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Exploring the Risk Factors behind Early Childhood Caries

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Abstract

ECC is a critical global health challenge affecting young children. The aim of this study is to assess the potential association of infant feeding practices, breastfeeding and its duration, and such other factors as socio-demographic determinants and maternal influences with the risk of early childhood caries (ECC) among young children (2 to 5yrs). The methodology consists a critical review of the existing literature, which was obtained through an electronic search of Pub Med, MEDLINE, Canadian Best Practices Portal, and UNBC library electronic databases. The review reveals that cariogenic diet, low socioeconomic status, parental influences and feeding habits are potential risk factors for development of ECC. However, there is lack of information about factors such as the effect of, day time v/s night time breast feeding or bottle feeding, quantity and quality of breastfeeding, specific characteristics of poverty associated with ECC, and the effect of both prenatal and postnatal smoke. The study concludes that the existing

literature is characterized by numerous conflicting reports and unanswered questions regarding the aetiology of the disease. In effect, there is a need for substantive research to identify the specific characteristics of each factor that contributes to or causes ECC.

Key words: Early Childhood Caries, infant feeding, dietary habits, maternal smoking, breastfeeding, socio-demographic factors, behavioural factors, young children.

Introduction

Early Childhood Caries (ECC) is defined as “the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries) or filled tooth surfaces in any primary tooth in a preschool-age child between birth and 71 months of age” [1]. ECC has several unique characteristics in clinical appearance such as lesions that develop rapidly, affecting a number of teeth often soon after they emerge in oral cavity. These lesions involve tooth surfaces that are usually considered at a low risk of caries development.

Although ECC is not a life-threatening disease, its impact on individuals and communities is considerable, resulting in malocclusion of permanent teeth, phonetic problems, lower self-esteem, and a poor parent-children quality of life [2]. Furthermore, infants with ECC grow up at a slower pace as compared to caries-free infants, and they may be severely underweight owing to their avoidance of eating because of caries-inflicted pain [3]. Thus, ECC is a major problem from the perspective of infants' health as well as a concern for families that are faced with the sufferings of their young children.

Prevalence of Early Childhood Caries

In the current scenario, ECC is of epidemic proportions in developing countries [4]. It is the most common chronic childhood disease in young children with the prevalence rate five times that of asthma and seven times more than hay fever, and is more common than rubella, mumps, measles and chicken pox [5].

According to the 2007 Report by the CDC (the most current report to date), cavities have

increased for toddlers and preschoolers. Cavities in children aged between 2 and 5 increased from 24 percent to 28 percent from 1988-1994 to 1999-2004 in both developed and developing regions of the world, including North America, South America, Europe, Australia, Asia, and the Middle East.

Objective and purpose of the study

As such, the aim of this study is to assess the potential association of infant feeding practices, breastfeeding and its duration, and such other factors as socio-demographic determinants and maternal influences with the risk of early childhood caries (ECC) among young children (2 to 5yrs) by critically reviewing the previously published research literature. All these variables or risk factors have been described separately in number of research papers, but there is a clear need for discussing them all together to create a more comprehensive picture. The central question of this review is: “What are the risk factors for early childhood caries in the deciduous teeth of a child aged 2 to 5yrs?”

Significance of the study

Better knowledge of the risk factors associated with ECC will help develop effective prevention strategies to reduce disease risks, initial and long-term dental treatment costs as well as the pain and sufferings of the affected children.

This review will also help identify the strategies to motivate parents to prevent ECC because parents’ lack of knowledge in this regard, compounded by their improper paediatric oral health and feeding practices, could negatively affect the growth and development of the infant.

Method

Literature search plan

To identify the previous literature pertinent to the above issues (Early Childhood Caries process, factors affecting dental caries initiation, and progression), an electronic search of Pub Med, MEDLINE, Canadian Best Practices Portal, and UNBC library electronic databases was

carried out using the following search strategy: Early Childhood Caries AND (infant feeding, dietary habits) OR (maternal smoking) OR (breastfeeding) OR (socio-demographic factors) OR (behavioural factors). In addition, the reference lists in articles were also considered. The initial screening was based on the title and abstract. The final screening consisted of evaluation of full-text reports and assessment of studies that could meet the inclusion criteria. The retrieved studies were confined to articles including children aged below 5 years.

Inclusion and exclusion criteria

- **Types of publications:** Research reports and articles were covered, with the exclusion of review papers.
- **Type of studies:** The studies included for review were not limited to any specific category. The data from various cross sectional, case control and cohort studies were incorporated in review.
- **Age of children:** Studies included children below five years of age.
- **Geographical areas:** The selected research reports were not restricted to any particular geographical area or country, while the data from numerous studies conducted worldwide were used in this paper.
- **Language:** Reports published in English, Japanese, Hindi, and many other languages were reviewed.

