SCIENTIFIC ARTICLE

Oral Health Behaviors of Children in Low and High Socioeconomic Status Families

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Abstract

Purpose: This prospective longitudinal study compared the patterns of oral health behaviors between low and high socioeconomic status (SES) families participating in the Iowa Fluoride Study for a period of 9 years.

Methods: Information on oral health behaviors, including consumption of juices/juice drinks, soda pop, and powder-based drinks, dental visits, and tooth-brushing frequency, was collected longitudinally at periodic intervals from 6 to 108 months of age. Dental exams were conducted at 5 and 9 years of age. Classification of low socioeconomic status (SES; n=70) and high-SES (n=128) children was based on baseline family income and mothers' education levels, with middle SES excluded.

Results: Low SES children consistently had significantly greater consumption of soda pop and powder-based beverages. There were, however, virtually no differences at any time point between groups in: (1) tooth-brushing frequency; (2) use of dentifrice; or (3) fluoride concentration in drinking water. Furthermore, the mean number of decayed and filled surfaces was significantly higher in the low-SES group.

Conclusions: Results suggest that beverage consumption patterns are a key difference between high- and low-socioeconomic status families and could in part explain differences in caries experience between subjects of different SES. Modification of the pattern of soda pop and powder-based beverage consumption in the low-SES groups might reduce their caries experience. (Pediatr Dent 2006;28:310-315)

KEYWORDS: ORAL, HEALTH, BEHAVIOR, SOCIOECONOMIC STATUS, SES, CHILDREN

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Across a wide range of health measures, it is recognized that people from lower socioeconomic backgrounds have higher rates of disease and disability. These health disparities include shorter life expectancy among the poor and higher rates of cardiovascular disease, cancer, diabetes, and birth defects.[1-3] It is also known that such disparities in health arise from a number of factors, including: (1) limited access to care and preventive services; (2) higher exposures to environmental pollutants; and (3) more hazardous occupations.[1] Another factor related to health disparities is health behavior, where persons from lower socioeconomic groups often are more likely to engage in unhealthy behaviors such as smoking or eating less healthy diets.[1-3]

As described in *The Surgeon General's Report on Oral Health*,[4] disparities exist in oral health whereby lower-socioeconomic status (SES) individuals are more likely to suffer from periodontal disease, oral cancer, and dental caries. While there is strong evidence to link smoking and spit tobacco use to oral cancer and periodontal disease, other relationships between health behaviors and oral health are less clear. In particular, there has been limited study on how health behaviors could be related to disparities in the occurrence of dental caries in children.

It is widely accepted that most caries experience is concentrated in a small minority of children.[5,6] While identification of specific risk factors has been elusive, SES consistently has been identified as a general risk factor for caries in children. Most studies have only documented a relationship between lower SES and caries, however, and have not assessed *why* such relationships exist.[7-9] Thus, there

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is very little known about specific behaviors in lower-SES families that place children at increased risk for dental caries. In fact, only one study was found in the literature[10] that assessed oral health-related lifestyle behaviors and food habits. This study found that children from lower-SES families had higher soft drink consumption rates and less frequent tooth-brushing.[10]

As stated by Reisine and Psoter,[7] based on their review of the literature, there is a clear need for more studies directly aimed at analyzing the relationship between SES and dental caries to identify factors associated with SES that contribute to dental caries risk. Therefore, the purpose of this paper was to compare patterns of oral health behaviors, including consumption of soft drinks, tooth-brushing, and dental visits between children of low and high socioeconomic status participating in the Iowa Fluoride Study.

