Appetite 216 (2026) 108268

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Predictors of ultra-processed foods consumption in 4-year-old Spanish children

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ARTICLE INFO

Keywords:
NOVA
Infancy
Cohort
Mother
Sex-specific
Associated factors
Determinants

ABSTRACT

Ultra-processed foods (UPF) consumption has increased in recent decades, contributing to poor diet quality and certain health problems in early childhood. This study aimed to evaluate UPF consumption in 4-year-old children and determine maternal and child sociodemographic and lifestyle predictors of UPF consumption. We analysed data for 1736 mother-child pairs from the INfancia y Medio Ambiente birth cohort study. Children's diets were parent-reported using validated food frequency questionnaires from which UPF consumption was calculated according to the NOVA classification. We used multinomial logistic regression to assess associations between sociodemographic and lifestyle characteristics and child UPF consumption in tertiles (low, intermediate, high). The mean (SD) daily UPF consumption was 414.6 (240.2)g/day, accounting for 32.8 % of the total daily intake. The main sources of UPF consumption were ultra-processed dairy products (44.3 %), ultra-processed beverages (17.8 %) and sweet foods (16.5 %). A higher maternal UPF consumption during pregnancy [$RRR_{medium} = 1.68$ (95 %CI 1.23–2.30) and $RRR_{high} = 2.86$ (95 %CI: 2.02–4.04)] and child television viewing [$RRR_{>1.5\ h/day} = 1.65$ (95 %CI: 1.21–2.25)] were positively associated with a higher child UPF consumption, whereas maternal age≥30 years was associated with reduced UPF consumption [RRR = 0.71 (95 %CI: 0.54–0.94)]. These associations remained similar when stratified by sex, although maternal age effect was not significant in sex-specific models. Medium and high UPF consumption of mothers during pregnancy, younger age at pregnancy, and more television viewing in children were associated with higher UPF consumption at age 4. The identification of factors associated with child UPF consumption could support the development of health promotion strategies aimed at reducing UPF consumption in children.

1. Introduction

Ultra-processed foods (UPF) are products created by the food

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https://doi.org/10.1016/j.appet.2025.108268
Received 30 May 2025; Received in revised form 11 August 2025; Accepted 12 August 2025
Available online 12 August 2025

Abbreviations

CI	Confidence Interval
BMI	body mass index
FFQ	food frequency questionnaire
INMA	INfancia y Medio Ambiente
RRR	Relative Risk Ratios
SD	Standard Deviation
UPF	ultra-processed foods

industry using a sequence of processes to obtain palatable, convenient, and ready-to-eat foods. According to NOVA (Monteiro et al., 2010), the most widely used UPF classification system, these products are predominantly made of processed substances extracted from whole foods such as hydrogenated fats, flours and starches, with the combination of additives such as preservatives or colourants (Monteiro et al., 2013). The most common examples of UPF include soft drinks, packaged snacks, and frozen ready meals, but also other products typically consumed by children such as industrial grain foods, sugar-sweetened beverages, sweet snacks and sweets (Conway et al., 2024; Wang et al., 2021).

The consumption of UPF has increased considerably in recent decades (Monteiro et al., 2018; Wang et al., 2021) and represents a high percentage of the total daily energy intake during childhood, that varies between 38 % in Spanish children (García-Blanco et al., 2022) to 66.4 % in children from the United States (Livingston et al., 2021). This high consumption directly affects the nutritional quality of children's diets (Martini et al., 2021) as it has been associated with low intake of protein, fibre, vitamin A and iron, and high intake of total energy, fats and sodium (de Lacerda et al., 2023). In addition, UPF consumption during childhood has been associated with food addiction (Jurema Santos et al., 2024) and several health problems such as dental caries (Cascaes et al., 2022), obesity (Vallianou et al., 2025), some increased metabolic syndrome components like blood pressure, waist circumference, body fat or resistance to insulin (Frías et al., 2023; Petridi et al., 2023; Vallianou et al., 2025). Due to the high consumption of UPF and their negative health effects, there is a growing interest in evaluating the factors related to UPF consumption during childhood.

Previous studies have pointed out that higher UPF consumption during childhood was associated with several sociodemographic characteristics and lifestyle factors in children such as older age (Carroll et al., 2024), increased television viewing (Carroll et al., 2024), low levels of physical activity (Fonseca et al., 2023), skipping breakfast (Fonseca et al., 2023), as well as, higher parental soft drink/fast-food consumption (Carroll et al., 2024). In contrast, higher household income (Pereira et al., 2022), higher parental educational level (Carroll et al., 2024; Pereira et al., 2022; Silva et al., 2018) and older mothers (Pereira et al., 2022) were associated with lower UPF consumption in children. These results support that UPF consumption is linked to a great variety of factors and highlight the relevance of parental factors as predictors of UPF consumption during childhood.

In Spain, some studies have examined UPF consumption during childhood in relation to cardiometabolic risk (Khoury et al., 2024) or neuropsychological development (Puig-Vallverdú et al., 2022). However, to the best of our knowledge, only one study to date has focused specifically on identifying the factors associated with higher UPF consumption in Spanish children (García-Blanco et al., 2022). To the best of our knowledge, few studies have characterised the factors associated with UPF consumption during preschool, particularly in Spain. It is necessary to identify these factors in order to plan suitable preventive strategies and to reach a deeper understanding of their relationship with health. Thus, we aim to describe UPF consumption and evaluate the factors associated with its consumption in 4-year-old children in Spain.

