

Early childhood caries: A current perspective

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Abstract

Early childhood caries (ECC) is a significant public health concern, affecting children globally. Despite preventive measures, the prevalence of ECC remains high, especially in underprivileged populations. This study aims to explore the etiology, risk factors, and prevention strategies associated with ECC, as well as to evaluate current treatment approaches for managing ECC in pediatric patients. This review is based on an extensive analysis of existing literature, including epidemiological studies, risk assessment tools, and treatment modalities for ECC. Sources were gathered from peer-reviewed journals, dental health organizations, and relevant clinical trials. Key aspects examined include microbiological, dietary, and environmental factors contributing to ECC, and an evaluation of preventive and therapeutic interventions. ECC is prevalent worldwide, with varying rates across regions. The etiology of ECC is multifactorial, with primary causes including the presence of cariogenic bacteria (e.g., *Streptococcus mutans*), frequent consumption of fermentable carbohydrates, and inadequate oral hygiene. Additional factors, such as prolonged breastfeeding, socioeconomic status, and maternal health, also play significant roles. Preventive strategies like fluoride application, dietary counseling, and maternal oral health care are crucial in reducing ECC incidence. Treatment options range from non-invasive approaches, such as fluoride varnish and silver diamine fluoride (SDF), to invasive interventions like the Hall Technique and pulpotomy for severe cases. ECC remains a pervasive challenge in pediatric dentistry, with high costs and negative impacts on children's quality of life. Early prevention, parental education, and individualized treatment plans are essential to mitigate the effects of ECC. Future research should focus on enhancing risk assessment tools and developing more cost-effective, accessible treatments to address ECC globally.

Keywords: Early childhood caries, caries etiology, preventive dentistry, risk assessment

1. Introduction

Early Childhood Caries (ECC) is defined as the presence of one or more decayed (cavitated or non-cavitated), missing (due to caries), or filled tooth surfaces in any primary tooth of a child aged 6 years or younger. The American Academy of Pediatric Dentistry (AAPD) states that in children under 3 years of age, the presence of any sign of smooth surface caries or a decayed, missing, or filled surfaces (DMFS) score of four or more at age 3, five or more at age 4, or six or more at age 5 is considered severe early childhood caries (S-ECC) (1).

Despite increased preventive strategies, ECC, previously referred to as baby bottle tooth decay, remains a significant chronic disease in childhood and a public health issue (2, 3).

Over the course of time, dental caries in preschool children has been referred by different names and linked to different causes. The terms "Comforter Caries" and "Milk Bottle Mouth" were used in 1911 and 1962, respectively, to describe dental caries in preschoolers. Throughout the years, this condition has been referred to as "Baby Bottle Syndrome", "Nursing Bottle Caries" and "Baby Bottle Tooth Decay". The occurrence of dental cavities in preschoolers is frequently attributed to poor bottle feeding (4). Due to factors such as the multifactorial nature of this disease's etiology and the inability to link bottle use with ECC, there was a shift towards the use of the term ECC following the 2014 Conference (5).

Caries risk assessment (CRA) is the process of determining the likelihood of an individual patient or a group of children developing new carious lesions over a certain time period or the likelihood of changes in the size or activity of existing lesions. There are several tools available for this purpose, including Cariogram, CAMBRA, and AAPD CRA forms. However, there is still no consensus regarding the superiority and specificity of these tools used in children (4).

The assessment tool known as the Bangkok checklist (BCL), named by Tinanoff et al. and resulting from the Bangkok Global Summit, is a list that includes risk and protective factors (5). In a study, the Bangkok checklist was validated against actual caries development, and its performance was evaluated. According to the results, the accuracy of the BCL was found to be similar to that of the CRA, but lower than that of the CAMBRA (6).

2. Epidemiology of ECC

The World Health Organization (WHO) has stated that ECC is a widespread global disease that poses a significant public health issue. The American Dental Association has determined that ECC is prevalent among children in the general population and is a significant public health issue in unprivileged populations (1). Furthermore, ECC poses a financial burden on both

families and society. In particular, ECC treatment under general anesthesia for primary dental treatment is notably expensive. However, the significance of ECC has been overlooked in the past, as primary teeth are exfoliated during a child's development (7). According to the presented summary report by Tinanoff et al., the results of 72 studies conducted in different regions between 1998 and 2018 have been summarized, and the following findings were recorded: the prevalence of ECC in 4-year-old children was found to be 12% in a study conducted in France and 98% in a study conducted in Australia. Additionally, the prevalence of ECC in children aged 1, 2, 3, 4, and 5 years was determined to be 17%, 36%, 43%, 55%, and 63%, respectively (4, 8).

