of the country different from ours. This increases the chances for the consumption of these food items throughout life, which could contribute to unhealthy eating habits when in excess.

Participants who did not have the habit of eating fruits and vegetables during childhood had the lowest current consumption of unprocessed and minimally processed foods and the highest consumption of processed foods. This corroborates with the findings of the Avon Longitudinal Study of Parents and Children, conducted in southwest England, which demonstrated that vegetable consumption at an older age was directly related to their smaller intake at age of 13 years.[36] Our findings are also in accordance with results of a population-based study of young adults, the EAT Project (Food and Activity in Adolescents and Young Adults), conducted in Minnesota, which found that selective feeding in childhood predisposed to lower dietary quality in young adults, characterized by lower intake of fruits, vegetables and whole grains and more frequent consumption of drinks sweetened with sugar

Table 5. Association between current energy consumption from processed foods and breastfeeding practice and childhood eating experiences in young adults from the NutriHS Fortaleza, Brazil

Breastfeeding practice and childhood eating experiences	Current energy consumption from processed foods (% of total energy)	
	Gross model	Adjusted model*
	Beta (95% CI)	Beta (95% CI)
Breastfeeding	*n* = 392	*n* = 392
Yes	Reference	Reference
No	−3.34 (−6.81 to 0.14)	−3.38 (−6.88 to 0.12)
Type of feeding during the first 6 months of life	*n* = 392	*n* = 392
Not breastfed	Reference	Reference
Introduction of solid, semi-solid or soft foods before 6 months	**4.40 (0.68 to 8.11)**	**4.30 (0.56 to 8.04)**
Exclusive breastfeeding	2.41 (−1.24 to 6.07)	2.56 (−1.13 to 6.25)
p-trend	0.716	0.621
Breastfeeding duration, months, n (%)	*n* = 367	*n* = 367
<6 months of life	Reference	Reference
6–24 months of life	0.91 (−1.80 to 3.62)	1.18 (−1.57 to 3.93)
≥24 months of life	−0.02 (−3.55 to 3.51)	0.63 (−2.95 to 4.21)
p-trend	0.855	0.588
At how many months was formula or milk introduced, months, n (%)	*n* = 346	*n* = 346
<1 month of life	Reference	Reference
1–3 months of life	1.85 (−2.88 to 6.58)	2.06 (−2.72 to 6.84)
3–5 months of life	3.88 (−0.48 to 8.24)	3.87 (−0.54 to 8.28)
≥6 months of life	0.74 (−3.16 to 4.63)	1.08 (−2.87 to 5.03)
p-trend	0.978	0.885
As a child, did you have a habit of eating fruits and vegetables?	*n* = 385	*n* = 385
Yes	Reference	Reference
No	**2.62 (0.04 to 5.20)**	2.43 (−0.18 to 5.03)

*Linear regression model adjusted for age, sex, BMI, skin color/self-declared race, use of dietary supplement, family income, and smoking status.
Values in bold indicate significant coefficients. 95% CI: 95% confidence interval.

and preparations rich in sodium.[37] These findings lead to the conclusion that, when the introduction of healthy foods occurs in an early, varied, and repeated way, it has positive influences throughout life.[38]

Although breastfeeding practices were not related to minimally processed foods in the present study, it is worthy mentioning the relevance of early weaning over adulthood dietary habits, evidenced by other studies,[1,16] as only 46.7% of the studied sample was exclusively breastfed for a minimum of 6 months. Long-term breastfeeding is known to improve the child's acceptance of new foods[33] due to the ability of human milk to transmit different smells and flavors from the mother's diet, expanding the healthy food variety and minimizing the presence of foods with the highest level of processing.

The same cannot be achieved by offering infant formula owing to its standard flavors.[39] In addition, the differences in macronutrient profile between infant formula and human milk and the absence of hormones in the former prevent the self-regulation of satiety. Breastfeeding makes it possible to conduct an autonomous feeding as it allows the baby to actively suck the milk and control the amount of milk consumed,[40] which promotes responsive signs of hunger and satiety throughout life.