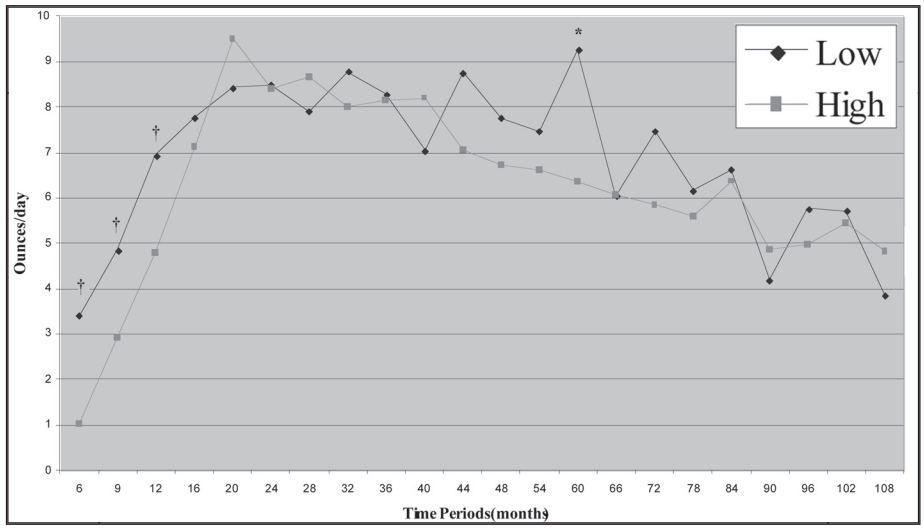

Figure 1. Mean quantities of juice/juice drink consumption by socioeconomic status
*Significant (P<.05).
†Significant (P<.01).

Methods

Children were participants in the Iowa Fluoride Study (IFS), which recruited a cohort at birth from 8 hospitals' postpartum units in Iowa.[11,12] Specifically, part-time research assistants recruited all interested individuals who expected to live in the general area for at least 4 years. Subjects (parents) received small incentives at recruitment and with each questionnaire mailing thereafter. This study was approved by the Institutional Review Board of the University of Iowa, Iowa City, Iowa, and parents provided informed consent.

At baseline (1992-1995), detailed information regarding ages, education, and income of parents, other family demographics, and water sources was gathered. This data was obtained via questionnaires developed and pilot tested by the investigators as well as through interviews with mothers.[13] Questionnaires then were mailed to participant homes at 6, 9, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 54, 60, 66, 72, 78, 84, 90, 96, 102, and 108 months concerning the preceding 3- to 6-month time period. Each questionnaire included questions concerning intake of fruit juice/juice drinks, soda pop, powder-based drinks,[14,15] use of dentifrice,[16] tooth-brushing frequency,[16] and dental visits.[17,18] Tooth-brushing was assessed using a 6-level scale: (1) never; (2) less than once per day; (3) once per day; (4) twice per day; (5) 3 times per day; or (6) more than 3 times per day. Parents were asked to record the brand of dentifrice that their child used. The information was then dichotomized into fluoride and nonfluoride dentifrice. Visits to a dentist for any reason were recorded if they occurred within the period covered by the questionnaire (3 months, 4 months, or 6 months). Questions about consumption of juices and juice drinks, beverages made from powder, and soda pop asked parents to record the amount per serving and the number of servings per day or week.

Since the original cohort included a number of children of college/university students, the grouping of socioeconomic status (SES) took into account both the baseline family income and the mother's educational level as assessed at recruitment. Low-SES families were defined as having baseline family income under $40,000 per year and also mothers who had not attended college (thus excluding college students with temporarily low income). Since 48% of mothers in the study had college degrees, the high-SES group was defined as families with income of $50,000 or more and mothers with college degrees. Subjects with neither high- nor low-SES status were not included in the analyses for this article.

Dental examinations of the primary and mixed dentition were conducted by 1 of 2 calibrated examiners using a portable chair, exam light, mirror and explorer when the children were 3 to 7 (mean=5.2 years) and 7 to 11 (mean=9.2 years) years of age. The criteria for caries examination were published previously.[16] Consistent with the approach of the World Health Organization[20] (WHO), Pitts et al,[21] and Ismail,[22] precavitated and cavitated lesions were assessed for the primary and permanent teeth.[19] For these analyses, only cavitated lesions were used in counts of caries.

