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IMPACT OF MODERN DIETARY HABITS ON ORAL HEALTH IN CHILDREN: A NARRATIVE REVIEW

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ABSTRACT

Introduction. Dental caries remains the most prevalent chronic disease of childhood worldwide. In recent decades, children's dietary patterns have shifted toward increased consumption of sugar-sweetened beverages, ultra-processed foods, and frequent snacking, raising concerns about their impact on oral health.

Aim. To examine the impact of modern dietary habits on oral health outcomes in children, integrating epidemiological patterns, mechanistic insights, and preventive strategies.

Material and Methods. A literature search was conducted across PubMed, Scopus, and Google Scholar for English-language studies examining dietary habits and oral health in children aged 0–18 years. Studies were selected based on relevance to contemporary dietary patterns and pediatric oral health outcomes, with priority given to publications from the last 20 years. A total of 27 studies met the inclusion criteria and were included in the review.

Results. Frequent consumption of sugar-sweetened beverages and sugary snacks was consistently associated with higher caries prevalence across age groups and geographic settings. Ultra-processed food consumption was associated with poorer diet quality and indirect caries risk, though direct oral health evidence remains limited. Nutrient-dense diets were associated with reduced caries incidence, particularly when combined with oral hygiene education in school-based programs. Socioeconomic factors, including low parental education and limited access to preventive care, significantly moderated these associations.

Conclusions. Modern dietary habits are consistently associated with poorer oral health outcomes in children, with the strongest evidence for sugar-sweetened beverages and dental caries. Integrated interventions combining dietary guidance, oral hygiene education, and targeted support for high-risk populations are needed to reduce the pediatric caries burden. Future prospective studies with standardized measures are warranted to strengthen the causal evidence base.

KEYWORDS

Dental Caries, Children, Dietary Habits, Sugar-Sweetened Beverages, Ultra-Processed Foods, Oral Health, Narrative Review

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1. Introduction

Oral health in children forms the foundation for lifelong well-being, influencing not only masticatory function, speech and nutritional intake, but also their mental wellbeing during critical developmental years. Dental caries, the most prevalent chronic disease in pediatric populations worldwide, affects a substantial portion of preschoolers in various regions and imposes substantial psychosocial and economic burdens, with treatment costs escalating in cases of early childhood caries [1]. Modern dietary habits—defined here as patterns dominated by sugary beverages, ultra-processed foods rich in fermentable carbohydrates, and frequent snacking—have emerged as modifiable risk factors amid urbanization and globalization. These patterns displace nutrient-dense whole foods and promote acidogenic oral environments [2]. These shifts are particularly concerning in children, whose developing dentition is vulnerable to demineralization, enamel erosion, and plaque accumulation leading to gingivitis or periodontal issues. With studies showing that frequent consumption of carbonated drinks and fruit syrups is associated with erosion and rampant caries in preschoolers aged 2-5 years [3]. While fluoride applications and hygiene practices mitigate risks, dietary influences remain underemphasized, especially in low-socioeconomic and diverse ethnic groups where access to preventive care is limited [4].

Existing research underscores bidirectional links between nutrition and oral health: cariogenic diets initiate decay, and untreated decay in turn impairs nutrient absorption through pain and infection, perpetuating cycles of poor health [5]. However, much of the evidence is fragmented across observational studies, reviews,

and regional cohorts, with inconsistencies arising from varying definitions of "modern diets" and outcome measures like the Decayed, Missing, and Filled Teeth (DMFT) index. Gaps persist in synthesizing how specific habits, such as daily elevated sugary drink consumption, interact with behavioral factors like parental education or family income to drive disparities [6]. This narrative review addresses these limitations by examining the impact of modern dietary habits on oral health outcomes in children, integrating epidemiological patterns, mechanistic insights, and preventive strategies to inform targeted interventions.