2. Methodology

2.1. Study design and sample

We conducted a cross-sectional analysis of data collected at the 4 year follow-up visit of the prospective cohort INMA-INfancia y Medio Ambiente- (Environment and Childhood) Project (https://www.proyectoinma.org/) (Guxens et al., 2012). The INMA Project is a mother-child population-based study carried out in seven geographical areas in Spain, of which four were included in the present study: Asturias, Gipuzkoa, Sabadell and Valencia. Between November 2003 and February 2008, pregnant women attending their first prenatal visit were invited to participate in the INMA Project if they met the following inclusion criteria: $\geq$16 years of age, intention to deliver at reference hospital, no communication problems, singleton pregnancy and no assisted conception (Guxens et al., 2012). After excluding those women who miscarriage ($n = 62$), who suffered foetal deaths ($n = 10$), who withdrew from the study ($n = 61$), or who were lost during follow-up ($n = 5$), 2626 women delivered a live infant between May 2004 and August 2008. For this study, we have included 1736 mother-child pairs with complete information regarding diet, sociodemographic characteristics, and lifestyle factors collected at the 4-year follow-up visit (see Fig. 1.).

All participants provided informed written consent. The study protocol was approved by the Ethical Committees of the Institutions involved in the INMA Project (CEIC-Hospital La Fe, Valencia; CEIC-Área Sanitaria de Guipúzkoa, Gipuzkoa; CEIC-Parc de Salut del Mar, Barcelona; CEIM del Principado de Asturias).

2.2. Dietary intake and UPF consumption

We used personal interviews with parents and caregivers carried out by nutritionists and trained fieldworkers to collect information on the usual diet of children at the age of 4 along the study period (mean age, 4.41 years; SD, 0.18 y). We used a validated semi-quantitative food frequency questionnaire (FFQ) with a list of 105 food items that included the most frequently consumed foods among children 4 years old, which allowed us to estimate total food and calory intake (Vioque et al., 2016). The FFQ included nine possible answers regarding frequency intake, ranging from 'Never or <1 per month' to '$\geq$6 per day'. Standard units and common serving sizes for children 4–5 years old were specified for each food item. To estimate daily intake for foods in grams, the reported frequency of consumption for each item was multiplied by the standard portion size and converted to average grams per day. Information on calorie and nutrient intakes were obtained from the databases from the United States Department of Agriculture (U.S. Department of Agriculture, Agricultural Research Service, 2008) and and, for some specific Spanish foods, from available food composition tables in Spain (Palma et al., 2008).

A specialized working group composed by dietitians and nutritional epidemiologists classified all the FFQ items into the four food groups proposed in the NOVA system (Monteiro et al., 2018). The first food group, Unprocessed or minimally processed foods, includes edible parts of natural, unprocessed, or minimally processed foods such as fruits, vegetables, and eggs among others. The second food group, Processed culinary ingredients, includes foods used for preparations, seasoning and cooking, including oils, butter, sugars and salt. The third food group, Processed foods, includes foods that have been modified using non-alcoholic fermentations or processing to preserve them and/or to modify their sensory qualities. This group includes food items such as canned fish, bread and cheese among others. The fourth food group, UPF, includes foods obtained after a series of processes and with several ingredients or substances such as oils, fats, salt, sugars, lactose, preservatives, antioxidants, and stabilizers. This group includes soft drinks, packaged snacks, processed meats, commercial sauces and frozen ready meals, among others. The classification of all food items from the FFQ according to the NOVA system can be found in supplemental materials,

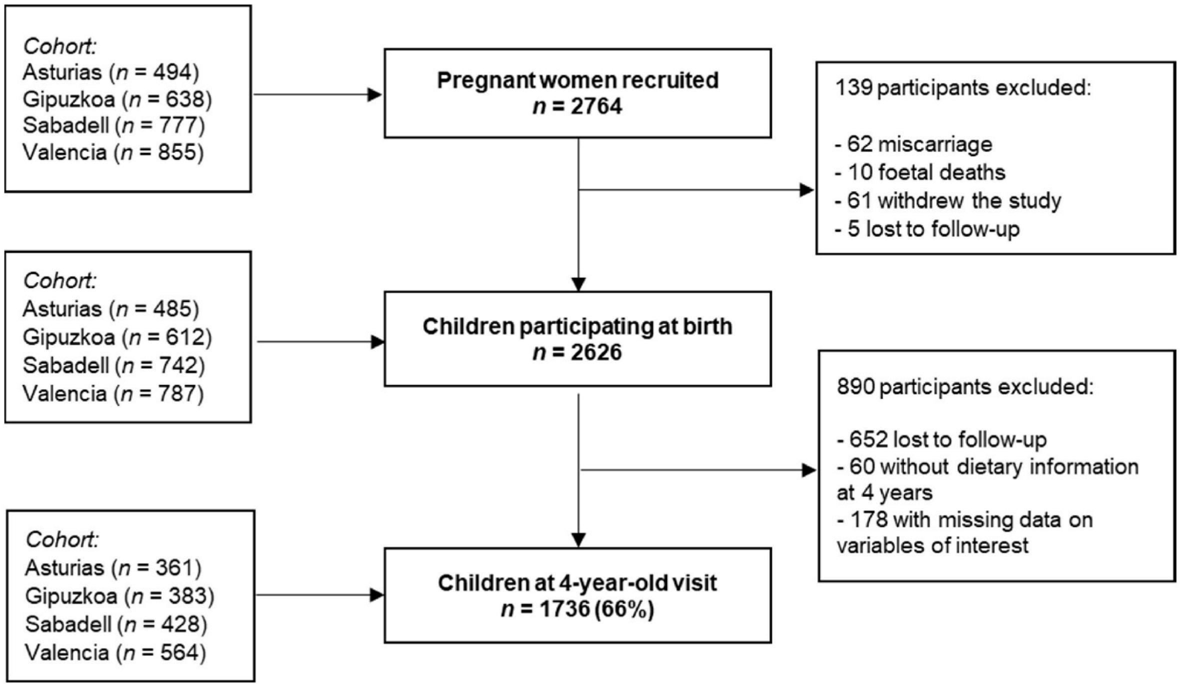

Fig. 1. Flowchart of participant progress across follow-up visits in the INfancia y Medio Ambiente (INMA) Study.

