

## Defining the Need for Dental Care in North Carolina: Contributions of Public Health Surveillance of Dental Diseases and Conditions

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A long-standing principle held by epidemiologists who study the health status of human populations is that any disease can demonstrate important variation among people with different characteristics, across different geographic locations, and over time. Substantial fluctuations in the amount of disease can occur as the relative importance of diseases rises and falls, usually in response to scientific breakthroughs and widespread application of effective interventions, but often for unknown reasons.

The prevalence of dental diseases and their consequences are particularly prone to change because of the complex and interacting nature of their many biological, environmental, and social determinants. Dental diseases were at record highs during the first half of the 20th Century.<sup>1</sup> Few people went unaffected, and most could expect to lose some of their teeth by middle age. In the early 1960s, almost 3,000 students graduated from high school in North Carolina having lost all their teeth to the ravages of dental disease.<sup>2</sup> In the mid-1970s, the number of missing teeth among those in their sixth decade of life was two and one-half times greater than the number of filled or decayed teeth.<sup>3</sup>

National trends through the 1990s demonstrated several significant advances in oral health status during the last half of the 20th Century.<sup>1,4</sup> Primary among these changes were substantial declines in dental caries (tooth decay) in permanent teeth beginning in childhood and extending through young adulthood, modest reductions in destructive periodontal (gum) disease, and improvements in tooth loss and oral cancer mortality. Even with these improvements, however, dental disease still is recognized as a silent epidemic, with dental caries and periodontal diseases being among the most common of all diseases. Particularly hard hit are the poor, minorities, those living in remote geographic areas and those with special healthcare needs, creating large disparities in disease and in access to

preventive and treatment services.

Important changes in public health practice, the field of dentistry, and the North Carolina population have occurred during the last few decades that should substantially affect the oral health of North Carolina residents. In this commentary, we briefly review the current status of dental diseases and trends that

*“After decades of remarkable improvements in the prevalence of tooth decay, the trend line seems to be leveling off or possibly increasing for primary tooth decay.”*

have direct relevance to issues involving access to dental care. Available data require us to focus primarily on children. We will use both clinically determined disease status as well as indicators self-reported in questionnaire surveys of the North Carolina population.

### North Carolina Oral Health Assessment Systems

A core function of dental public health is to monitor the burden of oral diseases and the availability of preventive and treatment services. The Institute of Medicine (IOM) of the National Academy of Sciences recommends that public health “...regularly and systematically collect, assemble, analyze, and make available information on the health of the community, including studies on health status, community health needs,

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and epidemiological and other studies of health problems.<sup>5</sup> The oral health surveillance system for North Carolina is one of the more comprehensive in the nation and is responsive to this IOM recommendation and historical precedents for public health practice.

The surveillance for oral health in North Carolina consists of several major elements. Periodically, a scientific sample representative of the entire state or subgroups of its population are selected to participate in dental examinations and interviews. Four of these surveys have been conducted, all with large samples and good response rates. The first two of the four surveys provided estimates for dental disease for the North Carolina population of all ages in 1960-1963<sup>6</sup> and 1976-1977.<sup>3</sup> The second two provide comparable estimates for school children in kindergarten through 12th grade in 1986-1987<sup>7</sup> and 2003-2004.<sup>8</sup> The North Carolina Oral Health Section also conducts annual surveillance of dental caries and its treatment in kindergarten and fifth grade. Assessments began in the 1996-1997 school year and continue with open-mouth dental screenings by trained dental professionals of about 80% of all children in these grades in almost all of North Carolina's counties.<sup>9</sup>

North Carolina participates in the Behavioral Risk Factor Surveillance System (BRFSS), a random telephone survey of

