Journal of Pediatric Nursing xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of Pediatric Nursing

journal homepage: www.pediatricnursing.org

Ultra-processed food consumption and the incidence of obesity in two cohorts of Latin-American young children: A longitudinal study

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ARTICLE INFO

Article history:
Received 24 August 2022
Revised 3 December 2022
Accepted 19 December 2022
Available online xxxx

Keywords:
Childhood obesity
Eating behavior
Ultra-processed foods

ABSTRACT

Purpose: We evaluated the potential associations between the consumption of ultra-processed food (UPF) and the incidence of obesity among Uruguayan and Brazilian preschoolers.
Design and methods: We conducted a longitudinal analysis using data from preschool children from Uruguay and Brazil. The "Health, child development and nutritional survey" (ENDIS) was conducted in Uruguay in 2013–2014 and 2015–2016. The Brazilian survey (Pelotas 2015 Birth Cohort) has measures from 2017 and 2019. The main outcome measure was obesity defined as body mass index (BMI) for age and sex ≥ +3 z-scores. The score of UPF consumption was the main exposure measured. Multilevel crude and adjusted Poisson regressions were performed to estimate risk ratios and the respective 95% Confidence Intervals (95% CI).
Results: The overall incidence of obesity in this group of young Latin-American children with a mean age of 48 months was 4.1%. We observed a relationship between UPF and obesity with statistical significance (RR: 1.10 (95% CI, 1.02–1.18). Adjustment for weight at birth, age, sex, breastfeeding, country, and time between waves resulted in a similar relationship but lack of statistical significance.
Conclusions: Whilst in this study we did not find strong evidence of an association between the incidence of obesity and the intake at baseline and currently of UPF, results suggest that higher UPF consumption is more favorable than reduced consumption for the development of obesity.
Practice implications: The present study reinforces the importance of nutrition education and more effective public policies for promoting healthier food choices in early childhood.

Introduction

It is an alarming fact that childhood obesity is increasing in most parts of the world, with the estimated prevalence of obesity in children tripling since 1975 (World Health Organization, 2021). Although childhood obesity has stagnated in wealthier nations, it is believed to be continuing to rise in lower- and middle-income countries, which poses a significant risk to public health in these settings (Lakshman et al., 2012; World Health Organization, 2021).

There is evidence that modifiable risk factors such as poor dietary habits, lack of physical activity, obesogenic family environment, and poor sleep quality can cause excess weight gain in children (Bawaked et al., 2020; Woo Baidal et al., 2016). Ultra-processed food (UPF) consumption has been associated with poor nutritional status in children (Costa et al., 2019).

UPF is categorized by the NOVA classification system defined by the Global Health Research Program to be "formulations of ingredients, most of exclusive industrial use, typically created by series of industrial techniques and processes" (Teixeira de Lacerda et al., 2020), and some examples of these include: carbonated soft drinks; sweet, fatty or salty packaged snacks; lollies; packaged bread and buns, biscuits, pastries, cakes; margarine; packaged cereals, fruit yogurt and energy drinks;

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https://doi.org/10.1016/j.pedn.2022.12.018
0882-5963/

pre-prepared meat, cheese, pasta and pizza dishes; poultry and fish 'nuggets' and 'sticks'; sausages, burgers, hot dogs and other reconstituted meat products; powdered and packaged 'instant' soups, noodles and desserts (Baker et al., 2020). Due to their addictive taste, low cost and ease of accessibility it has proven to be very difficult to reduce their intake. Consequently these types of food items represent a considerable proportion of the whole diet of many people, especially in high income countries (Machado et al., 2019).

Also, UPF consumption has risen remarkably in developing nations globally. These increases are closely linked with the industrialization of food systems, technological change and globalization, including market growth and political activities of transnational food corporations and inadequate policies to protect nutrition in these new contexts (Baker et al., 2020). This is especially reflected in Uruguay and Brazil, where UPF consumption has shown important increases. In Brazil, since the 1990s, sales of UPFs have skyrocketed (Bortoletto Martins et al., 2013; da Costa Louzada et al., 2015). In this setting, a recent study demonstrated that UPFs; in particular sweetened beverages; had been consumed by approximately 60% of the population between two to nine years of age the preceding day of the interview (Ribeiro & de Araújo Pinto, 2021). Over the last few years, in Uruguay, UPF consumption has increased despite the government's efforts to restrict their sales and advertising, and the prevalence of overweight and obesity in the general population has also increased (Popkin, 2020; Toledo et al., 2021).

