

Toothache in US Children

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Objectives: To describe the prevalence of and risk factors for recent toothache among US children and to estimate frequency of contact between children with toothache and their pediatric primary care providers (PPCP).

Design: Cross-sectional analysis of nationally representative data.

Setting: The 2007 National Survey of Children's Health.

Participants: Population-based sample of parents/guardians of 86 730 children aged 1 through 17 years from 50 states and the District of Columbia.

Outcome Measure: Parent-reported toothache in the last 6 months.

Results: A total of 10.7% of US children and 14% of children aged 6 to 12 years experienced toothache in the last 6 months. Poor and low-income minority children and

those with special needs were significantly more likely to have had a toothache on multivariable analysis. Most children with toothache in the last 6 months had their own physician (88.9%) and had a preventive medical visit in the last year (88.1%), pointing to opportunities for PPCP to identify and intervene with children who have untreated dental decay and toothache.

Conclusions: Toothache is not the universal experience it was before the advent of modern dentistry. Nevertheless, a substantial number of US children recently had a toothache, with noteworthy variability between states. There are opportunities for PPCP to address oral health prevention, assess for dental decay and toothache, and treat complications. We propose toothache as a potential quality indicator reflecting disparities in oral health for a population.

Arch Pediatr Adolesc Med. 2010;164(11):1059-1063

TOOOTHACHE RESULTS FROM A variety of etiologies, both odontogenic and nonodontogenic; however, the most common cause of toothache is dental decay.¹ Destruction of the tooth structure in the form of a cavity results from acidic byproducts of bacterial carbohydrate metabolism that erode through the enamel and dentin and then into the pulp. Within the pulp lies the nerve, which produces pain when inflamed, often described as excruciating.² This process of dental decay is one that optimally would be prevented or, at the very least, identified early and then arrested through provision of regular professional dental care. However, for some US children, including those who are Medicaid-insured,³ access to preventive and restorative dental care is more difficult. In 2005, 37% of children in Medicaid ages 2 through 18 received dental care in the previous year.⁴

Despite dental caries being a largely preventable disease, it continues to affect a substantial number of children. Disproportionately fewer children from low-income families receive timely dental treatment, as evidenced by the most recently published National Health and Nutrition

Examination Survey dental examination data; approximately one-third of children aged 6 to 19 years living at or below 200% of the federal poverty level (FPL) had untreated tooth decay—twice the rate among children from families above 200% of the FPL.^{5,6} Untreated dental decay causes chronic pain, difficulty eating and learning, more serious complications, and, in rare cases, death.^{6,7} Thus, it is important that we understand how often children experience sequelae from untreated dental disease, including toothache. We could find no nationally representative study addressing the frequency of toothache among US children.

With release of the most recent National Survey of Children's Health (NSCH) data, which included a question about whether a child experienced a toothache within the last 6 months,⁷ we now have an opportunity to describe the prevalence of toothache in US children and to examine which groups are at greatest risk of toothache. We hypothesized that children who have difficulty obtaining needed dental care—poor^{8,9} and minority¹⁰ children and those with special needs¹¹—would be more likely to experience toothache. In addition to characterizing the

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epidemiology of toothache, we also sought to estimate how often pediatricians and other pediatric primary care physicians (PPCP) encounter a child with a recent toothache to better understand medical professionals' potential role in the care of children with toothache.

METHODS

DATA SOURCE

We relied on data from the 2007 NSCH, which was sponsored by the Maternal and Child Health Bureau of the US Health Resources and Services Administration and conducted by the National Center for Health Statistics of the Centers for Disease Control. The data file is publicly available and contains stratum identifiers and primary sampling unit codes that account for the complex sample design and permit population-based estimates with accurate standard errors.¹²

The survey was conducted between April 2007 and February 2008 and was intended to collect information on the physical, emotional, and behavioral health and health care experience of a large sample of representative US children.¹² The State and Local Area Integrated Telephone Survey was used to complete 91 642 telephone surveys of households with children aged 0 to 17 years from each of the 50 states and the District of Columbia. After identifying a household with children, the interviewers asked for the birth dates of all children younger than 18 years.¹² One child in this age range was then randomly selected to be the subject of the interview. The respondent was the parent or guardian in the household who was most knowledgeable about the health and health care of the children. In general, this was the child's mother (73%) or father (20%). Grandparents or other relatives or guardians comprised the remainder (7%). Surveys were conducted primarily in English and Spanish (5.3% of interviews).¹²

VARIABLE SELECTION

The primary outcome of interest was report of a toothache during the previous 6 months, which was derived from the NSCH survey question, "To the best of your knowledge, has (he/she) had any of the following conditions within the past 6 months?"⁷ This question was asked for 4 dental-related conditions: toothache, cavities, broken teeth, and bleeding gums. The questions were not asked of children who were younger than 12 months, giving an effective unweighted N=86 730.

