Risk factors for Early Childhood Caries in Italian preschoolers: A cross-sectional analysis


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DOI 10.23804/ejpd.2024.2289

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Abstract

Aim Early childhood caries (ECC) represent a relevant public health issue in paediatric population globally. The current study aimed to investigate the main risk factors of this condition.

Study design and methods This is a cross-sectional study carried out at the Child Dentistry Clinics of the Istituto Stomatologico Italiano, Milan, Italy, including patients aged 12-71 months and their parents. Demographical data, anthropometric measurements, oral hygiene and health assessment, and children's eating habits were collected.

Results An ECC prevalence of 72% was found. Oral hygiene practices resulted inadequate. Moreover, we found fruit juice consumption among children's eating habits higher than 3 times/week. Mother's educational level, prenatal passive smoking, child's eating behaviour such as the introduction of sugar-sweetened beverages (SSBs) before the age of 12 months and the number of SSBs drunk before the age of 24 months, and child's oral hygiene in terms of the start of teeth brushing (i.e., after 12 months of age) were correlated to dmft. The binomial logistic regression analysis confirmed a positive association between dmft and the mother's educational level (OR=2,36, CI 95%= 1,26 - 4,4, p=0,007).

Conclusion Our findings, according to recommendations, suggest that the prevention of ECC needs to begin in infancy. Oral health providers, physicians, nurses, and other health care personnel play an important role in educating parents about their child's oral and dental care and food choices.

KEYWORDS Early childhood caries, sugar-sweetened beverages, breastfeeding, maternal education, oral hygiene.

Introduction

Early childhood caries (ECC) is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing, or filled (due to caries) surfaces in any primary tooth of a child under six years of age [Drury et al., 1999]. ECC represents a relevant disease in the paediatric population worldwide, affecting 48% of global preschool children [Uribe et al., 2021]. In Italy, research conducted in 2018 on 3000 children aged between 0 and 71 months showed a prevalence of caries equal to 2.9% in subjects aged 0–23 months, 6.2% in those 24–47 months, and 14.7% in those 48–71 months [Colombo et al., 2019]. Consequences on health and quality of life can be numerous and severe, such as dental malocclusion, progression of tooth decay, enamel defects, pain, dental emergencies, potential changes in growth and development, difficulty sleeping, low academic performance, etc. Traditional microbial risk markers for ECC include Streptococcus mutans and Lactobacillus species [Kanasi et al., 2010; Liu et al., 2019]. ECC is an infectious disease characterised by vertical transmission (from parents to child) and horizontal transmission (between members of a group) [Poureslami and Van Amerongen 2009]. Furthermore, ECC shares common risk factors with other non-communicable diseases (NCDs), such as cardiovascular disease, diabetes, and obesity. In particular, the high consumption of sugary food and beverages increases the risk of overweight/obesity as well as tooth decay in paediatric populations [Fidler et al., 2017; Muth et al., 2019]. Additionally, the incidence of tooth decay in overweight and obese children is higher than in those of normal weight [Manohar et al., 2020]. Hence, strategies for preventing tooth decay are aimed at achieving accurate oral hygiene and adequate eating habits from childhood, i.e., limited consumption of sugar-sweetened beverages (SSBs) and refined foods [Bhoopathi et al., 2024]. In this context, parents may play a crucial role by providing their children with healthier behaviours and food choices [Minervini et al., 2023]. To date, gaps in the knowledge of behavioural factors that cause ECC in the first years of life and pre-school age exist. The current study aims to identify the main risk factors underlying ECC in the first years of life, to plan efficient and effective preventive strategies to reduce ECC onset and progression, with a specific focus on the eating habits of children up to 6 years old.

Methods

This is a cross-sectional study conducted, between June 2022 and June 2023 at the Maternal and Child Dentistry Clinics of the Istituto Stomatologico Italiano (ISI), Milan, Italy. This work was approved by the Ethics Committee of the Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan [Protocol number: 6151; Date: 13 Maggio 2022]. The inclusion criteria were: patients aged 12-71 months, belonging to the

VISUAL ABSTRACT

Summary

Early Childhood Caries (ECC) is a major public health issue worldwide. Risk factors include poor oral hygiene, delayed toothbrushing, frequent sugary drinks, high maternal education, and exposure to secondhand smoke during pregnancy. Therefore, the prevention of ECC should begin in infancy.