Studies focused on the prevalence of UPF consumption and influences on children have described the following associations: highly ultra-processed diets result in increased ad libitum food intake and increased consumption of carbohydrates and fats. Also, UPF intake is associated with clinical diagnoses of food addiction and subclinical food addiction symptomatology. Furthermore, UPF intake is positively associated with higher means of body fat and cholesterol (Dolwick & Persky, 2021; Monteiro et al., 2019; Monteiro et al., 2018).

Socioecological factors associated to UPF consumption from an obesogenic perspective has been explored in depth in young children, however, the longitudinal relationship between UPF intake and obesity in this age group has been understudied (Kim et al., 2020). Given the inadequate amount of research on the subject, the objective of the current study was to examine the potential associations between the consumption of UPF during the first years of life and the incidence of obesity among Uruguayan and Brazilian preschoolers.

Method

Study design and sampling

We conducted a longitudinal analysis using data from preschool children from population-based surveys in two Latin American countries, Uruguay and Brazil. Uruguay is a country with an area of 176,215 km^2 (Km^2) and a population of approximately 3.5 million inhabitants, with a Human Development Index (HDI) of 0.765 (Unicef, 2011). Brazil is a continental country (approximately 8.5 million km^2) also located in South America. We used data from the city of Pelotas, in the state of Rio Grande do Sul. Pelotas is a city with nearly 350,000 inhabitants located in the south of Brazil with an HDI of 0.739 (Instituto Brasileiro de Geografia e Estatística, 2021).

The first included survey was the *"Encuesta de Nutrición, Desarrollo Infantil y Salud"* (ENDIS) (Health, Child Development and Nutritional Survey); a comprehensive, longitudinal study conducted by the Uruguayan Ministry of Social Development. The sampling frame consisted of children surveyed by the Continuous Household Survey in the period February 2012–December 2013 in urban locations with >5000 inhabitants. The baseline sample was designed to be nationally representative of children living in urban areas and born in Uruguay between 2009 and 2014 (Instituto Nacional de Estadística, 2014). Children aged 0 to 3 years and 11 months of age were eligible for the study. In 2013–14, 3077 children were assessed (1st wave) and were followed-up in 2015–2016 (2nd wave) (Ministerio de Desarrollo Social et al., 2018). Our analysis sample included children who were assessed during both the 1st and 2nd waves and had data on dietary intake and measured height and weight for at least one wave ($n = 2550$). The attrition rate occurred due to the participants' legal guardian having moved to other addresses and changing their phone numbers, and others refused to participate in the second wave, with a total of 17.1% (=527/3077). Data on demographics, health behaviors and socioeconomic characteristics were reported by parents (usually mothers - 96.6%) in the presence of a researcher in the respondents' homes. Trained interviewers collected the measurements following standard protocols, and quality control procedures were performed during data collection (Ministerio de Desarrollo Social et al., 2018). Further information on the general study design, sampling procedures, ethical approval, and the number of children/families who participated in the ENDIS study has been published by the National Institute of Statistics and the Ministry of Social Development (Ministerio de Desarrollo Social et al., 2018).

The second study was the Pelotas 2015 Birth Cohort (Brazil). In the year 2015, all live births between January 1 and December 31, for mothers that lived within the urban area of Pelotas were included in the survey. A total of 4387 live births that occurred in Pelotas in 2015 were eligible to be included in the Cohort and 4275 were included in the study. For the present study, we used data from the population at 24 and 48 months of age. For longitudinal data analysis, 3918 children who had two BMI measurements during 2017–2019 were included to test associations between the consumption of UPF products and the incidence of obesity. The attrition rate occurred due to participants' families having moved to other states in the country and participants whose mothers or legal guardians having moved to other addresses and changing their phone numbers, with a total of 8.3% (=357/4275). Data collection was performed by trained interviewers and the follow-up interviews took place at a research clinic (Hallal et al., 2018).

Ethical considerations

This study was conducted according to the guidelines of the Declaration of Helsinki and all procedures involving research study participants were approved by the Ethics Committee of the School of Medicine from the University of the Republic of Uruguay (Resolution no. 159 of the session from March 18, 2013 from the School of Medicine, file number 070153–000486-13) and by the School of Physical Education Ethics Committee, associated with the *"Comissão Nacional de Ética em Pesquisa"* (CONEP) (National Research Ethics Committee) (approval number 26746414.5.0000.5313) for Brazilian participants. Written informed consent was obtained.

