# Dental Caries Status in Primary Molars: Useful Indicator of Oral Health-care Service Delivery among 5–6 Years Old in Middle-Income Countries

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## Abstract

The main aims of the study were to quantify the burden of caries and determine factors associated with the highest risk for caries among 5–6-year-old schoolchildren in Sri Lanka. A cross-sectional descriptive study based on clinical oral examination, an interviewer-administered questionnaire for children and a parental self-administered questionnaire was conducted among, 5–6 years old ($n = 403$) in a selected province. Prevalence of caries was 56.7% (95% CI: 51.5–61.9%) and 3.4% (95% CI: 2.4–4.3%) for primary and permanent dentitions, respectively. A decayed, missing, and filled teeth (DMFT) index of 3.01 (95% CI: 2.61–3.41), significant caries index which is the DMFT of one-third of the study group with the highest caries score of 7.62 (95% CI of 7.34–7.9), prevalence of severely decayed untreated caries with pulpal involvement, ulcerations, fistula, and abscesses (PUFA) of 32.77% (95% CI of 32.32–33.22%), and a mean PUFA score of 1.26 (95% CI of 1.13–1.39) were observed for primary dentition. Although 43.3% of the sample did not have any caries, 10% had caries in all their primary molars, indicating a disproportionate treatment need. Having pulp exposed anterior teeth and father having three or more missing teeth were associated with having caries in all the primary molars. Severe burden of untreated caries at 5–6 years and polarization are seen as one in 10 study participants had all their primary molars decayed. While strengthening infant, toddler, and preschool oral health promotion, interventions targeting high-risk children are needed for reducing the caries burden.

**Keywords:** Children, Dental caries, High risk, Primary dentition, Socioeconomic factors

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## Introduction

Dental caries is a multifaceted public health challenge due to its high prevalence, incidence, negative impact on quality of life, and huge economic cost. Untreated caries in permanent teeth is the most prevalent condition worldwide and untreated caries in primary teeth the 10th most prevalent condition among children across the globe.[1] However, a decrease in caries prevalence and a skewed distribution are noted in several countries where part of the population at 12 years of age has very high or high decayed, missing, and filled teeth (DMFT) values while the rest have low DMFT values or are caries free.[2]

Proportion of high caries groups in terms of caries experience and untreated caries describes the polarization of dental caries.[3] Significant caries (SiC) index is useful to identify individuals with the highest caries scores in each population.[4] SiC index is the mean DMFT for the subgroup of one-third of the population with the highest caries scores. Pulpal involvement, ulcerations, fistula, and abscesses (PUFA) index assesses clinical consequences of untreated caries, recording the presence of severely decayed teeth with visible pulpal involvement (p), ulceration caused by dislocated tooth fragments (u), fistula (f), and abscess (a).[5] Economic deprivation is associated with the phenomenon of polarization of dental caries.[6]

A complex interplay of individual, behavioral, political, socioeconomic, and environmental conditions play a role in the etiology of caries. Acquiring *Streptococcus mutans* at an early age contributes to the development of caries in children. However, this may be partly compensated by other factors such as good oral hygiene and a non-cariogenic diet.[7] Identifying conditions associated with caries at 5–6 years are important for all levels of prevention as at this age with the emergence of first permanent molars a change in caries susceptibility is seen.[8]

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In the Sri Lankan context, National Oral Health Surveys shows sequential reductions in caries. For 5 years old in the years 1984, 1994, 2003, and 2015, prevalence has reduced from 78–76.4% to 65.5–63.1% and mean DMFT from 4.4–4.1 to 3.6–3.0, respectively.[9] Increase in the usage of fluoridated toothpaste over the years, which is currently around 75% among 5 years old,[9] may have contributed to the steady decline. Yet, the proportion of untreated caries remains high within this group.