Table S1.

Total UPF consumption was calculated as the sum of 38 food items assessed in the FFQ, subdivided into 5 subgroups: Ultra-processed Dairy products, ultra-processed meats, Fast foods, Sweet foods, and ultra-processed Beverages (see supplemental materials, Table S2). Total UPF consumption was relativized by total daily consumption in grams [UPF consumption (in grams)/total consumption of all foods other than water (in grams) *100 = % of UPF within total dietary intake] and was then divided in tertiles. We did not calculate the percentage of energy derived from UPF because some UPF, such as artificial-sweetened beverages, contain no calories and calculating the percentage of energy derived from them could lead to an underestimation of UPF consumption.

2.3. Covariates

Additional information was obtained through structured questionnaires administered by trained staff at pregnancy and childhood visits. The following maternal information was collected during pregnancy: age (in years), educational level (primary or less, secondary, university), social class derived from occupation using the Spanish adaptation of the international ISCO88 coding system (high, medium, low) (Domingo-Salvany et al., 2000), self-reported pre-pregnancy body mass index (BMI) (normal weight = BMI< 25 kg/m^2, overweight = BMI 25–29.99 kg/m^2 and obesity = BMI ≥30 kg/m^2) and the mean of UPF consumption during pregnancy (in tertiles [low, intermediate, high]). Pre-pregnancy UPF consumption was estimated using a validated 101-item FFQ administered at weeks 12 and 32 of gestation. Daily intake in grams was calculated by multiplying the reported frequency of consumption of each UPF item by its standard portion size and averaging the resulting values across both time points. At childhood visits, the following information was collected: child sex (girl, boy), age (in years), tertiles of television viewing (hours/day) and tertiles of physical activity level (hours/day).

2.4. Statistical analyses

First, sociodemographic and lifestyle characteristics were described for the total sample and according to tertiles of child UPF consumption using the mean and standard deviation (SD) for continuous variables or the number and percentage for categorical variables. We calculated ANOVA and Chi-square tests to compare participants' characteristics according to tertiles of UPF consumption. We tested the normality of UPF consumption using the Shapiro–Wilk test. Since UPF consumption was not normally distributed, we described it using both the median (interquartile range, IQR) and the mean (SD) for all participants, as well as stratified by child sex, to ensure statistical appropriateness and consistency with previously published findings.

Second, we categorized children's UPF consumption into tertiles to facilitates interpretation and to account for the skewed nature of the data. Multinomial logistic regression models were used to evaluate the association between the dependent variable, tertiles of UPF consumption (low: range 2.5–24.5 %, intermediate: range 24.6–36.9 %, high: range 37.0–80.4 %), and independent variables (sociodemographic and lifestyle characteristics). Results are presented as Relative Risk Ratios (RRR) with 95 % confidence intervals (95 %IC), using first tertile of UPF (i.e., low consumption) as the reference category. In the multivariate models we adjusted by the following variables: cohort (Asturias, Gipuzkoa, Sabadell, Valencia), mother's age, educational level, social class and pre-pregnancy BMI, as well as the children's sex, age, television viewing time and overall physical activity level. We repeated the analyses stratifying by child sex to explore possible differences in the associations between girls and boys, because differences between sex have been found in previous studies (Hilsen et al., 2013; Magalhães et al., 2021). In addition, we conducted a sensitivity analysis including breads as UPF, to enhance comparability with other studies that classify breads as UPF.

Statistical analyses were performed using STATA program (version 18, StataCorp, United States of America, http://www.stata.com) and two-side p-values <0.05 were considered statistically significant.

3. Results

Table 1 shows main characteristics of participants stratified by tertiles of UPF consumption in children at the age of 4 years. Children with the highest UPF consumption had older mothers (≥30 years 58.1 %, $p < 0.001$), with secondary educational level (44.6 %, $p < 0.001$), lower

Table 1
Characteristics of participants stratified by tertiles of UPF consumption (expressed as % of total daily intake in grams) in 4-year-old children from the INMA Study (n = 1736)[a].