Study measures

UPF consumption

For the ENDIS cohort a diet questionnaire was developed by a Uruguayan ad hoc Working Group from ENDIS comprised of academics, researchers, and experts in diverse fields related to childhood nutrition. The questionnaires covered a wide range of items to address children's food and beverage consumption patterns relevant to the ENDIS objectives (see the food items in each survey: on pages 6–8 of the 2013 survey and pages 6–7 of the 2015 survey) (National Institute of Statistics, 2013; National Institute of Statistics, 2015). For the 2013–14 ENDIS' 1st wave, a 24-h recall questionnaire was used, whereas for the ENDIS 2nd wave cohort the reference period was the previous week and weekly frequency was also available. The 24-h recall data (wave 1) and the short diet questionnaire for the preceding week with the number of days of food and beverage consumption (wave 2) were used to estimate the overall intake and by each wave. A manuscript detailing the development and testing of the food frequency questionnaire and a subsample for which the 24-h recall data was applied is currently

in preparation (Ministerio de Desarrollo Social et al., 2018). For Pelotas 2015, cohort participants were asked about the child's habitual diet, using a short food consumption questionnaire based on the Food Consumption Markers Form from the Sistema de Vigilância Alimentar e Nutricional (SISVAN – Food and Nutrition Surveillance System) in Brazil (Ministério da Saúde (BR), 2015). Minor adaptations were made in relation to the examples of foods items, according to empirical knowledge and previous studies about habits of consumption of Pelotas children. For the present study, the collected information about diet was assessed via harmonized procedures for longitudinal data. The information of each survey was converted into regular intake to allow the joint analysis.

Food considered to be UPF was: processed meat products (hamburgers, hot dogs, and poultry and fish nuggets), ready to heat and/or eat food (soup, pure, stock cubes, fried potatoes, noodles,), packaged dairy desserts, sweets (candy, chocolate, jelly, ice cream), cookies (biscuits, cakes), chips, chocolate milk, and sweetened drinks (soft drinks or artificial juices). Each positive answer was added up to create a UPF score (0; 1; 2; 3; 4; 5; 6 or more). The score was the main exposure measured.

Obesity indicator

Anthropometric measurements were performed at each site by trained field workers. Children's weight and height were collected. In the Uruguayan cohorts, data was collected using a Seca scale (sensitivity of 0.1 kg) and stadiometer (sensitivity of 0.5 cm). In Brazil, a TANITA® scale (model UM-080, sensitivity of 0.1 kg) and Harpenden® stadiometer (sensitivity of 0.1 cm) were used. Children were measured wearing light clothes and without shoes. Obesity was defined as Body mass index (BMI) for age and sex ≥ +3 z-scores, according to the WHO standards (De Onis & Lobstein, 2010). All anthropometric data were processed using Anthro Plus software from the World Health Organization (version 1.0.4; World Health Organization; Geneva, Switzerland).

Confounders

Possible confounders included as covariates were country of residence, age in months, sex, birth weight (grams), exclusive breastfeeding duration (months), household income, and maternal education (primary or less, incomplete high school, high school, and university).

Data analysis

Descriptive analyses of participants from the total sample and from each cohort according to included covariables, consumption of each UPF group and UPF scores were carried out. Furthermore, the sample was described considering nutritional status.

The association between UPF scores and infant and family related variables and the outcome (obesity) was initially analyzed with classical methods, which ignores the data's hierarchical structure in the modeling. Then, to account for repeated measures, a series of multilevel regression modeling (i.e., hierarchical regression) was used to determine the association between children's consumption of UPF, and relative risk of obesity. For the multilevel analyses, generalized hierarchical models were adjusted with two hierarchical levels to identify predictors of obesity, considering the variation among individuals (level 1) and z-score of BMI for age in each measure (level 2).

Crude and adjusted Poisson regressions were performed to estimate risk ratios, and the respective 95% Confidence Intervals (95% CI), for the associations of UPF consumption and obesity incidence in preschoolers. Multivariate Poisson regression included in the model all of the independent variables that were significant in the simple relative risk regression, with the enter method and significance set at 5%; additionally, we used a conservative approach and included theoretical variables that could have a relationship (sex and time between measurements) to allow the comparison of information to other studies.

Statistical significance was set at $p < 0.05$. Statistical analyses were performed in Stata version 14.1 and R version 4.1.1.