2. Materials and Methods

A literature search was conducted across PubMed, Scopus, and Google Scholar to identify studies examining the relationship between modern dietary habits and oral health outcomes in children. The search used combinations of terms including "sugar-sweetened beverages," "ultra-processed foods," "snacking," "dietary habits," "dental caries," "tooth erosion," "gingivitis," "oral health," "children," "pediatric," and "adolescent." The search was limited to English-language, peer-reviewed studies involving human pediatric populations (aged 0–18 years), with priority given to studies published from 2000 onward, though earlier foundational works were included where relevant.

Studies were selected based on their relevance to the review's objectives, with preference for cross-sectional, cohort, case-control, and review articles that examined associations between contemporary dietary patterns and oral health outcomes. Non-human studies, commentaries, and editorials were excluded. A total of 27 studies met the inclusion criteria and were retained for analysis.

Data were extracted on study design, population characteristics, dietary exposures, oral health outcomes, key findings, and preventive recommendations. Findings were synthesized thematically, organized by dietary exposure type (sugar-sweetened beverages, ultra-processed foods, snacking patterns) and oral health outcome (dental caries, erosion, periodontal health). Evidence strength was assessed qualitatively based on study design, sample size, and consistency of findings across studies.

3. Results

3.1 Association Between Sugary Drinks and Snacks and Dental Caries

Multiple studies report a consistent positive association between frequent consumption of sugary drinks and snacks and dental caries in children across age groups. A cross-sectional study of Turkish children aged 5–12 [7] found that daily consumption of sugary foods and carbonated beverages was significantly associated with higher caries prevalence in both primary and permanent teeth. A Portuguese cohort study [8] followed children from age 4 to 7 and reported that energy-dense snacking patterns were associated with the development of new carious lesions during the mixed dentition stage. A study of Malaysian preschoolers [9] found that children who consumed sugary drinks more than twice daily had significantly more decay than those with lower intake.

The association persists into adolescence. An Australian study from 2015 [6] reported that sugary drink consumption among New South Wales teenagers was associated with caries in permanent teeth, with higher consumption frequencies corresponding to greater caries experience. A study from 2016 [10] also observed a similar pattern among Taiwanese schoolchildren with mixed dentition, where sugar-sweetened beverage intake was a significant predictor of caries incidence. A cross-sectional survey of 1554 12-year-old Iranian children [4] found that dietary patterns high in sugary foods were associated with caries among these children, with awareness of diet's effect on oral health being low in the study population.

3.2 Enamel Erosion from Acidic Dietary Components

Acidic beverages and foods are consistently associated with enamel erosion in children, with effects observed across age groups and geographic settings. A cross-sectional study of 987 Saudi preschoolers aged 2–5 [3] found that frequent consumption of carbonated drinks and fruit syrups was significantly associated with dental erosion, with 31% of children showing signs of enamel wear. Erosion frequently co-occurred with caries and rampant caries in the same children, though the dietary risk factors for each condition overlapped only partially. Vitamin C supplements, carbonated drinks, and bedtime bottle use of fruit syrup were specifically linked to erosion [3].

In older children, acidic dietary components continue to pose risks. A study of Turkish children aged 5–12 [7] reported that regular consumption of carbonated beverages was associated with both caries and enamel erosion, with effects observed in primary and permanent teeth. Mishra and Mishra [2] reviewed the evidence on sugar-sweetened beverages in children and adolescents and highlighted that the acidity of carbonated drinks

lowers oral pH below the critical threshold for enamel demineralization, creating conditions for progressive surface breakdown particularly during periods of active tooth development.

The relationship between acidic diet and erosion is not limited to beverages. A study of rural Guatemalan children [11] found associations between fermentable carbohydrate consumption and dental decay, suggesting that in settings where processed drinks are less available, broader sugar exposure from local dietary sources may contribute to similar outcomes through overlapping erosive and cariogenic mechanisms.

3.3 Role of Ultra-Processed Foods in Oral Health Outcomes

Ultra-processed foods represent a growing share of children's daily caloric intake and have been associated with both poorer diet quality and increased caries risk. A data mining analysis of diet's impact on oral health in children and adolescents [12] found positive associations between ultra-processed food consumption — especially snack varieties — and caries development across multiple global datasets. A systematic review of ultra-processed food consumption in children and adolescents [13] confirmed that these foods are linked to adverse health outcomes including obesity and metabolic disruption, though the authors noted that direct oral health impacts remain less studied than systemic effects.

