Received: 28 July 2023 | Revised: 17 December 2023 | Accepted: 12 June 2024

DOI: 10.1111/obr.13796

OBESITY Reviews WILEY

REVIEW

Pediatric Body Weight

# Association between ultraprocessed food consumption and excess adiposity in children and adolescents: A systematic review

Brenda Robles[1,2,3] | Anna Mota-Bertran[2,3] | Marc Saez[2,3] | Marta Solans[2,3]

[1]Department of Economics, University of Rovira i Virgili, Reus, Spain

[2]Research Group on Statistics, Econometrics and Health (GRECS), University of Girona, Girona, Spain

[3]Centro de Investigación Biomédica en Red de Epidemiología y Salud Pública (CIBERESP), Instituto de Salud Carlos III, Madrid, Spain

**Correspondence**
Anna Mota Bertran, Research Group on Statistics, Econometrics and Health (GRECS) and CIBER of Epidemiology and Public Health (CIBERESP), University of Girona, Carrer de la Universitat de Girona 10, Campus de Montilivi, Girona 17003, Spain.
Email: a.mota@udg.edu

## Summary

Ultraprocessed foods (UPF) consumption is associated with excess adiposity in adults, but this linkage remains unclear among children and adolescents. The present systematic review sought to address this research gap. Publications up to November 2023 were retrieved from PubMed, Web of Science, and Scopus databases. Outcomes included overweight/obesity anthropometric and body composition indicators; the exposure was UPF consumption based on the NOVA classification system. The review included 23 studies (i.e., 8 cohort and 15 cross-sectional); approximately half were carried out in Brazil. Inconclusive and heterogeneous evidence exists as few cohort studies found positive/mixed associations between UPF consumption and excess adiposity in pediatric populations, whereas most cross-sectional studies reported null associations. Such inconsistencies may be attributed to underlying methodological issues, especially heterogeneity in the outcomes assessed and UPF consumption operationalization and/or categorization. Future studies should adopt longitudinal designs with sufficiently extended follow-up periods, account for relevant confounding factors, employ validated and standardized measurement tools to assess dietary exposure, ensure consistent operationalization of variables, and encompass diverse geographic contexts. Ultimately, strengthening the quality of existing research evidence may better inform current and forthcoming policy and practice interventions aimed at mitigating the increasing prevalence of overweight/obesity in childhood and across the life course.

KEYWORDS
NOVA, overweight/obesity, pediatric populations, ultraprocessed foods

## 1 | INTRODUCTION

Consumption of ultraprocessed food (UPF), which is often assessed by the schema proposed by Monteiro et al. for classifying foods according to their processing level,[1] has been increasingly recognized

**Abbreviations:** BMI, body mass index; CI, confidence interval; FM, fat mass; FMI, fat mass index; LMI, lean mass index; NOS, Newcastle-Ottawa scale; NWO, normal-weight obesity; OR, odds ratio; PR, prevalence ratio; Q, quartile; Qntl, quintile; RR, relative risk; SAD, sagittal abdominal diameter; T, tertile/tercile; UPF, ultraprocessed food; WC, waist circumference; WHtR, waist-to-height ratio.

as a public health problem around the world.[2,3] While the definition of UPF has historically varied across studies, UPF has been more recently conceptualized as industrially processed formulations that contain five or more ingredients, such as salt, sugar, oils, fats, and/or food substances not often used in culinary preparation (e.g., hydrolyzed protein, modified starches, hydrogenated or interesterified oils, additives, and colorants).[4]

The advent of pervasive access to UPFs within the food supply can be traced back to the mid-20th century in high-income countries,[1] whereas the proliferation of these highly processed foods or the so-called “nutrition transition” is a recent phenomenon in middle- and low-income countries.[5] Collectively, these global shifts from a traditional diet to one characterized by highly palatable processed foods (e.g., high in salt, sugar, and sodium) have coincided with upward trends in adverse noncommunicable health outcomes.[5–7]

A growing body of literature sheds valuable insight on the deleterious impact of UPF consumption on human health, especially in terms of exacerbating one's risk for noncommunicable diseases.[8–12] Particularly salient is overweight and obesity, a chronic condition that may be well connected to the aforementioned nutrition transition across diverse populations worldwide.[13] Indeed, several studies carried out in recent years have bolstered evidence that linkages between UPF consumption and risk for excess adiposity exist in adults.[14–16]

However, the relationship between UPF consumption and excess adiposity outcomes among pediatric populations, such as overweight/obesity, is less understood. To date, only four systematic reviews exclusively focused on this group of individuals (typically between 0 and 19 years of age) have been conducted[17–20]; they have yielded mixed findings and generally underscore the need for better-designed studies. Yet, since their publication, numerous relevant studies have been published, those which have not been captured by existing reviews on the topic. Synthesizing these new and more recent empirical findings offers an opportunity to elucidate the contribution of UPF consumption to the development of excess adiposity among children and adolescents.

Understanding the potential risk factors for excess adiposity among children and adolescents based on the latest scientific literature is imperative as the ramifications of experiencing this chronic condition in these populations appear to have a high cost to individuals throughout their lifetime. For example, children/adolescents who experience this chronic condition appear to be at an increased risk for a host of poor health outcomes earlier in life, such as liver disease,[21] cardiovascular health problems,[21] and psychological issues.[22] Research evidence also suggests that experiencing overweight/obesity in childhood amplifies individuals' risk for obesity into adulthood,[23] lifetime risk for cardiovascular diseases,[24] and other poor health outcomes such as cancer.[25] Hence, the present systematic review seeks to advance this area of research by synthesizing existing and more recent studies that have examined the linkages between UPF and excess adiposity in pediatric populations.

## 2 | METHODS

The protocol for this review is registered in the Prospective Register of Systematic Reviews (2022, CRD42022375774). This study was conducted following the recommendations of the Preferred Reporting Items for Systematic reviews and Meta-Analyses 2020 checklist.[26]

### 2.1 | Literature search

Relevant original articles, letters, or conference abstracts published up to November 21, 2023, were identified via PubMed, Web of Science, and Scopus databases. More details on the search string are delineated in Explanatory Note S1. Only publications written in English or Spanish were considered and no authors of these studies were contacted for additional information. We also reviewed the references of the final selected articles to identify relevant studies that may have been missed during the database searches.

### 2.2 | Study selection

After removing duplicates, all retrieved articles underwent an initial title and abstract screening and, subsequently, a full-text screening. Results were limited to peer-reviewed original publications or conference abstracts that fulfilled the following PICOTS criteria[27]: (1) *population*: children and adolescents (0–19 years); (2) *exposure*: consumption of UPF assessed using the NOVA classification; (3) *comparison*: children/adolescents that had higher UPF consumption relative to lower UPF consumption; (4) *outcome*: overweight/obesity as measured by anthropometric indicators (e.g., body mass index [BMI], waist circumference [WC], and waist-to-height ratio [WHtR]) or body composition indicators (e.g., fat mass [FM], FM index [FMI], and lean mass index [LMI]); (5) *timing of weight measurement*: childhood or adolescence (0–19 years); and (6) *setting*: any environmental, clinical, or country setting. Studies were limited to only those with a cohort, case–control, or cross-sectional design and that reported their findings as estimates of relative risk (i.e., risk ratios [RR], odds ratios [OR], prevalence ratios [PR]), and β coefficients) of changes in anthropometric/fatness parameters, with the corresponding measure of variability including a 95% confidence interval (CI) and/or *p*-value.

### 2.3 | Data extraction

The following data were extracted from the articles selected for inclusion: first author name, year of publication, country, study design, sample size, the age range of subjects, exposure assessment, duration of follow-up for cohort studies, study findings (primary and secondary outcomes), and covariates for adjustment. Results of all selected studies were synthesized into the following sections: (1) BMI *z*-score; (2) overall overweight/obesity; (3) central overweight/obesity;

(4) other excess adiposity measures; and (5) other body composition indicators.

### 2.4 | Quality of studies

Two reviewers independently used the Newcastle-Ottawa Scale (NOS)[28] to assess the risk of bias in the included studies; a third reviewer was consulted to resolve scoring disagreements. An adapted version of the NOS was used to assess the risk of bias in the included cross-sectional studies.[29] Overall, a score ranging from 0 to 9 was assigned to each article; studies assessed were considered "poor quality" if they received ≤3 stars, "fair quality" if they received 4 to 6 stars, and "high quality" if they received ≥7 stars. This categorization aligns with a previous systematic review and meta-analysis focused on UPF consumption and the risk of overweight and obesity.[14]

## 3 | RESULTS

### 3.1 | Study overview

As indicated in Figure 1, a total of 23 observational studies were selected after eliminating duplicate publications or those that did not fulfill the inclusion criteria. Their main characteristics and findings are detailed in Table 1. There were eight prospective cohort[31–38] and 15 cross-sectional studies,[39–53] including a total of 99,069 children and adolescents. Moreover, 12 studies focused just on children,[31,33–38,41,42,45,46,52] eight just on adolescents,[39,40,43,44,47,48,50,51] and three on both age groups.[32,49,53] However, the age ranges were inconsistent across studies. For example, some studies classified children as those aged 10 years or less,[31,34–38,42,45,46,52] while others classified children as those aged up to 11[33,49] or 12 years.[41] Studies were also inconsistent in their classification of adolescents, with some, for example, considering adolescents as those between 12 and 17 years of age,[51] 12 and 19 years of age,[48,49] or 14 and 19 years of age.[40,44]

Most studies were carried out in Brazil ($n = 10$)[33,39,40,42–44,47,50–52]; other settings included North America ($n = 4$),[31,34,35,37] Latin America ($n = 3$),[36,38,49] Southern Europe ($n = 3$),[31,34,35] the United Kingdom ($n = 1$),[32] China ($n = 1$),[53] and Iran ($n = 1$).[45]