Results

A total of 6468 children were included in the sample, 2550 (39.42%) from Uruguay and 3918 (60.58%) from Brazil. The final sample mean age was 24.46 (SD ± 6.66) months and 47.80 (SD ± 7.76) months on waves 1 and 2, respectively (Table 1).

The main sample characteristics from both included waves are presented in Table 1. Most mothers (48.44%) had six to twelve years of formal education. Boys (48.53%) and girls (51.47%) presented an average z-score birth weight of 0.24 (SD ± 1.17) and were exclusively breastfed for about 3.09 (SD ±2.33) months. The mean UPF count was 3.09 (SD ± 2.33) for wave 1 with 2.02% of children classified as obese, and 4.76 (SD ± 2.15) for wave 2 with a 5.28% frequency of obesity.

Supplementary Table 1 presents the consumption of each food considered as UPF according to country for waves 1 and 2. The most consumed groups were cookies (72.26%) and packaged dairy desserts (69.24%), for wave 1, and sweetened drinks (78.67%) and cookies (77.99%) for wave 2. Except for the similar frequencies of processed meat products for wave 2 ($p = 0.546$), the consumption of all included UPF groups was higher among Brazilian children compared to the Uruguayan ones ($p < 0.001$), for waves 1 and 2.

Total UPF consumption for waves 1 and 2 is displayed in Fig. 1. For wave 1, the diet of most children included three to four UPF, while for wave 2 most children were consuming 4 to 5 UPF, indicating a direct association with age.

The association between obesity for wave 2 and the included covariables is presented in Table 2. For the total sample, obesity was more prevalent among boys ($p = 0.021$). Obese children had a higher mean z-score birth weight ($p < 0.001$) and had been breastfed less ($p < 0.001$) than the non-obese ones. For the Uruguayan and Brazilian samples, similar results to the total sample were reported except for sex. Also, in Brazil, obese children were significantly older than the non-obese ones ($p = 0.007$).

Obesity incidence for wave 2 was 4.12% while obesity risk among those classified as obese for wave 1 was 13.72 times higher (56.56%) (Data not shown).

We found a crude association between UPF count (at baseline and at a current consumption) and obesity status for wave 2 (RR: 1.10; 95% CI 1.02–1.18). After adjusting for z-score birth weight, sex, age (months), country, exclusive breastfeeding duration, and accounting for the time between measures, the association was not significant (RR: 1.02; 95% CI 0.93–1.12) (Table 3).

Discussion

In the present study, increases in the incidence of obesity among children in the analyzed period were identified along with an increased intake of UPF; however, the relationship was not statistically significant after adjusting for confounders (birth weight, sex, age, country, exclusive breastfeeding duration, and time between measures). We identified persistent influences on obesity as being male, having had a higher birth weight, and duration of breastfeeding poorly aligned with current recommendations from public health organizations and medical societies (Eidelman & Schanler, 2012; US Department of Agriculture, 2020; World Health Organization (WHO), 2001).

The association between UPF intake and obesity have been shown in the literature, however published evidence regarding the longitudinal effects of UPF intake and obesity which focus on young children is still scarce and results are not conclusive. The meta-analysis of Askari et al. shows that consumption of UPF has a positive association with the amount of body fat during childhood and adolescence (Askari et al., 2020). These authors also recognize the need for studies with longitudinal designs and adequate control for confounding factors to clarify

Table 1
Characteristics of the included sample in each wave according to country.

	Wave 1				Wave 2			
	Total $n = 6468$	Uruguay $n = 2550$	Brazil $n = 3918$	*p*-value	Total $n = 6468$	Uruguay $n = 2550$	Brazil $n = 3918$	p-value
	Mean (±SD)	Mean (±SD)	Mean (±SD)		Mean (±SD)	Mean (±SD)	Mean (±SD)	
Sex (%)				0.065				
Male	51.47%	52.73%	50.64%					
Female	48.53%	47.27%	49.36%					
Birth weight (*Z*-score)	0.24 (1.17)	0.28 (1.39)	0.22 (1.06)	0.080				
Age (months)	24.46 (6.66)	25.05 (10.84)	24.02 (0.72)	<0.001	47.80 (7.76)	51.38 (11.03)	45.46 (2.52)	<0.001
Maternal education (years) (%)				<0.001				<0.001
<6	29.37%	41.78%	21.65%		25.23%	41.78%	14.93%	
6 to 12	48.44%	45.1%	50.52%		50.56%	45.10%	53.96%	
>12	22.18%	13.12%	27.83%		24.21%	13.12%	31.11%	
Exclusive breastfeeding (months)	3.09 (2.33)	4.53 (1.82)	2.14 (2.14)	<0.001				
UPF count	3.83 (2.18)	2.01 (1.56)	4.86 (1.76)	<0.001	4.76 (2.15)	3.27 (1.76)	5.73 (1.80)	<0.001
Obesity (%)				0.577				0.549
Yes	2.02%	2.16%	1.92%		5.28%	5.06%	5.44%	
No	97.86%	97.49%	98.08%		94.72%	94.94%	94.56%	

