Incidence of early childhood caries: A systematic review and meta-analysis

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Abstract
The aim was to systematically review the incidence of early childhood caries (ECC). The addressed focused question was "What is the reported incidence of ECC?" Indexed databases were searched using various key words. Five studies were included and processed for data extraction. All studies were prospective and two studies were randomized clinical trials. The number of participants ranged between 96 and 1275 children. Two studies reported the mean age of children, that ranged between 1.8 and 2.5 years (range 0.5 to 5 years). In three studies, the follow-up duration was 2 years, and in two studies the participants were followed-up till 3 and 5 years, respectively. Results from all studies reported that the incidence of ECC was significantly higher among children with caries at baseline compared with caries-free children. In conclusion, the incidence of ECC is significantly higher in children with a previous history of dental caries.

KEYWORDS
children, dental, early childhood caries, incidence, systematic review

1 | INTRODUCTION

Dental caries is a disease of the mineralized tissues of teeth (enamel, dentin, and cementum). It is caused by the action of cariogenic bacteria on fermentable carbohydrates leading to the demineralization these mineral portions and (if left controlled) disintegration of the organic matrix.¹ ³ Nearly two decades ago, the term "early childhood caries" (ECC) was suggested at a workshop that focused on the factors that contributed to the occurrence of caries at an early age.⁴ ECC is defined as the presence of at least one decayed tooth (cavitated or non-cavitated), missing teeth (due to caries), or filled dental surfaces (due to caries) in any primary tooth in a child aged 6 years or younger. Signs of smooth-surface caries in children younger than 3 years of age are indicative of severe ECC.⁵ ⁶ In general, ECC is recognized as a perturbing public health problem in developing and industrialized countries, and most caregivers agree that the child's first dental visit should be made by 1 year of age, as deciduous teeth are important and dental disease could lead to general health problems.⁴

Most studies in indexed literature have focused on the prevalence of ECC in their target populations.⁷ ¹² Results from these studies have reported a worrying prevalence rate of ECC (up to ~50%).⁷ ¹² However, there is a dearth of studies assessing the incidence rates of ECC. O'Sullivan and Tinanoff investigated the development of ECC in 142 preschool children over the age of 2 years according to a baseline caries pattern.¹³ The mean age of the children was 3.8 years (range: 3-4 years). The 2-year follow-up results showed that the mean scores of posterior decayed, missing (due to caries), and filled (due to caries) surfaces were higher in children who presented at baseline with maxillary anterior or pits and fissure caries in the primary dentition compared with children who were caries-free at baseline.¹³ The study concluded that 3-4-year-old children with maxillary anterior or pits and fissure caries in the primary dentition were at a significantly greatest risk for future caries development compared with caries-free children.¹³ Similarly, in a 3-year follow-up cohort study, Ghazal et al. investigated the incidence of ECC among 96 African American children who were approximately
The results showed that from baseline, the 2- and 3-year ECC incidence was 39.3% and 65.8%, respectively. It is therefore emphasized that the assessment of ECC incidence (and not merely prevalence) is a crucial factor that could help assess the risk for future caries development among children. To the best of our knowledge from indexed literature, a systematic review of the incidence of ECC has yet to be reported. With this background, the aim of the present study was to systematically review the incidence of ECC.

2 | MATERIALS AND METHODS

2.1 | Focused question

Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, a specific question was constructed according to the PICO (Participants, Interventions, Control, Outcomes) principle (Figure 1). The addressed focused question was "What is the reported incidence of ECC in indexed literature?"; (P, participants), it was essential for children to have undergone caries assessment at baseline and at follow up; (I, types of interventions), the intervention of interest was the assessment of caries status at follow up compared to baseline; (C, control intervention), caries-free children; and (O, outcome measures), incidence of ECC at follow up by means of odds ratios (OR).

2.2 | Eligibility criteria

The eligibility criteria were as follows: (a) original studies (clinical and epidemiological studies); (b) inclusion of a control group (caries-free children); and (c) studies with at least 1 year of follow up. Letters to the editor, commentaries, reviews, case reports, case series, and studies related to the prevalence of ECC were excluded.

2.3 | Literature search protocol

PubMed/Medline (National Library of Medicine, Washington, DC), EMBASE, Scopus, Web of Knowledge, and Google Scholar databases were searched up to and including April 2016 using different combinations of the following key words: (a) "early childhood caries"; (b) "dental"; (c) "incidence"; and (d) "children". The key words were used in the following combinations: a + b + c + d, a + b + c, a + c + d, and a + b + d. Titles and abstracts of studies identified using the above-described protocol were screened by one author (FJ) and evaluated for the stated eligibility criteria. Reference lists of potentially-relevant original and review articles were hand-searched to identify any studies that could have remained unidentified in the previous step. The pattern of the present systematic review was customized to mainly summarize the relevant data.

The initial search yielded 409 studies. A total of 405 did not fulfill the eligibility criteria and were excluded (Figure 1).

2.4 | Quality assessment

The quality assessment of studies was performed using the Critical Appraisal Skills Program (CASP) Cohort Study Checklist. The CASP tool uses a systematic approach based on 12 specific criteria: (a) study issue is clearly focused; (b) cohort is recruited in an acceptable way; (c) exposure (caries) is accurately measured; (d) outcome (incidence of caries) is accurately measured; (e) confounding factors are addressed; (f) follow up is long and complete; (g) results are clear; (h) results are precise; (i) results are credible; (j) results can be applied to the local population; (k) results fit with available evidence; and (l) there are important clinical implications. Each criterion was given a response of either "yes", "no", or "cannot tell". Each study could have a maximum score of 12. CASP scores were used to grade the methodological quality of each study assessed in the present systematic review.
In the meta-analysis, we combined results from those five studies to obtain an overall OR. For each study, we can only retract the estimated OR and 95% confidence interval. We used the method proposed by Chinn to convert the OR to effect sizes.