Data were reviewed, double-entered, and verified. Statistical analyses used both SPSS (SPSS, Inc, Chicago, Ill)[23] and SAS (SAS Institute, Inc, Cary, NC).[24] Statistical analyses included summary statistics of means and percentages of subjects with different outcome variables. Bivariate analyses were conducted for each time period separately. Independent *t* tests were used to assess the differences in the mean amounts of juice/juice drink, soda pop, and powder-based drink consumption among low- and high-SES groups. *t* tests were also used to assess differences in the frequency of tooth-brushing and the concentration of fluoride in home drinking water between the low- and high-SES groups.

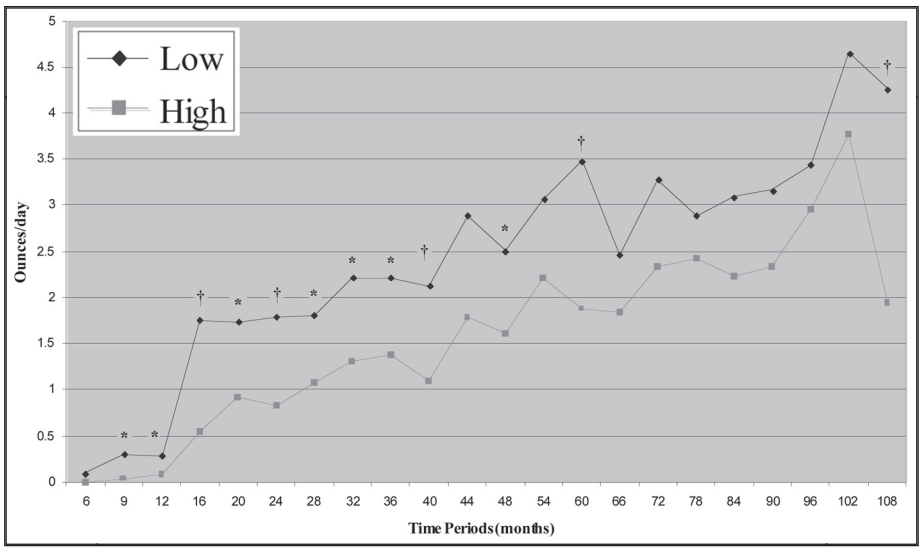

Figure 2. <Mean quantities of soda pop consumption by socioeconomic status
*Significant (P<.05).
†Significant (P<.01).
Note: Generalized estimating equations analysis of yearly time points from 24 to 96 months showed an overall significant effect of socioeconomic status on soda pop consumption (P=.007).

