Public Health Nutrition: 24(11), 3341–3351 doi:10.1017/S1368980020004759

Early consumption of ultra-processed foods among children under 2 years old in Brazil

Ana Maria Spaniol[1,*], Teresa Helena Macedo da Costa[2], Amanda de Moura Souza[3] and Muriel Bauermann Gubert[4]

[1]Postgraduate Program in Human Nutrition, Center for Epidemiological Studies in Health and Nutrition – NESNUT, University of Brasilia, Campus Universitário Darcy Ribeiro, Asa Norte, 70910-900 Brasilia, Federal District, Brazil: [2]Department of Nutrition, University of Brasilia, Campus Universitário Darcy Ribeiro, Asa Norte, 70910-900 Brasilia, Federal District, Brazil: [3]Institute of Collective Health Studies, Federal University of Rio de Janeiro, Av. Pedro Calmon, 550-Cidade Universitária, 21941-901 Rio de Janeiro, Rio de Janeiro, Brazil: [4]Department of Nutrition, Center for Epidemiological Studies in Health and Nutrition – NESNUT, University of Brasilia, Campus Universitário Darcy Ribeiro, Asa Norte, 70910-900 Brasilia, Federal District, Brazil

Submitted 6 January 2020: Final revision received 30 October 2020: Accepted 13 November 2020: First published online 23 November 2020

Abstract

Objective: To evaluate the complementary food consumption according to the extent and purpose of food processing based on NOVA classification among children aged 6–24 months of Federal District, Brazil.
Design: We performed a cross-sectional study using a 24-h recall to estimate the daily energy intake and nutrients according to NOVA classification. We conducted a linear regression to assess the association between the processed and ultra-processed foods (UPF) energy intake and the daily energy intake from saturated fat, daily energy intake from total sugars and daily intake of sodium.
Setting: Federal District, Brazil.
Participants: Five hundred and thirty-eight children aged between 6 and 24 months attended at Primary Health Care Units from March 2017 to March 2018.
Results: On average, children aged from 6 to 12 and from 12 to 24 months consumed 2393 and 4054 kJ/d, respectively, and processed and UPF represented one-third of dietary energy intake. Group 2 (processed and UPF) was higher carbohydrate contributors, and lower protein, fibre and most micronutrient contributors, when compared with Group 1 (unprocessed, minimally processed foods and processed culinary ingredients). In addition, the higher the energy intake from processed and UPF, the higher was the daily energy intake from saturated fat, daily energy intake from total sugar and daily intake of sodium.
Conclusion: Children are being exposed early to processed and UPF and their share affect the diet's nutritional quality.

Keywords
Children
Complementary feeding
NOVA classification
Ultra-processed foods

Food consumption is a modifiable risk factor for short- and long-term disease burden[1–3]. The complementary food introduction in the first 2 years of life represent a window of opportunity for infants to establish long-term healthy dietary patterns[4–7]. In contrast, early introduction of unhealthy foods can compromise child growth and development[1,8].

In recent decades, changes in dietary patterns have been observed, such as a lower consumption of fresh foods and a higher consumption of ultra-processed foods (UPF), usually with high energy density, free sugar, sodium and saturated fat[9–12]. The UPF consumption compromises the nutritional quality of diets and is an important contributor to current prevalence of overweight[8,13–15]. Overweight prevalence is rising dramatically worldwide[16] and is a public health problem because it is associated with the higher prevalence of chronic diseases, such as type 2 diabetes, cancer and cardiovascular diseases[17,18].

Some studies already showed a high consumption of UPF in childhood in Brazil[11,19,20]; however, only few studies evaluated the UPF consumption at earlier ages, including children aged from 6 to 24 months[12,21]. Considering the role of complementary feeding to the establishment of healthy dietary habits in childhood and adulthood, the

*Corresponding author: Email hani.spaniol@gmail.com

Public Health Nutrition

increased consumption of UPF observed in all ages and its association with chronic diseases, this study aimed to evaluate the complementary food consumption according to the extent and purpose of food processing based on NOVA classification among children aged 6–24 months from the Federal District, Brazil. Our hypothesis is that the consumption of UPF contributes to an unhealthy dietary pattern, presenting high intake of sugar, saturated fat and sodium.

Materials and methods

Study design and sample

We performed a cross-sectional study including a representative sample of children aged from 6 to 24 months attended at Primary Health Care Units (PHU), health facilities considered the first access to health services of the Unified Health System (SUS), in Federal District, Brazil. We followed the guide Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)[22].

The sample size was calculated assuming a margin of error of 5 % and a confidence level of 97 %. To calculate the sample, we considered the prevalence of exclusive breast-feeding among children under 6 months of age (equal to 50 %) in the Federal District[23] and the number of children attending in childcare consultations in PHU in Federal District in 2015. We adopted a two-stage sampling because children were not evenly distributed among the PHU. First, we listed all the 131 PHU of the Federal District and randomly selected 20 PHU. Second, based on the number of children attending each selected PHU, we defined their proportional sample. The final sample was 538 children.

All children aged from 6 to 24 months who were attending at the PHU for childcare follow-up consultations during the data collection days were invited to participate. The child must be accompanied by their mothers. We excluded twins and non-biological children.

Data collection

The data collection was conducted from March 2017 to March 2018. The questionnaire was applied by trained interviewer to the children's mothers. The questionnaire was divided into five parts: (I) identification, socio-economic and demographic data; (II) questions about prenatal, childbirth and puerperium; (III) child health; (IV) household food insecurity and (V) child's food consumption.

We evaluated household food insecurity using the Brazilian Household Food Insecurity Measurement Scale (EBIA)[24]. We evaluated household food insecurity by the affirmative answer scores to the 14 EBIA items, classifying the households as: secure (0), mild insecure (1–5), moderate insecure (6–9) and severe insecure (10–14)[24]. We evaluated family household income in ranges according to the Brazilian definition of minimum wage (240·26 USD equivalent to 937·00 BRL, in 2017).

We measured children's weight and length in duplicate according to the recommendations of the Brazilian Ministry of Health[25]. We performed the evaluation of children's weight and length according to the recommendations of the WHO[26]. We used Anthro software to calculate BMI for age, expressed in z-scores, and subjected to biological plausibility criteria. After this, all children were classified as underweight, adequate BMI, risk of overweight, overweight or obese. We evaluated children's individual dietary intake from a single 24-h recall, the most widely used method for obtaining quantitative dietary data[27]. To standardise data collection and to reduce food consumption underreporting, interviewers followed the five-step multiple-pass method for dietary recalls[28]. We asked the mother for a detailed description, including brands, preparation and quantification – using common household vessels, glassware, and silverware for reporting the portion size – of all food and drinks consumed by the children the day before the interview. We also used a photo album containing foods, kitchen utensils and portions sizes to accurately recall the portions consumed by the child[29].