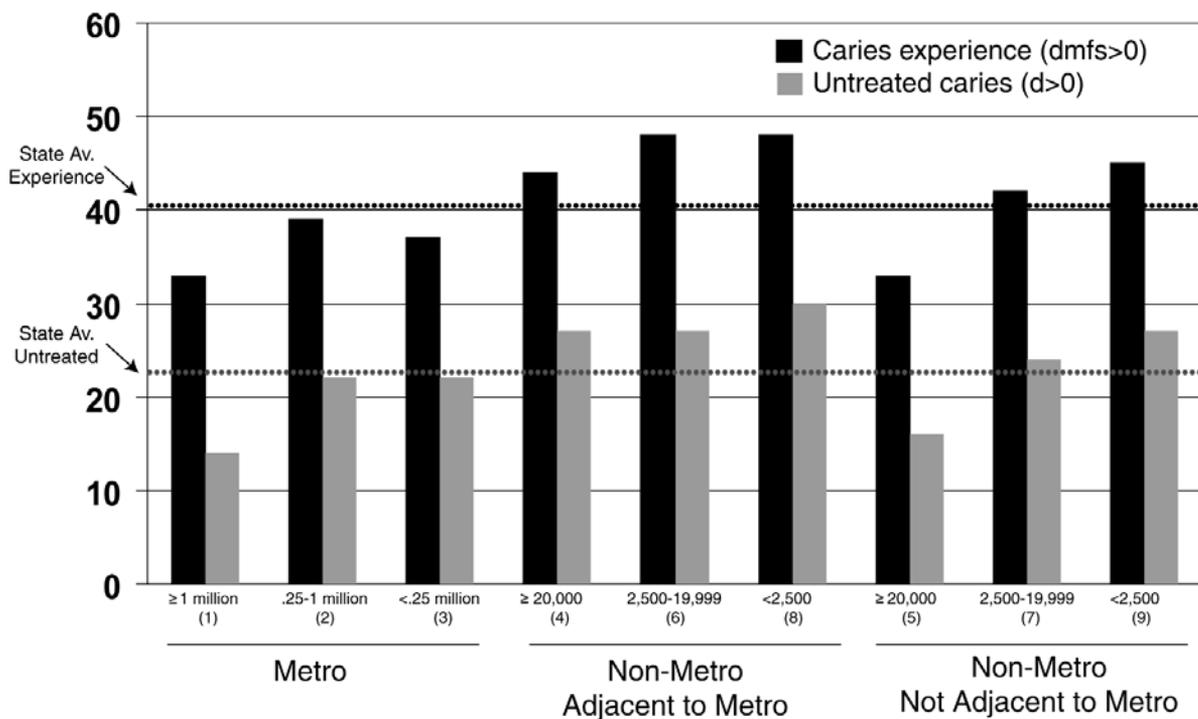
the state's residents 18 years of age and older.<sup>10</sup> This survey, done in all states, provides information on dental use and outcomes in North Carolina that is collected in a routine, standardized manner at the state level and for a few larger counties. This system was expanded in January 2005 by the Child Health Assessment and Monitoring Program (CHAMP) survey.<sup>11,12</sup> CHAMP is the first telephone survey of its kind in North Carolina to measure access to dental care, dental utilization, and outcomes of children from birth to 17 years of age, thus providing a seamless account of dental care access and outcomes for the entire state from birth into adulthood.

Other components of the oral health surveillance system for North Carolina include detailed information about water fluoridation and oral cancer incidence and mortality, but information from these elements of the system is not included in this commentary.

### Oral Health Status of North Carolina's Population

Key indicators for the oral health of North Carolinians are presented in Table 1 (see page 440), most of which are taken from the 2003-2004 survey of school children. Several findings are evident from these data. First, a large percentage of children

**Figure 1.**  
**Percent with Caries Experience and Untreated Caries by North Carolina County Rural-Urban Continuum Codes, Kindergarten Students, 2003-2004**



(1) Anson, Cabarrus, Gaston, Mecklenburg; (2) Alexander, Brunswick, Buncombe, Burke, Caldwell, Catawba, Chatham, Cumberland, Davie, Forsyth, Franklin, Haywood, Henderson, Hoke, Johnston, Madison, New Hanover, Orange, Pender, Person, Randolph, Rockingham, Stokes, Yadkin; (3) Alamance, Edgecombe, Greene, Nash, Pitt, Wayne, Onslow; (4) Carteret, Cleveland, Davidson, Halifax, Harnett, Iredell, Lee, Lenoir, Lincoln, Moore, Richmond, Robeson, Rowan, Rutherford, Surry, Vance, Wilson; (5) Craven, Dare; (6) Beauford, Bladen, Columbus, Duplin, Granville, Jackson, Martin, McDowell, Montgomery, Sampson, Scotland, Stanley, Transylvania, Watauga, Wilkes; (7) Hertford, Macon, Washington; (8) Avery, Caswell, Gates, Jones, Polk, Swain, Yancey, Warren; (9) Alleghany, Ashe, Bertie, Cherokee, Clay, Graham, Hyde, Mitchell, Northampton, Pamlico, Tyrrell.

