RESEARCH
Research Paper

Longer Breastfeeding Duration is Associated With Lower Consumption of Ultraprocessed Foods in a Sample of Spanish Preschoolers: The SENDO Project

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ABSTRACT

Background Breastfeeding has been linked to a higher consumption of fruit and vegetables at ages 4 to 5 years. More recently, it has been suggested that it may also be associated with lower ultraprocessed food (UPF) consumption in childhood.

Objective The aim of this study was to assess whether breastfeeding duration was associated with consumption of UPF in a sample of Mediterranean preschoolers.

Design This study involved a cross-sectional analysis of baseline information of children in the Child Follow-Up for Optimal Development cohort. Children were enrolled at ages 4 to 5 years and information was gathered through an online questionnaire completed by parents. Dietary information was collected with a previously validated semi-quantitative food frequency questionnaire and foods were classified based on the degree of processing according to the NOVA classification.

Participants/setting This study used baseline information for 806 participants enrolled in the Child Follow-Up for Optimal Development cohort between January 2015 and June 2021 in Spain.

Main outcomes measures Main study outcome measures were difference in grams per day and in the percentage of total energy intake from UPF consumption related to breastfeeding duration, and odds ratio that UPF represents a high percentage of total energy intake.

Statistical analyses Crude and multivariable adjusted estimates were calculated with generalized estimating equations to account for intracluster correlation between siblings.

Results The prevalence of breastfeeding in the sample was 84%. After adjusting for potential confounders, children who were breastfed for some time reported significantly lower consumption of UPF than children who were not breastfed at all. The mean differences were −19.2 g (95% CI −44.2 to 10.8) for children who were breastfed for <6 months, −42.5 g (95% CI -77.2 to −7.80) for those who were breastfed for 6 to 12 months, and −43.6 g (95% CI −79.8 to −7.48) for those who were breastfed for 12 months or more (P value for trend = 0.01). After adjusting for potential confounders, compared with children who were not breastfed, those who were breastfed for ≥12 months had consistently lower odds of UPF representing more than 25%, 30%, 35%, and 40% of total energy intake.

Conclusions Breastfeeding is associated with lower consumption of UPF in Spanish preschoolers.
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FOOD PROCESSING INVOLVES PHYSICAL, BIOLOGICAL, and chemical processes that occur after food is separated from nature and before it is consumed or sent for culinary preparation.[1] The NOVA classification divides food into four groups depending on its degree of processing.[2] The first group includes unprocessed or minimally processed food products (ie, mostly physical processes used to make single whole food products more durable or safe). The second group contains processed culinary ingredients, substances obtained from the first group or nature by industrial processes such as pressing, refining, or centrifuging. The third group comprises processed food products, which

implies the addition of substances such as salt, sugar, or oil to food products in Group 1 and the use of industrial processes such as smoking, curing, or fermentation. The fourth group includes ultraprocessed foods (UPF) and beverages; formulations of ingredients often created from substances derived from food components to which additives are added. The production of UPF involves physical, chemical and biological industrial processes that result in ready-to-consume or ready-to-heat products that require little or no culinary preparation, which makes them easily accessible but nutritionally poor.[3]

UPF consumption has dramatically increased worldwide over the past 20 years as a consequence of industrialization and globalization, shifting the dietary pattern of many countries from a traditional pattern to a Westernized one.[4-6] Spain is an example of how the traditional Mediterranean diet, based on high consumption of plant-based food products (ie, vegetables, fruits, nuts, legumes, and unprocessed cereals), low consumption of meat and meat products (with special avoidance of red and processed meats), moderate-to-high consumption of fish, and low consumption of dairy products (apart from yogurt and fresh cheeses), has been replaced by patterns rich in UPF.[7] The prevalence of adherence to the traditional Mediterranean dietary pattern in Spanish children decreased from 54% in 2008-2009 to 44% in 2018-2019.[6] In parallel, the purchase of UPF increased from 11.0% to 31.7%.[8] Along with this, a recent study from the Child Follow-Up for Optimal Development project (SENDO Project) reported an inverse association between the adherence to the Mediterranean dietary pattern and the consumption of UPF.[9] This change in dietary intake patterns is a public health concern because high consumption of UPF has been linked to a higher risk of obesity,[10] hypertension,[11] and all-cause mortality.[12,13] Higher UPF consumption was associated with lower non-UPF intake in an Australian cross-sectional study with more than 12,000 participants aged 2 years and older.[14] In addition, in the same study, the percentage of total energy intake from free sugars; total, saturated, and *trans* fats; and milligrams/1,000 kcal for sodium significantly increased as the percentage of total energy intake from UPF increased, whereas an inverse relationship was observed for fiber and potassium intake.[14]

Exclusive breastfeeding is the recommended diet for infants during their first 6 months of life.[15] The World Health Organization and the United Nations Children's Fund recommend the introduction of nutritionally adequate and safe complementary (solid) food products at age 6 months together with continued breastfeeding up to age 2 years or beyond.[16] Breastfeeding has been associated with short- and long-term benefits such as lower risk of respiratory infections,[17] obesity,[18] and cardiovascular risk factors.[19]

A recent study focusing on early feeding practices reported that exclusive breastfeeding for <3 months and starting complementary feeding before 4 months was linked to higher consumption of UPF in a large sample of 6-year old Brazilian children.[20] The current study aimed to evaluate the association between breastfeeding duration and consumption of UPF in a sample of Mediterranean preschoolers after control of confounding with progressive adjustments, including individual and family factors.

RESEARCH SNAPSHOT

Research Question: Is there an association between breastfeeding duration and consumption of ultraprocessed foods during early childhood?

Key Findings: An inverse linear trend between breastfeeding duration and the consumption of ultraprocessed foods during early childhood was found. More specifically, children who were breastfed for ≥12 months reported 6.5% less energy intake from ultraprocessed foods at 5 years old compared with those who were not breastfed.

MATERIALS AND METHODS

Study Population

The SENDO Project is an ongoing Spanish prospective cohort focused on studying the effect of diet and lifestyle on obesity in childhood and adolescence (www.proyectosendo.es). Potential participants are invited by their pediatrician at their medical center or by a member of the research team at school. In addition, families who learn about the project through the media can register a participant between ages 4 and 5 years through the Project's website. The recruitment is permanently open. Inclusion criteria are: age between 4 and 5 years and residence in Spain. The only exclusion criterion is the lack of access to an Internet-connected device to complete the questionnaires. Information is collected at baseline and updated every year through self-administered online questionnaires completed by the participants' parents. For this study, baseline information of participants enrolled between January 2015 and June 2021 was used (cross-sectional analysis). Of the 989 children eligible for the analyses, 183 were excluded (18%) because they did not provide information concerning either the exposure, the outcome, or both.