	Total sample	Child UPF consumption			p-value[b]
		Low (Tertile 1)	Intermediate (Tertile 2)	High (Tertile 3)	
Tertile range (% of total daily intake in grams)		2.5–24.5	24.6–36.9	37.0–80.4	
Number of participants	1736	580	578	578	
Mother characteristics during pregnancy					
Cohort					
Asturias	361 (20.8)	236 (40.7)	85 (14.7)	40 (6.9)	<0.001
Gipuzkoa	383 (22.0)	138 (23.8)	125 (21.6)	120 (20.8)	
Sabadell	428 (24.7)	95 (16.4)	169 (29.2)	164 (28.4)	
Valencia	564 (32.5)	111 (19.1)	199 (34.4)	254 (43.9)	
Age (years)					<0.001
<30	615 (35.5)	152 (26.2)	221 (38.2)	242 (41.9)	
≥30	1121 (64.6)	428 (73.8)	357 (61.8)	336 (58.1)	
Educational level					<0.001
Primary or less	363 (20.9)	97 (16.7)	125 (21.6)	141 (24.4)	
Secondary	722 (41.6)	220 (37.9)	244 (42.2)	258 (44.6)	
University	651 (37.5)	263 (45.3)	209 (36.2)	179 (31.0)	
Social class					0.026
High	412 (23.8)	154 (26.6)	146 (25.3)	112 (18.4)	
Medium	478 (27.5)	164 (28.3)	154 (26.6)	160 (27.7)	
Low	846 (48.7)	262 (45.2)	278 (48.1)	306 (52.9)	
Pre-pregnancy weight status (kg/m^2)					0.098
Normal weight (<25)	1280 (73.7)	444 (76.6)	411 (71.1)	425 (73.5)	
Overweight (25–29.99)	324 (18.7)	105 (18.1)	114 (19.7)	105 (18.2)	
Obesity (≥30)	132 (7.6)	31 (5.3)	53 (9.2)	48 (8.3)	
Pre-pregnancy energy intake (kcal/day)	2067 (458)	2039 (439)	2071 (446)	2092 (487)	0.131
Pre-pregnancy tertiles of UPF consumption (% g/day)					<0.001
Low (<10.4)	613 (35.3)	291 (50.2)	183 (31.7)	139 (24.1)	
Intermediate (10.4–17.1)	586 (33.8)	183 (31.6)	209 (36.2)	194 (33.6)	
High (>17.1)	537 (30.9)	106 (18.3)	186 (32.2)	245 (42.4)	
Child characteristics at 4-year-old					
Sex					0.577
Girl	832 (47.9)	288 (49.7)	274 (47.4)	270 (46.7)	
Boy	904 (52.1)	292 (50.3)	304 (52.6)	308 (53.3)	
Age (years)	4.41 (0.18)	4.43 (0.19)	4.42 (0.16)	4.40 (0.18)	0.016
Tertiles of physical activity (hours/day)					<0.001
Low (<1.7)	679 (39.2)	184 (31.7)	226 (39.1)	269 (46.5)	
Intermediate (1.7–2.7)	600 (34.6)	219 (37.8)	202 (35.0)	179 (31.0)	
High (>2.7)	457 (26.3)	177 (30.5)	150 (26.0)	130 (22.5)	
Tertiles of television viewing (hours/day)					<0.001
Low (≤1)	703 (40.5)	280 (48.3)	214 (37.0)	209 (36.2)	
Intermediate (>1 to 1.5)	487 (28.1)	158 (27.2)	177 (30.6)	152 (26.3)	
High (>1.5)	546 (31.5)	142 (24.5)	187 (32.4)	217 (37.5)	
Total energy intake (kcal/day)	1580 (347)	1560 (337)	1561 (328)	1620 (373)	0.003

BMI=Body Mass Index; g = grams; kcal = kilocalories; kg = kilograms; m = meters; UPF = Ultra-processed foods.
[a] Values are means (SD) or numbers of participants (percentages).
[b] P-values were calculated by ANOVA test for continuous variables and $\chi 2$ test for categorical variables.

social class (52.9 %, p < 0.026) and with higher UPF consumption (42.4 %, p < 0.001). In addition, these children showed lower levels of daily physical activity (46.5 %, p < 0.001), higher television viewing (>1.5 h 37.5 %, p < 0.001) and higher total daily energy intake (1620 kcal/day. p < 0.003).

Children's total UPF and subgroup consumption for the total sample and stratified by sex is shown in Table 2. The mean (SD) daily intake of UPF was 414.6 (240.2) g/day, which represented 32.8 % of total daily dietary intake. The most consumed UPF subgroups were Dairy products, which represented 44.3 % of their total UPF consumption, followed by Beverages (17.8 %) and Sweet Foods (16.5 %). Intakes and proportions were similar between both sexes, except for Beverages, where boys (92.8 g/d and 19.0 %) showed higher consumption than girls (71.6 g/d and 16.5 %, p-value <0.01), mainly due to a higher consumption of sugar-sweetened soft-drinks and packaged juices (see supplemental material, Fig. S1.). When we evaluated the consumption (mean [SD]) for each food item of UPF individually, the most consumed were packaged juices (66.6 [97.8] g/day), flavoured yogurt (57.8 [69.6] g/day), and flavoured milk drinks (39.6 [130.2] g/day) (Table 3).

Table 4 shows the results of the multivariable analyses. Maternal obesity (RRR = 1.83; IC95 % 1.11–3.02), higher maternal UPF consumption during pregnancy (RRR_{medium} = 1.49, IC95 % 1.11–2.00; and RRR_{high} = 1.87, IC95 % 1.33–2.62) and higher television viewing ($RRR_{>1–1.5\ h/day}$ = 1.42, IC95 % 1.06–1.92 and $RRR_{>1.5\ h/day}$ = 1.49, IC95 % 1.10–2.02), were positively associated with child UPF consumption in the intermediate tertile; whereas having a mother ≥30 years showed an inverse association with children UPF consumption (RRR = 0.73, IC95 % 0.56–0.95). In the highest tertile of child UPF consumption, a higher maternal UPF consumption during pregnancy (RRR_{medium} = 1.68, IC95 % 1.23–2.30; and RRR_{high} = 2.86, IC95 % 2.02–4.04), and a greater child television viewing ($RRR_{>1.5\ h/day}$ = 1.65, IC95 % 1.21–2.25) were positively associated with children's UPF consumption, whereas maternal age≥30 years (RRR = 0.71, IC95 % 0.54–0.94) was inversely associated. When analyses were stratified by child sex, results were similar, except for the association with maternal age, which lost significance in both sexes (see supplemental material, Table S3). Finally, a sensitivity analysis was conducted in which all types of bread were classified as UPFs. The mean of UPF was 33.5 % (SD 15.1), compared to 32.8 % (SD 15.1) in the main analysis, showing minimal variation. When we repeated the analyses the results and main associations remained

Table 2
Consumption of UPF in 4-year-old children from the INMA Study (n = 1736).