Statistical analysis

Dietary data analysis

First, for all 24-h recall, we converted all reported serving sizes' food amounts into grams or millilitres based on a food photography booklet developed to access children's food intake[29]. When the food or drink was not available in this photo album, we used a Brazilian food portion table to convert the portion size into grams or millilitres[30].

Second, we used the Nutrition Data System for Research (NDSR, version 2018) software (Nutrition Coordinating Center – NCC, University of Minnesota) to estimate the dietary nutrient content from every food listed in the 24-h recall, including total energy and amounts of macronutrients and micronutrients. When a food was not found in NDSR database, we have requested the nutritional information insertion by the NCC Customer Support. After finished the data entry, we conducted an exploratory analysis to check for possible errors. After that, we exported the database to Excel, version 2013 (Microsoft Corp.).

Third, we classified all 415 food items of our database according to NOVA food classification[10,31,32]. The NOVA classifies foods in four groups according to the extent and purpose of processing, covering physical, biological and chemical processes that occur after foods are harvested and before they are acquired and consumed. The first group consists of unprocessed foods and includes those obtained directly from plants or animals, which do not undergo any alteration following their harvest, such as vegetables and fruits. This group also includes minimally processed foods: foods which have been submitted to physical processes that may subtract part of the food but do not add oils, fats, sugar, salt or other substances.

Public Health Nutrition

Some examples are washed tubers and vegetables, frozen cuts of meat and pasteurised milk. The second group consists of processed culinary ingredients, such as oils, fats, sugar and salt. They are defined as products extracted from foods or from nature and they are used for seasoning, cooking foods and to create culinary preparations. The third group consists of processed foods, products manufactured essentially with salt or sugar in addition to unprocessed or minimally processed foods, including canned and bottled vegetables or fruits, cheese and breads. The fourth group consists of UPF, industrial formulations of which manufacture involves several stages and various processing techniques and ingredients, usually used exclusively by industry. Examples include packaged salty, oily snacks, confectionery, soft drinks, sweetened beverages, sweetened breakfast cereals, packaged cookies and cakes, nuggets and instant noodles[10,31,32].

In our study, the home-made meals were decomposed into their ingredients. Then, we classified all ingredients into the NOVA's four food groups. A small number of fresh meals, mainly based on unprocessed and minimally processed foods, were not decomposed and were classified in the NOVA first group. As our main objective was to study complementary feeding, we excluded breast milk and infant formula from the analysis.

For data analysis, we united unprocessed, minimally processed foods and processed culinary ingredients into a group (Group 1) and processed and UPF into another (Group 2). Despite the conceptual difference between processed and UPF, they were placed in the same group for two reasons: first, they are both unbalanced and non-recommended food, and second, the contribution of processed foods for total energy intake was very low (1·9 % for children aged between 6 and 12 months and 5·0 % for children aged between 12 and 24 months), which did not justifying its analysis as an isolated group.

We used the ratio of means to estimate the energy from different foods in Group 1 and Group 2, calculated from the ratio between the average of energy from the different food groups and the average of total energy intake. We used the same method to estimate the contribution percentage of Group 1 and Group 2 in relation to the total energy intake, macronutrient contents and micronutrient intakes. Regarding the macronutrient intakes, we calculated the ratio between the average of energy from macronutrients and the average of energy intake from Group 1 and Group 2, separately. Thus, it was possible to present the percentage contribution of macronutrients within the groups.

Dietary data analyses are summarised at Supplementary material.

Data analysis

We conducted the statistical analyses in Statistical Package for the Social Sciences (SPSS), version 20.0. First, we performed a descriptive analysis of the characteristics of children and their families by absolute and relative frequencies. Second, we presented a descriptive analysis of Group 1 and Group 2 food consumption in terms of the energy contribution from complementary food groups (absolute and relative) and in terms of macronutrient and fibre contents and micronutrient intakes. We presented the 95 % CI for all descriptive analyses, according to the sample design. Third, we conducted a multiple linear regression in order to assess the association between the energy intake from Group 2 (processed and UPF) and the daily energy intake from total fat, saturated fat, carbohydrate, total sugars and protein, daily intake of sodium and content of fibre. To perform the linear regression, we calculated the quartiles of energy intake from Group 2 as the independent variable and considered the first quartile as the reference group. We included the daily energy intake from carbohydrate, total sugar, total fat, saturated fat, protein, daily intake of fibre and sodium as the dependent variables. Micronutrients were not included because our main focus was chronic disease-related nutrients. For this analysis, we also considered socio-economic, demographic and health characteristics as possible confounding factors and the variables with $P < 0{\cdot}20$ remain at the final model.

Results

We evaluated 178 children between 6 and 12 months and 360 children between 12–24 months of age. Children's race was predominantly Black or Brown (56·3 and 56·7 % for children aged from 6 to 12 months and children aged over 12 months, respectively). Approximately 23 % of children presented risk of overweight and 14·6 % of children aged from 6 to 12 months and 12·4 % of children aged from 12 to 24 months already presented overweight or obesity. Most of the mothers were over 20 years old, Black or Brown and had from 4 to 8 years of schooling. The family income was most frequently between USD 240·26 and USD 480·52 and over 39 % of the children lived in households with some level of food insecurity (Table 1).

Regarding children's complementary food consumption (Table 2), the mean daily dietary energy intake was 2393 kJ/d (6–12 months) and 4054 kJ/d (12–24 months). The proportion of unprocessed, minimally processed foods and processed culinary ingredients (Group 1) of total dietary energy intake was, on average, 69·6 % among younger children and 65·2 % among children aged over 12 months. In Group 1, fruits/natural juices, rice/other cereals and meats/eggs contributed the most to the total energy consumed. On the other hand, about one-third of the dietary energy intake (30·4 and 34·8 %) came from processed and UPF (Group 2). In Group 2, infant and child food products, milk-sweetened beverages and bakery products contributed the most to the total daily energy consumed by the children for both age groups as well as processed foods for children aged between 12 and 24 months.

