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Early introduction of ultra-processed foods is associated with overweight and anaemia in socially vulnerable Brazilian children

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Abstract

This study aimed to evaluate the early introduction of ultra-processed foods (UPF) and identify its association with overweight and anaemia in Brazilian children living in a situation of social vulnerability. A population-based cross-sectional study was conducted in a Brazilian capital. Children aged 12-59 months were included. The presence of overweight and anaemia was evaluated, as well as the introduction of twelve different UPF in children's first year of life. Association analysis was performed using Poisson regression, with robust estimates of variances. A total of 561 children were studied; 85·5 % had consumed at least one UPF evaluated in the first year of life; 19·1 % were overweight and 52·0 % were anaemic. Adjusted multivariate analyses identified that the early introduction of soft drinks (Prevalence Ratio (PR) = 1·18, 95 % CI (1·02, 1·38)), packaged snacks (PR = 1·17, 95 % CI (1·05, 1·30)) and powdered soft drinks (PR = 1·36, 95 % CI (1·16, 1·60)) increased the likelihood of children being overweight, and the early introduction of chocolate drink (PR = 1·25, 95 % CI (1·02, 1·53)) increased the likelihood of them being anaemic, when comparing children who consumed these UPF before reaching 1 year of age with those who consumed these foods at 12 months of age or older. From the results found, one can see the existing relationship between the early introduction of UPF with overweight and anaemia, being necessary to intensify public health policies to combat malnutrition, focusing on the promotion of proper and healthy eating, especially during the phase of food introduction, focusing on the population living in socially vulnerable situations.

Keywords: **Early childhood: Complementary feeding: Infant nutrition**

The first 1000 d of the child's life, between birth and 2 years, represent a unique opportunity for building a healthy future[1]. In this context, food's fundamental role is ensuring growth and adequate child development and consolidating habits for a lifetime[1–3].

Thus, the importance of adequate and healthy complementary feeding is evident, and it is recommended that it begins at 6 months of life, prioritising the supply of fresh and minimally processed foods[4]. This situation is necessary to meet the child's nutritional needs and assist in developing motor, psychological and cognitive aspects and preventing diseases that may arise throughout life[4,5].

However, an increase in the introduction of ultra-processed foods (UPF) in the early years of the life of children has been observed, especially among the poorest, a situation that is related to the development of forms of malnutrition such as overweight, malnutrition and nutritional deficiencies[5,6].

Among the main factors contributing to malnutrition are environmental issues related to the greater availability of ultra-processed foods and ultra-processed drinks, which tend to be cheaper, especially in low- and middle-income countries, directly influencing the increase in their consumption[7]. This situation raises attention because exposure in the early years of life to malnutrition, overweight and nutritional deficiencies, such as anaemia, increases the risk of developing noncommunicable diseases later in life[8].

In addition, lower family income can also influence the development of outcomes related to malnutrition since poverty favours the acquisition of cheaper food, one of the main characteristics of most UPF, such as greater palatability, satiety capacity and durability[5,9,10]. Poverty is perceived as a strong determinant of health and well-being, as this condition affects the human right to healthy and adequate food, impacting the health of individuals, especially children[7,11].

Abbreviation: UPF, ultra-processed foods.

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Thus, realising the damages related to malnutrition in childhood, as well as its probable greater connection with lower income, which favours the increasingly early consumption of UPF, the objective of the present study was to evaluate the early introduction of UPF and identify its association with overweight and anaemia in Brazilian children under 5 years of age living in a situation of social vulnerability.

Methods

Study design and site

This is a cross-sectional, population-based study conducted between October 2020 and May 2021, which sought to assess the early introduction of UPF in the first year of life and the presence of excess weight and anaemia in children aged between 12 and 59 months, residents in the subnormal settlements of the Municipality of Maceió, capital of the State of Alagoas, Northeastern Brazil.

According to the Brazilian Institute of Geography and Statistics[12], subnormal settlements are a form of irregular occupation of third-party land (public or private) for housing purposes in urban areas and, in general, characterised by an irregular urban pattern, lack of essential public services and location in areas restricted to occupation.

Ethical aspects

This study is part of a larger research that was approved by the Research Ethics Committee of the Federal University of Alagoas (CAAE: 57829016.9.1001.5013; opinion number: 4 836 765). All procedures involving humans/patients were conducted in accordance with the guidelines of the Declaration of Helsinki. Written informed consent was obtained from all subjects/patients.

