Scientific Article

Dental Caries and Dietary Patterns in Low-income African American Children

Justine L. Kolker, DDS, MS, PhD[1] • Ying Yuan, MS, PhD[2] • Brian A. Burt, BDS, MPH, PhD[3] • Anita M. Sandretto, PhD[4] • Woosung Sohn, DDS, PhD, DrPH[5]
Sylvia W. Lang, PhD[6] • Amid I. Ismail, BDS, MPH, MBA, DrPH[7]

Abstract: ***Purpose:*** *The purpose of this study was to assess the relationship between dietary patterns and dental caries severity in low-income African American children.* ***Methods:*** *The participants were 3- to 5-year-old African American children in Detroit, Mich, with household incomes below 250% of the 2000 federal poverty level (N=436). Dietary intakes were obtained using the Block Kids Food Questionnaire. Dental caries in primary teeth were measured by the International Caries Detection and Assessment System criteria. The mean number of decayed surfaces (noncavitated and cavitated, missing, and filled surfaces [dmfs]) for each child was estimated. Factor analysis was carried out to identify the patterns of solid food consumption. The resulting factor scores and drink variables were then used as covariates in multinomial logistic regression, with 4 levels of dmfs as the outcome. Statistical analyses were conducted using SAS and SUDAAN.* ***Results:*** *Multinomial regression models found that age, soda consumption, and powdered/sport drink consumption were positively associated with dmfs scores. Milk and real juice (not orange) were associated with lower dmfs levels.* ***Conclusions:*** *Children frequently consume sugared drinks, which is associated with the prevalence of dental caries. Intervention programs that promote the adoption of noncariogenic dietary alternatives for children are needed.*
(Pediatr Dent 2007;29:457-64) Received September 5, 2006 / Revision Accepted February 2, 2007.

KEYWORDS: DIETARY PATTERNS, SOFT DRINKS, SUGARS, CARIES, CHILDREN, DISPARITIES, LOW-INCOME

Information is sparse on the dietary intake of American children under the age of 6 years. An evaluation of dietary trends from 4 National Health and Nutrition Examination Surveys (NHANES)—national cross-sectional surveys that collect data from a large representative sample—found that, between the 1970s and 1999-2000, 3- to 5-year-old children had a decreased mean intake of daily calcium.[1] During this period, consumption of milk declined and consumption of sugary drinks (especially soft drinks) increased among children.[1-4] Soft drinks represent the single largest source of refined sugars in American diets.[5] The consumption of these drinks increased by 300% between 1965 and 1996.[3] By the age of 5 years, the intake of soft drinks exceeds that of 100% fruit juices, and by age 13 the intake of soft drinks exceeds the intake of milk.[6] Children and adolescents are the most likely of all age groups to have diets high in added sugars.[1] Two- to 5-year-old children who get 25% or more of their energy from added sugars (such as fruit drinks and soft drinks) have the lowest levels of micronutrients, vegetables, fruits, and dairy products.[7]

Sugars are primary factors in causing dental caries.[8,9] The association between the consumption of sugar and dental caries, however, is not as clear and direct as was previously assumed, probably because of the widespread exposure to fluoride.[10] In the 1970s, NHANES found that in 9- to 25-year-old individuals there was a consistent association between caries experience and the consumption of soft drinks during and between meals.[11] A study conducted with 1½- to 4½-year-old children who participated in the British National Diet and Nutrition Survey, however, found that there was no association between the consumption of soft drinks and dental caries.[12] More recent studies found positive associations between a high intake of soft drinks and dental caries. These included 1 study of a group of 5-year-old children participating in the Iowa Fluoride Study[13] and another study of 2- to 10-year-old children in an evaluation of the NHANES III 24-hour diet recall.[14]

[1]*Dr. Kolker is Assistant Professor, Department of Operative Dentistry, College of Dentistry, University of Iowa, Iowa City, Iowa;* [2]*Dr. Yuan is Assistant Professor, Department of Biostatitics and Applied Mathematics, MD Anderson Cancer Center, The University of Texas, Houston, Tex;* [3]*Dr. Burt is Professor Emeritus, Department of Epidemiology and School of Dentistry;* [4]*Dr. Sandretto is Lecturer, Department of Environmental Health Science;* [5]*Dr. Sohn is Assistant Professor, Department of Cariology, Restorative Sciences and Endodontics; and* [6]*Dr. Lang is Senior Research Analyst, Institute of Gerontology;* [7]*Dr. Ismail is Professor, both in the Departments of Cariology, Restorative Sciences and Endodontics, and Epidemiology, all at the University of Michigan, Ann Arbor, Mich;*