The SENDO Project follows the rules of the Helsinki Declaration on Ethical Principles for Human Research, and its protocol was approved by the Ethical Committee for Clinical Research of Navarra (Proyecto. 2016/122). Each participant's parents provided written informed consent before their child was enrolled in the study.

Assessment of the Exposure

Parents were asked about their child's breastfeeding history (yes/no). Those with an affirmative answer indicated the duration of breastfeeding (<1 month, 1 to <3 months, 3 to <6 months, 6 to <12 months, or ≥12 months). The information was recategorized for the analyses as: no breastfeeding, breastfeeding for <6 months, breastfeeding between 6 and 12 months, or breastfeeding for ≥12 months. No breastfeeding was used as the category of reference in all the analyses.

Assessment of the Outcome

Dietary information was collected with a previously validated semiquantitative food frequency questionnaire (FFQ) that included 149 food items.[21] For each food item, a standard portion size was specified. Parents reported how often their child had consumed each of the food items over the previous year by choosing one out of 9 frequencies of consumption ranging from "never or almost never" to "six or more times

per day." The nutrient content of each item in the FFQ was calculated by a team of dietitians using updated Spanish food composition tables[22] and online information.[23] They multiplied the edible portion by the frequency of intake and by the nutrient composition of the specified serving size. The total energy intake (TEI) was obtained by adding the energy contribution of each item.

Each item of the FFQ was classified into 1 of the 4 NOVA groups considering the most frequent form of consumption by children in Spain. The classification was performed by 2 independent investigators and disagreements were solved by consensus.[24] Dietary intake of each NOVA group was analyzed as grams per day and as the percentage of TEI, which was calculated by dividing the energy content of each NOVA group by the TEI and multiplying the result by 100.

Evaluation of Covariates

The baseline questionnaire collected information on sociodemographic variables (eg, child sex, race, birth date, and mother's education), gestation, delivery and perinatal period, and lifestyle (eg, physical activity and sedentary behavior).

Both the child's and mother's age were calculated using the difference between the date the questionnaire was completed and their respective date of birth. Child's body mass index (BMI) was calculated using the ratio of reported weight to squared height. The *z* score of the BMI was calculated with the least squares means method suggested by Cole and colleagues.[25] Nutritional status was defined using sex- and age-specific BMI cutoff points based on International Obesity Task Force reference standards.[26] Child's screen time was calculated as the average number of hours dedicated to watching television, using a computer, or playing video games per day. To assess parental knowledge on nutrition recommendations for children, parents were asked how often they believed a child should consume 16 food groups (eg, fruits, vegetables, and dairy products).[27] The questionnaire included nine categories of response from "Never" to "Six or more times a day." Each question scored +1 if the answer complied with the recommendations of the Dietary Guidelines for the Spanish population, and zero if it did not.[28] The final score ranged from 0 to +16 with higher value meaning better knowledge about nutrition recommendations for children. For analysis, the final score was expressed as a percentage and categorized in low (<40%), average (40% to 70%), or high (>70%). Low knowledge was used as the reference category. Parental attitudes toward their child's dietary habits were assessed with eight yes/no questions about whether or not they tried to support their child to have healthy dietary habits (eg, I try to support my child to eat more fruit; I try to support my child to reduce the consumption of candies).[27] Positive answers scored +1 and negative answers, zero. The final score ranged from 0 to 8, with higher value meaning healthier attitudes. For analysis, the final score was categorized in unhealthy (0 to 3 points), average (4 to 5 points) or healthy (6 to 8 points). Unhealthy attitudes were used as the reference category. Knowledge and attitude questionnaires have not yet been validated; however, they have been analyzed in previous studies and considered potential predictors of the quality of children's diets.[29,30]

Statistical Analysis

Participants' sociodemographic characteristics and food consumption were compared by degree of food processing across categories of breastfeeding. For descriptive purposes, means ± SD were used for continuous variables and percentages for categorical ones. Spearman correlations were performed to calculate the correlation between breastfeeding duration and energy intake from each NOVA group.

In the main analysis, the association between breastfeeding duration and the consumption of UPF was assessed as the difference in grams per day, and percentage of TEI. Crude and multivariable adjusted estimates and 95% CI were calculated through 3 progressively adjusted models. The first model was adjusted for sex, age, recruitment period (2015-2017, 2018-2019, or 2020-2021), maternal age (continuous), and maternal higher-level education (yes or no). The second model was adjusted for all the variables in Model 1 plus gestational age (26 to <37 weeks, 37 to <40 weeks, or ≥40 weeks), mode of delivery (vaginal or caesarean), and birth weight (continuous). Finally, the third model was adjusted for all the variables in Models 1 and 2 plus number of children (1 or 2, 3 or ≥4), child's position among siblings (the oldest or singleton, second out of 3 or second or third out of 4, or the youngest of 4 or more), parental attitudes toward child's dietary habits (unhealthy, average, or healthy), parental knowledge about nutrition recommendations for children (low, medium, or high), and screen time (continuous).

Second, participants were identified as having a high intake of UPF if their reported intake was above 25%, 30%, 35%, or 40% of TEI. Crude and adjusted odds ratios (ORs) and 95% CIs were calculated for excessive UPF intake (above 25%, 30%, 35%, or 40% of TEI) associated with breastfeeding duration using the same progressive adjusting models. The marginal effect of breastfeeding duration was also calculated (ie, the adjusted proportion of children with UPF consumption above the specific cutoff points).

Generalized estimation equations (*xtgee* command) were performed to account for intra-cluster correlation between siblings. *Gaussian family* was indicated in the main analyses (difference in grams per day and in the percentage of TEI consumed from UPF between breastfeeding categories) and *binomial family* in the secondary ones (OR for excessive UPF consumption). The adjusted proportion of children with excessive UPF consumption in each category of breastfeeding was calculated with the *margins* postestimation command. The analyses were carried out with Stata.[31] Statistical significance was set at a $P < 0.05$.

To calculate the *P* value for trend across breastfeeding categories, a new variable was created by imputing to each participant the midpoint of the original variable (ordinal) and treating the new variable as continuous.