Note: UPF = Ultra-processed food. All variables had under 10% missing data with the exception of: total birth weight Z-score (13.33%) and in Uruguay (33.49%) in wave 1.

whether UPF intake alters anthropometric parameters and leads to obesity (Askari et al., 2020). A cohort study of 9025 children (7 to 13 years at baseline) followed up for a median of 10.2 years, found that growth trajectories among children with the highest (vs. lowest) UPF consumption increased by an additional 0.06 (95% CI, 0.04–0.08) per year for BMI (Chang et al., 2021). In the Spanish INMA (Infancia y Medio Ambiente [Environment and Childhood]) birth cohort study, a cohort of children at ages 4 and 7 years from three Spanish regions: Gipuzkoa, Sabadell, and Valencia, the low intake of UPF was associated with a lower BMI z-score at 7 years in the model adjusted for child age, sex, cohort, follow-up time, and the baseline of the corresponding outcome, but the association became borderline significant in the model further adjusted for maternal education, and maternal BMI (Bawaked et al., 2020).

Our results also demonstrated a dramatic increase in BMI z-score that determined a prevalence of obesity twofold in wave 2 and the cumulative incidence was four for every one hundred children. These findings are in line with the Spanish INMA study that found that the prevalence of obesity almost doubled between 4 and 7 years of age (Bawaked et al., 2020).

Our findings add positive associations between UPF consumption and excess weight outcomes throughout childhood, which is crucially important given that lifelong dietary patterns develop from childhood and may lead to widespread consequences on health and well-being throughout the course of life. The increasing availability and variety of UPF have reshaped global food systems by displacing dietary patterns previously based on fresh and minimally processed foods

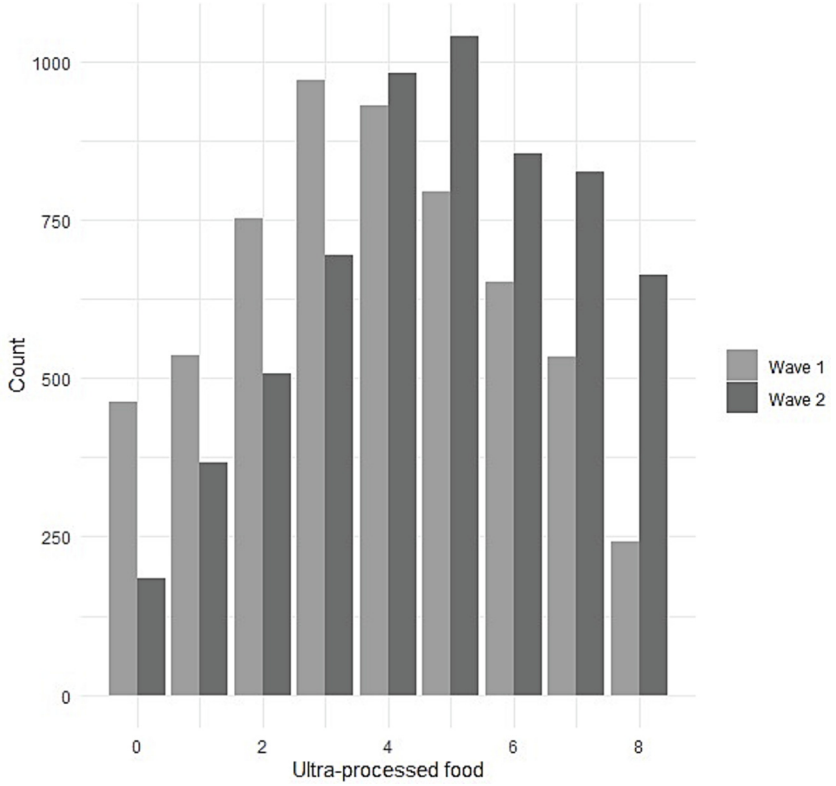

Fig. 1. Frequencies of total UPF consumption (score) according to baseline (wave 1) and current consumption (wave 2) among children of the total sample.