Table 3 presents the macronutrient contribution for the total energy intake by NOVA food group. Considering food

Table 1 Population descriptive characteristics. Federal District, Brazil, 2017–2018

	Children among 6 and 12 months of age			Children among 12 and 24 months of age		
	n 178			*n* 360		
Variable of study	n*	%	CI 95 %	n†	%	CI 95 %
Socio-economic and demographic variables of the mother, family and household						
Mother's age group						
Under 20 years	27	15·2	8·9, 21·4	39	10·8	7·2, 14·4
20 years or more	151	84·8	78·6, 91·0	321	89·2	85·6, 92·7
Mother's colour						
White	21	11·9	5·9, 17·9	52	14·5	9·8, 19·2
Black or Brown	143	81·3	73·1, 89·4	283	79·1	74·2, 83·8
Yellow or indigenous	12	6·8	2·1, 11·5	23	6·4	4·7, 8·7
Marital status						
Lives with partner	115	64·6	57·3, 71·2	249	69·4	64·4, 73·9
Does not live with partner	63	35·4	28·7, 42·6	110	30·6	26·1, 35·5
Maternal education						
Up to 4 years	44	24·7	16·5, 32·9	74	20·6	15·9, 25·3
Between 4 and 8 years	105	59·0	50·6, 67·3	213	59·3	54·4, 64·2
Between 8 and 12 years	15	8·4	5·0, 11·9	37	10·3	6·9, 13·7
Over 12 years	14	7·9	3·2, 12·5	35	9·7	4·8, 14·7
Family income[2]						
Up to $ 240·26	44	25·7	16·8, 34·6	88	24·9	18·1, 31·7
Between USD 240·26 and USD 480·52	59	34·5	26·7, 42·3	136	38·5	32·8, 44·2
Between USD 480·52 and USD 720·78	37	21·6	15·4, 27·8	62	17·6	14·1, 21·0
Between USD 720·78 and USD 961·04	19	11·1	4·9, 17·3	29	8·2	5·8, 10·6
Above $ 961·04	12	7·0	2·5, 11·5	38	10·8	5·1, 16·4
Household food and nutritional security						
Food security	108	61·0	0·53, 67·9	214	60·3	55·1, 65·2
Mild food insecurity	57	32·2	25·7, 39·4	108	30·4	25·8, 35·4
Moderate food insecurity	8	4·5	2·3, 8·6	21	5·9	3·9, 8·8
Severe food insecurity	4	2·3	0·8, 5·6	12	3·4	1·9, 5·8
Children characteristics						
Child's gender						
Male	85	47·8	40·5, 55·0	187	51·9	46·7, 57·0
Female	93	52·2	44·9, 59·4	173	48·1	42·9, 53·2
Child's colour						
White	69	39·2	34·5, 43·9	130	36·5	30·8, 42·2
Black or Brown	99	56·3	50·8, 61·7	202	56·7	50·9, 62·5
Yellow or indigenous	8	4·5	1·7, 7·4	24	6·7	4·3, 9·2
Nutritional status‡						
Underweight	6	3·4	0·0, 6·9	17	4·8	1·6, 7·9
Adequate	104	58·4	49·6, 67·3	212	59·6	53·2, 65·9
Overweight risk	42	23·6	16·5, 30·6	83	23·3	17·6, 29·0
Overweight	16	9·0	4·8, 13·2	31	8·7	5·6, 11·8
Obesity	10	5·6	0·7, 10·5	13	3·7	1·1, 6·2

*The total was lower for some variables due to missing information.
†Income range according to the Brazilian definition of minimum wage (240.26 USD equivalent to 937.00 BRL, in 2017).
‡Nutritional status according to BMI for age[26].

consumption among children aged from 12 to 24 months, higher percentage of energy came from carbohydrates in Group 2 (%: 70·0; CI 95 %: 64·9, 74·7) when compared with Group 1 (%: 58·3; CI 95 %: 54·3, 62·0) and higher energy from protein in Group 1 (%: 18·9; CI 95 %: 16·1, 22·2) compared with Group 2 (%: 9·8; CI 95 %: 7·1, 13·4). Group 1 presented a higher fibre content when compared with Group 2 both in children aged from 6 to 12 months and children aged from 12 to 24 months.

Table 4 presents the micronutrient intakes by NOVA food processing groups. In general, Group 1 was higher micronutrient contributors in both age groups. Group 2 presented higher intakes of iron, retinol, sodium and vitamin D among children aged from 6 to 12 months and children aged from 12 to 24 months. It is worth noting the higher Group 2 sodium intake in both age groups.

As presented in Table 5, the multiple linear regression showed that the mean daily carbohydrate, total sugar, total fat, saturated fat and protein and sodium intakes gradually increased with the quartiles of energy intake from Group 2 ($P < 0·001$), especially in the fourth quartile. In other words, the higher the energy intake from processed and UPF, the higher was the daily macronutrient and sodium intakes, with the presence of a dose–response association. However, the daily content of fibre decreased with the quartiles of energy intake from Group 2 ($P < 0·001$). Therefore, the higher the energy intake from processed and UPF, the lower was the daily content of fibre.

Table 2 Mean energy intake (kJ/d) and percentage of the total energy intake from complementary food by NOVA groups according to children's age. Federal District, Brazil

	Children between 6 and 12 months of age			Children between 12 and 24 months of age		
	n 178			*n* 360		
Food groups	kJ/d	% of total energy intake	CI 95 %	kJ/d	% of total energy intake	CI 95 %
Total	2393	100		4054	100	
Group 1: unprocessed, minimally processed foods and processed culinary ingredients	1669	69·6	65·8, 73·3	2644	65·2	62·1, 68·1
Fruits and natural juices	389	16·2	13·4, 19·5	552	13·6	11·6, 15·9
Rice and other cereals	280	11·8	9·3, 14·6	552	13·6	11·6, 15·9
Meats and eggs	255	10·7	8·3, 13·4	448	11·1	9·2, 13·1
Roots and other tubers	184	7·6	5·7, 10·1	113	2·7	1·9, 4·0
Beans and other pulses	180	7·5	5·6, 9·9	259	6·4	5·0, 8·1
Milk	92	6·8	5·0, 9·1	418	10·3	8·5, 12·3
Vegetables	92	3·8	2·5, 5·7	67	1·7	1·0, 2·6
Group 2: processed and ultra-processed foods	728	30·4	26·7, 34·3	1410	34·8	31·8, 37·8
Infant and child food products*	280	11·8	9·3, 14·6	297	7·4	5·8, 9·1
Milk-sweetened beverages†	130	5·3	3·8, 7·5	234	5·8	4·4, 7·4
Bakery products‡	84	3·5	2·2, 5·3	192	4·7	3·5, 6·2
Sweetened beverages§	75	3·1	2·0, 4·9	172	4·3	3·1, 5·6
Ultra-processed yogurts‖	75	3·1	2·0, 4·9	113	2·8	1·9, 4·0
Processed foods¶	46	1·9	1·0, 3·4	205	5·0	3·8, 6·6
Packaged snacks	33	1·4	0·7, 2·7	84	2·1	1·3, 3·1

*Flour for porridge, breakfast cereals and industrialised baby foods.
†Powdered and flavoured ready-to-eat dairy beverages.
‡Crackers, biscuits, cakes and other sweet bakery goods.
§Soft drinks and artificial fruit drinks.
‖Artificial and flavoured fruit yogurts.
¶Canned fish, cheese and breads.

