Prevalence of Noncavitated and Cavitated Carious Lesions in 5-year-old Head Start Schoolchildren in Alachua County, Florida

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Abstract

Purpose: The diagnosis of early carious lesions is essential for nonsurgical management of dental caries. This report describes the prevalence of early noncavitated and cavitated carious lesions in the primary dentition of 5-year-old Head Start schoolchildren in Alachua, Fla.
Methods: As part of the Fluoride Varnish Study conducted at the University of Florida, modified caries diagnostic criteria—which differentiated caries lesion activity and severity—were developed for the primary teeth. Dental examinations were conducted on 221 children ages 5 years by 2 calibrated examiners.
Results: Overall, 86% of the children had experienced noncavitated or cavitated caries lesions in the primary dentition. Prevalence of cavitated dentinal lesions was 48%, and prevalence of active noncavitated enamel lesions was 71%. The mean number of active noncavitated enamel lesions (mean±SEM: 2.91±0.21) was slightly higher than the mean number of cavitated dentinal lesions (2.52±0.31). The mean number of restored surfaces was 1.24 (±0.42), and only 8% of the children had 1 or more restored surfaces. Noncavitated lesions were most common on occlusal surfaces, especially in mandibular second molars. African-American children had a higher prevalence of noncavitated lesions (81%) than whites (69%) or others (33%; $P<.0001$). Prevalence of cavitated lesions was 49% for African Americans, 46% for whites, and 48% for others.
Conclusions: This study shows that noncavitated enamel and cavitated dentinal lesions are common in this study population's primary dentition. There is a need for preventive measures and treatment of decay in these children living in low-income families. (*Pediatr Dent.* 2005;27:54-60)

Keywords: carious lesions, primary dentition, noncavitated, cavitated

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Despite evidence of a decline in the incidence of dental caries in the United States over the past several decades, the disease remains a significant problem for the nation's children, especially children in low-income families.[1] Based on the analyses of the data from the National Health and Nutrition Examination Surveys (NHANES), the mean number of decayed or filled primary teeth (dft) among children ages 2 to 5 years decreased from 1.21 (NHANES I, 1971-1974) to 1.01 (NHANES III, 1988-1994).[2] The surveys, however, showed no reduction in untreated decay in children who were at or below the poverty level. Unfortunately, groups at highest risk for disease–the poor and minorities–have lower rates of receiving dental care than the US average.[3]

Head Start is a national program providing comprehensive developmental services, primarily to low-income preschool children and their families. Because Head Start serves low-income families, these children may be at greater risk for caries than other US children of similar age. Thus, they represent an important preschool group to examine for primary dentition caries.

Given the wealth of information about the possibility of remineralizing of early carious lesions and how dental health providers and patients themselves can influence this

Table 1. Description of Caries Diagnostic Criteria

Sound	Sound, normal enamel translucency and texture.
Active noncavitated enamel	Active enamel caries, surface of enamel is whitish/yellowish opaque with loss of luster; feels soft or rough on probing. Presence of small porosity involving enamel only.
Inactive noncavitated enamel	Inactive enamel caries, surface of enamel is brownish or black. Enamel may be shiny and feels hard and smooth on probing. Small porosity involving enamel only.
Cavitated enamel	Enamel cavity easily visible with the naked eye; surface of cavity feels soft or leathery on probing.
Cavitated dentinal	Dentinal cavity easily visible with the naked eye; surface of cavity feels soft or leathery on probing.
Pulpal involvement	Dentinal cavity extending into the pulp.

protective process, diagnosis of early carious lesions is a necessary first step for the prevention and management of dental caries. The current scoring systems for dental caries, however, do not consider the dynamic nature of the disease. The traditional measurement of caries at the stage of cavitation, excluding precavitation stages[4], no longer accurately reflects changes in the incidence of caries.