Size and selection of sample

Taking into account the estimate that there are 11 430 children under 5 years living in the ninety-four subnormal settlements in Maceió, with the outcome estimated excess weight in 14·9 % of children under 59 months in the state of Alagoas[13] adopting a margin of error of 3 %, and a 95 % confidence interval, it would be necessary to recruit at least 517 children. The sample calculation was performed using the StatCalc v. 7·2·5·0 program.

We recruited 599 children from forty substandard settlements, chosen randomly according to the criteria shown in Fig. 1. Only one child per household was collected. Children who did not have data on food introduction or anthropometric assessment were excluded from the sample. Thus, the final sample consisted of 561 children.

The sampling design was probabilistic and of the conglomerate type in three stages: (1) subnormal settlements, which were selected in a simple random proportional way in each of the seven administrative regions of Maceió that were studied; (2) census sectors, one of each subnormal settlement was selected by simple random draw and (3) streets, in each census sector evaluated a street was drawn for data collection from the children.

All households on the selected street were visited, and whenever necessary, the surrounding ones until the sample corresponding to the location was completed. We included all households with at least one child aged between 12 and 59 months and a mother aged between 20 and 44 years, the criterion adopted to follow the proposal in delineating the larger study in which this work is inserted.

Children whose mothers had a disability that could make it impossible to carry out the interview or understand the questionnaires or whose mothers had any disability that could compromise their food consumption and/or nutritional status were not included. In households with more than one child in the age group of the study, the youngest was chosen. When there were twins, before the beginning of the interview, a draw was made to define the child who would be included.

Data collection

Socio-demographic and health variables. Data were collected considering the following aspects: sex of children (male; female); the age of children (months) (≤ 23 months; ≥ 24 months); breast-feeding (if the child was breastfed at some point in life) (yes; no); maternal age (years) (≤ 30 years; ≥ 31 years); maternal marital status (with a partner; without a partner); maternal skin colour (black/brown; others); maternal parity (primiparous; multiparous); maternal schooling years (≤ 8 years; ≥ 9 years); maternal occupation (unpaid; paid); the number of household residents (≤ 4 people; ≥ 5 people); the beneficiary of the Brazilian Government's Income Transfer Program (yes; no); monthly family income per capita, classifying it according to the cut-off points for poverty (poverty – USA $ < 95·59; and out of poverty USA$ ≥ 95·59. Values converted from reais to USA dollars considering the dollar price on 31 May 2021 – R$ 5·22)[14].

Evaluation of nutritional status

Anthropometry. It was performed by measuring the children's weight and height using a digital scale (Avanutri® – Três Rios, Rio de Janeiro, Brazil) and portable infantometer/stadiometer (Avanutri® – Três Rios, Rio de Janeiro, Brazil), following the protocol proposed by the Brazilian Ministry of Health[15]. Subsequently, the data were entered into the software Anthro version 3·2·2 to obtain the *Z* score values of the anthropometric indicator BMI for Age (BMI/A). The classification took into account what was proposed by the WHO[16]. Children with BMI/A > +2 *Z* score were considered overweight.

Hb dosage. A digital puncture collected blood to measure Hb concentration using a portable HemoCue – *β* Hemoglobin Photometer® hemoglobinometer, whose analysis is based on photometric reading using *β* Hb microcuvettes. The mothers of 354 children agreed to have their children undergo this evaluation. Children with Hb concentrations below 11 g/dl were considered anaemic[17].

Premature introduction of ultra-processed foods. The introduction of UPF in the child's first year of life was evaluated. This evaluation considered the following UPF: chocolate milk, candies/lollipops, cookies/crackers, cream-filled cookies,

