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ASSOCIATION BETWEEN EARLY CHILDHOOD CARIES AND DIFFERENT LEVELS OF FLUORIDE IN SOUTH RAJASTHAN, INDIA

Dental Science

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ABSTRACT

To associate prevalence and pattern of ECC with fluoride levels in water and to determine its risk factors. A cross-sectional study was carried out with 1200 children aged 0–6 years in three different villages of Rajasthan. Five calibrated examiners performed the oral examinations using International Caries Detection and Assessment System (ICDAS) criteria. Data analysis involved the use of the new ICDAS tool. The drinking water samples of all the selected villages were collected in polyethylene bottles and the fluoride content of these samples was determined by fluoride Ion electrode (Orion 9609BN, Orion Research Inc). Statistical analysis was done to associate prevalence of ECC with different fluoride concentrations in water. The prevalence of ECC in the sample of 1200 children was 69.41% (n = 833) and 30.58% (n = 367) of children had no caries. No significant association was seen between fluoride levels in drinking water and overall prevalence of caries when compared using Chi square test. Inspite of high content of fluoride in drinking water, the prevalence of ECC was found to be strongly evident. Thus, determining fluoride concentration alone is insufficient for prevention of dental caries in children and various other factors should also be considered.

KEYWORDS

childhood caries, fluoride, ICDAS.

INTRODUCTION

Early childhood caries (ECC) is a serious public health problem in children in both developed and developing nations worldwide. The prevalence of ECC varies from population to population [Gaidhane et al., 2013]. A prevalence of 44% has been reported among 8- to 48-month-old children in India [Gopinath et al., 1999; Goel et al., 2000; Chawla et al., 2000; Dash et al., 2002; Goyal et al., 2007; Dixit et al.,2009; Simratvir et al.,2009; Bhayade et al., 2016]. ECC is known to have detrimental effects on both oral and general health.

Although largely preventable, ECC remains the most common chronic childhood disease with nearly 1.8 billion new cases per year globally [Goyal et al., 2000]. Despite major developments in the field of caries control over the past few decades, a high prevalence of this disease has been reported in young children. Disease control is a major societal concern and can be achieved if population segments that present with greater needs are identified.

Rajasthan is one of the states in India where almost all the districts receive highly fluoridated water. Despite high levels of fluoride in drinking water, the prevalence of ECC continues to remain high. Significant gaps have been observed in the collective evidence on ECC and its association with high levels of fluoride [Hussain J et al., 2004] This study shows the prevalence and pattern of ECC in areas with different concentrations of fluoride in drinking water in the southern region of Rajasthan, India.

MATERIALS AND METHODS

Figure 1 presents a schematic diagram of the study process. A cross-sectional population-based survey was conducted in three rural Anganwadi centers, namely, Sarada, Semari, and Thoor, distributed across the Udaipur district in Rajasthan. Areas with different levels of fluoride concentrations were selected. Children aged 0–6 years, who were enrolled in these daycare centers were invited to participate in the study. Advance notifications were provided to the Anganwadi centers so that the parents were informed, and the children were available for oral examinations. Children with special needs, those whose parents did not provide consent for participation, and those who did not cooperate during the oral examination were excluded from the study. The International Caries Detection and Assessment System (ICDAS) uses a two-digit coding system that categorizes the severity of a dental lesion from its earliest stage of visual demineralization to frank cavitation [Henry et al., 2017]

Prior to the outset of the study, all the examiners were trained to diagnose caries lesions according to the ICDAS criteria. Examiner training was provided based on the 2009 edition of the ICDAS criteria manual and, with the help of theory classes from the e-learning program accessible on the ICDAS Web site: eLearning programmes. https://www.icdas.org/ accessed 7 March 2014). Trained examiners were calibrated during daily examinations of the children who visited the outpatient institute of Darshan Dental College and Hospital of the Department of Pediatric and Preventive Dentistry, Udaipur, Rajasthan, India. The findings of the examiners were reviewed to detect differences in their interpretations. The examinations were repeated until an inter-examiner agreement was achieved. Reliability assessment was conducted for 2 days using live subjects who exhibited caries lesions with ICDAS codes 1–5. They were supervised by another experienced researcher, and the scores were compared between the two examiners; kappa values were calculated for inter- and intra-examiner agreement. Five examiners carried out the clinical examinations in the Anganwadi centers. For infants, oral examinations were carried out in the knee-to-knee position. The dental examination tools used included a mouth mirror, community periodontal index of treatment needs probe, torch, and chip blower. The teeth were initially assessed when wet and then re-examined after air-drying for 5 s. The examiners observed the occlusal, mesial, distal, buccal, and lingual aspects of each tooth.

Drinking water was collected in pre-cleaned polyethylene bottles, which were assigned with serial numbers that represented the different villages. Additionally, a sample of common water consumed by the school children of a particular village was collected. The fluoride content of these samples was determined using a fluoride ion electrode (Orion 9609BN, Orion Research Inc).