are affected by tooth decay, and the severity, as measured by the mean number of decayed, missing, and filled surfaces per child (dfs or DMFS), among those affected is high. Second, a large percentage of parents report that they believe that their children need

dental treatment, such as fillings, teeth pulled, or cleanings. This self-reported need is supported by actual clinically determined need through the oral health survey in 2003-2004. About 31% of North Carolina children have untreated decay in primary

**Table 1.**  
**Oral Health Status Indicators for North Carolina, 2003-2005**

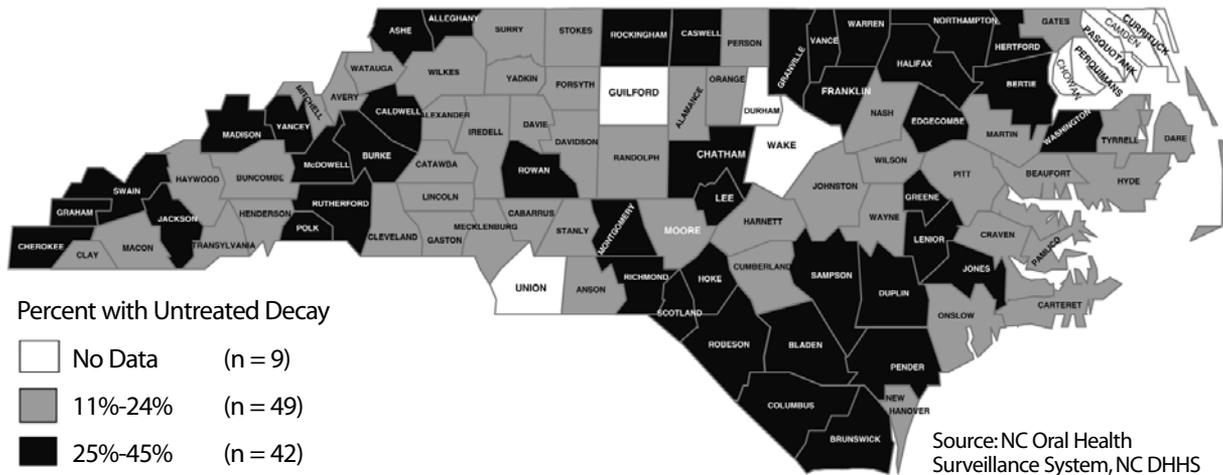
Condition	Overall <sup>†</sup>	Non-Hispanic White	Non-Hispanic African American	Hispanic
<b>Disease Experience</b>				
% any caries in primary teeth (5-9 year olds)	53.7	49.8	55.1	65.0
Mean dfs per child with any caries (5-9 year olds)	8.8	8.5	8.1	11.0
% any caries in permanent teeth (6-17 year olds)	37.5	35.7	41.6	35.7
Mean DMFS per child with any caries (6-17 year olds)	4.4	4.1	5.1	3.9
% any caries in either tooth type (5-17 year olds)	55.8	53.2	58.2	61.3
% clinical evidence of incisor trauma (6-17 year olds)	11.8	10.6	14.1	8.6
% parent reporting serious trauma (5-17 year olds)	10.7	11.5	9.3	8.6
<b>Untreated Disease</b>				
% with 90% of untreated primary tooth decay (5-9 year olds)	19.7	16.9	22.1	28.8
% with any untreated primary tooth decay (5-9 year olds)	30.8	25.7	37.0	41.4
Mean decayed primary tooth surfaces per child among those with any decay (5-9 year olds)	5.1	4.6	5.3	5.8
% with 90% of untreated permanent tooth decay (6-17 year olds)	10.0	9.1	11.4	10.7
% with any untreated permanent tooth decay (6-17 year olds)	13.4	10.6	18.2	16.5
Mean decayed permanent surfaces per child among those with any decay (6-17 year olds)	2.6	2.2	2.9	2.8
<b>Demand</b>				
% parents reporting child needs treatment (5-17 year olds)	51.5	42.4	67.5	60.3
% parent reporting wanted care, but did not get it (5-17 year olds)	60.1	65.8	49.6	72.2
% children ever experienced dental pain in lifetime (kindergarten-third grade)	23.5	19.1	28.2	32.2
% children experienced dental pain at least once in last 3 mos. (grades 4-12)	31.0	28.8	36.4	26.5
<b>Outcomes</b>				
% children's health rated fair or poor by parent	6.6	‡	‡	‡
1-4 year olds				
5-17 year olds	16.4	10.9	22.5	36.3
% adults with tooth loss (18 years and older)				
Some tooth loss because of tooth decay or gum disease, but not all	44.7	41.6	58.0	25.2
Complete tooth loss because of tooth decay or gum disease	9.3	9.5	11.0	3.9