Dietary assessments also differed across studies. Specifically, nine used a food frequency questionnaire,[31,33,36,40,43,45,47,49,53] 10 dietary recalls,[37–39,41,42,44,48,50–52] and four food diaries.[32,34,35,46] All of them assessed UPF consumption based on the original NOVA classification, except for two studies—namely, those by Bleiweiss-Sande et al.[41] and Gyimah et al.,[36] which employed adapted versions of the NOVA to better capture the food landscape of the United States[54] and Ecuador,[55] respectively. Yet, despite all studies using the NOVA classification or an adapted version of it, the operationalization of the exposure variable largely differed across studies. Specifically, it was computed as the percent of total kilocalories per day in 10 studies,[39,41–44,46,50–53] as the percent of total kilocalories per day and percent of total grams per day in two studies,[32,48] as absolute grams per day in five studies,[31,33,35,45,47] as absolute kilocalories per day in three studies,[34,37,49] and as frequency per day or week in three studies.[36,38,40]

The way studies categorized the continuous exposure variable also varied. In particular, tertiles/terciles (T) were used in seven studies,[31,36,44,45,48,51,52] quartiles (Q) in two studies,[47,53] quintiles (Qntls) in two studies,[32,39] and dichotomized by weekly UPF consumption level (i.e., either as "less than weekly" or "weekly or more") in one study.[40] Furthermore, even within studies employing identical operationalizations and categorizations, there were substantial variations in the ranges across categories. To illustrate, although Chang et al. and Louzada et al. both operationalized UPF consumption as the percent of total kilocalories per day and categorized this operationalization into Qntls, the cut-off values for each Qntl were markedly different in each study.[32,39] These and other discrepancies are presented in Table S1, which provides an overview of how UPF consumption was operationalized and categorized across studies.

All 23 studies measured weight and height, except one study by Hou and Qui that sourced this information from clinical (birth) records.[53] Eleven studies also measured WC,[31,32,35,40,42–44,46–48,50]

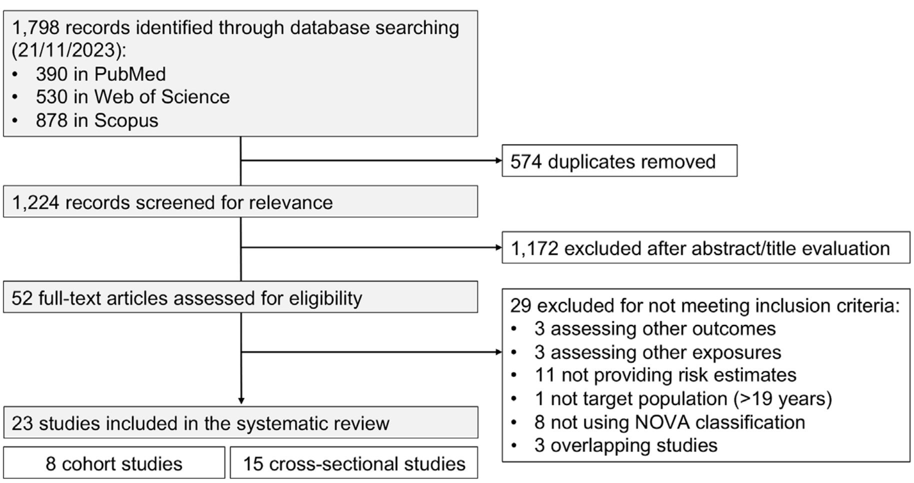


**FIGURE 1** Flow chart.

**TABLE 1** Summary of the included cohort and cross-sectional studies that investigated the association between ultraprocessed food (UPF) consumption and obesity/overweight in children and adolescents.

| A: Cohort studies | | | | | | |
|---|---|---|---|---|---|---|
| **Author (year), country** | **Study design (study name), time frame** | **Sample size (age range); follow-up period** | **Exposure assessment** | **Outcome assessment** | **Model and adjustment variables** | **Main findings of maximally adjusted model** |
| Gyimah et al. (2023), Ecuador | Follow-up cohort (Lulun II), 2017 | 125 children (2 years) | Measurement: 24-h FFQ, validated<br>Operationalization: UPF intake frequency (# of times consumed in the past day) categorized into T | Measurement: weight and height measured by trained staff<br>Operationalization: weight-for-height *z*-score based on WHO criteria | Model: linear regression<br>Covariates: sex, age, household/caregiver socioeconomic characteristics (i.e., employment status, involvement in food production, and livestock ownership), minimum dietary diversity, and group assignment from the Lulun trial | **Weight-for-height *z*-score** (β, standard error):<br>T1: reference<br>T2: 0.03 (0.17)<br>T3: −0.09 (0.16) |
| Heerman et al. (2023), United States | Prospective cohort (secondary analysis of Growing Right Onto Wellness [GROW] trial), 2012–2017 | 595 children (3–5 years); 3 years | Measurement: three 24-h diet recall completed by parents, not validated<br>Operationalization: UPF intake (kcal/day) | Measurement: weight and height measured by trained staff<br>Operationalization: age- and sex-specific sample *z*-scores for BMI | Model: longitudinal mixed-effects linear regression<br>Covariates: age, sex, mean kcal/day, mean daily % of time spent in moderate–vigorous physical activity, parent ethnicity, household food security, household participation in federal nutrition assistance programs, and random assignment in the original RCT. The model also included two 3-way interactions to allow estimates vary over time and child baseline age, while also adjusting for mean daily caloric intake | **BMI *z*-score overall** (β, 95% CI): 0.4 (−0.02 to 0.7)<br>**BMI *z*-scores by age** (β, 95% CI):<br>3 years: 1.2 (0.5 to 1.9)<br>4 years: 0.6 (0.2 to 1.0)<br>5 years: −0.1 (−0.6; 0.4) |
| Pereyra-González et al. (2023), Uruguay and Brazil | Two prospective cohorts: one from Uruguay (Encuesta de Nutrición, Desarrollo Infantil y Salud [ENDIS], 2013–2014 and 2015–2016); another from Brazil (PelotasBirth Cohort, 2015) | 6468 children (2–5 years); 2 years | Measurement:<br>ENDIS: 24-h recall questionnaire (first wave) and FFQ assessing intake during previous week (second wave), not validated<br>Pelotas: FFQ assessing intake during the previous day, not validated | Measurement: weight and height measured by trained staff<br>Operationalization: BMI *z*-scores based on WHO criteria and categorization:<br>• Obesity: BMI *z*-score > +2 | Model: Poisson regression<br>Covariates: *z*-score of birth weight, sex, age, country, exclusive breastfeeding duration, and time between measures | **Obesity** (RR, 95% CI): 1.02 (0.93 to 1.12) |

**TABLE 1** (Continued)

| A: Cohort studies | | | | | | |
|---|---|---|---|---|---|---|
| **Author (year), country** | **Study design (study name), time frame** | **Sample size (age range); follow-up period** | **Exposure assessment** | **Outcome assessment** | **Model and adjustment variables** | **Main findings of maximally adjusted model** |
| | | | Operationalization: UPF intake frequency (# of items/week) | | | |
| Vilela et al. (2022), Portugal | Prospective birth cohort (Generation XXI - Porto node), 2005–2006 | 3034 children (7–10 years); 3 years | Measurement: 3-day food diary for children at age 7 completed by parents or caregivers, not validated<br>Operationalization: UPF intake (g/day) | Measurement: weight, height, WC, FM, and fat-free mass (by bioelectrical impedance analysis) for children at age 10 measured by trained staff<br>Operationalization: age- and sex-specific sample *z*-scores for BMI, WC, FM, and fat-free mass | Model: generalized linear regression<br>Covariates: remaining NOVA groups, sex, maternal age, and maternal education | **WC *z*-score** (β, 95% CI): −0.003 (−0.019 to 0.014)<br>**BMI *z*-score** (β, 95% CI): −0.009 (−0.029 to 0.011)<br>**FM *z*-score** (β, 95% CI): −0.006 (−0.022 to 0.011)<br>**Fat-free mass *z*-score** (β, 95% CI): 0.012 (−0.005 to 0.029)<br>**Note:** β per 100 g/day increase of UPF |
| Chang et al. (2021), United Kingdom | Prospective birth cohort (The Avon Longitudinal Study of Parents and Children), 1998–2017 | 9025 children and adolescents (7–17 years); 24 years | Measurement: 3-day food diary for children at ages 7 and 10 and 13 completed by parents or caregivers of 7-year-old children and self-completed by 10- and 13-year-old children, not validated<br>Operationalization: Qntls of UPF intake (based on % of total g/day and % kcal/day) | Measurement: weight, height, WC, FM, and LM (by DEXA) measured by trained staff annually between 7 and 17 years of age and once at 24 years of age<br>Operationalization:<br>• BMI *z*-scores based on British 1990 growth reference<br>• FMI (FM in kg/height in $m^2$)<br>• LMI (LM in kg/height in $m^2$) | Model: linear growth curve models<br>Covariates: age at clinic assessment, sex, race, birth weight, baseline physical activity, mean daily calorie intake, Qntls of the Index of Multiple Deprivation 2004, maternal: prepregnancy, maternal BMI, maternal marital status, maternal education, and maternal socioeconomic status based on United Kingdom National Statistics Socioeconomic classification | **Coefficient of the interaction term**: examines the difference in mean growth trajectories among those in the higher UPF consumption Qntls compared with the lowest UPF Qntl reference group (β, 95% CI):<br>UPF operationalized as % of total g/day:<br>**BMI in kg/m²**: 0.06 (0.04 to 0.08)<br>**FMI in kg/m²**: 0.03 (0.01 to 0.05)<br>**Total fat in %**: 0.004 (−0.05 to 0.06)<br>**LMI in kg/m²**: 0.004 (−0.007 to 0.01)<br>**Weight in kg**: 0.20 (0.11 to 0.28)<br>**WC in cm**: 0.17 (0.11 to 0.22)<br>**BMI *z*-score:** 0.01 (0.003 to 0.01)<br>**FM in kg**: 0.15 (0.08 to 0.21)<br>**Lean mass in kg**: −0.04 (−0.11 to 0.02) |