Among the hormones associated with this ability, leptin controls food intake and regulates nutritional status by interacting with its receptor to activate the anorectic branch through the POMC peptide (proopiomelanocortin), with its alpha-cleavage product MSH (alpha-melanocyte-stimulating hormone) and CART peptide (cocaine-anphetamin-regulated transcript), and inhibit the orexigenic branch by means of NPY (neuropeptide Y) and AgRP (agouti gene-related protein).[5,6]

We also observed that participants fed infant formula or other types of milk between 3 and 5 months of age had the lowest consumption of ultra-processed foods in adulthood than those who were fed with human milk substitutes early, that is, before 1 month of life. Similar to our findings, a study including children participating in the Lactation Support Program in Viçosa, MG, found that breastfeeding for <4 months was associated with a higher intake of ultra-processed foods to the detriment exclusion of unprocessed foods from 4 to 7 years old.[16] Similarly, in a cross-sectional analysis of data from the NutriHS São Paulo cohort, women who were

Table 6. Association between energy consumption from ultra-processed foods and breastfeeding practice and eating experiences in childhood in young adults from the NutriHS Fortaleza, Brazil

Breastfeeding practice and childhood eating experiences	Energy consumption from ultra-processed foods (% of total energy)	
	Gross model	Adjusted model*
	Beta (95% CI)	Beta (95% CI)
Breastfeeding	*n* = 392	*n* = 392
Yes	Reference	Reference
No	1.24 (−1.28 to 3.76)	1.27 (−1.25 to 3.79)
Type of feeding during the first 6 months of life	*n* = 392	*n* = 392
Not breastfed	Reference	Reference
Introduction of solid, semi-solid or soft foods before 6 months	−1.42 (−4.13 to 1.28)	−1.47 (−4.16 to 1.23)
Exclusive breastfeeding	−1.09 (−3.75 to 1.57)	−1.09 (−3.75 to 1.57)
p-trend	0.632	0.645
Breastfeeding duration, months, n (%)	*n* = 367	*n* = 367
<6 months of life	Reference	Reference
6–24 months of life	−0.08 (−2.03 to 1.88)	−0.28 (−2.24 to 1.68)
≥24 months of life	0.74 (−1.80 to 3.28)	0.67 (−1.89 to 3.22)
p-trend	0.642	0.725
At how many months was formula or milk introduced, months, n (%)	*n* = 346	*n* = 346
<1 month of life	Reference	Reference
1–3 months of life	−3.00 (−6.29 to 0.30)	−3.15 (−6.43 to 0.14)
3–5 months of life	**−3.17 (−6.21 to −0.14)**	**−3.09 (−6.12 to −0.06)**
≥6 months of life	−2.27 (−4.98 to 0.44)	−2.06 (−4.78 to 0.65)
p-trend	0.302	0.424
As a child, did you have a habit of eating fruits and vegetables?	*n* = 385	*n* = 385
Yes	Reference	Reference
No	0.52 (−1.35 to 2.38)	0.49 (−1.38 to 2.35)

*Linear model adjusted for age, sex, BMI, skin color/self-declared race, use of dietary supplement, family income, and smoking status.
Values in bold indicate significant coefficients. 95% CI: 95% confidence interval.

breastfed for <6 months as babies were less likely to adhere to a dietary pattern consisting of healthy foods such as fruits, vegetables, whole grains, poultry and fish.[41]

However, we found that most of the evaluated breastfeeding practices were not associated with current food consumption, in contrast to findings reported in the literature, which indicates that there is a relationship between greater exposure to breast milk and adherence to the prudent dietary pattern in adulthood, which usually consists of fruits, vegetables, oats, lentils, nuts, brown rice, brown bread, and lean meats.[41,42] This finding can be explained by the early introduction of other foods, especially water and water-based foods, such as juices and teas, preventing the study of the real effects of EBF. Consistent with our results, the birth cohort of Terneuzen, the Netherlands reported no significant association between EBF and eating behavior at later ages.[43] As both are studies related to adulthood, other exposure variables may have confounded their results. In the present study, the homogenous level of education and access to information on nutrition found in our sample, being mainly composed of students and nutritionists, may be weakening the association.