Table 3 Percentage of the total energy intake of macronutrients and fibre content in complementary food by NOVA groups according to children's age. Federal District, Brazil

	Children between 6 and 12 months of age						Children between 12 and 24 months of age					
	n 178						*n* 360					
	Total		Group 1*		Group 2†		Total		Group 1*		Group 2†	
Dietary content	%	CI 95 %	%	CI 95 %	%	CI 95 %	%	CI 95 %	%	CI 95 %	%	CI 95 %
Macronutrients												
Carbohydrate	66·3	62·3, 70·0	63·7	58·8, 68·2	72·3	65·3, 78·5	62·4	59·3, 65·4	58·3	54·3, 62·0	70·0	64·9, 74·7
Total sugar	26·2	22·7, 29·9	25·2	21·1, 29·5	28·7	22·5, 35·8	28·3	25·5, 31·1	25·6	22·3, 29·1	33·4	28·7, 38·7
Total fat	18·2	15·2, 21·5	18·3	14·8, 22·3	17·7	12·8, 24·1	21·9	19·3, 24·5	22·8	19·6, 26·2	20·2	16·2, 24·7
Saturated fat	6	4·4, 6·4	6·4	4·5, 9·3	5·2	2·7, 9·5	7·6	6·0, 9·3	8·4	6·4, 10·8	6·0	3·8, 8·9
Protein	15·5	12·8, 18,7	18·0	14·6, 22·1	10·0	6·1, 15·1	15·7	13·6, 18·2	18·9	16·1, 22·2	9·8	7·1, 13·4
Fibre‡	1·6	1·5, 1·8	2·2	2·0, 2·3	0·7	0·6, 0·8	1·3	1·2, 1·3	1·5	1·4, 1·6	0·7	0·7, 0·8

*Unprocessed, minimally processed foods and processed culinary ingredients.
†Processed food and ultra-processed foods.
‡Results presented in grams per 418·4 kilojoules (g/418·4 kJ/d).

Furthermore, the statistical model explains more than 25 % of the included nutrients' daily intake variance, reaching at 43 % of the carbohydrates' daily content variance.

Discussion

Our study found that children are being exposed to UPF very early in life and that the share of UPF is high, affecting the diet's nutritional quality. UPF contributed to increased consumption of energy and carbohydrates and provided small amounts of fibre, protein and most micronutrients, similar to the results of other studies[14,33].

Additionally, we found that children between 6 and 12 months and children between 12 and 24 months of age consumed, on average, 2393 kJ/d and 4054 kJ/d from complementary feeding, respectively. The daily energy requirements, that is the recommended amount of daily

Table 4 Mean dietary intake of micronutrients and Na from complementary food by NOVA groups according to children's age. Federal District, Brazil

	Children between 6 and 12 months of age						Children between 12 and 24 months of age					
	n 178						*n* 360					
	Total		Group 1*		Group 2†		Total		Group 1*		Group 2†	
Micronutrients	Mean	CI 95 %	Mean	CI 95 %	Mean	CI 95 %	Mean	CI 95 %	Mean	CI 95 %	Mean	CI 95 %
Calcium (mg)	340·4	255·9, 424·9	158·7	115·9, 201·4	181·7	129·9, 233·5	614·6	560·5, 668·7	297·7	258·4, 337·1	316·9	249·5, 384·3
Copper (mg)	0·5	0·4, 0·6	0·4	0·4, 0·5	0·1	0·1, 0·2	0·8	0·7, 0·8	0·5	0·5, 0·6	0·2	0·2, 0·3
Folate (mcg)	127·1	108·7, 145·5	91·4	77·7, 105·2	35·6	26·3, 45·1	201·6	192·8, 210·3	131·5	121·5, 141·4	70·1	60·5, 79·7
Iron (mg)	9·5	8·3, 10·8	3·2	2·8, 3·6	6·0	4·0, 8·1	14·1	12·9, 15·3	4·7	4·3, 5·1	8·3	6·7, 9·8
Magnesium (mg)	101·2	88·5, 113·9	85·8	75·1, 96·5	15·4	11·5, 19·2	147·4	140·0, 154·8	118·3	108·6, 128·0	29·1	24·9, 33·4
Manganese (mg)	1·0	0·9, 1·1	0·8	0·7, 0·9	0·03	0·01, 0·05	1·5	1·4, 1·5	1·1	1·0, 1·1	0·2	0·1, 0·2
Phosphorus (mg)	363·3	298·2, 428·4	261·1	214·4, 307·7	102·2	76·9, 127·6	616·4	582·5, 650·3	429·1	388·8, 469·4	187·3	156·6, 218·0
Potassium (mg)	1222·7	1069·9, 1375·6	1060·4	938·2, 1182·5	162·4	118·9, 205·8	1708·1	1617·9, 1798·2	1409·7	1292·3, 1527·1	298·3	232·1, 364·6
Selenium (mcg)	26·6	22·2, 31·0	18·4	15·0, 21·9	8·1	6·1, 10·2	50·2	47·4, 52·9	32·9	30·4, 35·5	17·3	15·1, 19·4
Sodium (mg)	597·0	494·0, 699·9	478·2	397·0, 559·4	118·7	83·8, 153·7	1097·1	1024·6, 1169·7	811·6	732·0, 891·2	285·6	253·7, 317·3
Zinc (mg)	5·4	4·1, 6·6	2·5	2·1, 2·9	2·8	1·8, 3·9	8·0	7·5, 8·5	4·2	3·9, 4·6	3·8	3·1, 4·4
Retinol (mcg)	253·7	179·2, 328·2	32·5	18·8, 46·1	221·2	156·3, 286·1	380·0	327·9, 432·1	81·7	68·3, 95·2	298·3	245·9, 350·7
Niacin (mg)	7·7	6·4, 9·0	5·0	4·0, 5·9	2·7	1·9, 3·5	11·8	11·0, 12·6	7·2	6·6, 7·8	4·6	3·8, 5·4
Riboflavin (mg)	0·04	0·01, 0·06	0·3	0·3, 0·4	0·2	0·1, 0·2	0·2	0·1, 0·2	0·6	0·5, 0·7	0·4	0·3, 0·4
Thiamin (mg)	0·7	0·5, 0·8	0·3	0·3, 0·4	0·3	0·2, 0·4	1·0	0·9, 1·0	0·5	0·4, 0·5	0·5	0·4, 0·6
Vitamin B_{12} (mcg)	1·1	0·7, 1·4	0·7	0·5, 0·9	0·4	0·2, 0·5	2·1	1·9, 2·3	1·6	1·4, 1·8	0·5	0·4, 0·6
Vitamin B_6 (mg)	0·9	0·7, 1·0	0·7	0·6, 0·8	0·2	0·1, 0·3	1·1	1·1, 1·2	0·9	0·8, 0·9	0·3	0·2, 0·3
Vitamin C (mg)	79·9	62·1, 97·8	55·1	39·2, 70·9	24·9	17·1, 32·7	118·0	103·6, 132·4	75·4	60·6, 90·2	42·6	30·1, 55·1
Vitamin D (mcg)	3·9	2·7, 5·1	0·9	0·5, 1·35	3·0	2·1, 3·9	6·7	5·8, 7·6	2·3	1·9, 2·7	4·4	3·4, 5·3
Vitamin E (mg)	3·4	2·7, 4·0	1·6	1·4, 1·8	1·7	1·2, 2·3	4·7	4·1, 5·2	1·9	1·7, 2·1	2·8	2·1, 3·4
Vitamin K (mcg)	27·8	16·9, 38·6	23·5	12·8, 34·2	4·3	2·7, 5·8	41·8	32·5, 51·2	33·1	24·6, 41·6	8·7	6·6, 10·8

