

GLOBAL EARLY CHILDHOOD CARIES: A REVIEW OF LITERATURE

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ABSTRACT

Early Childhood Caries (ECC) is a major public health concern in the world. There is a high prevalence of ECC in developing countries. The review aimed to synthesise the published literature on the global prevalence of ECC and its associated factors. Researches conducted in Asian, European, American and African countries were included. The review included observational cross-sectional, case-control, cohort studies, and clinical trials. The ECC varies across countries and the continents. Several studies showed inequitable distribution of ECC within regions of a country. The result of this review provides global prevalence of ECC and associated risk factors. Despite the variation of prevalence of ECC, it remains a universal burden. Studies have demonstrated that even in developed countries, ECC represents a significant burden in preschool children. The *S. mutans* and , oral hygiene habits, breastfeeding and bottle feeding along with factors such as parental education are major risk factors for ECC. There have been limited studies conducted on ECC in Nepal.

KEYWORDS

Early childhood caries, global, prevalence, risk factors

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INTRODUCTION

Early Childhood Caries (ECC) is defined by American Academy of Pediatric Dentistry as the presence of one or more decayed (noncavitated or cavitated lesions), missing (because of caries), or filled tooth surfaces in any primary tooth in a child aged 71 months or younger.¹⁻⁴ ECC is an infectious, multifactorial disease in which fermentable carbohydrate and biofilms on the teeth induce *Streptococcus mutans* (SM).^{3,5} ECC follows a specific pattern in that there is initial presence of white spots in the facial surfaces of maxillary primary incisor followed by progressive carious involvement and subsequently affecting the maxillary and mandibular primary first molars, maxillary canines and sometimes mandibular canines.³ The possible causes of ECC are poor oral hygiene, inadequate tooth brushing, sugar consumption, and snacks and frequency of between-meal snacks.⁶ The parental socio-economic factors also have an association with ECC in children; lower social class, having lower social income, educational level and living conditions.⁷

ECC process begins as soon as the first teeth erupt in the oral cavity and develops on smooth surfaces.³ The demineralization process is similar to all types of dental caries wherein the hydrogen ions of the acidic metabolic results of acidogenic microorganisms dissolve the carbonated hydroxyapatite crystal lattice of enamel, cementum and dentin. In the deciduous dentition the caries progression is rapid as the demineralization progresses past the inorganic enamel layer to the more organic dentin layer.^{4,5} ECC manifests as pain, acute and chronic abscesses, fever and swelling of the cheek and/or lip. The sequelae does not end here but include a higher risk of new carious lesions, increase in dental treatment cost and time, emergency visits, increase in days with restricted activity, later caries in permanent dentition and malocclusion.^{3,8} It not only affects teeth and oral cavity but may lead to other extensive and progressive health issues like loss of appetite, lethargy, chewing difficulty, gastrointestinal disorders, malnutrition, delayed or insufficient growth, poor speech articulation, low self-esteem and social isolation.^{3,8} In this way, it affects the well-being and quality of life of the individual and his/her family.

Epidemiological surveys play an important role in monitoring the trends in dental caries for assessing the dental needs in a community. These surveys are essential for the development and implementation of effective oral healthcare programs.⁹ A summary of epidemiological data

for oral diseases is required to determine risk populations, respond with prevention and intervention, and plan for future.¹⁰

ECC is a major public health concern in the world. It is considered as the most widespread and unmet health need among children.⁹ Although preventive strategies have been implemented for decades, ECC remains a major problem in developed and developing countries.⁶ The aim of this review is to assess the published literature on the global prevalence of ECC and its associated risk factors.

MATERIALS AND METHODS

The search engines used were Medline, Scopus and Google Scholar. The search terms were “early childhood caries”, “preschool children”, “risk factors”, and “epidemiology”, “incidence” or “prevalence”.

Inclusion criteria: Scientific articles which reported the prevalence of ECC, the risk factors and stated the number of cases were included from Asian, European, American and African countries. The review also included observational cross-sectional, case-control, cohort studies, and clinical trials.

