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The impact of ultra-processed foods on pediatric health

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A B S T R A C T

Introduction: Ultra-processed foods (UPFs) have become increasingly incorporated into pediatric diets, accounting for approximately 67 % of the total energy consumption in United States (US) children. Manufactured through industrial processing and enriched with excess sugars, unhealthy fats, and sodium, while lacking essential nutrients, UPFs present a substantial public health concern. We aimed to conduct a comprehensive review of the impact of UPFs on pediatric health.
Methods: We reviewed the effects of UPF on pediatric health using data from observational studies, systematic reviews, and policy reports. Our review explored the social, environmental, and economic drivers of UPF consumption, associated health consequences, and proposed mitigation strategies. We also examined National Health and Nutrition Examination Survey (NHANES) data, the 2025 US Dietary Guidelines Advisory Committee's (USDA) report, and the Make America Healthy Again (MAHA) commission findings.
Results: UPF intake has dramatically increased during early childhood, with toddlers and school-aged children obtaining 47 % and 59.4 % of their daily calories, respectively, from UPFs. Higher consumption is linked to pediatric obesity, cardiometabolic risks such as insulin resistance and metabolic dysfunction-associated steatotic liver disease (MASLD), mental health concerns, and gut microbiome disruption. Early-life exposure to UPFs can establish unhealthy dietary patterns that persist into adulthood, raising the risk of chronic disease. Greater UPF consumption is often observed among lower-income families, highlighting a key health disparity.
Conclusion: UPF consumption is a modifiable risk factor for non-communicable diseases in children. Addressing it requires urgent, coordinated action at multiple levels. Strategies include UPF and sugar-sweetened beverage screening during well-child visits, policy restrictions on food marketing, clearer nutrition labeling, healthier school meals, and personalized family-centered dietary counseling. Clinicians need standardized tools and training to counsel families effectively. Policy initiatives should prioritize prevention-focused measures to protect children's health.

1. Introduction

Ultra-processed foods (UPFs) are a ubiquitous feature of the contemporary American diet, particularly among children. The NOVA (food categorization and classification system) defines UPFs as a combination of mainly industrial-use ingredients prepared through a chain of industrial reactions [1]. Some of the ingredients used in UPF products include refined sugars and fats, starches, and protein isolates, often in combination with additives that extend shelf life, enhance texture, generate flavor, and improve palatability [1]. The manufacturing process entails separating whole foods into their component substances, such as sugars, oils and fats, proteins, starches, and fiber. These components are generally obtained from high-yield plant foods such as corn, wheat, soy, sugar cane, and sugar beet, as well as from animal proteins.

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In most cases, these components are mechanically processed [2].

The commercialization of UPF products has led to the availability of some items that may have neutral or even beneficial health effects depending on their nutritional composition—for example, certain whole-grain breads, fortified breakfast cereals, hummus, protein shakes, and plain yogurts—particularly when they are low in added sugars, sodium, and unhealthy fats [3]. However, the majority of UPFs consumed are calorie-dense, nutrient-poor, and aggressively marketed to younger generations, such as sugary drinks, packaged snacks, fast food, and ready-to-eat meals [4]. Due to the impressionable nature of children and adolescents, as well as their developmental stage, they may be very susceptible to the negative health consequences of consuming UPFs [5–7]. This is a concerning vulnerability, as mere exposure to UPFs, particularly during infancy and toddlerhood, may influence long-lasting eating patterns and food preferences [8,9]. In particular, in-utero exposure to large amounts of added sugar and sodium can result in adverse effects on fetal development. These effects may persist during breastfeeding and, depending on the maternal nutrition, also affect the infant's intake [10]. High UPFs have displaced traditional foods in the past few decades, and their safety is becoming a growing concern. Numerous observational studies among children and adolescents indicate that an augmented UPF prevalence was related to an upsurge of overweight and obesity, together with cardiometabolic co-morbidities [6].

In this comprehensive review, we examine the role of UPFs in pediatric diets. We also discuss the social, environmental, and economic drivers, epidemiology, consumption patterns, and the health effects of consuming UPFs in children, as well as emerging policy and intervention strategies and future directions. With the national conversation beginning to acknowledge the implications of UPFs for public health, both the Scientific Report of the 2025 Dietary Guidelines Advisory Committee (2024) and The Presidential Commission to Make America Healthy Again (MAHA) report (May 2025) underscore the need for increased attention to UPF consumption in children and adolescents [11,12]. These reports identify UPF intake as a growing concern in pediatric nutrition and call for the development of evidence-based dietary strategies and public health initiatives. In this review, we summarize evidence from peer-reviewed studies, systematic reviews, and policy publications to provide an integrated overview of UPFs in pediatric health.

1.1. Methods

In this comprehensive review, we synthesized evidence from peer-reviewed research, systematic reviews, national survey data, and authoritative policy documents to provide an integrated overview of the impact of UPFs on pediatric health. We defined "comprehensive" as including epidemiologic data, mechanistic studies, intervention strategies, and relevant policy perspectives.

We conducted targeted literature searches in PubMed, prioritizing recent publications (2018–2025), using key terms including ultra-processed foods, NOVA classification, pediatric obesity, children, adolescents, cardiometabolic health, mental health, nutrition policy, and school meals. We also performed targeted Google Scholar searches and direct searches for policy documents from authoritative organizations, including the USDA, FDA, and WHO. Given the comprehensive nature of this review, we employed an iterative approach that allowed identification of additional sources through reference tracking and expert knowledge of the field.

We prioritized large cohort studies, nationally representative surveys, and systematic reviews/meta-analyses. When pediatric-specific data were limited, we incorporated adult studies investigating comparable pathophysiologic mechanisms, as these processes are biologically relevant across different age groups.

Following this methodology, we begin by characterizing UPFs in pediatric diets as a basis for interpreting their health consequences.

2. Understanding UPFs in the pediatric diet

Understanding how UPFs are defined, classified, and consumed in pediatric populations provides the foundation for examining their health impacts and developing targeted interventions.

2.1. NOVA classification system

NOVA is a food classification system that categorizes food based on its level and type of industrial processing. It identifies foods after they are separated from their natural state and undergo physical, chemical, and biological processes, but before they are consumed or prepared for meals. NOVA classifies foods into four groups: 1) Unprocessed or minimally processed foods, 2) Processed culinary ingredients, 3) Processed foods, and 4) UPFs [1] [Fig. 1].

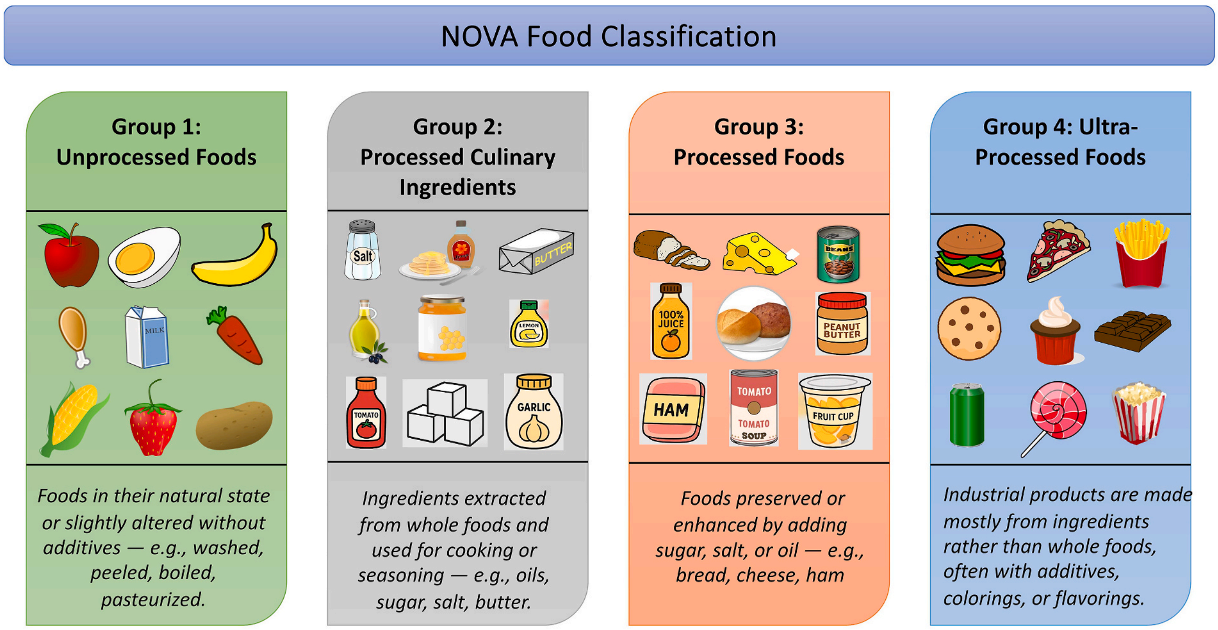
2.2. UPF consumption patterns in the pediatric population