*Unprocessed, minimally processed foods and processed culinary ingredients.
†Processed food and ultra-processed foods.

Table 5 Multiple linear regression between quartiles of energy from processed and ultra-processed foods and daily energy intake of carbohydrate, total sugar, total fat, saturated fat, protein, fibre and Na. Federal District, Brazil

	Quartiles of energy intake from processed and ultra-processed foods (kJ)*					
Nutrient	First quartile (< 276 kJ)	Second quartile (276–790 kJ)	Third quartile (794–1539 kJ)	Fourth quartile (> 1543 kJ)	*P* value for trend†	R^2
Macronutrients						
Daily energy intake of Carbohydrate (kJ)						
B	Reference	444·8	947·4	2212·3	< 0·001	0·43
CI 95 %	Reference	192·4, 697·2	690·9, 1203·8	1951·2, 2473·5		
Daily energy intake of total sugar (kJ)						
B	Reference	197·4	427·0	1130·8	< 0·001	0·30
CI 95 %	Reference	17·0, 377·9	243·6, 610·3	944·1, 1317·6		
Daily energy intake of total fat (kJ)						
B	Reference	183·0	421·2	748·3	< 0·001	0·38
CI 95 %	Reference	76·1, 289·9	312·6, 529·8	637·7, 858·9		
Daily energy intake of saturated fat (kJ)						
B	Reference	71·3	162·6	243·7	< 0·001	0·26
CI 95 %	Reference	22·2, 120·4	112·7, 212·5	192·9, 294·5		
Daily energy intake of protein (kJ)						
B	Reference	139·4	238·5	363·6	< 0·001	0·26
CI 95 %	Reference	67·5, 211·3	165·5, 311·6	289·2, 438·0		
Daily energy intake of fibre (g/418·4 kJ)						
B	Reference	–0·7	–0·9	–1·0	< 0·001	0·32
CI 95 %	Reference	–0·8, –0·5	–1·0, –0·7	–1·2, –0·8		
Micronutrient						
Daily intake of sodium (mg)						
B	Reference	210·8	398·8	606·3	< 0·001	0·28
CI 95 %	Reference	84·9, 336·6	271·3, 526·3	476·2, 736·5		

*Multiple linear regression adjusted for household food insecurity, children's nutritional status according to BMI for age and children's age.
†*P* value for trend obtained by multiple linear regression using quartiles of energy intake from processed and ultra-processed foods as continuous variable.

energy intake, from complementary feeding for infants are approximately 836 kJ/d at 6–8 months, 1255 kJ/d at 9–11 months and 2301 kJ/d at 12–23 months of age, for developing countries[34]. Our results exceed the recommended/estimated amount of daily energy from complementary foods for infants which is associated with potential overweight and obesity in childhood.

In the present study, about 30 and 34 % of the energy intake of children aged between 6 and 12 months and children aged between 12 and 24 months came from processed and UPF, respectively. Batalha *et al.* (2017) found that processed and UPF consumption reached 25·8 % of daily energy among children from 13 to 35 months of age in the north-east of Brazil[11]. Karnopp *et al.* (2017) found that processed and UPF contributed about 20 % of daily energy intake among children aged under 24 months in a southern region of Brazil[21]. Among Argentinian infants, the consumption of processed and UPF reached higher percentages than in Brazil (36 %)[35]. Thus, our findings are more alarming when compared with such studies, considering that a higher UPF consumption is related to the establishment of unhealthy dietary patterns and contributes to overweight and obesity development[1,14,15].

Concerning the type of UPF that mainly contributes to the daily energy intake, our results also corroborate other studies. Batalha *et al.* (2017) and Dallazen *et al.* (2018) present a high contribution of cookies, pastries and cakes, sugar-sweetened beverages, and, especially infant and child food products and milk-sweetened beverages, often offered to the child as a breast milk substitute or as a supposed healthy food option[11,36].

In our study, as recommended by the Brazilian dietary guidelines[32,37], unprocessed, minimally processed foods and processed culinary ingredients had a greater contribution to the energy intake of children. Although processed and UPF represented a smaller contribution to the total energy intake, it accounted for more than a third of total energy consumed by children under 2 years old. Compared with the group of unprocessed, minimally processed foods and processed culinary ingredients, processed and UPF were higher carbohydrate and lower fibre and protein contributors. Processed and UPF were also lower contributors to micronutrients, such as folate, phosphorus, potassium and niacin, similar to the observations in previous studies[15,38–40]. We found that average intake of iron, retinol and vitamin D was higher in Group 2. However, many foods with voluntary fortification of vitamins and minerals do not offer a nutritional equivalence compared with unprocessed and minimally processed foods, and micronutrient natural sources. In addition, the UPF consumption is related to the decline of unprocessed and minimally processed foods consumption, increasing unfavourable outcomes for health[41]. Thus, we should not consider UPF as a micronutrient source or recommend their consumption, especially in early life and regarding their overall nutritional profile. Still regarding the micronutrient intake, we highlight the high overall sodium intake. Although the present study is unable to assess inadequate micronutrient intake, high sodium intake should be considered, as it is higher than the recommended intake and can be associated with negative long-term health outcomes[42].