	Total sample (n = 1736)		Girls (n = 832)		Boys (n = 904)		p-value[c]	p-value[d]
	mean (SD)	median (IQR)	mean (SD)	median (IQR)	mean (SD)	median (IQR)		
Total UPF consumption								
Grams/day	414.6 (240.2)	353.3 (259.6)	397.0 (221.1)	338.2 (243.0)	430.8 (255.5)	372.0 (266.2)	0.001	0.006
% of UPF in total daily dietary intake[a]	32.8 (15.1)	30.2 (19.7)	32.5 (15.2)	29.6 (19.5)	33.1 (15.0)	30.4 (19.8)	0.322	0.379
UPF subgroups								
Dairy products								
Grams/day	204.7 (188.5)	149.2 (173.2)	200.2 (180.0)	148.4 (168.2)	208.7 (196.0)	149.8 (180.4)	0.180	0.644
% within total UPF[b]	44.3 (21.3)	43.7 (31.3)	45.1 (20.8)	45.9 (30.2)	43.5 (21.8)	42.6 (32.2)	0.154	0.098
Processed meats								
Grams/day	35.3 (17.7)	32.4 (21.8)	34.3 (17.0)	31.4 (21.7)	36.2 (18.2)	33.2 (22.4)	0.029	0.031
% within total UPF[b]	10.5 (6.6)	9.2 (7.7)	10.5 (6.1)	9.2 (7.7)	10.5 (7.1)	9.2 (7.8)	0.977	0.392
Fast foods								
Grams/day	36.8 (19.4)	34.8 (23.4)	36.0 (18.0)	34.2 (23.1)	37.6 (20.5)	35.1 (23.4)	0.106	0.246
% within total UPF[b]	10.9 (7.1)	9.5 (8.0)	11.0 (6.8)	9.5 (8.1)	10.9 (7.4)	9.5 (8.1)	0.721	0.347
Sweet Foods								
Grams/day	55.2 (29.7)	50.3 (35.6)	54.9 (28.9)	50.8 (35.6)	55.5 (30.3)	49.9 (35.5)	0.391	0.853
% within total UPF[b]	16.5 (10.8)	14.2 (12.4)	17.0 (10.8)	14.6 (12.6)	16.1 (10.9)	13.7 (12.0)	0.208	0.031
Beverages								
Grams/day	82.6 (112.7)	68.8 (82.1)	71.6 (91.0)	50.1 (82.1)	92.8 (128.7)	12.7 (24.2)	<0.001	0.002
% within total UPF[b]	17.8 (16.8)	14.6 (25.6)	16.5 (15.9)	68.8 (125.8)	19.0 (17.6)	15.8 (27.9)	0.006	0.008

SD=Standard Deviation; UPF=Ultra-processed foods.
Dairy products include milk with added sugar, flavoured yogurt with added sugar, flavoured milk drinks, Petit-Suisse or similar, custard, pudding or similar and ice cream. *Processed meats* include ham (cured and cooked), processed meat (dried sausage, chorizo or similar), sausages; other sausages, pâtés and foie gras and meat burgers. *Fast foods* include c*roquetas,* Spanish turnovers, fish derivates, French fries, potato chips, other snacks, pizza, margarine, commercial mayonnaise, fried tomato sauce and ketchup. *Sweet foods* include breakfast cereals, breakfast cereals with fiber, Maria type cookies, cookies with chocolate, cookies with fiber, muffins or similar, croissant, doughnuts or similar, other pastries with chocolate, chocolate, cocoa powder or similar, chocolate cream to spread and sweets or caramels. *Beverages* include sugar-sweetened soft drinks; artificial-sweetened soft drinks and packaged juices.

[a] The UPF consumption was expressed as a percentage of total daily dietary intake in g (intake of UPF (g/d)/total dietary intake (g/d)*100).
[b] The consumption of each food sub-group was expressed as a percentage of total UPF intake in g (intake of each food sub-group (g/d)/total UPF intake (g/d)*100).
[c] P-value from ANOVA test. [d]P-value from Kruskal-Wallis's test.
[d] P-value from Kruskal-Wallis's test.

mostly unchanged (Table S4).

4. Discussion

This study has shown that children's UPF consumption at 4 years of age was positively associated with pre-pregnancy maternal obesity, maternal increased UPF consumption during pregnancy and greater child television viewing at 4 years, whereas having a mother 30 years or older was protective in children's UPF consumption. Results were similar when stratifying analyses by child sex, except for maternal age, which did not maintain statistical significance.

In our study, nearly one third of the total dietary intake in children (32.8 %) came from UPF. This proportion is lower than the 38.8 % reported among 4-year-old children in Chile (Zancheta et al., 2024) and the 36.2 % found in 6-year- old Brazilian children (Costa et al., 2020), but higher than the 22.3 % observed Portuguese children aged 3–9 year (Magalhães et al., 2021). These differences may reflect cross-country variation in dietary patterns, availability of UPF, and methodological differences in how UPF consumption is assessed. Differences in the age range among study populations could also explain the differences in UPF consumption. Studies conducted in different countries have shown that older children tend to have a lower proportion of UPF in their total dietary intake, although these differences were not statistically significant. For instance, UPF consumption in Brazil was reported to be 42 % at the age of 6 and 32.7 % at the age of 11(Costa et al., 2020) and in Indonesia was 41.4 % at the age of 0–4 years and 29 % at the age of 5–12 (Setyowati et al., 2018). In Mexico, the difference between age groups was statistically significant, UPF accounted for 38.6 % of total energy intake in children aged 1–4 years and 34.3 % in those aged 5–11 years (Marrón-Ponce et al., 2018). The Mediterranean dietary pattern could also justify the differences found among studies. In the same study population as ours, 70 % of children had a medium or high adherence to the Mediterranean diet according to the relative Mediterranean Diet score (Notario-Barandiaran et al., 2020). The Mediterranean diet emphasizes fresh and minimally processed foods such as vegetables, fruits, nuts, whole grains, olive oil, and spices (Hu et al., 2025) which may result in a lower consumption of UPF. In this sense, there are some studies showing that adherence to the traditional Mediterranean diet was inversely associated with energy intake from UPF in children at the age 5 of in Spain (da Rocha et al., 2021), and in children and adolescents at ages 5–19 in Italy (Ruggiero et al., 2021).