Conceptual framework

The purpose of this paper is to provide a critical review of the literature pertinent to the ECC risk factors. After a critical evaluation of the literature and reporting of the existing data, knowledge gaps will be identified and conclusions will be drawn for each influencing variables (factors) summarizing the available evidence.

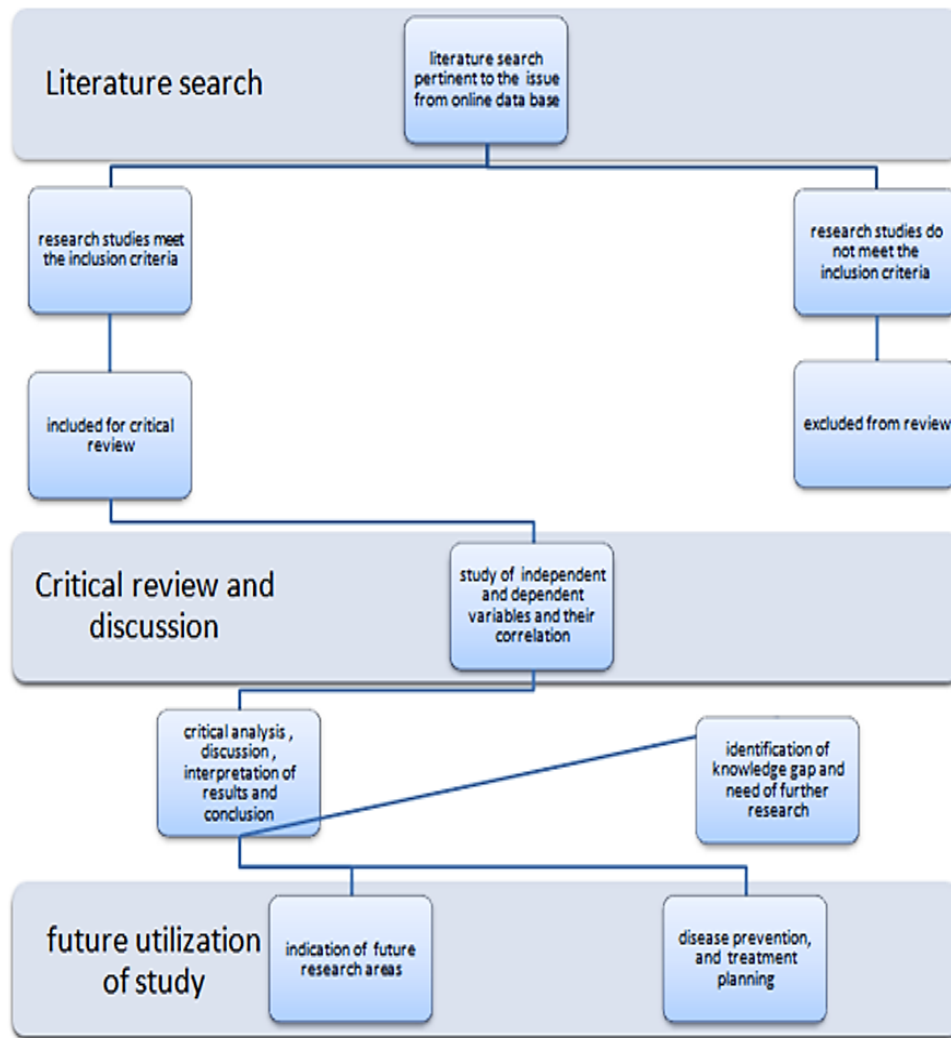


Figure (1): Conceptual framework of the review

Etiology

Early Childhood Caries (ECC) is regarded as an infectious, contagious, and multi-factorial disease produced by three primary individual factors: cariogenic microorganisms, cariogenic substrate, and susceptible host (or tooth). These factors interact in a certain period of time, causing an imbalance in the demineralization and remineralisation between tooth surface and the adjacent plaque (biofilm). Thus, the main players in the aetiology of the disease are: a) Cariogenic bacteria, b) Fermentable carbohydrates, c) Susceptible tooth and host, d) Time. However, while the general aetiology of ECC appears similar to that of other types of caries, the predisposing factors are still unclear. The biology of ECC may be modified by several factors

unique to young children, related to the implantation of cariogenic bacteria, immaturity of the “host defence systems” as well as “behavioural patterns associated with feeding” and oral hygiene in early childhood [6].

In addition to this etiological triad, there are other influential factors in the social and physical environment of children, including parental influences, socioeconomic status, ethnicity, culture and community influences, and other environmental determinants which impact caries' formation or prevention. Moreover, these factors do not act in isolation but rather operate via complex multilevel interactions. The strength of the association of these factors as well as the operational pathways in which they function determines the overall caries outcome. Influencing factors are expressed at the individual parent or family, and community levels. Based on the previous research findings, below is the brief description of potential risk factors.

