Interdental Spacing and Caries in the Primary Dentition

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Abstract

Purpose: This study assessed the relationship between interdental spacing patterns and caries experience in the primary dentition.
Methods: Caries examinations were conducted amoung 356 children 4 to 6 years of age. At the time of the examinations, alginate impressions were obtained and poured in yellow stone. From the stone casts, each interdental area was categorized as: (1) space >1 mm, (2) space <1 mm, (3) no space, teeth in contact, or (4) no space, teeth overlapped. These categories were collapsed into presence or absence of space for each interdental site, and counted for each individual. Analyses assessed the relationships between interdental spacing and caries experience with separate analyses for anterior spacing, posterior spacing and total spacing.
Results: Children with more total interdental spaces had less decay experience and less untreated decay than children with fewer interdental spaces, and children with more molar spacing had less molar decay experience; however, these relationships were weak. Correlation analyses demonstrated significant relationships between number of decayed surfaces and total number of interdental spaces (r=-0.11, P=.04) and number of molar sites with interdental spaces (r=-0.13, P=.02). Multivariate analyses revealed the total number of interproximal spaces to be weakly associated with interproximal caries experience, but that fluoride exposure was a much stronger predictor.
Conclusions: Absence of interdental spaces is weakly associated with greater decay experience in the primary dentition. (*Pediatr Dent*. 2003;25:109-113)

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It has been a long-held tenet in pediatric dentistry that the absence of interdental spaces in the primary dentition increases the risk for interproximal dental caries. Several pediatric dentistry textbooks have somewhat empirically suggested that crowding or lack of interdental spaces increase the caries susceptibility of adjacent interproximal surfaces.[1-6] For example, one text suggested that interproximal caries was rare in primary teeth until the early mixed dentition stage when proximal contact developed,[1,6] while another suggested that crowding (lack of interdental spacing) decreased the "accessibility to hygiene measures," thereby increasing plaque accumulation, with caries more likely to result.[3] However, none of the textbooks that made such statements cited any published studies, and a review of the literature found very few studies that have related interdental spacing in the primary dentition to caries experience. Thus, the lack of citations in the textbooks may be understandable.

In one of few studies to report on the relationship between dental caries and interdental spacing, Parfitt[7] found that, among 57 4-year-olds, 13% of interproximal surfaces in contact with an adjacent tooth were carious, compared to 1% of surfaces that were spaced at least 0.5 mm from the adjacent tooth. However, examination procedures—including sample characteristics and the recording of caries—were not described, and apparently no statistical analyses were performed, making it difficult to compare these data to any other studies. Moreover, the findings of this study reported in 1956 may not be relevant to contemporary populations with generally lower caries prevalence.

More recently, Ben-Basset[8] studied the relationship between interdental spacing and caries among a group of Ashkenazi children living in Jerusalem. In this study, 703 caries-free children were compared to 234 caries-affected children in the early mixed dentition. The caries-free children had a significantly (P<.05) higher proportion of surfaces with at least 0.5 mm of space adjacent to them (21% and 34% for the mandibular and maxillary arches, respectively), compared to the caries-affected group (8% and 16% for the mandibular and maxillary arches, respectively). Lastly, a study of 436 Japanese children in the primary dentition also suggested a relationship between caries and lack of spacing in the maxillary incisors, but no formal data analysis or statistical tests were presented to support this finding.[9]

Thus, while there have been previous studies assessing the relationship between interdental spacing and caries, they have been very few in number, and may not be applicable to contemporary US children. Therefore, the purpose of the present study was to describe the relationship between interdental spacing patterns and caries experience in the primary dentition among a large sample of US children.

Methods

Data were collected as part of the longitudinal Iowa Fluoride Study, which recruited a birth cohort from 8 hospital postpartum wards in eastern and central Iowa beginning in 1992.[10-16] Cohort children were born over a 35-month period from March 1992 to February 1995. More than 1,300 children were successfully recruited into the cohort, and 698 of these children received dental examinations at 4 to 6 years of age. As part of the fluoride study, data concerning family sociodemographic characteristics were collected at recruitment, and detailed data on each child's fluoride exposures and diet were collected at 3-, 4-, and 6-month intervals beginning at 6 weeks of age through the time of the examination.[12,15] The dental examinations collected data on dental caries experience and fluorosis, the results of which have been described previously.[16] No assessments of oral hygiene or plaque levels were made as part of the examinations. Of the 698 children receiving the dental examinations, 547 parents consented to having impressions made for their child and full arch maxillary and mandibular impressions were obtained for 526 of these children. The remaining 21 children either were uncooperative, refused to participate, or had sufficient difficulty with the impression that it wasn't completed. The impressions were poured in yellow stone and the casts were trimmed in centric occlusion.