Prior to undertaking data analysis, we identified, based on our experience and review of the literature, potential covariates hypothesized to be associated with toothache including age, race/ethnicity, income, being foreign born, metropolitan statistical area (MSA), insurance coverage, special needs status, and health care visits in the last year. We created new variables specific to our analysis from the variables included in the NSCH. From 2 questions about health care coverage, we developed a single medical insurance variable. Participants had been asked whether they had health care insurance and whether this coverage was "Medicaid or SCHIP (State Children's Health Insurance Program)," without differentiating which of the 2 the child had. The new variable had 3 categories: private insurance, Medicaid/SCHIP, and uninsured. Unfortunately, a question about dental care coverage, which had been included in the 2003 NSCH, was excluded from the 2007 version. We thus had to rely on medical insurance status as a proxy. In our experience, medical insurance or lack thereof approximates dental coverage for publicly insured children but overestimates dental coverage for children with private medical insurance.

We also developed a new race/ethnicity variable that combined NSCH variables for race and Hispanic/Latino ethnicity, as reported by parents. Hispanic/Latino ethnicity combined with any race was classified as Hispanic/Latino, and the other races were left unchanged: white, black, multiracial, and other. We considered Hispanic/Latino as a separate group because this group has been described as at high risk for untreated dental caries.¹³ We included race in our analysis because our previous study has identified race to be independently associated with differences in dental care use.¹⁴

We created 3 categories related to special needs status. The NSCH relies on the children with special health care needs (CSHCN) screener¹⁵ to classify whether children have a special need. We defined a subgroup of CSHCN with functional limitations based on an affirmative response to the screener item about a child's condition limiting or preventing his or her ability to do the things that most children of the same age can do. We have previously identified that CSHCN who meet this specific CSHCN screener criterion to be at greater risk for unmet dental care needs.¹⁶

To deal with MSA, we imputed MSA status in the 16 states where it was suppressed (missing values unweighted n=28 485). In those cases we assigned MSA status to children in states where most of the population live in metropolitan areas (eg, Connecticut) and assigned non-MSA status to children in states where most people live in nonmetropolitan areas (eg, Wyoming). This is a strategy recommended in the NSCH documentation and, according to that, results in an approximately 8% misassignment of MSA status.¹²

Where income relative to FPL was missing (unweighted n=7817), we relied on the multiply imputed poverty data file that accompanied the 2007 NSCH data set. In accordance with recommendations in the 2007 NSCH methodology report, we analyzed poverty status as a multiply imputed variable.¹² The original data included 4 categories of income relative to FPL in the 101% to 200% range and, after imputing missing values, we collapsed these into a single group. We conducted 5 separate analyses, using each of the 5 imputed data sets merged with a copy of the original 2007 NSCH data. For any analyses involving the poverty variable, we used the multiple imputation tools within Stata software (Stata Corp, College Station, Texas) to combine the analyses.

STATISTICAL ANALYSIS

Data were analyzed with Stata software, version 10.0. To account for the complex survey design, we used Stata survey commands and the population weights provided in the data files when generating population-level estimates and standard errors. We conducted descriptive analysis and χ^2 tests of association between explanatory covariates and our primary outcome, toothache in the previous 6 months. In addition, we conducted multivariable logistic regression on the outcome of recent toothache. For a more parsimonious model, we restricted covariates in the multivariable model to those with statistically significant association ($P < .05$) on bivariable testing.

RESULTS

There were 86 730 children aged 1 to 17 years whose parent/guardian was asked about any recent toothache, representing 69 million US children. Of these, 10.7% (95% confidence interval, 10.2-11.3) or approximately 7.5 million (95% confidence interval, 7.1-7.8 million) had experienced toothache in the past 6 months. Thirty-two percent of children with parent-reported cavities in the last 6 months had experienced a recent toothache. Likewise, 58% of children with toothache also had reported cavities in the past 6 months.