Our study evaluated past information, which may imply memory bias. Data on the practice and duration of breastfeeding and food consumption in childhood were recollected by the participants with the help of their mothers. However, previous research has shown that these variables are reported accurately up to 20 years after birth.[44,45] As the average age of participants was the same, the influence of this type of bias on our results may be small. The study cohort, composed of undergraduate students from the Nutrition Course and recently graduated nutritionists, is a strength of our study because they are aware of the importance of providing reliable information on food intake and are more familiar with the tools used for dietary assessment, ensuring internal validity. Therefore, this homogeneity may not allow generalization of results to other populations, interfering with external validity.

In conclusion, breastfed adults who started introduction of solid, semi-solid or soft foods before 6 months of age had a higher average consumption of processed foods than those who were not breastfed. Participants who did not have the habit of eating fruits and vegetables as children consumed less unprocessed and minimally processed foods in adulthood than those who ate fruits and

vegetables during childhood. Participants fed infant formula or other types of milk between 3 and 5 months of age had a lower current consumption of ultra-processed foods than those fed infant formula or other types of milk before 1 month of life. Therefore, feeding practices in the first 1000 days of the child's life seems to influence food choices in the long-term. Prospective studies, with different and bigger samples are desired to confirm the present results and to clarify literature inconsistences regarding associations between breastfeeding practices and adulthood dietary habits.

References

1. Eshriqui I, Folchetti LD, Valente AMM, et al. Early life feeding and current dietary patterns are associated with biomarkers of glucose and lipid metabolism in young women from the Nutritionist's Health Study. *Eur J Clin Nutr.* 2020; 74(3), 509–517.

2. Wang SF, Shu L, Sheng J, et al. Birth weight and risk of coronary heart disease in adults: a meta-analysis of prospective cohort studies. *J Dev Orig Health Dis.* 2014; 5(6), 408–419.

3. Paes ST, Gonçalves CF, Terra MM, et al. Childhood obesity: a (re) programming disease? *J Dev Orig Health Dis.* 2016; 7(3), 231–236.

4. Brasil. Ministério da Saúde. *Secretaria de Atenção Primária à Saúde. Guia alimentar para crianças brasileiras menores de 2 anos*, 2019, 2nd edn. Ministério da Saúde, Brasília.

5. Chan D, Goruk S, Becker A, et al. Adiponectin, leptin and insulin in breast milk: associations with maternal characteristics and infant body composition in the first year of life. *Int J Obes.* 2018; 42(1), 36–43.

6. Palou M, Picó C, Palou A. Leptin as a breast milk component for the prevention of obesity. *Nutr Rev.* 2018; 76, 875–892.

7. Melnik BC. The potential mechanistic link between allergy and obesity development and infant formula feeding. *All Asth Clin Immun.* 2014; 10(1), 1–10.

8. Gonsalez PS, Retondario A, Bricarello LP, et al. Exclusive breastfeeding, complementary feeding and association with body fat excess among schoolchildren in Florianópolis, Santa Catarina, Brazil. *Rev Bras Saúde Mater Infant.* 2017; 17(1), 115–112.

9. Rito AI, Buoncristiano M, Spinelli A, et al. Association between characteristics at birth, breastfeeding and obesity in 22 countries: The WHO European Childhood Obesity Surveillance Initiative – COSI 2015/2017. *Obes Facts.* 2019; 12(2), 226–243.

