Distribution of primary tooth caries in first-grade children from two nonfluoridated US communities

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Abstract

In a prospective longitudinal study, 1099 first grade children from Aiken, South Carolina, and 1086 children from Portland, Maine, were examined annually for 3 years. Caries prevalence and dmfs incidence were determined. The mean dmfs in Portland children was 2.9. In Aiken, white children had a mean dmfs of 8.4, and black children had a mean dmfs of 10.2. The mean 3-year primary tooth caries increment was 1.5 surfaces in the Portland cohort 3.3 surfaces in the Aiken white cohort and 2.8 surfaces in the Aiken black cohort. These increments were divided evenly between interproximal and fissure surfaces. Twenty percent of the children in Portland had 75% of the caries; in Aiken, 20% of the children had 60% of the caries. This distribution suggests a high-risk group that could be targeted for aggressive caries prevention efforts if risk factors can be identified. (Pediatr Dent 16:200–5, 1994)

Introduction

There have been significant changes in the epidemiology of coronal tooth caries in the past decade. For children aged 5–17, the mean DMFS was 36% lower in a US nationwide survey in 1986–87 [1] than in a similar survey in 1979–80.[2] Despite this decrease, dental caries continues to be a significant health problem for many children. In 1987, acute oral health conditions alone accounted for 3.5 million restricted activity days and nearly a half-million lost school days for children aged 5–17.[3] This should not be surprising because the 1986–87 data reveal that more than half of the children aged 5–17 have dental caries in permanent teeth.

The epidemiology of dental caries in the primary dentition of children has received less attention and investigation than that of permanent teeth. Comparing the 1986–87[1] and 1979–80[2] national surveys, the decline in dmfs for children aged 5–9 was only 26% versus a 36% decline in the DMFS of 12-year-olds. Based on these data it can be concluded that the prevalence of caries in the primary dentition was not only greater than that in the permanent dentition, but its decline from 1979–80 to 1986–87 was less dramatic.

The epidemiology of primary tooth caries needs more exploration. Underscoring this point further is the fact that the actual distribution of primary tooth caries within the US population is unknown. The National Preventive Dentistry Demonstration Project (NPDDP) found that 60% of the dental caries occurred in 20% of the children.[4] This distributional index is quoted often; however it should be noted that these caries distributional data apply to permanent teeth only, not primary teeth. A high-risk group of children with primary tooth caries has not been identified nor characterized; that was a major aim of our study. This information is essential to determine whether preventive methods should be applied universally to all children or targeted to those with elevated risk. In a time of limited oral health care resources, these questions have important health policy implications.

Data on primary tooth caries

The limited information available on primary tooth caries comes from studies in primary dentitions of narrowly defined population groups in developing or industrialized countries.[5] Data from these studies have not been collected by standardized methods, making comparisons very difficult. Moreover, most of these studies have been cross-sectional, so estimates of caries incidence are impossible to infer.

A few studies have attempted to estimate changes in primary tooth caries by comparing caries prevalence in successive cross-sectional studies. A decrease in prevalence of primary tooth caries has been reported from cross-sectional studies of national samples of US children from 1963 to 1987 (Table 1).

Outside the United States, a decrease in primary tooth caries has not been demonstrated clearly. Truin, et al. studied children in The Hague, The Netherlands,

Table 1. Prevalence of dental caries in primary teeth of children in US population studies

Date	*Age*	*deft*	*dfs*
1963–65[2]	6–11	3.0	n.r.
1971–74[2]	6–11	2.7	n.r.
1979–80[2]	5–9	2.6	5.3
1986–87[1]	5–9	1.9	3.9

n.r. = not reported.

finding that the dmfs in 5-year-old children increased between 1984 and 1989 in low and medium SES groups and decreased in high SES groups.[6] Between 1973 and 1988, Frencken, et al. reported a decrease in mean dmfs in 6-year-old children in the providence of Friesland, The Netherlands. However, between 1982 and 1988 very little change occurred. The authors believed these findings reflected a leveling off in the decline of primary tooth caries and suggested that an increase may be occurring again.[7] Holt examined preschool children from Camden, England, from 1966–86 and found that the prevalence of primary tooth caries declined during the 1970s, but the decline did not continue in the 1980s.[8]

Primary tooth caries by tooth type and surface

The prevalence of primary tooth caries by specific tooth type and by specific tooth surface has been reported in the United States (Table 2) and in foreign studies (Table 3). Trubman, et al. reported that primary first and second molars were affected more often than canines or incisors in 6-year-old children enrolled in the Mississippi Head Start program.[9] In a survey of 1,796 3- to 5-year-old Head Start children, Louie, et al. found that the percent distribution of dfs by surface type differed by ethnicity.[10] Occlusal and buccal/lingual caries accounted for 72% of the dfs in black children, 64% of the dfs in white children, and 52% of the dfs in Native Americans. Proximal caries accounted for 28% of the dfs in black children, 36% of the dfs in white children, and 48% of the dfs in Native Americans.[10] Greenwell, et al., in a retrospective dental record review of 317 children selected from three private pediatric dental practices in northeast Ohio, found that pit and fissure caries was seen more frequently than molar/proximal caries in the primary dentition.[11]