Beyond direct cariogenicity, ultra-processed foods are associated with broader nutritional displacement. A Belgian cross-sectional study [14] found that children and adolescents with higher ultra-processed food consumption had poorer overall diet quality, with reduced intake of protective nutrients. Similarly, a study of Mexican children [15] reported that ultra-processed food consumption was associated with nutritional imbalances, including excess sugar and insufficient micronutrient intake. A recent review of the impact of ultra-processed foods on pediatric health [16] highlighted that these foods contribute to systemic inflammation and metabolic dysfunction, which may indirectly compromise oral defenses, though isolated oral health outcomes were not the primary focus.

Across regions, the evidence suggests that ultra-processed foods affect oral health primarily through two pathways: direct sugar exposure promoting caries, and nutritional displacement reducing the intake of protective foods that support enamel integrity and gingival health.

3.4 Protective Effects of Nutrient-Dense Diets and Hygiene Integration

Nutrient-dense diets and integrated oral hygiene practices are consistently associated with better oral health outcomes in children. A narrative review of pediatric oral health strategies [1] emphasized that balanced diets rich in vitamins, minerals, and fresh produce support enamel remineralization and reduce caries susceptibility, while nutritional deficiencies impair the oral cavity's natural repair mechanisms. Similarly, a review of the effects of nutrition on pediatric oral health [5] highlighted that nutrient-poor diets contribute to both caries and periodontal vulnerability, and recommended that dentists and pediatricians actively educate families about the role of diet in oral health.

Observational studies support these findings across age groups. A Portuguese cohort study following children from age 4 to 7 [8] found that dietary patterns emphasizing fruits and vegetables were associated with lower caries severity during the mixed dentition stage. Among Romanian schoolchildren aged 6–12, Popescu et al. [17] reported that healthier body mass index and balanced dietary intake were associated with lower rates of both dental caries and gingival inflammation, with effects strengthened when combined with consistent brushing routines.

School-based programs that integrate dietary guidance with oral hygiene education show particular promise. A study of oral health-promoting school environments in Québec [18] found that schools incorporating both nutritional policies and hygiene practices had students with lower caries experience compared to schools without such programs. A Thai study [19] similarly reported that school environments promoting healthy eating and oral hygiene behaviors were associated with reduced caries prevalence, though the authors noted that effects were more modest in younger children due to ongoing dental development.

3.5 Socioeconomic and Behavioral Moderators

Socioeconomic status and caregiver behavior consistently moderate the relationship between dietary habits and oral health outcomes in children. A cross-sectional survey of 1,554 Iranian 12-year-olds [4] found that children from families with lower parental education had greater reliance on cariogenic foods and higher caries prevalence, with awareness of diet's effect on oral health being notably low across the sample. A Brazilian study [20] similarly reported that children from lower-income households had higher caries

experience, though the association was driven more by broad socioeconomic disadvantage than by specific sugar intake measures.

Caregiver knowledge and behavior play a central role. A Syrian study examining the influence of maternal oral health behavior on children's caries status [21] found that mothers' own caries experience and oral health practices were significant predictors of their children's decay levels, suggesting intergenerational transmission of both dietary and hygiene habits. A case-control study of Pakistani preschoolers [22] reported that children with early childhood caries were more likely to have experienced delayed initiation of oral hygiene practices and limited parental assistance, with firstborn children at elevated risk — though the authors noted that smaller sample sizes may limit generalizability.

Recent evidence also highlights the impact of disrupted routines. A study of Romanian children aged 6–12 [23] found that caries prevalence increased in the post-COVID-19 period despite improvements in reported hygiene behaviors, which the authors attributed to heightened access to sugary foods and disrupted dietary routines during and after the pandemic.