A social gradient and social inequality in dental caries are existing in Sri Lanka.[10] Factors frequently shown to be associated with caries in primary dentition in Sri Lankan children below the age of 5 years are as follows: Parental education,[11,12] frequency of consuming sweets, family income,[12] and ethnicity.[11]

However, Sri Lankan studies to determine factors associated with caries at school entrance in children aged 5–6 years are lacking. For a country with a per capita health expenditure of US$ 157.47,[13] it has achieved exemplary health indicators due to a vibrant public health service delivery model. Oral health is integrated into antenatal care and preschool health promotion. Furthermore,

Sri Lankan School Dental Services has catered to 5–13-year-old children, for well over 50 years. Yet, the high treatment needs at first compulsory screening among 5–6 years old are stagnant and are challenging to tackle as a lower-middle-income country with limited resources, especially to provide treatment-oriented services. Therefore, determining factors associated with this unfortunate disease status is necessary to target high-risk groups, particularly for preschool oral health promotion and to reduce untreated caries through affordable service improvements by identifying most vulnerable children for caries at first encounter with the School Dental Services. Such interventions should address the underlying factors, provide equitable services, and improve service coverage among the most vulnerable children. Therefore, the aim of the present study was to quantify the burden of caries and determine factors associated with the highest risk for caries in a group of 5–6-year-old schoolchildren aimed at improving children's oral health care in Sri Lanka.

## MATERIALS AND METHODS

Ethical clearance for the study was obtained from the Ethical Review Committee of the Faculty of Medicine, University of Colombo. Permission to conduct the study was obtained from Ministry of Education and the principals of selected schools. Written informed parental consent was obtained for all participants.

This was a school-based cross-sectional study conducted in the Western Province of Sri Lanka. The study population consisted of 5–6-year-old schoolchildren in public schools. A sample size of 403 was calculated using the formula for estimating a population proportion with absolute precision with a 2% allowance for non-response. The expected prevalence of dental caries was taken as 69% from the findings of a preliminary study, to obtain a maximum sample size with 5% precision. Design effect was taken as 1.2. Multistage cluster sampling with probability proportionate to size was done to select participants. The sampling unit was a school. A total of 18 schools (clusters) were included and average cluster size was 22.

Clinical examination, an interviewer-administered questionnaire for students, and a self-administered questionnaire for parents/caregivers of students were used in the study. Clinical examination form was developed by taking the World Health Organization, Oral Health Assessment Form for Children (2013), of "Oral health surveys: Basic methods - 5th edition" as a guide. Alterations and additions were done to suit the research question and the local context. All clinical examinations and interviews were done by first author who got systematically trained and calibrated under an expert in dental public health. Clinical oral examination was done with adequate natural sunlight while the students were seated on a normal chair.

Parental self-administered questionnaire collected data on general information, oral health habits, oral health service utilization, and dietary practices of the child, and family information (sociodemographic factors including education and occupation of child's parents, income, assets, oral health status, oral health habits, and oral health service utilization). Interviewer-administered questionnaire for students collected data which could be reliably collected from them. Questionnaires were first drafted in English and translated to local (Sinhala and Tamil) languages by professional translators. Interviewer-administered questionnaire was pre-tested among 20, 5-year-old students and self-administered questionnaire was pre-tested among their parents to confirm face validity.

Data were analyzed using Statistical Package for the Social Sciences (version 20) software package. Prevalence as a % and severity (DMFT, SiC, and PUFA) of caries were calculated. Sociodemographic characteristics and caries status of study participants were described using frequency distributions.

The DMFT values for overall dentition and DMFT values separately for posterior teeth and anterior teeth were considered as dependent variables. Based on the distribution of data, 90th percentile was taken as the cutoff to dichotomize the dependent variables as "high risk" and "low risk." Chi-square test was performed to test the relationship between categorical variables. Unadjusted odds ratios were calculated to assess the strength of associations for the factors associated with dental caries.

Binary logistic regression analysis was performed for the most suitable dependent variable, which best reflected polarized caries burden, need for treatment, and the current behavioral and socioeconomic factors associated with dental caries in 5–6 years old. Independent variables with $P < 0.05$ in the bivariate analysis were included in regression analysis. Backward logistic regression was performed where variables were entered into the model at 0.05 and removed at 0.1 significance levels.

## RESULTS

Of the 403 participants selected to the study, only 353 responded to the questionnaire, giving a response rate of 87.6%. Sociodemographic and caries-related characteristics of study participants in comparison with national figures are presented in Table 1.

Figure 1 shows skewed distribution of DMFT for the overall dentition, anterior teeth, and posterior teeth separately. Cutoff values at the 90th percentile for the study population were DMFT values of 8, 7, and 7 for overall dentition, anterior teeth, and posterior teeth, respectively. As the SiC index was 7.62, approximately 10% of children were SiC positive.

