Caries experience and mutans streptococci as indicators of caries incidence

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Abstract

Studies indicate that previous caries experience can influence future caries development; however, caries-free individuals also may develop caries. The aim of this study was to examine the relationship between baseline caries experience and salivary mutans streptococci (SMS) levels as an indicator for predicting caries incidence in preschool children. One hundred forty-eight preschool children (mean baseline age, 3.8 years) of low socioeconomic status were examined for dental caries and SMS levels at baseline and annually for 2 years. All children were identified at baseline as either caries free or caries positive. The 2-year Δdmfs scores for both groups were evaluated as 0, 1–2, 3–4, or > 4. The children's baseline SMS levels were categorized as low (0 CFU), moderate (1–50 CFU), or high (> 50 CFU), and were recoded to assigned ranges of 1, 2, and 3, respectively, in each year for longitudinal analysis. Both the caries-free and caries-positive groups had high SMS levels associated with the greatest Δdmfs, and when SMS ranges were added for the three examination years (minimum = 3, maximum = 9), the mean second-year dmfs scores varied directly as the sum of the ranges. Results from this study suggest that SMS levels may be useful in identifying and predicting future caries in preschool children, independent of baseline caries experience. (Pediatr Dent 18:371–74, 1996)

Previous caries experience is considered one of the best predictors of future caries development in young children.[1,2] In the majority of studies involving previous caries experience, the emphasis has been on predicting caries in the permanent teeth.[3,4] These studies are limited in that: 1) they do not address caries development in the primary dentition, and 2) they attempt to quantify the rate of disease in subjects who are caries positive at baseline, but do not address caries development in individuals who are caries free (CF) at baseline. Within a given population, many subjects who are potentially at risk for developing caries may be caries free when first examined, especially among preschool children. Previous caries experience would not be applicable in these groups; therefore, other indicators for caries need to be considered.

Salivary mutans streptococci (SMS) levels also are considered a valuable indicator of future caries experience.[2,5] However, few studies have investigated the influence of early mutans streptococci (MS) infection on caries progression in the primary dentition. Some studies[6,7] have reported an association between the establishment of MS and dental caries prevalence in preschool children. In other studies, MS levels have been shown to be associated with maxillary anterior caries (nursing caries).[8–10] In general, these studies deal with caries severity and describe little about caries prevalence or incidence.

As part of a series of investigations on biological and social risk factors in dental caries, our studies have shown that MS levels may vary by racial/ethnic background,[11] may be related to longitudinal caries development,[12] and may be associated with specific caries patterns.[13] The purpose of the current longitudinal study was to investigate the individual and combined roles of baseline caries experience and salivary MS levels in predicting future caries in the primary dentition of preschool children.

Methods and materials

One hundred forty-eight Head Start children, initial mean age 3.8 years, were examined for dental caries at baseline and once annually for 2 years. This cohort represented all children who completed a two-year longitudinal study that initially started with 462 subjects.[11] The procedures, possible discomforts or risks, as well as possible benefits were explained fully to the patients, and their parents' informed consent was obtained prior to the investigation.

All children's homes and Head Start centers had optimally fluoridated water. There were no differences in baseline caries levels or levels of MS infection between the group that completed the study and the group that was lost through attrition. There was also no significant age difference between the group of caries-free children and the caries-positive (CP) children. Examinations were conducted at the children's pre-

schools by two calibrated dentists using portable dental chairs, mirrors, #23 explorers, and focusable flashlights. Caries diagnosis was by the Radike method,[14] and all tooth surfaces were recorded as either sound, carious, filled, crowned, sealed, exfoliated, or missing due to caries. Stainless steel crowns were recorded as five filled surfaces per tooth, and teeth missing due to caries were considered as five missing surfaces. Although dental care was available from local clinics, the majority of children received little or no treatment during the study period.[15]