In a survey of urban 6-year-old schoolchildren in Madagascar, Petersen and Steengaard found a mean dmfs of 11.8. They further divided caries by tooth surfaces and reported a mean of 2.9 occlusal surfaces, 5.8 mesial/distal surfaces and 3.1 facial/lingual surfaces affected.[12] In a study in Tanzania in 1984 and

Table 2. Prevalence of dental caries and the proportion of caries-free children in US studies

Author	*Age (years)*	*Mean dmfs*	*Mean dmft*	*% caries free*	*Sample*
Infante and Russell (1974)[15]	1–5	2.6	1.8	62.1	Whites
Infante and Russell (1974)[15]	1–5	3.3	2.7	47.0	Blacks
Conti, et al. (1974)[16]	2–4	4.0	2.6	47.3	Blacks
Johnsen, et al. (1986)[17]	3–5	4.0	2.5	42.9	Head Start
Johnsen, et al. (1987)[18]	2–5	8.7	n.r.	32.2	Head Start
Trubman, et al. (1989)[9]	3–6	6.1	3.0	n.r.	Head Start
Brunelle (1982)[19]	5–9	3.91	1.9	n.r.	US children
Louie, et al. (1990)[10]	3–5	9.8	4.76	n.r.	Head Start
Smythe, et al. (1990)[20]	3–15	3.57	n.r.	38.8	USAF families
Marques and Messer (1992)[14]	2–6	4.0	2.4	n.r.	Minnesota children

n.r. = not reported.

Table 3. Prevalence of dental caries and the proportion of caries-free children in non-US studies

Author	*Age (years)*	*Mean dmfs*	*Mean dmft*	*% caries free*	*Sample*
Morgan and Holm (1987)[21]	6–10	n.r.	5.0	11	Vietnam
Petersen and Steengaard (1988)[12]	4–13	8.8	n.r.	n.r.	Madagascar
Mosha and Robison (1989)[22]	5–7	2.0	1.1	61	Tanzania
Songpaisan and Davies (1989)[23]	5–6	n.r.	4.4	29	Thailand
Kerosuo and Honkala (1991)[5]	3–7	2.6	n.r.	37	Tanzania
Kerosuo and Honkala (1991)[5]	3–7	2.0	n.r.	66	Finland
Al-Khateeb, et al. (1991)[24]	6	3.2	n.r.	n.r.	Saudi Arabia
Truin, et al. (1991)[6]	5	2.6	n.r.	60	Netherlands
Saemundsson, et al. (1992)[25]	4–8	6.5	n.r.	42	Iceland

n.r. = not reported.

Finland in 1987 of children age 3 to 7 years old, Tanzanian children had considerably higher caries experiences. In the Tanzanian children, the maxillary incisors were affected most frequently while in the Finnish children, the mandibular second molar was affected most frequently.[5]

The studies summarized here relied upon a cross-sectional research design, as did several other studies done inside or outside the US (Tables 2 and 3). While a cross-sectional design is useful for determining caries prevalence, it cannot be used to determine caries incidence, nor to identify factors that may predict subsequent caries development. To determine caries incidence, it is essential to follow a group over time, relying upon a longitudinal research design.

The purpose of this study was to employ a longitudinal research design to: 1) determine the prevalence of primary tooth caries in a well-defined population and to report this by specific tooth type and 2) determine the incidence and distribution of dental caries increments in primary teeth and to describe these by specific tooth type and surface.

Methods and materials

The data used in this study were collected as a part of the University of North Carolina Caries Risk Assessment study (UNCCRA) — a longitudinal caries prediction study conducted in the more than 4,000 first- and fifth-grade children from nonfluoridated areas surrounding Aiken, South Carolina, and Portland, Maine.

In the fall of 1986, baseline data were collected, salivary microbiological tests performed, and a questionnaire sent to the children's parents. Standardized clinical examinations were conducted by dentists using portable dental chairs, fiber optic lights, dental mirrors, and explorers. Data were entered directly into portable computers. Clinical exams were repeated at the same time of the year for the next 3 years.

Data collected from the first-grade children who were full participants in the UNCCRA study were used for this study. Children were defined as full participants if their parents returned a completed questionnaire and they were examined at years one and four.