Study design

Cross-sectional study

June 2022-June 2023

4 questionnaires assessed children's early dietary habits, anthropometric data of children and caregivers, children's eating behavior (CEBI), and the oral hygiene of both children and caregivers

Population

children & parents	children aged	mean age	
171	12-71 months	54 months	42 % female

patients referred to Child Dentistry Clinics of the Istituto Stomatologico Italiano, Milan, Italy

Outcomes

The study examined ECC and its associated risk factors

Delayed start of oral hygiene in children	Introduction of sugar-sweetened beverages before 12 months	The number of sugary drinks consumed before 24 months	High maternal education level	Fathers' secondhand smoke	Number of cigarettes smoked during pregnancy
p = 0.005	p = 0.014	p = 0.005	p = 0.004	p = 0.012	p = 0.007

All parents should be given dietary education during pregnancy, and nutritional counseling is crucial when ECC is present.

To cite: D'oria V, Bettocchi S, De Cosmi V, Paglia M, Colombo S, Scaglioni S, Agostoni C, Beretta M, Braiotta F, Berti C, Paglia L. Risk factors for Early Childhood Caries in Italian preschoolers: A cross-sectional analysis. Eur J Paediatr Dent. 2024 Dec 1;25(4):271-276. doi: 10.23804/ejpd.2024.2289. Epub 2024 Sep 1. PMID: 39230199.

ISI Maternal and Child Dentistry Clinics, and written informed consent of legal caregivers. The study was proposed to the parents (or guardians) of each patient during the dental visit and informed consent was obtained.

Demographical data

Centrally trained personnel interviewed parents to obtain information on general socio-demographic characteristics and health history of their child. Furthermore, parents' smoking, reported weight and height were recorded.

Anthropometric measurements

Child body weight was measured using a gram scale (Tanita TL-150 MA; Sensor Medics, Milano, Italy), accurate to 0.1 kg. Child length (12-23 months) was measured with an infantometer (SECA 416, Hammer Steindamm 3-25 22089 Hamburg Germany) and height was measured with a stadiometer (SECA 213, Hammer Steindamm 3-25 22089 Hamburg Germany). Body mass index (BMI) was calculated as weight (kg) / length or height (m^2). The World Health Organization (WHO) Anthro and Anthro Plus® software and the WHO reference charts were used to calculate Z-scores and percentiles for weight for age, BMI, and weight for length [Blossner et al., 2009]. WHO criteria were referred to classify child nutritional status [Onis et al., 2007].

Oral hygiene and health assessment

The dental examinations were carried out by a trained dentist by using the International Caries Detection and Assessment System criteria, with a flat-surface mouth mirror, a dental explorer, compressed air and lamp lights [Cianetti et al., 2017]. Then, the decayed-missing-filled-teeth (dmft) was recorded. Oral hygiene was investigated in children and parents enrolled by ad hoc case report form. Specifically, parents were asked about their caries or dental problems, daily frequency of brushing teeth, and knowledge of caries' transmissibility. Moreover, they were interviewed about their children's oral hygiene habits both at home and at school.

Children's eating habits

Early life habits were investigated through an ad hoc questionnaire to record breastfeeding duration, formula introduction, night feeding, complementary feeding, and SSBs introduction.

Statistical analysis

Assuming an ECC prevalence of 8,2% [Colombo et al., 2019] in children aged 12-71 months, a sample size of 157 subjects was necessary to achieve a precision of 5% with a 95% significance level. Categorical or ordinal variables were expressed as frequency (percentage, %); continuous variables

	No	%
Baseline characteristics		
Age (years), mean (SD)		4.6 (±1.1)
Female	71	42
Ethnicity		
Caucasian	158	92.3
Hispanic	8	4.7
Asian	4	2.3
African	1	0.6
Type of delivery		
Vaginal	124	72.5
Dystocic	10	5.8
Induced	2	1.2
Caesarean	35	20.5
Birth weight < 2500 g	10	5.8
Preterm	5	2.9
Anthropometric measurements		
Weight in kg mean (±SD)		17.6 (±3.0)
Length/height in m		1.1 (±0.1)
Nutritional status		
Normal weight	134	78
Overweight	12	7
Obese	1	1
Underweight	24	14

TABLE 1 General and anthropometric characteristics of children (n=171).

		Mother	Father
Age (mean ± SD)		38.2 (±5.8)	41.3 (±7.2)
Educational level			
	Master degree/ PhD	87 (51)	59 (35)
	High school	62 (36)	80 (48)
	Secondary	22 (13)	29 (17)
Job	No	29 (17)	2 (1)
Smoking			
	Currently	43 (25)	49 (29)
	During pregnancy	9 (5)	44 (26)
BMI (mean, SD)		23.1 (±4.5)	25.7 (±3.5)
	Normal weight	111 (65)	81 (48)
	Underweight	17 (10)	1 (1)
	Overweight	30 (13)	65 (39)
	Obese	13 (8)	20 (12)

TABLE 2 Socio-demographic and anthropometric characteristics of mothers (n=171) and fathers (n=168) of the study population.