(Continues)

**TABLE 1** (Continued)

| A: Cohort studies | | | | | | |
|---|---|---|---|---|---|---|
| **Author (year), country** | **Study design (study name), time frame** | **Sample size (age range); follow-up period** | **Exposure assessment** | **Outcome assessment** | **Model and adjustment variables** | **Main findings of maximally adjusted model** |
| | | | | | | UPF operationalized as % of total kcal/day:<br>**BMI in kg/m$^2$**: 0.05 (0.02 to 0.07)<br>**FMI in kg/m$^2$**: 0.04 (0.01 to 0.05)<br>**Total fat in %**: 0.04 (−0.01 to 0.09)<br>**LMI in kg/m$^2$**: −0.002 (−0.01, 0.009)<br>**Weight in kg**: 0.14 (0.06 to 0.22)<br>**WC in cm**: 0.11 (0.05 to 0.16)<br>**BMI *z*-score**: 0.01 (0.005 to 0.01)<br>**FM in kg**: 0.14 (0.07 to 0.19)<br>**Lean mass in kg**: −0.05 (−0.12, 0.01) |
| Costa et al. (2021), Brazil | Prospective birth cohort (Pelotas - Brazil Birth Cohort), 2004 | 3128 children (at age 6 years); 3454 children (at age 11 years); 5 years | Measurement: FFQ assessing consumption during previous year (at 6-year follow up, 54 items and reported by mothers; at 11-year follow-up, 88 items and reported by mothers and participants), not validated<br>Operationalization:<br>UPF intake (g/day) | Measurement (at age 6 and 11 years): weight, height, and FM (by BOD POD) measured by trained staff<br>Operationalization: FMI (FM in kg/height in m$^2$) | Model: generalized estimation equations<br>Covariates:<br>*Model A*: maternal, skin color, maternal age, maternal schooling, sex, birth weight, screen time, energy intake/ expenditure ratio at 6- and 11-year follow-ups, and grams from other food sources than UPF<br>*Model B*: maternal skin color, maternal age, maternal schooling, sex, | **FMI in kg/m$^2$** (β, 95% CI)<br>Model A (other foods sources adjustment): 0.14 (0.13 to 0.15)<br>Model B (total calorie intake adjustment): 0.05 (0.04 to 0.06)<br>**Note:** β per each 100 g/ day increase of UPF |

**TABLE 1** (Continued)

| Author (year), country | Study design (study name), time frame | Sample size (age range); follow-up period | Exposure assessment | Outcome assessment | Model and adjustment variables | Main findings of maximally adjusted model |
|---|---|---|---|---|---|---|
| **A: Cohort studies** | | | | | | |
| | | | | | birth weight, screen time, energy intake/ expenditure ratio at 6- and 11-year follow-ups, and total calorie intake | |
| Vedovato et al. (2021), Portugal | Prospective birth cohort (Generation XXI, Porto Node), 2005–2006 | 8647 children (4–10 years); 6 years | Measurement: 2- or 3-day food diaries for children at ages 4 and 7 (one or two weekdays and one weekend day) completed by parents or caregivers, not validated<br>Operationalization: UPF intake (kcal/day) | Measurement (at age 10): weight and height measured by trained staff<br>Operationalization: BMI *z*-scores based on WHO criteria | Model: linear regression<br>Covariates: maternal age, maternal education, maternal BMI before pregnancy, exclusive breastfeeding for the first 6 months, physical exercise, and screen time | **BMI *z*-score** (β, 95% CI):<br>Exposure at 4 years: 0.028 (0.006 to 0.051)<br>Exposure at 7 years: 0.014 (−0.007 to 0.036)<br>**Note:** β per 100 kcal/day increase of UPF |
| Bawaked et al. (2020), Spain | Prospective birth cohort (Infancia y Medio Ambiente - INMA), 2003–2008 | 1480 children (4–7 years); 3 years | Measurement: 105-item semiquantitative FFQ (assessing diet during the previous year) for children at age 4 completed by parents, validated<br>Operationalization: T of UPF intake (g/day) | Measurement (at ages 4 and 7): weight, height, and WC measured by trained staff<br>Operationalization: BMI *z*-score based on WHO criteria and WC *z*-scores based on age, sex, height, and cohort | Model: linear regression<br>Covariates: age, sex, cohort, maternal education, and maternal BMI | **BMI *z*-score** (β, 95% CI):<br>T3: reference<br>T1: 0.01 (−0.12 to 0.14)<br>T2: −0.05 (−0.18 to 0.08)<br>**WC *z*-score** (β, 95% CI):<br>T3: reference<br>T1: 0.00 (−0.15 to 0.15)<br>T2: −0.10 (−0.25 to 0.05)<br>**Note:** β per 100 g/day |
| **B: Cross-sectional studies** | | | | | | |
| Cota et al. (2024), Brazil | Cross-sectional (PASE Health Assessment Survey), 2015 | 364 children (8–9 years) | Measurement: three 24-h dietary recalls on nonconsecutive days (answered by child and guardian simultaneously), not validated<br>Operationalization: UPF intake (% of total kcal/day) categorized into T | Measurement: weight, height, and body fat measured by trained staff<br>Operationalization: NWO phenotype based on adequate BMI *z*-scores (according to WHO criteria) and high fat % ( ≥ 25% or 20% for girls and boys, respectively); those with NWO phenotype considered as having overweight or obesity placed in the excess weight group | Model: Poisson regression with robust variance<br>Covariates: sex, age, per capita income, and screen time | **NWO in normal-weight group** (PR, 95% CI):<br>T1: reference<br>T2: 1.9 (1.1 to 3.4)<br>T3: 1.8 (1.01 to 3.1)<br>**NWO in excess weight group** (PR, 95% CI):<br>T1: reference<br>T2: 2.0 (1.2 to 3.3)<br>T3: 1.2 (0.7 to 2.2) |
| Hou and Qui (2023), China | Cross-sectional study (Multicity Cohort Study), 2022 | 1370 children and adolescents (7–16 years) | Measurement: 142-item FFQ, not validated<br>Operationalization: | Measurement: height and weight based on birth records | Model: generalized linear model and logistic regression | **BMI in kg/m$^2$** (β, 95% CI)<br>Q1: reference<br>Q2: 0.07 (−0.65 to 0.78) |

(Continues)

**TABLE 1** (Continued)

| | | | | | | |
|---|---|---|---|---|---|---|
| **B: Cross-sectional studies** | | | | | | |
| | | | UPF intake (% of total kcal/day) categorized into Q | Operationalization: BMI and BMI $z$-scores based on age and sex BMI growth curves for Chinese children and adolescents<br>Categorization into underweight, normal weight, overweight, and obesity based on the Working Group for Obesity in China (WGOC) cutoffs | Covariates: age, sex, family income, maternal education, maternal BMI, physical activity, total energy intake, breastfeeding, gestational age at delivery, and delivery mode | Q3: 0.15 (−0.56 to 0.86)<br>Q4: 0.29 (−0.42 to 1.00)<br>P-trend: 0.861<br>**BMI $z$-scores** (β, 95% CI)<br>Q1: reference<br>Q2: 0.01 (−0.25 to 0.26)<br>Q3: 0.09 (−0.16 to 0.35)<br>Q4: 0.11 (−0.14 to 0.37)<br>P-trend: 0.746<br>**Overweight/obesity** (OR, 95% CI)<br>Q1: reference<br>Q2: 1.01 (0.57 to 1.80)<br>Q3: 1.27 (0.73 to 2.22)<br>Q4: 1.03 (0.58 to 1.82)<br>P-trend: 0.763 |
| Madalosso et al. (2023), Brazil | Cross-sectional (Estudo de Riscos Cardiovasculares em Adolescentes–ERICA), 2013–2014 | 36,952 adolescents (12–17 years) | Measurement: 24-h dietary recall, not validated<br>Operationalization:<br>UPF intake (% of total kcal/day) categorized into T | Measurement: weight and height measured by trained staff<br>Operationalization: BMI $z$-scores based on WHO criteria and categorization:<br>• Normal (BMI $z$-score ≤+1)<br>• Overweight (BMI $z$-score > +1 and ≤+2)<br>• Obesity (BMI $z$-score >+2) | Model: Poisson regression<br>Covariates: sex, age, school type, geographic region, skin color, physical activity, screen time, tobacco/cigarette, and power consumption | **Overweight/obesity** (PR, 95% CI):<br>T1: reference<br>T2: 0.99 (0.96 to 1.03)<br>T3: 0.98 (0.95 to 1.01) |
| Asgari et al. (2022), Iran | Cross-sectional, 2017–2018 | 788 children (6 years) | Measurement:<br>168-item semiquantitative FFQ (assessing consumption during the previous year) completed by mothers, validated<br>Operationalization:<br>T of UPF intake (g/day) | Measurement: weight, height, and mid-upper arm circumference measured by trained staff<br>Operationalization: BMI $z$-scores based on WHO criteria and categorization:<br>• Obesity (BMI $z$-score >+2)<br>• Overweight (BMI $z$-score >+1)<br>• Normal (BMI $z$-score >−1 and <1)<br>• Underweight (BMI $z$-score <−1)<br>• Wasting (BMI $z$-scores <−2) | Model: logistic regression<br>Covariates: energy intake, socioeconomic status, and physical activity | **Obesity** (OR, 95% CI):<br>T1: reference<br>T2: 1.57 (0.57 to 4.26)<br>T3: 0.97 (0.31 to 3.01)<br>**Overweight/obesity** (OR, 95% CI):<br>T1: reference<br>T2: 0.82 (0.56 to 1.18)<br>T3: 0.86 (0.59 to 1.25) |