We found that an increase in energy intake from processed and UPF raises the daily energy intake from carbohydrate, total sugar, total fat, saturated fat, protein and the daily intake of sodium and reduces the daily fibre intake. Due to the increase in energy intake, sugars, saturated fat and sodium and low contribution to micronutrient intake, several studies show that UPF are associated with unhealthy dietary patterns and contribute to higher overweight and obesity prevalence[14,15,39]. Pan *et al.* (2014) presented that children who consumed sugar-sweetened beverage in the first 6 months of life had 92 % more chance to become obese in childhood[43]. Rauber *et al.* (2014) showed association between UPF consumption and changes of lipid profiles with higher levels of cholesterol in Brazilian children[44]. In addition, UPF increase the consumption of sugar, not recommended for children under 2 years old. There is a mounting evidence about the harmful effects of excessive free sugar consumption, related to obesity, diabetes, dyslipidemia and other non-communicable diseases as well as dental caries[45]. Furthermore, an adequate protein and fibre intake is necessary for a healthy growth, appetite control and lower risk of obesity, and an adequate consumption of vitamins and minerals is essential for child growth and development, including for cognitive function, protection against infectious diseases and deficiencies[46,47]. The lower percentage contribution of fat from UPF can be explained by the fact that meat and milk, usually with high saturated fat content, were classified as Group 1[48].

As we evidenced in Brazil[11,21,49,50] and worldwide[39,40,51,52], UPF has been increasingly introduced earlier in the complementary feeding of children under 2 years old. This scenario is worrying since the early consumption of foods with high energy value is related to a higher energy intake and higher odds of rapid weight gain and overweight[53–55]. There is a consistent association between rapid weight gain during infancy and later childhood obesity[1,6,56]. Furthermore, UPF are often highly palatable, have a lower capacity to induce satiety and can cause overconsumption[14,57]. It becomes even more concerning as children have an innate preference for sweet taste and more palatable foods, and the exposure of unhealthy foods may magnify their preference for these products[58,59]. Considering the first 1000 d as a critical period for childhood obesity prevention, the central role that early feeding practices play in eating habits and food preferences' establishment and knowing the inappropriate nutritional profile of UPF, their consumption should be avoided in the first 2 years of life and consumed with restriction throughout life[10,32,37,60]. An early introduction of UPF may have consequences for child health and be a major contributor to childhood obesity growth and chronic diseases in adulthood[14,44]

Similar to other studies, we found that the consumption of UPF is related to the child's age, being higher among children over 12 months of age[11,20]. This result can be explained by the greater influence of the environment on older children that can promote unhealthy choices[50]. The high consumption of UPF also can be associated with low maternal education and family income. It can be related to caregiver's food patterns and their lack of knowledge on the harmful effects of UPF consumption[11,20,36]. These issues are magnified due to the intensive advertising of UPF targeted at children and caregivers as a persuasive strategy linking the consumption of low nutritional value foods to the child's well-being and health[61]. It is important to highlight that in early childhood, the family represents the main social influence and the family feeding style can have a meaningful impact on child's food preferences and obesity risk. Children have a strong observational learning capacity, which refers to the ability to observe, process and imitate what their caregivers do, including eating practice. Thus, as parental feeding behaviour is a key factor in food preferences among infants, parental healthy eating practices is necessary for developing healthy eating habits beginning in childhood[1].

Despite government's efforts and investments in public policies aimed to support actions of food and nutrition education and thus to promote healthy food choices, especially in Primary Health Care, its implementation is insufficient and challenging. It is necessary to improve strategies to promote healthy eating habits by health professionals to caregivers. Several studies present that training professionals for maternal counselling on healthy eating is effective to reduce the consumption of non-recommended foods and to improve dietary patterns among infants[62–64]. In addition, broader actions are needed by government to ensure that caregivers are able to make conscious and healthier food choices, as well as a health-promoting environment for children.

Although our study contributes to the evidence strengthening the importance of evaluating feeding practices by level of food processing, our results need to be interpreted in light of some limitations. First, we have not evaluated usual consumption since we used a single 24-h recall and it does not reflect the eating habits of children and may underestimate individual food consumption. However, we did not aim to assess nutrient intake inadequacy, and the population mean from a single 24-h recall is sufficient to provide a dietary assessment of the children and to evaluate the association between processed and UPF consumption and dietary nutrient intake. Still related to food consumption evaluation, although it is unlikely to affect the association between the consumption of processed and UFP and nutrient intake, we highlight the possibility of underreporting bias for UPF consumption due to the aspects of social desirability. Second, we also

Public Health Nutrition

highlight the residual confounding as a limitation. We might not have collected or included variables in the statistical model that can play an important role in the association between the consumption of UPF and the nutrient intake. Finally, regarding the sample, we included only children treated in PHU. Nevertheless, in Federal District, the population attended in Primary Health Care of SUS corresponds to 61·26 % of the local population[65].

Conclusions

We found an early and high consumption of UPF among children under 2 years old. We also found that processed and UPF consumption is associated with a poor dietary nutritional quality, since they contributed to increased intake of energy and sugar, and low consumption of fibre, protein and some micronutrients. Our results are concerning especially due to the establishment of food preferences in early life. The food practices in childhood can predict the nutritional and health status throughout life, and the first 2 years of life represent a crucial window of time for the adequate growth and development, and for prevention of obesity and chronic diseases[1].

Considering our findings, the recommendations presented in the dietary guidelines for Brazilian children under 2 years of age of not offering UPF at this stage of life and the health repercussions of UFP consumption, it is necessary to promote healthy food consumption among children and caregivers as well as an environment to foster healthy behaviour. Children need healthy feeding practices so they can accept healthy foods and establish long-term healthy dietary patterns. It is crucial to have trained professionals to guide parents and caregivers on adequate food introduction and complementary feeding and to ensure protective measures and access to healthy foods.

Acknowledgements

Acknowledgements: We thank the Brazilian National Council for Scientific and Technological Development (CNPq) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) for their financial support. THMC acknowledges a personal research grant from CNPq (grant number 308630/2017-3). We thank Edina Shisue Miazaki for help with statistical processing of the data. *Financial support:* This research was funded by the Brazilian National Council for Scientific and Technological Development (CNPq), grant number 446269/2014-0 and by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES), Finance Code 001. *Conflict of interest:* None. *Authorship:* Conceptualization, methodology, investigation, AMS and MBG; software, AMS and THMC; formal analysis, AMS and MBG; resources, supervision and funding acquisition, MBG and THMC; data curation, AMS; writing – original draft preparation, AMS; writing, review and editing, AMS, THMC, ADMS and MBG. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving research study participants were approved by the Research Ethics Committee of the University of Brasilia and the Research Ethics Committee of the Health Sciences Education and Research Foundation (FEPECS) of the Federal District (under no. 43228515.5.0000.0030). Written informed consent was obtained from all subjects.

Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S1368980020004759

References

1. Pérez-Escamilla R, Segura-Pérez S & Lott M (2017) Feeding guidelines for infants and young toddlers: a responsive parenting approach. *Nutr Today* **52**, 223–231.
2. Hawkes C, Smith TG, Jewell J *et al.* (2015) Obesity 2 Smart food policies for obesity prevention. *Lancet* **6736**, 1–12.
3. Porter RM, Tindall A, Gaffka BJ *et al.* (2018) A review of modifiable risk factors for severe obesity in children ages 5 and under. *Child Obes* **14**, 468–476.
4. World Health Organization (WHO) (2016) *Good Maternal Nutrition: The Best Start in Life*. Geneva: WHO.
5. Blake-Lamb TL, Locks LM, Perkins ME *et al.* (2016) Interventions for childhood obesity in the first 1,000 days a systematic review. *Am J Prev Med* **50**, 780–789.
6. Pietrobelli A, Agosti M, Palmer C *et al.* (2017) Nutrition in the first 1000 days: ten practices to minimize obesity emerging from published science. *Int J Environ Res Public Health* **14**, 1491.
7. Mameli C, Mazzantini S & Zuccotti GV (2016) Nutrition in the first 1000 days: the origin of childhood obesity. *Int J Environ Res Public Health* **13**, 838.
8. Zobel EH, Hansen TW, Rossing P *et al.* (2016) Global changes in food supply and the obesity epidemic. *Curr Obes Rep* **5**, 449–455.
9. Lobstein T, Jackson-leach R, Moodie ML *et al.* (2015) Obesity 4 child and adolescent obesity: part of a bigger picture. *Lancet* **6736**, 1–11.
10. Monteiro CA, Cannon G, Levy RB *et al.* (2019) Ultra-processed foods: what they are and how to identify them. *Public Health Nutr* **22**(5), 1–6.
11. Batalha MA, França AK, Conceição SI *et al.* (2017) Processed and ultra-processed food consumption among children aged 13 to 35 months and associated factors. *Cad Saude Publica* **33**, 1–16.
12. Relvas GRB, dos S Buccini G & Venancio SI (2019) Ultra-processed food consumption among infants in primary health care in a city of the metropolitan region of Sao Paulo, Brazil. *J Pediatr* **95**, 584–592.
13. Aguayo-Patrón S & Calderón de la Barca A (2017) Old fashioned *v.* ultra-processed based current diets: possible implication in the increased susceptibility to type 1 diabetes and celiac disease in childhood. *Foods* **6**, 100.
14. Pan American Health Organization (PAHO) (2018) Ultra-processed food and drink products in Latin America: trends,

impact on obesity, policy implications. Brasília; available at: https://iris.paho.org/bitstream/handle/10665.2/34918/9789275718643-por.pdf?sequence=5&isAllowed=y (accessed November 2019).
15. da C Louzada ML, Ricardo CZ, Steele EM *et al.* (2018) The share of ultra-processed foods determines the overall nutritional quality of diets in Brazil. *Public Health Nutr* **21**, 94–102.
16. World Health Organization (WHO) (2016) *Report of the Commission on Ending Childhood Obesity*. Geneva: WHO.
17. Sahoo K, Sahoo B & Choudhury AK (2015) Childhood obesity: causes and consequences. *J Fam Med Prim Care* **4**, 187–192.
18. Williams EP, Mesidor M, Winters K *et al.* (2015) Overweight and obesity: prevalence, consequences, and causes of a growing public health problem. *Curr Obes Rep* **4**, 363–370.
19. Longo-Silva G, Silveira JAC, Menezes RCE *et al.* (2017) Age at introduction of ultra-processed food among preschool children attending day-care centers. *J Pediatr* **93**, 508–516.
20. Mais LA, Warkentin S, Vega JB *et al.* (2018) Sociodemographic, anthropometric and behavioural risk factors for ultra-processed food consumption in a sample of 2–9-year-olds in Brazil. *Public Health Nutr* **21**, 77–86.
21. Karnopp EVN, dos S Vaz J, Schafer AA *et al.* (2017) Food consumption of children younger than 6 years according to the degree of food processing. *J Pediatr* **93**, 70–78.
22. Lachat C, Hawwash D, Ocké MC *et al.* (2016) Strengthening the Reporting of Observational Studies in Epidemiology-Nutritional Epidemiology (STROBE-nut): an extension of the STROBE Statement. *PLoS Med* **13**(6), e1002036.
23. Ministry of Health of Brazil (2009) II research of breastfeeding predominance in Brazilian capitals and Federal District. Brasília; available at: http://bvsms.saude.gov.br/bvs/publicacoes/pesquisa_prevalencia_aleitamento_materno.pdf (accessed August 2019).
24. Brazilian Institute of Geography and Statistics (IBGE) (2014) National Household Survey. Rio de Janeiro; available at: https://biblioteca.ibge.gov.br/visualizacao/livros/liv91984.pdf (accessed August 2019).
25. Ministry of Health of Brazil (2011) Guidelines for collection and analysis of anthropometric data in health services: technical standard system of food and nutrition surveillance – SISVAN. Brasília; available at: https://bvsms.saude.gov.br/bvs/publicacoes/orientacoes_coleta_analise_dados_antropometricos.pdf (accessed August 2019).
26. World Health Organization (WHO) (2006) *WHO Child Growth Standards : Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development*. Geneva: WHO.
27. Rutishauser IH (2005) Dietary intake measurements. *Public Health Nutr* **8**, 1100–1107.
28. Conway J, Ingwersen L & Moshfegh A (2003) Effectiveness of the USDA 5-step Multiple-Pass Method to assess food intake in obese and non-obese women. *Am J Clin Nutr* **77**, 71–78.
29. Falcão-Gomes RC, Barbosa RC, Miguel RM *et al.* (2006) *Photographic Registration for Food Surveys with Preschoolers*. Brasília: Observatory of Food Security and Nutrition Policies (OPSAN), University of Brasília.
30. Brazilian Institute of Geography and Statistics (IBGE) (2014) National Household Survey: Table of Reference Measures for Food Consumed in Brazil. Rio de Janeiro; available at: https://biblioteca.ibge.gov.br/visualizacao/livros/liv50000.pdf (accessed April 2019).
31. Monteiro CA, Levy RB, Claro RM *et al.* (2010) A new classification of foods based on the extent and purpose of their processing. *Cad Saude Publica* **26**, 2039–2049.
32. Ministry of Health of Brazil (2019) *Dietary Guidelines for the Brazilian Children Under Two Years of Age*. Brasília: Ministry of Health.
33. Monteiro CA, Cannon G, Moubarac JC *et al.* (2018) The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr* **21**, 5–17.
34. Pan American Health Organization (PAHO) (2001) *Guiding Principles for Complementary Feeding of the Breastfed Child*; available at: https://iris.paho.org/handle/10665.2/752 (accessed September 2019).
35. Drake SB, Gilardon EA, Mangialavori G *et al.* (2018) Description of nutrient consumption based on the level of industrial food processing: national survey on nutrition and health of 2005. *Arch Argent Pediatr* **116**, 345–352.
36. Dallazen C, Silva SA, Gonçalves VSS *et al.* (2018) Introduction of inappropriate complementary feeding in the first of life and associated factors in children with low socioeconomic status. *Cad Saude Publica* **34**, 1–13.
37. Ministry of Health of Brazil (2014) *Dietary Guidelines for the Brazilian Population*. Brazil: Ministério da Saúde.
38. O'Halloran SA, Lacy KE, Woods J *et al.* (2018) The provision of ultra-processed foods and their contribution to sodium availability in Australian long day care centres. *Public Health Nutr* **21**, 134–141.
39. Cornwell B, Villamor E, Mora-Plazas M *et al.* (2018) Processed and ultra-processed foods are associated with lower-quality nutrient profiles in children from Colombia. *Public Health Nutr* **21**, 142–147.
40. Martínez Steele E, Popkin BM, Swinburn B *et al.* (2017) The share of ultra-processed foods and the overall nutritional quality of diets in the US: evidence from a nationally representative cross-sectional study. *Popul Health Metr* **15**, 1–11.
41. Cirino ACL, De Vargas Zanini R & Gigante DP (2014) Consumption of foods with voluntary fortification of micronutrients in southern Brazil: prevalence and associated factors. *Public Health Nutr* **17**, 1555–1564.
42. National Academies of Sciences, Engineering and M 2019 (2019) *Dietary Reference Intakes for Sodium and Potassium. Diet Ref Intakes Sodium Potassium*. Washington, DC: National Academies Press.
43. Pan AL, Li R, Park S *et al.* (2014) A longitudinal analysis of sugar-sweetened beverage intake in infancy and obesity at 6 years. *Pediatrics* **134**, 29–35.
44. Rauber F, Campagnolo PDB, Hoffman DJ *et al.* (2014) Nutrition, metabolism & cardiovascular diseases consumption of ultra-processed food products and its effects on children's lipid profiles: a longitudinal study. *Nutr Metab Cardiovasc Dis* 1–7.
45. World Health Organization (WHO) (2015) *Guideline: Sugars Intake for Adults and Children*. Geneva: WHO.
46. World Health Organization (WHO) (2002) *Protein and Amino Acid Requirements in Human Nutrition*. Geneva: WHO.
47. Food and Agriculture Organization of the United Nations (FAO) & World Health Organization (WHO) (1998) *Vitamin and Mineral Requirements in Human Nutrition Second Edition*. Bangkok: FAO, WHO.
48. Manso T, Gallardo B & Guerra-Rivas C (2016) Modifying milk and meat fat quality through feed changes. *Small Rumin Res* **142**, 31–37.
49. Bielemann RM, Santos LP, dos S Costa C *et al.* (2018) Early feeding practices and consumption of ultraprocessed foods at 6 y of age: findings from the 2004 Pelotas (Brazil) Birth Cohort Study. *Nutrition* **47**, 27–32.
50. Sparrenberger K, Roggia R, Dihl M *et al.* (2015) Ultra-processed food consumption in children from a Basic Health Unit &x0B1D;. *J Pediatr* **91**, 535–542.

