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Review Article

Assessing long-term impact of soft drinks and acidic beverages on dental health

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ABSTRACT

Soft drinks and acidic beverages are immensely widespread, raising questions about potential long-term effects on dental health. Their high sugar content and acidic makeup demineralize enamel, erode teeth, and increase the risk of cavities. Frequent consumption weakens tooth structure and promotes bacterial growth, which accelerates decay. Due to the extensive marketing and accessibility of these drinks, their consumption has increased, especially among younger people, raising concerns about dental health. With a focus on caries development, erosion mechanisms, and preventative measures, this review examines recent studies on the effects of these beverages. Peer-reviewed research from 2016 to 2024 was selected after a comprehensive literature search using PubMed, Web of Science, and Google Scholar. The review assesses the effects of several variables on enamel deterioration and cavity formation, including pH levels, sugar content, and frequency of consumption. Important tactics like applying fluoride, altering one's diet, and using protective coatings are being researched to reduce damage. New developments in dental care, such as protective dental coatings and remineralization procedures, are also investigated as possible ways to lessen the negative effects of acidic and soft drinks. To protect long-term dental health, the results highlight the need for greater awareness and legislative measures to support better oral hygiene practices and healthier beverage choices.

Keywords: Dental erosion, Dental caries, Soft drinks, Acidic beverages

INTRODUCTION

Concern over the effects of soft drinks and acidic beverages on dental health has grown as their consumption has increased globally. The availability and affordability of soft drinks have significantly expanded over the last few decades, which has led to higher levels of consumption, especially among younger populations.[1] Since soft drinks and acidic beverages have a high acidity, sugar content, and erosive potential, they are among the most detrimental dietary factors causing oral health deterioration. These products are heavily marketed by the beverage industry, which contributes to their widespread consumption. Even though these beverages are frequently thought of as pleasant and refreshing, they have a substantial and enduring effect on oral health. These drinks often contain high levels of acids including carbonic, citric, and phosphoric acids which can erode teeth and weaken enamel. Because enamel cannot be replaced once it is gone, erosion is a serious and permanent condition. A higher risk of dental caries is also brought on by their high sugar content, which promotes

the growth of cariogenic bacteria. A very harmful environment for oral health is produced by the interaction of acids and sugars, which speeds up the deterioration of tooth structure and encourages the formation of cavities. Soft drink consumption has been directly linked in numerous studies to negative dental outcomes such as increased rates of caries and erosion.[2] Studies have also demonstrated that the frequency and timing of consumption are important factors in assessing the degree of harm.[3] For example, drinking acidic drinks all day long increases the exposure to acid, which raises the risk of tooth decay considerably. It is essential to comprehend the long-term effects of these drinks on dental health to create efficient preventative and intervention plans. Acidic drinks put some groups at higher risk of dental damage, including kids, teenagers, athletes and people with gastroesophageal reflux disease (GERD).

Young people frequently adopt eating habits that involve consuming soda and fruit juices frequently, which exposes their developing enamel to acidic challenges before it reaches full maturity. The frequent exposure of teeth to acidic and sugar-rich fluids by athletes, especially those who drink sports drinks for hydration, accelerates the rate of tooth erosion. Dental erosion is also more likely to occur in people with GERD or bulimia because of their inherent exposure to acids, which when paired with outside sources like acidic drinks speeds up the loss of tooth structure. Potential strategies to reduce excessive consumption have included public health campaigns, school-based education initiatives, and legislative changes like imposing a tax on sugar-filled beverages.[4-6]

To lessen the detrimental effects of soft drinks and acidic beverages on dental health, this review attempts to summarize the most recent research on the subject, emphasizing important discoveries and suggesting remedies.

METHODS

A thorough literature search across the PubMed, Web of Science, and Google Scholar, using medical subject headings (MeSH) and pertinent keywords like “Soft Drinks”, “Acidic Beverages”, “Dental Erosion”, “Dental Caries”, “Enamel Demineralization”, “Erosive Potential of Beverages”, “Oral Health” “Fluoride Therapy”, and “Preventive Dentistry”. Peer-reviewed, English-language, recent publications from 2016 to 2024 were included in the search, which was conducted on March 2, 2024. In vitro research, systematic reviews, and human subjects’ studies were taken into account.