**TABLE 1** (Continued)

| | | | | | | |
|---|---|---|---|---|---|---|
| **B: Cross-sectional studies** | | | | | | |
| Ashraf et al. (2022), Canada | Cross-sectional (Guelph Family Health Study - GFHS), 2017–2020 | 267 children (1.5–5 years) | Measurement: 3-day food diary completed by parents or caregivers, not validated<br>Operationalization: UPF intake (% of total kcal/day) | Measurement: weight, height, WC, and percent FM (by bioelectrical impedance analysis) measured by trained staff<br>Operationalization: BMI *z*-scores based on WHO criteria | Model: generalized estimating equations<br>Covariates: age, sex, annual household income, ethnicity, and highest level of parental education | **BMI *z*-scores** (β, 95% CI): −0.002 (−0.008 to 0.004)<br>**WC in cm** (β, 95% CI): 0.013 (−0.007 to 0.033)<br>**Weight in kg** (β, 95% CI): −0.001 (−0.01 to 0.01)<br>**FM in %** (β, 95% CI): 0.01 (−0.03 to 0.05)<br>**Note:** β per 1% kcal/day increase of UPF |
| Crisóstomo et al. (2022), Brazil | Cross-sectional (Population-based health survey in the municipalities of Teresina and Picos, Piauí [ISAD-PI]), 2018–2019 | 120 adolescents (10–19 years) | Measurement: 24-h dietary recall using multiple-pass method (repeated in the 40% of sample within 2 months), not validated<br>Operationalization: UPF intake (% of total kcal/day) | Measurement: weight, height, and WC measured by trained staff<br>Operationalization: BMI *z*-scores (based on WHO criteria) and WC (according to sex and age cut-offs of Taylor et al., 2000)[30] | Model: linear regression<br>Covariates: sex, age, education, alcohol consumption, smoking status, and total diet energy in kcal | **BMI *z*-scores** (β, 95% CI): −0.04 (−0.06 to −0.01)<br>**WC *z*-scores** (β, 95% CI): −0.07 (−0.11 to −0.02) |
| de Souza et al. (2022), Brazil | Cross-sectional, (School Policy and Cardiovascular Risk: A Multi-Country Study), 2017 | 576 adolescents (10–17 years) | Measurement: 99-item FFQ assessing consumption during the previous 6 months, validated<br>Operationalization: Q of UPF intake (g/day) | Measurement: weight, height, and WC measured by trained staff<br>Operationalization:<br>• Overweight: BMI > 85th percentile (according to BMI *z*-scores based on WHO criteria)<br>• Central obesity: WC > 80th percentile (according to sex and age cut-offs of Taylor et al., 2000)[30]<br>• Central obesity: WHtR ≥0.5 | Model: Poisson regression<br>Covariates: age, sex, and socioeconomic status | **Overweight** (PR, 95% CI):<br>≤Q3: reference<br>>Q3: 1.58 (1.07 to 2.34)<br>**Central obesity** [based on WC] (PR, 95% CI):<br>≤Q3: reference<br>>Q3: 2.48 (1.41 to 4.36)<br>**Central obesity** [based on WHtR] (PR, 95% CI):<br>≤Q3: reference<br>>Q3: 2.09 (1.11 to 3.92) |
| Neri et al. (2022), United States | Cross-sectional (National Health and Nutrition Examination Survey - NHANES), 2011–2016 | 3587 adolescents (12–19 years) | Measurement: two 24-h dietary recalls (first in person and second by telephone), not validated<br>Operationalization: UPF intake (% of total g/day and as % of total kcal/day), as continuous or categorized into T | Measurement: weight, height, WC, and SAD measured by trained staff<br>Operationalization: age- and sex-specific categories for BMI, WC, and SAD based on US Centers for Disease Control and Prevention | Model: logistic regression<br>Covariates: age, sex, race/ethnicity, educational attainment of household head, physical activity, being on special diet for weight loss, and total calories | **UPF operationalized as % of total g/day**<br>**Overweight/obesity** (OR, 95% CI):<br>T1: reference<br>T2: 1.21 (0.90 to 1.63)<br>T3: 1.45 (1.02 to 2.06)<br>P-trend: 0.040<br>Continuous*: 1.06 (1.00 to 1.12) |

(Continues)

**TABLE 1** (Continued)

| B: Cross-sectional studies | | |
|---|---|---|
| | 2000 growth charts.<br>Categorization:<br>• Overweight/obesity: BMI ≥ 85th percentile<br>• Central overweight/obesity: WC ≥ 85th percentile<br>• Visceral overweight/obesity: SAD ≥ 85th percentile | **Central overweight/obesity** (OR, 95% CI):<br>T1: reference<br>T2: 1.36 (0.99 to 1.86)<br>T3: 1.52 (1.06 to 2.18)<br>P-trend: 0.026<br>Continuous*: 1.07 (1.01 to 1.13)<br>**Visceral overweight/obesity** (OR, 95% CI):<br>T1: reference<br>T2: 1.48 (1.14 to 1.91)<br>T3: 1.63 (1.19 to 2.24)<br>P-trend: 0.005<br>Continuous*: 1.07 (1.02 to 1.13)<br>***Note:** Per 10% g/day increase of UPF<br>**UPF operationalized as % of total kcal/day**<br>**Overweight/obesity** (OR, 95% CI):<br>T1: reference<br>T2: 1.01 (0.75 to 1.35)<br>T3: 1.22 (0.83 to 1.78)<br>P-trend:.0.291<br>Continuous**: 1.55 (0.60 to 4.02)<br>**Central overweight/obesity** (OR, 95% CI):<br>T1: reference<br>T2: 1.17 (0.81 to 1.71)<br>T3: 1.17 (0.79 to 1.74)<br>P-trend: 0.437<br>Continuous**: 1.56 (0.60 to 4.06)<br>**Visceral overweight/obesity** (OR, 95% CI):<br>T1: reference<br>T2: 1.29 (0.92 to 1.80)<br>T3: 1.41 (0.99 to 2.01)<br>P-trend: 0.057<br>Continuous**: 2.26 (0.95 to 5.40)<br>****Note:** Per 10% g/day increase of UPF |

**TABLE 1** (Continued)

| | | | | | | |
|---|---|---|---|---|---|---|
| **B: Cross-sectional studies** | | | | | | |
| Nascimento et al. (2021), Brazil | Cross-sectional (Health at the School: Situational Diagnosis in High School), 2016 | 327 adolescents (14–19 years) | Measurement: multiple-pass 24-h dietary recall (note: to correct for intrapersonal variability, a second 24-h dietary recall was applied to 40% of the population during a 2-month interval), not validated<br>Operationalization: T of UPF intake (% total kcal/day) | Measurement: weight, height, and WC by trained staff<br>Operationalization: BMI *z*-scores based on WHO criteria and categorization:<br>• Obesity: >+2 BMI *z*-score<br>• Central obesity (based on WC): percentile ≥90<br>• Central obesity (based on WHtR): ≥0.50 | Model: logistic regression<br>Covariates: sex, age, income, and type of school | **Obesity** (OR, 95% CI):<br>T1: reference<br>T2: 0.93 (0.46 to 1.90)<br>T3: 0.67 (0.31 to 1.45)<br>**Central obesity (based on WC)** (OR, 95% CI):<br>T1: reference<br>T2: 1.73 (0.62 to 4.84)<br>T3: 0.47 (0.11 to 1.96)<br>**Central obesity (based on WHtR)** (OR, 95% CI):<br>T1: reference<br>T2: 1.08 (0.52 to 2.23)<br>T3: 1.68 (0.77 to 3.66) |
| Oviedo-Solís et al. (2022), Mexico | Cross-sectional, (Mexican National Health and Nutrition Surveys), 2006 and 2016 | 8074 children (5–11 years) and 6482 adolescents (12–19 years) in 2006; 2934 children and 2118 adolescents in 2016 | Measurement: semiquantitative FFQs (101 items and 140 items in 2006 and 2016, respectively) reported by study participants ≥12 years of age or mothers of study participants <12 years of age), validated<br>Operationalization: UPF intake (total kcal/day) | Measurements: weight and height measured by trained staff<br>Operationalization: BMI *z*-scores based on WHO criteria and categorization:<br>• Overweight: BMI *z*-score >+1<br>• Obesity: BMI *z*-score >+2 | Model: logistic regression<br>Covariates: survey year, energy NOVA groups (energy partition model), age, socioeconomic status, indigenous status, place of residence, regions, screen time, and sex | **Child overweight/obesity** (OR, 95% CI):<br>No: reference<br>Yes: 1.09 (1.02 to 1.16)<br>**Adolescent overweight/obesity** (OR, 95% CI):<br>No: reference<br>Yes: 1.04 (0.98 to 1.10)<br>**Note:** OR per 200 kcal/day increase of UPF |
| Bleiweiss-Sande et al. (2020), US | Cross-sectional, 2017–2018 | 131 children (6–12 years) | Measurement: three 24-h dietary recalls collected on nonconsecutive days (including two weekdays and one weekend day) for children <10 years of age completed by parents or caregivers, not validated<br>Operationalization: UPF intake (% of total kcal/day) | Measurement: weight and height measured by trained staff three times at baseline<br>Outcomes: BMI *z*-scores based on US Center for Disease Control and Prevention 2000 growth charts | Model: linear regression<br>Covariates: sex, participation status in the *School Breakfast Program* and *National School Lunch Program* | **BMI *z*-score** (β, 95% CI):<br>0.0006 (−0.0068 to 0.0080)<br>**Note:** β per 10% kcal/day increase of UPF |
| Oliveira et al. (2020), Brazil | Cross-sectional (Grow up with Health in Vitória de Santo Antão), 2018–2019 | 164 children (7–10 years) | Measurement: three 24-h 195-item dietary recalls carried out on three nonconsecutive days (including one on the weekend) completed with children over an interval of less than 4 weeks, not validated | Measurement: weight, height, and WC measured by trained staff<br>Operationalization:<br>• BMI *z*-scores based on WHO criteria<br>• Central obesity (WC ≥ 90th percentile for age and sex or WHtR ≥ 0.5) | Model: linear regression<br>Covariates: age, sex, and total caloric intake | **BMI *z*-score** (β, 95% CI):<br>−0.004 (−0.057 to 0.048)<br>**WC in cm** (β, 95% CI):<br>−0.037 (−0.167 to 0.092)<br>**WHtR** (β, 95% CI): 0.001 (−0.001 to 0.001) |