Correspond with Dr. Justine Kolker at University of Iowa, College of Dentistry, justine-kolker@uiowa.edu

There is less certainty, however, about the relationship between overall dietary patterns and caries. From an oral health perspective, we might intuitively expect that poor-quality diets promote dental caries, but apart from sugar's role there is little firm evidence to support such a relationship. Assessing the relationship of dietary patterns and caries experience in a group of low-income, urban, African American children presents an opportunity to understand how dietary composition is associated with dental caries prevalence and severity in a group of children with limited access to restorative care.

This study's purpose was to examine the relationship between caries experience and dietary patterns in a group of low-income, 3- to 5-year-old African American children from Detroit, Mich. This paper used data from the first wave (2002-2003) of a cohort epidemiological study carried out by the Detroit Center for Research on Oral Health Disparities, in Detroit, Michigan. This project targets African American children, initially under the age of 6 years, living in Detroit households with income below 250% of the 2000 poverty level.

Methods

Study population. This study was approved by the Institutional Review Board for Health Sciences at the University of Michigan, Ann Arbor, Mich. Participants were selected using a 2-stage area probability sample. Thirty-nine census tracts with the largest proportions of households below 250% of the US federal poverty level (set by the US government) and with African American children under 6 years of age were selected. Within the tracts, 118 blocks were systematically selected, with probability proportionate to size. To the selected blocks, other adjacent or nearby blocks were added to form segments of equal sizes (approximately 100 housing units). Within each of the segments, housing and nonhousing units were listed and a random sample was selected. Each sampled household was visited and screened for eligibility. Eligibility required that children had to be: (1) African American; (2) under the age of 6 years; and (3) living in Detroit households with income below 250% of the 2000 poverty level.

When there was more than 1 child under the age of 6 in the household, one of the children was randomly selected as the "index" child for the study. From the 1,386 eligible households screened, a total of 1,021 pairs of index children and caregivers were recruited to the study.

Data collection. Data were collected through dental screenings and questionnaires administered by trained interviewers. The questionnaires were designed to collect information on: (1) caregiver and child demographic information (ie, age, gender, employment, income, and education); (2) access to care; (3) oral and general health status and beliefs; (4) psychosocial and environmental factors that might influence their oral health; (5) quality of life; (6) brushing habits; and (7) dietary intake.

Caregivers were interviewed by trained staff to assess their children's dietary intake. The Block Kids Food Questionnaire (FFQ) from Block Dietary Data Systems of Berkeley, Calif., was used to collect the dietary data for children who were at least 3 years old. For a wide variety of individual foods, the FFQ asked the: (1) number of days during the last week that particular foods were eaten; and (2) usual amount eaten in one day.

To judge portion sizes, participants were asked to look at clay models and photographs. As suggested by Block Dietary Data Systems, the authors used a conservative approach that excluded outliers based on reported diet.

The dental examinations were performed by trained dentists using the International Caries Detection and Assessment System (ICDAS).[15] ICDAS detection codes ranged from 0 (sound, no caries) to 6 (distinct cavitation that involves dentin and at least half of the tooth surface). This system allows for separate severity detection of early noncavitated enamel lesions and cavitated enamel and/or dentin lesions. For this study, the unit of evaluation was the number of tooth surfaces (s) that: (1) have either a noncavitated or cavitated lesion (d); or (2) have a filling due to caries (f); or (3) are missing due to caries (m). This unit of evaluation is a measure of severity, labeled dmfs, with the "d" component including both noncavitated and cavitated carious tooth surfaces.

Data analysis

Statistical analyses were conducted using software from SAS (SAS Institute Inc, Cary, NC), and SUDAAN (SAS Institute Inc, Cary, NC) to estimate variances adjusted for the design effect. Caries was evaluated by creating 4 ordinal groups based on the level of dmfs. One group was created with the 25% of the children who had a dmfs=0. Children with a dmfs>0 were divided into tertiles resulting in the following groups: (a) 1-4 dmfs; (b) 5-11 dmfs; and (c) 12-52 dmfs.

