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Original Research Article

Ultra-Processed Food Consumption and Cardiometabolic Risk in Adolescents: A Systematic Review of Observational Studies

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ABSTRACT

Introduction. Rising ultra-processed food (UPF) consumption among adolescents poses public health concerns due to its potential links to obesity and early cardiometabolic risk. This systematic review aims to synthesize evidence on the association between UPF intake and overweight, obesity, adiposity, and cardiometabolic indicators in adolescents aged 10–19 years**. Method**. A systematic review of observational studies was conducted following PRISMA 2020 guidelines. Literature searches were performed in PubMed/MEDLINE, Scopus, Web of Science, Embase, and other relevant databases. Study selection, data extraction, and bias assessment were independently performed by at least two reviewers. **Result & Analysis.** Higher UPF consumption was consistently associated with overweight and obesity (pooled OR = 1.63; 95% CI: 1.36–1.95) and several adiposity indicators, whereas associations with metabolic markers showed greater variability due to heterogeneity in study design, dietary assessment, outcome definitions, and confounding control. **Discussion**. This review provides an adolescent-specific synthesis linking UPF exposure to adiposity and metabolic disturbances. The findings highlight the need for standardized methodologies and further prospective studies to clarify causal pathways and inform targeted preventive strategies.

Keywords: Adolescents, cardiometabolic Risk, Non-Communicable Diseases, Obesity, Ultra-Processed Foods.

INTRODUCTION

Adolescence represents a critical developmental period. During this phase, biological,psychosocial, and environmental changes occur alongside the establishment of dietary habits that may persist into adulthood and influence long-term health outcomes (Kokoszka et al., 2026). Within the dynamics of the current global food system, one of the most prominent changes is the rising consumption of ultra-processed foods (UPF) among adolescents. The NOVA classification system, developed within the Brazilian epidemiological tradition, categorizes foods according to the extent and purpose of industrial processing into four groups: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods, with the last category referring to industrial formulations containing little or no intact whole food (Louzada & Gabe, 2025). Data from Korea indicate that the proportion of energy derived from UPF increased from 28.7% in 2007–2009 to 36.9% in 2022–2024, while national dietary surveys in the United Kingdom show that UPF accounts for an average of 65.9% of total energy intake among adolescents (Chavez-Ugalde et al., 2024; Jung et al., 2026). Comparable patterns are observed in Indonesia. Analysis of the Indonesia Health Survey 2023 involving 46,432 adolescents aged 10–19 years identified associations between obesity and various consumption characteristics, including habits of consuming fatty foods and energy drinks (Widyastuti et al., 2026). At the local level, a study among secondary school students in Pontianak, West Kalimantan, demonstrated that 51.6% of participants had excessive consumption levels of UPF and ultra-processed beverages, while 40.3% were classified as overweight or obese (Ginting et al., 2024; Widyastuti et al., 2026). These patterns collectively confirm that increasing UPF exposure during adolescence warrants attention as a significant public health issue.

The relationship between UPF consumption and adverse health outcomes in adolescents has not demonstrated fully consistent patterns across all cardiometabolic indicators. A systematic review and meta-analysis specifically evaluating adolescent populations identified 23 studies with approximately 155,000 participants and demonstrated that the group with higher UPF consumption had significantly greater odds of overweight or obesity compared to the group with lower consumption (OR = 1.63; 95% CI: 1.36–1.95) (Aweke et al., 2026). However, associations have shown variability across different outcomes. Research among adolescents in Colombia found that higher UPF consumption was associated with decreased dietary quality and increased blood glucose levels, but did not show significant associations with all cardiovascular risk factors analyzed (Castrillón-Ruiz et al., 2025). Similarly, findings from the I.Family Study across multiple European countries indicated that UPF consumption did not show a statistically significant relationship with metabolic syndrome z-score or its components among adolescent participants (Formisano et al., 2025). Earlier systematic reviews summarizing observational studies found that while longitudinal studies with follow-up periods longer than four years demonstrated positive associations between UPF consumption and obesity parameters, cross-sectional studies generally failed to find such associations (De Amicis et al.,

2022). This body of evidence suggests that adiposity, blood pressure, glucose-insulin homeostasis, lipid profiles, and various metabolic outcomes should be understood as a spectrum of interconnected yet distinct indicators that respond differently to UPF exposure.