The World Health Organization (WHO) reports that the prevalence of ECC varies by continent as follows: Africa has a prevalence of 30%, the Americas 48%, Asia 52%, Europe 43%, and Oceania has the highest prevalence at 82% (8).

Health surveys conducted in Turkey on children aged 0 to 6 years in 2010, 2015, and 2019 revealed that 7.8%, 9.3%, and 6.4% of them, respectively, experienced oral and dental health issues (9).

According to the results of a study conducted in the Thrace region of Turkey, which included children aged 18 to 71 months, the prevalence of ECC was found to be 81.9%, with a noted increase associated with age (10). In studies conducted in İzmir and Erzurum, two different sociodemographic regions of Türkiye, the prevalence of caries at age six was found to be 44.8% and 76.6%, respectively (11, 12). According to another study conducted in Erzurum in 2021 with 1156 children, the prevalence rate of ECC was 73% (9).

3. Etiology of ECC

Several factors influence the etiology and pathogenesis of dental caries. These factors are known to include the host (teeth), cariogenic microorganisms, diet, and certain environmental factors (13). Previously, dental caries has been considered as an infectious condition, necessitating the elimination of the causative microorganisms from carious tissues, mainly bacterially contaminated and demineralized dentin, for effective treatment. Conversely, the modern interpretation of caries characterizes it as an ecological disruption within the dental biofilm, wherein acidogenic and aciduric bacteria become more competitive owing to frequent carbohydrate consumption, leading to their eventual predominance in the biofilm (14).

3.1 Microbiological factors

While *S. mutans* has long been regarded as the main cause of dental caries, DNA and RNA studies have identified interactions among a greater number of microorganisms in the oral environment in addition to *S.*

mutans. Bacterial species such as *Provetella*, *Neisseria*, *Veillonella*, *Fusobacterium*, and *Porphyromonas* are some of the dominant species found in different regions of the oral cavity (13).

Proteomic analysis studies of salivary proteins have shown that the expression of different proteins increases depending on the various stages of caries. The reason for this is that proteins play roles in different metabolic processes. Similarly, in the proteomic analysis of saliva from children without caries, it is thought that the increased expression of certain proteins may be related to low carbohydrate intake (14).

Another opportunistic pathogen, *Candida albicans*, is a type of fungus that, together with *S. mutans*, plays a role in the development of dental caries in children with ECC. Although it has both antagonistic and synergistic interactions with *S. mutans*, the exact nature of these interactions is not yet fully understood (15).

Children with oral *C. albicans* have a significantly increased likelihood (>5 times) of developing ECC compared to those without *C. albicans* (16). In addition, a higher proportion of active carious lesions and more severe dental caries are associated with an increased total amount of *C. albicans* and *S. mutans* in the supragingival dental plaque of children with ECC (17). Understanding the multifactorial nature of ECC allows for the development of caries prevention practices and treatment strategies, as well as the improvement of oral hygiene (18).

3.2 Dietary factors

The presence of microorganisms in the oral environment is inadequate for the development of dental caries. Fermentable carbohydrates are an important nutritional category that modifies the oral microbiota. The intake of these nutrients results in the formation of byproducts, especially lactic acid. When consumed with high amounts and frequency, these acids can surpass the buffering capacity of saliva, resulting in a decreased local pH. This alteration encourages the growth of acidogenic and aciduric bacteria, leading to alterations in the oral microbiota.

Over time, these ecological shifts can lead to the formation of dental caries (19, 20). Studies have shown that high and frequent consumption of free sugars, especially sugary drinks, is correlated with the development of (ECC) (21). Similarly, it has been reported that reducing free sugar consumption is important for minimizing the risk of caries throughout life (22).

Although there are different interpretations regarding the duration of breastfeeding in the literature, which is an essential factor in ECC risk, according to systematic reviews, breastfeeding up to 12 months has a protective effect against dental caries, but breastfeeding beyond 12 months and nocturnal feeding may increase the risk of ECC (23). A direct correlation exists between breastfeeding for 24 months or longer and the severity of

dental caries in the primary dentition (24). However, due to the multifactorial nature of dental caries, dentists and parents should jointly assess the patient's feeding routine, frequency of sugar intake, fluoride use, and oral hygiene when the breastfeeding duration exceeds 12 months (25, 26).

3.3 Environmental factors

Oral hygiene deficiency increases the risk of ECC development. Families should receive oral care education as soon as their baby's first teeth erupt, and tooth brushing should be initiated (27). Socioeconomic factors, such as ethnicity, parental education level, particularly the mother, low family income, low birth weight, and maternal smoking, are often associated with ECC (4, 28). Children from families with low socioeconomic status have been found to have a higher risk of developing dental caries than children from families with higher income levels (29).