STATISTICAL ANALYSIS

Data were entered into a Microsoft Excel spreadsheet and checked for any discrepancies. The summarized data were presented using tables and graphs. The data were analyzed using SPSS (21.0 version Package (IBM Corp., 2015, Virginia, US). The Chi-square test was used for categorical variables and to determine the association of fit. The level of significance was set at ≤ 0.05.

RESULTS

Demographic characteristics and distribution of subjects

The sample comprised 1200 individuals with ages ranging from 0 to 6 years (mean ± standard deviation [SD] = 23 ± 10 months). Only those with at least one tooth were included in the analysis.

ECC prevalence

The prevalence of ECC in the sample of 1200 children was 69.41% (n = 833), and 30.58% (n = 367) of the children had healthy dentition.

Prevalence of caries according to age group

The prevalence of caries up to the age of one was 0% (Table 1). However, the prevalence was found to increase with age. The prevalence of caries until the first window of infectivity in 1- to 3-year-old children was 26.6%. Those belonging to the 3- to 4-year age group (50%) were the most affected by ECC, followed by a significant decline in proportion in 4- to 6-year-olds (23.2%; Table 1).

Caries experience in children

The prevalence of ECC was high with more than half of the children having a lesion on one or more tooth surfaces. Of the 1200 children, 367 presented with non-cavitated teeth only, and 833 with cavitated teeth only. The ICDAS codes assessed represented the caries component only because there was no single tooth surface restored. No significant association was observed between fluoride levels in drinking water and the overall prevalence of caries (Table 2).

Likewise, no significant differences in the patterns of pit and fissure and smooth surface caries on the mesial, distal, lingual, and incisal surfaces were observed among the areas with different concentrations of fluoride in drinking water (Table 3). However, a significantly higher number of subjects presented with caries on the occlusal surfaces in the Thoor center, where the fluoride concentration was 0.30 mg/l.

DISCUSSION

Although studies on dental caries have been conducted for more than a century, there is no consensus on how it should be defined and measured. To understand the severity of any infectious disease, one must describe how it could be clinically detected. Therefore, for a better understanding of the disease, the early stages of dental caries in various kinds of environments should be examined. Knowledge about the oral environment of an infant prior to and during the early eruption process is important as it may have a significant effect on the health of the primary dentition. The present study was conducted among 0- to 6-year-old children in Anganwadi centers in Rajasthan, India. Anganwadis offer basic health care, which includes general health services and vaccinations for children, in Indian villages. This age group was selected in the present study because, most often, the chances of recording non-cavitated lesions reduce with the increase in age due to the susceptibility of newly erupted teeth to become decayed in the existing oral hygiene [Arangannal et al., 2016]. Furthermore, the changes in the dietary habits and oral hygiene practices of the children present greater cariogenic challenges as they age. Based on a systematic review conducted by Leong et al., 2013, the causative factors of ECC are significant during the first year of life. The studies included in this review have reported early caries experience and the presence of cariogenic oral bacteria in the pre-dentate and very early dentate period of an infant's life [Leong et al., 2013].

Clinical visual caries assessments continue to be considered as the foundation for the detection and assessment of caries. The use of the ICDAS in general dental practice aims to provide high-quality information about caries status that, when coupled with a caries risk assessment, enables a personalized care pathway to be developed for individual patients [Ormound et al., 2010]. ICDAS presents with good reliability and validity in epidemiological surveys conducted in preschool children. [Henry et al., 2017]. This detection system leads to better quality information about the appropriate diagnosis, prognosis, and clinical management of dental caries at both individual and public health levels [Pitts., 2004]. The concentration of fluoride in drinking water was higher than the optimum levels required; hence, fluoride opacities were observed in some children. The differential diagnosis in the ICDAS criteria manual was followed to rule out initial carious lesions with fluoride opacities. According to the manual, initial lesions on free smooth surfaces are in contact with or within 1 mm of the gingival margin, whereas opacities due to poor calcifications are not confined to these areas. Developmental defects on tooth surfaces without signs of caries were coded as zero (ICDAS code 0). Caries opacity (white spot lesions) or discolorations not consistent with sound enamel were coded as initial lesions (ICDAS code 1 or 2).

The overall prevalence of ECC in the sample of 1200 children was 69.41% (n = 833), and 30.58% (n = 367) of the children had healthy dentitions. According to a systematic review by Ganesh et al (2018), the overall prevalence of ECC in India is 49.6%. Andhra Pradesh was found to have the highest prevalence of ECC at 63%, followed by Tamil Nadu at 55.73%. The lowest prevalence of ECC was reported in Sikkim (41.92%), followed by Assam (43.4%) [Ganesh et al., 2019].

A review of the literature suggests that the prevalence of ECC is between 1% and 12% in most developed countries [Congiu et al., 2014]. In less developed countries and among the disadvantaged groups in developed countries, the prevalence has been reported to be as high as 70%. National surveys from some countries, such as Greece (36%), Brazil (45.8%), and Israel (64.7%), showed inconsistent values for the prevalence of this disease [Gomes et al., 2004, Natapov et al., 2010, Oulis et al., 2012, Koya et al., 2016].

