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ORIGINAL SCIENTIFIC ARTICLE

Risk factors for early childhood caries: a case–control study

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Abstract
Aim To investigate the risk factors for early childhood caries (ECC) among Indian preschool children.
Methods This case control study recruited 380 children who were divided into two groups based on their def scores. The study group (cases) included children who were diagnosed with ECC (def > 0). The cases were compared with the control group which included children who were caries free (def = 0). Data were statistically analysed using χ^2 test and multiple logistic regression analysis.
Results Risk factors specific to the ECC group were first born child (OR 4.18, 95 % CI 1.98–8.80), snacking more than thrice per day (OR 2.78, 95 % CI 1.41–5.47), bottled drinking water (OR 4.58, 95 % CI 2.13–9.86), use of more than a smear amount of toothpaste (OR 4.99, 95 % CI 2.54–9.81), mother unemployed (OR 3.45, 95 % CI 1.70–6.99) and day care person of the child (OR 8.49, 95 % CI 3.98–18.10).
Conclusions Most common risk factors were order of birth, snacking more than thrice per day, source of drinking water, use of more than a smear amount of toothpaste, mother's work status and day care person of the child.

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Keywords Early childhood caries · Risk factors · Dietary habits · Feeding practices

Introduction

Early childhood caries (ECC) can be a particularly severe form of caries, beginning soon after dental eruption, developing on smooth surfaces, progressing rapidly and having a lasting detrimental impact on the dentition (AAPD 2008). Despite reports of an overall decrease in caries prevalence, severe decay is still a prevalent disease of early childhood (Retnakumari and Cyriac 2012). It has been estimated that prevalence rates vary from 1 to 12 % in developed countries and can be as high as 70 % in developing countries (Milnes 1996).

ECC remains a serious public health problem which is difficult to control despite its well-known aetiology (Seow et al. 2009). The early manifestations include pain, chewing difficulties, speech problems, general health disorders, psychological problems and lower quality of life (Davies 1998; Ismail 1998; Rosenblatt and Zarzar 2002). There are numerous risk factors significantly related to ECC which can be biological, behavioural or socio-economic contributors to the caries process (Harris et al. 2004). The most important of them are probably high-frequency intake of sugary snacks and sweetened feeding bottles, particularly used during the night (van Palenstein Helderman et al. 2006). It has also been demonstrated that prolonged breast feeding (longer than 1 year) is a possible risk factor in the development of S-ECC along with improper feeding habits such as night feeding and high frequency of sugar intake (O'Sullivan and Tinanoff 1993). Parental knowledge and attitude towards oral health can also promote appropriate oral

hygiene skills to their children and there is evidence indicating positive influence of good parental knowledge on the child's dental health (Tetuan 2004). Understanding the role of diet, eating behaviours, demographic characteristics and environmental influences in contributing to increased caries rates is essential to improve the oral component of general health in these children.

Most of the previous studies examined children on discrete and isolated populations (Rosenblatt and Zarzar 2002; van Palenstein Helderman et al. 2006). Although many studies in the past have examined the socio-economic, dietary and microbiological risks on development of ECC, there is still a need for controlled investigations on other risk factors that have to be addressed. The prediction models which have been developed may differ in different populations, especially in developing countries (Ismail 1998; Weinstein 1998; Vanobbergen et al. 2001). Hence, there is a need for extensive research on ECC and associated risk factors.

Methods

Study design and ethical approval

We designed a case–control study to analyse the risk factors for ECC among Indian preschool children. The project was submitted to and approved by the Scientific Review Board, Saveetha University and ethical approval was also obtained from the Institutional Human Ethics Committee.

Sampling and sample size

Prior to the main study, a pilot study was carried out in the Department with a group of 20 children equally divided into two groups. All the oral examinations were repeated to check the reliability of the examiners. The intra-examiner variability was calibrated using Intraclass correlation coefficient. The calculated intra-examiner agreement for defs was 67 % and power calculated as 90 %. The preliminary study was carried out to evaluate the feasibility of conduct of a larger study and to aid in the calculation of sample size.