To assess the strength of our results, a sensitivity analysis was conducted excluding children who reported extreme values of energy intake (below the first percentile or above 99th percentile).

RESULTS

This study included 806 participants of the SENDO Project who had completed the baseline questionnaire up to June 2021. The main characteristics of participants and their

Table 1. Main characteristics of participants in the Child Follow-Up for Optimal Development project enrolled between January 2015 and June 2021 and their families, classified by breastfeeding duration

Characteristic	Breastfeeding duration				*P* value for trend
	No breastfeeding	<6 mo	6 to <12 mo	≥12 mo	
N	125	252	209	220	
Children's characteristic					
	←——— *n (%)* ———→				
Male sex	56 (44.80)	119 (47.22)	99 (47.37)	123 (55.91)	0.13
White race[a]	119 (95.20)	246 (97.62)	204 (97.61)	210 (95.45)	0.57
	←——— *mean (SD)* ———→				
Age (y)	5.1 (1.0)	5.0 (0.9)	5.1 (0.8)	4.9 (0.8)	0.08
Screen time (h/d)	1.10 (0.81)	1.07 (0.68)	1.01 (1.12)	1.05 (0.89)	0.58
Physical activity (METs-h/wk)	38.33 (29.72)	41.93 (32.80)	39.79 (29.77)	42.14 (28.86)	0.50
Birth weight (g)	3,020 (665.2)	3,239 (525.8)	3,282 (537.8)	3,298 (499.3)	< 0.01
***z* score of BMI**	−0.15 (1.31)	0.17 (1.09)	0.06 (1.13)	0.10 (1.16)	0.42
	←——— *n (%)* ———→				
Type of delivery: caesarean	38 (39.18)	54 (25.00)	39 (21.20)	41 (19.52)	< 0.01
Gestational age (wk)					< 0.01
20 to <37	31 (24.80)	37 (14.68)	26 (12.44)	23 (10.45)	
37 to <40	48 (38.40)	104 (41.27)	95 (45.45)	75 (34.09)	
≥40	42 (33.60)	110 (43.65)	87 (41.63)	122 (55.45)	
Missing data	4 (3.20)	1 (0.40)	1 (0.48)	0	
Child position held among siblings	0.04				
The oldest or singleton	37 (29.60)	86 (34.13)	85 (40.67)	91 (41.36)	
Second out of 3 or second-third out of 4	25 (20.00)	48 (19.05)	44 (21.05)	21 (9.55)	
The youngest or ≥4th	63 (50.40)	118 (46.83)	80 (38.28)	108 (49.09)	
Family characteristic					
	←——— *mean (SD)* ———→				
Mother's age (y)	40.9 (4.6)	39.9 (3.9)	39.8 (3.6)	39.8 (4.0)	0.14
	←——— *n (%)* ———→				
Mothers with high education[b]	82 (65.60)	207 (82.14)	184 (88.04)	177 (80.45)	0.04
No. of children	< 0.01				
1-2	72 (57.60)	139 (55.16)	125 (59.81)	163 (74.09)	
3	28 (22.40)	57 (22.62)	50 (23.92)	44 (20.00)	
≥4	25 (20.00)	56 (22.22)	34 (16.27)	13 (5.91)	
Parental knowledge about dietary recommendations for children[c]					< 0.01
Low	39 (31.20%)	66 (26.19%)	40 (19.14%)	38 (17.27%)	
Medium	79 (63.20%)	147 (58.33%)	140 (66.99%)	152 (69.09%)	
High	7 (5.60)	39 (15.48)	29 (13.88)	30 (13.64)	
Parental attitudes toward child's dietary habits[d]					< 0.01
Unhealthy	9 (7.20)	20 (7.94)	10 (4.78)	7 (3.18)	

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Table 1. Main characteristics of participants in the Child Follow-Up for Optimal Development project enrolled between January 2015 and June 2021 and their families, classified by breastfeeding duration (*continued*)

Characteristic	Breastfeeding duration				*P* value for trend
	No breastfeeding	<6 mo	6 to <12 mo	≥12 mo	
Average	43 (34.40)	87 (34.52)	72 (34.45)	63 (28.64)	
Healthy	73 (58.40)	145 (57.54)	127 (60.77)	150 (68.18)	

[a]Other races: Black, Latin, and Asian race.
[b]High education includes university degree, master's degree, or doctorate.
[c]Parents were asked who often they believed a child should consume 16 food groups (eg, fruits, vegetables, and dairy products). Each question scored +1 if the answer complied with the recommendations of the Dietary Guidelines for the Spanish population, and zero if it did not. Low = <40%, medium = 40% to 70%, and high = >70%.
[d]Parental attitudes toward their child's dietary habits were assessed with eight yes/no questions about whether they tried to support their child to have healthy dietary habits (eg, "I try to support my child to eat more fruit;" "I try to support my child to reduce the consumption of candies"). Positive answers scored +1 and negative answers scored 0. Unhealthy = 0 to 3 points, average = 4 to 5 points, and healthy = 6 to 8 points.

parents are shown in Table 1. Six hundred eighty-one participants (84%) reported having been breastfed for some time, 252 (31%) for <6 months, 209 (26%), for 6 to <12 months, and 220 (27%) for ≥12 months. In this study, children who had been breastfed for longer were more often the oldest sibling. They were also more often born vaginally and had higher birthweight.

Parents who breastfed their children for longer had lower premature deliveries. Maternal education was positively associated with breastfeeding duration, and parents who breastfed their children for longer showed better knowledge about children's dietary recommendations and healthier attitudes towards their child's dietary habits (Table 1).

The results showed that breastfeeding duration was directly associated with energy intake from food in NOVA 1 and indirectly associated with energy intake from food products in NOVA 4 (Table 2). More specifically, the correlation between breastfeeding duration and energy intake from food products in NOVA 1, NOVA 2, NOVA 3, and NOVA 4 groups was 0.18 ($P < 0.01$), 0.02 ($P = 0.69$), −0.01 ($P = 0.92$), and −0.21 ($P = < 0.01$), respectively (data not shown). Among the food products in NOVA 1, significant positive associations were observed between breastfeeding duration and the consumption of rice, fruit, nuts, potatoes, and vegetables. Conversely, a negative association was found with the consumption of dairy products. Regarding food products in NOVA 4, breastfeeding duration was found to be inversely associated with the consumption of ultraprocessed meat, chocolate, fast food, and ultraprocessed dairy products (eg, smoothies and custards) (Table 2).