Ultra-processed Dairy products, Beverages and Sweet Foods were the most consumed UPF subgroups in our sample and the most consumed individual UPF were packaged juices, flavoured yogurt and flavoured milk drinks. This consumption was similar to that reported in toddlers from the United Kingdom (Conway et al., 2024), in preschool children from Spain (Khoury et al., 2024) and in children from Portugal (Magalhães et al., 2021), where children consumed large amounts of sugary and flavoured yogurt (Conway et al., 2024; Khoury et al., 2024; Magalhães et al., 2021), other dairy products such as flavoured milk, sugary beverages (Khoury et al., 2024; Magalhães et al., 2021) and sugary foods and sweets (Khoury et al., 2024).

The high proportion of ultra-processed dairy products in preschool children diets could be due to the parental perception that they are healthy foods (Girona et al., 2025), although many of them contain added sugar. In addition, marketing strategies promoting these products may play a key role, as ultra-processed dairy products are the most advertised foods on children's television channels (Rovirosa et al., 2017). Ultra-processed beverages were the second most consumed subgroup, with a significantly higher consumption in boys than in girls. When we explored the types of ultra-processed beverages, we found that boys consumed more sugar-sweetened soft-drinks and packaged juices than girls. This sex difference has been previously described in the Portuguese National Food, Nutrition and Physical Activity Survey, that showed similar consumption of soft drinks in girls and boys during childhood and adolescence, but not from young adulthood, when men

Table 3
Mean consumption of each UPF for total sample at 4 years old.

	Mean (SD)	Median (IQR)
Milk with added sugar	39.6 (130.2)	0 (0)
Flavoured yogurt	57.8 (69.6)	45.2 (90.4)
Flavoured milk drinks	46.8 (89.1)	11.7 (68.8)
Petit-Suisse or similar	37.5 (58.2)	21.6 (39.6)
Custard, pudding or similar	18.6 (25.2)	6.7 (39.3)
Ice cream	4.5 (6.5)	2.7 (5.7)
Ham (cured and cooked)	12.8 (8.8)	9.8 (7.1)
Dried sausage, chorizo or similar	7.7 (6.5)	9.8 (6.3)
Sausages	2.7 (4.4)	1.3 (2.9)
Other sausages	4.7 (5.3)	2.7 (5.7)
Pâtés and foie gras	1.5 (2.6)	0 (2.9)
Burger	6.2 (5.6)	6.0 (3.2)
Croquetas	4.6 (5.7)	2.7 (5.7)
Spanish turnovers	1.0 (2.1)	0 (0)
Fish derivates	3.7 (5.6)	4.0 (4.0)
French fries	3.0 (5.5)	0 (3.4)
Potato Chips	3.1 (3.5)	1.7 (1.9)
Other snacks	2.6 (3.2)	1.7 (3.6)
Pizza	7.7 (7.9)	6.7 (14.3)
Tomato sauce	6.9 (5.9)	4.3 (9.8)
Mayonnaise	1.00 (1.8)	0 (1.4)
Ketchup	2.9 (4.4)	1.0 (5.9)
Margarine	0.6 (1.9)	0 (0)
Breakfast cereals	7.4 (13.8)	0 (11.8)
Breakfast cereals with fiber	6.2 (16.8)	0 (0)
Maria type cookies	5.9 (8.9)	2.4 (5.1)
Cookies with chocolate	3.7 (6.9)	1.7 (4.7)
Muffins or similar	0.5 (2.6)	0 (0)
Cookies with fiber	3.4 (8.0)	0 (4.3)
Croissant, doughnuts or similar	2.0 (3.7)	0 (2.0)
Other pastries with chocolate	2.4 (7.1)	0 (0)
Chocolate	6.5 (8.4)	3.6 (8.2)
Cocoa powder or similar	9.1 (9.8)	7 (16.5)
Chocolate cream to spread	3.2 (3.9)	2.9 (2.9)
Sweets or caramels	4.9 (6.7)	1.9 (4.2)
Sugar-sweetened soft-drinks	15.4 (42.6)	0 (11.7)
Artificial-sweetened soft-drinks	3.6 (19.2)	0 (0)
Packaged juices	66.6 (97.8)	25.0 (68.8)

UPF=Ultra-processed foods.

tended to consume more soft-drinks than women (Magalhães et al., 2021). Gender differences in the consumption of soft drinks might be related to taste preferences and the influence of relatives' consumption, among others (Hilsen et al., 2013), although further research is needed to fully understand this disparity.

Our study found that higher maternal UPF consumption during pregnancy was associated with higher children's UPF consumption. This is also consistent with previous studies showing that parents' dietary habits, including UPF consumption, could be transmitted to the offspring (Carroll et al., 2024; Oliveira et al., 2024), possibly through early exposure to these products and their availability at home. In addition, we found that maternal age over 30 years was inversely associated with UPF consumption in children. This finding is consistent with other studies that have reported that children with older mothers tend to consume less UPF (Pereira et al., 2022). We hypothesize that the association between maternal age and children's UPF consumption is influenced by maternal UPF consumption because previous studies have described that older women consume fewer UPF than younger women (Dicken et al., 2023). In this sense, we analysed maternal UPF consumption according to age in our sample, and we found that younger mothers had significantly higher UPF consumption than older mothers (data not shown). We also used a likelihood ratio test to explore a possible interaction between maternal age and maternal UPF consumption in the association with children's UPF consumption, but no significant interaction was found (data not shown). When we stratified the analysis by child sex, the association between maternal age and children's UPF consumption lost statistical significance which may be in part due to the decrease in sample size.

Table 4
Factors associated with UPF consumption in 4-year-old children from the INMA Study (n = 1736)[a].