Dental examiners were trained and calibrated for all methods used in the study through multiple training sessions held to clarify interpretations of definitions, diagnostic criteria, and decision rules. Examiner reliability was tested with an annual reliability sample of 30 children from each grade at each site (120 children total). Children in the reliability study were scored first by one examiner and then by a second examiner. Intraclass correlation of interexaminer reliability for dmfs at baseline was 0.99 and at the 3-year followup 0.92.[13]

Statistical measures used in the descriptive parts of this study included proportions, means, and standard deviations. Comparisons were made among white children in Portland, white children in Aiken, and black children in Aiken.

To determine overall primary tooth caries increment experienced by children in the two first-grade cohorts, the baseline dmfs score was subtracted from the final dmfs score for each child. To determine the 3-year dmfs increment in primary canines and molars, each child's baseline dmfs score in the primary canines and molars was subtracted from the final dmfs in the primary canines and molars. Each tooth surface was scored by the examiner and subsequently a computer program classified each carious surface as interproximal caries or fissure caries. Fissure surfaces were defined as occlusal surfaces of all first and second primary molars, the buccal surfaces of the mandibular molars, and the lingual surfaces of the maxillary molars. Buccal lesions on the maxillary molars and lingual lesions on the mandibular molars were infrequent and not included as fissured surfaces. These surfaces were included as components of all primary decayed surfaces. Interproximal surfaces were defined as mesial or distal surfaces of the primary incisors, canines, and molars.

Table 4. Prevalence of primary tooth caries for all primary teeth and for tooth type in first-grade children in Aiken, South Carolina, and Portland, Maine

		Portland Whites $N = 1086$	*Aiken Whites* $N = 549$	*Aiken Blacks* $N = 550$
All primary teeth	% caries free	63	33	20
	Mean dmfs	2.9	8.4	10.2
	SD	6.0	11.8	10.6
Maxillary				
Molars	Mean dmfs	1.2	2.9	3.2
	SD	2.7	4.0	4.3
Canines	Mean dmfs	0.1	0.2	0.2
	SD	0.5	0.9	0.8
Incisors	Mean dmfs	0.3	1.1	1.0
	SD	1.3	2.7	2.5
Mandibular				
Molars	Mean dmfs	1.6	4.2	4.4
	SD	3.3	5.2	5.3
Canines	Mean dmfs	0.1	0.3	0.2
	SD	0.6	1.0	0.7
Incisors	Mean dmfs	0.0	0.1	0.1
	SD	0.2	0.5	0.5

Table 5. Three-year primary tooth caries increment in first-grade children in Aiken, South Carolina, and Portland, Maine

Primary Tooth Increment	*Portland Whites N = 1086* %	*Aiken Whites N = 549* %	*Aiken Blacks N = 550* %
≤ 0	62	36	35
1	6	10	10
2	10	9	11
3	4	6	7
4	3	5	6
5	2	4	5
6	2	4	4
7	2	3	4
8	2	4	2
9	1	3	2
Mean	1.5	3.3	2.8
SD	3.1	5.1	4.3

Table 6. Three-year primary tooth caries increment by components, in first-grade children in Aiken, South Carolina, and Portland, Maine

		Portland Whites N = 1086	*Aiken Whites N = 549*	*Aiken Blacks N = 550*
All primary molars surfaces	Mean	1.5	3.3	2.8
	SD	3.0	5.0	4.2
Primary tooth interproximal surfaces	Mean	0.7	1.6	1.4
	SD	1.5	2.3	2.0
Primary tooth fissured surfaces	Mean	0.7	1.4	1.1
	SD	1.4	2.2	1.9
All primary tooth surfaces	Mean	1.5	3.3	2.8
	SD	3.1	5.1	4.3

Results

Of the 1406 first-grade children examined at baseline in Aiken, 1099 (78%) were full participants. Of the 1404 first-grade children examined at baseline in the Portland, 1086 (77%) were full participants. The participating Aiken cohort was 47% female and 50% black with an average age of 6.6 years. The participating Portland cohort was 50% female and 0% black with an average age of 6.9 years.

Table 4 summarizes the prevalence of primary tooth caries by tooth type with the data shown separately by race. Caries prevalence was lower in Portland children. The mean dmfs in Portland whites was 2.9, in Aiken whites 8.4, and in Aiken blacks 10.2. Portland children were much more likely than Aiken children to be caries free in the primary dentition: 63% in Portland versus 33% for white children and 20% for black children in Aiken. Prevalence of dental caries affecting primary maxillary molars and canines was two or more times greater in Aiken than in Portland. Caries prevalence in maxillary incisors was three times greater in Aiken than in Portland. Caries affecting mandibular primary teeth showed similar patterns. Aiken children had approximately 2.5 times more caries affecting their molars and canines than Portland children. Very few children had caries affecting their mandibular incisors in either group.