The potential relationship between UPF consumption and noncommunicable disease risk in adolescents can be understood through a sequence involving dietary quality, adiposity, and metabolic disturbances. Research on Iranian adolescents with overweight or obesity demonstrated that each 10 g/day increase in UPF consumption was associated with increased odds of metabolically unhealthy overweight/obesity phenotype, as well as associations with hyperglycemia, hypertriglyceridemia, low HDL-C, hypertension, and insulin resistance (Farzam et al., 2024). Studies on Kuwaiti adolescents further support this perspective, showing that higher UPF consumption was associated with lower protein and fiber intake, as well as higher consumption of total fat, saturated fat, trans fat, and salt (AlBaloul, 2026). Evidence from adult populations demonstrates that higher UPF consumption may be simultaneously associated with BMI, waist circumference, diastolic blood pressure, HbA1c, triglycerides, insulin, and inflammatory markers, though some associations weaken after adjustment for overall dietary quality (Baric et al., 2025). Based on the cumulative evidence, this review conceptually positions UPF consumption as a dietary exposure with potential effects on dietary quality and intake characteristics, subsequently associated with adiposity and metabolic changes that may increase noncommunicable disease risk.

The research question is directed not only toward assessing the existence of an association between UPF consumption and health outcomes in adolescents, but also toward understanding the extent to which these associations are influenced by methodological and demographic characteristics of available studies. The analytical focus encompasses comparisons between higher and lower UPF consumption levels regarding risks of overweight, obesity, abdominal obesity, various adiposity indicators, blood pressure, glucose and insulin metabolism, lipid profiles, metabolic syndrome, MASLD, and other relevant cardiometabolic indicators. Additionally, this study evaluates potential variations based on sex, age group, geographic region, socioeconomic status, study design, and dietary assessment methods. This approach is essential because patterns of UPF consumption among adolescents are influenced by social, demographic, and environmental characteristics that shape dietary behavior during this life phase (Louey et al., 2024). Longitudinal evidence from Germany demonstrates that increased UPF exposure was associated with greater odds of overweight and obesity after adjustment for age, sex, socioeconomic status, physical activity, and baseline BMI (Figueiredo Barata et al., 2025), the importance of temporality and confounding control in interpreting the relationship between UPF exposure and health outcomes. Based on these gaps, this study aims to systematically analyze and synthesize scientific evidence regarding the association between UPF consumption and obesity as well as cardiometabolic NCD risk factors in adolescents aged 10–19 years. The analysis considers variations in study design, dietary assessment methods,

exposure definitions, population characteristics, and confounding control strategies.

The scientific novelty of this study lies in its effort to construct an evidence synthesis specifically focused on the adolescent population while encompassing a broader spectrum of outcomes beyond overweight or obesity. The need for this approach arises because many reviews on UPF and obesity continue to combine children, adolescents, and adults, thereby obscuring risk characteristics specific to adolescence (Dewi, 2026). In addition to population variation, heterogeneity also originates from how UPF exposure is measured. Instruments such as food frequency questionnaires and 24-hour dietary recalls, as well as the use of grams, weight proportions, or energy percentages, can yield different consumption characterizations, making the validity of instruments based on NOVA classification important for assessing comparability across studies (Paladino et al., 2025). This complexity becomes more apparent when multiple metabolic indicators are analyzed simultaneously, as research on adolescents indicates that the direction of association with UPF consumption can differ depending on the marker used (Madalosso et al., 2023). The diversity of exposure measurement methods represents another important source of heterogeneity. Comparisons between different classification systems demonstrate that processing levels, additive use, and nutritional quality are not always represented identically, so NOVA is best understood as a processing-based classification framework (Medin et al., 2025) Methodological experiments using child dietary data from Chile further demonstrate that the use of food descriptions, ingredient markers, or combinations of markers with additives can yield different proportions of products and UPF energy contribution, even when all use the NOVA framework (Zancheta Ricardo et al., 2023). Therefore, a single anthropometric indicator is insufficient to represent the entire spectrum of cardiometabolic risk. The contribution of this article is directed toward an integrated adolescent-specific evidence synthesis approach that systematically maps the continuum of UPF exposure → adiposity → metabolic disturbances → cardiometabolic NCD risk factors, while maintaining clear analytical boundaries between empirical associations found in studies, biological mechanisms that remain hypothetical, and causal inferences that cannot be established from the predominantly observational evidence base (Nadirawati et al., 2023; Sulistyo Febiyanti & Ayu Ainun Nafies, 2024)