10. World Health Organization. *Guideline: Counselling of Women to Improve Breastfeeding Practices.* 2018. https://www.who.int/nutrition/publications/guidelines/counselling-women-improve-bf-practices/en/.

11. Flores TR, Nunes BP, Neves RG, et al. Consumo de leite materno e fatores associados em crianças menores de dois anos: Pesquisa Nacional de Saúde. *2013 Cad Saúde Pública.* 2017; 33(11), 1–15.

12. Neves PA, Barros AJ, Baker P, et al. Consumption of breast milk, formula and other non-human milk by children aged under 2 years: analysis of eighty-six low- and middle-income countries. *Public Health Nutr.* 2020; 16, 1–9.

13. United Nations Children's Fund. Infant and young child feeding. 2019. https://data.unicef.org/topic/nutrition/infant-and-young-child-feeding/.

14. Brasil. Ministério da Saúde. *Sistema de Vigilância Alimentar e Nutricional (SISVAN).* 2019. https://sisaps.saude.gov.br/sisvan/relatoriopublico/index.

15. Hamulka J, Zielinska MA, Jeruszka-Bielak M, et al. Analysis of association between breastfeeding and vegetable or fruit intake in later childhood in a population-based observational study. *Int J Environ Res Public Health.* 2020; 17(11), 1–19.

16. Fonseca PCA, Ribeiro SAV, Andreoli CS, et al. Association of exclusive breastfeeding duration with consumption of ultra-processed foods, fruit and vegetables in Brazilian children. *Eur J Nutr.* 2019; 58(7), 2887–2894.

17. Monteiro CA, Cannon G, Levy RB, et al. NOVA. A estrela brilha. Classificação dos alimentos. Saúde Pública. *World Nutr.* 2016; 7, 1–40.

18. Folchetti LG, Silva IT, Almeida-Pititto B, et al. Nutritionists' Health Study cohort: a web-based approach of life events, habits and health outcomes. *BMJ Open.* 2016; 6(8), 1–6.

19. Hulley SB, Cummings SR, Browner WS, et al. *Delineando a Pesquisa Clínica: Uma Abordagem Epidemiológica*, 2008, 3rd edn. Artmed, Porto Alegre.

20. Valente A, De Almeida-Pititto B, Archanjo FA, et al. Birth weight associated with dual energy X-ray absorptiometry-determined muscle-bone unit in young healthy women from the Nutritionists' Health Study. *J Dev Orig Health Dis.* 2021; 12(1), 42–49.

21. World Health Organization. *Physical Status: The Use and Interpretation of Anthropometry*, 1995. WHO, Geneva.

22. Olfert MD, Barr ML, Charlier CM, et al. Self-reported vs. measured height, weight, and BMI in young adults. *Int J Environ Res Public Health.* 2018; 15, 1–9.

23. Hodge JM, Shah R, McCullough ML, et al. Validation of self-reported height and weight in a large, nationwide cohort of U.S. adults. *PLoS One.* 2020; 15(4), 1–11.

24. Selem SSC, Carvalho AM, Verly-Junior E, et al. Validade e reprodutibilidade de um questionário de frequência alimentar para adultos de São Paulo, Brasil. *Rev Bras Epidemiol.* 2014; 17(4), 852–859.

25. Universidade de Minnesota. *Nutrition Data System for Research.* 2005. http://www.ncc.umn.edu/products/.

26. Monteiro C, Cannon G, Moubarac J, et al. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr.* 2018; 21(1), 5–17.

27. Berti TL, Rocha TF, Curioni CC, et al. Consumo alimentar segundo o grau de processamento e características sociodemográficas: Estudo Pró-Saúde. *Rev Bras Epidemiol.* 2019; 22, 1–14.

28. Louzada MLC, Martins APB, Canella DS, et al. Ultra-processed foods and the nutritional dietary profile in Brazil. *Rev Saúde Pública.* 2015; 49, 1–11.