To assess the naturally occurring spaces in the primary dentition, children with erupted permanent teeth were excluded. Of the 526 children for whom casts were obtained, 98 children were excluded due to the presence of 1 or more permanent teeth, and 72 others were excluded because their casts had broken teeth, large voids, or other problems. Thus, 356 children were included in the present analyses.

Evaluation of tooth spacing was performed by 1 examiner (TY) on a space-by-space basis using criteria similar to ones used in a previous study.[17] The interdental spaces were categorized as: (1) spacing present >1 mm, (2) spacing present but <1 mm, (3) spacing not present, teeth in contact, or (4) spacing not present, teeth overlapped. For the present analysis, the categories were collapsed into: (a) spacing present (1 or 2, above), or (b) spacing absent (3 or 4, above). Intraexaminer agreement for the examiner's categorization of interdental spacing, based on repeat assessment of approximately 20 casts, was 100%.

Surface-specific dental caries data were collected by 1 or 2 trained and standardized examiners (JJW, MJK), using cavitated/noncavitated criteria.[16] Only cavitated lesions and filled surfaces were included in the present analysis, and as described previously,[16] interexaminer reliability for decayed teeth was 99%, with κ=0.81, and values for filled teeth were 99% and 0.88. The examinations were part of an epidemiological study and were conducted at several different sites using portable equipment, so that no radiographs were made. In addition, concerns with exposing children to radiation strictly for research purposes precluded the making of radiographs. Thus, assessment of interproximal sites for caries was accomplished through direct visual and tactile means only.

The spacing data were linked to surface-specific caries data and analyzed using SPSS[18] and SAS[19] statistical software at the person level for all interproximal sites, as well as separate analyses for molar spaces and anterior spaces. Pearson's correlations were used to relate the number of interproximal and total carious or filled surfaces with number of interproximal spaces. In addition, data were analyzed at the interproximal site level, using Cochran-Mantel-Haenszel chi-square tests which control for clustering effects within subjects to assess the relationship between the presence or absence of caries experience and the presence or absence of interdental spacing for each interproximal site. Lastly, generalized linear regression procedures were used to assess the relative contribution of different risk factors for total number of interproximal caries. These risk factors included sociodemographic data, fluoride exposure data, and the number of sites of interproximal spacing per individual. These models assumed a Poisson distribution of interproximal caries experience and a log-link function.

Results

Table 1 presents characteristics of the study sample. Overall, the sample was of high socioeconomic status, with over 70% of mothers having had at least some college, and over half having annual family incomes of $40,000 or more. In addition to the information presented in Table 1, the mean age for mothers in the sample was 30 years at baseline, while the mean age of fathers at baseline was 32 years. Cohort children resided in both optimally fluoridated and nonfluoridated areas, so that cohort subjects had a fairly broad range (0.1-2.7 mg fluoride/day) of fluoride exposures as assessed at 60 months. Tables 2 to 4 present results of

Table 1. Sociodemographic Characteristics of the Sample

Characteristic	N	%
Males	177	50
Females	179	50
Mother's education		
High school diploma	96	28
Some colleg/2-year degree	102	29
4-year college degree or higher	149	43
Family income at baseline		
<$20,000/y	34	10
$20,000-$39,999/y	131	38
$40,000-$59,999/y	109	32
$60,000 or more	69	20
Race		
White	349	98
Black, Asian, or Hispanic	7	2

person-level Pearson correlation analyses of the relationships between spacing and caries. Table 2 presents correlations between whole-mouth number of interdental spaces and number of surfaces with different measures of caries experience. There was a statistically significant relationship between the number of interdental spaces and the number of decayed surfaces, but no other relationships between whole-mouth caries and interdental spacing were statistically significant. Similarly, as presented in Table 3, there was a statistically significant relationship between the number of molar sites with interdental spacing and the number of decayed molar surfaces. None of the other relationships between the number of molar sites and caries experience were statistically significant. Table 4 presents correlation analyses of the relationships between the number of anterior sites with interdental spacing and caries experience. None of these relationships were statistically significant.

Surface-level analyses relating caries experience of a particular interdental site to the presence or absence of interdental spacing at that site were conducted for each interdental site. In these analyses, caries experience for a site was defined as a decayed or filled lesion on either surface adjacent to an interdental site. Caries experience was higher for each site with no interproximal spacing, although due to the low prevalence of interproximal caries experience, none of the relationships for specific, individual interdental sites were statistically significant. However, when all sites were combined, a Cochran-Mantel-Haenszel test, which controls for clustering within individual children, demonstrated a significant relationship between spacing and caries experience. Specifically, 1% of sites without spaces had caries experience, whereas only 0.1% of sites with spaces had caries experience ($P<.001$). A similar analyses limited to only molar interdental sites also demonstrated a significant relationship.