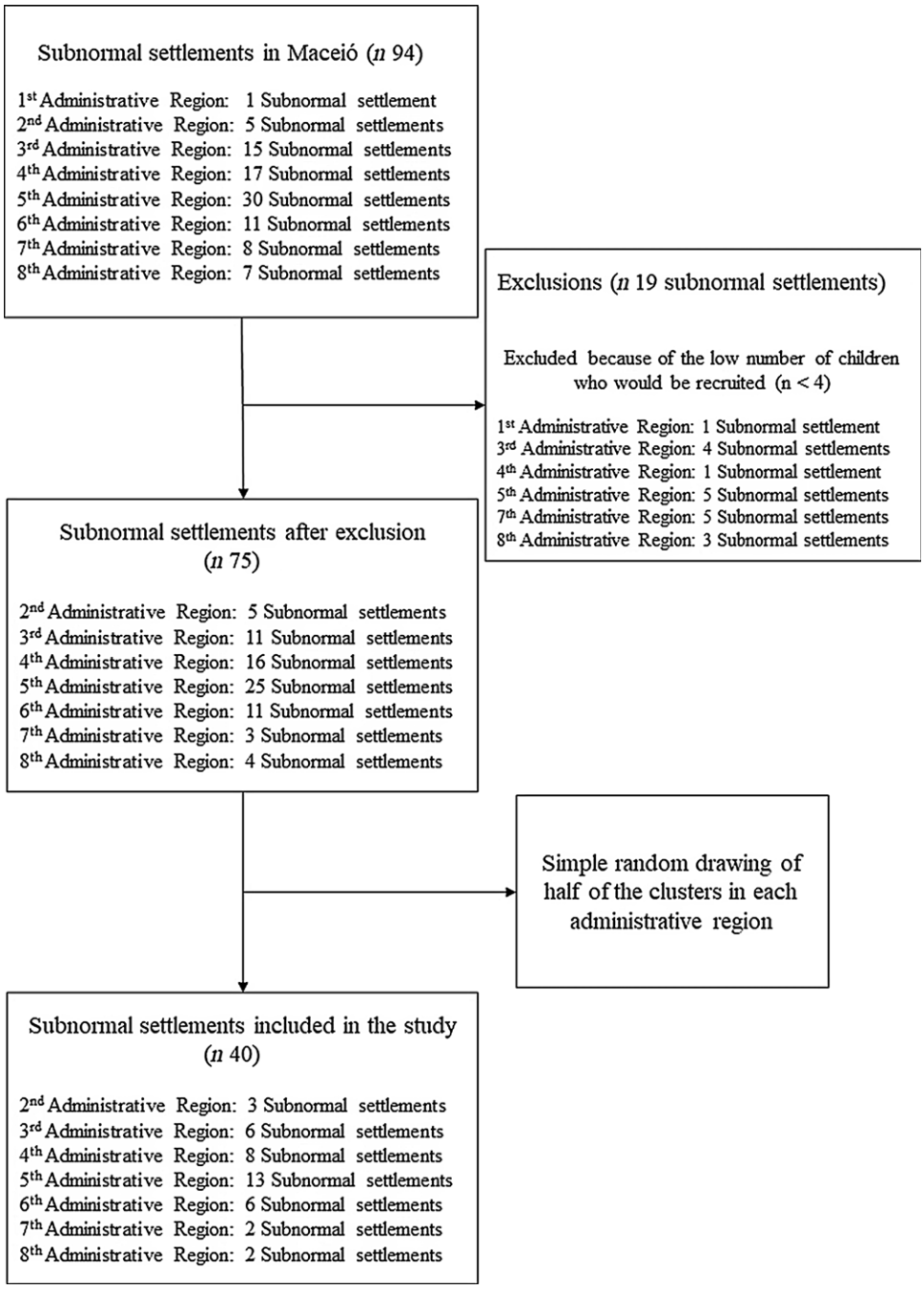

Figure 1. Flow chart of the sample selection of the subnormal agglomerations included in the study.

chocolate, jelly, creamy yogurt, soft drinks, packaged salty snacks, dried soup mix, ice cream and powder refreshment mixture.

The selection of these foods was considered the proposal developed by Dallazen *et al.*[9], based on the recommendations proposed in the Food Guide for Brazilian children under 2 years[18]. At the time of the interview with the child's mother, it was questioned whether each of these foods was introduced in the first year of the child's life and whether she continued consuming that food after the introduction. For UPF consumption over time, the introduction was only considered when the child continued consumption after experiencing them for the first time.

The age at which food was introduced into the child's diet was stratified in two different ways: (1) for descriptive analysis – taking into account only the child's first year of life: < 4 months, 4 to < 6 months, 6 to < 8 months and 8 to < 12 months and (2) for association analysis – taking into account the introduction in the first year of life, or after 1 year: < 12 months and 12 months. For the descriptive analysis, the 4-month cut-off point adopted in this study took into account that the interruption of exclusive breast-feeding

usually occurs early, before 6 months (https://aplicacoes.mds.gov.br/sagi/RIv3/geral/index.php).