It has been shown that the diagnosis of caries at the cavitation stage results in a significant underestimation of the actual caries experience in populations.[5-7] Differentiation of the activity of lesions using a modified caries scoring system has been tested in the permanent dentition,[7,8] but there are only few reports from North America on the distribution of noncavitated carious lesions in a representative sample of a population.[5]

This study's purpose was to describe the prevalence and distribution of noncavitated and cavitated carious lesions in the primary dentition of a random sample of 5-year-old Head Start preschool children in Alachua County, Fla. The data presented were collected during the baseline examination of a clinical fluoride varnish study conducted during 1999-2000 at the University of Florida.

Methods

Children in 10 Head Start schools in Alachua County were invited to participate in this study. The schools were located in areas where the drinking water contained 0.80 mg of fluoride per liter. Two hundred twenty-one children (109 females, 112 males) between 5 and 6 years of age with parental consent were randomly selected to this study. The procedures, possible discomforts or risks, as well as possible benefits were explained fully to the parents, and their informed consent was obtained prior to the investigation. The research protocol and informed consent forms were reviewed and approved by the University of Florida Health Science Center Institutional Review Board (IRB) Involving Human Subjects.

For caries diagnosis, the activity and severity of caries lesions were differentiated on the basis of a combination of visual and tactile criteria. Radiographic bite-wings were used to confirm that lesions had not extended into the dentin and to identify proximal lesions. Radiographic bite-wings were taken from each child using a standard technique and positioning devices. For visual examination, teeth were isolated with cotton rolls and the surfaces were dried with compressed air. The explorer's tip was gently used to check for the loss of surface smoothness or loss of tooth structure. Table 1 shows the scoring criteria for clinical caries assessment, as discussed by Nyvad et al.[7]

Two calibrated dentists performed the examinations in the pediatric dental clinic at the University of Florida. They were blinded from each other's examinations. The examiners and 4 other pediatric dentists held preliminary discussions and clinical rehearsals on caries diagnosis and calibration before the initial examinations were performed. Clinical pictures were taken and reviewed during the calibration discussions. Only 2 main examiners were calibrated clinically. Interexaminer reliability of the caries diagnostic criteria was assessed by re-examining 10% of the subjects. The percentage agreement was 79%, and the Cohen's value was 0.71—indicating a substantial level of agreement. Due to a low incidence of lesions in bite-wings, the authors did not calculate the inter-rater reliability on radiographic diagnosis.

Statistical analysis

Data analyses were conducted at the person and tooth level. For person-level analyses, SAS version 9.0 statistical software (SAS Institute, Inc., Cary, NC) was used to conduct univariate and bivariate analyses. Chi-square analysis was used to test differences in the prevalence of enamel and dentin lesions by sex and race. The generalized linear modeling (GLM) procedure was used for analysis of variance (ANOVA) modeling to test differences between children who had cavitated dentinal lesions and those who did not in the mean number of enamel lesions.

Linear regression modeling was used to test the association between the number of enamel lesions and number of dentinal lesions. Tooth-level analyses were conducted by using SUDAAN 7.50 statistical software (Research Triangle Institute, Research Triangle Park, NC), which adjusts for clustering effect of teeth within individuals when calculating standard errors. Tooth-level analysis tested differences in means and proportions by tooth type by using chi-square

Table 2. Mean Number of Decayed, Missing, or Filled Primary Teeth or Tooth Surfaces per Child and Prevalence of Caries Lesions, by Race and Lesion Type