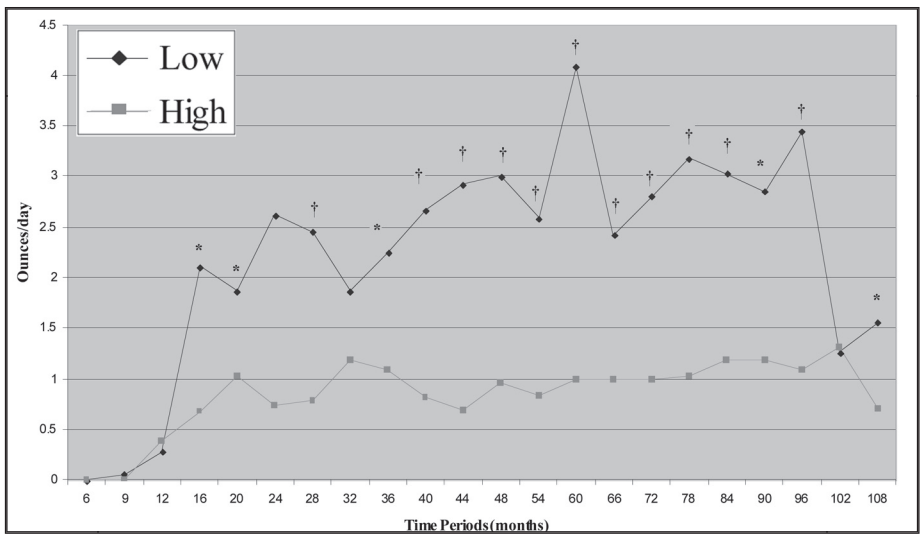

Figure 3. Mean quantities of powder-based drink consumption by socioeconomic status
*Significant (P<.05).
†Significant (P<.01).
Note: Generalized estimating equations analysis of yearly time points from 24 to 96 months showed an overall significant effect of socioeconomic status on powder-based drink consumption (P=.0001).

Chi-square tests were used to assess differences between the low- and high-SES groups in the percentages of children with dental visits and percentages of children using fluoridated dentifrice. Comparison of the mean numbers of decayed and filled surfaces of primary and mixed dentition teeth between low- and high-SES groups was done using independent *t* tests. Then, generalized estimating equations (GEE) were used. GEE is a regression method used for data with repeated measurements from the same individuals and accounts for correlated outcomes within an individual and different numbers of measured outcomes among individuals. The GEE analyses were used in this study to model the consumption of soda pop and powder-based drink intake and dental visits using yearly data from 24 to 96 months as repeated measures over the multiple time periods, and to assess the relationships with SES. Values of $P \leq .05$ were considered statistically significant.

Results

The number of children in this study with completed baseline questionnaires, including responses to a family income question, and one or more subsequent questionnaires every 2 years from 6 to 108 months of age, was 516. According to the definitions described previously, there were 89 subjects excluded with family income between $40,000 to $50,000, with 229 being excluded because either their income was high and education level low or their income was low and education level high. Thus, the final sample comprised 70 children who were categorized in the low-SES group and 128 children in the high-SES group.

The patterns of consumption of juice/juice drinks, soda pop, and powder-based drinks (eg, Kool-Aid) by low- and high-SES groups are presented in Figures 1, 2, and 3, respectively. Figure 1 presents the mean quantity (ounces) of juice/juice drink consumed by low- and high-SES groups by age of the children (time periods). Low-SES children consumed significantly more juice/juice drinks when they were 6, 9, 12, and 60 months of age compared to high-SES children. There was no overall significant difference, however, between the 2 groups considering all time periods. The mean quantities of soda pop consumption of low- and high-SES children by age of children (time periods) are presented in Figure 2. The low-SES group consistently consumed higher amounts of soda pop for all time periods from 6 to 108 months of age. Similarly, the consumption of beverages prepared from powder was significantly different by SES status during the ages of 16 to 96 months (Figure 3). The GEE analyses for soda pop and powder-based drink intake used yearly data from 24 to 96 months. For soda pop, the low-SES group consumed sig-

nificantly more collectively over all ages (*P*=.007). For powdered-based drink consumption, the low-SES group consumed significantly more collectively than did the high-SES group (*P*=.0001).

The percentage of children with dental visits by age is presented in Figure 4. Very few children visited the dentist before age 3 for both the low- and high-SES groups. The proportions of children with dental visits were similar between the 2 groups from ages 12 to 32 months. High-SES children, however, reported more dental visits thereafter. Dental visits were significantly higher for the high-SES groups for the time periods at 48, 54, 66, and 84 to 108 months. The GEE analysis for dental visits was conducted using yearly data from 24 to 96 months. The number of dental visits showed significant linear and quadratic trends with age, which reflect the increasing trend through approximately 6 years of age (Figure 4), and a leveling off of dental visits thereafter. The low-SES group showed significantly fewer dental visits collectively than the high-SES group (*P*=.0002). No interactions were statistically significant.