<sup>†</sup> Denominator includes all race and ethnic groups.

<sup>‡</sup> Preliminary estimates from CHAMP, 2005. Sample sizes do not permit estimates by race or ethnicity.

Notes: All estimates are from the 2003-2004 oral health survey of schoolchildren except parents' perceptions of oral health of children one to four years of age and tooth loss, which are from the CHAMP<sup>11</sup> and BRFSS,<sup>10</sup> respectively.

**Figure 2.**  
**Percent of Kindergarten Students with Untreated Dental Caries by County, 2003-2004**



(baby) teeth; 13% in permanent teeth. A third interpretation from data presented in Table 1 is that untreated tooth decay is highly concentrated in a small percentage of children. With regard to outcomes, a large percentage of adults overall lose teeth because of dental disease, and this is highly age-dependent, probably reflecting inadequate access to dental care and values held years ago. Finally, disparities by race and ethnicity exist for most of the indicators, with Hispanics being much worse than whites on many important indicators. African Americans have indicators that usually fell between those of the other two groups.

Surveillance data on caries experience and untreated dental caries in kindergarten students are presented in Figure 1 according to a scheme used by the federal government to classify United States counties according to their rurality.<sup>13</sup> Each county in North Carolina has been classified according to the population size of its metropolitan (metro) area if it has one, and nonmetropolitan (nonmetro) area according to its degree of urbanization and adjacency to a metro area. A nonmetro county is defined as adjacent to a metro county if it physically adjoins one of the state's metro areas and has a least 2% of its employed labor force commuting to central metro counties. Both dental caries experience and untreated tooth decay differ by population size of the county and its adjacency to a metro area. Children in nonmetro counties that are adjacent to a metro county have more caries experience and untreated decay than children in other types of counties, regardless of population size. Between 40% and 50% of children in these nonmetro counties of all three size categories show obvious signs of tooth decay, and close to 30% have some untreated decay. Within each of the three metro and nonmetro classifications, caries experience and untreated decay generally increase as the population size decreases,

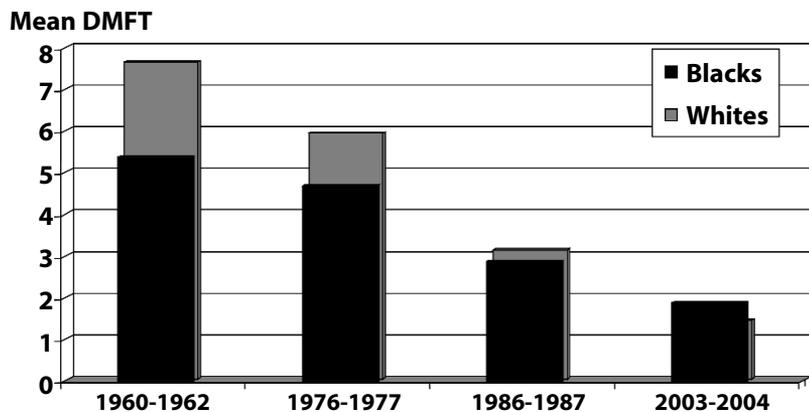
particularly in those counties not adjacent to metro areas.