Data analysis. Data analysis was performed using the statistical software R (R Foundation for Statistical Computing). For descriptive statistics, absolute (%) and relative (mean and 95 % CI) frequencies were calculated (95 % CI). The variance-inflation factor performed the multicollinearity test, adopting < 5 as the perceived absence of multicollinearity as the cut-off point. Being overweight (BMI/A > +2 *Z* score) and anaemia (Hb < 11 g/dl) were considered outcome variables. The variable exposure was considered the introduction of each UPF that was evaluated.

A bivariate analysis was performed with each evaluated food to form the multivariate model. All those with a *P* value < 0·20 were maintained. Bivariate analyses were also performed between the outcomes (overweight and anaemia) and socio-economic and health variables. All those with a *P* value < 0·20 were used as adjustment measures for the multivariate model. After carrying out this evaluation (Table 1), the adjustment variables selected for the overweight outcome were the child's age, breast-feeding, the mother's race/colour and the fact that she was a beneficiary of a Brazilian government cash transfer program. The confounding variables for the anaemia outcome were the child's age, maternal years of schooling, maternal parity, the fact that she was a beneficiary of a Brazilian government cash transfer program and income. Association analysis was performed using Poisson regression, with robust estimates of variances. A significance level of 5 % was adopted.

Results

The characteristics of the sample are shown in Table 1. 55·6 % of the children were male, 76·5 % were 24 months or older and 93·2 % had been breastfed at some time in their lives. It was also identified that 71·1 % of the mothers were under 30 years of age, 54·0 % had 8 or more years of education and 75·6 % were not employed. It was also seen that 91·3 % of the children lived in poverty. Regarding the nutritional status of the children, 19·1 % were overweight, and 52 % were anaemic (Table 2).

In the evaluation of early food introduction, it was found that 85·5 % of the children had consumed at least one of the UPF investigated in the first year of life. Among the UPF, the three most introduced in the children's diet still in the first year of life were creamy yogurt (406, 72·4 %), cookies/crackers (363, 64·7 %) and cream-filled cookies (211, 37·6 %) (Table 3).

A multivariate association analysis was carried out between the presence of excess weight and early consumption of UPF, adjusted for the child's age, breast-feeding, the mother's race/colour and the fact that she was a beneficiary of a Brazilian government cash transfer program. Through this evaluation, it was possible to identify a significant association between the consumption of soft drinks (PR = 1·18, 95 % CI (1·02, 1·38)), packet snacks (PR = 1·17, 95 % CI (1·05, 1·30)) and powdered soft drinks (PR = 1·36, 95 % CI (1·16, 1·60)) with being overweight (Table 4), when comparing children who consumed these UPF before reaching 1 year of age with those who consumed these foods at 12 months of age or older.

A multivariate association analysis was also carried out between the presence of anaemia and early consumption of UPF, adjusted for the child's age, maternal years of schooling, maternal parity and the fact that she was a beneficiary of a Brazilian government cash transfer program and income. This evaluation revealed a significant association between chocolate drink consumption (PR = 1·16, 95 % CI (1·01, 1·35)) and the presence of anaemia (Table 5) when comparing children who consumed this UPF before reaching 1 year of age with those who consumed this food at 12 months of age or older.

Discussion

The findings of this study show the high prevalence of the introduction of UPF in the first year of life of children living *in situ*ations of social vulnerability. At the same time, there is also a high prevalence of overweight and anaemia. It can also be seen that the early introduction of soft drinks, packet snacks and powdered soft drinks increases the likelihood of children being overweight by up to 18 %, 17 % and 36 %, respectively. The early introduction of chocolate drinks increased the likelihood of children being anaemic by up to 16 %.

The prevalence of overweight and anaemia identified in this study is higher than that found in another study in Brazil[19,20]. This situation demonstrates an even more marked worsening of the nutritional status of poorer children, highlighting that the nutritional transition observed worldwide mainly affects the lower-income population.

This scenario may be a consequence of the change in food systems, with an increase in the amount and types of UPF made available to the population, which is even more aggravated in lower-income regions[21]. Such a panorama can trigger changes in dietary patterns, a situation that directly affects the population's nutritional status, especially among children[22].