Immediately following each examination, unstimulated saliva was collected by instructing the children to moisten the tip of a sterile tongue blade, which was impressed onto plates containing a medium selective for MS.[16] Plates were incubated for 72 hr at 37°C in a CO_2-enriched environment, after which time colony forming units (CFU) of SMS were semiquantitatively determined. MS counts were assigned into three ranges for statistical evaluation: low (0 CFU), moderate (1–50 CFU), or high (> 50 CFU).[11]

For some of the statistical evaluations, low, moderate, and high SMS ranges were ranked as 1, 2, and 3, respectively. The rankings of each child were added to obtain a composite SMS score based on three examinations. Therefore, composite scores for each child ranged from 3 (representing a child with three low SMS evaluations) to 9 (representing a child with three high SMS evaluations).

Statistical differences in caries prevalence between groups were evaluated with the chi-square test. Differences in dmfs scores by MS group were evaluated with the Kruskal-Wallis test, and the association between composite SMS levels and Δdmfs was evaluated with Spearman's Rank Correlation Coefficient.

Results

All children in the study were categorized by their baseline SMS group and caries status. Of those children who were caries free at baseline, 34, 49, and 17% had low, moderate, and high SMS levels, respectively. Fig 1 shows that children in the high SMS group were the least likely to remain caries free, and of those who developed caries, nearly 50% had a Δdmfs of more than four surfaces. In contrast, among children who were caries free at baseline, only 3% and 5% who had low and moderate SMS levels, respectively, had a Δdmfs greater than 4. Children in the low SMS group were the most likely to remain caries free, and of those who developed caries, the majority had an increment of one or two surfaces. Of those children who were caries positive at baseline, 7, 30, and 63% had low, moderate, and high SMS levels, respectively. In the caries-positive group, approximately 75% of the children with either moderate or high baseline SMS levels developed more caries.

The Table shows 2-year caries increments (Δdmfs) for all individuals, evaluated by baseline SMS levels. Both caries free and caries positive children with high SMS levels had significantly ($P < 0.05$) higher caries increments than children with low and moderate SMS levels. The mean Δdmfs for children in the low SMS group was approximately the same for those who were

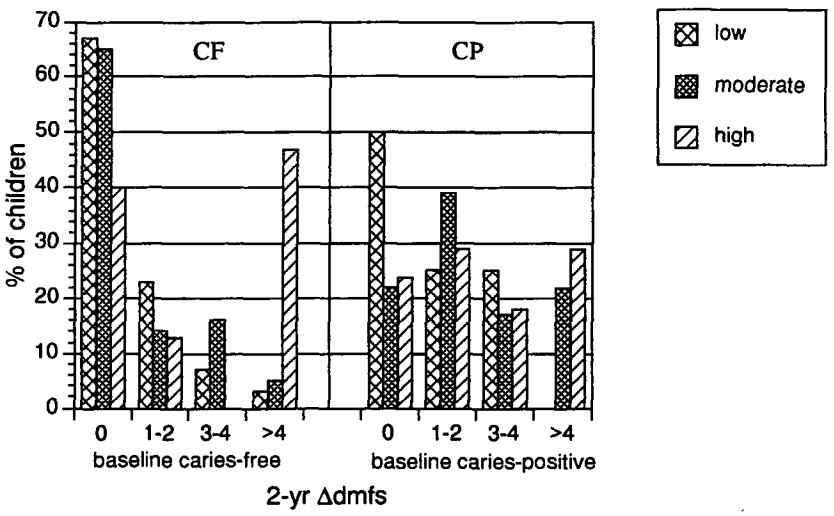
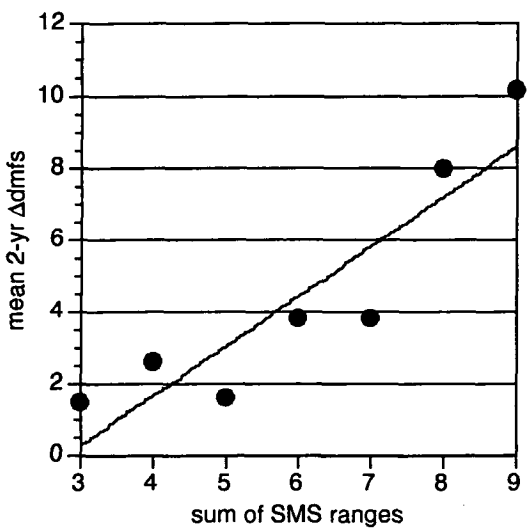