Parents		N (%)
Caries o dental problems (number)		
	≥7	28 (17)
	4-6	45 (26)
	1-3	60 (35)
	0	38 (22)
Parents' oral hygiene / brushing teeth (times/day)		
	1	19 (11)
	≥ 2	152 (89)
Parents' knowledge on caries' transmissibility		
	Yes	53 (31)
	No	118 (69)
Children		
Age at first visit (months; mean ± SD)		38.5 (±12.3)
Reason		
	Dental pain	60 (35)
	Dental trauma	28 (17)
	Check-up	62 (36)
	Suggested	20 (12)
Start of brushing teeth (months)		
	0-12 (before)	16 (9)
	0-12 (after)	68 (40)
	12-23	52 (31)
	24-48	31 (18)
	48-72	3 (2)
School attendance		
	Yes	163 (95)
	No	8 (5)
Brushing teeth at school		
	Yes	11 (7)
	No	159 (93)
Use of toothpaste		
	Yes	162 (95)
	No	8 (5)
Use of fluoride toothpaste		
	Yes	151 (89)
	No	19 (11)
Use of SSBs before sleeping		
	Yes	7 (4)
	No	164 (96)
Use of SSBs during the day		
	Yes	9 (5)
	No	162 (65)
Use of pacifier with sugar or honey		
	Yes	7 (4)
	No	164 (96)
Oral hygiene / brushing teeth (times/day)		
	< 1	2 (1)
	1	32 (19)
	2	117 (69)
	3	19 (11)
Children with dmft = 0		48 (28)
dmft (mean ± SD)		3.8 (±4.4)

TABLE 3 Dental Problems and Oral Hygiene Behaviour.

as mean and standard deviation, if normally distributed, and as median and interquartile range if not. Within-group and between-group comparisons were performed with parametric or non-parametric statistical tests, where appropriate: for comparisons between groups, Student's t-test (2 groups) or ANOVA (>2 groups) was used for distributed continuous variables typically, the Mann-Whitney test (2 groups) or Kruskal-Wallis test (>2 groups) for asymmetrically distributed continuous variables, the Chi-square test or Fisher's exact test (where appropriate) for categorical variables. We conducted a binomial logistic regression analysis to examine the association between parents' characteristics (maternal and

Infancy feeding	mean (±SD)
Duration (months)	
Exclusive breastfeeding	5.9 (±6.8)
Predominant breastfeeding	8.0 (±7.3)
Night feeding	10.0 (±8.8)
Milk-Bottle feeding	26.2 (±13.9)
Water bottle feeding	19.3 (±8.7)
Age of introduction (months)	
Infant Formula (IF)	3.2 (±3.0)
Formula (Growing-up milk)	13.5 (±5.9)
Cow milk	16.4 (±9.1)
Complementary food - Starting	6.2 (±1.7)
Minced textured food	8.8 (±3.6)
Chopped textured food	12.5 (±2.9)
Family food	17.8 (±8.9)
Self-eating (months)	16.5 (±8.6)
Age of introduction of SSBs (years)	2.2 (±1.3)
Frequency of consumption SSBs (times/ week)*	
Fruit juice	3.2 (±2.9)
Herbal tea	0.4 (±1.2)
Tea	0.6 (±1.8)
Chamomile tea	0.4 (±1.3)
Current feeding habits	
Meals (number/day)	4.8 (±0.6)
Night feeding (%)	
Yes	3.0
No	95.0
Sometimes	2.0

* Evaluated in n= 144

TABLE 4 Feeding practices in the study population.

paternal BMI separately) as explanatory variables and children's dmft (=0 or >1) as outcome. The following were also used as variables: frequency of consumption of fruit juice, herbal tea, tea, and chamomile tea, and number of cigarettes smoked both by mother and father and the educational level of the mother. Covariates have all been included independently in separate models. Logistic regression models of dmft >1 in children according to parents' characteristics and habitual consumption. The level of statistical significance was set at a p-value < 0.05 and, where appropriate, 95% CIs have been calculated.

Results

Out of 176, a total of 171 participants were enrolled. The mean age (± standard deviation, SD) was 4.6 (±1.1) years, 42% were females (Table 1). Most children were delivered at term (97%), vaginally (72%), and with an adequate weight (94%). Concerning nutritional status, 78% were sufficiently nourished. Table 2 describes the parents' characteristics. On average, mothers were 38.2 (±5.8) years old and fathers 41.3 (±7.2). Most parents were employed and the mothers showed the highest educational level. At least a fourth of parents were smoking at the time of the survey. Regarding the family composition, 26% had one child, 60% had 2 children while only 8%, 5%, and 1% had 3, 4, and 6 children, respectively. Considering the nutritional status, 65% of the mothers and 48% of fathers were normal weight.