METHOD AND ANALYSIS

A systematic review of observational studies was conducted to examine the association between ultra-processed food consumption and obesity as well as cardiometabolic risk factors in adolescents, with reporting following the PRISMA 2020 guidelines (Page et al., 2021). The target population was defined as adolescents aged 10–19 years, with the primary exposure being UPF consumption categorized under NOVA Group 4, and outcomes encompassing overweight, obesity, adiposity indicators, blood pressure, glucose-insulin metabolism, lipid profiles, metabolic syndrome, and MASLD (Louzada & Gabe, 2025). The research protocol was developed prior to the screening process to minimize the potential

for methodological decisions being influenced by knowledge of the results. Studies were eligible for inclusion if they were observational analytical designs (prospective cohorts, retrospective cohorts, cross-sectional analytic studies, or case-control studies) that reported measurable associations between UPF consumption and relevant outcomes in adolescent populations.

Primary literature searches were performed across PubMed/MEDLINE, Scopus, Web of Science Core Collection, and Embase , combining controlled vocabulary with free-text terms across three concept groups: UPF exposure ("ultra-processed food," "ultra-processed food," "NOVA classification"), adolescent population ("adolescent," "teenager," "youth"), and outcomes ("obesity," "overweight," "adiposity," " cardiometabolic risk," "blood pressure," "hypertension," "glucose," "insulin resistance," "dyslipidemia," "metabolic syndrome"). Synonyms within each concept were combined using Boolean OR, while different concept groups were combined using AND, with syntax adapted to each database. Study selection, data extraction, and risk of bias assessment were carried out independently by at least two reviewers using the JBI Critical Appraisal Tools appropriate to each study design (Barker et al., 2025, 2026). Data extracted included author, publication year, country, study design, population characteristics, dietary assessment methods, UPF classification approaches, exposure quantification, outcome measurements, confounding factors, effect estimates with 95% confidence intervals, and information for bias assessment.

Due to anticipated heterogeneity arising from population differences, dietary assessment instruments, outcome definitions, and confounding adjustment strategies, a narrative synthesis was planned as the primary approach. Quantitative pooling using random-effects meta-analysis was considered only if sufficient methodological homogeneity existed across studies, with heterogeneity evaluated using I^2, τ^2, and relevant tests (Borenstein, 2024; Higgins & López-López, 2026) Subgroup analyses and sensitivity analyses were planned to explore sources of heterogeneity, though final analytical decisions would depend on the characteristics of the included studies after full data extraction. All findings were reported as observational associations rather than causal effects, with the understanding that mediation interpretations would only be made if primary studies explicitly tested such pathways.

RESULTS

Preliminary evidence mapping from the identified studies demonstrated that the association between UPF consumption and health outcomes in adolescents did not form a uniform pattern across all outcome domains. On the domain of overweight, obesity, and adiposity, relatively more consistent associations were observed. A previously published systematic review and meta-analysis by Aweke et al. (2026)which examined 23 studies with approximately 155,000 adolescent participants, reported that higher UPF consumption was associated with significantly greater odds of overweight or obesity compared to lower consumption (OR = 1.63; 95% CI: 1.36–1.95) .Longitudinal evidence from the German KiGGS study further supported temporal ordering, demonstrating that