Table 1. Summary of Evidence

Theme	Key Finding	Population Applicability	Direction of Association	Consistency of Evidence	Study Designs	Supporting Studies
Sugary Drinks and Snacks on Caries	Frequent snacking and carbonated drink habits linked to elevated decay in primary and permanent teeth	Children 2-15 years, global (urban/rural)	Increased risk	Strong (consistent across multiple cross-sectional and cohort studies with robust designs)	Cross-sectional, Cohort	[6, 7,8]
Enamel Erosion from Acidic Components	Frequent carbonated drinks and citrus intake tied to enamel wear and rampant decay patterns	Preschoolers 2-6 years, Middle East/Europe	Increased risk	Moderate (generally consistent but limited to cross-sectional designs)	Cross-sectional, Narrative review	[2, 3, 7]
Ultra-Processed Foods Role	High energy shares from ultra-processed snacks associated with poorer diet quality and indirect caries risks	Schoolchildren 6-12 years, Europe/Latin America	Mixed	Limited (sparse direct oral evidence, indirect via diet quality)	Cross-sectional, Data mining analysis, Narrative review	[12, 14, 15]
Protective Nutrient-Dense Diets	Fruit-rich school meals and balanced patterns linked to reduced sweet intake and decay protection	Children 4-12 years, diverse SES	Decreased risk	Moderate (consistent protective patterns with hygiene integration)	Cross-sectional, Narrative review	[1, 17, 19]
Socioeconomic/Behavioral Moderators	Low-SES urban diets and maternal factors amplify caries amid rising post-pandemic sugar habits	Children 2-12 years, low-SES/rural	Increased risk	Strong (consistent moderation effects across surveys)	Cross-sectional, Case-control	[4, 22, 23]

4. Discussion

4.1 Principal Findings and Their Interpretation

The findings of this review indicate a consistent positive association between modern dietary habits — particularly frequent consumption of sugary drinks, snacks, and ultra-processed foods — and dental caries in children. This association was observed across age groups, geographic settings, and study designs, with the strongest evidence emerging for sugar-sweetened beverages and frequent snacking.

The cariogenic mechanism is well-established: fermentable carbohydrates are metabolized by oral bacteria, predominantly *Streptococcus mutans*, producing lactic acid that lowers oral pH below the critical threshold of approximately 5.5 and initiates enamel demineralization [2]. Frequent snacking is particularly harmful because it prolongs periods of low pH, reducing the time available for saliva to buffer acids and support remineralization [2]. This is consistent with cohort data showing that energy-dense snacking patterns were associated with the development of new carious lesions during the mixed dentition stage, when newly erupted permanent teeth are most vulnerable [8].

Conversely, nutrient-dense diets appear to confer protective effects that extend beyond simple sugar avoidance. Adequate intake of calcium, phosphorus, and vitamins A, C, and E supports enamel integrity and gingival health [5]. These benefits were most pronounced when dietary improvements were combined with oral hygiene practices, as demonstrated by school-based programs integrating nutritional guidance with brushing education [18].

Confidence in these findings varies by outcome. The association between sugary drink and snack consumption and dental caries is supported by consistent results across studies using standardized measures such as the DMFT index, with adjustment for socioeconomic confounders. However, evidence for erosion and gingivitis is more tentative, relying primarily on cross-sectional designs that cannot establish temporal progression [3]. Similarly, the role of ultra-processed foods in oral health remains indirect, operating mainly through nutritional displacement rather than through well-documented direct oral effects.

4.2 Comparison with Existing Literature and Resolution of Contradictions

The findings of this review are broadly consistent with the established literature on diet and dental caries in children. The cariogenic role of sugars has been recognized for decades, from early Finnish data showing that children with high caries experience consumed more refined carbohydrates and had lower nutrient density in their diets [24], to recent post-pandemic evidence from Romania where increased access to sugary foods during lockdowns was associated with rising caries prevalence despite reported improvements in hygiene behaviors [23]. This consistency across time periods and settings supports the biological plausibility of the sugar–caries relationship and suggests that the underlying mechanism — bacterial acidogenesis driven by fermentable carbohydrate exposure — operates independently of geographic or temporal context.