Figure 1 represents the percentage of the TEI (kilocalories per day) from each NOVA group by breastfeeding. Trend from energy intake from foods in NOVA 1 appears different from the trend in energy intake from foods in NOVA 4. Compared with children who were not breastfed, those who were breastfed for 12 months or more reported a higher percentage of up to 5.2 (95% CI 4.7 to 5.6) of TEI from food products in NOVA 1 and a lower percentage of up to 6.5 (95% CI 6.3 to 6.8) of TEI from food products in NOVA 4.

In the multivariable analysis, an inverse association was found between breastfeeding duration and UPF consumption in childhood (P for trend < 0.01). After adjusting for potential confounders, children who were breastfed for some time reported significant lower consumption of UPF than children who were not breastfed at all. More specifically, the observed mean differences were −19.2 g (95% CI −44.2 to 10.8) for children who were breastfed for <6 months, −42.5 g (95% CI −77.2 to −7.80) for those who were breastfed for 6 to <12 months, and −43.6 g (95% CI −79.8 to −7.48) for those who were breastfed for 12 months or more (Table 3). These differences in grams were equivalent to a mean reduction of −2.3 (95% CI −4.5 to −0.1), −3.0 (95% CI −5.4 to −0.6), and −4.7 (95% CI −7.0 to −2.5) points respectively in the percentage of TEI (Figure 2).

In secondary analyses an inverse association was observed between breastfeeding and the odds of consuming more than 25%, 30%, 35%, or 40% of TEI from food products in NOVA 4 (P for trend < 0.01) (Figure 3). After adjusting for potential confounders, compared with children who were not breastfed, those who were breastfed for ≥12 months had consistently lower odds of UPF representing a high percentage of their TEI. More specifically, the OR for UPF representing more than 25%, 30%, 35%, or 40% of their TEI was 0.24 (95% CI 0.08 to 0.71), 0.25 (95% CI 0.11 to 0.53), 0.18 (95% CI 0.10 to 0.36), and 0.45 (95% CI 0.26 to 0.80), respectively. In all the 4 considered scenarios (energy intake from products in the NOVA 4 group more than 25%, 30%, 35%, and 40% of TEI), the proportion of children exceeding the cutoff point was lower in the categories with longer duration of breastfeeding (Table 4). These results were consistent in sensitivity analyses done after excluding 182 (22%) children with extreme energy intake (data not shown).

DISCUSSION

This cross-sectional analysis of 806 Mediterranean preschoolers in the SENDO cohort showed an inverse linear trend between breastfeeding duration and UPF consumption at age 5 years. An inverse linear trend was also observed between breastfeeding duration and the odds of UPF representing more than 25%, 30%, 35%, and 40% of TEI, with consistently lower estimates for children in the highest category (breastfeeding ≥12 months) compared with those who were not breastfed.

High consumption of UPF is an important public health concern as it is associated with an increased risk of several chronic diseases, including overweight and obesity,[10]

Table 2. Consumption of foods by the NOVA classification system by categories of breastfeeding duration adjusted for total energy intake for children aged 4 or 5 years enrolled in the Child Follow-Up for Optimal Development project between January 2015 and June 2021

	Breastfeeding duration				
Food	No breastfeeding	<6 mo	6 to <12 mo	≥12 mo	*P* value for trend[a]
n	125	252	209	220	
	← *mean (SD)* →				
Total energy intake (kcal/d)	1907 (438)	2030 (577)	2033 (460)	2039 (506)	0.17
Food groups in NOVA 1 (g/d)					
Rice	13.1 (13.3)	13.1 (13.2)	14.08 (13.2)	16.8 (12.2)	< 0.01
Lean meat, such as poultry meat	36.0 (25.6)	39.7 (25.6)	41.2 (25.5)	37.7 (23.4)	0.26
Red meat such as veal, cow, and pork	44.1 (30.8)	46.5 (30.8)	46.8 (30.5)	40.8 (28.2)	0.15
Fruit	303 (285)	309 (284)	340 (281)	442 (261)	< 0.01
Nuts	4.5 (10.4)	5.8 (10.3)	5.6 (10.3)	7.6 (9.5)	0.02
Egg	19.4 (11.1)	19.4 (11.4)	19.2 (11.5)	20.8 (10.5)	0.41
Dairy products	316 (243)	325 (243)	310 (240)	258 (220)	0.01
Pulses	51.8 (36.3)	57.9 (36.3)	54.2 (36.0)	58.8 (33.2)	0.23
Seafood	2.5 (3.2)	2.9 (3.3)	2.5 (3.2)	3.0 (3.0)	0.34
Pasta	15.7 (10.7)	16.2 (10.6)	16.7 (10.6)	17.4 (9.8)	0.40
Potatoes	27.9 (26.9)	27.2 (26.7)	29.9 (26.6)	33.5 (24.7)	0.04
Fish	28.3 (18.1)	30.6 (18.1)	30.9 (17.9)	30.4 (18.1)	0.60
Vegetables	182 (166)	197 (167)	203 (165)	250 (153)	< 0.01
Viscera	0.7 (2.9)	0.6 (2.8)	0.6 (2.7)	0.7 (2.5)	0.97
Fruit juice	46.6 (813)	39.8 (81.4)	46.4 (81.1)	32.2 (74.7)	0.21
Energy intake (kcal/d) from NOVA 1[b]	737	821	810	855	< 0.01
Food groups in NOVA 2 (g/d)					
Vegetable oil	1.2 (3.8)	1.6 (3.8)	0.6 (3.7)	0.7 (3.4)	0.02
Olive oil	17.5 (13.7)	17.5 (13.8)	18.6 (13.6)	18.4 (12.6)	0.80
Sugar	1.9 (4.3)	1.8 (4.3)	1.6 (4.2)	1.0 (3.9)	0.14
Cream and butter	3.9 (10.3)	3.3 (10.27)	4.2 (10.2)	4.7 (9.5)	0.51
Salt	2.6 (2.6)	2.6 (2.52)	2.5 (2.4)	2.4 (2.4)	0.06
Energy intake (kcal/d) from NOVA 2[b]	209	207	209	207	0.96
Food groups in NOVA 3 (g/d)					
Olives	4.0 (5.6)	3.5 (5.6)	4.2 (5.6)	4.3 (5.2)	0.47

(*continued on next page*)