Several studies have identified concerning trends in UPF intake among children of various ages. A UPF study in the United Kingdom estimated that approximately half of the total energy of the toddler age group (cohort with a median age of 21 months) and 60 % in mid-childhood (cohort with a median age of 7 years) came from UPF intake. It is important to note that eating patterns varied with age; there was an increased consumption of yogurts, higher-fiber breakfast cereals, and whole-grain breads during the toddler years, as compared to puddings, sweet cereal products, and white breads during early childhood. A higher intake of free sugar and sodium was observed in children with greater UPF consumption [13].

Based on data collected by the Demographic and Health Surveys and other national surveys, Popkin and Laar noticed that approximately 25 % of the calories in toddlers' diets are derived from UPFs, with an alarming increase in the consumption of UPFs among preschoolers [8]. This evidence suggests that early-life exposure to UPFs and patterns of socialization in the diet, combined with the consumption of other discretionary foods, may influence children's preference for high-sugar and high-salt diets. Longitudinal studies provide support for these patterns, with a large United Kingdom (UK) birth cohort demonstrating associations between childhood UPF consumption and adiposity trajectories over time [14], while the UK Gemini twin cohort showed tracking of UPF intake patterns from toddlerhood through mid-childhood [13]. These dietary preferences established in early life may shape lifetime eating patterns [8], though further research is needed to establish definitive causal relationships.

2.3. Methodological challenges and classification limitations

Although widely accepted, the NOVA classification system has several methodological drawbacks that make the interpretation of research challenging. Namely, the scheme does not address the nutritional profile and idiosyncratic health effects of individual ingredients, thereby omitting the possibility of conducting detailed analyses of their different impacts on dietary patterns. For example, both processed meats and whole-grain bread are under the same UPF category. However, they have varied nutritional compositions and effects on health, indicating the inconsistencies in the NOVA classification system. According to Loftfield et al. (2024), it is challenging to standardize UPF definitions and quantify intake. Therefore, there is a need to combine traditional dietary assessment methods with machine-learning approaches to explain and validate food processing parameters and compositions [15]. Moreover, an online survey conducted by Brasesco et al. suggested that the NOVA criteria do not consistently yield accurate food assignments, regardless of the type of ingredient information presented to the user [16]. Such methodological shortcomings underscore the need to conduct high-level nutrition research to establish the quality and safety of UPFs and develop an evidence-based discourse, as the consumption



NOVA classification of foods based on degree of processing. Figure created by Chamarthi V.S., adapted from Monteiro et al. [1].

Fig. 1. NOVA Food Classification with commonly used food examples in Pediatric Diet.

patterns of UPFs among children are rapidly increasing [15,17,18].

As we explore the UPF classification system and understand UPF consumption in pediatric diets, it is also essential to consider the epidemiology and trends in consumption.

3. Epidemiology and trends in consumption

Understanding the prevalence of UPF consumption among children and adolescents is essential for identifying at-risk populations and targeting public health efforts.

3.1. Rising global trends in ultra-processed food consumption

Due to the demanding time constraints of everyday life for most people, the use of UPFs has increased significantly. It is more affordable and widely accessible than most unprocessed food, and often more palatable to both adults and children. Worldwide, UPF consumption has been growing steadily over the past decade, accounting for around 25–60 % of the daily energy intake in some middle- and high-income countries, with a similar trend observed in low-income countries [19].

3.2. UPF consumption among children in the United States

An observational study, published in Pediatric Obesity, analyzed NHANES data from 2009 to 2014 to assess UPF intake, calculated the total percentage of calories derived from UPFs, and categorized food items consumed by individuals into the different NOVA food categories. The findings revealed that an astounding 67 % of total energy intake in US children's diet comes from UPF intake [20,21].

3.3. Socio-demographic disparities in ultra-processed food consumption

Among children in the US, UPF intake significantly differs based on ethnicity, income status, and socioeconomic status. An observational study examined the NielsenIQ Homescan Consumer Panel 2020, which tracked the foods purchased by US households each year and classified them according to the NOVA food classification system [22]. Amongst products purchased by US households in 2020, 48 % were considered UPFs. The foods were further categorized into different types; amongst the highest were carbonated drinks, which accounted for 90 % of drinks, followed by mixed dishes and soups at 81 %, and sweets and snacks at 71 %. The study showed that UPF purchases were more prevalent among non-Hispanic white households with lower income and educational attainment [23]. According to the report by Poti et al. (2016), the likelihood of non-Hispanic white households buying UPFs in higher quantities than black and Hispanic families increases once the impact of income level, level of education, and maternal age is held constant. Socioeconomic differences have a significant effect on the consumption of UPFs in children. Findings have shown that children from low socioeconomic backgrounds consume more UPFs, and the educational level of the mother is considered the most important predictive factor of diet quality, among other measures of socioeconomic status. Additionally, demographic variables such as race (white) and gender (male) are positively correlated with increased consumption of UPF [24].

3.4. UPF consumption in adolescents

Adolescent eating habits and BMI percentiles are important predictors of future health problems, including cardiovascular disease and obesity [25,26]. National data show that U.S. adolescents obtain nearly two-thirds of their calories from UPFs, and higher intake is linked to significantly poorer cardiovascular health [7]. Additional studies highlight the broader public health impact of these patterns [25] and show that food insecurity pushes many families toward inexpensive, energy-dense UPFs, worsening health disparities [27]. Together, these findings indicate that UPF consumption is both a nutritional and social equity concern for adolescents.

The types of UPFs most often eaten by adolescents include sugar-sweetened drinks, packaged snacks, processed meats, and ready-to-eat meals [20,28]. Longitudinal and controlled trial data show that these foods contribute to excess weight gain, unhealthy dietary pattern tracking, and reduced well-being [29]. These findings are consistent with the Dietary Guidelines for Americans, 2020–2025, which emphasize limiting high-energy UPFs while prioritizing nutrient-dense food choices [30].

As we review the epidemiology and economic trends, it is evident that we should consider the social and environmental drivers of UPF consumption in children.

4. Social and environmental drivers

Social and environmental factors strongly shape children's dietary behaviors and represent key modifiable drivers of UPF consumption across pediatric populations.

4.1. Food insecurity

According to the Food Research and Action Center, food insecurity is defined as a household-level economic and social condition characterized by limited or uncertain access to adequate food [27]. Around 12.8 % of the US population (17 million households) experience food insecurity. Food insecurity is a significant factor influencing UPF consumption, and women in severely food-insecure households have up to 2.3 times the odds of obesity compared to food-secure women [31]. Food-insecure households are disproportionately likely to purchase and maintain low-quality dietary patterns, which are often consistent with poor health outcomes [32]. Children living in food-insecure households are more vulnerable to UPF marketing strategies and develop unbalanced eating patterns that are more UPF dependent than children in food-secure households [33]. Low-income level households often opt for lower-cost, energy-dense processed foods. UPF products are especially appealing to families with low incomes due to their low prices, long shelf life, and convenience of storage and transportation [34].