Subject population

The reference population included 380 children who reported to the Outpatient Department of Paediatric and Preventive Dentistry. The process of convenience sampling methodology was employed for sample selection. The children were then divided into two groups based on their def scores. The study group ($n = 190$) included children (cases) who were diagnosed with ECC (def > 0) who were compared with the control group ($n = 190$) which included caries-free children (def $= 0$).

Inclusion and exclusion criteria

The inclusion criteria were developed using the definition of the American Academy of Paediatric Dentistry (AAPD) as a guide. The AAPD defined Early Childhood Caries (ECC) as the presence of one or more decayed, missing or filled tooth surface in any primary tooth in a child of 71 months of age or younger. Children who were medically compromised and those who declined to participate were excluded. Written informed consent was obtained from the parent/guardian before the commencement of the study.

Survey procedure

The study was undertaken in two stages: stage 1 and stage 2, comprising of a questionnaire survey and an intra-oral examination, respectively. The dental examination was carried out by one of the three trained investigators. Caries was diagnosed using the WHO criteria and recorded using the def index.

Oral health questionnaires

Three trained examiners collected information through a face-to-face interview with the parent/caretaker of the child. Parent questionnaires adapted from a prior study (Weber-Gasparoni et al. 2007) were modified, piloted and used during the survey procedure, which was designed to elicit information regarding the demographic characteristics and social profiles of the child. Socio-demographic status (gender, order of birth, previous dental visit, maternal educational level, mother's work status, day care person), feeding practices (breast feeding, bottle feeding), dietary habits (snacking history, sharing the same spoon, pre-chewing child's food), oral hygiene practices (brushing frequency, parental supervision, amount of toothpaste) and other factors (awareness of baby bottle tooth decay, water source) were evaluated.

Intra-oral examination

The children were examined in the dental chair using a mouth mirror and an explorer under dental chair light (Kavo, Germany). Prior to the examination, the teeth were not cleaned and dried. Knee to knee examination was performed in case of very young children. A tooth was considered decayed (d) if there was visible evidence of cavitations, filled (f) if the tooth was restored and extracted (e) if extracted due to caries. An assistant recorded the findings and the dental examination was usually completed within 15 min.

Statistical analysis

Both the questionnaire and oral examination forms were manually checked for completion of data. All data were entered in a data entry form which was transferred to SPSS software (SPSS, version 17 for Windows). Chi square test was performed for each variable to assess whether significant differences were observed between the case and control groups. Multivariate logistic regression analysis was subsequently performed to assess the relative contributions of these predictor variables between the case and control groups. $p < 0.05$ was considered to be statistically significant.

Results

The total sample comprised of 380 children aged 6 months–6 years, of which 190 children were in the study group and 190 children in the control group.

Socio-demographic factors

Table 1a shows the socio-demographic features of the children in the control and study groups. There was an almost equitable gender distribution in both the study and control groups. The study group data, with regard to the order of birth revealed that 90 (47.36 %) were first born, 100 (52.63 %) were second born or more, while in the control group 35 (18.42 %) were first born, 155 (81.57 %) were second born or more which showed a significant relationship ($p = 0.0001$). There were no significant differences between cases and controls in terms of the educational status of the mother ($p = 0.5522$) and gender of the child ($p = 0.9182$). A significant ($p = 0.0001$) number of children (155) in the control group (81.57 %) were taken care of by their parent/grandparent than that (95) in the study group (50 %). Of the 190 mothers in the study group, 153 (80.52 %) were not employed compared with 92 (48.42 %) mothers in the control group which showed a significant relationship ($p = 0.0001$). In the study group, 78 (41.05 %) reported a dental visit in the past, while only 20 (10.52 %) in the control group had a previous dental visit. There was a significant difference ($p = 0.0001$) between the two groups in relation to the history of previous dental visits.

Feeding practices

Table 1b shows the feeding practices between the study and control groups.

Weaning from breast feeding

The age at which the mother had weaned the child from breast feeding was not significantly different between ECC cases and control group ($p = 0.8903$).

Weaning from bottle feeding

There was a significantly higher number (129) of children (67.89 %) being never bottle fed in the control group as compared with 88 (46.31 %) in the study group.