Table 5 presents the final regression model for person-level interproximal caries experience. While the number of interproximal spaces was a significant risk factor in the model, its relative contribution was much less than fluoride exposure at 60 months or maternal education level. A similar model for interproximal caries experience at molar sites did not find the number of interproximal molar spaces to be a significant predictor.

Discussion

The results of the present study lend credence to the belief that the absence of interdental spaces in the primary dentition may increase the risk for dental caries. Although the analyses showed these relationships to be weak, several were statistically significant. Moreover, the relationships between interdental spacing and caries were uniformly negative; that is, in every instance, the analyses showed that the less the

Table 2. Pearson Correlation Between Whole-mouth Spacing Variables and Selected Caries Variables

Caries variable	Number of sites with interdental spacing	
	r	*P* value
Number of decayed surfaces	-0.111	.037
Number of decayed or filled surfaces	-0.071	.183
Number of decayed or filled anterior surfaces	-0.033	.531
Number of decayed or filled molar surfaces	-0.072	.178

Table 3. Pearson Correlation between Molar Spacing Variables and Selected Caries Variables

Caries variable	Number of molar sites with interdental spacing	
	r	*P* value
Number of decayed molar surfaces	-0.131	.013
Number of filled molar surfaces	-0.036	.495
Number of decayed or filled molar surfaces	-0.080	.132

Table 4. Pearson Correlation Between Anterior Tooth Spacing Variables and Selected Caries Variables

Caries variable	Number of anterior sites with interdental spacing	
	r	*P* value
Number of decayed anterior surfaces	-0.013	.807
Number of filled anterior surfaces	-0.022	.678
Number of decayed or filled anterior surfaces	-0.027	.609

Table 5. Results of Log-linked Regression Analysis of Factors Associated with Number of Sites with Interproximal Caries Experience

Variable	Parameter estimate±SE	*P* value
Number of interproximal spaces	-0.068±0.034	.046
Maternal education level	-0.619±0.121	<.001
Total fluoride exposure at 60 mos (mg/day)	-1.669±0.519	.002

interdental spacing (the absence of space), the greater the caries experience.

One possible reason for the weakness of the relationships between interdental spacing and caries, was that the prevalence of caries was low in this cohort, with only 27% of cohort children having any caries experience.[16] Furthermore, as evidenced by the data presented in Table 4, the prevalence of interproximal caries experience was especially low in the study sample, with less than 1% of interproximal sites affected. As part of a longitudinal cohort study, with considerable time involved for parents to continue participation over time, the cohort was made up of children from families who were better able to continue participating and were generally of higher socioeconomic status and, therefore, generally at reduced risk for caries.

In addition to these factors, as an epidemiological study, no radiographs were made so that some interproximal caries was likely to have been undiagnosed. In addition, as it is sometimes difficult to detect posterior composite restorations, some restorations involving proximal sites also may not have been diagnosed. However, despite these limitations, the authors did find a slight relationship between absence of space and greater caries experience. The study findings and the recognition of its limitations further supports the rationale for bitewing radiographs, particularly in cases where interproximal spaces are absent.

In future studies, other approaches to assessing relationships between caries and interdental spacing, including the case-control approach used previously by Ben-Basset,[8] may be appropriate and better able to assess the strengths of the interproximal caries-spacing relationship. However, any study (including the present one) that is based on a single assessment at 4 to 5 years of age may be limited by the effect of dental treatment, whereby the treatment of interproximal surfaces may have closed spaces that were present prior to treatment, thus confounding any relationships between caries and interdental spacing. Hence, a definitive study of the relationships between interdental spacing and caries would require assessments of interdental spacing both prior to and at the time just after the eruption of all of the primary dentition with periodic examinations for caries including radiographs. Given the costs of conducting such a study on a representative population and the rather limited, confirmatory knowledge to be gained, such a study may not be warranted.

Conclusions

The results of the study demonstrate that the absence of interdental spaces in the primary dentition is weakly associated with an increased risk for dental caries.