(Continues)

**TABLE 1** (Continued)

| B: Cross-sectional studies | | | | | | |
|---|---|---|---|---|---|---|
| | | | Operationalization: UPF intake (% of total kcal/day) | | | **Note:** β per each 10% increase of UPF (kcal/day) |
| Viola et al. (2020), Brazil | Cross-sectional, (Determinants Throughout the Life Cycle of Obesity, Precursors of Chronic Diseases, Human Capital and Mental Health - RPS Cohorts Study), 1997–1998 | 1525 adolescents (18–19 years) | Measurement: semiquantitative 106-item FFQ assessing consumption during the previous year (adapted for adolescents of Sao Luis), not validated<br>Operationalization:<br>T of UPF intake (% of total kcal/day) | Measurement: weight, height, WC, FM percentage (by BOD POD), muscle mass, and android fat (by DEXA) measured by trained staff<br>Outcomes: BMI *z*-scores based on WHO criteria | Model: linear regression<br>Covariates: sex, education, socioeconomic classification according to the Brazilian Association of Research Companies, total dietary energy intake, dieting to lose weight, physical activity, alcohol consumption, smoking, and number of hours spent sleeping/night | **BMI *z*-score** (β, 95% CI): −0.01 (−0.03 to −0.01)<br>**WC in cm** (β, 95% CI): −0.02 (−0.05 to 0.01)<br>**Android fat in kg** (β, 95% CI): −0.02 (−1.06 to 1.08)<br>**Muscle mass in kg** (β, 95% CI): −0.04 (−0.06 to −0.02)<br>**LMI in kg/m$^2$** (β, 95% CI): −0.01 (−0.02 to −0.01)<br>**Note:** β per each 1% increase of UPF (kcal/day) |
| Melo et al. (2017), Brazil | Cross-sectional, *missing timeframe* | 249 adolescents (14–19 years) | Measurement: 84-item FFQ, validated<br>Operationalization: daily frequency of UPF intake grouped into two groups (i.e., "less than weekly" or "weekly or more") | Measurement: weight, height, and WC measured by trained staff<br>Operationalization:<br>• BMI-for-age *z*-scores based on WHO criteria<br>• Overweight (BMI *z*-score >+1)<br>• High WC based on sex- and age-specific cut-off values (Taylor et al., 2000)[30] | Model: Poisson regression<br>Covariates: age and sex | **Overweight/obesity (PR, 95% CI)**<br>Less than weekly: reference<br>Weekly or more: 0.76 (0.47 to 1.22)<br>**High WC *z*-score (PR, 95% CI)**<br>Less than weekly: reference<br>Weekly or more: 0.94 (0.51 to 1.72) |
| Louzada et al. (2015), Brazil | Cross-sectional (subsample of National Household Budget Survey), 2008–2009 | 7534 adolescents (10–19 years) | Measurement: Two 24-h dietary recalls spanning 1 week, not validated<br>Operationalization:<br>Qntls of UPF intake (% of kcal/day) | Measurement: weight and height measured by trained staff<br>Operationalization: BMI *z*-scores based on WHO criteria and categorization:<br>• Overweight: BMI *z*-score >+1<br>• Obesity: BMI *z*-score >+2 | Model: linear regression (for BMI) and logistic regression (for overweight or obese)<br>Covariates: age, sex, race, region, urban status, smoking, physical activity, Qntls of years of education, per capita household income, consumption of fruits, vegetables, and beans (each in % of total energy intake from nonultraprocessed food), | **BMI in kg/m$^2$ (mean difference, 95% CI):**<br>Qntl1: reference<br>Qntl2: 0.01 (−0.33 to 0.31)<br>Qntl3: 0.34 (−0.12 to 0.81)<br>Qntl4: 0.40 (−0.17 to 0.97)<br>Qntl5: 0.84 (−0.16 to 1.85)<br>P-trend: 0.08<br>**Overweight/obesity (OR, 95% CI):**<br>Qntl1: reference<br>Qntl2: 1.05 (0.78 to 1.41) |

**TABLE 1** (Continued)

| **B: Cross-sectional studies** | | |
|---|---|---|
| | and the interaction between sex and income | Qntl3: 1.12 (0.77 to 1.61)<br>Qntl4: 1.15 (0.74 to 1.77)<br>Qntl5: 1.52 (0.75 to 3.07)<br>P-trend: 0.25<br>**Obesity (OR, 95% CI):**<br>Qntl1: reference<br>Qntl2: 0.96 (0.55 to 1.68)<br>Qntl3: 1.74 (0.82 to 3.73)<br>Qntl4: 1.90 (0.88 to 4.09)<br>Qntl5: 2.74 (0.78 to 9.60)<br>P-trend: 0.05<br>**Note:** Effect modification by age and sex |

Abbreviations: BMI, body mass index; CI, confidence interval; FFQ, food frequency questionnaire; FM, fat mass; FMI, fat mass index; LMI, lean mass index; NWO, normal-weight obesity; OR, odds ratio; PR, prevalence ratio; Q, quartile; Qntl, quintile; RR, risk ratio; SAD, sagittal abdominal diameter; T, tertile/tercile; WC, waist circumference; WHO, World Health Organization; WHtR, waist-to-height ratio.

two studies additional anthropometric measures (i.e., sagittal abdominal diameter [SAD] and mid-upper arm circumference),[45,48] and six studies compositional measures related to fat.[32,33,35,43,46,52] The corresponding outcomes calculated based on these measurements greatly varied across studies (e.g., BMI *z*-scores, overweight/obesity based on BMI, central obesity based on WC/SAD, and body composition indices such as FMI), with most reporting a combination of different outcomes. Among studies that reported BMI *z*-scores, 15 of them reported this outcome measure according to the World Health Organization reference standards,[31,34,38–40,42–47,49–52] while two studies used age and sex standardization based on the study sample,[35,37] two studies the US Centers for Disease Control and Prevention 2000 growth charts,[41,48] one study British references,[32] and one study Chinese references.[53]

## 3.2 | Quality assessment results

The NOS scores for the cohort and cross-sectional studies included in the present systematic review can be found in Tables S2 and S3, respectively. Most studies ($n = 12$) were assessed to be of "fair quality,"[32,34,35,37,41–46,49,50] while the rest of the studies ($n = 11$) were classified as "high quality."[31,33,36,38–40,47,48,51–53] Explanatory Note S2 provides a detailed description of the quality assessment results.

## 3.3 | Narrative synthesis

### 3.3.1 | Results by BMI *z*-scores

Five out of the eight cohort studies reported BMI *z*-scores as a measure of overweight/obesity, yielding inconsistent findings—that is, one study reported positive associations,[32] two studies mixed findings,[34,37] and two studies null associations with UPF consumption.[31,35] The largest prospective cohort to date (i.e., 9025 seven-year-old children residing in the United States), when assessing growth trajectories up to 24 years, found that the trajectories of BMI *z*-score were significantly greater among those with the highest consumption of UPF.[32] Specifically, when UPF consumption was operationalized as percent of total grams per day and categorized into Qntls, those in Qntl5 increased their BMI *z*-scores by an additional 0.01 ($\beta = 0.01$, 95% CI: 0.003 to 0.01) per year in comparison with those in Qntl1. Similar results were obtained when UPF consumption was operationalized as percent of total kilocalories per day ($\beta = 0.01$, 95% CI: 0.005 to 0.01).

Among those that reported mixed findings, Vedovato et al.'s prospective cohort of 1175 four-year-old children residing in Portugal found that for every 100 kcal/day UPF consumed at 4 years of age, BMI *z*-scores at 10 years of age significantly increased by 0.028 ($\beta = 0.028$, 95% CI: 0.006 to 0.051); in contrast, no association was found at the 7 years of age follow-up period.[34] Likewise, a more recent US prospective cohort analysis of 595 children reported that compared with low UPF consumption (i.e., 300 kcal/day), high UPF intake (i.e., 1300 kcal/day) was associated with a 1.2 higher BMI *z*-score at 36 months for 3-year-olds (β = 1.2, 95% CI: 0.5 to 1.9) and a 0.6 higher BMI *z*-score for 4-year-olds (β = 0.6, 95% CI: 0.2 to 1.0).[37] However, this association was not statistically significant for 5-year-olds or in the overall model.

Finally, among those that reported null findings, Vilela et al. did not find any association between UPF consumption (in grams per day) and BMI *z*-scores in a Portuguese cohort of 3034 children aged 7 years and followed up to 10 years of age.[35] Similarly, Bawaked et al. constructed a child lifestyle score by summing five lifestyle behaviors (i.e., physical activity, sleep time, television time, plant-based foods, and intake of UPF in grams per day) in a Spanish cohort of 1480 children aged 4 years and did not find any association.[31]

Results from the seven cross-sectional studies that reported BMI *z*-scores do not support a positive association with UPF intake, with five reporting null findings[41,42,44,46,53] and two reporting inverse associations.[43,50] In terms of the latter two studies, both conducted in adolescent Brazilian populations, they found that for every 1% increase in the contribution of UPF to total kilocalories per day, there was a decrease of 0.01 (β = −0.01, 95% CI: −0.03 to −0.01)[43] or 0.04 (β = −0.04, 95% CI: −0.06 to −0.01)[50] in BMI *z*-scores.

