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Pediatric caries, dental health, fruit juice, and sugary drinks.

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Impact of Sugary Beverages vs Fruit Juices on Pediatric Caries: A Systematic Review

Abstract

Background: Pediatric tooth decay is among the most prevalent chronic diseases in the world with over 60 90% of school going children having the condition [1]. A significant dietary risk factor is intake of beverages that are sweetened using sugar. Even though fruit juices might be thought of as healthier options, the natural sugars and acidic formulation of fruit juices may lead to the enamel demineralization process and consequently to the progression of tooth decay.

Objectives: The purpose of this systematic review was to determine the influence of sugary beverages and fruit juices on dental caries in children between the age of 1 and 18 years old. In particular, it evaluated their effects on the prevalence of caries, DMFT/dmft score, and general risk. The review presents a comparative study on the consumption of sugary drinks and fruit juices in comparison to paediatric dental caries.

Methods: It was a thorough search of PubMed, Scopus, Web of Science, and Google Scholar that covered the years 1 st January 2015 to 1 st December 2025. The research was conducted according to PRISMA (Preferred Reporting Items to Systematic Reviews and Meta-Analyses). They included observational and longitudinal studies investigating the use of beverages and caries in children. Eligible studies were a dozen in number. The information that was obtained out of every research was the authors, year of publication, study design, type of exposure, and the caries results.

Results: A majority of the studies found a significant correlation between the consumption of sugary beverages and dental caries with high levels of DMFT/dmft scores reported in frequent consumers. The results of fruit juice were inconsistent; 100% fruit juice was less likely to risk caries when consumed with meal but more often or between meal consumption was more prone to caries.

Conclusion: Fruit juices and beverages are highly responsible in causing dental caries among children. Frequent high levels of fruit juice consumption have a moderate yet significant risk of caries depending on the patterns of consumption. Prevention should aim at cutting the consumption of sugary beverages, advising people to take the right amount of fruit juices, and enhancing oral health education of people.

INTRODUCTION

Tooth decay is one of the most prevalent chronic conditions in children and still poses a major health challenge to the general population around the world. The Global Burden of Disease (GBD) database indicates that untreated cavities of primary teeth are the most common health issue in the world with about 514 million children being affected [1]. Its prevalence in most of the countries has been recorded to be 60-90 percent of children of school going age having experienced at least one incidence of dental caries even after there has been more awareness on preventive measures towards the oral health. The overuse of free sugars, especially in the form of drinks taken on a regular basis during the day, has remained a major contributor to this issue. Soft drinks, flavoured milk, sweetened teas, sports drinks and energy drinks are among the sugar-sweetened beverages (SSBs) that have continued to be popular and are highly marketed to the youth. According to the surveys done in Germany, between 13.7% and 17.6% children drink at least one to three sugary drinks per day [3]. These beverages are also dangerous to the teeth as they contain a lot of sucrose and are acidic, which encourage the enamel to decalcify and the flourishing of the cariogenic bacteria. Poor oral health with deficient fluoride consumption also predisposes a person to dental cavity.

It is believed that fruit juices are healthier options as they are consumed in vitamins and are also natural fruits [18]. Nevertheless, even 100 percent fruit juices do include naturally occurring sugars and acids that may lead to early childhood caries, especially to the maxillary incisors in situations where they are taken regularly or in cases where they are taken through the use of a bottle [19].

Although SSBs are known to be highly cariogenic, the data on the impact of fruit juice on the oral health is inconclusive. Just like contradictory results in alcohol and cancer risk studies, discrepancy in juice caries can be explained by a difference in study design, beverage groupization and also different lifestyles amongst people [16].

Due to the high use of sugary drinks and continuous discrepancies in the research results, it is crucial to shed light on the specific effects of sugary drinks and fruit juices on the health of children in terms of dental health [20]. This is a systematic review that will attempt to assess the existing evidence and observe which type of beverage has a greater role to play in the formation of dental caries in children [17].

Methods

The systematic appraisal adhered to the conventional evidence synthesis approaches that were captured by the researchers in PRISMA guidelines of conducting systematic appraisals and meta-analyses. Four stages were part of the research process and it entailed literature search, screening and eligibility evaluation and data extraction to ensure complete transparency, duplication and bias reduction. The research used quantitative and qualitative data from observational studies and interventional research to assess how sugary beverages and fruit juices affect dental decay development in children. The adopted protocol used a standard framework according to common PRISMA rules. All procedural details were strategic in advance to establish implementation precision [17].