Table 2. Consumption of foods by the NOVA classification system by categories of breastfeeding duration adjusted for total energy intake for children aged 4 or 5 years enrolled in the Child Follow-Up for Optimal Development project between January 2015 and June 2021 (*continued*)

Food groups in NOVA 3 (g/d)					
Curdled sheep's milk	1.4 (5.3)	1.0 (5.3)	0.9 (5.3)	0.7 (4.9)	0.71
Fruit in syrup	2.4 (6.3)	1.6 (6.2)	1.9 (6.2)	1.3 (5.8)	0.40
Cured ham	9.1 (9.7)	8.7 (9.6)	9.6 (9.7)	8.0 (8.9)	0.34
Canned fish	3.3 (6.6)	3.3 (6.5)	3.3 (6.5)	4.1 (5.9)	0.44
Marmalade	1.3 (5.5)	2.2 (5.6)	2.4 (5.5)	2.4 (5.0)	0.31
Processed bread	39.6 (36.8)	42.7 (36.8)	42.0 (36.4)	35.2 (33.6)	0.09
Processed cheese	7.4 (11.5)	6.8 (11.4)	9.2 (11.4)	10.7 (10.5)	< 0.01
Bacon	1.0 (2.7)	0.7 (2.7)	1.3 (2.8)	1.3 (2.5)	0.07
Energy intake (kcal/d) from NOVA 3[b]	182	205	206	196	0.78
Food groups in NOVA 4 (g/d)					
Sugar sweetened beverages	54.1 (85.9)	41.3 (85.7)	30.4 (85.12	54.3 (78.6)	0.0.1
Pastries	24.4 (19.8)	25.3 (19.6)	26.3 (19.7)	24.8 (18.1)	0.82
Ultraprocessed meat	42.9 (23.1)	45.5 (22.9)	41.6 (23.0)	36.7 (21.2)	< 0.01
Chocolate	19.4 (15.7)	18.0 (15.7)	17.3 (15.7)	14.5 (14.4)	0.01
Candies	2.2 (2.8)	2.5 (2.7)	2.0 (2.7)	1.9 (2.5)	0.13
Fast food	45.2 (23.5)	38.7 (23.4)	37.5 (23.23	38.7 (17.0)	0.02
Ultraprocessed fats	1.4 (2.4)	1.0 (2.2)	1.3 (2.3)	1.2 (2.01	0.43
Ultraprocessed dairy products such as smoothies and custards	84.8 (78.0)	76.5 (77.6)	59.0 (77.4)	53.9 (71.5)	< 0.01
Ultraprocessed bread	9.9 (15.7)	12.7 (15.6)	11.3 (15.5)	10.7 (14.4)	0.32
Ultraprocessed cheese	9.4 (12.0)	6.7 (11.9)	7.4 (11.89)	6.7 (11.0)	0.16
Ultraprocessed yogurt	103 (98.6)	93.4 (98.0)	99.3 (96.9)	94.3 (90.13	0.77
Ice cream	22.5 (28.0)	15.3 (27.8)	17.8 (27.6)	17.7 (25.5)	0.14
Other ultraprocessed foods[c]	12.0 (13.4)	10.3 (13.5)	10.0 (13.3)	9.8 (12.3)	0.49
Energy intake (kcal/d) from NOVA 4[b]	852	850	802	720	< 0.01

[a]*P* value for trend calculated in linear regression models.
[b]In the row showing energy intake from each NOVA group, a darker colour indicates a higher intake.
[c]Other ultraprocessed foods such as jellies, popcorn, and nougat.

hypertension,[11] and all-cause mortality.[32,33] Identifying factors related to lower UPF consumption in childhood is key to developing preventive strategies from an early age. The results of this study add to previous evidence because an association for total breastfeeding duration, and not just exclusive breastfeeding duration, was found and a thorough analysis was carried out to control for important individual and family potential confounders.[32,33]

Opposing trends in energy intake from products in NOVA 1 (lower in those with shorter breastfeeding duration) and those in NOVA 4 (higher in those with shorter breastfeeding duration) were observed. Regarding products in NOVA 1, a positive association was found between breastfeeding duration and the consumption of rice, fruits, nuts, potatoes, and vegetables and a negative association was found with dairy products. These findings are consistent with previous studies