Additional pertinent studies were found by manually searching the reference lists of chosen papers using Google Scholar to guarantee thorough coverage. Randomized controlled trials, longitudinal studies, and large cohort studies were prioritized, but there were no limitations on study design. Articles that only discussed the effects of soft drinks on non-dental health were not included. Study design, sample size, beverage type, pH values, sugar content, exposure time and key findings about dental erosion and caries development were among the extracted data.

DISCUSSION

Dental erosions and soft drinks

Mechanism of dental erosion

The irreversible loss of dental hard tissues brought on by chemical processes unrelated to bacterial activity is known as dental erosion. The low pH levels of soft drinks and acidic beverages cause demineralization of the enamel, which furthers erosion. According to studies, consuming these beverages for an extended period can weaken enamel's microhardness, making it more vulnerable to wear and decay. Moreover, frequent exposure to acid weakens the structure of enamel, increasing its vulnerability to mechanical harm like chewing or brushing abrasions.[7]

The acidity and pH of beverages

When the pH levels of different commercial soft drinks were compared, it was discovered that cola-based drinks had the lowest pH values (~2.5) followed by citrus-flavored sodas (~3.0) and energy drinks (~3.5).8,9 Because they can dissolve hydroxyapatite, the main mineral component of enamel, beverages with a pH lower than 5.5 are regarded as erosive. Regularly consuming extremely acidic beverages without practicing proper oral hygiene (such as waiting before brushing or rinsing with water) greatly accelerates the erosion of enamel.

Because saliva naturally buffers acids and remineralizers enamel, too much acidic drink can overwhelm this defense mechanism and prevent adequate remineralization. In the long run, this results in irreversible cumulative enamel loss. Furthermore, the phosphoric and citric acids found in many soft drinks lower pH and chelate calcium from enamel further weakening its structure.[7] It is necessary to limit the consumption of acidic beverages, use a straw to reduce contact with teeth, and wait at least half an hour before brushing to give enamel time to reharden. Selecting less acidic substitutes such as milk, unsweetened tea or water can also help prevent enamel damage. Enamel can be strengthened against acid attacks and remineralizer with the help of fluoride-containing toothpaste and proper oral hygiene.[10]

Dentin and enamel softening

Prolonged exposure to acidic beverages has been shown to cause enamel and dentin to gradually soften. Since the softened enamel is more vulnerable to mechanical abrasion, frequent brushing right after consumption exacerbates enamel wear.[11] Furthermore, research suggests that the tooth's underlying structure, the dentin,

is even more susceptible to acidic attacks, which may result in long-term structural weakness and increased tooth sensitivity.[12] Underneath the enamel is dentin, which is more prone to demineralization due to its lower mineralization and higher organic content. More acid is absorbed by the exposed dentin as the enamel thins and erodes, increasing tooth sensitivity and structural weakness. Improper oral hygiene practices like brushing right away after consuming acidic beverages can hasten the loss of enamel.

To preserve the impacted teeth, restorative procedures like dental bonding, fluoride treatments or even crowns may be necessary. This can cause pain, discomfort, and long-term dental issues.[13] Avoiding excessive mechanical abrasion utilizing remineralizing dental products (like fluoride and calcium phosphate treatments) and minimizing the frequency of acidic beverage consumption are all preventive measures.[14] Chewing sugar-free gum can increase saliva production and promote natural remineralization, while drinking water right away after consuming acidic beverages can help balance pH levels. Maintaining optimal oral health and preventing irreversible dental erosion require careful management of prolonged exposure to acidic beverages.

Dental caries and sugary drinks

Sugars function in the formation of caries

Because soft drinks contain a lot of sugar, they not only damage enamel but also encourage dental cavities. Cariogenic bacteria like Streptococcus mutans use sugar as a substrate and generate acid as a metabolic byproduct, which lowers oral pH and speeds up demineralization.[15] Caries development is significantly influenced by the frequency and length of sugar exposure. Long-term sugar retention in the mouth, particularly from consuming sugary beverages during the day, feeds bacteria and prolongs the production of acid.[16]

This starts a demineralization cycle where calcium and phosphate, two vital minerals, are lost from the enamel. Caries starts to form if saliva or fluoride is unable to remineralize. Furthermore, even in the absence of bacterial activity, the phosphoric and citric acids found in soft drinks can further demineralize teeth.[7,17,18] Over time, deep caries, enamel erosion, and increased tooth sensitivity are the results of bacterial fermentation triggered by sugar and acidic exposure. It is necessary to reduce sugar intake, enhance oral hygiene habits, and select healthier beverage options to prevent dental caries linked to sugary drinks.[19] To lessen the negative effects of consuming too much sugar, use fluoride toothpaste, rinse with water after consuming sugary drinks, and get regular dental checkups.