4.2. Marketing influence and digital advertising on dietary choices

Review of the literature reveals that a combination of marketing tools, including television advertising, character-branded packaging, advergames, magazine imagery, and celebrity endorsements by professional athletes, is highly successful in promoting higher intakes of UPF in children. These tactics exploit developmental vulnerabilities, particularly children's inability to distinguish between entertainment and commercial messages, thus creating strong associations between branded products and desirable experiences. Brands further enhance their appeal through persuasive tools such as promotional gifts or discount offers, which capture and sustain children's attention to marketing messages. The strategic placement of these advertisements during children's programming amplifies these effects, as repeated exposure creates familiarity and brand preference, leading children to favor specific UPF brands over alternatives [35].

Advertising algorithms significantly enhance the success of promotional interventions. They track the online behavior of children to personalize advertisements, making them more persuasive. This algorithmic profiling represents a notable development in modern marketing practice, as it ensures stability in the delivery of marketing messages across various online touchpoints, thereby enhancing brand loyalty and consumer behavior [36].

4.3. Role of school meals and cafeteria policies

Evidence suggests that the proportion of UPFs consumed at breakfast and lunch is greater in secondary schools compared to primary schools. Low-income groups show higher UPF consumption than high-income groups, both in school meals and packed lunches at secondary schools, as well as in packed lunches at primary schools [37,38]. School and packed meals vary substantially in nutritional quality. Evidence from the *School Nutrition and Meal Cost Study-I* demonstrates that school meals meeting updated nutrition standards can significantly improve children's diet quality, particularly among low-income populations [39]. Access to healthy school meals may help mitigate disparities in dietary intake, though effectiveness depends on consistent implementation and adequate funding.

Improving the quality of, and expanding access to, free school meals has the potential to enhance dietary intake and improve health outcomes for food-insecure children. Additional benefits of school lunches include improved attendance rates, reduced household financial burden, and, in many cases, positive effects on BMI. Moreover, the application of nutrition guidelines to improve the school food environment, as shown in a randomized trial, demonstrated favorable impacts on children's dietary intake and overall nutrition [40,41].

4.4. Parent knowledge and cultural dietary customs

Parents and caregivers play a crucial role in shaping children's eating behaviors and dietary patterns. Shared dining practices lead to greater parent-child interaction, enable parents to supervise their children's food consumption, and establish regular dietary patterns while being role models [42]. Additionally, parental training on healthy snacking options can help to improve the overall nutritional status of children.

Parents from all socioeconomic classes often purchase UPFs due to several converging factors, including their children's taste preferences, limited efforts at cooking, and time constraints that restrict the potential impact of family choices on existing schedules. Processed goods offer substantial logistical benefits to consumers experiencing food insecurity, including individuals participating in the Supplemental Nutrition Assistance Program (SNAP). Their long shelf lives help prevent food waste and alleviate the burdens of food insecurity that often arise during periods of limited food access [37]. This shelf life is beneficial to households whose grocery expenditure serves an extended period, as the non-perishable qualities of most UPFs provide a reliable source of food when fresh food becomes economically prohibitive or otherwise unattainable [40].

Reducing UPF intake could improve diet quality and reduce health disparities for all consumers, particularly those experiencing food insecurity. For SNAP recipients, programs such as the Gus Schumacher Nutrition Incentive Program (GusNIP) [43] provide additional support by increasing access to fruits and vegetables, complementing broader efforts to promote minimally processed, nutrient-dense foods.

Cultural influences provide an additional layer of explanation for the use of UPFs in certain groups. The acculturation process strongly influences the food preferences of immigrant groups. Foreign-born adults in the United States are significantly less likely to consume UPF than their U.S.-born counterparts. However, this protective factor becomes weaker as the proportion of English language use within the household grows and the time spent in the United States increases [44,45]. Since the food behaviors of parents and the nutritional habits of the home are instrumental in shaping the eating behaviors of children, dietary alterations related to UPF noted in adult immigrants are likely to be reflected in the eating behaviors of their children. However, additional studies exploring the consumption of UPFs among diverse cultural pediatric populations are needed to fully explain these intergenerational dietary practices.

The related sections provide an in-depth analysis of the health implications associated with the consumption of UPF.

5. Health consequences of UPF consumption in children

Childhood obesity is among the most important issues in public health, and its increasing prevalence [46] is inextricably connected with the perniciousness of UPF and related co-morbidities, such as early-onset hypertension, insulin resistance in children, early-onset type 2 diabetes, hyperlipidemia, and atherosclerosis. In this section, we will discuss the evidence supporting the link between UPF consumption and its health consequences in the pediatric population.

5.1. Obesity in childhood and early metabolic disorders

A prospective, multi-center cohort study from Canada assessed the dietary patterns of children at their 3-year well-child visit, with anthropometric indicators measured at the 5-year well-child visit. The study revealed that children with more than 50 % of their caloric consumption from UPFs had a significantly greater BMI, waist-to-hip ratio, and triceps skinfold compared to their counterparts who consumed lower percentages of UPFs [47]. Additionally, the cohort characterized by increased UPF consumption had a higher risk of developing obesity in subsequent years. The study highlights the pressing need to adopt healthier dietary choices as early in life as possible to prevent the long-term development of obesity-related sequelae. Reinforcing this concern, a large-scale national surveillance dataset (2008–2023) from the US shows a 253 % increase in extremely severe obesity in youth, with a significant correlation between obesity severity and metabolic dysfunction, including metabolic dysfunction-associated steatotic liver disease (MASLD), insulin resistance, and type 2 diabetes [48].

5.2. Cardiometabolic health risks

Over the past few years, a substantial body of evidence has emerged demonstrating a strong relationship between the consumption of UPF and poorer cardiometabolic health among pediatric populations [49]. Such associations are insulin resistance, type 2 diabetes, hypertension, dyslipidemia, and other metabolic disruptions that increase the occurrence of early-onset chronic illnesses like cardiovascular and chronic kidney disease [6,7]. The main pathophysiological mechanisms involved are those based on the nutritional content of UPF.

UPFs exhibit high caloric density coupled with diminished nutritional value, thereby providing children with considerable excess energy intake in the form of empty calories. These products contain high amounts of refined carbohydrates, added sugars, unhealthy fats, and sodium, and often lack naturally occurring fiber and protein. Although some UPFs are fortified and may appear nutritious, their overall nutritional quality remains compromised and is consistently associated with adverse health outcomes [50,51]. The high levels of easily absorbed carbohydrates and free sugars trigger postprandial hyperglycemic episodes, stimulating the unregulated release of insulin by pancreatic beta cells. Prolonged exposure to these metabolic disruptions fosters insulin resistance and has a direct impact on the development of type 2 diabetes. Repeated UPF exposure is consistently associated with dyslipidemia, characterized by elevated triglyceride levels and reduced high-density lipoprotein cholesterol levels, accompanied by systemic inflammatory processes that span multiple metabolic pathways [52]. While this study was conducted in adults, the inflammatory and metabolic effects of excessive sugar intake are well-established in children and likely operate through similar biological pathways. Moreover, because adults often hold the purchasing power within households, counseling caregivers to identify UPFs and choose food options with less added sugar, lower saturated fat, and higher protein can influence healthier dietary patterns across the family, including children. Emerging mechanistic evidence suggests that the consumption of UPFs is linked to gut microbiome disruption, neuroinflammation, and epigenetic alterations, which may contribute to long-term cardiometabolic and neurodevelopmental risks [51,53]. Although derived from adult data, the mechanisms of gut microbiome disruption and neuroinflammation are biologically consistent across age groups and therefore relevant to pediatric populations.

The pediatric populations are especially impacted by such metabolic changes, which can predispose them to future cardiometabolic disorders. A Korean observational study analyzed the dietary pattern of 149 participants aged 8–17 years with a BMI above the 85th percentile. The participants were stratified into three groups based on their percentage intake of UPF: low (11 %), moderate (26 %), and high (45 %). The authors demonstrated a significant correlation between high UPF intakes and MASLD prevalence, with the high-level group showing higher odds of MASLD and moderate to severe MASLD compared to the low-level group [5]. Notably, MASLD, as well as insulin resistance, follow a linear dose-response relationship with UPF intake, although further studies are needed to confirm causality. This underscores the clinical implications of reduced UPF intake in pediatric populations. A Swedish study published long-term prospective data on the effectiveness of pediatric obesity treatment, combining lifestyle changes and medication during childhood, which resulted in a significant reduction in BMI and associated comorbidities, such as future type 2 diabetes, dyslipidemia, hypertension, and even a reduced mortality risk in young adulthood [54].