Infant feeding practices

- **Cariogenic diet:** The diet that primarily contains a high level of sucrose plays a significant role in the advancement of caries, while other dietary sugars such as fructose and glucose, along with various fermentable carbohydrates (i.e. refined flour), also contribute to caries' development process.

According to the findings of a cross-sectional study, which was aimed at investigating the relationship between sugar exposure and caries risk, high levels of total sugar exposure (OR = 5.45) showed a significant association with ECC ($p < .05$). These findings supported the conclusion that dietary sugar experience influences the microbiological composition of dental plaque and leads to caries development (Thai's A. et al., 2007). Two other cohort studies of preschool children (observing them from 1 up to 5 years) reported that daily consumption of sugar-containing drinks, especially during night, and daily sugar intake acted as independent risk factors for ECC [7,8].

Moreover, it is not only the amount of sugar in the diet which determines the caries

development but also the frequency of sugar intake. Studies conducted in respect of preschool children have reported that the frequency of sugar consumption, particularly in between meals, is highly associated with caries.

- **Bottle feeding:** Several laboratory based studies prove that milk is least acidogenic drink (minimum PH6.3) among various other snack food and drinks tested. But the addition of sucrose or lactose to the milk decreases the PH and makes it more acidogenic. In an experimental study with rats, Stephan, RM [9] showed that milk given to rats along with a non-cariogenic diet did not produce caries but when it was combined with a cariogenic diet including 66% sucrose, a low caries effect was found.

To investigate the potential relationship between prolonged bottle feeding and early childhood caries, several epidemiological studies with various experimental designs have been carried out. Some of the studies show a significant relationship between prolonged (specifically night time) bottle feeding and development of ECC, while others do not.

- **Breast feeding:** Epidemiological data on infant feeding practice particularly breastfeeding and caries risk are quite limited and inconclusive. The World Oral Health Report [10]states that “...breast milk prevents the occurrence of rampant early childhood caries.” In support of the above statement, researchers from the University of Athens suggested that breast milk may contain antibodies that inhibit the bacteria that cause tooth decay whereas the cross-sectional National Health and Nutrition Examination Survey (NHANES) findings do not support the paradigm that breast milk prevents ECC. However, NHANES data provide no evidence that breastfeeding or its duration is independently associated with an increased risk for ECC.

On the other hand, W.H. van Palenstein Helderma’s [11] retrospective cohort study and some other cross sectional studies [12,13] on ECC and associated factors revealed that a higher exposure time to breastfeeding significantly increased the children’s risk of developing ECC. Therefore, the literature pertinent to this issue is inconclusive.

Socioeconomic status

Other than feeding and dietary habits, family socio-economic status (SES) also influences the incidence of caries development. Impact of socio-economic status has been widely studied in different age groups in association with dental caries experience. However, few studies have investigated the relationship between SES and ECC in preschool children.

A cross-sectional study identified poverty and low SES as independent risk factors for ECC [14]. Furthermore, a cross-sectional study of ECC reported that income and education are inversely associated with early childhood caries. The study found “significant linear increase in caries prevalence with decreasing SES, as measured by annual family income” [15].

In addition, a study analyzing the socio-demographic characteristics of paediatric dental caries reported that “the prevalence of preschool children with at least one decayed or filled tooth was negatively associated with the income level, showing a five times increase in caries prevalence among children from families with the lowest income level compared to the highest income group” [16].

Parental Influences

According to the findings of a study conducted by Agarwal V. et al “significant differences were found in mothers’ caries activity, high level of *S. mutans*, educational level, socioeconomic status, frequency of maternal sugar consumption, and their child’s caries experience ($P < .001$)” [17].

Several epidemiological studies demonstrated that maternal smoking is an independent risk factor for ECC. A cross sectional study in which data regarding oral health were extracted from the 1999–2002 National Health and Nutrition Examination Survey, indicated maternal smoking as an independent risk factor for early childhood caries [18]. Furthermore, Tanaka K. et al [19]. suggested that maternal smoking throughout pregnancy is associated with an increased

prevalence of ECC in children. Another cross sectional study concluded that maternal smoking is a significant factor to be considered as an additional risk indicator beyond social class when predicting caries risk in young children [20].

In addition, several epidemiological studies demonstrated that parents, with higher education background, tended to have children with reportedly less teeth decay, compared to the less-educated parents [21-23].

Discussion

Dietary factors

Critical analysis of literature suggests that a simple exposure to cariogenic foods would not be a risk factor for dental caries, but the frequent and prolonged contact of these substances with teeth would result in caries development. The strength of association between dietary factors and early childhood caries depends on frequency, timing, and amount of sugar consumption. Specific dietary factors which leads to the development of ECC include daily high sucrose intake, night-time meal/drinks, frequent consumption of sugary drinks and carbonated drinks, and amount and frequency of in- between meal snaking, especially higher number of sweetened food consumption per day.