	Child UPF consumption in tertiles (ref.: Low, 2.5–24.5 %, n = 580)			
	Intermediate (24.6–36.9 %) (n = 578)		High (37.0–80.4) (n = 578)	
	RRR[b]	95 % CI[b]	RRR[b]	95 % CI[b]
Mother characteristics during pregnancy				
Age (years). *Ref. <30*				
≥30	0.73	0.56–0.95	0.71	0.54–0.94
Educational level. *Ref. Primary or less*				
Secondary	1.08	0.76–1.55	1.13	0.79–1.62
University	0.82	0.53–1.26	0.82	0.53–1.27
Social class. *Ref. High*				
Medium	0.78	0.55–1.11	1.00	0.68–1.46
Low	0.80	0.55–1.17	1.04	0.69–1.55
Pre-pregnancy weight status (kg/m^2). *Ref. Normal weight* (<25)				
Overweight (25–29.99)	1.27	0.92–1.75	1.17	0.83–1.64
Obesity (≥30)	1.83	1.11–3.02	1.56	0.92–2.66
Tertiles of UPF consumption (% g/day)[2]. *Ref. Low* (<10.4)				
Intermediate (10.4–17.1)	1.49	1.11–2.00	1.68	1.23–2.30
High (>17.1)	1.87	1.33–2.62	2.86	2.02–4.04
Child characteristics at 4-year-old				
Age (years)	1.07	0.51–2.28	0.75	0.33–1.70
Sex. *Ref. Girl*				
Boy	1.09	0.85–1.39	1.14	0.88–1.47
Tertiles of physical activity (hours/day). *Ref. Low (<1.7)*				
Intermediate (1.7–2.7)	1.16	0.84–1.58	1.01	0.73–1.39
High (>2.7)	1.10	0.75–1.60	0.85	0.57–1.26
Tertiles of television viewing (hours/day). *Ref. Low (≤1)*				
Intermediate (>1 to 1.5)	1.42	1.06–1.92	1.22	0.89–1.66
High (>1.5)	1.49	1.10–2.02	1.65	1.21–2.25

BMI=Body Mass Index; CI= Confidence Intervals; kg = kilograms; m = meters; Ref = Reference; RRR=Relative risk Ratios; UPF=Ultra-processed foods. Bold style indicates statistically significant results.
[a] UPF consumption as % of total daily intake in grams.[2]Tertiles of consumption.
[b] Relative risk ratios and 95 % CI from multinomial logistic regression adjusted by all variables included in the table and cohort.

We also found a positive association between child television viewing time and UPF consumption. This finding has also been reported in a community-based prospective cohort of American preschool children from the New Hampshire, US (Carroll et al., 2024) and in Spanish preschool children from the SENDO project ('Seguimiento del Niño para un Desarrollo Óptimo') (García-Blanco et al., 2022). This association could be explained by children's exposure to a large number of UPF advertisements during television viewing (Powell et al., 2024) which can influence food preferences. In Argentina, food and beverage advertising in children's channels account for 20 % of television advertising time (Rovirosa et al., 2017), and the most advertised products are ultra-processed dairy products, sweets and candies, fast-food meals, and ultra-processed beverages (Rovirosa et al., 2017), which coincide with the most consumed subgroups of UPF in our sample. Similarly, another study conducted among Spanish children and adolescents aged 4 to 16 found that they were exposed to an average of 82 food and beverage advertisements per week, 82 % of which promoted unhealthy products. In other words, they were exposed to 10 advertisements per day for unhealthy foods and drinks on television. Interestingly, this exposure was significantly higher among children from lower socio-economic backgrounds (Royo-Bordonada et al., 2024). Another possible explanation for our results is that eating while watching TV may be a distraction leading to non-conscious eating of UPF (López-Gil et al., 2025). In fact, previous studies have shown that TV watching during meals is associated with higher UPF consumption in children (Avery et al., 2017; López-Gil et al., 2025; Martín-Calvo et al., 2024).

In our study, no significant association was found between child physical activity and UPF consumption. This finding is consistent with previous research reporting null associations between physical activity levels and UPF consumption in children (Fonseca et al., 2023). This lack of association may reflect the fact that physical activity and dietary patterns are shaped by different behavioral, social, and environmental influences, particularly during early childhood, when the family context plays a crucial role. Indeed, some studies have shown that certain parent-related habits, such as increased screen time (Oliveira et al., 2024) or eating meals with the family while watching TV (Onita et al., 2021), are associated with higher consumption of UPF in children. This evidence, together with the significant association we found between higher TV viewing in children and increased UPF consumption, supports the hypothesis that sedentary behaviors may be stronger predictors of UPF consumption during childhood than physical activity levels.

This study has some limitations that should be acknowledged. First, our cross-sectional design limits the ability to establish causal associations. However, the INMA Project is a perspective birth cohort study, and the data used in our analyses was collected chronologically in different visits of follow-up (pregnancy, birth and at the age of 4 years) what ensure the quality of the information and reduce recall bias. Second, children's dietary intake was reported by their caregivers. In this regard, if parents were not fully aware of their children's food consumption at pre-school, some degree of misreporting or underestimation may have occurred. In addition, the reported intake may be influenced by social desirability bias, which occurs when participants consciously or unconsciously adjust their self-reports to align with what they believe is socially acceptable or desirable. As a result, individuals might report their dietary habits more positively than they actually are, leading to overreporting of 'healthy' foods and underreporting of less desirable or unhealthy foods (Hebert et al., 1995). Although the two FFQ that we used in this study were previously validated (Vioque et al., 2013, 2016), in both pregnant women and children, and were also administered by trained staff, which helps minimize the risk of misinterpretation or non-response, they may not have captured all consumed foods by the participants, particularly those rarely consumed. This could cause some underestimation of UPF consumption although the bias should be non-differential, if any. Third, we cannot rule out the possibility of misclassification of foods into the four groups proposed by NOVA. We used a validated and structured FFQ to collect dietary intake which, in some items, may not allow for distinction between different levels of processing, such as breads, burgers, or packaged juices items. However, the way we used the NOVA classification for these items was in line with other studies carried out in Mediterranean populations (Puig-Vallverdú et al., 2022; Ruggiero et al., 2021). In addition, to minimize potential bias a working group with expert dietitians and nutritional epidemiologists performed the classification by consensus according to the Spanish context during the period of data collection. However, to minimize this bias, a specialized working group of dietitians and nutritional epidemiologists performed the classification by consensus. Fourth, although we adjusted for multiple confounders, the lack of control for other potential unmeasured factors cannot ruled out. Fifth, when comparing our results to previous studies, it is important to note that our UPF consumption tertiles were based on sample-specific cut-offs: low (2.5–24.5 %), intermediate (24.6–36.9 %), and high (37.0–80.4 %). This may limit direct comparability, as other studies may use different thresholds depending on their population's distribution.