5.3. Mental health and behavioral outcomes

Epidemiological studies show a parallel increase in mental illnesses in children and adolescents in correlation with the growing intake of UPFs [55]. Some studies show that high-UPF diets promote the occurrence and worsening of anxiety, depression, and attention-deficit hyperactivity disorder (ADHD) [56]. These results suggest that the negative impact of UFPs extends beyond somatic manifestations. Mental health-associated disorders may be linked to the intake of a high amount of UPFs, which have been tied to internalization of symptoms such as persistent sadness, sleep disturbances, feelings of loneliness, fear, crying episodes, and boredom. Further evidence of this association is supported by a systematic review and meta-analysis of observational studies, which reveals consistent evidence of an increased risk of mental health disorders [57]. Several mechanisms are suggested in the literature, including pro-inflammatory responses and dysfunction of the gut-brain axis, particularly in young individuals who are still developing their neurological systems [55].

5.4. Cognitive development and neurobehavioral impacts

A recent Chinese cross-sectional study evaluated the correlation between UPF consumption and cognitive performance among children aged 4–7 years. Using structured interviews and standardized questionnaires, parents provided information on the frequency of their children's consumption of UPFs, including confectionery, chocolates, and fast food. The study found that frequent consumption of UPFs significantly increased the risk of cognitive deficits in children [58]. These results suggest that dietary habits in early life have a significant impact on brain development. The pathophysiology behind these relationships is likely multifaceted. The excessive amount of added sugar, preservatives, and other artificial additives that are typical of UPFs has been shown to negatively impact the neurological system by impairing the gut-brain connection. This deregulation can lead to the occurrence of systemic inflammatory reactions and changes in neurotransmitter pathways [59]. Evidence consistently associates high UPF consumption with adverse neurocognitive and cardiometabolic outcomes [60].

5.5. Gut health and systemic inflammation

There is strong evidence that UPFs exert undesirable influences on gastrointestinal health that may occur via various mechanisms. The additives used in preserving UPFs, such as artificial preservatives, sweeteners, emulsifiers, and other artificial compositions, may disrupt the balance of the gut microbiome, leading to limited microbial diversity and weakening of the intestinal barrier [53,61]. These changes increase intestinal permeability, and this compromised intestinal barrier potentially enables the unhealthy passage of pathogenic bacterial components, especially lipopolysaccharides (LPS), into the circulation. This results in chronic low-grade inflammation, which is a precursor for type 2 diabetes mellitus, metabolic syndrome, cardiovascular disease, and malignancies associated with obesity, such as prostate, colorectal, renal, and endometrial cancer [62].

UPFs also contain preservatives, artificial colors, emulsifiers, and other additives that have been linked to potential health risks. The American Academy of Pediatrics has raised concerns that certain additives may contribute to behavioral changes, hyperactivity, or endocrine disruption in children [63]. Reviews and mechanistic studies further suggest associations with allergic reactions, developmental effects, and gut microbiome alterations that may promote metabolic dysfunction [64,65]. While causality is not fully established, these findings highlight the importance of considering additive-related risks when evaluating the overall health impacts of UPFs in pediatric populations.

5.6. *Oral health implications of UPF consumption*

UPF consumption has been consistently associated with an increased risk of dental caries in the pediatric population, with meta-analytic evidence supporting this relationship in children and adolescents [66]. Longitudinal studies have confirmed these associations across diverse age groups, including adolescents [67], preschool children [68], and children under the age of three [69]. Early UPF exposure may particularly exacerbate oral health disparities among socioeconomically vulnerable populations. The relationship between dietary patterns and oral acidogenicity has been demonstrated in pediatric populations, with high-sugar consumption patterns contributing to cariogenic environments [70]. These findings underscore the need for early dietary interventions to mitigate UPF-related oral health risks during critical developmental periods.

It is crucial to develop interventions at an early age to minimize children's UPF consumption and preserve long-term health by reducing the risk of chronic illnesses later in adulthood [Fig. 2].

6. Intervention strategies

Evidence-based interventions to reduce UPF consumption in pediatric populations require a coordinated, multi-level approach, integrating clinical counseling, school-based programs, and community initiatives.

6.1. *Clinical practice integration and screening protocols*

The introduction of UPF screening into standard pediatric care is a critical shift in traditional preventive nutritional care. Evidence suggests that regular screening through well-child visits provides clinicians with an opportunity to identify high-UPF consumption and propose targeted interventions [71]. A variety of dietary assessment tools have been used to evaluate UPF intake, including 24-h dietary recall, Food-frequency questionnaires (FFQs), and brief screening questionnaires; however, it is well-documented that individuals with obesity tend to underreport their food intake [72,73].

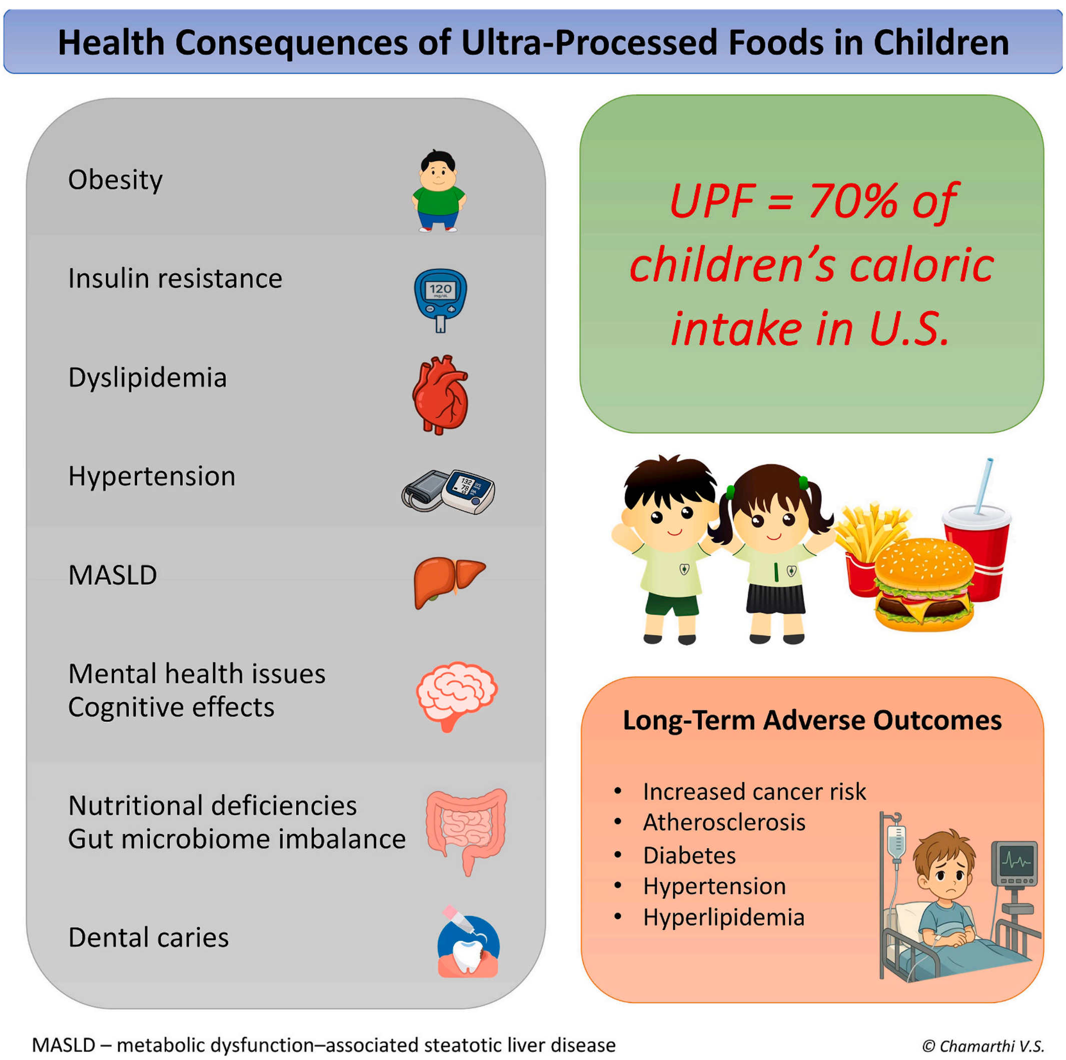


Fig. 2. Health consequences of ultra-processed foods in children.
This figure illustrates the potential health impacts of frequent ultra-processed food (UPF) consumption in children. Associated conditions include obesity, insulin resistance, dyslipidemia, hypertension, metabolic dysfunction-associated steatotic liver disease (MASLD), mental health issues, cognitive effects, nutritional deficiencies, gut microbiome imbalance, and sleep apnea. The figure also highlights long-term adverse outcomes such as increased cancer risk, atherosclerosis, diabetes, hypertension, and hyperlipidemia. Visual elements are used to support pediatric health education and counseling.