The articles meeting the the inclusion criteria were selected, reviewed and data were extracted. The characteristics recorded were time period, study country, study design, reference population (if any) and the prevalence of ECC. Where available, data for subtypes were extracted. Other variables such as consanguinity, or previous family history of ECC were included. The risk of bias was assessed for each individual study based on the data source, population included in the study, and any special characteristics of the population.

Exclusion criteria: Systematic reviews and meta-analysis were not considered. Case report or case series, in vitro studies, etiology and treatment of dental caries, and quality of life researches were excluded .

RESULTS

The literature search yielded 385 titles which matched the search terms. Duplicates and literature not conforming to the objectives were removed, leaving 30 studies in the review.

Prevalence of ECC

The prevalence of ECC varied from population to population.¹ Centers for Disease Control and

Prevention reported that in the United States, the prevalence of dental caries among 2–5 year-old children increased from 24.2 % in 1994 to 27.9% in 2004.^{1,5,11} The Dutch child population showed ECC prevalence of only 9.3%.³ The prevalence in Germany ranged from 26.2% to 28.6%,¹² Wales had a prevalence of ECC of 41%, England 27.9% and Scotland 33%. Similarly, Italy had a prevalence ranging from 29.8% to 43.4% and north-eastern Greece had 64.2%.¹³ Other studies showed 19% had experienced ECC⁷ and 15.99%¹⁴ in Italy. Similarly, ECC among preschool children in Kosovo was 17.36%.¹⁵

In spite of community fluoridation programs like water fluoridation, ECC has been a significant problem in many developing countries and in minority communities in western industrialized countries.³ The caries prevalence among 3-5 year-olds in Bosnia and Herzegovina was 83%. In Southern Brazil ECC prevalence was reported as 15.1%, whereas other studies in the same country showed 22.6%,¹⁶ 43.3%,¹⁷ and 54.8%.¹⁸ The same can be said for Italy where two studies showed a prevalence of 19%⁷ and 15.9%.¹⁴

A prevalence of ECC up to 85% has been reported for disadvantaged groups in developing countries.⁵ The prevalence of ECC is greatest in Far East Asia, where among 3-year-olds, it ranges from 36% to 85%.¹⁹ Clinical dental examinations of 2-5 year old Vietnamese children showed a caries prevalence of 89.1%.²⁰ A study done with Hong Kong children showed that ECC was found in 1,130 children (22%).²¹ However, in Beijing a prevalence of 49% was found.⁶ Over three years (2011-2013), the prevalence of dental caries among 3-4 year-olds rose from 59.8% in 2011 to 71.8% in 2012 and 76.4% in 2013.²² In Songkhla province, Thailand, a longitudinal study showed that the prevalence of ECC rose sharply from 2% at 9 months, 22.8% at 12 months, and 68.1% at 18 months, whereas in Suphan Buri province, ECC prevalence was reported to be 83%. Of the 0-6 year children in Cambodia, 65.6% had caries.²³ Although the western world prevalence at 3 years of age was 19.9% and for Japanese children, 25.9%.⁵ The overall prevalence of ECC in India was 49.6%. The highest prevalence was seen in Andhra Pradesh (63%) whereas the lowest prevalence was reported in Sikkim (41.92%).¹⁹ However,