Race/caries lesion type	Mean (SEM)*	Median	Range	Prevalence of ≥1 lesion(%)
Total (N=221)				
Active noncavitated enamel surfaces	2.91 (0.21)	2.00	0-19	71
Inactive noncavitated enamel surfaces	0.18 (0.05)	0.00	0-5	8
Cavitated enamel surfaces	0.41 (0.08)	0.00	0-11	17
Cavitated dentinal surfaces	2.52 (0.31)	0.00	0-30	48
Pulpal involvement, surfaces	0.13 (0.04)	0.00	0-5	7
Filled surfaces	1.24 (0.42)	0.00	0-55	8
Missing surfaces	0.46 (0.19)	0.00	0-25	4
dft†	2.39 (0.21)	1.00	0-12	56
dfs‡	4.29 (0.52)	1.00	0-55	56
African-American (N=148)				
Active noncavitated enamel surfaces	3.27 (0.27)	3.00	0-19	77
Inactive noncavitated enamel surfaces	0.23 (0.06)	0.00	0-4	11
Cavitated enamel surfaces	0.44 (0.11)	0.00	0-11	18
Cavitated dentinal surfaces	2.32 (0.34)	0.00	0-29	49
Pulpal involvement, surfaces	0.17 (0.05)	0.00	0-5	9
Filled surfaces	1.36 (0.56)	0.00	0-55	8
Missing surfaces	0.61 (0.27)	0.00	0-25	4
dft†	2.34 (0.24)	1.00	0-12	57
dfs‡	4.29 (0.66)	1.00	0-55	57
White (N=52)				
Active noncavitated enamel surfaces	2.40 (0.36)	2.00	0-11	69
Inactive noncavitated enamel surfaces	0.00 (0.00)	0.00	N/A	0
Cavitated enamel surfaces	0.46 (0.15)	0.00	0-4	19
Cavitated dentinal surfaces	3.21 (0.80)	0.00	0-30	46
Pulpal involvement, surfaces	0.08 (0.05)	0.00	0-2	6
Filled surfaces	1.08 (0.74)	0.00	0-37	10
Missing surfaces	0.21 (0.19)	0.00	0-10	4
dft†	2.75 (0.49)	1.00	0-12	56
dfs‡	4.83 (1.11)	1.00	0-40	56
Other or unreported race (N=21)				
Active noncavitated enamel surfaces	1.62 (0.72)			29
Inactive noncavitated enamel surfaces	0.24 (0.24)			5
Cavitated enamel surfaces	0.05 (0.05)			5
Cavitated dentinal surfaces	2.19 (0.90)			48
Pulpal involvement, surfaces	0.00 (0.00)			0
Filled surfaces	0.76 (0.76)			5
Missing surfaces	0.00 (0.00)			0
dft†	1.90 (0.62)			52
dfs‡	3.00 (1.26)			52

*SEM=standard error of the mean.
†Decayed or filled primary teeth. Includes teeth with cavitated enamel lesions, cavitated dentinal lesions, pulpal involvement, or restorations.
‡Decayed or filled primary tooth surfaces. Includes surfaces with cavitated enamel lesions, cavitated dentinal lesions, pulpal involvement, or restorations.

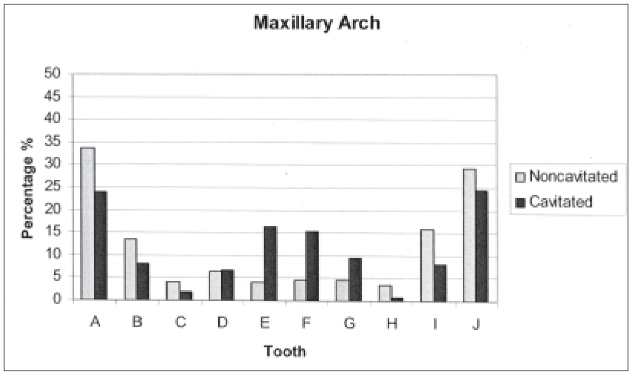

Figure 1. Prevalence of noncavitated and cavitated enamel and dentinal lesions in maxillary arch, by tooth type (%).