Table 1. Characteristics of US Children With Toothache and Adjusted Odds Ratio of Toothache^a

Variable	Participants, %	Participants With Toothache, % Weighted	Adjusted OR (95% CI), Weighted
Total		10.7	
Sex			
Male	51.3	10.3	...
Female	48.7	11.2	...
Age, y			
0-5	30.1	7.2 ^b	1.00 [Reference]
6-12	36.1	14.1	1.94 (1.67-2.25)
13-17	33.8	9.7	1.30 (1.11-1.53)
Race/ethnicity			
White	56.4	8.8 ^b	1.00 [Reference]
Hispanic/Latino	20.2	12.6	1.22 (1.00-1.48)
Black	14.4	15.8	1.56 (1.35-1.81)
Multiracial	4.2	13.6	1.45 (1.16-1.82)
Other	4.7	9.4	0.94 (0.74-1.20)
Foreign born			
Yes	4.4	12.2	...
No	95.6	10.7	...
Federal poverty level, %			
≤100	18.2	16.3 ^b	1.88 (1.50-2.35)
101-200	21.1	13.2	1.58 (1.31-1.89)
201-300	17.6	9.9	1.29 (1.08-1.54)
301-400	13.4	8.4	1.14 (0.94-1.40)
>400	29.3	7.1	1.00 [Reference]
Health insurance			
Uninsured	9.4	13.2 ^b	1.14 (0.91-1.41)
Medicaid/SCHIP	28.4	14.7	1.17 (0.99-1.38)
Private	70.0	8.6	1.00 [Reference]
CSHCN			
Yes, with functional limitation	4.9	18.7 ^b	1.67 (1.41-2.00)
Yes, without functional limitation	14.2	15.0	1.37 (1.19-1.59)
No	80.9	9.7	1.00 [Reference]
MSA			
Yes	85.0	10.5	...
No	15.0	11.1	...
At least 1 preventive medical visit last y			
Yes	87.9	10.8	...
No	12.1	10.6	...
At least 1 preventive dental visit last y			
Yes	78.4	11.1 ^c	0.88 (0.76-1.03)
No	21.6	9.5	1.00 [Reference]
Received all needed dental care			
No	2.9	34.6 ^b	3.88 (3.08-4.90)
Yes	97.1	10.0	1.00 [Reference]

Abbreviations: CI, confidence interval; CSHCN, children with special health care needs; ellipses, not included in the model; MSA, metropolitan statistical area; OR, odds ratio; SCHIP, State Children's Health Insurance Program.

^aUnweighted, n=86 730; weighted, n=6.95 million. Data source is the National Center for Health Statistics and Maternal and Child Health Bureau, National Survey of Children's Health, 2007

^bDifferences within this category; significant on χ^2 analysis, $P < .001$.

^cSignificant on χ^2 analysis, $P = .01$.

Toothache was most common in children aged 6 to 12 years and affected significantly more black, Hispanic/Latino, and multiracial children on bivariable analyses (**Table 1**). Poor children (at or under 100% FPL) had the highest prevalence of toothache followed by children whose families' incomes were in the 101% to 200% FPL category. The prevalence of toothache among Medicaid-insured children exceeded that of uninsured and privately insured children. Children with special health

Table 2. Five US States With Lowest and 5 With Highest Prevalence of Toothache in the Last 6 Months of All Children and Those Aged 6 to 12 Years^a

Lowest Toothache Prevalence		Highest Toothache Prevalence	
State	Participants, % Weighted	State	Participants, % Weighted
All Children			
Massachusetts	6.9	Mississippi	16.2
Minnesota	7.0	Alabama	13.9
Vermont	7.0	Arizona	13.3
Maine	8.4	Ohio	13.3
South Dakota	8.5	Oklahoma	13.2
Children Aged 6 to 12 y			
Massachusetts	7.4	Mississippi	19.4
Vermont	8.6	Florida	18.5
Maine	9.0	New Mexico	18.4
Minnesota	9.4	Alabama	18.1
South Dakota	9.5	Arkansas	17.6

^aPrevalence data for other states is available from the authors. Data source is the National Center for Health Statistics and Maternal and Child Health Bureau, National Survey of Children's Health, 2007

care needs had a significantly higher prevalence of toothache relative to their peers without special needs, and functionally limited CSHCN had higher prevalence yet. The degree and direction of the relationships seen between toothache and covariates of interest on bivariable analyses were largely preserved on multivariable analysis, with the exception that insurance type and having had a preventive dental visit in the last year were no longer statistically associated with recent toothache.