A county-specific geographic distribution of untreated decay in kindergarten students is displayed in Figure 2. As many as one out of every four kindergarten students in 42 counties begin school with untreated decay. This number is as high as one out of every three students in a dozen of these counties. Most of the counties with students who experience large amounts of caries and receive a small amount of treatment are located in northeastern, southeastern, or western counties.

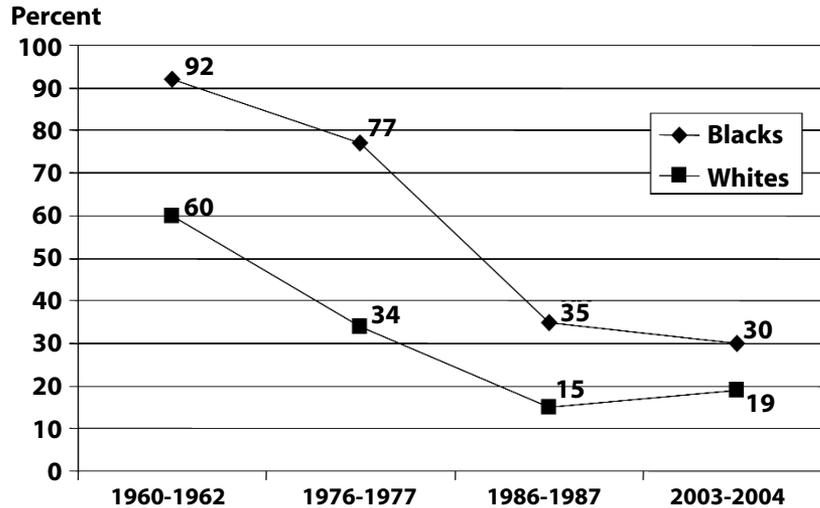
### Trends in Dental Diseases in North Carolina

Remarkable improvements in dental caries have occurred in the permanent dentition of school-aged children in North Carolina over the last 40 years. Trends in 12-17-year-old children are presented as an example of these improvements (see Figure 3). Lifetime caries experience is presented as the mean of the person-level count of decayed, missing, and filled teeth (i.e., the DMFT index, a standard epidemiologic tool designed for these

**Figure 3.**  
**Trends in Dental Caries (DMFT) in 12-17-Year-Old Children, North Carolina**



**Figure 4.**  
Trends in Untreated Decay (%DT/DMFT), in 5-17-Year-Old Children, North Carolina



purposes). The mean DMFT score per person declined by 82% in white adolescents between 1960-1962 and 2003-2004 from 7.6 per person to a low of 1.4. A reduction of 65% occurred in black adolescents. The decrease in mean DMFT per person from 5.4 to 1.9 is likewise impressive. Along with the decline in the occurrence of tooth decay, the proportion that is untreated also has declined, and by a substantial amount (see Figure 4). Most of this change occurred, however, between 1960-1962 and 1986-1987. The amount of untreated decay did not change much between 1986-1987 and 2003-2004 (see Figure 4).

Trends in primary tooth decay are not as favorable as for permanent teeth. After years of decline, trendlines in the prevalence of caries in primary teeth have leveled off or appear to have even increased in some groups of children between 1986-1987 and 2003-2004 (see Figure 5). The increase is particularly striking for children whose caregivers have less than a high school education. Surveillance data suggest that most of this increase prob-

ably occurred in children born in the mid- to late-1990s and, thus, entered kindergarten in the early 2000s and thereafter.