Another factor as influential as the family's socioeconomic status is the trauma experiences that parents faced during their childhood. A recent study has shown that childhood trauma experienced by individuals affects their children. It has been noted that the ACE scores of parents of children with ECC are higher compared to those of parents with caries-free children (30).

In addition to these, dental-related factors should also be considered among the environmental factors. Some structural changes in the tooth surfaces that bacteria in the mouth can adhere to, such as hypoplasia or enamel defects, are factors that alter the qualitative or quantitative properties of the enamel and, consequently, increase the risk of cavities. Low birth weight and preterm birth have been associated with the presence of hypoplastic enamel defects in teeth (31, 32).

Saliva is another one of the defense mechanisms within the oral cavity, and multiple parameters related to saliva significantly affect the risk of caries. The flow rate, quantity, and buffering capacity of saliva significantly influence this risk (13).

According to a study conducted on 64 children aged 24 to 71 months, children with ECC had lower saliva flow rate, buffering capacity, and pH compared to caries-free children, while their sIgA levels were found to be higher (33).

Another salivary marker, the gene coding for the enzyme alpha-amylase (AMY), which is responsible for the digestion of polysaccharides, shows wide variability in copy number across individuals (34). AMY1GCN has a significant impact on the total number of cavities and the severity of caries. Research has shown that an increase in alpha-amylase enzyme activity, meaning an increase in gene copy number, may lead to an increase in dental caries in children. However, some studies have indicated that low amylase activity is effective in early childhood caries, which contradicts these findings (35).

4. Treatment of ECC

The management of ECC is crucial because dental caries may progress to the pulp, resulting in discomfort and infection. Suboptimal primary dentition negatively affects children's dental health and can also affect their masticatory function, nutritional absorption, cognitive development, growth, and quality of life (36). Despite global attempts to manage the condition, the prevalence of untreated cavities remains increased, and addressing its consequences costs substantial financial expenses (37). Furthermore, ECC serves as a prognostic factor for the development of carious lesions in permanent teeth (38). Effective caries management involves early detection of lesions, accurate diagnosis, assessment of caries activity and risk, and prevention of future carious lesions (39).

According to the AAPD, ECC prevention strategies should begin in the infancy stage. Educating parents or caregivers includes preventive practices, such as limiting sugar intake, avoiding bottle feeding or sugary drinks before bedtime, refraining from frequent and nighttime breastfeeding after 12 months, and brushing the child's teeth twice daily with a smear of fluoridated toothpaste. For infants at high risk of dental caries, professionally applied fluoride treatments should be included as part of an individualized preventive plan, especially for communities that do not have access to fluoride (40).

5. Prenatal oral health care

Maternal oral health literacy, attitudes, and behaviors are associated with the risk of infant caries. In traditional health education models, it is hypothesized that providing oral hygiene and/or dietary advice to mothers will improve the oral health outcomes of children by changing their behavior (dietary choices and oral health hygiene practices) and interest in engaging with dental services. Similarly, mothers improving their own oral hygiene practices may reduce caries in their offspring both by reducing maternal bacterial load and by modeling behavior. Providing mothers with information and/or free or low-cost fluoridated toothpaste may optimize their infants' exposure to fluoride, which is strongly associated with reduced caries risk (41, 42). Dental treatment should be performed before pregnancy to prevent the occurrence of dental diseases during pregnancy. Dental history, including diet and fluoride use, pre-existing oral conditions, current oral hygiene habits, tobacco, and other substance use, should be recorded. During pregnancy, women are advised to consume a balanced diet with high-quality proteins, trace elements, and vitamins. Folic acid, choline, and omega-3 fatty acids are also required (43).

According to studies conducted in Japan, health education provided to pregnant women as part of antenatal health services has been shown to be an

important step in preventing early childhood caries (ECC) (44). Similarly, reducing the transmission of mutans from mother to baby plays a significant role in ECC prevention strategies. Xylitol is a sugar alcohol that reduces extracellular polysaccharide production. Studies have demonstrated the effect of regular xylitol chewing by the mother on the transmission of *S. mutans* to infants (45).