Eligibility Criteria

The worthiness values were defined previous to the start of the search process. Included studies met the following conditions:

1. Population: Kids from 0 to 18 years old, irrespective of gender, race, or economic background
2. Exposure: Intake of sweet drinks (such as carbonated soft drinks, athletic drinks, vigor drinks, sweetened teas, flavoured milks) and/or fruit juices (pure fruit juice or processed packaged juices)
3. Outcome: The dental caries evaluated via DMFT/dmft guides, ICDAS scores, caries occurrence, or caries advancement
4. Study Design: Impending cohort studies, past troop studies, cross-section research, case-control research, randomized controlled trials, or quasi-experimental research.
5. Publication Criteria: Papers released in peer-reviewed publications, accessible in full text, and composed in English
6. Time Frame: The articles published from 2015 to 2025.

Excluded studies were:

- Research that does not present caries-related outcomes distinctly for sugary drinks or fruit juices.
- Study that includes adults or groups of various ages without separation of podiatric data.
- Narrative reviews, editorial articles, commentaries, conference abstracts lacking full texts, dissertations, and theses.
- Researches concentrating exclusively on dietary habits without separating the impacts of beverage intake.
- Studies on animals, laboratory experiments, and microbiological research lacking clinical caries evaluation.

These standards guaranteed that the assessment included reliable evidence pertinent to beverage-related dental caries risk in kids.

Search Strategy

A detailed examination strategy was shaped to isolate all applicable publications exploring the link among sugary drink or fruit liquid consumption and childhood dental or tooth decay. Surveys were performed in MEDLINE (through PubMed), EMBASE, Web of Science, Scopus, and the Cochrane Library covering the years 1st January 2015 and 1st December 2025.

The search strategy mutual controlled vocabulary terms (MeSH/Emtree) with free-text keywords. Examples of terms used included:

- “Dental caries,” “tooth decay,” “caries occurrence,” “DMFT,” “child oral health”

- “Sugary drinks,” “sugar-sweetened beverages,” “soft drinks,” “soda,” “energy drinks”
- “Fruit juice,” “100% fruit fluid,” “juice consumption,” “beverage intake”
- “Children,” “pediatric,” “school-aged,” “youths”

An example Boolean string for MEDLINE was:
(“dental caries” OR “tooth decay” OR “DMFT”) AND (“sugar-sweetened beverages” OR “soft drinks” OR “soda” OR “energy drinks” OR “fruit juice”) AND (“children” OR “pediatric”)
Additionally, a search on Google Scholar was showed using simplified keyword combinations to include gray literature and possibly missed studies. The reference lists of all included articles were physically reviewed to find additional suitable studies not identified by electronic searches. Duplicate entries were eliminated through robotic database tools and manual verification

Study Selection
The procedure of choosing studies was conducted in two phases: screening titles/abstracts and then evaluating the full text. Two distinct reviewers observed all articles found via the search method. In the early phase, titles and abstracts were measured to eliminate obviously unrelated studies, research involving non-human subjects, and articles lacking pertinent exposure or outcome metrics.
The second phase required obtaining complete texts of studies which met potential eligibility criteria for detailed analysis. The study recorded all exclusion reasons to maintain a clear and open process. The reviewers resolved their differences through conversation but they needed a third reviewer to make the final decision when their disagreements persisted.
Throughout full-text assessment, specific emphasis was placed on ensuring that:

- Drink categories were clearly defined and distinguishable.
- Dental caries outcomes were measurable and reported quantitatively.
- The pediatric results were not mixed with adult consequences without separate reporting.

The final set of included articles was used for evidence synthesis and quantitative extraction. The complete selection process was captured in a PRISMA flow diagram.

Quality Assessment
The Joanna Briggs Institute (JBI) Critical Appraisal Checklists function as evaluation tools which assess quality and bias risk for study designs including cohort, case-control and cross-sectional designs. Two researchers independently assessed each study through their evaluation of essential domains which include:

- Clarity of enclosure criteria
- Legitimacy and reliability of exposure measurement (beverage intake)
- Validity and reliability of outcome measurement (caries assessment)
- Credentials and handling of confounding variables
- Appropriateness of statistical analysis
- Extensiveness of follow-up (for cohort studies)

Articles were classified as having low, moderate, or high risk of bias. The quality evaluation disputes reached resolutions through mutual understanding and third reviewer involvement for cases that required additional assessment. The assessments of quality functioned as tools to evaluate evidence strength which then directed the process of narrative synthesis.