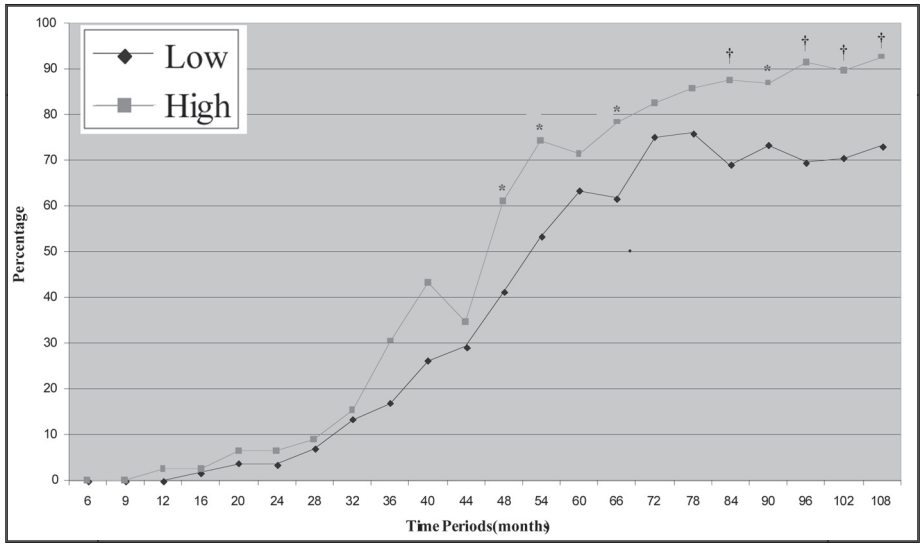

Figure 4. Percentage of children with dental visits socioeconomic status
*Significant (P<.05).
†Significant (P<.01).
Note: Generalized estimating equations analysis of yearly time points from 24 to 96 months showed an overall significant effect of socioeconomic status on dental visits (P=.0002).

Table 1. Prevalence of Frank Decay or Filled Decay at the Primary Dentition and Mixed Dentition Exams by Low- and High-SES Groups

Prevalence (mean d_2fs or D_2FS)	Low SES (±SD)	High SES	Fisher's exact test P value
Primary exam d_2fs	45% (2.3)	17% (0.8)	.0003
Mixed dentition exam d_2fs	64% (5.1)	43% (2.3)	.02
Mixed dentition exam D_2FS	24% (0.4)	20% (0.4)	.68

Mean tooth-brushing frequencies, percentages using fluoridated dentifrice, and mean home water fluoride levels for the low- and high-SES groups were examined at different ages and then combined (data not shown). There were some differences in the mean tooth-brushing frequencies between the low- and high-SES children. The results, however, were not consistent with age. The low-SES group had slightly greater frequency at 9, 12, and 16 months (*P*<.05), frequency was very similar for 24 to 54 months, and the high-SES group was higher at 84, 96, and 108 months (*P*<.05). The mean home water fluoride concentration (ppm) was generally slightly higher for the low-SES group, with no statistically significant differences between the 2 SES groups, except for the time periods 54, 60, and 66 months. Overall, the mean home water fluoride level was not significantly different.

As expected, the mean number of df surfaces in the primary teeth was significantly higher for the low-SES group (2.3 surfaces) compared to the high-SES group (0.8 surfaces) (*P*=.012) at age 5. Similarly, the mean number of decayed and filled surfaces in the primary and permanent teeth combined (mixed dentition) was significantly higher for the low-SES group (5.5 surfaces) compared to the high-SES group (2.6 surfaces; *P*<.001) at age 9 years using independent *t* tests. Table 1 demonstrates that the prevalence of frank or filled decay in the primary teeth was significantly higher at both examinations for those in the low-SES group, although prevalence was not significantly different between the SES groups for the permanent teeth.