increased UPF pattern exposure was associated with higher odds of overweight, and that higher exposure categories were also associated with incident overweight and obesity after adjustment for demographic characteristics, socioeconomic status, physical activity, and baseline BMI (Figueiredo Barata et al., 2025). A cross-sectional study on 245 adolescents aged 12–17 years using the NOVA screener showed that the association between UPF consumption and overweight risk after adjustment for biological, behavioral, and socioeconomic factors was at the borderline of statistical significance (OR = 0.91; 95% CI: 0.83–1.01; p = 0.06) (Machado-Rodrigues et al., 2024). In Jordanian children and adolescents, UPF was reported to contribute approximately 40% of daily energy intake, with overweight prevalence at 23.9% and obesity at 13.3%, while UPF consumption showed a weak positive correlation with waist circumference (r = 0.119; p = 0.005) (Al Hourani et al., 2025). At the local level, a cross-sectional study of 273 high school students in Pontianak, Indonesia, found that 51.6% of participants had excessive UPF and ultra-processed beverage consumption, while 40.3% were classified as overweight or obese. The study reported that higher UPF consumption was associated with lower nutritional status, which in this context may reflect undernutrition rather than overweight/obesity, alongside associations of nutritional status with sex, maternal education, and family income (Ginting et al., 2024). This finding is notably different from the positive associations observed in most other studies and may reflect the dual burden of malnutrition in this population, where both undernutrition and over nutrition coexist. These findings indicate that preliminary evidence on adiposity has not moved in a fully uniform pattern and must be interpreted with consideration of differences in design, population, and UPF measurement methods.

In contrast, associations with metabolic outcomes demonstrated greater variability. On the glucose and insulin metabolism domain, the I.Family Study encompassing 645 adolescents aged 10–19 years found that UPF consumption assessed using 24-hour recall did not show a statistically significant relationship with metabolic syndrome z-score or its components, with reported effect sizes being relatively small (η^2 = 0.015) (Formisano et al., 2025). Conversely, a pilot cross-sectional study of 31 Muslim adolescents aged 15–17 years in Melilla found that UPF consumption expressed as percentage of daily energy was positively associated with BMI, body fat percentage, waist circumference, waist-to-height ratio, and fasting glucose after false discovery rate control (Mohatar-Barba et al., 2026). Among 402 adolescents in Antioquia, Colombia, UPF contribution was recorded at 17.6 ± 1.9% of total energy, and participants in the highest consumption quartile had blood glucose levels 3.13 mg/dL higher, although no significant associations were found for other cardiovascular risk factors examined (Castrillón-Ruiz et al., 2025). Broader results were obtained from a cross-sectional study of 203 Iranian adolescents with overweight or obesity (mean age 13.98 ± 1.61 years), in which each 10 g/day increase in UPF consumption was associated with increased odds of metabolically unhealthy overweight/obesity phenotype by IDF criteria (OR = 1.14; 95% CI: 1.08–1.19), as well as with increased odds of hyperglycemia, hypertriglyceridemia, low

HDL-C, hypertension, and insulin resistance (Farzam et al., 2024). On the hepatic outcome domain, evidence remained limited. On the hepatic outcome domain, evidence remained limited. Analysis of adolescent participants in NHANES using percentage of energy from UPF based on NOVA classification as exposure and controlled attenuation parameter (CAP) as an indicator of steatosis reported a median UPF contribution of 75% (IQR 62–86%) of total energy intake, but found no significant correlation between UPF consumption and CAP ($\rho = 0.061$; $p = 0.091$), with UPF consumption proportion not differing by steatosis severity (Buytaert et al., 2025). However, this finding is derived from a single study and requires confirmation from additional research before any definitive conclusion can be drawn. These findings demonstrate that the association between UPF consumption and metabolic outcomes varies not only across studies but also according to the specific cardiometabolic marker used as the outcome.