This scenario is a cause for concern because, as identified in this study, other studies in Brazil have also shown a high consumption of UPF in the first months of life[9,20]. It is also known that children have an innate preference for sweet and salty flavours, so when they are exposed at an early age to foods that naturally have this flavour or that contain ingredients that have been added and provide or intensify them, it will lead to an increasing preference for products that contain these characteristics[23]. Such a panorama denotes attention, as UPF are mainly rich in sugar, fat and Na, nutrients that increase the palatability of food and contribute to changes in eating behaviour[24,25], a situation resulting from their ability to produce changes in reward neurocircuits, leading to their excessive consumption[26,27].

The high introduction of some UPF, such as creamy yogurt, cookies/crackers and cream-filled cookies in the first year of life, as identified in this study, is probably related to the socio-economic characteristics of this population[9], who perceive these foods as a good alternative for children, especially because of their commercial appeal. It is noticeable that the supply of these foods in the first year of a child's life has increased, especially in low- and middle-income countries[28], as is the case in Brazil, a situation that raises concerns due to the negative impacts of this dietary practice, such as insufficient intake of

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Table 1. Bivariable analysis to estimate the prevalence ratio and 95 % CI by means of Poisson regression, with robust variance estimates, between overweight and anaemia in socially vulnerable Brazilian children aged 12–59 months and socio-demographic and health characteristics. 2020/2021

	Overweight*					Anaemia†				
	Total (*n* 561)					Total (*n* 354)				
Variables	*n*	%	PR	95 % CI	*P* value	*n*	%	PR	95 % CI	*P* value
Child										
Gender										
Male	312	55·6	1·00			205	57·9	1·00		
Female	249	44·4	0·98	0·81, 1·20	0·913	149	42·1	1·03	0·90, 1·13	0·582
Age										
≤ 23 months	132	23·5				80	22·6	1·00		
≥ 24 months	429	76·5	0·81	0·66, 1·00	0·060	274	77·4	1·18	1·02, 1·35	0·020
Breast-feeding										
No	38	6·8	1·00			25	7·1	1·00		
Yes	523	93·2	0·75	0·55, 1·01	0·064	329	92·9	0·87	0·70, 1·07	0·202
Maternal										
Age										
≤ 30 years	399	71·1	1·00			246	69·5	1·00		
≥ 31 years	162	28·9	1·06	0·86, 1·31	0·533	108	30·5	0·99	0·86, 1·13	0·899
Race/colour										
Others	104	18·5	1·00			72	203	1·00		
Black/brown	457	81·5	1·27	0·96, 1·69	0·091	282	79·7	1·01	0·87, 1·17	0·872
Years of schooling										
≤ 8 years	303	54·0	1·00			183	51·7	1·00		
≥ 9 years	258	46·0	1·00	0·83, 1·22	0·925	171	48·3	1·09	0·97, 1·22	0·140
Occupation										
Unpaid	424	75·6	1·00			249	70·3	1·00		
Paid	137	24·4	0·93	0·73, 1·17	0·540	105	29·7	0·94	0·83, 1·07	0·419
Marital status										
No partner	228	40·6	1·00			166	46·9	1·00		
With partner	333	59·4	1·06	0·87, 1·30	0·519	188	53·1	0·99	0·89, 1·10	0·952
Parity										
Primiparous	163	29·1	1,00			100	28·2	1·00		
Multíparous	398	70·9	0·89	0·72, 1·09	0·263	254	71·8	1·09	0·95, 1·25	0·199
Household										
Number of residents of the household										
≤ 4 people	350	62·4	1·00			237	66·9	1·00		
≥ 5 people	211	37·6	1·04	0·85, 1·27	0·660	117	33·1	0·96	0·84, 1·10	0·564
The beneficiary of the income transfer program										
No	175	31·2	1·00			105	29·7	1·00		
Yes	386	68·8	0·80	0·65, 0·97	0·026	249	70·3	0·89	0·79, 1·02	0·099
The monthly family income per capita‡										
USA$ < 95·59	512	91·3	1·00			318	89·8	1·00		
USA$ ≥ 95·59	49	8·7	1·06	0·93, 1·20	0·352	36	10·2	1·14	0·93, 1·40	0·179

PR = prevalence ratio.
* Classified according to the *Z*-score of the BMI-for-age index.
† Classified according to Hb concentration.
‡ Variable classified according to World Bank proposal to determine poverty status (USA$ < 95·59); out of poverty status (USA$ ≥ 95·59). Values converted from reais to USA dollars considering the 31 May 2021 dollar rate – R$ 5·22.

essential nutrients for this stage of life, such as Fe, compromising the child's growth and development[29].