According to bivariate analysis, all three dependent variables were significantly associated with having pulp exposed anterior teeth, having pulp exposed posterior teeth and visible plaque index of 2 or 3 at $P = 0.05$ level of significance. The presence of plaque on posterior teeth was significantly associated with overall DMFT and anterior DMFT, while more than once a week snacking between meals, father educated up to O/L and father having three or more missing teeth were significantly associated with posterior DMFT [Table 2].

Based on the distribution of data [Figure 1] and significantly associated factors [Table 2], posterior DMFT was selected as the most suitable dependent variable for logistic regression analysis. Table 3 shows the findings when variables which achieved less than 0.05 level of significance were included for logistic regression analysis. Children having pulp exposed anterior teeth (OR = 8.1; 95% CI 1.7, 37.8) and children having a father with three or more missing teeth (OR = 4.8; 95% CI 1.4, 16.1) were more likely to have caries on all their eight primary molars, compared to children not having pulp exposed anterior teeth and children having a father with less than 3 missing teeth.

Around 15.1%–34.3% of variability of the dependent variable is explained by the five variables retained in the model.

## DISCUSSION

The present study quantified the burden of caries and determined factors associated with the highest risk of caries in a group of

**Table 1:** Sociodemographic and caries-related characteristics of the study participants in comparison with national figure

| Characteristic | Figures for current study | ᶜNational figures |
|---|---|---|
| Sociodemographic characteristics | | |
| Sex (*n*=353) | | |
| Male | 191 (54.1%) | 48.4% |
| Female | 162 (45.9%) | 51.6% |
| Ethnicity (*n*=353) | | |
| Sinhalese | 294 (83.3%) | 74.9% |
| ᵃNon-Sinhalese | 59 (16.7%) | 25.1% |
| Religion (*n*=353) | | |
| Buddhists | 263 (74.5%) | 70.1% |
| ᵇNon-Buddhists | 90 (25.5%) | 29.9% |
| Mother's education (*n*=272) | | |
| Up to O/L | 100 (36.8%) | |
| O/L and above | 172 (63.2%) | |
| Father's education (*n*=272) | | |
| Up to O/L | 109 (40.1%) | |
| O/L and above | 163 (59.9%) | |
| Mother's occupation (*n*=274) | | |
| Yes | 64 (23.4%) | |
| Housewife | 210 (76.6%) | |
| Father's occupation (*n*=274) | | |
| Yes | 271 (98.9%) | |
| None | 3 (1.1%) | |
| Caries-related characteristics and other related characteristics | | |
| Primary dentition (*n*=353) | | |
| Prevalence | 56.7%, 95% CI (51.5%, 61.9%) | 60.7% |
| Mean DMFT | 3.01, 95% CI (2.61, 3.41) | 3.0, 95% CI (2.85, 3.15) |
| Mean anterior DMFT | 2.2, 95% CI (1.88, 2.53) | - |
| Mean posterior DMFT | 2.36, 95% CI (2.06, 2.65) | - |
| Significant caries index | 7.62, 95% CI (7.34, 7.9) | - |
| PUFA | 32.77%, 95% CI (32.32%, 33.22%) | - |
| Mean PUFA score | 1.26, 95% CI (1.13, 1.39) | - |
| Permanent dentition (*n*=353) | | |
| Prevalence | 3.4%, 95% CI (2.4%, 4.3%) | 1.5% |
| Mean DMFT | 0.05, 95% CI (0.02, 0.08) | 0.02, 95% CI (0.01, 0.03) |
| Significant caries index | 0.14, 95% CI (0.1, 0.18) | - |
| ᵈVisible plaque index | | |
| Scores 2 and 3 | 24 (6.8%) | |
| Scores 0 and 1 | 329 (93.2%) | |
| Type of toothpaste | | |
| Non-fluoridated | 49 (22.9%) | |
| Fluoridated | 165 (77.1%) | |
| ᵉSnacking between meals | | |
| Several times a week | 103 (30.9%) | |
| Once a week or less | 230 (69.1%) | |

ᵃTamil, Muslims, other ethnicities; ᵇHindus, Islamises, Christians/Catholics, other religions; ᶜNational figures taken from Department of Census and Statistics (2012) for sociodemographic characteristics and National Oral Health Survey (2015) for caries related characteristics; ᵈScore 0: No visible biofilm, Score 1: Thin biofilm in anterior and/or posterior teeth, Score 2: Thick biofilm, anterior, or posterior, Score 3: Thick biofilm in both anterior and posterior teeth; ᵉsnacks containing fermentable carbohydrates. DMFT: Decayed, missing, and filled teeth