A linear mixed model was used to estimate the overall effect size (and standard deviation) from the studies included in the present systematic review. The estimated effect size was converted to the OR using the methods proposed by Chinn.

The statistical analysis was implemented with SAS 9.4 (SAS Institute, Cary, NC, USA).

### 2.5 | Meta-analysis

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### 3 | RESULTS

#### 3.1 | General characteristics of the studies

In total, five prospective studies were included and processed for data extraction. All were performed under university settings. The general characteristics of the studies that fulfilled the eligibility criteria are summarized in Table 1.

#### 3.2 | Quality assessment

Quality assessment results showed that all of the studies had a longitudinal design. The total quality score for each study was 10.

The most common shortcoming among all the studies was control of confounders. The quality assessment of the individual studies is summarized in Table 2.

### 3.3 | Meta-analysis result

From the literature reviewed, the five studies reported the OR with a 95% confidence interval (Table 3). The combined effect size from the meta-analysis was 0.92 (SE = 0.31, P = .04). The combined OR was 5.28, with a 95% confidence interval of 1.76-15.88, indicating that dental caries incidence was higher in children who received counseling alone compared to children who received counseling and fluoride varnish (Figure 2).

### 4 | DISCUSSION

To the best of our knowledge from indexed literature, the present study is the first to have systematically reviewed indexed literature regarding the incidence of ECC. Following an exhaustive literature search, five studies were identified. Based on the results reported in these studies, we speculated that the incidence of dental caries was significantly higher among children who had dental caries at baseline than children who were caries-free at baseline. An explanation for this is that elevated levels of cariogenic microbes...
JAVED Vet Jal (predominantly Streptococcus mutans) have been identified in the oral cavity of children with ECC. Such microbes produce abundant acid ferment carbohydrates in the oral cavity, thereby lowering the plaque pH, and if left untreated, this condition ultimately demineralizes the child’s teeth. However, it is pertinent to mention that the aforementioned results might have been skewed by confounding variables, such as underprivileged socioeconomic status (SES). It has been reported that the SES of the child’s parents/guardians during early childhood can significantly influence the child’s oral health status. Moreover, an underprivileged SES during childhood has also been associated with worse physical, psychological, and cognitive functioning. ECC has therefore been labeled as “a marker of social inequalities worldwide” by Baggio et al., who conducted a study to assess the prevalence of ECC in children living in French-speaking Switzerland, and to determine whether or not ECC was an early marker of social inequalities in Switzerland. In Baggio et al.’s study, 856 children (36-71 months old) were screened for ECC, and their parents or legal guardians filled in a questionnaire that included questions on socioeconomic background, dental care, and dietary habits. The results showed that ECC was more frequent among children from a poorer SES than children that had socially-privileged backgrounds. In a recent study, Peres et al. reported that through childhood to
adolescence, dental caries increment is associated with sugar consumption. However, in their study, the incidence of ECC in the study population was not addressed. Another factor that could influence the incidence of ECC is the education status of parents or guardians. In a recent study, Chia et al. reported that besides a deprived SES, a poor education status of caregivers also influences a child’s caries status. In all of the studies that fulfilled our eligibility criteria, the children were socioeconomically compromised. Although the education status of the caregivers was not considered in these studies, we speculated that they had poorer education statuses. We hypothesized that, had the caregivers had been educated and were socioeconomically stable, then the incidence of ECC would have been much lower than the reported values. It is therefore important to note that besides offering treatment for ECC, it is mandatory to educate caregivers, as well as children, about daily dietary patterns and regular oral hygiene maintenance. The authors of the present systematic review also suggest that routine community-based programs should be conducted in order to educate people about the significance of oral hygiene maintenance and its influence on the overall quality of life.

The findings by Weintraub et al. and Lawrence et al. demonstrated that the local application of varnish on teeth surfaces helps reduce the incidence of ECC. The expert panel of the American Dental Association has also reported that a biannual fluoride varnish application is effective in preventing caries in the primary and permanent dentition of children. However, it is noteworthy that the duration of the studies by Weintraub et al. and Lawrence et al. was only 24 months. Again, it is important to emphasize that in order to minimize the incidence of ECC, caregivers must be educated about the role of varnish toward the prevention of ECC and the dietary and oral hygiene habits that could contribute to better oral health of children.

A controversial aspect related to the risk factors of ECC is the determination of the age at which the child becomes most vulnerable to tooth decay. According to Caulfield et al., mutans streptococci is acquired between the ages of 1.6 and 2.6 years, whereas in the study by Brown et al., children as young as 11 months were infected with mutans streptococci. Although children included in the present systematic review were approximately 1.8 years old, the age ranged from 6 months to 5 years. Therefore, it is possible that there might have been younger children (≤12 months old) with dental caries at the time of follow up. Additional research is needed to clarify the precise age in which children of various caries risk acquire mutans streptococci.

5 | CONCLUSION

ECC is a global dilemma, and with the exception of oral hygiene maintenance, its incidence is associated with additional factors, such as SES and education status. As there is a lack of well-designed, randomized clinical trials assessing the incidence of ECC, further studies are warranted in this regard.

REFERENCES