Bottle feeding

After reviewing the literature we can conclude that “inappropriate bottle-feeding behaviours (i.e. nocturnal bottle feeding on demand, sweetened contents) increase the risk of caries development, rather than bottle-feeding solely” [24]. Previous research results do not establish a direct causal relationship between bottle-feeding and ECC. In most of the studies, the effect of bottle feeding is masked by other dietary habits such as frequent snacking and consumption of sweetened food, soft drinks and sweet liquids. These factors may be stronger determinants for caries development.

Moreover, most of the studies pertaining to bottle feeding were carried out on patients

attending dental offices or on minority groups, and did not use any random samples. Therefore, these findings can be ascribed to a unique population only. In addition, there are such methodological weaknesses as exclusion of potential confounding factors (other individual risk factors for ECC) from the study design, lack of information regarding quantity and quality of supplemental feedings, and reliance on parental recall when using detailed questionnaires. These limitations compromise the reliability and generality of the study results, requiring a cautious extrapolation of results to the general population.

Breast feeding

Literature addressing this issue is contradictory and inconclusive. Most of the previous researches are open to criticism. Poorly defined variables, exclusion of confounding factors such as the use of complementary sweetened foods and fluids, as well as the use of non-random samples constitute some of the methodological weaknesses. Moreover, most of them are cross sectional studies, which is not a proper design to study the association between breastfeeding and ECC.

Although the literature findings are contradictory, with most of the current studies do not supporting the establishment of breast-feeding as a single independent caries risk factor for ECC, caution is still needed concerning frequent and on-demand night breast-feeding, since when it is prolonged, it may be implicated in ECC development [25]. Overall, this review leads us to conclude that there is no scientific evidence that confirms association of breast milk with caries development. Moreover, this is a complex relationship and contains “several confounding variables, mainly infection caused by mutans streptococci, enamel hypoplasia, intake of sugars in varied forms and social conditions represented by parental educational and socioeconomic level” [26].

Socioeconomic status

Specific social and behavioural determinants can be considered responsible for high ECC prevalence in poor populations with low SES such as low family income, limited access to dental

care, low educational level of caregivers and their least concern for oral health and poor child rearing practices. Although it is well recognized, based on the previous research findings, that socio-economic factors influence dietary and oral health-related behaviours as well as access to dental care, it remains unclear why poor children are at increased risk of ECC. The NHANES 1999–2002 and other research reports lack information about nursing patterns as well as other potentially cariogenic factors that might have been associated with poverty such as frequency of carbohydrate intake, or personal oral hygiene habits, and the level of oral cariogenic microorganisms. Therefore, future research needs to take into account the real-life circumstances of low-income groups including their experiences interacting with the dental care system.

Parental Influences

Review of literature clearly demonstrates that low parental education level and parental smoking are significant risk factors for dental caries in young children. However, it is not possible to predict from these research results whether prenatal, postnatal, or both prenatal and postnatal tobacco smoke exposure is associated with an increased risk of ECC. This points to a need for future research to establish the possible causal nature of the association of exposures with maternal smoking in utero and postnatal and ECC.

Public health approaches and preventive measures for ECC

Infants and young children depend on parents or caregivers. Therefore, health care determinants such as ensuring proper diet, establishing good oral hygiene practices, giving access to necessary fluoride regimens, periodic dental visits, and other behaviours to prevent ECC are ultimately in the domain of parents' or caregiver's responsibility.

Thus, programs that counsel parents and caregivers, enlighten them on the importance of oral health, encourage reduction in children's sugar intake, and motivate them to adopt sound oral hygiene behaviours to decrease the ECC incidence rate. However, preventive measures cannot and will not work unless parents and caretakers actually follow the prevention methods. Therefore, there is an imperative need for collaborative efforts by health professionals (such as

dentists and paediatricians), caregivers, and the public community to ensure a three-fold solution to the problem of ECC and to make the necessary improvements in dental health care for young children that they deserve.

Conclusion

The foregoing literature review reveals numerous conflicting reports and unanswered questions regarding the aetiology of ECC. Moreover, interpretations of the results of previous studies relevant are inconclusive and limited in a number of ways. For example, information about factors such as effects of daytime vs. night time breast feeding or bottle feeding, quantity and quality of supplemental feedings and breastfeeding, and specific characteristics of poverty associated with ECC, is not available. It is not possible to predict from these research results whether prenatal, postnatal, or both prenatal and postnatal tobacco smoke exposure is associated with an increased risk of ECC. Therefore, effective preventive and treatment strategies demand further research into identification of specific characteristics of each factor that contributes to or causes ECC.

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Authors Column



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