### 3.3.2 | Results related to overall overweight/obesity based on BMI

One cohort study[38] and nine cross-sectional studies have explored the association between UPF consumption and overall obesity/overweight based on BMI.[39,40,44,45,47–49,51,53] All but two studies utilized World Health Organization cutoffs to determine overall obesity/overweight outcomes. One exception was the study conducted by Neri et al., where obesity was defined as a BMI ≥ 85th percentile according to US Centers for Disease Control and Prevention 2000 Growth Charts[48]; the second exception was the study conducted by Hou and Qui, who categorized BMI based on the Working Group for Obesity in China cut-offs.[53]

Only 2 of these 10 studies found a positive association between UPF and overweight/obesity.[47,48] In particular, Neri et al. in their cross-sectional study of 3587 adolescents aged 12–19 years from the United States found that those with the highest consumption of UPF (T3, based on percent of total grams per day) had 45% higher odds (OR = 1.45, 95% CI: 1.02 to 2.06) of overweight/obesity compared with those in T1.[48] They also found a 10% increment in the proportion of UPF consumption associated with increased risk for overweight/obesity (OR = 1.06, 95% CI: 1.00 to 1.12). A smaller cross-sectional study carried out on 576 Brazilian adolescents aged 10–17 years yielded similar results, namely, that the highest level UPF consumption in grams per day (i.e., ≥Qntl3) was associated with a 58% higher PR (PR = 1.58, 95% CI: 1.07 to 2.34) of overweight/obesity compared with the lowest level of consumption (i.e., ≤Qntl3).[47]

Mixed findings were reported in the cross-sectional study carried out by Oviedo-Solís et al.[49] The authors found that for each 200 kcal/day of increased UPF consumption, the odds of having excess weight were 9% higher in children (OR = 1.09, 95% CI: 1.02 to 1.16), while null results were reported in adolescents. The remaining seven studies, mostly focused on Brazilian populations,[38–40,44,51] reported null findings on the relationship between UPF consumption and overweight/obesity in children,[38,45] adolescents,[39,40,44,51] or both children and adolescent populations.[53]

### 3.3.3 | Results related to central obesity

Eleven studies assessed the association between UPF consumption and central obesity by measuring WC,[31,32,35,40,42–44,46–48,50] WHtR,[42,44] and SAD.[48] Among them, four studies focused on children,[31,35,42,46] six on adolescents,[40,43,44,47,48,50] and one on both children and adolescents (i.e., those between 7 and 17 years of age).[32]

Five of the seven studies that analyzed UPF consumption continuously found null associations between UPF consumption and WC or WHtR.[31,35,42,43,46] Only the large prospective cohort study of Chang et al. found that trajectories of WC increased by an additional 0.17 (95% CI, 0.11–0.22) cm/year[32]; in contrast, a small Brazilian study involving 120 adolescents reported an inverse association (β = −0.07, 95% CI: −0.11 to −0.02).[50]

Among the four studies that analyzed the outcome categorically, two reported null findings[40,44] and the other two reported strong positive associations.[47,48] In particular, when comparing T3 of UPF consumption (percent of total grams per day) to T1, Neri et al. found there was 52% higher odds (OR = 1.52, 95% CI: 1.06 to 2.18) of abdominal obesity/overweight (based on WC) and 63% higher odds (OR = 1.63, 95% CI: 1.19 to 2.24) of visceral obesity/overweight based on SAD.[48] They also found that a 10% increment in the proportion of UPF consumption was associated with an increased risk of both central overweight/obesity measure (OR = 1.07, 95% CI: 1.01 to 1.13) and visceral overweight/obesity measure (OR = 1.07, 95% CI: 1.02 to 1.13). Consistent with this finding, de Souza et al. found positive associations for central obesity, albeit the estimates were less pronounced. This was observed when central obesity was based on WC (PR = 2.48, 95% CI: 1.41 to 4.36), as well as WHtR (PR = 2.09, 95% CI: 1.11 to 3.92).[47]

### 3.3.4 | Other excess adiposity measures

Other adiposity indicators, such as weight (in kilograms), weight-for-age *z*-scores, and normal-weight obesity (NWO), were examined in few studies. Chang et al. reported positive associations between UPF and weight, when UPF consumption was both operationalized as percent of total grams per day (β = 0.20, 95% CI: 0.11 to 0.28) and percent of total kilocalories per day (β = 0.14, 95% CI: 0.06 to 0.22).[32] Instead, the cross-sectional study of 267 Canadian children conducted by Ashraf et al. reported null results.[46] Gyimah et al. in their cohort study of 125 two-year-old Ecuadorian children similarly found that UPF consumption (number of times per day categorized into T) was not associated with weight-for-height *z*-scores.[36] More recently, Cota et al. carried out a cross-sectional study which assessed the association between UPF consumption (in percent of kilocalories per day categorized into T) and NWO phenotype in 364 school-aged Brazilian children.[52] They defined NWO as individuals with normal weight who were assessed to have a high amount of body fat. This study revealed that increased UPF consumption was associated with higher prevalence of NWO, both among normal-weight children ($PR_{T2vsT1} = 1.9$, 95% CI: 1.1 to 3.4; and $PR_{T3vsT1} = 1.8$, 95% CI: 1.01 to 3.1) and those with excess weight ($PR_{TvsT1} = 2.0$; 95% CI, 1.2 to 3.3); albeit null findings were reported for children with excess weight in the highest UPF consumption category.

### 3.3.5 | Results by body composition indicators

Three prospective cohorts[32,33,35] and two cross-sectional studies[43,46] have assessed the association between UPF and body composition indicators. Different measurement instruments were used to assess body composition, including the BOD POD™ digital scale,[33,43] DEXA,[32] and bioelectrical impedance analysis.[35,46] Among them, two prospective studies reported positive associations.[32,33] After a 5-year follow-up, Costa et al. reported that a 100-g increase in UPF consumption was associated with an FMI increase of 0.05 kg/m$^2$ (95% CI: 0.04 to 0.06).[33] In the same vein, when assessing growth trajectories from 7 to 24 years, Chang et al. observed increases of 0.03 kg/m$^2$ in FMI ($\beta = 0.03$, 95% CI: 0.01 to 0.05) and of 0.15 kg in FM ($\beta = 0.15$, 95% CI: 0.08 to 0.21) per year in children in the highest Qntl of UPF (based on percent of total grams per day) compared with the lowest Qntl. Null associations were reported for total fat in percent, lean mass in kilograms, or LMI in kilograms per square meter; and similar results were observed when UPF was operationalized as percent of total kilocalories per day.[32] In contrast, the cross-sectional study by Viola et al. focused on Brazilian adolescents reported an inverse association between UPF (percent of total kilocalories per day, categorized into T) and LMI in kilograms per square meter ($\beta$: $-0.01$, 95% CI: $-0.02$ to $-0.01$).[43]

## 4 | DISCUSSION

This systematic review provides an overview of the limited and heterogeneous evidence regarding UPF consumption and excess adiposity in children and adolescents. Of the 23 studies that met the inclusion criteria, only one cohort study[33] and three cross-sectional studies[47,48,52] reported consistent positive associations in children[33,52] or adolescents.[47,48] And of the remaining 19 studies, one reported inverse associations,[50] five mixed results,[32,34,37,43,49] and 13 null findings.[31,35,36,38–42,44–46,51,53]

The five studies that reported mixed results varied according to (a) the type of outcome assessed or (b) the time of exposure to UPF. Regarding the former, Chang et al. found positive associations between UPF (both as percent of total grams per day and as percent of total kilocalories per day) and BMI *z*-score, BMI, FMI, weight, WC, and FM, but not for percent of total fat, LMI, or lean mass[32]; Viola et al. reported inverse associations for BMI and LMI and null findings for WC and android fat.[43] Regarding the latter, Vedovato et al. found positive associations among children with exposure at 4 years of age, but not at age 7[34]; Heerman et al. found positive associations for exposures at 3 and 4 years, but not at 5 years of age[37]; and Oviedo-Solís et al. found positive associations among children, but not among adolescents.[49]

Our results align with four other previous systematic reviews conducted on children and adolescents.[17–20] The first study, by Costa et al., found that while some studies found a positive association between high UPF consumption and excess body fat, there was a lack of association in others.[17] The researchers noted that methodological issues may explain the mixed findings and pointed to a need to use a standardized UPF classification system that considers the level of food processing. Subsequent systematic reviews on this topic sought to address this study limitation by restricting their synthesis to studies using the NOVA classification system to assess exposure to UPF[18–20]; nevertheless, these reviews also noted mixed associations with several adiposity indicators. Even with more recently published studies included in our updated systematic review, existing research findings are still very heterogeneous, making it difficult to draw firm conclusions on the linkages between UPF consumption and excess adiposity among pediatric populations. Conversely, the existence of these linkages is more to the well-established for adult populations.[14,16,56] Overall, current available evidence indicates that only longitudinal studies with long follow-up periods provide some level of consistency in supporting the relationship between high consumption of UPF and several adiposity indicators in pediatric populations. A notable example is the study conducted by Chang et al.,[32] which reported null findings when examining associations between UPF consumption and excess adiposity at baseline. However, it is important to point out that in their linear growth curve models, higher UPF consumption was associated with greater increases in adiposity from childhood to early adulthood.

From a research standpoint, the present systematic review emphasizes the need to expand and homogenize investigations regarding the impact of UPF consumption on weight outcomes in children and adolescents. This includes standardizing how UPF consumption and excess adiposity are measured in this population. Although the utilization of the NOVA classification system serves as an initial starting point to better measure UPF consumption, it is imperative to consistently operationalize measurement units across studies (e.g., grams vs. kilocalories and absolute vs. relative intakes) to ensure uniformity. A good practice, already followed by some studies,[32,48] may involve presenting results as relative amount of total grams and kilocalories, both as continuous and categorical variables. Researchers have also suggested that the implementation of the NOVA classification system could be enhanced by incorporating tools that are specifically validated for its application.[57] Moreover, the measurement and operationalization of excess adiposity varies considerably across studies. This issue is not novel, as it has been previously pointed out that there are dissimilarities in terminology and measurement approaches employed to examine excess adiposity in children, which can create confusion within research.[58] It is also worth noting that the adequacy of BMI as a measure of health and excess adiposity has been increasingly questioned,[59,60] especially in diverse populations of children.[61,62] Within this context, it is unsurprising there have been recent calls to stop using BMI due to its potential for stigmatization and inadequate reflection of health.[63,64] Furthermore, there is a need to conduct studies that encompass diverse populations, as existing research focused on the relationship between UPF consumption and excess adiposity in young populations has primarily been carried out in Brazil. This limitation may result in a restricted geographic representation and dietary patterns that differ from other countries. Multicenter studies involving multiple countries offer an opportunity to generalize findings to specific regions and better enhance global applicability.