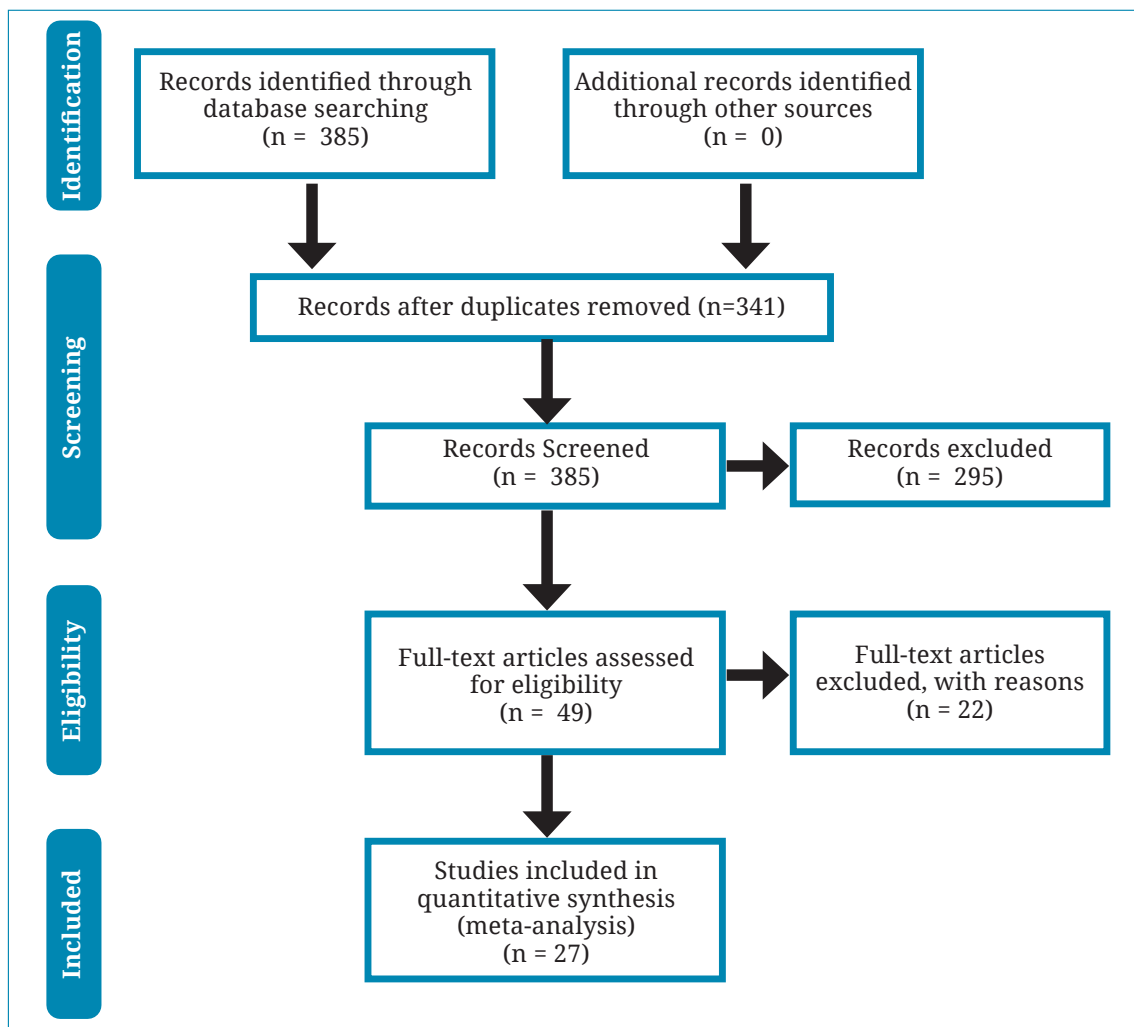


Fig. 1: PRISMA 2009 Flow Diagram

1486 South Indian children from Tiruchirapalli District in Tamil Nadu, aged 0-3 years old, showed the prevalence as 40.6%.⁹ ECC was not only highly prevalent in developing Asian countries as the developed Gulf Cooperation Council States had a higher prevalence of primary teeth caries as 80.95%.²⁴

The prevalence of caries in Qatar, a country in the Arabian Gulf region, was 89.2% where 15.6% had ECC and 73.6% had S-ECC.²⁵ In Iran, 4-7 year-old school children showed that 84.9% had dental caries.²⁶ Although there is a wide variation of ECC prevalence across countries, it remains prevalent in most countries worldwide.¹³ A study done in Lagos showed a prevalence of 21.2%; however the prevalence of ECC increased with age and for children aged 61-71 months was 35.4%.²⁷