Methodological standardization has facilitated these comparisons. The widespread use of the DMFT index across studies spanning different decades and dietary assessment methods (food frequency questionnaires, 24-hour recalls, data mining approaches) allows for meaningful cross-study comparison [12]. However, differences in dietary assessment methods remain a source of heterogeneity and should be considered when interpreting effect sizes.

Some contradictions in the literature merit discussion. The association between ultra-processed food consumption and caries is less consistent than for sugary beverages. While a data mining analysis found positive associations between ultra-processed snack consumption and caries [12], cross-sectional studies in Belgium [14] and Mexico [15] did not identify direct effects on oral health outcomes. This discrepancy may reflect differences in study populations and outcome measures: the Belgian study focused on overall diet quality and nutrient displacement rather than caries as a primary endpoint, while the Mexican study assessed nutritional status and obesity rather than oral health directly. In both cases, the absence of adjustment for oral hygiene confounders may have obscured potential associations.

Similarly, a Brazilian study [20] reported weaker sugar–caries associations than the broader literature, which the authors attributed to the study's specific population characteristics. Studies conducted in selected populations — such as sports club participants or those enrolled in intervention programs — may underrepresent high-risk groups, introducing selection effects that attenuate observed associations.

Finally, publication bias should be acknowledged. Null findings, such as the absence of a significant association between ultra-processed food consumption and inflammatory markers in Chilean children [25], may be less likely to appear in oral health-focused journals. The progression from cross-sectional to prospective cohort designs in recent years has strengthened the evidence base by capturing caries incidence rather than prevalence alone, which helps to clarify the temporal sequence between dietary exposure and disease development.

4.3 Practical Implications

The findings of this review have several implications for clinical practice, public health policy, and community-level interventions.

At the school level, programs that combine dietary education with environmental changes show particular promise. A Québec-based study [18] found that school environments incorporating fruit provision and nutritional policies were associated with lower caries experience in children, suggesting that restricting access to sugary beverages in schools and providing healthier alternatives could meaningfully reduce caries risk, particularly among children from low-socioeconomic backgrounds.

In clinical settings, the evidence supports integrating dietary screening into routine pediatric care. Pediatricians and dentists should assess children's intake of sugar-sweetened beverages and ultra-processed foods during well-child visits, with targeted counseling for high-risk groups [16]. For preschool-aged children (2–6 years), limiting carbonated drink consumption and applying fluoride varnishes remain evidence-based preventive strategies. Culturally sensitive approaches may be especially important for ethnic minority communities where early childhood caries disparities persist — a study of Latino families [26] found that maternal self-efficacy and oral health beliefs were significant predictors of children's caries outcomes, highlighting the need for family-centered interventions.

At the public health level, the post-pandemic increase in caries observed among Romanian children [23] despite improved hygiene behaviors underscores the need to address dietary access, not only hygiene education. Subsidized access to nutrient-dense foods and telehealth-based dietary and hygiene guidance for rural families could help close gaps that hygiene interventions alone cannot address.

From a regulatory perspective, the consistent association between frequent sugar exposure and caries in young children supports policies restricting the marketing of sugar-rich and ultra-processed foods to children [27]. However, such recommendations should be proportionate to the evidence: while the case for reducing sugar-sweetened beverage consumption is strong, the evidence linking ultra-processed foods specifically to oral health outcomes remains indirect, and the evidence for dietary interventions targeting gingivitis supports integrated approaches (diet plus hygiene) rather than standalone dietary changes.

4.4 Strengths and Limitations

This review has several strengths. It synthesizes evidence from a broad range of study designs — including cohort studies, cross-sectional surveys, case-control studies, and narrative reviews — across diverse geographic and socioeconomic settings. The thematic organization allows for comparison across dietary exposure types and age groups, providing a more integrated picture than individual studies alone. The inclusion of both mechanistic reviews and observational data strengthens the interpretive framework.

However, several limitations of the included studies should be acknowledged. The majority of evidence is cross-sectional in design, which limits the ability to establish causal relationships between dietary exposures and oral health outcomes. Dietary data in most studies relied on self-report or caregiver-report methods (food frequency questionnaires, 24-hour recalls), which are subject to recall and social desirability bias. Geographic representation was uneven, with limited data from African and certain Latin American populations. Some studies had small sample sizes, which may have contributed to null findings due to insufficient statistical power.