The University of North Carolina Physicians Network (UNCPN), community-based weight management clinicians adapted a validated dietary assessment tool—the FFQ—to create a more practical dietary assessment tailored for clinical use [Fig. 3]. While traditional FFQs contain over a hundred items and are impractical for routine clinical workflows, the adapted version simplifies the process by organizing questions into categories such as beverages, snacks, three daily meals, and the frequency of fast food or restaurant food consumption.

This streamlined dietary assessment tool, aligned with the NOVA food processing categories, has been used in UNCPN's weight management clinics over the past five years, serving approximately 1800 adults [74,75]. An institutional review board-approved patient registry was

UNC Health Lifestyle Inventory Questionnaire

Eating Pattern

Name: ______________________________ **Date:** ______________________________

Breakfast:	**Lunch:**	**Dinner:**
Do you skip Breakfast? **(Yes/No)**	Do you skip Lunch? **(Yes/No)**	Do you skip Dinner **(Yes/No)**
1. How often do you eat out or order take out for breakfast? ________________ **times/week** 2. Typical Restaurants? ________________________	1. How often do you eat out or order take out for lunch? ________________ **times/week** 2. Typical Restaurants? ________________________	1. How often do you eat out or order take out for dinner? ________________ **times/week** 2. Typical Restaurants? ________________________
I typically eat (circle): Cereal, Eggs, Bacon/Ham, Oatmeal/Grits, Pastries White/Wheat Toast, Bagels, Biscuits, Muffins, French Toast, Pancakes, Waffles, Pop Tarts, Honey Buns, Protein Shake Regular/Greek yogurt, Fruit Other:______________________	**I typically eat (circle):** Salad, White/Wheat Sandwich, Soup, Pasta, Burgers/fries, Pizza, Fried/Grilled Chicken, Lean Meat, Red Meat, Pork, Fish, Veggies, White/Brown Rice, Frozen meal, Leftovers, Fruits, Protein Shake Other:______________________	**I typically eat (circle):** Salad, White/Wheat Sandwich, Soup, Pasta, Burgers/fries, Pizza, Fried/Grilled Chicken, Lean Meat, Red Meat, Pork, Fish, Veggies, White/Brown Rice, Frozen meal, Leftovers, Fruits, Protein Shake Other:______________________

Drinks:	**Snacks:**
□ Water (with crystal lite? **Yes/No**)	□ Fruit
□ Milk **(Type:_________) -** Quantity/Week:_________	□ Vegetables
□ Coffee **(Black or Sweetened?)** - Quantity/Week:_________	□ Granola bars
□ Hot tea (with sweetener? **Yes/No**) - Quantity/Week:_________	□ Nuts
□ Soda **(Reg or Diet)** - Quantity/Week: _________	□ Crackers/Pretzels
□ Iced Tea **(Sweet or Unsweet)** - Quantity/Week: _________	□ Cheese
□ Juice **(Type:_________) -** Quantity/Week:_________	□ Cookies/Cakes/Cupcakes/Muffins
□ Smoothies	□ Chips
□ Alcohol **(Type:_________) -** Quantity/Week:_________	□ Ice cream
□ Sports drink **(Reg or Zero)** - Quantity/Week: _________	□ Candy bars
□ Energy Drinks (**Type:_________) -** Quantity/Week:_________	□ Popcorn
□ Other ______________________	□ Pastries
	□ Other ______________________

Physical Activity

What physical activity do you do regularly?

□ Walk □ Run □ Gym □ Lift Weights □ Exercise Class □ Sports □ Other: ________________

For how many minutes at a time? ____________________

For how many times per week? ______________________

Fig. 3. University of North Carolina health lifestyle inventory questionnaire for eating patterns and physical activity.
University of North Carolina (UNC) Health adapted the validated "Food Frequency Questionnaire" to Lifestyle Inventory Questionnaire to assess dietary habits, beverage and snack consumption, and physical activity in clinical settings. The tool prompts patients to self-report their typical eating behaviors for breakfast, lunch, and dinner, including the frequency of eating out, food choices, and patterns at restaurants. Additional sections capture the intake of common beverages (e.g., water, soda, coffee, alcohol, energy drinks) and snacks (e.g., fruits, chips, pastries), as well as details about regular physical activity, including type, duration, and frequency. This instrument is designed for practical use in identifying and quantifying Ultra-processed food (UPF) and Sugar sweetened beverages (SSB) so clinicians can offer personalized counseling.
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used to track anthropometric parameters, including weight, height, and BMI. The underlying physiology of obesity was treated with accessible anti-obesity medications (mostly 1st generation medications) and paired with a simplified lifestyle counseling approach described below. Results in this adult clinical population on anti-obesity medications (AOMs) therapy showed that approximately 58 % of these patients achieved a total body weight loss of more than 5 %, and 35 % achieved a total body weight loss of more than 10 %. It should be noted that patients receiving AOMs may have altered appetite, satiety, and food preferences, and these outcomes may not be representative of general population responses to UPF-focused interventions. In clinical experience, children and adolescents are showing similar reductions in their BMI using the same UPF assessment tool filled out by caregivers. Quantitative data are being analyzed [75]. These assessment forms were completed by patients and reviewed by weight management clinicians or dietitians, who used visual aids—photos of UPFs displayed in exam rooms—to help