To evaluate dietary patterns, the foods consumed daily at the highest frequencies were selected. Of these food items, 18 were solid foods while only 6 were drinks. Therefore, we chose to use these drinks as individual variables in the multinomial logistic regression models. To determine the patterns of solid food consumption, factor analysis was conducted using the PROC FACTOR command in SAS. The scree plot of eigenvalues supported the creation of 4 or fewer solid food factors. The results of the 3 solid food factors solution made the most theoretical nutritional sense and were then used for further analyses. The 3 solid food factors and the 6 individ-

ual drinks were then evaluated for collinearity and inclusion as covariates in multinomial logistic regression modeling. Through this process, solid food factor 2 was dropped from inclusion in the multinomial logistic regression models, due to the collinearity with soda.

To determine the best predictive model for caries (4-level ordinal variable of dmfs), a cumulative multinomial logistic regression model was constructed using the PROC MULTILOG command in SUDAAN, which accounts for within-cluster correlations by using generalized estimating equations (GEE) and sandwich robust variance estimates. The final variables in the model were selected by backward selection. Regression modeling accounted for the following variables for each child: (1) age; (2) gender; (3) type of caregiver; (4) caregiver employment status; (5) caregiver education level; (6) family income level; and (7) brushing frequency. The regression analysis evaluated the inclusion of the remaining 2 solid food factors and the 6 drink variables (quantity consumed each week). All of these variables were included in the initial full model. While keeping all the demographic variables in the model (regardless of statistical significance, they were retained for theoretical importance), the food variable with the highest *P*-value was dropped from the model. This process was repeated until the most parsimonious model resulted, containing only those food variables which that had a *P*-value <.10. Prior to determining a final model, interactions between the remaining food variables (milk, soda, powdered/sports drinks, and real fruit juices [not including orange]) were ruled out.

The Block Kids Food Questionnaire separates the collection of information on real orange juice vs other real fruit juices such as grape and apple. Real orange juice is one of the best sources of vitamin C and folic acid compared to other real fruit juices and, therefore, is not grouped with other real fruit juices. The authors followed Block's separation of real orange juices from other real fruit juices, since young children, such as in this study, often consume real grape and apple juice at a much higher frequency than real orange juice.

Results

A total of 517 3- to 5-year-old children completed food questionnaires. Of the 517 children, 40 did not report having a typical diet in the week prior to the examination and, therefore, they were removed from further analyses. An additional 41 children were removed from the dataset due to serious errors in their responses, resulting in a sample of 436 children. Block Dietary Data Systems labeled children with "serious errors" when a caregiver reported that the child ate fewer than 3 solid foods per day or more than 17 solid foods per day. When the group of 436 individuals included in the analyses was compared to the 41 individuals with severe errors, there were no significant differences between: (1) the children's ages; (2) the children's BMI percentiles; (3) the age of the children's caregivers; and (4) the caregiver's BMI percentiles.

Table 1. FREQUENCIES FOR DEMOGRAPHIC VARIABLES AND DMFS BY AGE FOR A GROUP OF LOW-INCOME AFRICAN AMERICAN CHILDREN IN DETROIT, MICH, FOR THE TIME PERIOD 2002-2003 (N=436)

			3-year-olds (N=148)		4-year-olds (N=139)		5-year-olds (N=149)	
Variables	**Level**	**Overall**	**N**	**% ± SD ***	**N**	**% ± SD ***	**N**	**% ± SD ***
Child gender	Male	198	66	30 ± 4.0	68	35 ± 3.3	64	35 ± 3.9
	Female	238	82	31 ± 3.4	71	32 ± 3.2	85	37 ± 3.8
Caregiver type	Mother	377	126	30 ± 2.7	123	34 ± 2.7	128	36 ± 2.9
	Nonmother	59	22	34 ± 7.5	16	28 ± 6.6	21	38 ± 8.3
Caregiver employed	Yes	169	58	29 ± 4.0	54	35 ± 3.6	57	36 ± 4.9
	No	263	89	31 ± 3.0	82	32 ± 3.2	92	37 ± 3.7
Income level	<$10,000	191	57	29 ± 3.8	67	36 ± 4.3	67	35 ± 4.2
	$10,000-$19,000	119	47	35 ± 5.8	33	28 ± 4.8	39	37± 4.8
	$20,000+	126	44	28 ± 4.2	39	34 ± 4.6	43	38 ± 5.0
Caregiver education	Not a high school graduate	195	62	27 ± 3.7	63	36 ± 4.0	70	37 ± 3.5
	High school graduate without higher education	139	56	35 ± 5.3	45	33 ± 4.0	38	32 ± 6.7
	High school graduate with some higher education	96	29	30 ± 6.8	29	29 ± 5.8	38	41 ± 5.0
dmfs †	0	109	53	48 ± 5.4	36	37 ± 5.3	20	15 ± 4.4
	1-4	106	42	35 ± 5.8	29	30 ± 5.4	35	35 ± 6.4
	5-11	117	31	21 ± 4.1	39	31 ± 4.3	47	48 ± 5.4
	12-52	104	22	16 ± 2.9	35	36 ± 6.0	47	48 ± 5.7