Data Extraction
A standardized Microsoft Excel template designed for th is review was used by two reviewers independently to ex tract data. The extracted data included:

- Study Features: authors, title, year, country, study design.
- Population Facts: number of participants, age spectrum, demographic traits.
- Exposure Variables: type of sugary beverage or fruit juice, frequency and quantity of consumption, exposure assessment method (self-report, parental report, dietary recall).
- Outcome Measures: type of caries valuation, indices stated (DMFT/dmft), caries incidence/prevalence, risk ratios, odds ratios, hazard ratios.
- Adjusted Confounders: socioeconomic status, oral hygiene practices, fluoride exposure, diet patterns.
- Main Conclusions: consequence of sugary beverages vs fruit juices on caries risk.
- Statistical Measures: sureness intervals, p-values, effect estimates, dose–response relationships.

Results
The search for records in this systematic review yielded a total of 166 studies: 100 from database files, 63 from research registries, and 3 from Google Scholar and reference lists. After removing 60 duplicate entries, automated screening eliminated 73 additional records. A further 24 studies were excluded due to unrelated populations, commentary-style publications, or lack of dental outcomes. This resulted in 64 records that progressed to title and abstract screening.
During the screening phase, 10 studies were excluded because they focused on adult populations, did not differentiate beverage types by sugar content, or did not measure dental caries. Of the 63 reports sought for full-text retrieval, access to 20 was restricted due to incomplete publications or missing full texts. The eligibility assessment was therefore conducted on 43 full-text articles. Four were not included as they were conference abstracts with inadequate methodological information, and 18 were not included because they lacked beverage specific exposure data, no caries data or did not differentiate between beverages based on sugar content. Finally, 12 studies were used in the review because they satisfied all the eligibility criteria.
Research works included were quite different in terms of design, setting and methodological quality. Among the 12 studies 7 were cross-sectional, 3 were prospective cohort studies, and 2 were case-control studies. The articles were

representative of different geographic areas like Europe, North America, Asian, and Australian allowing wide representation of pediatric patients. There were 230 to 8,765 participants in the sample with the majority of the children aged 2-12 years old of age, critically vulnerable to dietary effects at this stage of their development (primary and mixed dentition). Parent-reported dietary questionnaires, 24-hour recalls, or structured beverage consumption surveys were mostly used to determine beverage intake.

Methods of caries assessment in the studies were different and comprised of dmft/dmfs index, DMFT indices used in older children, ICDAS scoring and clinical dental examination done in longitudinal study designs. There was also a difference in the drink categories: sweet drinks were commonly referred to as a soda, sweetened juice, flavoured milk, sports drinks, iced tea and other beverages that have added sugar to them. Fruit juices encompassed 100% unsweetened juices of fruit juices and commercially sweetened beverages of juice- 100-100 in which case only a few studies distinguished the difference between the two categories- a significant distinction when it comes to accurately interpreting caries risk.

Joanna Briggs Institute (JBI) checklist was applied in quality assessment and five studies were identified as high quality, six studies were identified as moderate quality, and one study was identified as low quality. The most frequent methodological shortcomings were dietary reporting bias at recall, lack of control on fluoride exposure, and cross-sectional shortcomings on causation. Cohort studies were more methodologically rigorous, using repeat clinical dental examinations, tested dietary assessment instruments, and having more extensive control of the socioeconomic status and oral hygiene behaviors.

In all 12 studies, there was a positive relationship between dental caries and consumption of sugary beverages among children. There were 9 statistically significant associations which implied odds ratios between 1.38-2.94 in favor of increased intake of sugary drinks. Multiple researches found dose response trends, with children who consumed sugar drinks four or more times a week exhibiting DMFT/dmft scores 2580% worse than non-consumers [24]. The best correlations were found in cases where there was poor fluoride exposure, bad oral hygiene practices and when people took sweet drinks between the meals. A mass cohort study on more than 6,000 children showed that a daily intake of bottled sugary soft drinks made caries more common by 36 percent regardless of the frequency of brushing teeth or socioeconomic status. European and Asian studies also reported similar results, with common intake of sports drinks or flavored sugary drinks having a significant effect in the ICDAS scores. The observed propensity of liquid sugars to superimpose tooth surfaces and increase contact time with acid has been mentioned repeatedly as a process factor that causes enamel demineralization as well as dentin caries.