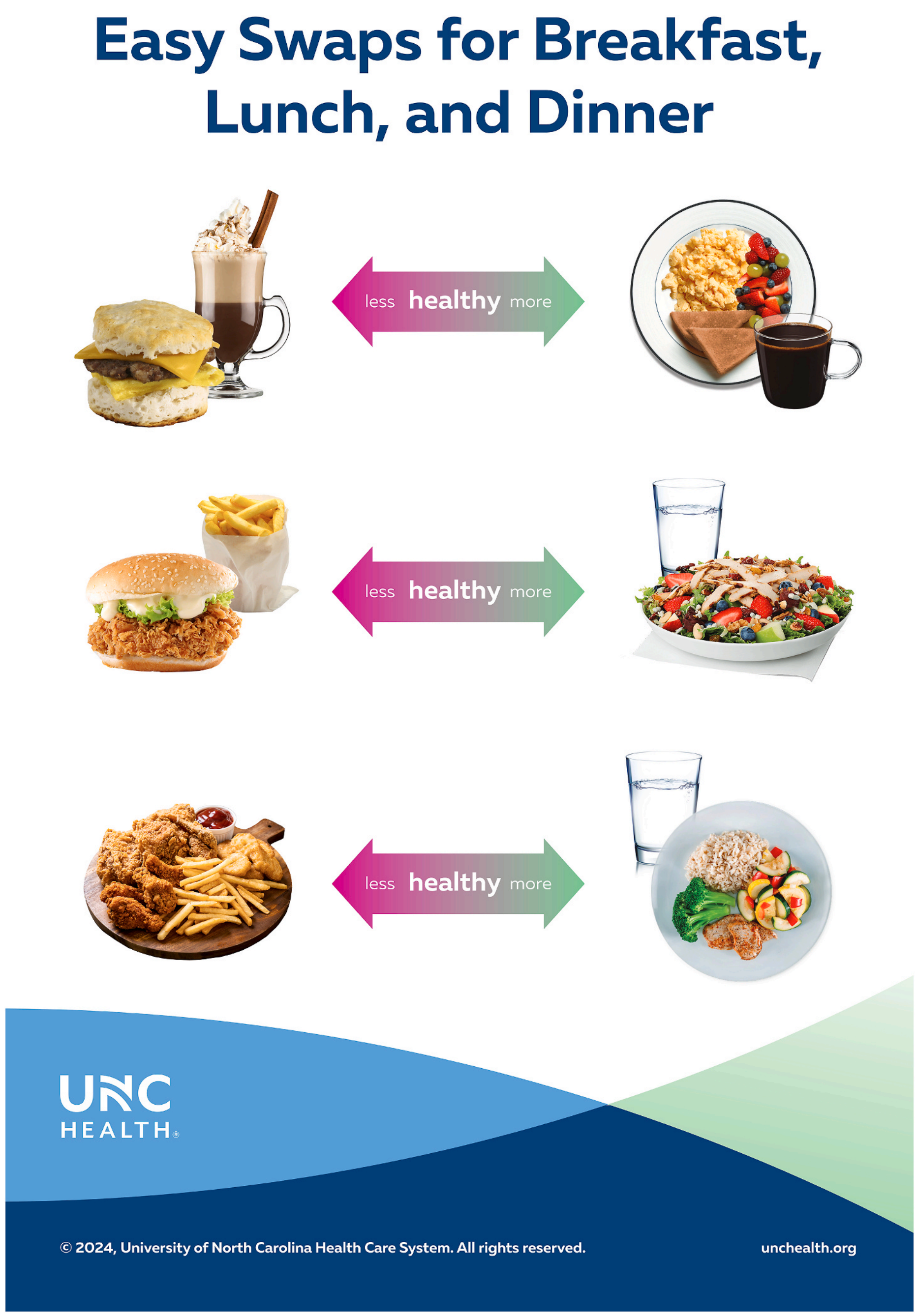

Fig. 4. Healthier meal swaps for common fast-food choices.
This figure illustrates examples of common fast-food meals (left) and their healthier alternatives (right), as part of dietary counseling aimed at reducing the consumption of ultra-processed foods (UPF). Each row contrasts a typical less healthy fast-food option with a more healthier choice.
Top row: A high-calorie breakfast, featuring a sweetened coffee beverage and a sausage biscuit, is compared to a balanced meal of scrambled eggs, fresh fruit, whole-grain toast, and black coffee.
Middle row: A fried chicken sandwich meal with soda and fries is replaced by a grilled chicken salad with water.
Bottom row: A fried chicken platter with sides and soda is substituted with a balanced plate of grilled chicken, brown rice, broccoli, and vegetables.
Arrows indicate a spectrum from "less healthy" to "more healthy," reinforcing the concept of practical, achievable dietary improvements.
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patients more accurately recall and describe their eating behaviors [Fig. 4].

6.2. Nutrition and behavior counseling — family-centered approaches

Practical behavioral counseling approaches require the active involvement of parents and children to engage in nutrition-based communication. Some studies suggest that early intervention during the infancy stage is beneficial for developing healthy eating habits [76]. Multicenter randomized controlled trials have provided evidence of a significant reduction in UPF consumption following systematic instruction of families [9]. This type of counseling should normalize the discussion of food choices and present realistic, practical suggestions for changing the diet.

Recommendations for pediatric care providers:

The following counseling recommendations for pediatric clinicians (including pediatricians, family physicians, nurse practitioners, and physician assistants) are synthesized from evidence presented throughout this review. While direct pediatric evidence on UPF counseling effectiveness remains limited, these recommendations integrate findings from available pediatric and adult studies, where appropriate, examining physiologically and behaviorally relevant mechanisms, adapted for pediatric developmental stages and family-centered interventions.

6.2.1 Patients find general non-personalized counseling advice to be limited in effectiveness, such as "Eat less and move more," "Eliminate all sugared drinks", "Stop eating fast foods". Explaining these concepts using visual aids—such as posters comparing sugar content in common beverages or displaying bottles filled with equivalent teaspoons of sugar—can significantly enhance patient understanding and engagement, especially when displayed in exam rooms [Fig. 5].
6.2.2 Personalized counseling advice based on the individual's dietary assessment has been shown to increase adherence to behavioral change in patients with obesity [77]. For example, instead of advising "Zero sugar drinks" such as in the 5-2-1-0 Health Habits Program, suggest "swap two cans of soda (specific name) to diet soda" or "swap two cups of orange juice to two oranges or bananas, while documenting these goals in the clinical note for future reference.
6.2.3 A step-by-step approach, combined with ongoing longitudinal follow-up and built-in accountability, is essential for supporting behavioral change in patients receiving obesity care. During follow-up visits, clinicians should assess progress toward previously set goals and adjust them accordingly, either scaling up or down based on the patient's response. If a goal has not yet been achieved, patients should be encouraged to continue working toward it with continued support.

Primary care providers in the field of healthcare should focus on minor and achievable dietary modifications that families can incorporate into their daily routines. These small changes will have a better chance of affecting long-term behavior change as compared to radical changes in diet. The counseling process is expected to incorporate children into the age-based discussions on nutrition, thus leading to healthy food preferences and decision-making capacity. The defined counseling patterns, especially the Intensive Healthy Behavior and Lifestyle Treatment (IHBLT) method, provide a systematic approach to involve the family in conversations about nutrition [78,79]. While these frameworks are grounded in empirical evidence and emphasize consistency and age-appropriate communication, the recommendation of twenty-six face-to-face sessions per year is often impractical in real-world settings. As Ro (2024) notes in the e-letter [80], most primary care clinics lack the resources to deliver such intensive treatment, and many families—particularly those in underserved communities—face significant logistical and financial barriers to participating. Community-based primary care models, led by clinicians trained in obesity management and designed with flexible, lower-burden approaches, may offer a more realistic and scalable alternative for delivering effective obesity care.

In Table 1, we provide practical counseling tips for primary care providers to incorporate into daily clinical practice.

6.3. Comprehensive support systems and community integration

Efficient UPF reduction strategies must overcome the limitations of

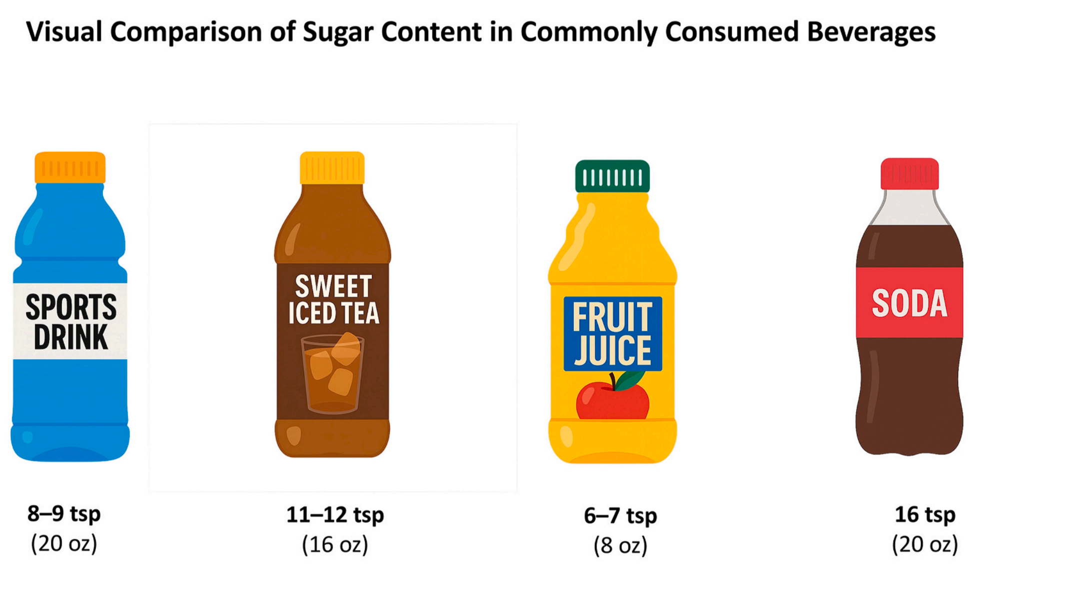
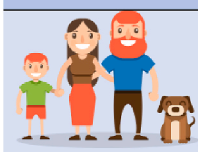
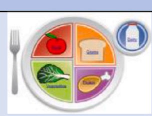
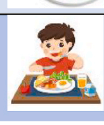