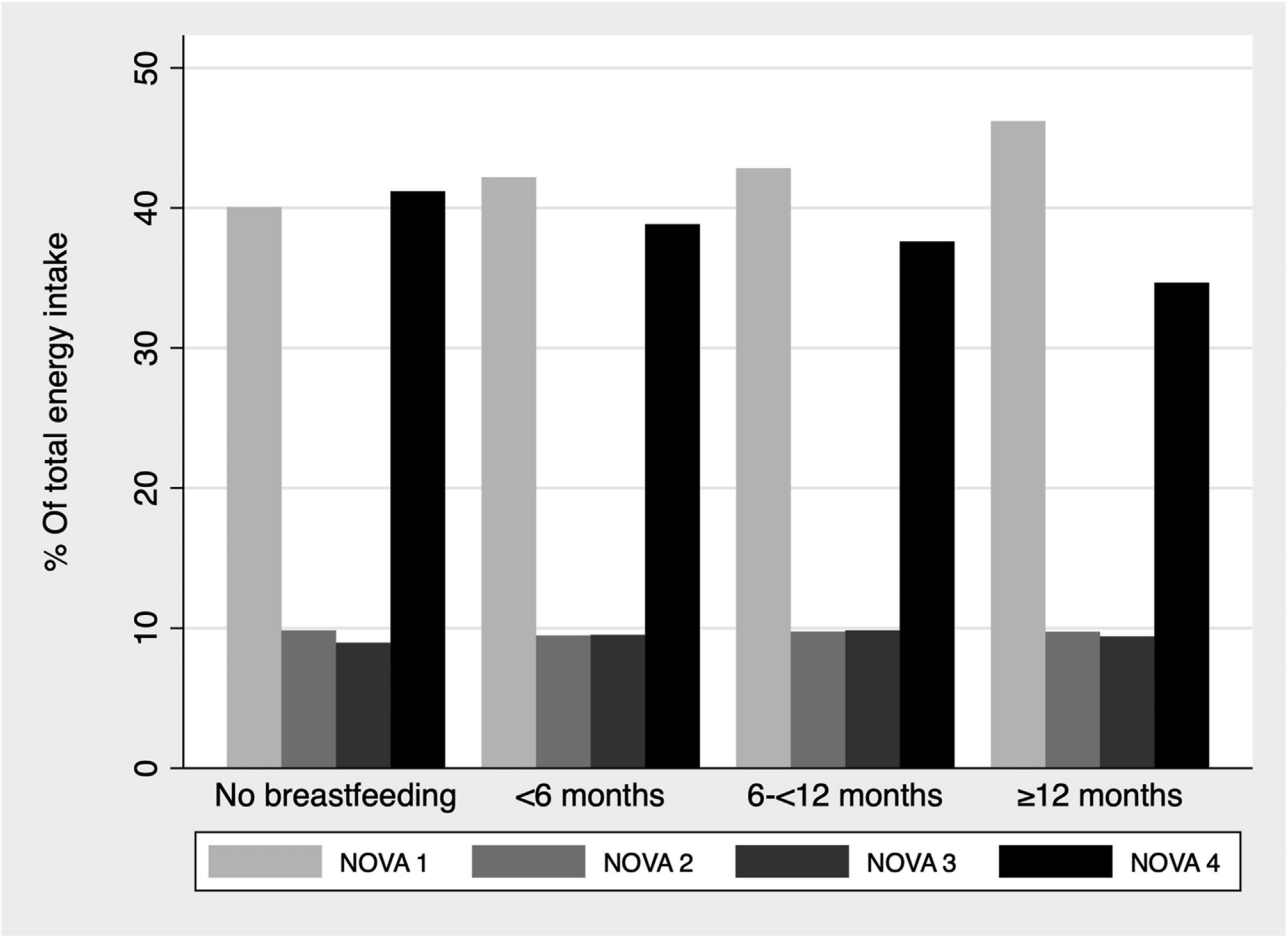

Figure 1. Percentage of total energy intake from each NOVA group by breastfeeding duration caegories in children aged 4 or 5 years enrolled in the Child Follow-Up for Optimal Development project between January 2015 and June 2021.

Table 3. Difference and 95% CI in the consumption of ultraprocessed foods associated with breastfeeding duration for children aged 4 or 5 years enrolled in the Child Follow-Up for Optimal Development project between January 2015 and June 2021

	Breastfeeding duration				
	No breastfeeding	<6 mo	6 to <12 mo	≥12 mo	*P* value for trend
n	125	252	209	220	
	← *difference (95% CI)* →				
Crude	0 (Reference)	−16.97 (−61.91 to 27.97)	−38.57 (−82.78 to 5.64)	−67.37 (−111.25 to −23.5)	< 0.01
Model 1[a]	0 (Reference)	−10.17 (−55.14 to 34.81)	−25.50 (−69.50 to 18.50)	−35.34 (−68.86 to −1.82)	< 0.01
Model 2[b]	0 (Reference)	−7.32 (−33.15 to 18.51)	−28.20 (−50.06 to 6.34)	−25.82 (−48.29 to −3.35)	< 0.01
Model 3[c]	0 (Reference)	−19.19 (−44.19 to 10.81)	−42.52 (−77.24 to −7.80)	−43.64 (−79.80 to −7.48)	0.01

[a]Model 1 is adjusted for sex, age, recruitment period (2015-2017, 2018-2019, or 2020-2021), maternal age (continuous), and maternal high education (yes or no).
[b]Model 2 is adjusted for all the variables in model 1 and additionally gestational age (26 to <37 weeks, 37 to <40 weeks, or ≥40 weeks), mode of delivery (vaginal or caesarean), and birth weight (continuous).
[c]Model 3 is adjusted for all the variables in model 2 and additionally for number of siblings and position held among them, parental attitudes toward child's dietary habits (unhealthy, average, or healthy), parental knowledge about nutritional recommendations for children (low, medium, or high), and screen time (continuous).