* Weighted % † Includes both noncavitated and cavitated lesions

Demographic variables that are often associated with caries prevalence in children were selected and are presented in Table 1 by the children's ages. Fifty-five percent of the children were female, and 86% of the caregivers were mothers. The families in this study were from lower socioeconomic groups, with over half of the caregivers being unemployed (60%), and just fewer than half of the caregivers having income levels less that $10,000 (44%) and not graduating from high school (45%). All demographic variables were relatively equally distributed across all ages. There was a significant association, however, between levels of dmfs and age (P=.002).

The most frequently consumed solid foods on an average day were (in descending order): (1) cold cereal; (2) potato chips; (3) sliced cheese; (4) bread/toast; (5) bologna; and (6) ketchup (data not tabulated.) Of the 18 solid foods most frequently consumed on a daily basis, no vegetables were listed. In fact, green beans were the most frequently consumed vegetable and were ranked 33rd of all solid foods consumed. On the other hand, a number of fruits (bananas, apples, oranges, seasonal fruits, and canned fruits) were on the list of the 18 solid foods most often consumed daily. When evaluating the primary sources of sugar intake, the 5 top sources were all sweetened drinks and accounted for 54% of daily sugar intake (Table 2).

Table 2. THE TOP 6 SOURCES OF SUGAR FOR A GROUP OF LOW-INCOME AFRICAN AMERICAN CHILDREN IN DETROIT, MICH, FOR THE TIME PERIOD 2002-2003

Food	Average amount of sugar/day (g)	% of total sugar intake	Cumulative % of total sugar intake
1. Powdered drinks and sports drinks (Kool-aid/ Gatorade)	20	12	12
2. Fruit drinks (Sunny Delight, Hi-C, Hawaiian Punch, Ocean Spray)	21	12	24
3. Soda (nondiet)	20	11	35
4. Real fruit (such as apple or grape, but not including orange)	19	11	45
5. Real orange juice	15	9	54
6. Sweetened cereal	9	5	59

The factor analysis resulted in 3 factors for the 18 solid food items:

1. Factor 1 included all fruits.
2. Factor 2 included: (a) chocolate candy; (b) nonchocolate candy; (c) chips; (d) ice cream; (e) crackers; (f) cookies; and (g) cereal.
3. Factor 3 included: (a) bread; (b) margarine; (c) cheese; (d) ketchup; (e) peanut butter; and (f) bologna.

When the relationships between the 3 solid food factors and 6 individual drink items were individually evaluated, there was strong correlation/collinearity between solid food factor 2 and the quantity of soda consumed. Of all comparisons, soda and factor 2 had the highest correlation coefficient of 0.47, with a P<.001. It was decided to keep soda in the model during model selection instead of including solid food factor 2. This decision was made because soda: (1) accounts for a high percentage of total sugar intake (11%; Table 2); (2) is significantly associated with higher levels of dmfs (of the 4-level grouping) when consumption is divided into tertile levels (P=.049); and (3) is positively associated with caries in the adult caregivers of these children.[16]

Solid food factor 1, solid food factor 3, and the 6 drink items were then used as continuous independent variables in the multinomial logistic regression, with the 4 levels of dmfs as the outcome. The full model is shown in Table 3. Age, employment, powdered/sports drinks, real orange juice, and real juices (not including orange) were significantly associated with dmfs levels when a significance value of P<.10 was used. Since the authors used the backward elimination procedure to do model selection, they selected a significance level of 0.10 to be liberal in terms of significance level to avoid accidentally eliminating some important covariates from the model. Additionally, it is the default value suggested by SAS.