Fig. 5. Visual comparison of sugar content in commonly consumed beverages.
This infographic shows the estimated sugar content (in teaspoons) of four commonly consumed beverages: a 20 oz sports drink (8–9 tsp), a 16 oz sweet iced tea (11–12 tsp), an 8 oz serving of apple juice (6–7 tsp), and a 20 oz soda (16 tsp). Each bottle is labeled with its corresponding serving size and sugar content to support patient education and promote healthier beverage choices. For reference, 1 teaspoon of sugar is approximately 4 g. Figure created by Chamarthi V.S.

Table 1
Practical Counseling Tips for Providers on Ultra-Processed Foods (UPF).

Practical Counseling Tips for Providers			
	Strategy	**Use in Clinical Setting**	
	Normalize discussions about food choices and ultra-processed food intake during routine visits.	"Shall we discuss healthy food choices and the effects of UPFs on health?"	
	Actively engage both the child and parent in conversations about nutrition and lifestyle habits.	"Tell me what snacks you usually buy for your kids."	
	Emphasize small, achievable dietary changes that families can realistically adopt.	"Can you swap one sugary drink for a bottle of water?"	
	Incorporate visual aids to simplify concepts and enhance recall.	Provide pictorial handouts showing common UPFs and healthier options.	
	Assess UPF consumption using a standard tool.	Use the Lifestyle Questionnaire [Figure 3] and offer personalized counseling.	

This table summarizes key strategies and sample language for pediatric providers to support effective counseling and personalized guidance on nutrition and the consumption of ultra-processed foods (UPFs). Each row highlights a specific technique—ranging from normalizing food discussions and engaging families to using visual aids and assessment tools—paired with practical examples for use in clinical encounters. Table created by authors VSC, RK, and SR.

Table 2
Fact-based counseling strategies, which identify distinctive recommendations and clinical actions to apply in regular pediatric practice. *Table created by authors VSC, RK, and SR.*

Clinical Recommendations for Reducing UPF Consumption in Pediatric Practice	
Recommendation	**Clinical Action**
Integrate UPF screening into routine care	Screen for high UPF consumption during well-child visits. Educate families about health risks and benefits of whole foods.
Promote practical food skills	Encourage home cooking and teach nutrition label reading, especially to families with young children.
Utilize visual nutrition education tools	Use MyPlate guidelines and a food–color coding system. Simplify nutrition counseling with visual aids.
Address broader determinants of dietary quality	Assess food insecurity and economic constraints. Address limited access to fresh, minimally processed foods.
Advocate for supportive food environments	Collaborate with schools and community organizations. Stay informed about dietary guidelines and nutrition policies.

the single-session counseling approach. The concept of systematic interventions within frameworks that address the social determinants of diet quality is advised. Family-based pediatric pilot programming interventions were conducted in adult samples using weekly group interventions, personalized meal plans, and a support mechanism for funding [81]. When considered in tandem with complementary feeding studies, evidence suggests that strategies for introducing solid food have a significant impact on lifelong dietary choices [82]. This indicates that healthcare providers should prioritize sharing practical food literacy skills, including teaching individuals how to cook at home and read food labels, especially in families with younger children. Inclusion of graphic materials can be a feasible plan to strengthen health education by communicating subtle differences in dietary learning to diverse family members. Using MyPlate-like models, food hierarchy systems, and color codes to show changes in food complexity [83]. Awareness of MyPlate and the USDA dietary guidelines remains low among adults with lower incomes, those experiencing food insecurity, and those receiving SNAP benefits, with persistent disparities over time [84].

It is vital to address food access inequities and focus on the sustainability of economic access to fresh, minimally processed food by mitigating broader structural and social factors that detract from diet quality. Health professionals must coordinate with educational facilities and community-based organizations to create enabling food environments that facilitate the promotion of professional dietary advice. The main determinants of sustained effectiveness in such collaborations include the ongoing surveillance of existing nutrition policies and guidelines, which guide clinical practice and food choices at the household level. The combination of these multi-level approaches can be summarized in a coherent framework [Table 2] to help minimize UPF intake among pediatric age groups by intervening at individual, family, and community levels. While these interventions show promise, their long-term effectiveness depends largely on broader policy and environmental factors that shape food availability, marketing practices, and community food environments.

7. Emerging policies and public health initiatives

Policy and regulatory measures can play a pivotal role in shaping the food environment and reducing children's exposure to UPFs.

7.1. Federal regulatory framework updates

The 2025 Dietary Guidelines Scientific Report, prepared by the USDA Dietary Guidelines Advisory Committee, systematically reviewed the association between dietary patterns with varying amounts of UPF and growth, body composition, and the risk of obesity. The authors found an increased risk of high adiposity and overweight in children and adolescents consuming greater amounts of UPF (Grade: Limited). However, the evidence base remains limited regarding UPF-based dietary patterns in infants and children under 24 months, preventing definitive conclusions in this age group. (Grade: Not assignable) [12]. A randomized clinical trial demonstrated that a parent-targeted digital health intervention improved nutrition behaviors and reduced the risk of obesity in young children aged 0–2 years [85]. Building on this path of inquiry, a systematic review was conducted to explore how to alter parental provision of unhealthy foods to children aged 3–8 years using the Behavior Change Wheel framework within the home context [78]. Their conclusions hypothesized an integrative intervention agenda through environmental modification, parental reflective emotion, psychological capability, education, and enablement. A thematic analysis of nineteen publicly available national dietary guidelines revealed six distinct rationales for limiting UPFs consumption, with findings indicating that most guidelines employ nutrient-based explanations rather than upstream determinants of health related to food processing itself [86].

In May 2025, the Presidential Commission to Make America Healthy Again (MAHA) released its report that identified and categorized the major contributors to the childhood chronic disease epidemic. The report highlighted factors such as poor diet quality, exposure to environmental toxins, insufficient physical activity, chronic stress, and increased use of medications. It advocates for a government-led, prevention-focused approach that prioritizes food quality and independent research free from corporate influence. The report anticipates regulatory action by the Food and Drug Administration (FDA) regarding specific ingredients and recommends that the National Institutes of Health (NIH) fund research on UPFs while the FDA reforms its Generally Recognized as Safe (GRAS) approval process [11].

The GRAS designation is a regulatory mechanism used by the FDA to determine whether food additives can be safely used in foods without formal pre-market approval. Under current policy, food manufacturers can conduct internal safety assessments of substances and voluntarily notify the FDA, which may or may not independently review the evidence. While this framework enables efficiency in food innovation, it has drawn increased discrepancies from health experts who advocate for enhanced transparency and greater federal oversight, particularly for ingredients widely used in ultra-processed foods. The policy landscape is shifting, with proposed legislative and regulatory changes that may significantly alter GRAS safety evaluation processes and federal oversight [87,88]. Ensuring that the GRAS process keeps pace with emerging scientific evidence regarding long-term health effects remains a priority, and clinicians and policymakers should monitor these developments as forthcoming revisions could affect the classification and permissible use of certain additives commonly found in UPFs.