Several limitations present in the included studies must be considered when interpreting our findings. First, most of them were cross-sectional studies, making it difficult to establish causal relationships and examine associations over time. While some of these limitations are addressed by the longitudinal cohort studies included in the review, they do not consider potential changes in dietary patterns that may contribute to changes in adiposity trajectories. Additionally, the assessment of UPF exposure primarily relied on food frequency questionnaires or food records that were not originally designed to capture detailed information on food processing (and were not always validated to the study population), potentially leading to UPF misclassification.[57] Moreover, studies relying on caregiver reports of child dietary intake are prone to misreporting and social desirability bias, which may introduce additional measurement errors. Another significant limitation pertains to the lack of adjustment for relevant confounding factors in certain studies, such as physical activity (or energy expenditure), dietary patterns, and socioeconomic status. As previously mentioned, it is important to acknowledge that most studies were conducted in children or adolescents from Brazil, limiting the generalizability of the results to other regions.

The present systematic review was also subject to a few limitations. First, findings may be affected by publication bias. While we made a concerted effort to be thorough in the selection of search terms used for conducting the systematic review, it is possible that given the vast terminology on excess adiposity, some keywords may have been overlooked. In addition, the heterogeneity of the studies encompassed variations in age range, outcome assessment, and operationalization/categorization of UPF consumption, which made it difficult to synthesize the results and, thus, prevented us from carrying out a meta-analysis which may have offered stronger evidence on this topic.

Nonetheless, this study represents, to date, the most comprehensive and updated synthesis of observational studies examining the risk of excess body weight resulting from UPF intake in children and adolescents. It provides an extensive overview of the existing literature on this topic, highlights study limitations that warrant improvement, and identifies research gaps and opportunities for future investigation.

## 5 | CONCLUSION

The existing scientific literature investigating the association between high consumption of UPF and excess adiposity measures in children and adolescents remains limited and heterogeneous. Consequently, drawing definitive conclusions within this population continues to be a challenge. Given that methodological issues may lie behind some of these inconsistencies, future studies should adopt longitudinal designs with sufficiently extended follow-up periods, account for relevant confounding factors, employ validated and standardized measurement tools to assess dietary exposure, ensure consistent operationalization of variables, and encompass diverse geographic contexts. Addressing such current research constraints may shed better insights necessary to inform current and forthcoming policy and practice interventions aimed at mitigating the increasing prevalence of overweight and obesity in childhood and across the life course.

## AUTHOR CONTRIBUTIONS

B. R. and M. So. conceptualized the initial study and M. Sa. guided the search strategy. B. R., M. So., and A. M. extracted the data and independently appraised all guidelines. Any discrepancies were resolved by M. Sa. B. R. and M. So. synthesized the results and B.R. drafted the original version of the manuscript. All authors contributed to the interpretation and presentation of the data and assisted with the preparation of the final version of the article. All authors have read and approved the article for publication.

## ACKNOWLEDGMENTS

We would like to thank El Centro de Investigación Biomédica en Red de Epidemiología y Salud Pública (CIBERESP) for their support.

## CONFLICT OF INTEREST STATEMENT

No conflicts of interest are declared by the authors.

## ORCID

*Brenda Robles* https://orcid.org/0000-0001-6023-7809
*Anna Mota-Bertran* https://orcid.org/0000-0002-7580-6127

## REFERENCES

1. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr*. 2018;21(1): 5-17. doi:10.1017/S1368980017000234
2. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. *Am J Clin Nutr*. 2006;84(2):289-298. doi:10.1093/ajcn/84.1.289
3. Baker P, Machado P, Santos T, et al. Ultra-processed foods and the nutrition transition: global, regional and national trends, food systems transformations and political economy drivers. *Obes Rev*. 2020; 21(12):e13126. doi:10.1111/obr.13126
4. Gibney MJ. Ultra-processed foods: definitions and policy issues. *Curr Dev Nutr*. 2019;3(2):nzy077. doi:10.1093/cdn/nzy077
5. Popkin BM. Measuring the nutrition transition and its dynamics. *Public Health Nutr*. 2021;24(2):318-320. doi:10.1017/s136898002000470x

6. Lawrence MA, Baker PI. Ultra-processed food and adverse health outcomes. *BMJ*. 2019;365:l2289. doi:10.1136/bmj.l2289
7. Elizabeth L, Machado P, Zinöcker M, Baker P, Lawrence M. Ultra-processed foods and health outcomes: a narrative review. *Nutrients*. 2020;12(7):1955. doi:10.3390/nu12071955
8. Chen X, Zhang Z, Yang H, et al. Consumption of ultra-processed foods and health outcomes: a systematic review of epidemiological studies. *Nutr J*. 2020;19(1):86. doi:10.1186/s12937-020-00604-1
9. Santos FSD, Dias MDS, Mintem GC, Oliveira IO, Gigante DP. Food processing and cardiometabolic risk factors: a systematic review. *Rev Saude Publica*. 2020;54:70. doi:10.11606/s1518-8787.2020054001704
10. Silva Meneguelli T, Viana-Hinkelmann J, Hermsdorff HHM, Zulet MÁ, Martínez JA, Bressan J. Food consumption by degree of processing and cardiometabolic risk: a systematic review. *Int J Food Sci Nutr*. 2020;71(6):678-692. doi:10.1080/09637486.2020.1725961
11. Jardim MZ, Costa BVL, Pessoa MC, Duarte CK. Ultra-processed foods increase noncommunicable chronic disease risk. *Nutr Res*. 2021;95:19-34. doi:10.1016/j.nutres.2021.08.006
12. Wang M, Du X, Huang W, Xu Y. Ultra-processed foods consumption increases the risk of hypertension in adults: a systematic review and meta-analysis. *Am J Hypertens*. 2022;35(10):892-901. doi:10.1093/ajh/hpac069
13. Popkin BM, Ng SW. The nutrition transition to a stage of high obesity and noncommunicable disease prevalence dominated by ultra-processed foods is not inevitable. *Obes Rev*. 2022;23(1):e13366. doi:10.1111/obr.13366
14. Askari M, Heshmati J, Shahinfar H, Tripathi N, Daneshzad E. Ultra-processed food and the risk of overweight and obesity: a systematic review and meta-analysis of observational studies. *Int J Obes (Lond)*. 2020;44(10):2080-2091. doi:10.1038/s41366-020-00650-z
15. Pagliai G, Dinu M, Madarena MP, Bonaccio M, Iacoviello L, Sofi F. Consumption of ultra-processed foods and health status: a systematic review and meta-analysis. *Br J Nutr*. 2021;125(3):308-318. doi:10.1017/s0007114520002688
16. Moradi S, Entezari MH, Mohammadi H, et al. Ultra-processed food consumption and adult obesity risk: a systematic review and dose-response meta-analysis. *Crit Rev Food Sci Nutr*. 2022;63(2):249-260. doi:10.1080/10408398.2021.1946005
17. Costa CS, Del-Ponte B, Assunção MCF, Santos IS. Consumption of ultra-processed foods and body fat during childhood and adolescence: a systematic review. *Public Health Nutr*. 2018;21(1):148-159. doi:10.1017/s1368980017001331
18. De Amicis R, Mambrini SP, Pellizzari M, et al. Ultra-processed foods and obesity and adiposity parameters among children and adolescents: a systematic review. *Eur J Nutr*. 2022;61(5):2297-2311. doi:10.1007/s00394-022-02873-4
19. Frías JRG, Cadena LH, Villarreal AB, et al. Effect of ultra-processed food intake on metabolic syndrome components and body fat in children and adolescents: a systematic review based on cohort studies. *Nutrition*. 2023;111:112038. doi:10.1016/j.nut.2023.112038
20. Petridi E, Karatzi K, Magriplis E, Charidemou E, Philippou E, Zampelas A. The impact of ultra-processed foods on obesity and cardiometabolic comorbidities in children and adolescents: a systematic review. *Nutr Rev*. 2023;7(7):928. doi:10.1093/nutrit/nuad095
21. Faienza MF, Chiarito M, Molina-Molina E, et al. Childhood obesity, cardiovascular and liver health: a growing epidemic with age. *World J Pediatr*. 2020;16(5):438-445. doi:10.1007/s12519-020-00341-9
22. Quek YH, Tam WWS, Zhang MWB, Ho RCM. Exploring the association between childhood and adolescent obesity and depression: a meta-analysis. *Obes Rev*. 2017;18(7):742-754. doi:10.1111/obr.12535
23. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obes Rev*. 2016;17(2):95-107. doi:10.1111/obr.12334
24. Ayer J, Charakida M, Deanfield JE, Celermajer DS. Lifetime risk: childhood obesity and cardiovascular risk. *Eur Heart J*. 2015;36(22):1371-1376. doi:10.1093/eurheartj/ehv089
25. Weihrauch-Blüher S, Schwarz P, Klusmann JH. Childhood obesity: increased risk for cardiometabolic disease and cancer in adulthood. *Metabolism*. 2019;92:147-152. doi:10.1016/j.metabol.2018.12.001
26. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. doi:10.1136/bmj.n71
27. Thompson M, Tiwari A, Fu R, Moe E, Buckley DI. *A Framework to Facilitate the Use of Systematic Reviews and Meta-Analyses in the Design of Primary Research Studies*. Agency for Healthcare Research and Quality (US); 2012. Report No.: 12-EHC009-EF. PMID: 22299187
28. Wells GA, Shea B, O'connell D, et al. *The Newcastle–Ottawa Scale (NOS) for Assessing the Quality of Nonrandomized Studies in Meta-Analyses*. 2000. Available at: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp
29. Herzog R, Álvarez-Pasquin MJ, Díaz C, Del Barrio JL, Estrada JM, Gil Á. Are healthcare workers intentions to vaccinate related to their knowledge, beliefs and attitudes? A systematic review. *BMC Public Health*. 2013;13:154. doi:10.1186/1471-2458-13-154
30. Taylor RW, Jones IE, Williams SM, Goulding A. Evaluation of waist circumference, waist-to-hip ratio, and the conicity index as screening tools for high trunk fat mass, as measured by dual-energy X-ray absorptiometry, in children aged 3–19 y. *Am J Clin Nutr*. 2000;72(2):490-495. doi:10.1093/ajcn/72.2.490
31. Bawaked RA, Fernández-Barrés S, Navarrete-Muñoz EM, et al. Impact of lifestyle behaviors in early childhood on obesity and cardiometabolic risk in children: results from the Spanish INMA birth cohort study. *Pediatr Obes*. 2020;15(3):e12590. doi:10.1111/ijpo.12590
32. Chang K, Khandpur N, Neri D, et al. Association between childhood consumption of ultraprocessed food and adiposity trajectories in the Avon longitudinal study of parents and children birth cohort. *JAMA Pediatr*. 2021;175(9):e211573. doi:10.1001/jamapediatrics.2021.1573
33. Costa CDS, Assunção MCF, Loret de Mola C, et al. Role of ultra-processed food in fat mass index between 6 and 11 years of age: a cohort study. *Int J Epidemiol*. 2021;50(1):256-265. doi:10.1093/ije/dyaa141
34. Vedovato GM, Vilela S, Severo M, Rodrigues S, Lopes C, Oliveira A. Ultra-processed food consumption, appetitive traits and BMI in children: a prospective study. *Br J Nutr*. 2021;125(12):1427-1436. doi:10.1017/s0007114520003712
35. Vilela S, Magalhães V, Severo M, Oliveira A, Torres D, Lopes C. Effect of the food processing degree on cardiometabolic health outcomes: a prospective approach in childhood. *Clin Nutr*. 2022;41(10):2235-2243. doi:10.1016/j.clnu.2022.07.034
36. Gyimah EA, Nicholas JL, Waters WF, et al. Ultra-processed foods in a rural Ecuadorian community: associations with child anthropometry and bone maturation. *Br J Nutr*. 2023;130(9):1609-1624. doi:10.1017/s0007114523000624
37. Heerman WJ, Sneed NM, Sommer EC, et al. Ultra-processed food consumption and BMI-Z among children at risk for obesity from low-income households. *Pediatr Obes*. 2023;18(8):e13037. doi:10.1111/ijpo.13037
38. Pereyra González I, Farías-Antúnez S, Buffarini R, et al. Ultra-processed food consumption and the incidence of obesity in two cohorts of Latin-American young children: a longitudinal study. *J Pediatr Nurs*. 2023;69:e120-e126. doi:10.1016/j.pedn.2022.12.018
39. Louzada ML, Baraldi LG, Steele EM, et al. Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. *Prev Med (Baltim)*. 2015;81:9-15. doi:10.1016/j.ypmed.2015.07.018