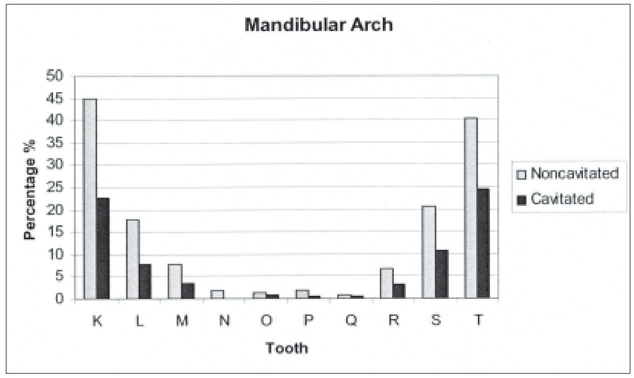

Figure 2. Prevalence of noncavitated and cavitated enamel and dentinal lesions in mandibular arch, by tooth type (%).

and *t* tests based on standard errors that took into account the correlated nature of the data.

Results

Two hundred twenty-one children (109 females, 112 males) between 5 and 6 years of age were examined. The mean age of children was 5.5 years; 49% were females and 51% were males. African-Americans comprised 67% of study subjects, 23.5% were white, and 9.5% were of other or unknown race/ethnicity.

Table 2 presents the mean number of noncavitated (active or inactive) or cavitated enamel lesions, dentinal lesions, lesions with pulpal involvement, filled surfaces, and missing surfaces. The mean number of active noncavitated enamel lesions (2.91±0.21) was slightly higher than the mean number of cavitated dentinal lesions (2.52±0.31). Eighty-six percent of the children had experienced cavitated or noncavitated caries lesions in the primary dentition. Prevalence of cavitated dentinal lesions was 48%, and prevalence of active noncavitated enamel lesions was 71%. The mean number of restored surfaces was 1.24±0.42, and only 8% of the children had 1 or more restored surfaces. When cavitated enamel or dentinal lesions and lesions with pulpal involvement and filled surfaces were combined—representing a traditional dfs score (decayed and filled surfaces)—the mean number was 4.29±0.52.

There were no significant differences between females and males in the prevalence of noncavitated or cavitated lesions, but some racial differences were found. African-American children had a higher prevalence of active or inactive noncavitated lesions (80%) than whites (69%) or others (33%; *P*<.0001). Prevalence of cavitated lesions was 49% for African-Americans, 46% for whites, and 48% for others, with no statistically significant differences.

Table 3. Relationships Among Individuals by Noncavitated Versus Cavitated Decay Experience

Any noncavitated surfaces*	Any cavitated surfaces*		
	No	Yes	Total
No	33	26	59
Yes	70	92	162
Total	103	118	221

*P<.0935.

Figures 1 and 2 show the prevalence of noncavitated and cavitated lesions by individual primary tooth. Both types of caries experience were most common on the primary second molars. Noncavitated lesions were more common on the mandibular second molars (45% left and 40% right) than on the maxillary second molars (29% left and 34% right). Maxillary anterior teeth experienced more cavitated lesions (48%) than noncavitated lesions (19%).

Table 3 present the results of chi-square analysis that tested the association between the presence of any noncavitated (active or inactive) enamel lesion and the presence of 1 or more cavitated enamel or dentinal lesions or lesions with pulpal involvement. There was a trend toward a significant association in this comparison (*P*<.09).

Table 4 presents the distribution of noncavitated and cavitated lesions by tooth type and surface. Most of the noncavitated lesions occurred on the occlusal surfaces of the first and second molars. Also, the buccal surfaces of the second mandible molars and lingual surfaces of the maxillary second molars exhibited more noncavitated lesions than other surfaces. Cavitated lesions were more common than noncavitated lesions on the maxillary incisors, and the mesial surface was the most common cavitated surface. Also, the occlusal surfaces of the second molars had a significantly higher number of cavitated lesions than other surfaces.

In linear regression analysis (data not shown), the number of cavitated enamel or dentinal lesions was not significantly associated with the number of noncavitated lesions affecting primary molars (R^2=0.0038; P=.36). It was significantly associated, however, with the number of noncavitated lesions on anterior teeth (R^2=0.13; P<.0001).