Dietary habits

Table 1c elaborates the snacking habits. The snacking frequency was categorised as (a) less than thrice per day or (b) more than thrice per day. Out of the total 190 children in the study group, 79 (41.57 %) had a snacking history of less than thrice per day, while 111 children (58.42 %) snacked more than thrice per day. In the control group, 117 children (61.57 %) had a snacking history of less than thrice per day and 73 (38.42 %) snacked more than thrice per day. Nearly twice the number of children had a snacking frequency of more than thrice per day in the study group when compared with the control group which showed statistical significance ($p = 0.0001$).

With respect to the sharing of the same spoon between the mother and child, there was no significant difference ($p = 0.7293$) between the 20 children (10.52 %) in the study group and the 17 in the control (8.94 %) group. There was no significant difference between the two groups in relation to the prior chewing of the child's food ($p = 0.3811$).

Oral hygiene practices

Table 1d shows the oral hygiene practices among the study and the control group.

In the control group only 168 (88.42 %) children reported a daily brushing habit, whereas 190 (100 %) children in the study group demonstrated daily brushing habit. Regarding the frequency of brushing, 174 children (91.57 %) brushed once daily, 16 (8.42 %) twice daily in the study group as compared with 142 (84.52 %) children who brushed once and 26 (15.47 %) brushed twice daily in the control group.

Regarding the parental supervision of brushing practices, for 109 children (57.36 %) in the study group, brushing was supervised while in the control group parental supervision was noted in 117 children (69.64 %). Although the mothers of the control group had a better understanding of oral hygiene, no statistically significant difference was found between the two groups in relation to the frequency of brushing and parental supervision of the child's brushing habits.

Table 1 Comparison between the study and control group children based on the analysed risk factors

	Study group ($n = 190$)	Control group ($n = 190$)	p value
1a) Socio-demographic characteristics			
a) Gender			
Male	99 (52.10 %)	98 (51.57 %)	0.9182
Female	91 (47.89 %)	92 (48.42 %)	
b) Order of birth			
First child	90 (47.36 %)	35 (18.42 %)	0.0001*
Second child	100 (52.63 %)	155 (81.57 %)	
c) Previous dental visit			
Yes	78 (41.05 %)	20 (10.52 %)	0.0001*
No	112 (58.94 %)	170 (89.47 %)	
d) Maternal educational level			
College degree	50 (26.31 %)	44 (23.15 %)	0.5522
Less	140 (73.68 %)	146 (76.84 %)	
e) Mother's work status			
Working	37 (19.47 %)	98 (51.57 %)	0.0001*
Not working	153 (80.52 %)	92 (48.42 %)	
f) Day care person			
Parent/grand parent	95 (50 %)	155 (81.57 %)	0.0001*
Others	95 (50 %)	35 (18.42 %)	
1b) Feeding practices			
a) Breast feeding			
<24 months	158 (83.15 %)	159 (83.68 %)	0.8903
More	32 (16.84 %)	31 (16.31 %)	
b) Bottle feeding			
Bottle fed	102 (53.68 %)	61 (32.10 %)	0.0001*
Never	88 (46.31 %)	129 (67.89 %)	
1c) Dietary habits			
a) Snacking history			
Less than thrice per day	79 (41.57 %)	117 (61.57 %)	0.0001*
More than thrice per day	111 (58.42 %)	73 (38.42 %)	
b) share same spoon			
Yes	20 (10.52 %)	17 (8.94 %)	0.7293
No	170 (89.47 %)	173 (91.05 %)	
c) Pre-chew child's food			
Yes	14 (7.89 %)	21 (11.05 %)	0.3811
No	175 (92.10 %)	169 (88.94 %)	
1d) Oral hygiene practices #			
a) When do you brush			
Morning only	174 (91.57 %)	142 (84.52 %)	0.0567
Morning and bedtime	16 (8.42 %)	26 (15.47 %)	
b) Brushing supervised			
Yes	109 (57.36 %)	117 (69.64 %)	0.0219
No	81 (42.63 %)	51 (30.35 %)	
c) Amount of toothpaste			
Smear amount	64 (33.68 %)	111 (66.07 %)	0.0001*
More	126 (66.31 %)	56 (33.33 %)	
1e) Other risk factors			
a) Awareness of baby bottle tooth decay			
Yes	40 (21.05 %)	48 (25.26 %)	0.3946