29. World Health Organization. *Diet, Nutrition and the Prevention of Chronic Diseases*, 2003. WHO, Geneva. =https://apps.who.int/iris/bitstream/handle/10665/42665/WHO_TRS_916.pdf?sequence=1.

30. World Health Organization. *Diretriz: Ingestão de açúcares por adultos e crianças*, 2015. WHO, Geneva. https://www.who.int/publications-detail/9789241504836.

31. Instituto Brasileiro de Geografia e Estatística. *Pesquisa de orçamentos familiares 2017-2018: avaliação nutricional da disponibilidade domiciliar de alimentos no Brasil*, 2020. IBGE, Rio de Janeiro.

32. da Saúde Brasil Ministério. *Secretaria de Atenção Primária à Saúde. Guia alimentar para a população brasileira*, 2014, 2nd edn. Ministério da Saúde, Brasília.

33. Santos LP, Assunção MCF, Matijasevich A, et al. Dietary intake patterns of children aged 6 years and their association with socioeconomic and demographic characteristics, early feeding practices and body mass index. *BMC Public Health.* 2016; 16(1), 1–12.

34. Maciel B, Moraes ML, Soares AM, et al. Infant feeding practices and determinant variables for early complementary feeding in the first 8 months of life: results from the Brazilian MAL-ED cohort site. *Public Health Nutr.* 2018; 21(13), 2462–2470.

35. Wang L, van Grieken A, van der Velde LA, *et al.* Factors associated with early introduction of complementary feeding and consumption of non-recommended foods among Dutch infants: the BeeBOFT study. *BMC Public Health.* 2019; 19(388), 1–12.

36. Lauzon-Guillain B, Jones B, Oliveira A, *et al.* The influence of early feeding practices on fruit and vegetable intake among preschool children in 4 European birth cohorts. *Am J Clin Nutr.* 2013; 98(3), 804–812.

37. Pesch MH, Bauer KW, Christoph MJ, *et al.* Young adult nutrition and weight correlates of picky eating during childhood. *Public Health Nutr.* 2020; 23(6), 987–995.

38. Hetherington MM, Schwartz C, Madrelle J, *et al.* A step-by-step introduction to vegetables at the beginning of complementary feeding. The effects of early and repeated exposure. *Appetite.* 2015; 84, 280–290.

39. Beckerman JP, Slade E, Ventura AK. Maternal diet during lactation and breast-feeding practices have synergistic association with child diet at 6 years. *Public Health Nutr.* 2020; 23(2), 286–294.

40. Azad MB, Vehling L, Chan D, *et al.* Infant feeding and weight gain: separating breast milk from breastfeeding and formula from food. *Pediatrics.* 2018; 142(4), 1–14.

41. Eshriqui I, Folchetti LD, Valente AMM, *et al.* Breastfeeding duration is associated with offspring's adherence to prudent dietary pattern in adulthood: results from the Nutritionist's Health Study. *J Dev Orig Health Dis.* 2020; 11(2), 1–10.

42. Robinson S, Ntani G, Simmonds S, *et al.* Type of milk feeding in infancy and health behaviours in adult life: findings from the Hertfordshire Cohort Study. *British J Nutr.* 2013; 109(6), 1114–1122.

43. De Kroon ML, Renders CM, Buskermolen MP, *et al.* The Terneuzen Birth Cohort. Longer exclusive breastfeeding duration is associated with leaner body mass and a healthier diet in young adulthood. *BMC Pediatr.* 2011; 11(1), 1–7.

44. Li R, Ingol TT, Smith K, *et al.* Reliability of maternal recall of feeding at the breast and breast milk expression 6 years after delivery. *Breastfeed Med.* 2020; 15(4), 224–236.

45. Natland ST, Andersen LF, Nilsen TI, *et al.* Maternal recall of breastfeeding duration twenty years after delivery. *BMC Med Res Methodol.* 2012; 12(1), 224–236.