There have been limited studies conducted in Nepal regarding ECC.²⁸⁻³¹ The ones conducted have reported a prevalence ranging from 52% to 69% among 5-6-year-old Nepalese school children.^{28,29,31-33} Among patients attending dental clinics in a teaching institute showed a prevalence as high as 85.2%.³⁴ On the contrary, similar patients attending dental clinics in another teaching institute showed a prevalence of 22%.³³

Risk factors for ECC

Microbiological risk factors: MS including *Streptococcus sobrinus* are the most common causative agents for dental caries.^{3,8,35} Although *lactobacillus* does not participate in the initiation, it aids in the lesion progression.^{3,8} MS contributes to caries formation with its ability to adhere to tooth surfaces, produce copious amounts of acid, and survive and maintain their metabolism in low pH conditions.¹¹ These organisms may be transmitted from the caregiver to the child,^{3,5,11} the major reservoir being the mother.^{3,5} The child acquires the microorganisms during a window period of two years. Mothers with dense salivary reservoirs of MS are at high risk of infecting their child very early in life. Recent studies have shown that neonatal factors may also increase the risk for early acquisition of MS by vertical transmission. Infants delivered by cesarean section acquire MS earlier than those delivered normally.^{3,5} Horizontal transmission between members of a group for example, siblings, toddlers at a nursery have also been shown.^{3,5} The MS prevalence in ECC children was 98% in a study done among preschool children in Kosovo.¹⁵

The time span between MS colonization and caries lesion development has shown to be

approximately 13-16 months. In high risk children the duration may be shorter (such as in preterm and low-birth-weight infants, with hypomineralized teeth).^{3,5,36} Frequent sugar exposure in infant and habits that allow salivary transfer from mother to infants are factors that influence colonization.¹¹ Apart from bacteria, *Candida albicans* have been associated with ECC. A systematic review indicates that children with oral *C. albicans* have more than five times higher odds of having ECC compared to those without *C. albicans*.³⁷

Dietary risk factors: Abundant epidemiological evidence points toward dietary sugar, especially sucrose, as factor for affecting dental caries prevalence and progression. Sucrose is a unique cariogenic carbohydrate in that it also serves as a substrate for extracellular glucan synthesis.¹¹ Glucan polymers enable MS to adhere firmly to teeth and to inhibit the diffusion properties of dental plaque. Frequent and prolonged consumption of sugared beverages lead to heavy infection with MS and use of nursing bottle enhances exposure to lactose. However, cow's milk in a nursing bottle has negligible cariogenicity because of its mineral content and low level of lactose.⁵ Nocturnal breastfeeding along with drinking or eating sweets after dinner every day, and the intake of candy, soda and/or isotonic drinks more than four days a week had significant positive associations with ECC.³⁸ The children who had soft drinks (24.7%) and higher frequency of consumption of sugar drinks had a significant association with ECC.²⁷

Studies show that breastfeeding in infancy may protect against dental caries upto 12 months, but higher risk of dental caries in children breastfed beyond 12 months. Hence, further research is needed to understand the increased risk of caries in children breastfed after 12 months.³⁹ There was higher caries prevalence among children who were exclusively bottle-fed (33.3%), however, the ECC significantly increased with duration of breastfeeding in that those who were breastfed for 12 months or less, the caries prevalence was 7-25% and those that were breastfed for over 13 months the prevalence was 57%. There was a statistical significant association of ECC between the children who were bottle-fed at night (51%) compared to those who were not (13%).²⁷ Bottle feeding and use of baby's pacifier at night had a significant association with caries risk.¹⁴ High-frequency feeding in late infancy along with both bottle use and breastfeeding were positively associated with ECC.¹⁸ Category of day care, bottle-feeding before sleep time, and presence of active white spots are risk factors for increased rate of caries.¹⁶ It was found that