Table 1 continued

	Study group ($n = 190$)	Control group ($n = 190$)	p value
No	150 (78.94 %)	142 (74.73 %)	
b) Source of drinking water			
Bottled water	95 (50 %)	37 (19.47 %)	0.0001*
Others	95 (50 %)	153 (80.52 %)	

In the control group only 168 children reported regular oral hygiene practices

* Statistically significant $p < 0.05$

In the study group, 64 (33.68 %) children used a smear amount while 126 (66.31 %) children used more than a smear amount of toothpaste for brushing. In the control group, 111 (66.07 %) children used a smear amount and 56 (33.33 %) children used more than a smear amount of toothpaste. The amount of toothpaste used for brushing was significantly different ($p = 0.0001$) between the two groups.

Other factors

Table 1e regarding the awareness of baby bottle tooth decay showed that 48 (25.26 %) of the mothers in the control group were aware of it, while in the study group only 40 (21.05 %) of the mothers showed awareness. However, the differences were not statistically significant ($p = 0.3946$). A significant difference ($p = 0.0001$) was observed between the two groups regarding the main source of drinking water.

Multiple logistic regression analysis

The final multivariate logistic regression model (Table 2) contained the best predictors of ECC in this study population. Multivariable models were fitted to estimate the independent association of each of the identified factors with ECC group status. The common ECC risk factors identified in the final model for all study children are shown in Table 2. Statistically significant risk factors for ECC include day care person of the child, source of drinking water, mother's work, no history of previous dental visit and use of more than a smear amount of toothpaste. Risk factors specific to the ECC group were snacking more than thrice per day (OR 2.78, 95 % CI 1.41–5.47), use of more than smear amount of toothpaste (OR 4.99, 95 % CI 2.54–9.81), bottled drinking water (OR 4.58, 95 % CI 2.13–9.86), history of bottle feeding (OR 2.03, 95 % CI 1.04–3.98), first born child (OR 4.18, 95 % CI 1.99–8.81), mother unemployed (OR 3.45, 95 %CI 1.70–6.99) and day care person of the child (OR 8.49, 95 % CI 3.98–18.10).

Discussion

The present study is the first case control study on children with ECC in the Indian subcontinent. ECC is a disease which has significant racial or ethnic variations in its occurrence. ECC remains a sizeable and significant public health problem in developing countries and among minorities in the developed countries. Therefore, knowledge about this disease pattern and associated risk factors in developing nations is essential (Tickle 2006). The high public cost of treating ECC, especially in severe cases in need of hospitalisation and general anaesthesia, implicates a crucial need for prevention of this disease (Weinstein 1998). Identifying the common risk factors would certainly help to improve the oral health status and in planning appropriate preventive regimens. In the evaluation of risk factors, there would be a confounding influence of one factor over the other. The effect of such confounding factors has been eliminated in this study using the multiple logistic regression model.

Despite the fact that the sample was not randomly selected, there was an equitable gender distribution between the two groups, which showed no relationship between ECC and gender. Birth order showed a significant correlation between the study and the control group. When birth order was alone taken into account, the first born child was at a significant risk of having more carious lesions

Table 2 Risk ratio and β value using the multiple logistic regression model

	p value	Risk ratio	β value
Snack more than thrice per day	0.0003*	2.782	1.023
More than a smear amount of toothpaste	0.0001*	4.993	1.608
Bottled drinking water	0.0001*	4.584	1.522
Bottle fed	0.0383	2.037	0.711
First born child	0.0001*	4.182	1.431
Unemployed mother	0.0001*	3.451	1.239
Day care person	0.0001*	8.495	2.139

* Statistically significant $p < 0.05$

which is similar to the finding of Wyne et al. (1995). This can be attributed to the relative lack of experience on the part of new parents in managing the child's behaviour and also the lack of dental health education and dietary counselling (Wyne et al. 1995). In the present study, the level of education of parents and its relation to the risk of the child having ECC did not reveal any statistical significance. There are a significant number of children who had a previous dental visit in the study group and they showed a higher percentage of untreated dental caries. The person responsible for the care of the child during the day had an influence on the development of ECC. Lesser caries prevalence was observed in children who were taken care of by the mother/grandparent when compared with children who were taken care of by other care givers. Mothers are undoubtedly the primary source of early education with regard to good oral health care for the children. However, in recent years there is an increase in mothers who are employed outside homes; as a result, young children tend to spend a considerable amount of time in day-care centres. The role of care providers in the day care centres is very important because they are involved in children's daily diet, general hygiene and oral health care (Mani et al. 2010). Improving the knowledge of the care giver regarding oral health can reduce the occurrence of ECC.