Relative to children without toothache, children who had experienced a recent toothache had a significantly higher mean number of preventive medical visits in the previous year (1.8 vs 2.2; $P < .001$). However, children without a physician of their own had a higher prevalence of toothache (15.2% vs 10.4%; $P < .001$).

There was variation between US states in the prevalence of toothache. There was a 2.3 times greater prevalence of toothache in the highest prevalence state compared with the lowest. The highest prevalence of toothache was found in Mississippi at 16.2% and the lowest in Massachusetts at 6.9% of the state's children (**Table 2**). These 2 states also had the highest and lowest toothache prevalence, respectively, among children aged 6 to 12 years, with 19.4% in Mississippi and 7.4% in Massachusetts.

COMMENT

We found that approximately 7.5 million US children had experienced a toothache in the previous 6 months. The prevalence was highest in children aged 6 to 12 years, with 1 in 7 affected by toothache. Among children with parent-reported dental cavities in the last 6 months, 32% had experienced a recent toothache. We identified disproportionately increased rates and higher adjusted odds of toothache among children who were from poor or low-income families, in minority groups, specifically black or multiracial, or had special health care needs, thus confirming our hypotheses. Even after controlling for insur-

ance and poverty status, black and multiracial children had significantly higher odds of toothache than white children. These results are consistent with our previous findings from the 2003 NSCH in which we found that black children, regardless of dental insurance type or income, were significantly less likely to receive preventive dental care relative than white and Hispanic/Latino children.¹⁰

While other studies have found that these 3 groups—minorities, low-income families, and children with special needs—have significantly more unmet dental care needs,^{10,17,18} this study is the first to demonstrate population-based evidence that CSHCN, particularly those with functional limitations, have more dental-related symptoms relative to children without special needs. In our previous study in this area, we found that more severely affected CSHCN have an increased likelihood of using only restorative dental care (and forgoing preventive care altogether) relative to less severely affected CSHCN.¹⁶ It remains unclear what the exact mechanism is that underlies differences in unmet dental care need and patterns of dental care use among subgroups of CSHCN; however, the need for sedation or general anesthesia to perform even routine dental care likely explains at least some of the barriers encountered by CSHCN and their parents, given long wait times for such care.¹⁹

We also found differences in toothache prevalence by state. These are difficult to attribute to any one economic or health service characteristic of a state because toothache, like a number of other health conditions, has its roots in a complex interplay of inequities. States with more children affected by toothache tend to be those with the highest proportion of children living in poverty, and the converse is true of states with the lowest prevalence of toothache. Toothache also correlates well with inverse per capita dentist supply. For example, Massachusetts has more than twice the per capita dentist supply—1.1 dentists per 1000 persons—of that of Mississippi, which has 0.5 dentists per 1000 persons.²⁰ After the District of Columbia, Massachusetts has the highest per capita number of dentists in the United States while Mississippi is tied for last.

Toothache has implication on multiple levels. In this section we discuss 3 of these: that of the child, the medical professional, and the population. On an individual level, toothache is a source of chronic and often severe pain that interferes with a child's ability to play, eat, and pay attention in school.^{21,22} In states such as Mississippi, where the average elementary school class size is 20,²³ we estimate that, on average, 4 children in every grade school classroom have or recently had a toothache.

In a 2007 well-publicized case, a 12-year-old African American boy from Maryland died after infection from an abscessed tooth spread to his brain.²⁴ This boy's death represents one end of the spectrum of dental caries complications; yet, every day hundreds of children present to US emergency departments with toothaches.²⁵ From a medical professional perspective and as advocates for children, it is important to ask, in addition to oral health prevention, what is the role of pediatricians and other PPCP in identifying and treating toothache and other caries-related complications? The degree to which toothache arises as an explicit complaint in medical offices is

not discernable from NSCH data. However, results from this study indicate that 88% of children with recent toothaches had at least 1 well-child-care visit in the previous year; in fact, children with a recent toothache averaged more than 2 preventive medical care visits in the previous year.