Table 1: Summary of the findings of the studies reviewed

Reference	Country	Design	Participants	Prevalence of ECC
Weerheijm <i>et al.</i> (1998)	Netherland	Descriptive	96	9.3%
Wagner <i>et al.</i> (2015)	Germany	Clinical trial	755	26.8%
Nobile <i>et al.</i> (2014)	Italy	Cross-sectional	515	19%
Congiu <i>et al.</i> (2014)	Italy	Cross-sectional	544	15.99%
Begzati <i>et al.</i> (2010)	Kosovo	Cross-sectional	1008	17.36%
Sacic <i>et al.</i> (2016)	Bosnia & Herzegovina	Cross-sectional	165	83%
Feldens <i>et al.</i> (2018)	Brazil	Cohort	345	54.8%
Correa-Faria <i>et al.</i> (2015)	Brazil	Cross-sectional	387	43.3%
Nobile <i>et al.</i> (2014)	Brazil	Cross-sectional	515	19%
Nguyen <i>et al.</i> (2018)	Vietnam	Cross-sectional	1028	89.1%
Gao <i>et al.</i> (2018)	Hong Kong	Cross-sectional	5167	22%
Fan <i>et al.</i> (2016)	China	Case-control	787	49%
Wang <i>et al.</i> (2017)	China	Longitudinal	606	59.8% (2011); 71.8% (2012); 76.4% (2013)
Thitasomakul <i>et al.</i> (2006)	Thailand	Longitudinal	599	2% (9 months); 22.8% (12months); 68.1% (18 months)
Turton <i>et al.</i> (2013)	Cambodia	Cross-sectional	362	65.6%
Nakayama <i>et al.</i> (2015)	Japan	Survey	1675	3.3%
Henry <i>et al.</i> (2016)	India	Cross-sectional	1486	40.6%
Alkhtib <i>et al.</i> (2016)	Qatar	Cross-sectional	250	89.2%
Khani-Varzegani <i>et al.</i> (2017)	Iran	Cross-sectional	756	84.9%
Olatosi <i>et al.</i> (2015)	Lagos	Cross-sectional	302	21.2%
Yee <i>et al.</i> (2002)	Nepal	Cross-sectional	2177	67%
Limbu <i>et al.</i> (2013)	Nepal	Cross-sectional	177	22%
Karki <i>et al.</i> (2018)	Nepal	Cross-sectional	340	78.8%
Koirala <i>et al.</i> (2003)	Nepal	Cross-sectional	600	52%
Limbu <i>et al.</i> (2017)	Nepal	Cross-sectional	1445	55.6%
Khanal <i>et al.</i> (2013)	Nepal	Cross-sectional	122	85.2%
Subedi <i>et al.</i> (2011)	Nepal	Cross-sectional	313	69%

among preschool children in Kosovo most of the children with ECC represented those who were bottle fed up to the age of two; there was also statistical correlation between daily sweet consumption and ECC.¹⁵

Environmental risk factors: The environment affecting the oral hygiene habits included social status, poverty, ethnicity, deprivation, education, etc. of carers.⁴⁰ Certain parental factors influence the development of ECC in developing countries. Family size, living

conditions, parental child feeding practice, parental oral health behaviour, and parental attributes were associated with development of ECC.⁴¹ A study also has shown that mother's education was inversely related to prevalence of ECC.⁷ The caries risk increased with lower parents' educational level, increased number of siblings and mother being employed.¹⁴ Although there is widespread decline in caries prevalence and severity in permanent teeth in high income countries, there are disparities and many children still develop dental caries. Ethnic

minorities and new immigrants experience oral health disparities beyond ability to pay for care. 'Life-course epidemiology' is the name given to this relatively new area of research as there are advantages and disadvantages collected throughout life which generate differentials in health along the life course and lead to large effects in later part of life.⁵ It is debatable whether there is any association between prenatal maternal cigarette smoking and ECC.⁴²