It is noticed that UPF are gaining more and more space, especially in small markets close to households, increasing their access, especially when compared with healthier and more nutritious foods[30]. In addition, hyperpalability, the predominance of packaging with large portions, and persuasive marketing can promote excessive consumption[27]. These factors make them increasingly accessible to families. They are incorporated into their eating habits, especially in low-income families, increasing the availability of UPF in households[5,9,31,32], leading to its greater consumption in the first years of life[6,33,34].

Our findings show that the early introduction of soft drinks and powder refreshment mixture, foods with a high added sugar content and packaged salty snacks with a high fat and Na content increased the likelihood of children being overweight. The nutritional characteristics[4] of these UPF directly contribute to increased body weight[35,36], especially in the low-income population[36], as well as contributing to the adoption of an inadequate eating pattern, which can be perpetuated the rest of the child's life, due to the difficulty of stopping consuming them[24–27]. The Brazilian infant feeding guidelines recommend that especially at the beginning of food introduction, sugar or products containing this nutrient should be avoided to prevent unnecessary weight gain at this stage of life due to the higher risk of developing chronic diseases related to obesity in adulthood [4].

It was also possible to identify that early consumption of chocolate drinks was related to a higher incidence of anaemia. This UPF is rich in added sugar[4], a condition that aids in the development of anaemia, as it can influence changes in the

Table 2. Nutritional status of Brazilian children in social vulnerability aged between 12 and 59 months participating in the study, 2020/2021

Variables	*n*	%
Anthropometric (*n* 561)*		
Thinness	18	3·2
Eutrophy	436	77·7
Overweight	62	11·1
Obesity	45	8·0
Anaemia (*n* 354)†		
No	170	48·0
Yes	184	52·0

* Classified according to the *Z*-score of the BMI-for-age index.
† Classified according to Hb concentration.

Table 3. Period of introducing ultra-processed foods in the first year of life of Brazilian children aged between 12 and 59 months living in a situation of social vulnerability. 2020/2021 (*n* 561)

	Age in months							
	< 4		4 to <6		6 to < 8		8 to < 12	
Foods*	*n*	%	*n*	%	*n*	%	*n*	%
Chocolate drink (*n* 116)	11	9·5	24	20·7	30	25·9	51	44·0
Candy/lollipop (*n* 182)	15	8·2	27	14·8	67	36·8	73	40·1
Cookies/crackers (*n* 363)	29	8·0	76	20·9	172	47·4	86	23·7
Cream-filled cookies (*n* 211)	15	7·1	24	11·4	98	46·4	74	35·1
Chocolate (*n* 134)	5	3·7	15	11·2	47	35·1	67	50·0
Jelly (*n* 37)	8	21·6	6	16·2	16	43·2	7	18·9
Creamy yogurt (*n* 406)	42	10·3	87	21·4	223	54·9	54	13·3
Soft drink (*n* 85)	3	3·5	15	17·6	22	25·9	45	52·9
Packaged salty snacks (*n* 180)	6	3·3	19	10·6	68	37·8	87	48·3
Dried soup mix (*n* 52)	7	13·5	5	9·6	13	25·0	27	51·9
Ice cream (*n* 57)	2	3·5	4	7·0	13	22·8	38	66·7
Powder refreshment mixture (*n* 81)	2	2·5	15	18·5	17	21·0	47	58·0

* The values vary because they correspond only to the number of children who consumed each food during the first year of life.

body's insulin response and can promote increased storage of nutrients in adipose tissue[27], such as Fe. In addition to compromising the digestion and absorption of fresh foods, such as vegetables, meat and fruit, impairing the absorption of the nutrients contained therein[9,37].

There has been a significant increase in malnutrition, such as overweight and anaemia, in low- and middle-income countries. This situation is probably related to greater access and consequent consumption of UPF, especially by the poorest population[5,32,33]. If proven, food price projections in Brazil denote an even more worrying scenario because, from 2026, UPF is already cheaper than fresh food, with an even greater price difference in 2030, further increasing its consumption, especially among the poorest[38].