The frequency of contact between medical professionals and children with toothache reinforces the important role of the pediatricians and other PPCP in providing anticipatory guidance on oral health, applying fluoride varnish, performing oral screening examinations, inquiring about dental-related complaints, referring to professional dental care and, when necessary, advocating for access to dental care for their patients. As importantly, physicians need to recognize dental caries, dental abscesses, and their sequelae, refer patients with these conditions to professional dental care, and when professional dental care is not immediately available, treat appropriately with antibiotics and analgesics and monitor closely until definitive dental treatment can be obtained. In this regard, a dental abscess is no different from an abscess in another part of the body. Oral health training for medical professionals is available from a variety of sources. A free online program, "Protecting All Children's Teeth (PACT): An Oral Health Training Program" produced by the American Academy of Pediatrics, addresses, among other topics: preventive oral health, oral screening examination, and management of dental emergencies and is available at <http://www.aap.org/oralhealth/pact/index.cfm>.

On a population level, toothache represents a potentially measurable indicator of unmet need for dental care. There are relatively few oral health quality indicators: an annual dental visit and number of treated/untreated dental caries are the most often cited. Of the 45 core health disparity measures established by the Agency for Healthcare Research and Quality,²⁶ only 1, a dental visit in the calendar year, deals specifically with dental care or oral health. Even while setting a low bar—using the Health People 2010 target of 56% of the population with at least 1 dental visit per year²⁷—only 1 group, individuals with incomes greater than 400% FPL, exceeds the target level.²⁶ Furthermore, measuring the proportion of a population with a dental visit in a year tells us nothing about the quality of dental care delivered or about the consequences of poor-quality dental care on an individual or system level. Consequence-based quality indicators are relatively common in medicine; the rate of perforated appendix is just one example.²⁶ We believe that toothache prevalence is a consequence-based outcome that reflects the quality of our dental care system, including its outreach, access, and effectiveness. Higher rates of toothache in a population signal more unrealized opportunities for primary and secondary prevention and indicate potential system-level failures. Given ongoing disparities in dental care access and oral health, we recommend development, validation, and monitoring on a community, state, and national basis, of an array of oral health quality indicators among which toothache prevalence would be included.

This study has certain limitations. All data were based on parent report and thus may be subject to bias or error. Furthermore, in the absence of an oral examina-

tion, we have no way to know the degree to which toothache represents underlying dental disease, although cavities and toothache were commonly reported together. Lastly, by eliminating the question about dental coverage from the NSCH,¹² we have lost the opportunity to better understand an important part of the relationship between dental disease and access to dental care. Because US children are 2 times as likely to be insured for medical than for dental care,¹⁰ using medical insurance as a proxy for dental insurance means that we are overestimating the number of children with private dental insurance. This probably dilutes out any protective association between dental insurance and toothache and may be one reason why we did not see a significant association between health insurance and toothache.

Until the early 20th century, toothache was so common that few escaped the experience during a lifetime.²⁸ As fluoride became more widely available and dental care has advanced, toothache is fortunately no longer universal. Even so, results from this study indicate that toothache is far from eradicated. The difference now is that toothache disproportionately affects vulnerable groups—poor, minority, and special needs children—and further compounds the other challenges they face in life. Optimally, our nation's health care system would include equitable and universal dental care access so that all Americans could obtain preventive oral health care as well as timely diagnosis and treatment of dental disease. Despite recent expansions in SCHIP, including mandated coverage for dental care, we are far from this goal. The prevalence of toothache, particularly among vulnerable groups who disproportionately experience it, serves to reinforce the importance of physician involvement in oral health and of efforts to better evaluate and improve our nation's oral health and dental care system.

Accepted for Publication: April 28, 2010.

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Author Contributions: Dr Lewis had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Lewis. *Acquisition of data:* Lewis. *Analysis and interpretation of data:* Lewis and Stout. *Drafting of the manuscript:* Lewis. *Critical revision of the manuscript for important intellectual content:* Lewis and Stout. *Statistical analysis:* Lewis.

Financial Disclosure: None reported.

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