Diversity in exposure measurement methods emerged as another important characteristic observed in the preliminary literature on UPF consumption among adolescents. Analysis of the Korea National Health and Nutrition Examination Survey 2019–2023 involving 1,720 adolescents aged 12–18 years employed 24-hour dietary recall and classified participants into quartiles based on the percentage of energy derived from UPF. Adolescents in the highest consumption quartile were reported to have lower intake of protein, vitamin A, B1, B2, niacin, iron, and potassium, as well as a smaller proportion of healthy eating practices compared to the group with lower UPF exposure (Kim & Lee, 2025). Meanwhile, a study of 7,761 adolescents aged 11–17 years in Chongqing used a consumption score developed from the unhealthy eating subscale and found that UPF consumption coefficients were lower across several quartiles of food literacy compared to the lowest quartile, with interaction patterns differing according to sex and screen time duration (Guo et al., 2025). Such variation appeared alongside the use of food frequency questionnaires, NOVA screeners, single or multiple 24-hour recalls, measures in grams per day, servings per day, energy percentages, and quartile or tertile grouping in other publications that had been identified. Therefore, dietary assessment methods and the form of UPF consumption quantification must be treated as distinct variables and extracted separately in the final review dataset to enable proper analysis of exposure measurement heterogeneity.

Studies examining dietary quality and nutrient intake patterns in relation to UPF consumption provided additional insights into potential mediating pathways. Research on Colombian adolescents demonstrated that higher UPF consumption levels were associated with greater intake of total energy, total fat, and saturated fat, as well as lower fiber consumption, with the highest exposure group also showing higher glucose levels, although not all cardiovascular risk factors showed significant differences (Castrillón-Ruiz et al., 2025). A similar pattern was found in Kuwaiti adolescents, where higher UPF consumption was associated with lower protein and fiber intake and higher consumption of total fat, saturated fat, trans fat, and salt (AlBaloul, 2026). These dietary quality alterations may represent one pathway through which UPF consumption influences metabolic risk. In the Korean

population, adolescents in the highest UPF consumption quartile were reported to have lower intake of several micronutrients including vitamin A, B1, B2, niacin, iron, and potassium, alongside a smaller proportion of healthy eating practices (Kim & Lee, 2025). Furthermore, the relationship between UPF consumption and food literacy observed in the Chongqing study suggests that knowledge and behavioral factors may modify the association, with the interaction patterns differing according to sex and screen time duration, indicating that the effect of UPF consumption on health outcomes may be context-dependent and influenced by behavioral and environmental factors (Guo et al., 2025).

The preliminary evidence also revealed substantial variation in how studies handled confounding factors, which may contribute to the heterogeneity of findings. Some studies adjusted for comprehensive sets of confounders including age, sex, socioeconomic status, physical activity, screen time, and total energy intake, while others adjusted for more limited sets of variables. The KiGGS longitudinal study, for example, adjusted for age, sex, socioeconomic status, physical activity, and baseline BMI, which strengthens the validity of its findings regarding the temporal association between UPF exposure and overweight/obesity (Figueiredo Barata et al., 2025). In contrast, some cross-sectional studies with more limited adjustment may have been more susceptible to residual confounding, potentially explaining why certain studies found weaker or non-significant associations. The Iranian study, which adjusted for age, sex, physical activity, energy intake, and parental education, still found robust associations with multiple metabolic markers even after comprehensive adjustment, suggesting that the relationship between UPF consumption and metabolic health may be relatively resistant to confounding in certain populations (Farzam et al., 2024). These variations in confounding control strategies underscore the importance of considering adjustment quality when interpreting the consistency and strength of associations across studies.

The examination of dietary patterns and sociodemographic correlates provided additional contextual information for interpreting UPF consumption among adolescents. Analysis of UK adolescents demonstrated that UPF consumption levels followed distinct patterns according to socioeconomic status and geographic region, indicating that population context modifies both exposure levels and potentially the strength of associations with health outcomes (Chavez-Ugalde et al., 2024). The Indonesian context is particularly relevant, where Widyastuti (2026) found that adolescent obesity was associated with various consumption characteristics and lifestyle factors, suggesting that UPF exposure operates within a complex web of determinants that must be considered when interpreting associations. The sociodemographic gradients observed in multiple populations highlight the importance of considering social and environmental factors as potential effect modifiers rather than merely confounders, as the distribution of UPF consumption and its health consequences may be systematically patterned by socioeconomic position and geographic location. These contextual factors must be incorporated into the analytical framework to avoid overgeneralizing findings from specific populations to other settings with different

food environments and socioeconomic conditions.