This review also has its own methodological limitations. Study selection was based on title and abstract screening, which may have excluded relevant findings available only in full texts. No formal meta-analysis was conducted due to heterogeneity in study designs, dietary exposure definitions, and outcome measures. Additionally, no standardized risk-of-bias assessment tool (such as the Newcastle-Ottawa Scale) was applied to individual studies. These limitations are partially offset by the thematic synthesis approach, which prioritized consistency of findings across multiple independent studies rather than relying on any single result.

5. Gaps and Future Directions

Several gaps in the current evidence base warrant attention. First, longitudinal studies tracking the relationship between modern dietary transitions — particularly the rise in ultra-processed food consumption observed since 2020 — and long-term oral health outcomes in children remain scarce. This gap is especially pronounced in underrepresented regions such as sub-Saharan Africa, where socioeconomic factors are frequently studied but direct pediatric oral health data linked to dietary exposures are limited.

Second, the evidence on dietary influences on gingivitis and periodontal outcomes in children is underdeveloped. Gingivitis is typically assessed as a secondary outcome alongside caries, making it difficult

to isolate the independent effects of dietary patterns. Additionally, the role of diet-induced changes in the oral microbiome — such as shifts in microbial composition associated with frequent processed carbohydrate consumption — has been discussed in reviews but lacks validation through pediatric-specific biomarker studies.

Third, contradictions regarding the oral health impact of ultra-processed foods remain unresolved, largely because existing studies measure indirect outcomes (diet quality, obesity) rather than oral health endpoints directly, and rely predominantly on cross-sectional designs.

To address these gaps, future research should prioritize prospective cohort studies with adequate sample sizes, following children from early childhood through adolescence and using standardized outcome measures such as the DMFT index and validated erosion scoring systems. The use of objective dietary assessment methods — such as app-based food diaries or photographic records — would reduce the recall bias inherent in current self-report tools. Integrating salivary biomarkers (e.g., pH monitoring, microbial profiling) with dietary and behavioral data could strengthen the mechanistic evidence base. Finally, future studies should prioritize recruitment from low-socioeconomic, rural, and ethnic minority populations to address the disparities identified in this review and improve the generalizability of findings.

6. Conclusions

This narrative review examined the impact of modern dietary habits on oral health outcomes in children, drawing on evidence from observational studies, cohort data, and reviews across diverse geographic and socioeconomic settings. The findings consistently indicate that frequent consumption of sugar-sweetened beverages, sugary snacks, and ultra-processed foods is associated with increased dental caries risk in children across age groups, while nutrient-dense diets and integrated school-based programs combining dietary guidance with oral hygiene education are associated with improved outcomes.

The evidence is strongest for the association between sugar-sweetened beverages and dental caries, supported by consistent findings across multiple study designs and populations. The role of ultra-processed foods in oral health remains less well-defined, operating primarily through nutritional displacement rather than direct cariogenic effects. Socioeconomic disadvantage and caregiver knowledge consistently moderate these associations, amplifying risk in vulnerable populations.

However, the predominance of cross-sectional designs in the current literature limits the ability to draw causal conclusions, and important gaps remain — particularly regarding longitudinal outcomes, underrepresented populations, and the independent effects of diet on periodontal health in children.

Addressing the burden of diet-related oral disease in children will require coordinated efforts across clinical, educational, and policy settings. School-based nutritional policies, routine dietary screening in pediatric care, and targeted support for low-socioeconomic and minority communities represent actionable strategies informed by the available evidence. Future prospective studies with standardized outcome measures and objective dietary assessment methods are needed to strengthen the causal evidence base and guide more precise interventions.

Author's Contribution:

Conceptualization: H.K.

Methodology: W.J-T. and Z.W.

Validation: E.S. and M.K.

Formal analysis: N.B. and D.S.

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Supervision: E.S. and E.M.

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