This study gains greater attention for evaluating the introduction of UPF and its consequent impacts in the first year of children's lives. It can be seen that it is at this stage of life that feeding should gain greater prominence due to progressive weaning and the consequent importance of complementary feeding, which must meet the child's nutritional needs as a way of ensuring their proper growth and development[39], in addition to contributing to the formation of healthy eating habits that will be followed throughout life[40]. In addition, as shown in our findings, adequate nutrition in the first year of life, i.e., without the introduction of UPF, contributes directly to preventing overweight[39] and anaemia[41], thus reducing the burden of diseases that this child may develop in adulthood.

Our findings draw attention because it was developed with children in social vulnerability who are exposed to UPF consumption before they reach the first year of life, which may also be associated with other risk factors for morbidity and mortality, such as increased concentrations of total cholesterol[6], LDL and obesity during childhood[7,42] and cardiovascular risk factors, which may lead to shorter survival of these children.

Even though other studies have tried to assess the relationship between UPF consumption and nutritional outcomes[43], evidence related to early consumption of these foods, given the importance of this condition in shaping eating habits, is still scarce, especially when looking at children under the age of five who live *in situ*ations of social vulnerability. It is also important to highlight the need to evaluate the consumption of specific UPF, especially those that are most commonly offered during the introduction phase, a situation that until this study was carried out had been little addressed in other investigations, leaving an even more evident gap regarding its association with overweight and anaemia.

This situation was highlighted in a systematic review conducted by Petridi *et al.*[44], which identified a relationship between UPF consumption and overweight but pointed out the need to evaluate the consumption of specific types of UPF and their repercussions on health. In line with the results found in this study, an investigation also carried out with Brazilian children under the age of five, but which did not focus on the context of social vulnerability, identified that the consumption of UPF was associated with a lower prevalence of anaemia[45]. Thus, there is a clear need to evaluate specific population groups due to the different repercussions that could be identified.

This study presents some strengths, such as being a population-based study, representative of children living in a situation of social vulnerability in a Brazilian capital. Also, having evaluated the introduction of UPF in the first year of life, the results found here can support the development of specific strategies for this population group. Additionally, we need to familiarise ourselves with the evaluation of the introduction of UPF in the first year of life of socially vulnerable children to identify its relationship with the current nutritional status.

The present work also presents some limitations, such as its cross-sectional design, which reduces the inference of the causality effect because of the retrospective nature of evaluating the early introduction of UPF. However, we used an evaluation methodology similar to that used in other studies, including those conducted in Brazil. In addition, the results regarding the stratification of the months of the introduction of each food must be interpreted, taking into account the memory bias of the children's mothers. However, this limitation was minimised for the association analysis because we used consumption in the first year of life and did not categorise it in several periods.

Finally, this study identified a high prevalence of the introduction of UPF in the first year of life of Brazilian children living *in situ*ations of social vulnerability while also finding a

Table 4. Association by Poisson regression, with robust variance estimates, between the introduction of ultra-processed foods in the first year of life and overweight in Brazilian children aged 12 to 59 months living in a situation of social vulnerability. 2020/2021 (*n* 561)

	Bivariable			Multivariable*,†		
Variables	PR	95 % CI	*P* value	PR	95 % CI	*P* value
Chocolate drink						
≥ 12 months	1·00					
< 12 months	0·94	0·73, 1·20	0·645			
Candy/lollipop						
≥ 12 months	1·00					
< 12 months	1·09	0·89, 1·33	0·377			
Cookies/crackers						
≥ 12 months	1·00					
< 12 months	1·07	0·87, 1·32	0·478			
Cream-filled cookies						
≥ 12 months	1·00					
< 12 months	0·93	0·76, 1·14	0·538			
Chocolate						
≥ 12 months	1·00					
< 12 months	1·00	0·80, 1·25	0·976			
Jelly						
≥ 12 months	1·00			1·00		
< 12 months	1·29	0·94, 1·77	0·102	1·11	0·93, 1 ·33	0·229
Creamy yogurt						
≥ 12 months	1·00					
< 12 months	1·13	0·90, 1·42	0·282			
Soft drink						
≥ 12 months	1·00			1.00		
< 12 months	1·23	0·97, 1·56	0·080	1·18	1·02, 1·38	0·024
Packaged salty snacks						
≥ 12 months	1·00			1·00		
< 12 months	1·28	1·06, 1·56	0·010	1·17	1·05, 1·30	0·004
Dried soup mix						
≥ 12 months	1·00					
< 12 months	0·80	0·54, 1·17	0·260			
Ice cream						
≥ 12 months	1·00					
< 12 months	1·13	0·84, 1·51	0·408			
Powder refreshment mixture						
≥ 12 months	1·00			1·00		
< 12 months	1·09	0·97, 1·22	0·110	1·36	1·16, 1·60	< 0·001