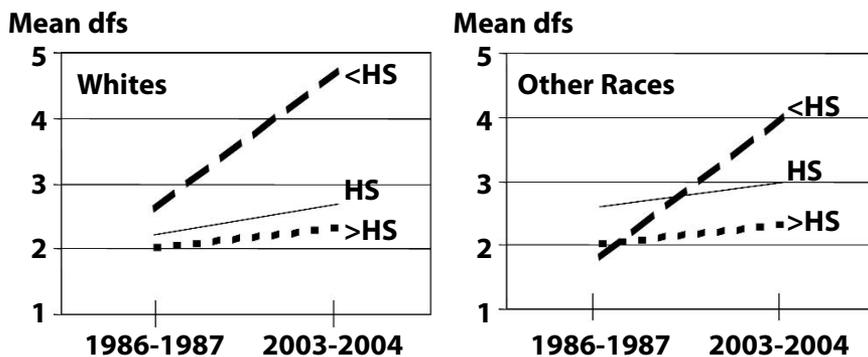
## Discussion of Key Findings from Oral Health Surveillance

The key indicators reviewed in this commentary suggest that substantial improvements in the prevalence and severity of tooth decay, the major dental disease affecting children and young adults in North Carolina, have occurred over the last 40 years. Multiple factors are likely to have contributed to these changes in disease status. A comparison of a few of the possible dental experiences of adolescents born in the 1950s with those born in the 1990s, roughly the cohorts being

compared in 1960-1963 and 2003-2004 as 12-17 year olds in Figure 3, reveals major differences. Of significance is the increase in preventive programs. In the 1950s, only 15% of the North Carolina population was drinking fluoridated water, while other public health preventive programs, such as school water fluoridation and fluoride mouthrinse programs in schools were nonexistent. Fluorides were rarely a part of preventive services provided in private dental offices, and less than 20% of children used fluoridated toothpaste. By the 1990s, more than 80% of the population served by municipal drinking water systems was drinking fluoridated water. A significant portion of the remaining child population was exposed to systemic fluorides through the school water fluoridation program, to topical fluorides in public health mouthrinse programs, or applications in dental office settings. A major contribution to the downward trend in tooth decay has been the increase in use of fluoridated toothpaste. By the 1990s, almost everyone who brushed their teeth was using fluoridated toothpaste. Although not presented, our survey results also show that in 2003-2004, close to 60% of adolescents had one or more dental sealants, surpassing the national goal of 50% set for 2010.

The availability of dental services also increased during this 40-year period. In the 1950s, only one dentist for every 4,000 people practiced in the state.<sup>14</sup> They employed fewer than 100 dental hygienists. By the 1990s, the ratio had improved to one dentist for every 2,500 people.<sup>15</sup> Public health workforce supply also increased rather dramatically during this period. In the 1950s, only about

**Figure 5.**  
Trends in Caries (dfs) in 5-9-Year-Old Children, by Parent Education Level, North Carolina



Note: HS = high school

30 public health dentists worked for the state in school-based programs, and the state employed no public health dental hygienists. Only a few local health departments had dental clinics. By the 1990s, a network of more than 100 public health dentists and dental hygienists was providing services in almost every county.

Demand for dental services also likely grew rather dramatically after the 1950s because of changing norms about dental health. The significant increase in dental insurance coverage, which was not available to the earlier cohort of adolescents, but had grown to be more than 50% when the later cohort was growing up, also was likely to be a contributing factor to the increase in demand for care.<sup>16</sup>

These changes in tooth decay mirror trends in dental disease nationwide. Between 1988-1994 and 1999-2002, the two most recent national surveys, a reduction in the prevalence of caries in permanent teeth of up to 10% was observed among persons six to 19 years of age and up to 6% among dentate adults 20 years of age and older.<sup>4</sup> While we do not have recent information about dental caries or periodontal diseases for the adult population of North Carolina, national information suggests that destructive periodontal disease should have improved as well.<sup>17</sup> The North Carolina BRFSS indicates improved tooth retention in adults, an important outcome measure of oral health status. The growing number of people with more teeth can increase the need for dental care, although this need can be counterbalanced by a shift in types of dental procedures from treatment to diagnostic and preventive. While not addressed in this commentary, publications from the North Carolina State Center for Health Statistics suggest declines in oral cancer incidence during the 1990s in most population groups.<sup>18</sup>

This review of surveillance information available for North Carolina also suggests that in the face of these improvements, a large percentage of the population continues to have unmet need and suffer its consequences on oral health-related quality of life. The public's demand for dental services is much more difficult to measure than unmet clinical need or even self-reported need for care. However, responses to the one question asked of parents in the most recent school survey most directly related to demand for dental care suggests that excess demand does exist, ranging from about 21% to 36% depending on race and ethnicity. The extent to which these children and adolescents are able to get dental care in North Carolina depends on a number of factors, many of which present significant barriers to realizing their desire for dental care.