Discussion

The study sample consisted of children who participated in the IFS. This represented a cohort of children who were followed longitudinally from birth to 108 months of age. This study assessed consumption of juices/juice drinks, soda pop, and powder-based drinks, dental visits, and tooth-brushing frequency near the times of use, thus reducing recall bias. This study demonstrated significant differences in oral health-related behaviors between children in high- and low-SES groups. Specifically, children in the low-SES group consistently consumed more sugared beverages (soda pop and powder-based beverages) during their first 8 years of life than did their higher-SES counterparts. In addition, lower-SES children consumed more juice/juice drinks dur-

ing the first year of life, suggesting a pattern of higher sweet beverage consumption beginning very early in life. There were few differences in home water fluoride level, toothpaste use, or tooth-brushing frequency between groups, however, and only modest differences in dental visits. Since the low-SES group had higher caries experience coupled with fewer dental visits, the low-SES group may have a higher proportion of unmet need for treatment.

Results suggest that messages regarding tooth-brushing and dental visits as ways to promote oral health may be reaching lower-SES families, but that the relationships between soft drink consumption and caries may not be widely recognized. Perhaps this is because most messages regarding avoidance of sugary snacks traditionally have focused on food items such as cakes, candy, etc, rather than sugared beverages. Also, it is possible that lower-SES families have higher powdered beverage consumption because such beverages are relatively inexpensive compared to alternatives such as milk and juice. Similarly, although bottled water consumption was generally low among study children, bottled water is often more expensive than are powdered beverages made with tap water. Thus, this study's results suggest that in developing strategies to reduce disparities in children's dental caries experience, it is important that messages aimed at improving health behaviors stress the hazards of soft drink consumption, including both soda pop and powered-based beverages.

As the authors reported previously,[14,15,25] soft drink consumption is a risk factor for dental caries in children. Furthermore, comparison of caries experience between groups in the present study demonstrated greater caries experience in the lower-SES group. This is especially important in that there have been increases in the consumption of soda pop and sugared powder-based drinks in the United States in recent years.[26] Thus, changing health behaviors toward less sugared beverage consumption in children will require changing this trend. This is a difficult proposition, given the profitability of such products and the inherent difficulties in changing behaviors among large groups of people. Considering the limited economic and educational backgrounds of lower-SES families, coupled with limited access to preventive care, changing such behaviors in lower-SES populations will be especially difficult.

This study was unique in that it gathered longitudinal data on a variety of oral health-related behavioral factors—a major strength of the study. Nonetheless, the study did have limitations, including behavioral data reported by the parents, with no practical way to validate their responses, and a sample that was disproportionately white.[11,13] In addition, the determination of high and low SES was based on limited baseline measures only, so there was potential for misclassification. Also, given the relatively high SES of the study cohort, it might not have accurately represented the full range of SES in the population. While the difference between SES groups in the study may not have provided a large contrast, however, the finding of significant differences in health behaviors suggests that, in the general population with more profound differences in SES, such differences in health behavior could be even more pronounced.

Conclusions

Based on this study's results, the following conclusions can be made:

1. There were important differences in beverage consumption patterns between children from low- and high-socioeconomic status families.
2. There were differences between low- and high-SES groups in the proportion of children with dental visits, but there were no differences in tooth-brushing frequency or fluoride dentifrice use.
3. Targeting reduction of soda pop and powder-based beverage consumption by low-SES groups could be important in reducing the caries experience.

Acknowledgements

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References

1. Fiscella K, Williams DR. Health disparities based on socioeconomic inequities: Implications for urban health care. Acad Med 2004;79:1139-1147.
2. Drewnowski A, Specter SE. Poverty and obesity: The role of energy density and energy costs. Am J Clin Nutr 2004;79:6-16.
3. Adler NE, Boyce T, Chesney MA, Cohen S, Folkman S, Kahn RL, Syme SL. Socioeconomic status and health—the challenge of the gradient. Am Psychol 1994;49:15-24.
4. Department of Health And Human Services, US Public Health Services. Oral Health in America: A Report of the Surgeon General, May 2000. Available at: www2.nidcr.nih.gov/sgr/sgrohweb/welcome.htm. Accessed January 17, 2006.
5. Kaste LM, Selwitz RH, Oldakowski RJ, Brunelle JA, Winn DM, Brown LJ. Coronal caries in the primary and permanent dentition of children and adolescents 1-17 years of age: United States, 1988-1991. J Dent Res 1996;75(special issue):631-641.
6. Brown LJ, Kaste LM, Selwitz RH, Furman LJ. Dental caries and sealant usage in US children, 1988-1991: Selected findings from the Third National Health and Nutrition Examination Survey. J Am Dent Assoc 1996;127:335-343.
7. Reisine ST, Psoter W. Socioeconomic status and selected behavioral determinants as risk factors for dental caries. J Dent Educ 2001;65:1009-1016.
8. Gillcrist JA, Brumley DE, Blackford JU. Community socioeconomic status and children's dental health. J Am Dent Assoc 2001;132:216-222.