The backward variable selection resulted in the final model displayed in Table 4. The independent variables retained in the final model, in addition to the demographic variables, included: (1) milk; (2) soda; (3) powdered/sport drinks; and (4) real juice (not orange). Soda and powdered/sport drinks were associated with higher dmfs levels, while milk and real juice (not orange) were associated with lower dmfs levels. Evaluation of interactions did not affect the resulting final model. Brushing frequency was not associated with dmfs levels in the initial or final regression models. Plaque levels were not evaluated for inclusion in the model, since this information was not collected from the children. Brushing frequency, however, was kept in the models as an indication of oral hygiene.

Discussion

The prevalence of caries in this population was high, with 75% of the children experiencing either noncavitated or cavitated carious lesions. This level of caries experience was much higher than in a Connecticut Head Start program, where 38% had dental caries and 49% had enamel defects (hypoplasia and opacities).[17] The prevalence in Detroit's children, however, was lower than the 86%[18] and 91%[19] reported in other Head Start children. This study's children had similar caries experience to that observed in children of other low-income families, especially those below the poverty level.[20]

The Block Kids Food Questionnaire was used in this study because: (1) it is an efficient method of collecting dietary intake information from a large number of people; and (2) the outcomes can be compared to studies on other populations.

Table 3. FULL INITIAL CUMULATIVE MULTINOMIAL LOGISTIC REGRESSION MODEL WITH 4 LEVELS OF DMFS* (1=0 DMFS, 2=1-4 DMFS, 3=5-11 DMFS, 4=12-52 DMFS

Parameter	Level	Odds ratio±(SD)	95% confidence interval	*P*-value
	3	1.00 ± 0.00		
Age	4	1.80 ± 0.33	0.9, 3.4	.09
	5	4.00 ± 0.30	2.2, 7.3	.0001
	Male	0.80 ± 0.23	0.5, 1.2	.26
Child gender caregiver type	Female	1.00 ± 0.00		
	Mother	0.90 ± 0.35	0.4, 1.8	.68
	Nonmother	1.00 ± 0.00		
Employed	Yes	0.70 ± 0.21	0.4, 1.0	.06
	No	1.00 ± 0.00		
Income	< $10,000	1.00 ± 0.00		
	$10,000 - $19,000	1.00 ± 0.29	0.5, 1.8	.95
	$20,000 +	0.90 ± 0.26	0.5, 1.5	.61
	Not a high school graduate	1.00 ± 0.00		
Education	High school graduate without higher education	0.60 ± 0.32	0.3, 1.2	.15
	High school graduate with some higher education	0.90 0.41	0.4, 2.0	.70
Brushing frequency		1.00 ± 0.03	1.0, 1.1	.55
Milk		1.00 ± 0.02	0.9, 1.0	.11
Soda		1.00 ± 0.02	1.0, 1.1	.10
Powdered drinks and sports drinks		1.00 ± 0.02	1.0, 1.1	.09
Fruit drinks		1.00 ± 0.02	1.0, 1.1	.23
Real orange juice		1.00 ± 0.02	1.0, 1.1	.09
Real juice (not orange)		0.90 ± 0.02	0.9, 0.9	.0001
Solid food factor 1 †		0.90 ± 0.32	0.5, 1.7	.71
Solid food factor 3 ‡		0.90 ± 0.37	0.4, 2.0	.85

* Includes both noncavitated and cavitated lesions.

† Factor 1 foods included all fruits.

‡ Factor 3 foods included bread, margarine, cheese, ketchup, peanut butter, and bologna.

Other methods of collecting dietary intake, such as 24-hour recall or 3-day diet histories, require significant resources in collecting and summarizing dietary intake. A limitation of the Block Kids Food Questionnaire is that it does not collect the frequency or interval at which foods and beverages are consumed. Knowing whether a sugared beverage was consumed with a meal or was sipped over a long period of time is useful in predicting caries risk.