Large disparities in oral health status and access to dental services continue to exist in the state. We chose to present disparities by race and ethnicity, rurality and geographic location, but clear disparities also are apparent by other characteristics of individuals, such as their age and poverty status. The analysis of untreated dental caries found that statewide roughly one out of five children have untreated decay in primary teeth when they start school, but many counties have as many as one of four young children in this condition, 24 counties with one out of three. These counties clearly cluster in sections of the state known to have other health and social disadvantages.

Untreated disease also clusters in a small number of people. The ubiquitous distribution of tooth decay among children has shifted so that most are not affected in their permanent teeth at any time during their childhood, and only 10% to 20% of those who are affected have almost all of the untreated disease.

Statistics for dental caries presented in this commentary are for obvious carious lesions. We did not include non-cavitated lesions, nor were radiographs used for any determinations of caries status. The true amount of tooth decay in the North Carolina population is underestimated, probably by about 35% to 40% based on the exclusion of noncavitated lesions alone. Noncavitated lesions are responsive to fluoride therapy and other preventive interventions, which implies the need to continue programs that emphasize preventive strategies that will prevent noncavitated lesions from progressing to the stage that they need restorative intervention.

## Implications for Public Health Action

Several conclusions with important implications for public health can be drawn from this review. After decades of remarkable improvements in the prevalence of tooth decay, the trend line seems to be leveling off or possibly increasing for primary tooth decay. Smaller reductions in decay prevalence are evident in the permanent teeth of today's young children than in those in the past. So far, this effect seems to be most pronounced in children born during or after the mid-1990s. These trends are consistent with national trends through 2001, providing some support for the conclusion that these observations in North Carolina reflect actual trends.<sup>4</sup> These emerging trends need to be monitored closely so that we can determine if they represent statistical fluctuations around what are historic low levels of decay, or if we are observing the early signs of a trend toward more disease.

Nevertheless, investigations need to be undertaken into the possible reasons for what appear to be unfavorable trends in dental disease. We may be seeing the early indications of increased disease—the consequence of a reduced availability of preventive dental services, particularly school-based services. The rapid growth of the North Carolina population overall and, more specifically, the number of people at elevated risk for disease, may be straining the capacity of the dental care system to respond to public needs and demands. Key factors related to the demand for dental services, such as the importance the public places on oral health, may also be a contributing factor. A better understanding about why these trends are occurring would help guide public policy.

Progress has been made since the early 1960s in reducing disparities in dental disease and access to care between whites and African Americans living in North Carolina. The growing Hispanic population, who have more disease than its non-Hispanic counterparts, may be eroding the gains made in reducing these disparities. Programs that can help eliminate disparities in dental disease and access to dental care are needed. Approaches will require implementation of innovative strategies, such as: the current *Into the Mouths of Babes* program that encourages physicians to provide preventive dental services for

very young, low-income children; expanding existing community-based programs; or restoring discontinued community-based programs that helped us achieve the observed major reductions in dental disease during the 1960s, 1980s, and parts of the 1990s.

Wide concern has been expressed about the lack of access to dental care in North Carolina and nationally, particularly for children from low-income families and for preschool-aged children overall. This concern is bolstered by information abstracted from surveillance systems in North Carolina. Many young, school-aged children have untreated decay, but the overall amount of untreated decay is highly concentrated in a small segment of the population. Untreated decay in older, school-aged children, although less prevalent, is even more concentrated in a small number of children. Addressing the dental needs of these very high-risk children will require intense and concentrated efforts involving multiple strategies.

Finally, the ability to examine trends in dental disease in some detail for North Carolina demonstrates the value of the oral health surveillance system in North Carolina. The surveillance

system has matured over the years, but still has limited ability to monitor adult oral health status in general and the oral health status of some minorities, such as American Indians or Asians, who are a small proportion of the state's population, at the level of detail possible with other population groups. The oral health status of adults needs to be brought under surveillance so that the oral health conditions of children being born today can be monitored as they grow into adulthood.

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