5–6-year-old Sri Lankan children. The prevalence of caries in primary dentition and DMFT in the sample are in line with the National Oral Health Survey findings (2015) and substantiate the pattern of a steady decline of caries seen over the years in the country. However, caries prevalence is yet to reach the WHO and FDI goal of 50% of 5–6 years old to be free of caries by 2020. One reason may be despite effective application of population level preventive measures such as the use of fluoridated toothpaste, some distal factors for caries remaining unaddressed.

Sri Lanka been a patriarchal society, the sole income generator in majority of households is the father. It is substantiated by the present study as 76% of mothers were housewives [Table 1]. Therefore, father may have more influence on the consumer behaviors and oral health-related behaviors of the family, may it be purchase of sugary snacks and fluoridated toothpaste, or oral health-care seeking behavior. This may have contributed to father's

educational status and oral health status, having an influence on child's caries status in the present study [Table 2]. Similar results were found in a Brazilian study where father having <8 years of education was a risk factor for high caries of 6 years old.[14]

Father missing three or more teeth been associated with child having caries in all their primary molars in the present study [Table 3], may be indicative of poor attitudes toward oral health. Studies from other countries also have reported father having several carious teeth to be a significant predictor of polarization of caries in 5 years old.[15] However, associations between child's caries and maternal missing teeth failed to achieve significance. There may be issues with accuracy of data as the parental perception was taken regarding their oral health status rather clinical examination of the parents. Alternatively, it could be maternal caries status having a larger role to play regarding caries in primary anterior teeth at a much younger age.

**Table 2:** Factors associated with caries in 5 years old in the primary dentition taken as overall DMFT, anterior DMFT, and posterior DMFT

| Variable | Overall DMFT≥8 | | Anterior DMFT≥7 | | Posterior DMFT=8 | |
|---|---|---|---|---|---|---|
| | OR | P value | OR | P value | OR | P value |
| Demographic and oral health related factors of child | | | | | | |
| Sex: Female (n=353) | 1.0 | 0.967 | 1.3 | 0.364 | 1.1 | 0.827 |
| Ethnicity non-Sinhalese (n=353) | 2.1 | 0.053 | 1.3 | 0.477 | 2.3 | 0.065 |
| Having pulp exposed anterior teeth (n=353) | 11.2 | <0.001* | 6.9 | <0.001* | 6.1 | < 0.001* |
| Having pulp exposed posterior teeth (n=353) | 13.1 | <0.001* | 13.1 | <0.001* | 2.3 | 0.023* |
| aVisible plaque index of 2 or 3 (n=353) | 9.7 | <0.001* | 8.2 | <0.001* | 3.6 | 0.022* |
| Presence of plaque on posterior teeth (n=353) | 3.7 | <0.001* | 3.2 | <0.001* | 1.3 | 0.457 |
| bMore than once a week snacking between meals (n=333) | 1.6 | 0.212 | 1.3 | 0.387 | 2.5 | 0.024* |
| Tooth unfriendly food/drinks in the school interval (n=353) | 0.8 | 0.724 | 1.0 | 0.915 | 2.0 | 0.165 |
| Using non-fluoridated toothpaste (n=214) | 2.5 | 0.214 | 1.5 | 0.427 | 1.3 | 0.824 |
| Brushing frequency of less than twice per day (n=276) | 1.7 | 0.237 | 2.1 | 0.076 | 1.6 | 0.488 |
| Never visited a dental clinic (n=249) | 1.8 | 0.224 | 1.0 | 0.845 | 1.0 | 0.966 |
| Family-related factors | | | | | | |
| Mother educated up to O/L (n=272) | 1.5 | 0.296 | 1.3 | 0.429 | 1.2 | 0.893 |
| Father educated up to O/L (n=272) | 2.2 | 0.054 | 1.0 | 0.993 | 2.4 | 0.033* |
| cMother's occupational category – Group 1 (n=264) | 2.1 | 0.236 | 0.9 | 0.863 | 0.7 | 0.757 |
| cFather's occupational category – Group 1 (n=266) | 1.4 | 0.410 | 1.1 | 0.804 | 1.0 | 0.982 |
| Mother having three or more missing teeth (n=236) | 1.7 | 0.237 | 1.6 | 0.388 | 1.1 | 0.846 |
| Father having three or more missing teeth (n=216) | 2.5 | 0.042* | 0.7 | 0.556 | 4.1 | 0.007* |
| Mother experiencing dental pain in the past 12 months (n=220) | 1.9 | 0.151 | 1.9 | 0.151 | 1.6 | 0.560 |
| Father experiencing dental pain in the past 12 months (n=211) | 1.3 | 0.562 | 2.5 | 0.095 | 2.6 | 0.110 |
| Monthly household income of less than Rs. 20,000 (n=258) | 1.2 | 0.686 | 2.0 | 0.055 | 1.4 | 0.612 |
| No documents for the ownership of the house (n=275) | 1.3 | 0.638 | 1.2 | 0.690 | 2.3 | 0.108 |
| Having a radio as a household item (n=278) | 1.2 | 0.626 | 0.6 | 0.246 | 2.1 | 0.106 |