9. Källestål C, Wall S. Socioeconomic effect on caries. Incidence data among Swedish 12- to 14-year-olds. Community Dent Oral Epidemiol 2002;30:108-114.
10. Vereecken CA, Maes L, De Bacquer D. The influence of parental occupation and the pupils' educational level on lifestyle behaviors among adolescents in Belgium. J Adolesc Health 2004;34:330-338.
11. Levy SM, Kiritsy MC, Slager SL, Warren JJ. Patterns of dietary fluoride supplement use during infancy. J Public Health Dent 1998;158:228-233.
12. Warren JJ, Levy SM, Kanellis MJ. Prevalence of dental fluorosis in the primary dentition. J Public Health Dent 2001;61:87-91.
13. Levy SM, Warren JJ, Davis CS, Kirchner HL, Kanellis MJ, Wefel JS. Patterns of fluoride intake from birth to 36 months. J Public Health Dent 2001;61:70-77.
14. Marshall TA, Levy SM, Broffitt B. et al. Dental caries and beverage consumption in young children. Pediatrics 2003;112:e184-191.
15. Levy SM, Warren JJ, Broffitt B, Hillis SL, Kanellis MJ. Fluoride, beverages and dental caries in the primary dentition. Caries Res 2003;37:157-165.
16. Franzman MR, Levy SM, Warren JJ, Broffitt B. Toothbrushing and dentifrice use among children ages 6 to 60 months. Pediatr Dent 2004;26:87-92.
17. Slayton RL, Warren JJ, Levy SM, Kanellis MJ, Islam M. Frequency of reported dental visits and professional fluoride applications in a cohort of children followed from birth to age 3 years. Pediatr Dent 2002;24:64-68.
18. Levy SM, Broffitt B, Slayton R, Warren JJ, Kanellis MJ. Dental visits and professional fluoride applications for children ages 3 to 6 in Iowa. Pediatr Dent 2003;25:565-571.
19. Warren, JJ, Levy SM, Kanellis MJ. Dental caries in the primary dentition: Assessing prevalence of cavitated and noncavitated lesions. J Public Health Dent 2002;62:109-114.
20. World Health Organization. *A Guide to Oral Health Epidemiology Investigations*. Geneva, Switzerland: WHO; 1979.
21. Pitts NB. Diagnostic tools and measurements—impact on appropriate care. Community Dent Oral Epidemiol 1997;25:24-35.
22. Ismail AI. Clinical diagnosis of precavitated carious lesions. Community Dent Oral Epidemiol 1997;25:13-23.
23. SPSS for Windows release 9.0 Chicago, Ill: SPSS, Inc; 1998.
24. The SAS system, version 8 for Microsoft Windows. Cary, NC: SAS Institute, Inc; 1999.
25. Mariri BP, Levy SM, Warren JJ, Bergus GR, Marshall TA, Broffitt B. Medically administered antibiotics, dietary habits, fluoride intake and dental caries experience in the primary dentition. Community Dent Oral Epidemiol 2003;31:40-51.
26. Cavadini C, Siega-Riz AM, Popkin BM. US adolescent food intake trends from 1965 to 1996. Arch Dis Child 2000;83:18-24.