40. Melo ISV, Costa CACB, Santos JVLD, Santos AFD, Florêncio TMMT, Bueno NB. Consumption of minimally processed food is inversely associated with excess weight in adolescents living in an underdeveloped city. *PLoS ONE*. 2017;12(11):e0188401. doi:10.1371/journal.pone.0188401
41. Bleiweiss-Sande R, Sacheck JM, Chui K, Goldberg JP, Bailey C, Evans EW. Processed food consumption is associated with diet quality, but not weight status, in a sample of low-income and ethnically diverse elementary school children. *Appetite*. 2020;1(151):104696. doi:10.1016/j.appet.2020.104696
42. Oliveira T, Ribeiro I, Jurema-Santos G, et al. Can the consumption of ultra-processed food be associated with anthropometric indicators of obesity and blood pressure in children 7 to 10 years old? *Foods*. 2020;9(11):1567. doi:10.3390/foods9111567
43. Viola PCAF, Carvalho CA, Bragança MLBM, França AKTDC, Alves MTSSBE, da Silva AAM. High consumption of ultra-processed foods is associated with lower muscle mass in Brazilian adolescents in the RPS birth cohort. *Nutrition*. 2020;79–80:110983. doi:10.1016/j.nut.2020.110983
44. Nascimento LM, do Nascimento Monteiro NV, Vilar TM, Lucio de Sousa Ibiapina CR, Gonçalves Frota KM. The influence of ultra-processed food consumption in anthropometric and atherogenic indices of adolescents. *Revista de Nutrição*. 2021;34:e200036. doi:10.1590/1678-9865202134e200036
45. Asgari E, Askari M, Bellissimo N, Azadbakht L. Association between ultraprocessed food intake and overweight, obesity, and malnutrition among children in Tehran, Iran. *Int J Clin Pract*. 2022;2022:8310260. doi:10.1155/2022/8310260
46. Ashraf R, Duncan AM, Darlington G, Buchholz AC, Haines J, Ma DWL. The degree of food processing is associated with anthropometric measures of obesity in Canadian families with preschool-aged children. *Front Nutr*. 2022;9:1005227. doi:10.3389/fnut.2022.1005227
47. de Souza SF, Conceição-Machado MEPD, Costa PRF, et al. Degree of food processing and association with overweight and abdominal obesity in adolescents. *Einstein*. 2022;20:eAO6619. doi:10.31744/einstein_journal/2022ao6619
48. Neri D, Martínez-Steele E, Khandpur N, Levy R. Associations between ultra-processed foods consumption and indicators of adiposity in US adolescents: cross-sectional analysis of the 2011-2016 National Health and Nutrition Examination Survey. *J Acad Nutr Diet*. 2022;122(8):1474-1487.e2. doi:10.1016/j.jand.2022.01.005
49. Oviedo-Solís CI, Monterrubio-Flores EA, Cediel G, Denova-Gutiérrez E, Barquera S. Trend of ultraprocessed product intake is associated with the double burden of malnutrition in Mexican children and adolescents. *Nutrients*. 2022;14(20):4347. doi:10.3390/nu14204347
50. Crisóstomo JDM, Rodrigues LARL, Lavôr LCDC, et al. Consumption of ultra-processed foods among adolescents, adults and the elderly in a capital city of Northeastern Brazil. *Revista Chilena de nutrición*. 2022;48(6):884-892. doi:10.4067/s0717-75182021000600884
51. Madalosso MM, Martins NNF, Medeiros BM, et al. Consumption of ultra-processed foods and cardiometabolic risk factors in Brazilian adolescents: results from ERICA. *Eur J Clin Nutr*. 2023;77(11):1084-1092. doi:10.1038/s41430-023-01329-0
52. Cota BC, Filgueiras MDS, Pereira PF, Juvanhol LL, Novaes JF. Higher consumption of ultra-processed foods and a pro-inflammatory diet are associated with the normal-weight obesity phenotype in Brazilian children. *Nutrition*. 2024;117:112234. doi:10.1016/j.nut.2023.112234
53. Hou M, Qiu C. Ultra-processed food as mediator of the association between birthweight and childhood body weight outcomes: a retrospective cohort study. *Nutrients*. 2023;15(9):4178. doi:10.3390/nu15194178
54. Poti JM, Mendez MA, Ng SW, Popkin BM. Is the degree of food processing and convenience linked with the nutritional quality of foods purchased by US households? *Am J Clin Nutr*. 2015;101(6):1251-1262. doi:10.3945/ajcn.114.100925
55. Freire W, Belmont P, Jiménez E, Román D, Burgos E. Lista de alimentos, preparaciones y bebidas que se consumen en Ecuador según la clasificación NOVA 2017. *Bitácora Académia*. 2018;5:1-130. Available at: http://bitacora.usfq.edu.ec
56. Harb AA, Shechter A, Koch PA, St-Onge MP. Ultra-processed foods and the development of obesity in adults. *Eur J Clin Nutr*. 2023;77(6):619-627. doi:10.1038/s41430-022-01225
57. Marino M, Puppo F, Del Bo' C, et al. A systematic review of worldwide consumption of ultra-processed foods: findings and criticisms. *Nutrients*. 2021;13(8):2778. doi:10.3390/nu13082778
58. Flegal KM, Ogden CL. Childhood obesity: are we all speaking the same language? *Adv Nutr*. 2011;2(2):159S-166S. doi:10.3945/an.111.000307
59. Nuttall FQ. Body mass index: obesity, BMI, and health: a critical review. *Nutr Today*. 2015;50(3):117-128. doi:10.1097/NT.0000000000000092
60. Adedia D, Boakye AA, Mensah D, Lokpo SY, Afeke I, Duedu KO. Comparative assessment of anthropometric and bioimpedence methods for determining adiposity. *Heliyon*. 2020;6(12):e05740. doi:10.1016/j.heliyon.2020.e05740
61. Whitney DG, Miller F, Pohlig RT, Modlesky CM. BMI does not capture the high fat mass index and low fat-free mass index in children with cerebral palsy and proposed statistical models that improve this accuracy. *Int J Obes (Lond)*. 2018;43(1):82-90. doi:10.1038/s41366-018-0183-1
62. Shypailo RJ, Wong WW. Fat and fat-free mass index references in children and young adults: assessments along racial and ethnic lines. *Am J Clin Nutr*. 2020;112(3):566-575. doi:10.1093/ajcn/nqaa128
63. Mahase E. Stop using body mass index as measure of health, say MPs. *BMJ*. 2021;373:n941. doi:10.1136/bmj.n941
64. Tanne JH. Obesity: avoid using BMI alone when evaluating patients, say US doctors' leaders. *BMJ*. 2023;381:1400. doi:10.1136/bmj.p1400

## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**How to cite this article:** Robles B, Mota-Bertran A, Saez M, Solans M. Association between ultraprocessed food consumption and excess adiposity in children and adolescents: A systematic review. *Obesity Reviews*. 2024;25(10):e13796. doi:10.1111/obr.13796