PR, prevalence ratio.
* In the multivariate analysis, all foods with $P < 0{\cdot}20$ in the bivariate analysis were inserted.
† The multivariable analysis was adjusted for the following variables: child's age, breast-feeding, the mother's race/colour and the fact that she was a beneficiary of a Brazilian government cash transfer program.
Overweight classified according to the *Z*-score of the BMI-for-age index.

high prevalence of overweight and anaemia. Among the UPF evaluated, ultra-processed beverages such as soft drinks, powder refreshment mixtures and chocolate drinks, which have a high amount of added sugar, increased the likelihood of children being overweight or anaemia, and packaged salty snacks were associated with a higher likelihood of overweight among children. Notably, these UPF are offered to children at an increasingly early age. This situation reinforces the need for better attention to the nutritional quality of children's nutrition during the food introduction period to create good eating habits that will positively contribute to children's health.

Therefore, the findings of this study reinforce the need for effective actions, such as the intensification of public policies to combat excess weight and childhood anaemia, based on the promotion of healthy eating, the correct introduction of complementary feeding and continued breast-feeding, considering that the first 2 years of life are essential for the encouragement and development of healthy eating habits, as well as the implementation of social strategies to combat poverty.

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Table 5. Association by Poisson regression, with robust variance estimates, between the introduction of ultra-processed foods in the first year of life and anaemia in Brazilian children aged 12–59 months living in a situation of social vulnerability. 2020/2021 (*n* 354)

	Bivariable			Multivariable*,†		
Variables	PR	95 % CI	*P*-value	PR	95 % CI	*P*-value
Chocolate drink						
≥ 12 months	1·00			1·00		
< 12 months	1·23	1·09, 1·39	0·001	1·16	1·01, 1·35	0·041
Candy/lollipop						
≥ 12 months	1·00			1·00		
< 12 months	1·10	0·99, 1·23	0·071	0·98	0·86, 1·12	0·552
Cookies/crackers						
≥ 12 months	1·00			1·00		
< 12 months	1·07	0·96, 1·19	0·176	0·99	0·88, 1·12	0·934
Cream-filled cookies						
≥ 12 months	1·00					
< 12 months	1·03	0·92, 1·14	0·584			
Chocolate						
≥ 12 months	1·00					
< 12 months	1·03	0·91, 1·16	0·605			
Jelly						
≥ 12 months	1·00			1·00		
< 12 months	1·27	1·04, 1·55	0·015	1·17	0·92, 1·50	0·186
Creamy yogurt						
≥ 12 months	1·00					
< 12 months	1·01	0·89, 1·14	0·843			
Soft drink						
≥ 12 months	1·00			1·00		
< 12 months	1·25	1·09, 1·42	0·001	1·20	0·93, 1·37	0·203
Packaged salty snacks						
≥ 12 months	1·00					
< 12 months	1·06	0·95, 1·19	0·252			
Dried soup mix						
≥ 12 months	1·00					
< 12 months	1·04	0·87, 1·23	0·649			
Ice cream						
≥ 12 months	1·00			1·00		
< 12 months	1·20	1·02, 1·41	0·027	0·99	0·79, 1·24	0·963
Powder refreshment mixture						
≥ 12 months	1·00			1·00		
< 12 months	1·14	0·99, 1·31	0·064	0·94	0·78, 1·12	0·514

PR, prevalence ratio.
* In the multivariate, all foods with $P < 0{\cdot}20$ in the bivariate analysis were inserted.
† The multivariable analysis variables were adjusted for the following variables: child's age, maternal years of schooling, maternal parity, the fact that she was a beneficiary of a Brazilian government cash transfer program and income.
Anemia classified according to Hb concentration.

J. M. R. G.: data collection, tabulation and article writing and approval of the final version; L. G. R. S.-N.: study design, data collection, tabulation, analysis and interpretation of results, article writing and approval of the final version; T. L. F. D. S.: data collection, tabulation and article writing and approval of the final version; N. B. B. and T. M. D. M. T. F.: study design, analysis and interpretation of results, article writing and approval of the final version.

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