Other contributing factors: Risk factors of primary caregivers (mothers) like high level of MS, socioeconomic status, frequency of sugar consumption have seen to be associated with children's caries experience.⁸ The socioeconomic status based on mother's level of education and father's occupation showed that there was high caries in higher socioeconomic status.²⁷ However, other studies showed that lower socioeconomic status, unsatisfactory behavioral factor and rural place of residence had significant associations with ECC.¹⁷ However, in Japan, child rearing behaviors were more strongly associated with dental caries than mother-related factors such as dental health status, health behavior, and health insurance.⁵ The results of a univariate and multivariate analysis showed a significant relationship was seen between dmft and mother's years of education, mother's employment status, and family socio-economic status.²⁶ Use of non-fluoride toothpaste, and whether mothers or caretakers examined the child's teeth have also been listed as other contributing risk factors.⁴³ Lack of access to dental care, inadequate availability of preventive measures (e.g. water fluoridation, fluoride supplement, dental sealants, etc.), and lack of knowledge of importance of teeth and oral health have been shown to be affecting factors as well.⁴⁴ Developmental defects have shown clear association with dental caries in primary dentition. Children with hypoplasia and diffuse opacities had higher odds of having dental caries.⁴⁵

DISCUSSION

This review was conducted to provide information regarding prevalence of ECC in the world and the factors responsible for it. The ECC varies from country to country and it is not even same in the same continent. Various studies have shown a difference in the prevalence of ECC in the same country but in different regions. Although ECC has been found in the general population, it is more prevalent in low socio-economic groups.³ Disadvantaged children, regardless of race, ethnicity or culture, are

the most vulnerable.¹ A 9.6% was seen among the Dutch populations whereas the Greeks showed 64.2%. The remaining countries which showed the in between these belonged to the same continent. There is a lower prevalence of ECC in developed countries than in developing countries. The only country which showed the most was Bosnia and Herzegovina which had a prevalence of 83%.

In Brazil, there was a mixed prevalence ranging from 15.1% to 54.8%. It is probably because the country is large and the population differs in different areas. The same can be said for Italy as the prevalence varied in various researches. However, in Nepal, only hospital based studies have been conducted as well as community studies focusing on 5-6 year-olds only which showed a prevalence of 22% to 80.6%. To the authors' knowledge, Nepalese children under five years have not yet been the target of ECC research.

In terms of microbiological factors, SM seems to be the primary organism followed by *S. sobrinus*. The role of SM in the etiology of ECC is very crucial as the data demonstrate that there is high prevalence of this bacterium in preschool children. The presence of higher counts of this bacterium were found in children with ECC. The high salivary counts of SM has been correlated with high caries count and has been demonstrated in various studies. Although *C. albicans* has been shown to be associated with ECC, further cohort studies are needed to determine whether they could be risk factor for ECC and whether it is dependent on different saliva/plaque sample sources.

Significant factors in the etiology of ECC is breast and bottle feeding. Investigations have shown that the relationship between bottle feeding and high salivary counts of SM.¹⁵ Another harmful practice is putting children to sleep with bottle feeding. On the other hand, the cariogenicity of human milk is controversial, suggesting breast feeding for longer than one year and at night may be associated with increased prevalence of dental decay.^{3,36,46} Breast feeding and its duration were independently associated with increased risk for ECC and greater number of decayed or filled tooth surfaces.^{5,23}

When oral hygiene is established at the age of one year, it can be maintained throughout early childhood.¹⁵ It is very important to have mothers' or parents' cooperation in disabling the belief deciduous dentition can be ignored. The importance of primary dentition in oral health promotion must be focused on the education of mothers to motivate their children

for oral hygiene.¹⁵ A review highlighted parental attributes, attitudes, knowledge and beliefs as associated factors with ECC.⁴⁷ Another review pointed out the key risk indicators as infant feeding practices, maternal circumstances and oral health, and infant-related oral health behaviours.⁴⁸ Children who have already experienced dental caries⁴⁹ and whose primary caregiver and siblings have severe dental caries are also regarded as being at risk for ECC. In addition to this, the children's experience of socioeconomic disadvantage affect adult dental health.⁵

The results of this review paper provide additional information about the global prevalence of ECC and the risk factors

associated with the disease. The prevalence varied in developing and developed countries. The S. mutans and other various microorganisms along with oral habits, breastfeeding and bottle feeding along with other factors like parental education are major risk factors for ECC. The review demonstrates that even in western countries, ECC represents a significant burden in preschool children. Pediatricians and more specifically dental practitioners should play an effective role in the prevention of ECC. There have been limited researches conducted in Nepal regarding ECC and they need to be done.

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