Discussion

This study shows that active noncavitated lesions are common in the primary molars in this population. There are only a few studies that have assessed the prevalence of noncavitated and cavitated caries lesions in the primary dentition, but none that focused specifically on Head Start children. Warren et al[9] evaluated the prevalence of noncavitated and cavitated lesions in children who were part of the Iowa Fluoride study, which was a largely self-selected study cohort. The prevalence of untreated cavitated decay was 17%, and prevalence of noncavitated caries lesions was 24%. In this study population, the prevalence was higher than in Iowa, probably due to socioeconomic differences.

It has been shown that Head Start children suffer from high caries experience[10] and that these children tend to be at high caries risk, with at least a mean dft score of 2.0.[11] Studies show that 60% or more of these children have cavities and that the average number of tooth surfaces affected exceeds 5.[12] In a study by Montere et al[13] with Connecticut Head Start children, the mean dmfs score was 3.0 and 38% of the children had caries. In a study by Vargas et al[14] in Maryland Head Start centers, the mean ds score was 2.90, which was slightly lower than in this study. Unlike the present study, however, neither of those studies assessed noncavitated caries lesions.

This study reveals that these children have a great amount of untreated tooth decay. According to the Surgeon General's Report on Oral Health in America,[15] the caries seen in children living in low-income families is more likely to be untreated than caries in those living above the poverty level. In 1988-1994, 37% of poor children ages 2 to 9 had 1 or more untreated decayed primary teeth, compared to 17% of nonpoor children. In a study by Albert et al,[16] 3- to 4-year-old children (N=1,605) enrolled in Head Start or day care programs in northern Manhattan communities were evaluated for caries. The mean dft was 3.14 for children with dft>0, and the level of untreated decay was 91%, which is above the US average. Enhanced dental services and preventive treatment for these young children are needed.

In addition to poverty level, the proportion of teeth affected by dental caries also varies by ethnicity.[15] It has been suggested that ethnic minorities show an increased caries risk.[17] In this study, African-American children experienced more noncavitated lesions than others, but there were no differences in cavitated lesions. This study's limitation was a low sample size of whites, which could affect the statistical determina-

Table 4. Mean Number (SEM)* of Primary Tooth Surfaces by Caries Status and Tooth Type

Noncavitated lesions	Maxillary				Mandible				
	incisors	canines	1st molars	2nd molars	incisors	canines	1st molars	2nd molars	Total
All surfaces	0.11 (0.03)	0.04 (0.01)	0.15 (0.02)	0.40 (0.04)	0.03 (0.02)	0.07 (0.01)	0.20 (0.02)	0.52 (0.04)	0.15 (0.01)
Incisal/occlusal	0.00 (0.00)	0.00 (0.00)	0.14 (0.02)	0.25 (0.02)	0.00 (0.00)	0.00 (0.00)	0.17 (0.02)	0.33 (0.03)	0.09 (0.01)
Mesial	0.01 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.02 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Distal	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Buccal	0.08 (0.01)	0.04 (0.01)	0.00 (0.00)	0.01 (0.00)	0.01 (0.00)	0.07 (0.01)	0.03 (0.01)	0.18 (0.02)	0.04 (0.00)
Lingual	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.14 (0.02)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.02 (0.00)
Cavitated lesions									
	Maxillary				Mandible				
	incisors	canines	1st molars	2nd molars	incisors	canines	1st molars	2nd molars	Total
All surfaces	0.34 (0.06)	0.03 (0.01)	0.10 (0.02)	0.33 (0.04)	0.01 (0.01)	0.04 (0.02)	0.12 (0.03)	0.31 (0.04)	0.13 (0.01)
Incisal/occlusal	0.03 (0.01)	0.01 (0.00)	0.08 (0.02)	0.21 (0.02)	0.00 (0.00)	0.00 (0.00)	0.09 (0.02)	0.21 (0.02)	0.07 (0.01)
Mesial	0.16 (0.03)	0.00 (0.00)	0.01 (0.01)	0.02 (0.01)	0.01 (0.01)	0.00 (0.00)	0.01 (0.01)	0.03 (0.01)	0.02 (0.00)
Distal	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Buccal	0.07 (0.02)	0.01 (0.01)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.03 (0.01)	0.01 (0.01)	0.05 (0.01)	0.02 (0.00)
Lingual	0.06 (0.01)	0.00 (0.00)	0.01 (0.00)	0.10 (0.01)	0.00 (0.00)	0.00 (0.00)	0.01 (0.01)	0.02 (0.01)	0.02 (0.00)