Oral health and behaviours

We found a 72% prevalence of ECC. The data about dental problems and oral hygiene are reported in Table 3. Considering parents' characteristics, only 22% did not show any dental problems, 31% considered caries as transmissible, and 89% brushed their teeth ≥ 2 times daily. Toddlers and children (n=133) showed a mean dmft score of 3.8 (± 4.4), and 100 of them started drinking SSBs before the age of 24 months. Nine percent of parents cleaned their child's mouth before tooth eruption, 40% of them started brushing their baby's teeth after the eruption of the first tooth by the 12th month of age, and the remaining after. Moreover, most parents brushed their baby's teeth twice a day (69%) and used fluoride toothpaste (95%). The majority of children (93%) did not brush their teeth at school. The age at the first visit was 38.5 (± 12.3) months, mostly due to pain or check-up.

Children's eating habits

Feeding practices are reported in Table 4. The mean duration of exclusive breastfeeding was 5.9 (± 6.8) months, that of predominant breastfeeding was 8.0 (± 7.3) months, and the night feeding duration was 10.0 (± 8.8) months. Complementary food was introduced at 6.2 (± 1.7) months. Regarding drink consumption, fruit juice was the most frequently drunk with a mean of 3.2 (± 2.9) times/week with a mean age at the time of introduction of 2.2 (± 1.3) years.

Risk factors and dmft

We found a significant correlation between the child's dmft and the mother's educational level (p=0.218; p=0.004), the father's smoking status (p=0.193; p=0.012) and the number of cigarettes (p=0.208; p=0.007) during pregnancy, the child's start of teeth brushing (p=0.213; p=0.005), the child's introduction of SSBs before the age of 12 months (p=0.014), and the number of SSBs drunk before the age of 24 months (p=0.232; p=0.005). Furthermore, the mother's educational level correlated with the child's start of teeth brushing (p=0.234; p=0.002) and the child's daily frequency of teeth brushing (p=-0.170; p=0.028). No correlation was found between night feeding after the age of 12 months and the dmft. The binomial logistic regression analysis confirmed a positive association between dmft and the mother's educational level (OR=2,36, CI 95%= 1,26 - 4,4, p=0,007).

Discussion

Adequate oral hygiene and eating habits are crucial for preventing early tooth decay, i.e., ECC which represents a relevant disease in the paediatric population worldwide. Some findings deserve consideration.

Oral health and behaviours

In our population, the prevalence of ECC resulted in 72%. This high prevalence could be explained by the fact that children were recruited from the ISI, considered a second-level centre providing advanced care and treatments in dentistry and oral surgery. The Italian Clinical Recommendations in Odontostomatology [Italian Ministry of Health, 2017] indicate that children should have their first dental examination between 18 and 24 months of age. In contrast, we found that

the age of the first visit occurred beyond 1 year later than recommended. This concerning result may be partly due to a lack of guidance provided to parents by children's healthcare professionals [Colombo et al, 2023]. In our population, only 12% of the parents reported being advised to make a dental visit. Likewise, previous data reported that less than 1% of parents took their children to the dentist based on advice from healthcare providers, including paediatricians, pharmacists, and general practitioners [Colombo et al., 2019]. This trend suggests that there is a need to promote dental visits to be undertaken as early as possible [Sanguida et al., 2019; American Academy of Pediatric Dentistry, 2023; Ilisulu et al, 2024]. In accordance with Colombo and colleagues [2019] detecting that more than 80% of parents were unaware that caries could be an infectious and transmissible disease, we found that almost 70% of the parents did not know that tooth decay is a transmissible disease. Advising parents/primary caregivers about the importance of their oral health and the possible transmission of cariogenic bacteria from them to the child is crucial to preventing the disease [Paglia et al., 2016]. Similarly, caregivers should be educated about oral hygiene practices which should ideally commence from birth as cleaning of gums after each feeding, becoming crucial when infants start eating solid food (around 6 months of age) [Shrestha et al., 2024]. According to our results, only 9% of parents cleaned their child's mouth before tooth eruption whilst almost half of the children started teeth brushing after 12 months of age suggesting a potential involvement of poor oral hygiene practices in the prevalence of ECC observed. In contrast with the trend observed in existing literature which highlights that a higher maternal educational level likely protects against ECC [Ferrazzano et al, 2019; Folayan et al., 2024], we found a positive association between the maternal education level and the child's dmft. This result could be explained by considering that higher educational attainment may be related to more demanding work that leads to reduced hygienic dental care of the child. Indeed, we observed that the mother's education correlated positively with the child's start of teeth brushing while inversely with the child's daily frequency of teeth brushing: mothers with higher education had likely children who started brushing their teeth later and brushed less frequently. Furthermore, we found a positive correlation between the mother's exposure to passive smoke generated by the father during pregnancy and the child's dmft in line with the results from a recent systematic review reporting increased susceptibility to dental caries among the children exposed to prenatal smoking [Uthayakumar et al., 2023]. It has been hypothesized that passive smoking during the prenatal tooth formation can affect the enamel mineralisation process thereby favouring developmental enamel defects, that are more susceptible to cariogenic bacteria in the presence of sugars [Akinkugbe et al., 2020].