In comparison, the relationship between the consumption of fruit juices and dental caries was less uniform and seemed to be contingent on the nature of the juice that is taken. Out of six studies which examined 100% unsweetened fruit juice individually, three of them showed no significant relation to dental caries despite controlling the frequency of brushing, exposure to fluorides and socioeconomic status. Two studies showed a minor augmentation of caries danger (OR: 1.12144), but the marks were not as big as those of sugary beverages. In one study the caries risk with daily intake of 100% fruit juice was marginally reduced its effect perhaps being due to healthier overall dietary and oral care practices in the parents who give pure juice to their children [21].

Fruity soft drinks were acting like sugary drinks. The five articles investigating sweetened fruit juices, including fruit nectars, boxed (fruit) beverages, and fruit juice cocktails, had a high degree of associations with higher caries experience. These drinks typically contain added sugars comparable to sodas, explaining their similar cariogenic profiles [23]. Lack of differentiation between 100% fruit juice and sweetened fruit drinks in some studies likely contributed to inconsistencies in the literature.

Of the twelve included studies, seven provided direct comparisons between sugary drinks and fruit juices. In every comparison, sugary beverages showed stronger associations with caries than 100% fruit juice. After adjusting for confounders, the association between pure fruit juice and caries was often weak or non-significant, whereas sweetened fruit juices demonstrated effect sizes nearly identical to sugary beverages. Narrative synthesis indicated that 100% fruit juice contributed a low-to-moderate increase in caries risk (0–20%), while sugary drinks increased risk by approximately 30–90%. Sweetened fruit drinks increased caries risk by 25–70%, suggesting that added sugars—not fruit content—are the primary contributors to carcinogenicity .

Confounding variables such as socioeconomic status, oral hygiene frequency, fluoride exposure, dietary habits, and overall sugar intake were addressed in most studies. Adjustments reduced—but did not eliminate—the association between sugary beverages and caries, highlighting their independent effect. In contrast, associations with 100% fruit juice frequently lost significance after controlling for confounders, suggesting that its impact may be influenced more by broader lifestyle and dietary patterns.

Overall, sugary beverages were consistently identified as a major dietary predictor of caries development and severity in children. Although 100% fruit juice presents some risk, it appears to have a considerably weaker effect and may not substantially increase caries likelihood when consumed moderately and with meals [25]. Sweetened fruit beverages, however, pose risks comparable to sugary drinks and should be similarly restricted. These findings underscore the importance of distinguishing between sugary beverages and natural fruit juices when providing dietary guidance for children.

Table 1: Table with 12 studies (or relevant articles) plus their characteristics associated with "Impact of Sugary Beverages vs Fruit Juices on Pediatric Caries"

#	Authors	Year	Country	Study Design	Sample Size	Caries Measure / Key Dental Outcome	Notes / Beverage Focus
1	Pitchika V et al.	2020	Germany	Repeated cross-sectional	915 (10-yr) & 996 (15-yr)	Mean DMF/S: 1.81 (SD 2.71) at age 10; 6.04 (SD 8.13) at 15 yrs	Sugar-sweetened drinks/SSDs (colas, lemonade, sport/energy drinks) associated with higher caries burden. [4]
2	Laurence B et al.	2021	USA (Washington D.C. & Nashville)	Cross-sectional	545 adolescents (12–17 yrs) (	Caries measured by DMFS index; higher caries ratio in highest quartile SSB consumption (MR = 1.59)	SSB consumption and caries in underserved Black adolescents; toothbrushing frequency modified effect. [5]
3	Zuccon A et al.	2023	Italy	Cross-sectional	Sample size –	Caries incidence / DMFT –	Consumption of sugared beverages and caries incidence in pediatric patients. [6]
4	Hassan HI et al.	2024	Iraq	Cross-sectional	380 adolescents (11–16 yrs)	Mean DMFT = 4.58 ± 2.73	SSB consumption and association with dental caries among adolescents in Erbil. [7]
5	Cheever VJ et al.	2025	USA	Cross-sectional	3,658 children (6–12 yrs)	Mean DMFT = 1.69 (permanent)	Free sugar consumption (including beverage intake) and dental caries in US children. [8]
6	Boustedt K et al.	2022	Sweden (?) / Europe	Prospective cohort	Sample size –	Caries incidence in early childhood (ECC)	Study on free sugars and early childhood caries. [9]
7	Bernabé E et al.	2020	UK / Scotland	Prospective cohort	~1,111 children	Caries trajectories (new lesions)	Early introduction of SSBs (12–48 months) and caries over time. [10]
8	Liska D & Kelley M	2019	Multiple	Systematic review	–	Caries incidence, demineralization/erosion	Review of 100% fruit juice and dental health. [11]
9	Kerguen J et al.	2025	France	Prospective cohort	Sample size –	Early childhood caries at 3.5 years	Introduction of juice and SSB before 6 months and ECC (ELFE cohort). [12]
10	Rela R et al.	2022	India / Pakistan	Cross-sectional	Children aged 6–10 yrs	Caries prevalence (DMFT)	Correlation between BMI, sugar-containing beverage intake and caries in children. [13]
11	Firdous N et al.	2025	Pakistan	Cross-sectional	Children aged 6–12 yrs	Mean DMFT = 3.5 (±2.1)	Sweetened beverage consumption, caries and oral health–related quality of life in children. [14]
12	Large et al.	2023	UK	Prospective cohort	Children aged ≤10 years	Caries prevalence (DMFT)	Consumption of beverages increases the risk of dental caries among children aged ≤10 years. [15]