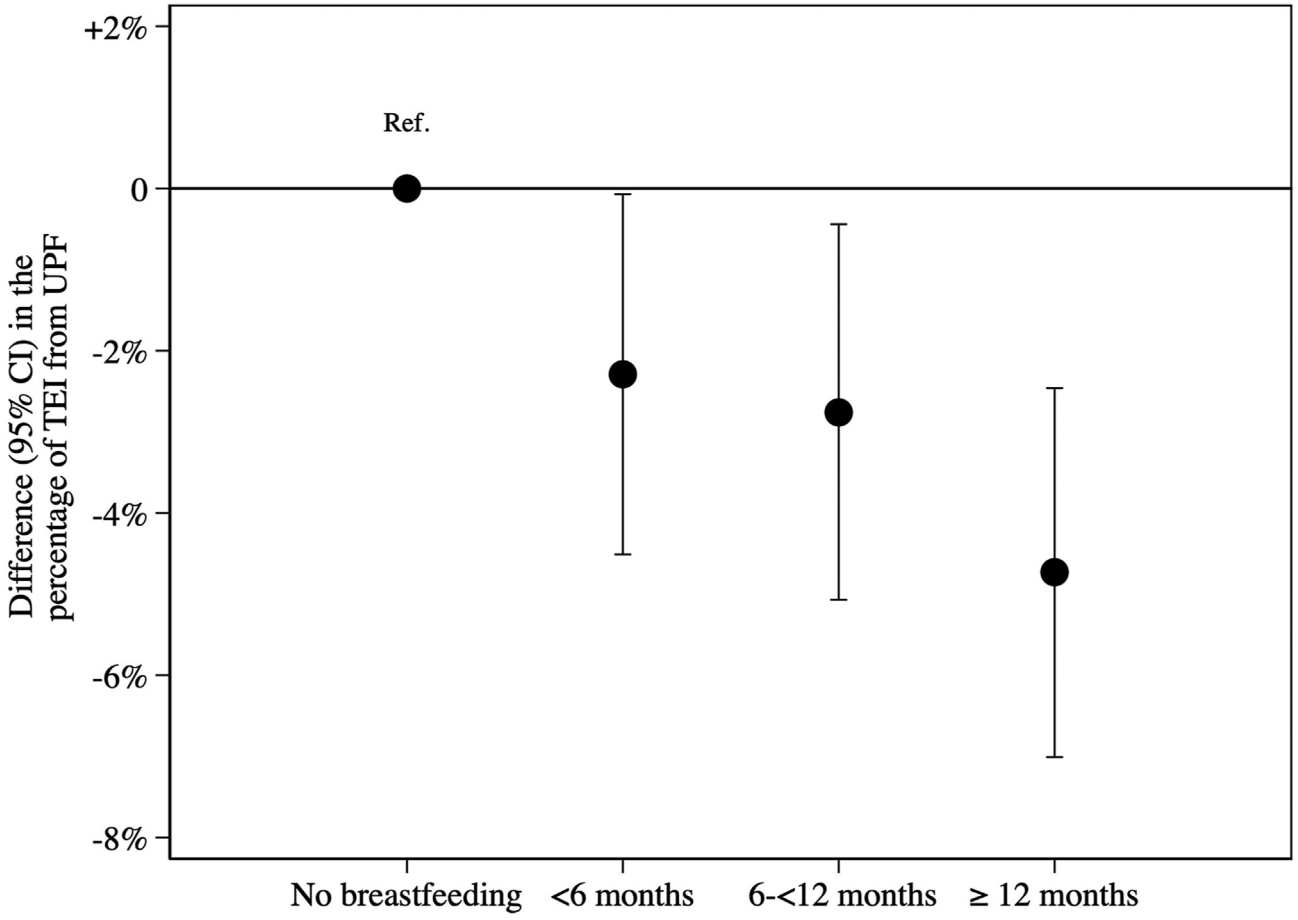

Figure 2. Difference and 95% CI in the percentage of total energy intake (TEI) from ultraprocessed foods (UPF) by category of breastfeeding duration in children aged 4 or 5 years enrolled in the Child Follow-Up for Optimal Development project between January 2015 and June 2021. General esstimating equation model adjusted for sex, age, recruitment period (2105-2017, 2018-2019, or 2020-2021), maternal age (continuous), maternal high education (yes or no), gestational age (26 to <37 weeks, 37 to <40 weeks, or ≥40 weeks), mode of delivery (vaginal or caesarean), birth weight (continuous), number of siblings and position held among them, parental attitudes toward child's dietary habits (unhealthy, average, or healthy), parental knowledge about nutrition recommendations for children (low, medium, or high), and screen time (continuous).

that reported higher consumption of fruits and vegetables in children who had been breastfed,[34-39] and with a work from our team in which higher adherence to the Mediterranean diet was observed in breastfed children.[40]

The consistency across studies with different designs suggests that the results may not be explained by just residual confounding. Although the mechanisms behind the association between breastfeeding and UPF consumption are not entirely clear, evidence suggests that early exposure to different flavors favors a greater predisposition to healthy products (ie, fruit and vegetables) in infancy.[41-43] Unlike with formula milk, the taste of breast milk can change with the mother's diet.[44] For this reason, breastfed infants are exposed to a wider variety of flavors than formula-fed infants, which may facilitate the acceptance of foods often rejected in infancy such as fruits and vegetables.

Becaudse the percentage of TEI that children consume from products in NOVA 4 varies worldwide, four cutoff points ranging from 25% to 40% were considered to represent different scenarios of UPF consumption.[45,46] A significant inverse linear association between breastfeeding and UPF consumption in the analysed scenarios was found. The reduction of the estimates in the least-conservative scenario (UPF representing >40% of TEI) may be explained by the reduced number of participants reporting that consumption.

In this study, the proportion of breastfed children was similar to that reported in a previous cohort study,[47] but higher than that reported by the Spanish Association of Pediatrics using data of the Spanish National Institute of Statistics of 45% at 6 months.[48] That difference may be due to the already known self-selection of participants in cohort studies, which causes samples in those studies to be composed of participants who are particularly health-conscious and that tend to have better adherence to healthy lifestyles.[49] Along with this, mean UPF consumption observed in this study was similar to that reported in a previous Spanish cohort study (25%),[32] but lower than in other European (>50%)[46,50] and North American (>50%) studies.[51] The differences observed in terms of UPF