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References

1. McDonald RE. *Pedodontics*. St. Louis, Mo: CV Mosby Company; 1963:36-37.
2. Krasse B, Newbrun E. Objective methods for evaluating caries activity and their application. In: Stewart RE, Barber TK , Troutman KC, Wei SHY, eds. *Pediatric Dentistry–Scientific Foundations and Clinical Practice*. St. Louis, Mo: CV Mosby Company; 1982:610-611.
3. Mathewson RJ, Primosch. Hard tissue assessment. In: *Fundamentals of Pediatric Dentistry.* Chicago, Ill: Quintessence Publishing Co Inc; 1995:78-79.
4. Adair SM. The dynamics of change, epidemiology, and mechanisms of dental disease. In: Pinkham JR, ed. *Pediatric Dentistry–Infancy Through Adolescence*. 3rd ed. Philadelphia, Pa: WB Saunders Company; 1999:261-262.
5. Axellsson P. Etiological factors involved in dental caries. In: *Diagnosis and Risk Prediction of Dental Caries*. Vol 2. Chicago, Ill: Quintessence Publishing Co Inc; 2000:41.
6. McDonald RE, Avery DR, Stookey GK. Dental caries in the child and adolescent. In: McDonald RE, Avery DR, eds. *Dentistry for the Child and Adolescent*. 7th ed. St. Louis, Mo: Mosby; 2000:209-246.
7. Parfitt GJ. Conditions influencing the incidence of occlusal and interstitial caries in children. *J Dent Child*. 1956;23:31-39.
8. Ben-Basset Y, Harari D, Brin I. Occlusal traits in a group of school children in an isolated society in Jerusalem. *Br J Orthod.* 1997;24:229-235.
9. Nagatani N. Dental health examination in infancy and early childhood. Part 2. The results of dental survey and screening of dental caries. *Kanagawa Shigaku*. 1989;23:537-555.
10. Levy SM, Kiritsy MC, Slager SL, Warren JJ, Kohout FJ. Patterns of fluoride dentifrice use among infants. *Pediatr Dent*. 1997;19:50-55.
11. Warren JJ, Levy SM, Nowak AJ, Tang S. Non-nutritive sucking behaviors in preschool children: a longitudinal study. *Pediatr Dent.* 2000;22:187-191.
12. Levy SM, Warren JJ, Davis CS, Kirchner HL, Kanellis MJ, Wefel JS. Patterns of fluoride intake from birth to 36 months. *J Public Health Dent.* 2001;61:70-77.

13. Slayton RL, Warren JJ, Kanellis MJ, Levy SM, Islam M. Prevalence of enamel hypoplasia and isolated opacities in the primary dentition. *Pediatr Dent.* 2001;23:32-36.
14. Warren JJ, Bishara SE, Yonezu T, Steinbock KL, Nowak AJ. Effects of oral habits' duration on dental characteristics in the primary dentition. *J Am Dent Assoc*. 2001;132:1685-1693.
15. Slayton RL, Kanellis MJ, Levy SM, Warren JJ, Islam M. Frequency of reported dental visits and professional fluoride applications in a cohort of children followed from to age 3 years. *Pediatr Dent.* 2002;24:64-68.
16. Warren JJ, Levy SM, Kanellis MJ. Dental caries in the primary dentition: assessing the prevalence of cavitated and noncavitated lesions. *J Public Health Dent*. 2002;62:109-114.
17. Kisling K, Krebs G. Patterns of occlusion in 3-year-old Danish children. *Community Dent Oral Epidemiol.* 1976;4:152-159.
18. SPSS Base 7.5 for Windows User's Guide 7.5. Chicago, Ill: SPSS Inc; 1997.
19. SAS Version 8 for Microsoft Windows. Cary, NC: SAS Institute; 1999.

Abstract of the Scientific Literature

Normal Growth and Revised Growth Charts

In January 2002, the Centers for Disease Control and Prevention published revised growth charts for children to replace those published in 1977. These revised charts and additional technical information are available at www.cdc.gov/growthcharts. Three new features are available: (1) extension of the age ranges up to the 20th birthday; (2) body mass index (BMI), a measure of obesity; and (3) the 3rd and 97th percentiles (for cases at the extremes of growth). These provisions also provide technical improvements in the charts, 2 of which are particularly important. First, whereas the old charts were based on a small sample of children from 1929-1975, the revised charts are based on 5 recent, ethnically diverse, national samples. Secondly, the revised charts also include breast-fed infants, as opposed to the old charts which were largely based on bottle-fed infants. Training modules at the Web site provide additional information about how to use the updated growth charts. The author also states 5 helpful rules of thumb to remember when monitoring children's growth: (1) Term infants usually lose 5%-10% of their birth weight immediately after birth, but regain their birth weight within 2 weeks. (2) Term infants double their birth weight in 4 to 5 months and triple it by 1 year of age. (3) A child's height doubles during the time between birth and 3 to 4 years of age. (4) The average size of 4-year-old children is 40 inches and 35 pounds. (5) From 3 to 10 years of age, children grow an average of 2.5 inches/year.

Comments: As primary health care providers, pediatric dentists are in an important position to monitor a child's growth and development. Recording vitals statistics including height and weight is a routine element of a child's dental visit. These revised charts are for all ethnic groups. Online availability and technical information is also helpful. **SS**

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Dawson P. Normal growth and revised growth charts. *Pediatr Rev.* 2002;23:255-256.

0 references; 4 articles for suggested readings