Childhood caries and soft drink consumption

Children are especially vulnerable to the negative effects of soft drinks because of their developing teeth and eating habits. Compared to adults, their teeth are still developing and have thinner enamel, which leaves them more susceptible to acid attacks from sugar-sweetened beverages (SSBs).[20] SSBs expose teeth to constant acid production, which depletes minerals and causes tooth decay, research steadily demonstrates that high consumption of these drinks is strongly associated with childhood caries.

Long-term dental issues can result from consuming large amounts of these drinks, which are linked to a higher Decayed Missing and Filled Surfaces (DMF/S) index.[21] Research shows that kids who drink sugary drinks daily have a significantly higher DMF/S index than kids who only drink them occasionally.[22] The demineralization process is accelerated by frequent and extended exposure to sugars, particularly when SSBs are eaten between meals or right before bed. Additionally, consuming too many soft drinks as a child is frequently linked to long-term dental health issues such as irreversible enamel damage, heightened dental sensitivity, and a higher chance of needing restorative procedures in the future.[23]

Oral bacteria produce highly acidogenic plaque, which quickly erodes enamel and causes early childhood caries.[21] Compared to kids who consume SSBs infrequently, children who consume them daily are much more likely to develop cavities. Parents and guardians should limit sugary drinks, encourage the use of water and milk and support early oral hygiene habits like brushing with fluoride toothpaste and getting regular checkups to prevent dental caries. Children can drastically reduce their chance of getting cavities and keep healthier teeth for the rest of their lives by limiting their exposure to sugar and practicing good oral hygiene.

Studies that examine epidemiology

Frequent soft drink consumption was found to be strongly associated with an increased incidence of dental caries in adolescents in a longitudinal study.[24] According to a systematic review, people who drink more than two servings of soft drinks per day have a significantly higher prevalence of dental cavities than people who drink less.[7,25] Children who frequently drink sugary beverages before bed have a much higher rate of tooth decay than children who drink them during meals, according to another study.[26]

Techniques for prevention and mitigation

Fluorides function

To re-mineralize teeth and stop dental erosion, fluoride is essential. Research has demonstrated that by strengthening enamel's resistance to acid attack, fluoridated toothpaste and mouthwash can mitigate the negative effects of consuming acidic beverages.[27] A fluoride treatment is a crucial preventive measure for people who frequently drink acidic beverages because it

fortifies enamel and aids in reversing early demineralization symptoms.

Using of alkaline ionized water as a protective mechanism

The potential of alkaline ionized water (AIW) to stop dental erosion brought on by acidic beverages has been highlighted by recent studies.[28] Research has demonstrated that AIW can lessen enamel demineralization and balance the acidity of soft drinks. According to research, enamel that has been exposed to AIW after consuming an acidic beverage maintains a higher microhardness than enamel that has not been treated.[29] Due to its ability to restore pH balance and lessen the erosive effects of acidic beverages, AIW may be a straightforward and efficient preventive measure.

Dietary adjustments and consumption patterns

Implementing healthier consumption practices can considerably decrease the risks associated with soft drinks. Research shows that enamel erosion can be reduced by drinking these drinks through a straw, limiting how often you consume them, and then drinking water.30 Incorporating more water and milk into the diet and lowering total sugar intake can also help maintain the best possible oral health.

Dental protective coatings

More defense against dental erosion is provided by recent developments in protective coatings such as hydroxyapatite formulations and casein phosphuretted-amorphous calcium phosphate (CPP-ACP).31 An investigation revealed that using these coatings considerably lessened the enamel softening brought on by acidic beverages. These shielding substances aid in restoring enamel that has been eroded and act as a barrier to prevent further acid attacks.

CONCLUSION

There is substantial evidence that soft drinks and acidic beverages raise the risk of dental erosion and cavities, which has a substantial long-term effect on dental health. These drinks' acidic content erodes enamel, their high sugar content encourages the growth of bacteria, and the development of cavities. To lessen these effects, preventive actions like applying fluoride, changing one's diet, and applying protective coatings are crucial. More research is required to evaluate the efficacy of novel remineralization agents in shielding enamel and dentin from acid attacks as well as to investigate new approaches for reducing dental damage brought on by consuming acidic beverages.

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