Fig 1. Percentage of subjects with caries increments by baseline SMS group and caries status.



$r_s = 0.93$, $p<0.01$

Fig 2. Association between caries increments and salivary mutans streptocci (as the sum of ranges in three examination years).

TABLE. TWO-YEAR CARIES INCREMENTS (ΔDMFS) BY BASELINE SMS GROUP

Baseline Caries Status and SMS Groups	All Subjects in Baseline SMS Group N	Δdmfs (mean ± SD)	Subjects with Increment N	Δdmfs (mean ± SD)
*Caries-free**				
Low	30	1.03 ± 2.50	10	3.10 ± 3.60
Moderate	43	0.98 ± 1.61	15	2.80 ± 1.52
High	15	4.53 ± 4.98	9	7.56 ± 4.22
Caries-positive				
Low	4	1.00 ± 2.16	2	2.50 ± 2.12
Moderate	18	3.28 ± 5.28	14	4.71 ± 5.08
High	38	4.50 ± 6.48	29	6.03 ± 6.71

* Significant difference ($P < 0.05$ by Kruskal-Wallis) in Δdmfs by baseline SMS level in children who were CF at baseline.

caries free and caries positive at baseline. Similar results were obtained for children in the high SMS group. Additionally, children who were caries-free at baseline and had high SMS levels experienced the greatest Δdmfs of all groups.

Children's SMS levels for each of the three examination years were ranked as 1, 2, and 3 for low, moderate, and high, respectively, and were added to obtain individual composite SMS scores. As composite SMS scores increased, both the mean second-year dmfs and the mean two-year Δdmfs increased ($r_s = 0.93$, $P < 0.01$). Children with the highest composite SMS scores had 4.6 times the second-year dmfs, and 3.8 times the Δdmfs, of children with the lowest composite SMS scores (Fig 2).

Discussion

Previous caries experience in the primary dentition long has been considered an indicator of future caries development in the permanent dentition.[3,4] However, few studies have investigated either primary caries as an indicator of future caries in the primary dentition, or caries development in preschool children who are initially caries free. Recent evidence suggests that MS levels may be one of the best indicators of caries development.[12] The combination of these two indicators may be useful in predicting caries in preschool children.

Results from this study suggest that baseline SMS levels may identify both caries-free and caries-positive children at risk for dental disease, and may predict future primary caries development. Children in both the caries-free and caries-positive groups with high baseline SMS levels were the most likely to develop new or additional caries. Children in the high SMS groups, independent of baseline caries status, also were the most likely to have the greatest caries increment after 2 years.

Although variations in oral hygiene and low levels of fluoride might have explained some of these findings, all subjects in this study lived in optimally fluoridated areas throughout the course of the study and participated in a daily, supervised morning brushing regimen (without the use of dentifrice) conducted by the Head Start program. The appearance of caries in the same children at later visits, despite referrals to dental clinics, suggests that the parents did not follow through with their child's referral or treatment.

Studies that have examined the relationship between MS levels and dental caries in the primary dentition have used a single sampling method. Since MS levels have been shown to fluctuate,[17] sampling at single time points may not adequately indicate current or potential disease activity. To improve our understanding of how MS levels affect longitudinal caries activity, we ranked individual mutans samples for each subject in every examination year, then generated a composite score based on the sum of those ranks. Our results show that children with the highest composite scores had significantly greater caries activity than children with the lowest composite scores. Since dental caries normally progresses slowly, longitudinal sampling techniques — which more accurately reflect temporal and accumulative changes in an individual's MS levels — may be of greater value than single readings for indicating a child's caries risk.