Children who were bottle fed showed a higher prevalence of ECC when compared with children who were never bottle fed. Bottle feeding predisposes to ECC because the nipple blocks the access of saliva to the upper incisors. In the case of lower incisors, they are close to the main salivary glands and are also protected from liquid contents by the bottle nipple and the tongue (Davies 1998). In this study, there was no correlation between breastfeeding practices and the presence of caries. This finding corresponds to that of the previous study of Iida et al. (2007) who also found no correlation between breastfeeding and ECC. The relationship between breast feeding and dental caries is likely to be complex and confounded by many biological variables such as mutans streptococci, enamel hypoplasia, intake of sugars and social variables, such as parental education and socio-economic status, which may affect oral health (Seow 1998). Some have attributed S-ECC to the use of nursing bottles and even prolonged breast-feeding habits, but this association is mainly a correlation, not causation (Caufield et al. 2012). At present, the influence of breast feeding on the development of ECC remains unclear, and both quantitative and qualitative studies addressing this issue are needed.

Dietary habits and feeding practices have long been assumed to play primary roles in the development of ECC. The present study also demonstrated that the frequency of consumption of snacks was one of the strongest factors in the occurrence of ECC which was similar to that reported earlier (Jose and King 2003). ECC was more prevalent among children who had a snacking history of more than thrice per day. Pre-chewing child food and sharing the same spoon are considered to be significant factors for vertical transmission of *S. mutans* from the care giver to the child (Caufield et al. 1993). In the present study, the relationship between pre-chewed food and caries was not clear, because the habit of pre-chewing food may be a random behaviour and it is very difficult to determine its duration and frequency.

The child brushing his/her own teeth was an indicator that showed association with caries in the present study. Children under the age of 8 years were not able to brush their teeth by themselves. Parental help with brushing should be performed up to 10 years of age (Sandstrom et al. 2011). The present study also confirmed that parental supervision of brushing had a positive influence on improving the child's oral hygiene.

The source of drinking water showed a significant difference between the two groups with bottled water showing more ECC prevalence when compared with well water and city water supplies. Most bottled water does not contain more than 0.3 ppm of fluoride which is lower than that in the other sources of drinking water (Mythri et al. 2010). The fluoride content in the drinking water must have probably contributed to the reduction in caries prevalence. When relating parent's knowledge and awareness with regard to ECC, we observed that lower parental knowledge was associated with a higher likelihood of their children having ECC.

Multiple logistic regression analysis

The multiple logistic regression model offers an accurate interpretation as to how risk factors interplay. Children with snacking frequency of more than thrice per day had an increased risk of ECC when compared with children who snacked less than thrice per day. Use of more than a smear amount of toothpaste showed an increased risk for ECC which was similar to the study reported earlier (Hallett and O'Rourke 2006). They recommended use of only a smear size amount of toothpaste as larger amounts tend to create excessive foam making it more difficult for the child to brush (Hallett and O'Rourke 2006). Other factors which showed statistically significant risk for ECC included source of drinking water, order of birth, mother's work status and day care person warranting further research.

The present research study was subject to the limitations of maternal recall bias; however, it did not fail to provide information on various factors contributing to the occurrence of ECC in this population. Longitudinal studies are further needed to assess the interplay of various risk factors and for better understanding of these factors so that

appropriate preventive and treatment methods can be provided with a better focus for those who are at a greater risk of developing ECC.

Conclusions

The present study identified that snacking more than thrice per day, source of drinking water, use of more than a smear amount of toothpaste and day care person of the child significantly influenced the occurrence of ECC in children when compared with other risk factors such as gender, order of birth, feeding habits, and frequency of brushing.

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