This study also presents several strengths. Our analyses were conducted using a large sample of participants from a well-designed prospective birth cohort study which was carried out in several geographical areas in Spain. Furthermore, the inclusion of maternal covariates collected during pregnancy allows a clear temporal definition of their potential influence on the children's UPF consumption. In addition, we analysed the association by sex, to evaluate the robustness of our findings and to explore its potential role. We additionally explored the effect of considering breads as UPF in sensitivity analyses and results did not change. This consistency supports the robustness of our findings and enhances comparability with other studies that included breads as UPF. This study addressed a highly relevant topic, as it focuses on 4-year-old children, a critical age for establishing dietary habits, and the consumption of UPF, which has been associated with negative long-term health effects.

In conclusion, higher UPF consumption in 4-year-old children is associated with several maternal factors, such as maternal obesity, UPF consumption during pregnancy, and a maternal age under 30 years, and with child television viewing time. These findings highlight the importance of developing comprehensive strategies to reduce UPF consumption in early childhood. The strategies may include improving marketing regulations, particularly those designed for television advertisements, promoting the consumption of minimally processed foods, and supporting family-level interventions to encourage healthier eating habits. These combined efforts can contribute to reducing UPF consumption and their impact on child health outcomes.

CRediT authorship contribution statement

Laura-María Compañ-Gabucio: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Laura Torres-Collado:** Writing – review & editing. **Alejandro Oncina-Cánovas:** Writing – review & editing. **Guillermo Fernández-Tardón:** Writing – review & editing, Investigation, Conceptualization. **Adonina Tardón:** Writing – review & editing, Investigation. **Loreto Santa-Marina Rodríguez:** Writing – review & editing, Investigation. **Ziortza Barroeta:** Writing – review & editing, Investigation. **Martine Vrijheid:** Writing – review & editing, Investigation. **Sarah Warkentin:** Writing – review & editing, Investigation. **Sabrina Llop:** Writing – review & editing, Investigation. **Raquel Soler-Blasco:** Writing – review & editing, Investigation. **Carolina Ojeda-Belokon:** Writing – review & editing. **Manuela García-de-la-Hera:** Writing – review & editing, Investigation. **Jesús Vioque:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Conceptualization. **Sandra González-Palacios:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization.

Data share statement

Data requests for this article will be forwarded to the INfancia y Medio Ambiente Project Committee for consideration. Data are not publicly available, as participant consent and ethics approvals did not permit open sharing.

Ethical statement

The work in this article is original and is not under consideration for publication anywhere else. All procedures conducted in this study were performed in accordance with the Declaration of Helsinki, all participants provided informed written consent. The INMA study protocol was approved by the Ethical Committees of the Institutions involved in the INMA Project (CEIC-Hospital La Fe, Valencia; CEIC-Área Sanitaria de Guipúzkoa, Gipuzkoa; CEIC-Parc de Salut del Mar, Barcelona; CEIM del Principado de Asturias). This work was approved by the Ethical Committee "CEIm Departamento de Salud de Alicante – Hospital General" (Ref.: PI2024-087. Data: June 19, 2024).

Funding sources

This work was supported by ESP24PI02/2024 CIBER -Consorcio Centro de Investigación Biomédica en Red (Convocatoria Intramural Proyectos CIBERESP 2024), Instituto de Salud Carlos III, Ministerio de Ciencia e Innovación and Unión Europea – European Regional Development Fun". Project PI23/01568, funded by Instituto de Salud Carlos

III (ISCIII) and co-funded by the European Union. ISGlobal acknowledges support from the grant CEX2023-0001290-S funded by MCIN/AEI/10.13039/501100011033, and support from the Generalitat de Catalunya through the CERCA Program. Sarah Warkentin acknowledges receiving the funding by the Agency for Management of University and Research Grants with a Beatriu de Pinós post-doctoral fellowship (Ref: 2021 BP 00058). Raquel Soler-Blasco acknowledges receiving the funding by the Generalitat Valenciana (CIGE2023/142). Carolina Ojeda is recipient of a fellowship "Personal Investigador en Formación" from the "Universidad Miguel Hernández de Elche" (04-541-6-2024-0153-N). This study was funded by Grants from UE (FP7-ENV-2011 cod 282957, HEALTH.2010.2.4.5-1, cod 874583, and cod 101136566), Spain: ISCIII (G03/176; FIS-FEDER: PI03/1615, PI04/1509, PI06/1213, PI11/01007, PI11/02591, PI11/02038, PI12/00610, PI13/1944, PI13/2032, PI14/00891, PI14/01687, PI16/1288, PI17/00663, PI19/1338; PI23/1578), Generalitat Valenciana (CIAICO/2021/132, BEST/2020/059, AICO 2020/285, AICO/2021/182 and CIDEGENT/2019/064), Consejo General de Enfermería (PNI22_CGE45).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We specially thank to all the families who participated in this study, the field technicians of the INMA project, the hospital technicians, midwives, and health workers for recruitment, and the whole INMA team for their commitment and their role in the success of the study. We also thank Jessica Gorlin for the English revision.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2025.108268.

Data availability

The authors do not have permission to share data.

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