Table 2
Association between obesity status at wave 2 and the covariables in the total sample and according to country.

	Wave 2				
	Obese		Not obese		
	n	Mean (±SD)	n	Mean (±SD)	p-value
Total (n = 6468)					
Sex (%)					0.021
Male	187	5.94%	2962	94.06%	
Female	136	4.58%	2831	95.42%	
Birth weight (Z-score)	282	0.67 (1.22)	4973	0.22 (1.17)	<0.001
Exclusive breastfeeding (months)	317	2.63 (2.33)	5732	3.18 (2.33)	<0.001
Age (months)	323	48.05 (7.36)	5793	47.91 (7.97)	0.762
Maternal education (years) (%)					0.731
<6	92	5.16%	1691	94.84%	
6 to 12	151	5.19%	2761	94.81%	
>12	75	5.73%	1234	94.27%	
UPF count 1	306	3.80 (2.18)	5488	3.77 (2.19)	0.799
UPF count 2	321	4.73 (2.21)	5793	4.71 (2.15)	0.880
Uruguay (n = 2550)					
Sex (%)					0.067
Male	79	5.84%	1273	94.16%	
Female	50	4.17%	1148	95.83%	
Birth weight (Z-score)	88	0.77 (1.45)	1608	0.25 (1.38)	0.001
Exclusive breastfeeding (months)	129	4.20 (1.86)	2421	4.55 (1.82)	0.033
Age (months)	129	51.26 (10.48)	2421	51.39 (11.06)	0.893
Maternal education (years) (%)					0.442
<6	58	5.69%	961	94.31%	
6 to 12	53	4.82%	1047	95.18%	
>12	13	4.06%	307	95.94%	
UPF count 1	112	1.91 (1.52)	2119	2.02 (1.57)	0.487
UPF count 2	129	3.10 (1.84)	2421	3.28 (1.75)	0.266
Brazil (n = 3918)					
Sex					0.150
Male	108	6.01%	1689	93.99%	
Female	86	4.86%	1683	95.14%	
Birth weight (Z-score)	194	0.62 (1.10)	3365	0.21 (1.05)	<0.001
Exclusive breastfeeding (months)	188	1.55 (1.98)	3311	2.17 (2.14)	<0.001
Age (months)	194	45.91 (2.48)	3372	45.41 (2.52)	0.007
Maternal education (years) (%)					0.249
<6	34	4.45%	730	95.55%	
6 to 12	98	5.41%	1714	94.59%	
>12	62	6.27%	927	93.73%	
UPF count 1	194	4.89 (1.71)	3369	4.87 (1.76)	0.865
UPF count 2	192	5.82 (1.70)	3372	5.73 (1.80)	0.529

Note: UPF = Ultra-processed food. All covariables except for UP count 2 and Age were collected during wave 1.

(Baker et al., 2020). Since UPF are highly palatable, low cost, and high on convenience, these foods may lead to higher energy intake, inattentive eating, overconsumption, and finally weight gain and several negative health outcomes (Dolwick & Persky, 2021).

Our results suggest that there is a direct relationship between birth weight and obesity. There is consistent evidence from large cohort studies of a linear and positive association between birth weight and later-life BMI, and this may be equally attributable to correlations with adiposity and lean mass. These associations with high birth weight might be explained by the proposed developmental pathway to obesity following the effects of hypernutrition during fetal and/or early postnatal life (Lakshman et al., 2012).

Differences between the prevalence of obesity and duration of exclusive breastfeeding were also found, as children with obesity in the second wave presented a shorter duration of exclusive breastfeeding (nearly one month) than the children without obesity. Any duration of breastfeeding compared to exclusive commercial infant formula feeding can reduce child and adolescent obesity rates (Eidelman & Schanler, 2012). A multinational cross-sectional study found that breastfeeding may be a protective factor against obesity and high body fat in 9- to 11-year-olds from 12 countries (Ma et al., 2020). In the adult population, the Framingham Offspring study noted a relationship between breastfeeding and a lower BMI and higher high-density lipoprotein concentration in adults (Parikh et al., 2009). Thus, early childhood obesity prevention should consider perinatal factors like maternal weight status, infant birth weight and exclusive breastfeeding duration (Zhang et al., 2021).