7.2. Food safety and labeling reform measures

Efforts to improve food labeling transparency have also gained momentum. In January 2025, the U.S. FDA proposed introducing front-of-package (FOP) nutrition labels, termed the "Nutrition Info Box," on most packaged food items [89]. This proposed label would visually categorize nutrient content per serving (saturated fat, sodium, and added sugars) using standardized descriptors (e.g., "Low," "Medium," or "High") to assist consumers in making informed decisions. The FDA based its proposal on literature reviews, focus group studies, and peer-reviewed experiments, which demonstrated that simple, black-and-white, percent-daily-value schemes were the most effective in helping consumers identify healthier food options [90].

In parallel, legislative efforts continue to address the regulation of food additives. While certain ingredients, such as Red Dye No. 3 and brominated vegetable oil, are already restricted under federal law, others (e.g., potassium bromate, propylparaben) have been banned in several states, including California. Additional states, including West Virginia and New York, are considering similar restrictions [91]. Federal legislation has also been introduced to enhance the safety of school meals, proposing systematic reviews of GRAS-listed ingredients with potential carcinogenic, reproductive, or developmental health risks [92]. Reformulation initiatives have aimed to reduce or remove certain preservatives and other additives of concern, thereby complementing broader strategies aimed at improving the nutritional profile and safety of UPFs.

7.3. Public health nutrition programs and tax laws implementation

Public health strategies aimed at reducing UPF consumption and improving dietary quality include both community-level interventions and fiscal policies, though their effectiveness varies. Programs led by the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC), such as nutrition education and taxation on sugary beverages, have yielded mixed results in real-world settings [7,93]. For example, a prospective evaluation of Seattle's 2018 municipal sweetened beverage tax found a modest but measurable reduction in BMI at the 95th percentile (P95) among children, suggesting that targeted fiscal measures may contribute to improving weight-related outcomes [93]. Further studies are needed across different geographic and socioeconomic contexts to assess the replicability and long-term impact of such interventions.

Efforts to strengthen school and childcare nutrition policies remain critical. Programs such as MyPlate, Supplemental Nutrition Assistance Program-Education (SNAP-Ed), and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) have the potential to promote healthier dietary behaviors, particularly among vulnerable populations [83,94,95]. However, ongoing efforts are needed to expand reach, update curricula, and reduce disparities in program awareness and utilization.

In particular, Farm to School (FTS) programs, which integrate local produce into school meals and provide food literacy education, have shown promise in improving access to fresh foods and reducing reliance on UPFs in low-income, high-minority school settings. These programs, when supported through local, state, and federal partnerships, offer a scalable solution for promoting food equity and fostering healthier school food environments [96]. Taken together, the evidence highlights the need for coordinated clinical, community, and policy actions to address the pervasive role of UPFs in pediatric diets.

8. Future directions

Research priorities should focus on some of the following areas that could improve our understanding and ability to respond to the intake of UPF in the pediatric population. The top priority would be an internationally coordinated, longitudinal, and prospective study to clarify the causal relationships between early exposure to UPFs and the subsequent development of chronic disease. This type of research can identify exposure timelines and dose-response relationships throughout childhood development.

There is an urgent need for mechanistic research to clarify how UPF consumption contributes to long-term disease risk. Priority areas include UPF-induced gut dysbiosis, neuroinflammation, and neurodevelopmental disruption during critical periods, as well as epigenetic modifications potentially linked to adverse health outcomes. The effectiveness of multilevel interventions (at the family, school, and community levels), such as dietary modification with the family, nutrition education programs at the school level, environmental interventions throughout the community, and novel online technologies to monitor and teach dietary intakes should also be assessed. A population-based research study on UPF consumption behavior, categorized by socioeconomic, racial, and ethnic levels, is also necessary for designing culturally specific intervention measures and ensuring fair food availability for all individuals. Future studies should also incorporate objective measures of the food environment, such as density of fast-food outlets, marketing exposure, and food availability indices, to better understand contextual drivers of UPF intake.

Emerging efforts are exploring innovative strategies to integrate UPF and sugar-sweetened beverage (SSB) assessment and counseling into routine pediatric care. A pediatric weight management pathway is being developed at the University of North Carolina (UNC) that guides pediatric primary care clinicians in incorporating UPF-focused counseling, exploring the use of digital tools, including an artificial intelligence (AI)-assisted UPF titration system. A rigorous evaluation of digital tools, including their usability, effectiveness, and health outcomes, is essential before their widespread implementation in pediatric populations. As this area evolves, future research may benefit from the development of validated, age-specific UPF screening tools that address the full continuum of pediatric care—from infancy through adolescence—to enable practical and scalable implementation in diverse clinical settings.

The health of future generations can only be improved with sustained political determination, sufficient research funding, and an understanding of the importance of health trajectories associated with children, which are inextricably linked to their food environments.

9. Limitations

This comprehensive review has several significant limitations. Where pediatric-specific data were limited, we incorporated adult studies examining comparable mechanisms such as inflammation, insulin resistance, and gut microbiome disruption. These processes are biologically relevant across age groups, but direct extrapolation to children requires caution, given developmental and metabolic differences. Our search strategy relied primarily on PubMed, supplemented by Google Scholar and policy documents, which may have limited the capture of all available studies on UPF and pediatric health.

Most pediatric studies on UPF consumption are observational, restricting causal inference, and heterogeneity in study design, UPF classification methods, and outcome measures complicates synthesis. Additionally, as a review article, scope and length constraints prevented us from including every relevant or emerging study in this rapidly evolving field. Nonetheless, the consistency of findings across diverse study designs and populations strengthens the conclusion that UPF consumption adversely affects child health and underscores the urgent need for coordinated intervention strategies and further pediatric-focused research.

10. Conclusion

The high intake of UPFs poses a growing concern for child and adolescent health. There are strong correlations between high UPF intake and several unfavorable health outcomes in children and adolescents, especially obesity, insulin resistance, metabolic dysfunction-associated steatotic liver disease, mental health disorders, cognitive deficiency, and dysbiosis of the gut microbiome. Notably, higher rates of UPF intake among children from early childhood to adolescence, particularly in crucial periods of development, set a pattern that predisposes children to chronic disease trajectories extending into adulthood. These findings are particularly alarming given that dietary habits formed in childhood tend to persist throughout life and become increasingly difficult to modify with age.

Based on our comprehensive review, urgent and coordinated action involving both individual behavior change and structural reforms is imperative to limit UPF consumption. Clinicians should consider integrating UPF assessment into routine practice through standardized screening tools and evidence-based counseling, while advocating for policy changes addressing the root causes of our toxic food environment. Key policy interventions should aim to include stringent restrictions on UPF marketing targeting children, full disclosure through front-of-package nutrition labeling, and radical improvements to school nutrition programs. Given the mounting evidence of harm and the irreversible nature of early developmental programming, swift and decisive action is essential to protect current and future generations from this preventable public health crisis. A practical approach to reducing UPF consumption should focus on cutting back the most harmful products that are high in unhealthy fats, added sugars, and salt, while recognizing that select, affordable UPFs of better nutritional quality may be consumed as part of a healthy dietary pattern. This nuanced strategy acknowledges that not all UPFs pose equal health risks and provides realistic guidance for families navigating food choices.

11. Bulleted key takeaway clinical messages

- UPF intake has profoundly increased throughout childhood and adolescence. Children are obtaining up to 70 % of their daily calories from UPFs during critical developmental years.
- High intakes of UPF among children result in excess weight, insulin resistance problems, dyslipidemia, and dental cavities. It is pivotal for pediatric providers to have standardized screening tools for UPF consumption and receive training to conduct personalized

counseling and longitudinal care with built-in accountability to increase adherence to healthier behaviors.

- Policy-level interventions are imperatively needed to regulate the demographic target of food marketing with strict reinforcement. of nutrition labeling, and improving food environments in schools and childcare settings.

Contributors' statement

- Drs. VSC, PS, RK, and SR conceptualized and designed the review, conducted the primary literature search, drafted the initial manuscript, and revised it for critical intellectual content.
- Drs. SP, UR, and HPC contributed to the literature review, manuscript drafting, and critical revision of the manuscript.
- Drs. RK, SR, EN, SB served as the supervising author and mentor, providing oversight, guidance, and critical review of the manuscript for accuracy and scholarly value.
- All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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Declaration of competing interest

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