aScore 0: No visible biofilm, Score 1: Thin biofilm in anterior and/or posterior teeth, Score 2: Thick biofilm, anterior, or posterior, Score 3: Thick biofilm in both anterior and posterior teeth; bsnacks containing fermentable carbohydrates; cInternational Standard Classification of Occupations 08 (ISCO) Group 1: Legislators, senior officials, managers, professionals, technicians and associate professionals and clerks, service and sales workers; Group 2: Skilled agriculture, forestry and fishery workers, craft and related workers, plant and machine operators and assemblers, elementary occupations (sales, services, agriculture, related laborers, mining, construction, manufacturing, and transport). DMFT: Decayed, missing, and filled teeth

**Table 3:** Logistic regression indicating likelihood of all primary molars been carious in 5–6 years old

| Predictor variable | B | SE (ß) | Wald | Df | P | Exp (ß) | 95% CI for Exp (ß) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Father having three or more missing teeth | 1.6 | 0.6 | 6.6 | 1 | 0.010* | 4.8 | 1.4 | 16.1 |
| Father's educational status up to O/L | 1.1 | 0.7 | 2.9 | 1 | 0.088 | 3.0 | 0.8 | 11.0 |
| More than once a week snacking between meals | 0.8 | 0.6 | 1.7 | 1 | 0.193 | 2.2 | 0.7 | 7.5 |
| Having pulp exposed posterior teeth | 1.1 | 0.7 | 2.6 | 1 | 0.108 | 2.9 | 0.8 | 10.5 |
| Having pulp exposed anterior teeth | 2.1 | 0.8 | 7.1 | 1 | 0.008* | 8.1 | 1.7 | 37.8 |

Nagelkerke R$^2$: 34.3%; Cox and Snell R$^2$: 15.1%. Hosmer and Lemeshow test P=0.521. Classification accuracy: 93.1%

The influence of mother's education on child's caries was apparent at a lower education level than that of the father.[16] Level of education of the mothers was slightly higher than the fathers in the sample. Therefore, mother's education level may not be reflecting the socioeconomic status of the family and caries in their offspring, which may have contributed to mother's educational status showing no associations with child's caries in the present study.

High-risk children were 8 times more likely to have at least one pulp exposed anterior primary tooth [Table 3]. Reasons for this may be inaccessibility to oral health services, lack of knowledge, and poor attitudes of parents on oral health. A study on 3–5-year-old children indicates similar patterns where highly significant associations are seen between caries in anterior and posterior teeth, despite differences in probable behavioral factors involved.[17] This indicates continuity of poor oral health from very early years of life through the preschool years into the school age.

In the present study, around 10% of children have a saturated level of caries in all their primary molars. Therefore, this 10% of 5–6 years old are contributing mostly to the treatment need for caries at the first compulsory exposure to School Dental Services.

At around the age of 5–6 years, most of the carious anterior teeth are to be replaced by permanent successors, are arrested, or are beyond simple restorations. Therefore, in a middle-income country with resource limitations and a high treatment need, treating posterior caries may take precedence over treating some of the anterior caries for this age group.

At the population level, diet and sugar intake have re-emerged as major influences on caries incidence.[8] However, dietary associations among 5–6-year-old study participants were significant only for primary molars [Table 2]. This may be due to caries in molars reflecting current behavioral practices more closely, exclusive of the effects of past unfavorable liquid feeding practices during early years of life.