In the current study, obesity was more prevalent among boys. This is consistent with a study of children in mega-cities in China, which found that boys had a higher BMI and waist circumference than girls (Gao et al., 2020). This study also found parents' preference for thinness in girls and bigger body size in boys (Gao et al., 2020). The differences in obesity by sex in our study may be due to parents' ideal body image perception (contrary to girls, obese boys may be perceived as strong), however, this was not explored, nor were other factors related to sex, as the study was not designed to examine the cause of such trends, only to detect them.

This study has its strengths including its prospective design, the large size of the sample, and the partial correction of the effect of repeated measures which tend to produce correlated data on longitudinal studies through multilevel analysis. In addition, our models were

Table 3
Relative risk and 95% confidence intervals for incident obesity according to baseline and current consumption of ultra- processed food.

	n	RR unadjusted (IC95%)	*p* value	n	RR adjusted (IC95%) [1]	*p* value
UPF count	6416	1.10 (1.02–1.18)	0.008	5484	1.02 (0.93–1.12)	0.680

UPF = ultra-processed food; CI, confidence interval; RR, relative risk.
[1]RRs was adjusted for z-score of birth weight, sex, age (months), country, exclusive breastfeeding duration, time between measures.

adjusted for several important confounders; future studies should consider potential mediators in UPF and obesity, such as nutritional status in small periods and UPF serving sizes.

There are also some limitations that must be outlined. One of them is based on the inherent potential biases when using food questionnaires: underestimating food consumption and differences between the nutritional composition of the consumed foods versus the nutritional composition table used. Also, the food questionnaires used in both cohorts were not validated. Measures were taken to minimize these biases in all the cohorts, including having trained interviewers collect the measurements following standard protocols. In addition, the food questionnaires used were specifically built for these studies, including foods that are more consistent with the habits of local people. As the instrument used to record food consumption was not the same in each cohort, some consumption items may have been misclassified. Classification errors are more likely to occur with the frequency of the items. However, for this study, we harmonized data to compare each cohort and combined data in a single database. Another potential limitation is that the use of the NOVA food classification system enabled to an assessment of underestimated food groups, however, some items may have been misclassified. Likewise, the study did not include serving size, no adjustments for energy intake were made, and therefore we could not measure amounts of energy and nutrient intake. Finally, the study suffered from attrition and non-response, and due to our use of pooled data across waves and across cohorts, appropriate sampling weights were unavailable.

Practice implications

Increases in UPF consumption from wave 1 to wave 2 in both Uruguayan and Brazilian samples were observed, this situation is especially important, as eating behaviors can track from childhood to adolescence resulting in a higher risk of developing cardiometabolic conditions later in life. The present study reinforces the importance of nutrition education actions and more effective public policies for promoting healthier food choices in early childhood.

Conclusion

In conclusion, the present paper demonstrates that, although lacking statistical significance, higher UPF consumption is more favorable thana reduced consumption for the development of obesity.

Financial support

The project has received funding from the National Agency of Investigation and Innovation (ANII/ FSPI_X_2020_1_161855. Uruguay). The 2015 Pelotas Birth Cohort was also funded by the Wellcome Trust (Grant numbers 095582 and 10735_Z_18_Z), the C*onselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq), the *Fundação de Amparo a Pesquisa do Estado do Rio Grande do Sul* (FAPERGS), and the Children's Pastorate.

CRediT authorship contribution statement

Isabel Pereyra González: Conceptualization, Supervision, Writing – original draft, Funding acquisition. **Simone Farías-Antúnez:** Conceptualization, Methodology, Writing – review & editing, Visualization. **Romina Buffarini:** Methodology, Writing – review & editing. **Andrea Gómez Ayora:** Conceptualization, Methodology, Formal analysis, Visualization. **Andrea Mary Fletcher:** Conceptualization, Writing – original draft, Writing – review & editing. **Marlos Rodrigues Domingues:** Writing – review & editing. **Mariângela Freitas da Silveira:** Conceptualization. **Augusto Hernán Ferreira Umpiérrez:** Conceptualization.

Declaration of Competing Interest

The authors declare no conflicts of interest.

Acknowledgements

The authors would like to thank the participants in this study, including the pilot study participants who provided feedback on the survey's instruments.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pedn.2022.12.018.

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