The National Oral Health Survey 2002–2003 estimated an average prevalence of 40%–60% in Indian preschool children; rural children and those from underprivileged backgrounds displayed the greatest burden [Sreedharan et al., 2016].

In the present study, we evaluated the levels of fluoride in drinking water. The concentration of fluoride in drinking water from Sarada (Udaipur, Rajasthan) was 2 mg/l, and the prevalence of ECC in this region was 37.06%. One of the attributable factors for the presence of caries in highly fluoridated areas might be the plasma fluoride level. It can be independent of, or even inversely related to, fluoride intake, which strongly points out the necessity of using plasma fluoride levels, rather than total fluoride intake, to assess the dose-effect relations [Whitford and Reynolds, 1979]. A study by Angmar-Mansson and Whitford (1982) determined that the magnitude of fluoride plasma peak levels, and not the total daily dose, is the factor that determines whether or not this type of enamel mineralization defect will form [Angmar-Mansson and Whitford, 1982]

In the present study, the occlusal surfaces of posterior teeth and smooth surfaces of anterior teeth were more affected, whereas the lingual or palatal surfaces showed the least prevalence.

Various studies suggest a relationship between mineral concentration and caries susceptibility [Shellis., 1984]. A more permeable cervical enamel could be attributed to the clinical fact that the initiation of Severe ECC starts within that region [Centers for Disease Control and Prevention, 1998]. Shellis., 1984 determined a strong relationship between the mineral concentration in the enamel and caries susceptibility. The thinness of the enamel along with its low mineralization and increased porosity could be the cause for the increased permeability of the primary enamel structure [Wong et al., 2004]. The development of shallow coronal and deep cervical pits on the surface of the highly fluorotic dental enamel likely results from cystic lesions formed because of the local disruption of late/transitional- and early-secretory ameloblasts, respectively.

No single tooth surface restoration was observed in the entire sample. The probable reason for this could be the absence of caries prevention programs and routine dental care in this rural community. Preventive care, such as motivating the parents and caregivers about oral hygiene maintenance at the daycare centers, increasing fluoride exposure (fluoride application performed professionally or by caregivers), and enhancing access to dental care, can reduce unfavorable outcomes. The late-secretory ameloblasts in incisors are less susceptible to fluoride than those in molar tooth germs [Bronckers et al., 1984]. Damage to early-secretory ameloblasts is directly correlated with the amount of mineral deposited in the aprismatic enamel and inversely related to the thickness of the enamel present before fluoride use. The thinner the layer of enamel, the more strongly it is hypermineralized, and the more severely the adjacent ameloblasts are affected [Bronckers et al., 1984; Lyaruu et al., 2006].

CONCLUSION

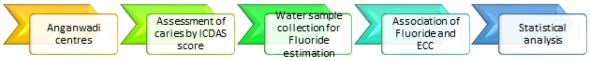
Despite the high content of fluoride in drinking water, the prevalence of ECC was found to be strong in the Anganwadis examined in this study. Thus, determining the fluoride concentration alone is insufficient for the prevention of dental caries among children; various other factors need to be taken into consideration.

Figure Legends

Fig. 1. Schematic diagram showing the steps followed in this study

Figures

Figure 1.



Tables

Table 1: Distribution of subjects and prevalence of caries according to age groups.

Age groups in years	Number of subjects	Percentage
Upto 1	0	0.00
1–2	100	8.3
2–3	220	18.3
3–4	600	50
4–5	80	6.6
5–6	200	16.66
Total	1200	100

Table 2: Association between fluoride levels in drinking water and the prevalence of caries.

Anganwadi centers	Total no of subjects	Prevalence of ECC		
		N	Overall	District wise
Sarada	348	129	10.75	37.06
Semari	400	64	5.33	16
Thur	452	174	14.5	38.49
P-value	0.248			

Table 3: Association between fluoride level in drinking water and the patterns of pit and fissure and smooth surface caries.

Anganwadi centers	Fluoride level	Pit & fissure	Mesial	Distal	Buccal	Lingual /Palatal	Occlusal	Incisal
Sarada	2.0 mg/l	165	76	50	28	10	234	24
Semari	1.5 mg/l	151	80	62	20	15	56	8
Thur	0.30 mg/l	367	95	104	149	45	569	54
P-value		0.346	0.247	0.876	0.543	0.113	**0.047***	0.765

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Statement of Ethics

Informed consent form was obtained from the Parents/guardians. The Ethical clearance was obtained from The Scientific and Ethical Review Committee of Darshan Dental College and Hospital (DDCH/ADM-1572), Loyara, Udaipur, Rajasthan, India. The authors have no ethical conflicts of interest to disclose.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

All authors made substantial contributions to the conception and design of this protocol. All authors have critically read this manuscript and have made their revisions, and they have approved this final version for submission. All authors agree to be accountable for the future integrity of this study.

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