Due to above advantages, posterior DMFT was chosen as the dependent variable for logistic regression analysis [Table 3]. Moreover, caries experience of primary molars is widely used in determining factors associated with caries in this age group and is a powerful predictor of future caries.[18] In the present study as the SiC index is 7.6, SiC-positive participants accounted for 10% of the study population. They coincided with participants beyond the 90th percentile for caries in overall dentition with
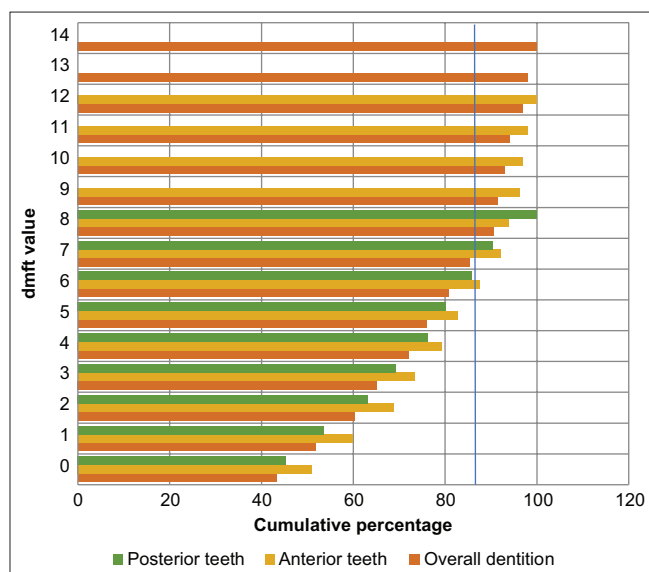
**Figure 1:** Distribution of DMFT values of the study participants for overall dentition, anterior teeth, and posterior teeth of the primary dentition

a DMFT value of more than or equal to 8 [Figure 1]. Therefore, posterior caries may be reasonable than even the widely used SiC index, as a simple measure of child's caries risk at 5–6 years of age.

A SiC index of nearly 8, while the mean DMFT is 3, and a mean PUFA score of 1.3, gives evidence for polarization of caries among the study participants. With a deciduous caries prevalence of 56.7%, a PUFA of 32.8% indicates a substantial proportion of children with caries to be suffering from consequences of untreated caries due to pulp exposure, ulceration, and fistula. A similar pattern is observed in other countries where, despite the reductions in caries, it is unevenly distributed in the pediatric population. A small proportion of individuals carry most of the disease burden, while proportion of untreated carious teeth remained stable over the years. With the decrease and polarization of caries, inequality and social exclusion is noted.[19] In the Sri Lankan context, the existence of social inequalities in dental caries[10] plays a role in polarization of caries in the country.

Despite causative effect of diet on caries, after controlling for confounders, snacking between meals was not significant in the present study. It may be due to recall and social desirability bias and challenges in determining cariogenicity of the diet. Association between diet and caries appears to have diminished with better plaque control and fluoride exposure.[20] Plaque control and fluoridated toothpaste usage among participants in the present study could be considered somewhat satisfactory.

Due to time constrains, the study had to be confined to a province in the country, limiting the generalizability of the findings. Unanticipated association of father having three or missing teeth with child's caries needs to be further researched. The non-response associated with self-administered questionnaire may have affected the results of the study.

## CONCLUSION

The present study confirming a strong polarization of caries together with a considerable proportion of caries been untreated

at 5–6 years of age, warrants revisions in children's oral healthcare delivery. Dedicated programs ensuring children with the highest need have access to services will overcome this avoidable, unfair, and unjust disease status. Renewed strategies on caries prevention and treatment prioritized on uneven disease burden and socioeconomic parameters with equitable resource use may prevent perpetuating oral health inequalities. Strengthening infant, toddler, and preschool oral health promotion programs are mandatory to reduce the childhood caries burden in the country. More engagement of the father is recommended in such health promotion efforts. The possibility of using the caries status of primary molars at 5–6 years of age as a simple and reliable measure to assess the success of preschool oral health promotion programs, a selection criterion to target high-risk children for special interventions, and a predictor for future caries needs to be studied.

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## COPYRIGHT AND PERMISSION STATEMENT

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