Conclusion

There is convincing evidence from numerous studies that previous caries experience may predict future caries development. These studies are limited in that they do not address the large numbers of caries-free individuals who are found in many populations. Our results indicate that baseline levels of SMS may be useful in identifying and predicting caries in preschool children. Earlier research on this population has shown the ability of MS, despite relatively high standard deviations in caries data, to both identify and predict caries prevalence,[11,12] as measured by sensitivity, specificity, and predictive values. Therefore, microbiological data may be used to enhance the identification and prediction of caries in the primary dentition, independent of baseline caries status.

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1. ter Pelkwijk A, van Palenstein Helderman WH, van Dijk JWE: Caries experience in the deciduous dentition as a predictor for caries in the permanent dentition. Caries Res 24:65–71, 1990.
2. Demers M, Brodeur JM, Mouton C, Simard PL, Trahan L, Veilleux G: A multivariate model to predict caries increment in Montreal children aged 5 years. Community Dental Health 9:273–81, 1992.
3. Hill IN, Blayney JR, Zimmerman SO, Johnson DE: Deciduous teeth and future caries experience. J Am Dent Assoc 74:430–38, 1967.
4. Poulsen S, Holm AK: The relation between dental caries in the primary dentition of the same individual. J Public Health Dent 40:17–25, 1980.
5. Alaluusua S, Kleemola-Kujala E, Nyström M, Evälahti M, Grönroos L: Caries in the primary teeth and salivary *Streptococcus mutans* and lactobacillus levels as indicators of caries in the permanent teeth. Pediatr Dent 9(2):126–30, 1987.
6. Alaluusua S, Renkonen OV: *Streptococcus mutans* establishment and dental caries experience in children from 2 to 4 years old. Scand J Dent Res 91:453–57, 1983.
7. Köhler B, Andréen I, Jonsson B: The earlier the colonization by mutans streptococci, the higher the caries prevalence at 4 years of age. Oral Microbiol Immunol 3:14–17, 1988.
8. Berkowitz RJ: *Streptococcus mutans* and dental caries in infants. Compendium of Contin Educ Dent 6(6):463–66, 1985.
9. Loesche WJ: Role of *Streptococcus mutans* in human dental decay. Microbiol Rev 50(4):353–80, 1986.
10. O'Sullivan DM, Tinanoff N: Social and biological factors contributing to caries of the maxillary anterior teeth. Pediatr Dent 15(1):41–44, 1993.
11. Thibodeau EA, O'Sullivan DM, Tinanoff N: Mutans streptococci and caries prevalence in preschool children. Community Dent Oral Epidemiol 21(5):288–91, 1993.
12. Thibodeau EA, O'Sullivan DM: Salivary mutans streptococci and the incidence of caries in preschool children. Caries Res 29(2):148–53, 1995.
13. Thibodeau EA, O'Sullivan DM: Salivary mutans streptococci and dental caries patterns in pre-school children. Community Dent Oral Epidemiol 24(4):164–68, 1996.
14. Radike AW: Criteria for diagnosis of dental caries. In: Proceedings of Clinical Testing of Cariostatic Agents. Chicago: American Dental Association 1972, pp 87–88.
15. Tinanoff N, Crall J, Thibodeau E, O'Sullivan D: The unmet dental needs of some preschool children. Dental caries patterns and treatment in Connecticut Head Start children: preliminary results. Conn St Dental Assoc J 67(2):21–23, 1991.
16. Kimmel L, Tinanoff N: A modified mitis salivarius medium for a caries diagnostic test. Oral Microbiol Immunol 6:275–79, 1991.
17. Weinberger SJ, Wright GZ: Variables influencing *Streptococcus mutans* testing. Pediatr Dent 12(5):312–15, 1990.