DISCUSSION

The findings of this review demonstrate that the association between UPF consumption and health outcomes in adolescents is not uniform, with more consistent evidence supporting relationships with overweight and obesity compared to metabolic markers. This pattern aligns with previous systematic reviews, including the work of De Amicis et al. (2022), which found that longitudinal studies consistently demonstrated positive associations between UPF consumption and obesity parameters, whereas cross-sectional studies often failed to find such associations. The longitudinal evidence from the KiGGS study (Figueiredo Barata et al., 2025) and the meta-analysis by Aweke et al. (2026) further strengthen this temporal relationship, suggesting that study design plays a critical role in detecting associations that may be obscured in cross-sectional analyses due to reverse causation or behavioral modifications following weight gain. The geographic diversity of findings, extending from Jordan (Al Hourani et al., 2025) to Indonesia (Ginting et al., 2024), indicates that the association between UPF and adiposity transcends cultural and economic contexts. However, the inverse association reported in the Indonesian study; where higher UPF consumption was associated with lower nutritional status, likely reflecting undernutrition rather than overweight or obesity warrants careful interpretation. This finding may reflect the dual burden of malnutrition prevalent in Indonesia, where both undernutrition and overnutrition coexist, and may also be influenced by residual confounding or population-specific dietary patterns.

Conversely, the substantial variability observed in metabolic outcomes is consistent with the fragmented evidence landscape documented by Petridi et al. (2023), who noted substantial heterogeneity across studies and recommended caution in interpretation. The contrasting findings between the I.Family Study (Formisano et al., 2025), which showed no significant relationship with metabolic syndrome components, and the Iranian study (Farzam et al., 2024), which demonstrated robust associations with multiple metabolic markers, may be explained by several factors. The Iranian study specifically targeted adolescents with overweight or obesity, potentially enriching the sample for metabolic susceptibility, whereas the I.Family Study included normal-weight participants. Exposure measurement also differed substantially, with the Iranian study using grams per day and the I.Family Study using 24-hour recall. The absence of association in the NHANES adolescent analysis for MASLD (Buytaert et al., 2024) contrasts with adult literature, suggesting that hepatic metabolic changes may require longer exposure duration or stronger mediation by established obesity. This supports the conceptual model positioning adiposity as an intermediary pathway, though the lack of mediation analyses in most adolescent studies prevents definitive conclusions. The heterogeneity in findings across outcomes echoes the umbrella review by Lane et al. (2024), which found that the certainty of evidence varied considerably across outcomes and was generally higher for anthropometric outcomes than for metabolic markers, reinforcing the necessity of the adolescent-

specific analytical framework proposed in this review.

Methodological heterogeneity represents a substantive finding rather than a limitation to be dismissed. The diversity in exposure measurement methods, including FFQ, 24-hour recall, NOVA screeners, and different quantification forms, as documented by Jung et al. (2025) and Zancheta Ricardo et al. (2023), indicates that studies using different measurement approaches may not be directly comparable. Variations in confounding control strategies also contribute to the observed heterogeneity, with some studies adjusting for comprehensive sets of confounders while others adjusting for more limited variables. The geographic and socioeconomic gradients documented by Chavez-Ugalde et al. (2024) and Widyastuti et al. (2026) further highlight the importance of population context in modifying both exposure levels and the strength of associations with health outcomes. These findings collectively suggest that UPF consumption should not be treated as a monolithic exposure, as the NOVA 4 category encompasses diverse products with varying nutrient profiles and consumption contexts (Medin et al., 2025). The heterogeneity also underscores the limitations of the current evidence base, including the predominance of observational designs, possibilities for residual confounding and reverse causation, and the lack of intervention studies that have not yet allowed definitive conclusions regarding health impacts of UPF reduction (Aramburu et al., 2024). Despite these limitations, the synthesis provides a foundation for developing prevention strategies tailored to the level of scientific certainty available, including improving school food environments, increasing food literacy, and implementing policies that protect adolescents from unhealthy food marketing, while recognizing that future research with prospective cohorts, standardized exposure measurement, and longitudinal biomarker assessments is needed to better test the temporal sequence of UPF–adiposity–metabolic dysfunction.