6. Non-invasive intervention

Non-cavitated lesions can be managed by biofilm removal (tooth brushing), remineralization, or sealing. Fluoride is a commonly used preventive agent for dental cavities. Fluoride products, including fluoridated water, mouthwash, standard toothpaste, and prescription toothpaste, play an essential role in preventing dental cavities. The main mechanisms of fluoride efficacy against dental cavities are the reduction of enamel solubility and improvement of its remineralization (14). The most commonly used agents for professionally applied fluoride treatments are five percent sodium fluoride varnish ([NaFV]; 2.26 % F, 22,600 ppm F) and acidulated phosphate fluoride ([APF]; 1.23% F, 12,300 ppm F) (46). Silver diamine fluoride (SDF), which is bactericidal, is used as an antimicrobial agent to arrest caries. The application of the SDF is a cost-effective, simple, and noninvasive approach to the prevention of dental caries. The action of SDF has been shown to increase the microhardness of carious dentin lesions and the elemental content of carious enamel lesions (47). Abdellatif et al. reported that the combination of SDF and NaF showed an improved arrest rate compared to SDF alone, with this difference being significant in moderate lesions but not in more severe ones (48).

A meta-analysis indicated that probiotic conditioning has a beneficial impact on managing dental caries, as well as reducing salivary counts of *S. mutans* and *Lactobacillus* in children (49, 50). Additionally, studies have shown that probiotics play a proven role in supporting oral flora and can be recommended for children identified as having a high risk of caries (51).

7. Minimal invasive intervention

Fissure sealants are used for occlusal lesions; nevertheless, alternative sealing procedures or resin infiltration can be used for proximal or smooth surfaces with pits (39). The AAPD stated that fissure sealants reduce caries by 76% (46). The results of a study by Jorge et al. showed that resin infiltration effectively controlled proximal carious lesions in first molars after 2 years, even in patients at high caries risk (52).

Restorative treatment for primary teeth is essential for the oral health management of children, providing

acceptable functional and cosmetic conditions until tooth exfoliation occurs.

Atraumatic restorative treatment (ART) is a minimal intervention technique that simplifies the restorative process by using only hand devices, thereby reducing anxiety and pain, and infrequently requiring local anesthesia (53). Glass ionomer cement (GIC) is the optimal material for ART performance. Calcium or strontium aluminofluoro-silicate glass particles and a water-soluble polymer are the components of glass polyalkenoate cement (GIC). Fluoride release from glass ionomer cement seems to be advantageous for atraumatic restorative treatment. The fluoride produced by glass ionomer cement increases the resistance of dental structures, such as enamel and dentin, to acidic attacks by microorganisms (54). A randomized, split-mouth clinical research by Faustino-Silva DD et al. showed that caries activity was well treated over a four-year period, with 94.7% of the children presenting no disease activity.

Silver modified Atraumatic restorative treatment (SMART) is a technique that combines the use of SDF and GIC restorations. This method combines the ability of SDF to eliminate bacteria with that of GIC to protect the tooth and reduce the amount of nutrients that are essential for bacterial growth. SMART may not only prevent cavities but also enhance enamel remineralization while conserving the pulp vitality. Aly AAM et al. reported that there was no statistically significant difference in the clinical efficacy of occlusal restorations between the SMART and ART groups after the 6 and 12-month follow-up periods (55).

Interim therapeutic treatment is advised when obstacles exist to achieving appropriate dental treatment. This issue could be related to cavity preparation, repair, or the patient's oral condition. Teeth treated with ITR need to be replaced with more permanent restorations within six months to prevent an increase of oral bacterial load to pre-treatment levels. The application of GIC in ITR reduces the presence of cariogenic bacteria and helps neutralize the oral flora (54).

8. Operative management

Hall Technique (HT) used preformed metal crowns (PMCs), in which PMCs were cemented using glass-ionomer (luting) cement over carious primary molars. The technique was different because it was free of carious tissue removal, dental preparation or local anesthesia (56). In a randomized controlled trial, the 36-month follow-up reported a 93.4% survival rate for occluso-proximal dentin lesions in first molars treated with HT restoration, compared to 32.7% with ART restoration (57).

Lesions involving the pulp can be treated with partial pulpotomy, pulpectomy, or tooth extraction. Determining the pulpal status consists of a combination

of clinical and radiographic assessments, encompassing clinical symptoms, presence of abscess, mobility, and radiographic evaluation of furcation or periapical pathology (58). In cases of S-ECC, extraction is necessary when vital and nonvital pulp treatments cannot be performed (59).

Clinicians face numerous challenges when planning operative interventions for severe ECC. The morphology of primary teeth differs from that of permanent teeth, as they have larger pulp chambers and a thinner enamel-dentin layer, which accelerates the caries process, potentially leading to pain and pulp complications. Additionally, the pain and fear caused by ECC during emergency dental care can negatively affect the child's future oral health-related quality of life. Young children are often immature and pre-cooperative, requiring sedation or general anesthesia, and the decision-making process is more complex because parents are responsible for their child's care (60).

9. Conclusion

In summary, ECC is a critical public health concern characterized by complex etiology and treatment difficulties, necessitating early preventative methods, efficient management, and individualized interventions to reduce its lasting impact on children's oral health and quality of life.

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