Discussion

The findings of this review clearly indicate that sugary drinks—including carbonated soft drinks, sweetened fruit beverages, energy drinks, and flavored milk—are major contributors to increased dental caries in children. In contrast, the impact of 100% fruit juice remains less straightforward. All twelve included studies showed that consumption of sugar-sweetened beverages was consistently associated with higher DMFT/dmft scores, and several reported that dental decay developed rapidly among frequent consumers. As an example, [4] and [7] found that prevalence of caries among children who took

sugary drinks every day was high. The results support the already known fact that long-lasting exposure of the teeth to fermentable carbohydrates stimulates the acid production by the oral bacteria, which results in enamel demineralization and subsequent caries. Comparatively, there were more fluctuating results on 100% fruit juice. Other studies such as several NHANES data sets did not find significant relationship between moderate consumption of fruit juice and early childhood caries, especially when juice was taken with meals. This non-relation can be associated with more healthy teeth care habits, healthier food habits, or a combination of other positive life practices between the families who use 100% fruit juice. Since pure fruit juice has naturally occurring nutrients with added sugars, it could have a lower risk of caries than beverages with added sugars. Nevertheless, as long-term research has demonstrated, the regular use of fruit juice, particularly in the form of a snack or as a result of the use of bottles or sippy-cubes, may play a part in the development of caries [9]. Therefore, even though 100 percent fruit juice has some risk, it is more of a harmless drink compared with the sweetened beverages in their moderation. Socioeconomic factors and behavioral patterns are other important factors that lead to variation of caries risks. Children with poor socioeconomic status tend to have elevated DMFT/dmft scores that can be explained by the higher intake of sugary drinks, the inability to access dental preventive measures, and inferior oral health habits [22]. The consumption of sweet beverages along with poor oral care has not only been observed to cause an erosion of the dental but also dental caries. Behavioral change interventions might not be enough and more comprehensive social determinants of health should be considered at the same time [12]. The prevention measures that have been effective include limiting sugary drinks in schools and day cares, educating of parents and access to dental services. The study strength and comparability were also affected by methodological differences of studies included. The differences in assessing the diet, categorizing the drinks, caries diagnosis criteria and follow-up periods were problematic to s21ynthesis. The insufficient standardization of the differences between 100% fruit juice and sweetened juice products also restricted the interpretability of the findings, especially because assessing parental self-reported actual consumption is usually underestimated [10]. However, the overall evidence constantly leads to the conclusion that diminished consumption of sugar-sweetened drinks makes a positive impact on the oral health results of children [14]. The time constraint is another limitation of this study as the registration of PROSPERO was not done because of time restriction that might have influenced transparency and protocol pre-registration. On the whole, this is a review that indicates the importance of children having a considerable decrease in the consumption of sugary drinks as these drinks are the direct cause of the development of caries. Consumption of fruit juice is to be avoided in large amounts and it should be taken in conjunction with meals, which reduce the risk. The drinking and drinking-water policies and campaigns should be used to encourage the use of water and milk as the main beverages by children [9]. Further researches on a larger scale applying standardized research designs and extended follow-ups are required to provide a more conclusive explanation on the risk of caries with the consumption of 100 percent fruit juice [5], [6], [9].

Conclusion

Sweetened beverages are one of the leading causes of dental caries in children and have a big part in its evolution. It is also proven that these drinks promote the caries progression and raise DMFT/dmft scores. Even though it is true that 100% fruit juice has less health risks, it poses some health threats especially when taken regularly or not during meals. There exist good research facts in support of the use of soda restriction, as well as, awareness programs to emphasize the adoption of healthier drinks like water and milk. In general, this review advocates a holistic care of oral health that is informed by three main pillars, which include appropriate nutrition, effective brushing habits and supervision by the parent, and favorable health policies of the population.

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