*SEM=standard error of the mean.

tion of difference by ethnicity. It has been difficult, however, to separate the cultural influences of ethnicity from the effects of low socioeconomic status or poverty status on the prevalence of dental caries.[18] Montero et al[13] did not find any significant differences in dmfs scores when analyzed by ethnicity. In a study by Shiboski et al,[19] the highest prevalence of Early Childhood Caries in California Head Start children was observed in Asians (33%) and Latinos/ Hispanics (30%). Among African-American children, however, the prevalence was 18% and for whites it was 13%.

Consistent with other investigations, this study found that the most commonly affected surfaces in the primary molars were the occlusal surfaces of the first and second molars. In a study by Gizani et al,[20] the occlusal surfaces of the primary molars also showed the highest attack rates. Grindefjord et al[21] studied the development of dental caries in children from 2 1/2 to 3 1/2 years of age and found that the majority of new lesions were located on the occlusal surfaces of the second molars, which was also found in this study.

As this study showed, the presence of early enamel lesions indicates that the child had a significantly higher probability of having more than one dentinal lesion. This association has been reported by Ismail et al[5] and Graves et al,[22] who found that "white spot lesions" are more frequently observed in children with high caries prevalence. This study extended those findings by examining the association by tooth type. Although noncavitated lesions were more prevalent on primary molars than on primary anterior teeth in this study, the number of cavitated lesions in the mouth was most strongly associated with the number of noncavitated lesions on anterior teeth. That pattern suggests that noncavitated lesions on anterior primary teeth may be an indicator of high risk for cavitated caries lesions. The association between decay in anterior teeth and posterior teeth has been noticed also by other studies.[23-25]

Caries progression in the primary dentition is reportedly rapid, and within 12 months, enamel caries may progress into the dentin.[26] Head Start children show very high caries progression rates–in Connecticut they were found to have an increase in the average number of dmfs of 2.2 per child over 2 years.[25] The ability of fluoride to remineralize and arrest noncavitated lesions (ie, revert active caries lesions to "intact" remineralized surfaces) has been recognized[27,28] and tested in clinical studies.[29] Since control of the disease is important, one must first determine whether the caries process is progressing, active, or arrested.

Diagnostic criteria can be used to make distinctions in the lesions' activity status.[8] Nyvad et al[7] evaluated modified caries diagnostic criteria, which differentiated between active and inactive caries lesions at both cavitated and noncavitated sites in the permanent dentition. They concluded that use of criteria based on an activity assessment could be performed with high reliability, even when noncavitated caries lesions are included in the scoring system. Additionally, Pitts and Fyfee[30] have shown that early carious lesions can be measured reliably. In this study, the overall reliability was good. In other clinical studies, the interexaminer reliability has also been assessed via examinations of approximately 10% of subjects.[5,9] The Cohen's value indicates that calibration and standardization were performed successfully.

Children at high risk for developing caries need extra prevention.[31] The author suggests that varnish applications may be a practical prevention method that can be performed even in the school environment, allowing more high-caries-risk children to be reached.[29] Since the goal of prevention is either to ensure that a disease process never starts or to reverse the disease in its early stages, health authorities should recommend performing onsite prevention for caries-risk children (ie, in kindergartens and elementary schools).

Conclusions

1. Dental caries prevalence in the primary dentition was high among children in this study, and noncavitated lesions were more common than cavitated lesions.
2. It appears that the differentiation between noncavitated and cavitated lesions is useful in assessing the primary dentition.
3. Detection and monitoring of early noncavitated lesions is critical in determining effectiveness of preventive measures as a nonsurgical alternative for the treatment of decay in children.

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