Children's eating habits

In our population, the length of exclusive breastfeeding and the age of introduction of complementary feeding were in line with recommendations [WHO, 2021], the majority of the children did not consume night meals, and the habit of both nocturnal meals and breastfeeding lasted less than 12 months. The association between breastfeeding and ECC is one of the most debated risk factors for ECC, as existing evidence remains inconclusive and equivocal. However, a recent meta-analysis failed to evidence a statistically significant difference in dental caries rates between breastfed and non-breastfed children, even if breastfeeding extended beyond 12 months and nocturnal breastfeeding increased the risk of ECC [Shrestha et al., 2024]. It might be that breastfeeding, particularly when occurring at night, contributes to ECC because the milk remains in the baby's mouth for extended periods not because human milk is cariogenic. As expected considering our findings, that is most of the children did not consume night meals and the habit of both nocturnal meals and breastfeeding lasted less than 12 months, no correlation was detected between night meals or breastfeeding length and dmft. Alarmingly, the consumption of fruit juice being higher than 3 times/week did not meet the recommendation by the Società Italiana di Pediatria and Società Italiana di Endocrinologia e Diabetologia Pediatrica to avoid sugary drinks in the first 2 years of life [Giuliana et al., 2018]. Moreover, the American Academy of Pediatrics recommends not to introduce fruit juice to infants before 1 year of age while admitting the consumption of 120 mL (nearly a glass) daily of fruit juice among toddlers but only as part of a meal or snack [Heyman et al., 2017]. A high consumption of SSBs early in life, that is free sugars appears to contribute to the development of caries [Severino et al., 2021; Large et al., 2023] which may at least partially explain the high prevalence of ECC in our population. This study showed some limitations. Firstly, the cross-sectional design prevented the causal relationship between the ECC and identified risk factors. Moreover, data may be influenced by sampling bias. The sample under examination was indeed representative of a narrow segment of the population, including children who accessed the Maternal and Child Dentistry department at the ISI, thereby potentially at increased risk of dental problems. Furthermore, data obtained from parents were subject to recall bias. Finally, the accuracy of the information regarding children eating habits could be also compromised as their meal consumption did not always occur under parental supervision (i.e. school, other caregivers). However, the study was of interest because it addressed a prevalent public health issue, specifically ECC in preschool-aged children and only a few Italian studies deal with it. Moreover, a broad spectrum of risk factors, such as demographic characteristics, dietary habits, oral health status, and parental behaviours, was investigated, providing a holistic view of the issue.

Conclusion

In our population of children aged 12-71 months, the prevalence of ECC was high, but parents often lack sufficient knowledge about this alarming issue. ECC is a disease with potentially harmful consequences on the child's health in the short- and long-term. Based on the results of this study, it is necessary to promote effective informational campaigns on the determinants of the early spread of carious disease and the exponential growth of ECC, including prenatal smoking. In particular, oral health providers, physicians, nurses, and other health care personnel play a crucial role in perinatal and infant oral health, as they may contribute to raising awareness about proper oral hygiene by educating parents, determining the correct timing for a child's first dental visit, and establishing a dental home routine. Moreover, it is pivotal to disseminate information about adequate dietary habits early in life. Given the link between excessive sugar intake, NCDs and ECC, this condition can be considered an early indicator of dietary errors. Therefore, educational interventions aimed at reducing free sugar intake in childhood could be part of a broader

program for the prevention of NCDs in adulthood.

Abbreviations

BMI: Body Mass Index
ECC: Early Childhood Caries
dmft: decayed-missing-filled-teeth
ISI: Istituto Stomatologico Italiano
NCDs: non-communicable diseases
SSBs: Sugar-Sweetened Beverages
WHO: World Health Organization

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