Data describing the 3-year primary tooth caries increment are shown in Table 5. The proportion of children who were caries free over the 3-year study was 62% in Portland, 36% in Aiken whites, and 35% in Aiken blacks. The mean caries increment was much lower in Portland than in Aiken, with an increment of 1.5 in Portland, and an increment of 3.3 in whites and 2.8 in blacks in Aiken.

The majority of the 3-year primary tooth caries increment was found in the primary molars, with little occurring on remaining anterior teeth (Table 6). Interproximal and fissure decay was divided almost equally for all three groups.

In this study, a primary tooth caries increment greater than or equal to 3 was assigned arbitrarily as a proxy for high caries risk (Table 7). This assignment gave a distribution index in which 20% of the Portland cohort had 75% of the new caries increment. In Aiken, 20% of the white children had 60% of the new caries, while 20% of the black children had 58% of the new caries. (Table 8). This disproportionate distribution index is similar to that reported in the NPDDP, which found 60% of permanent tooth caries occurred in 20% of the children.[4]

Discussion

The areas surrounding Aiken, South Carolina, and Portland, Maine, were selected for the UNCCRA study because residents were considered to have environmental and social characteristics that would permit a 3-year longitudinal study and because both areas were located in regions of the US with historically high caries experience. All children studied were from nonfluoridated areas in which the schools had no topical fluoride program. Both areas had a low dentist-to-population ratio and both comprised predominantly middle- to low-income families. Considering the simi-

Table 7. Cumulative frequency distribution three-year primary tooth caries increment

Surfaces	*Portland Whites N = 1086*	*Aiken Whites N = 549*	*Aiken Blacks N = 550*
≤ 0	100	100	100
1	36	58	59
2	29	48	50
3*	19	39	38
4	15	33	31
5	12	28	25
6	10	24	20
7	8	21	17
8	6	17	12
9	4	13	10
10	4	10	8

* Three or more was selected as high caries risk.

Numbers in the table are the proportion of children in each cohort who developed at least as many carious primary tooth surfaces as indicated in column labeled "surfaces."

Table 8. Percent of primary tooth caries increment found in each caries risk group

Caries Risk Group % of Children	*% of Caries Increment*		
	Portland Whites N = 1086	*Aiken Whites N = 549*	*Aiken Blacks N = 550*
30	84	78	73
20	75	60	58
10	52	39	33

larities described, the difference in caries prevalence in these two areas was surprising. Additional analyses comparing these two communities is needed to establish reasons for these observed differences.

Maxillary and mandibular molars were affected much more frequently than canines or incisors in both areas. The primary tooth caries increment in canines and incisors accounted for very little of the new decay. However it is important to note that most children had exfoliated some incisors before the start of the study. Therefore, incisor caries could not be accurately determined nor was it possible to describe to what extent nursing caries contributed to the decay seen in these two populations.

The findings from this study agree with those of Trubman, et al. where primary molars were affected more frequently than canines or incisors in Mississippi Head Start children.[9] In Tanzanian children, maxillary incisors were the most affected teeth;[5] however, these children were age 3–7, permitting a more accurate description of caries in primary incisors. On the other hand, Finnish children in the same age group had a much higher prevalence of caries in molars.[5] The difference between these two groups was explained as differences in dietary habits, access to fluorides, oral hygiene, and host resistance.

Previous data from permanent teeth suggest that most of the caries prevalence[1] and increment[4] occurs in fissured surfaces. In this longitudinal study of primary teeth, the increment was divided almost equally between fissure surfaces and interproximal surfaces. Due to the predominance of pit and fissure caries in permanent teeth, there has been a shift in public health policy away from fluoride mouth rinse programs, favoring a more aggressive approach of sealants in caries preventive programs. Based on this study, in which the fissure and interproximal caries increment were nearly equal, it would appear that fluoride is an equally important preventive measure for primary teeth. This concurs with Marques and Messer, who found that suboptimal fluoride consumption was an important predictor of primary tooth caries.[14]

This report describes data on primary tooth caries from a longitudinal study conducted between 1986–1989. To date they are the only data reported on the incidence and increment of caries in primary teeth from a study conducted with a prospective longitudinal design. This study shows clearly that there is a group of first-grade children at high risk for primary tooth caries. This indicates a need to identify those risk factors that predict best those children at high risk of developing caries in primary teeth. If we can identify those children in population groups, it may be possible to target them with prevention strategies to reduce their caries burden.

Conclusions

Using a longitudinal study design, this study demonstrated that:

1. Significant levels of primary tooth caries occurred in children in two nonfluoridated areas.
2. Primary tooth caries was distributed evenly between pit and fissures and smooth surfaces.
3. A minority of the children had a majority of the caries, revealing the presence of a high-risk group in the population under study.

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