51. Pries AM, Huffman SL, Adhikary I *et al.* (2016) High consumption of commercial food products among children less than 24 months of age and product promotion in Kathmandu Valley, Nepal. *Matern Child Nutr* **12**, 22–37.
52. Cediel G, Reyes M, Da Costa Louzada ML *et al.* (2018) Ultra-processed foods and added sugars in the Chilean diet (2010). *Public Health Nutr* **21**, 125–133.
53. Vos MB, Kaar JL, Welsh JA *et al.* (2017) Added sugars and cardiovascular disease risk in children. *Circulation* **135**, 1017–1034.
54. Healthy Eating Reserach: Building evidence to & Obesity prevent childhood (2013) *Recommendations for Healthier Beverages*. Minneapolis, MN: Healthy Eating Research.
55. Mennella JA & Trabulsi JC (2012) Complementary foods and flavor experiences: setting the foundation. *Ann Nutr Metab* **60**, 40–50.
56. Institute of Medicine (IOM) (2011) *Early Childhood Obesity Prevention Policies*. Washington, DC: The National Academies Press.
57. Gibney MJ, Forde G, Mullally D *et al.* (2017) Commentary ultra-processed foods in human health: a critical appraisal. *Am J Clin Nutr* **106**, 717–724.
58. Ventura AK & Mennella JA (2011) Innate and learned preferences for sweet taste during childhood. *Curr Opin Clin Nutr Metab Care* **14**, 379–384.
59. Mennella JA, Bobowski NK & Reed DR (2016) The development of sweet taste: from biology to hedonics. *Rev Endocr Metab Disord* **17**, 171–178.
60. Monteiro CA Cannon G, Lawrence M *et al.* (2019) *Ultra-Processed Foods, Diet Quality, and Health Using the NOVA Classification System*. Rome: FAO.
61. Boyland EJ & Whalen R (2015) Food advertising to children and its effects on diet: review of recent prevalence and impact data. *Pediatr Diabetes* **16**, 331–337.
62. Vazir S, Engle P, Balakrhisna N *et al.* (2014) Feeding education to caregivers found improved dietary intake, growth, and development among rural Indian toddlers. *Matern Child Nutr* **9**, 99–117.
63. Vitolo MR, Bortolini GA, Campagnolo PDB *et al.* (2012) Maternal dietary counseling reduces consumption of energy-dense foods among infants: a randomized controlled trial. *J Nutr Educ Behav* **44**, 140–147.
64. Vitolo MR, Louzada ML, Rauber F *et al.* (2014) The impact of health workers' training on breastfeeding and complementary feeding practices. *Cad. Saúde Pública* **30**, 1695–1707.
65. Ministry of Health of Brazil (2019) Primary health care coverage public reports. 2019; available at: https://egestorab.saude.gov.br/paginas/acessoPublico/relatorios/relHistoricoCoberturaAB (accessed March 2019).

Public Health Nutrition