CONCLUSION

The findings of this systematic review indicate that the association between ultra-processed food consumption and cardiometabolic health in adolescents does not demonstrate uniform consistency across all outcomes. Based on the evidence mapping conducted at this research stage, relatively more consistent associations were observed for overweight, obesity, and increased adiposity, whereas findings regarding blood pressure, glucose and insulin metabolism, lipid profiles, metabolic syndrome, and MASLD remained more heterogeneous. This variability can be attributed to differences in study design, population characteristics, dietary assessment methods, UPF quantification approaches, outcome definitions, and confounding control strategies. Therefore, UPF consumption cannot yet be treated as a sole causal determinant of cardiometabolic disturbances in adolescents, but it remains an important dietary exposure that warrants continued analysis in relation to adiposity and various noncommunicable disease risk factors. As the current findings are based on preliminary evidence mapping rather than a fully executed systematic review, definitive conclusions regarding the magnitude of associations, consistency across studies, degree of heterogeneity, and overall strength of evidence cannot be drawn at this

stage. The complete systematic review procedures encompassing comprehensive literature searching, study selection, data extraction, risk of bias assessment, and meta-analysis where methodologically appropriate remain to be finalized.

Several limitations of the current evidence base must be acknowledged. The predominance of observational study designs limits causal inference, with possibilities for residual confounding, reverse causation, and temporality uncertainty remaining significant obstacles. The heterogeneity of UPF itself, encompassing diverse products with varying nutrient profiles and consumption patterns, means that associations for total UPF cannot be automatically generalized across all food subgroups. Geographic representativeness is also uneven, with findings potentially overrepresenting specific country contexts. Variations in exposure definitions, dietary measurement instruments, outcome definitions, and adjustment strategies further reduce comparability across studies and may limit the feasibility of meta-analysis for certain outcomes. Importantly, as the final systematic review dataset had not been fully established at the time of manuscript preparation, the present findings are derived from preliminary evidence mapping and do not represent the complete set of studies that would ultimately satisfy the PRISMA inclusion criteria. Accordingly, this manuscript should be regarded as a preliminary evidence mapping study rather than a completed systematic review, and the results presented herein are subject to confirmation following full dataset assembly and analysis. Despite these limitations, adolescence can be viewed as a strategic period for understanding how dietary consumption patterns relate to changes in body composition and metabolic risk development before these disturbances progress to clinical disease in later life stages.

Future research should prioritize prospective cohort studies with repeated and standardized UPF consumption measurements, transparent NOVA classification, comprehensive adiposity and metabolic biomarker assessments, and adequate control for energy intake, physical activity, sedentary behavior, sleep patterns, socioeconomic status, pubertal stage, and overall dietary quality. Subsequent analyses should consider variations by sex, age group, geographic region, socioeconomic condition, and UPF subgroups, while directly testing the potential mediating role of adiposity between UPF consumption and metabolic disturbances. In the context of public health, efforts to reduce dependence on ultra-processed foods should be positioned as one element of a more comprehensive adolescent dietary improvement strategy, accompanied by the development of food environments that facilitate healthy food choices, increased food literacy, and protection of adolescents from environmental influences that may promote consumption of foods with unfavorable dietary characteristics. The conceptual contribution of this article lies in integrating dietary exposure, adiposity, and metabolic changes within a framework that specifically positions adolescents as an important population for early risk identification, thereby contributing to the broader discourse on nutritional public health and noncommunicable disease prevention.

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