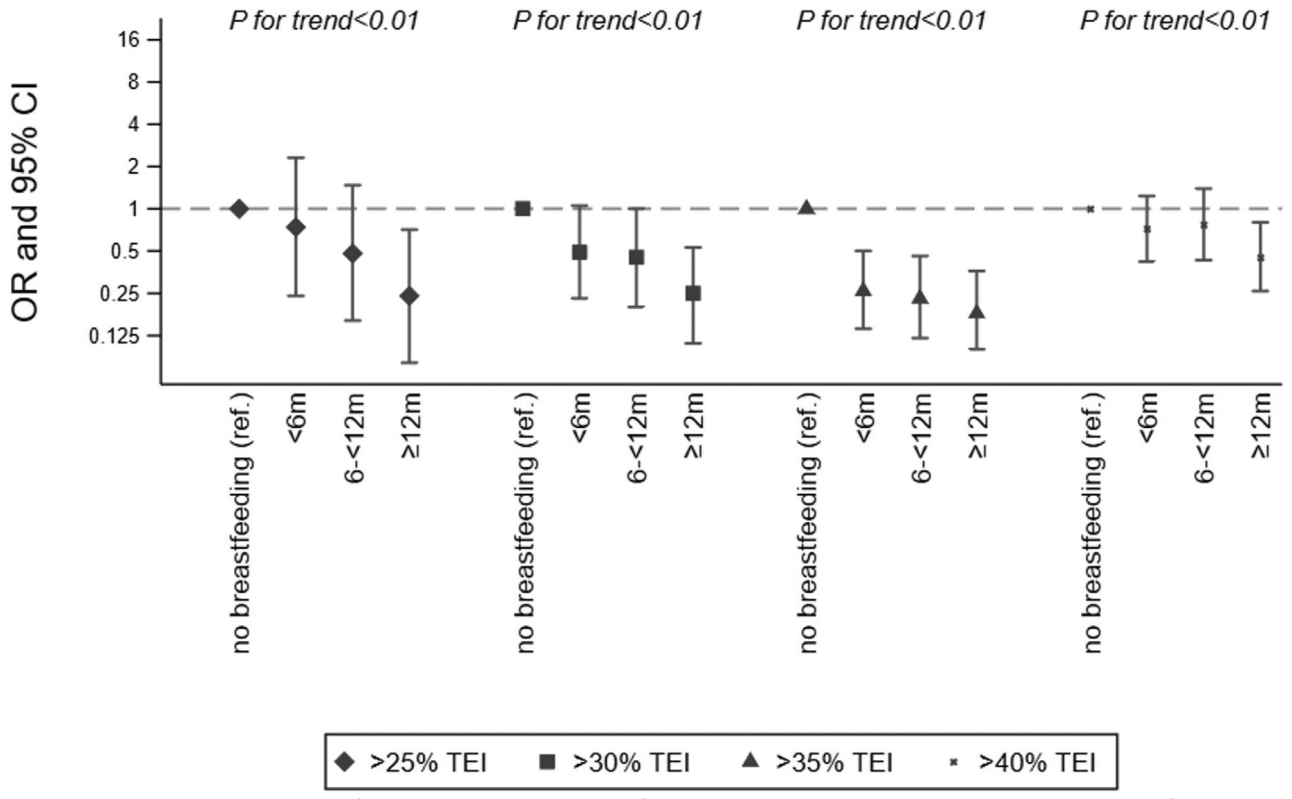

Figure 3. Odds rati (OR) and 95% CI for excessive ultraprocessed foods (UPF) intake (above 25%, 30%, 35%, and 40% of total energy intake (TEI) by breastfeeding duration category in children aged 4 or 5 years enrolled in the Child Follow-Up for Optimal Development project between January 2015 and June 2021. General esstimating equation model adjusted for sex, age, recruitment period (2105-2017, 2018-2019, or 2020-2021), maternal age (continuous), maternal high education (yes or no), gestational age (26 to <37 weeks, 37 to <40 weeks, or ≥40 weeks), mode of delivery (vaginal or caesarean), birth weight (continuous), number of siblings and position held among them, parental attitudes toward child's dietary habits (unhealthy, average, or healthy), parental knowledge about nutrition recommendations for children (low, medium, or high), and screen time (continuous).

consumption in Spain with respect to other European countries and especially with respect to the United States is probably due to a greater adherence in our population to traditional eating patterns.[52]

The relationship between breastfeeding and UPF consumption may be confounded by family factors. In this study, parents who breastfed their child had higher education levels ($P = 0.04$), higher nutritional knowledge ($P < 0.01$) and

Table 4. Adjusted proportions (95% CI) of children with energy intake from ultraprocessed foods above 25%, 30%, 35%, and 40% of total energy intake (TEI) by category of breastfeeding for children aged 4 or 5 years enrolled in the Child Follow-Up for Optimal Development project between January 2015 and June 2021

	Breastfeeding Duration			
	No breastfeeding	<6 mo	6 to <12 mo	≥12 mo
n	125	252	209	220
	← *adjusted proportion[a] (95% CI)* →			
>25% of TEI	94 (89-99)	93 (90-97)	88 (83-93)	80 (74-85)
>30% of TEI	87 (81-94)	81 (75-86)	77 (70-83)	66 (59-73)
>35% of TEI	82 (74-90)	59 (52-66)	54 (46-62)	45 (38-52)
>40% of TEI	45 (35-54)	37 (30-44)	35 (27-43)	27 (20-33)

[a]Adjusted for sex, age, recruitment period (2015-2017, 2018-2019, or 2020-2021), maternal age (continuous), maternal high education (yes or no), gestational age (26 to <37 weeks, 37 to <40 weeks, or ≥40 weeks), mode of delivery (vaginal or caesarean), birth weight (continuous), number of siblings and position held among them, parental attitudes toward child's dietary habits (unhealthy, average, or healthy), parental knowledge about nutrition recommendations for children (low, medium, or high), and screen time (continuous).

healthier attitudes toward their child's dietary habits ($P < 0.01$). Nevertheless, the observed association remained significant after adjusting for these potential confounders, suggesting there may be different pathways linking breastfeeding with UPF consumption.

Our study has several strengths, including the large sample size and a thorough control of confounding. However, some limitations must be acknowledged. First, due to the cross-sectional design, causality cannot be inferred. Nevertheless, reverse causality bias (ie, higher UPF consumption leading to lower breastfeeding) is highly unlikely. Second, information reported by the participants' parents was used. Nevertheless, previous validation studies in the SENDO Project showed that the information reported by parents on gestational weeks, birthweight, birth length,[53] and anthropometric measures[54] was valid with intraclass correlation coefficients ranging from 0.59 to 0.96. These findings strengthen the confidence in the accuracy and validity of parental self-reports in our participants. Third, the information regarding breastfeeding was susceptible to a memory bias. However, medical records of a random sample of 188 participants were consulted and observed a 96.8% agreement of breastfeeding history as a dichotomous variable and a 73.2% agreement in the duration of breastfeeding (<6 months, 6 to <12 months, or ≥12 months). Moreover, there is no evidence to conclude that the validity of the reported information on breastfeeding is associated with a child's consumption of UPF and therefore, in case of an information bias, it would lead to a non-differential misclassification, which would, in any case, bias the estimate toward the null.[55] Fourth, the SENDO cohort is mainly composed of highly educated families and therefore it is not representative of the Spanish population. Although this factor may hamper the generalizability of these results, it could also have some benefits, such as higher validity of the self-reported information and a reduction of potential confounding by socioeconomic variables.[56] Five, the FFQ used in this study was not designed to capture food intake according to NOVA classification. Although the NOVA classification is not exempt from limitations, the most notable being that it classifies products according to their degree of processing, not their nutritional value, studies carried out in different countries found a direct association between the consumption of products in NOVA 4 group and nutritional deterioration.[57] Besides, the use of the NOVA classification system in nutritional epidemiology research is widespread, which facilitates comparison with other studies.[58,59] Other classification systems, such as the Nutriscore,[60] are also not free of limitations and are less commonly used in epidemiological studies. Moreover, FFQs are prone to bias, which could result in misclassification.[61] Six, although FFQ are recommended to assess usual diet, they tend to overestimate dietary intake,[62] which could be an explanation for the energy intake reported by children this sample. Lastly, although these results were robust through the progressively adjusted models, the possibility of residual confounding by variables that were not considered, such us family socioeconomic status and parent's dietary intake, cannot be completely dismissed.

CONCLUSIONS

This study found an inverse linear trend between breastfeeding duration and UPF consumption in a sample of Mediterranean preschool-aged children. In addition, breastfeeding for 12 months or more was associated with lower odds of UPF representing more than 25% of daily energy intake. Further studies are needed to fully understand the association of breastfeeding with food consumption during childhood and the influence that breastfeeding promotion campaigns could have on preschool-aged childrens' diet.

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All authors collected the data. A. Olid and N. Martín-Calvo performed the statistical analyses. A. Olid and N. Martín-Calvo wrote the first draft with contributions from V. de la O and O. Bueso. All authors reviewed and commented on subsequent drafts of the manuscript.