To manage the compound intercorrelations of multiple foods, it has been suggested that well-tested statistical techniques such as factor analysis should be used.[21] Factor analysis permits examination of the relationship between diet patterns and chronic diseases, resulting in a broader picture of food and nutrient consumption.[22] This method uses dietary intakes to empirically aggregate individuals with similar diets. Factor analysis is useful when, as was the case in this study, no association with specific nutrients has been found.[23]

It is difficult to compare the dietary patterns found in this project with other studies because of the paucity of data on the dietary patterns of low-income African American children. The Detroit child population was similar to other groups of children who reported not eating the recommended minimum of 5 servings per day of fruits and vegetables.[7,24] It does appear that the Detroit children were consuming fruits, but relatively few children consumed vegetables on a daily basis. This is similar to the findings in the Bogalusa Heart Study, which found that 10-year-old children do not follow dietary recommendations, yet they have an increased total intake of fruits, fruit juices, and soft drinks.[25]

For this Detroit population, the children may have limited availability of good-quality vegetables and fruits; consequently, their dietary intake was skewed towards nonhealthy foods. Additionally, this population experiences daily economic challenges, such as having no cash. Therefore, they may not be able to afford healthy foods, especially fresh fruits and vegetables. In a previous analysis, the authors found that the number of grocery stores (which are mostly convenience stores affiliated with gas stations) in this community was associated with high caries severity.[26] These findings may indicate the lack of availability of healthy food options in the community.

The result of children consuming 54% of their sugars from sweetened beverages is similar to other reports where adolescents as an age group not only have the highest intake of added sugars, but consume 40% of their sugars from soft drinks.[5,27,28] We were surprised that the second most popular solid food item was potato chips, but this is similar to the findings of Briefel and Johnson.[1] The investigators found that individuals at or below 130% of the poverty level had a higher intake of fried potatoes, potato chips, whole milk, and fruit drinks as snacks than individuals in families with incomes of 300% or higher of the poverty level. Food consumption trends since the 1970s include an increase in: (1) the amount of eating that is done away from home; (2) increased snack consumption; and (3) increased availability of snacks.[1]

The amount of money spent on food away from home has increased for all racial/ethnic groups and income levels. Between the 1970s and the 1990s, women and young children had a 50% increase in eating away from home, and soft drinks were one of the most common items consumed away from home.[1]

In the past, cariogenic foods were thought of as being mostly solid foods (eg, candy, chocolate, baked goods). The classical Vipeholm study[8] in the 1950s emphasized the cariogenicity of sticky foods and downplayed the importance of sugar in beverages. More recently, however, it has been documented that sugared beverages are a major risk factor for caries development in children.[13,29-31] This study's data confirm these findings, with 54% of the children's energy coming from the sugars in just a few types of drinks. Marshall et al found that combining solid and liquid sugar sources minimizes the contribution of specific beverages or foods to caries.[30] With this information and the clear evidence that sugar sources in this population were predominantly from drinks, the authors decided not to include the 6 drinks in factor analysis and instead left them as separate covariates in the multinomial logistic regression. One of the limitations of this study is that the Block Kids Food Questionnaire does not collect information on the frequency or amount of water that the children consumed. Additionally, although the city of Detroit has fluoridated water, many focus group participants reported not drinking tap water due to the poor taste. Because we do not know the main water source for the children in this study, we cannot make assumptions regarding their fluoride intake.

In addition to an increased risk of caries, children with poor diet quality are at risk for other health problems, including: (1) obesity; (2) heart disease; and (3) osteoporosis.[32] The prevalence of overweight children in the United States has tripled in the last 3 decades; for 6- to 11-year-old children, the prevalence of being overweight grew from 4% to 15%.[33] The prevalence of overweight children among the Detroit population in this study was 11%. Potentially, the prevalence of overweight children in Detroit could surpass national levels as they grow older, given that 13% of the young children in this study were classified as being at risk of being overweight. Research has shown that the increased risk of childhood obesity is associated with the consumption of sugar-sweetened beverages.[34] Also, overweight children were more likely to have a high soft drink intake than normal-weight children.[34,35]

We found that real fruit juices, not including orange juice, were protective of caries. Other reports have found that the consumption of 100% juice was not associated with caries.[13,30,31] Marshall points out that it is unclear why real fruit juices are not associated with higher caries rates, but it may have something to do with the different types of sugars in real vs added sugar drinks.[30] Sugars in real fruit juices are primarily fructose and glucose, while added sugar drinks usually have the addition of high fructose corn syrup, which may result in an overall higher quantity of sugar.

Another factor may be the overall diet pattern. Perhaps children who drink real fruit juice have more health conscious caregivers and as a result they have an overall healthier diet. A healthier diet may include: (1) lower amounts of solid sugars; (2) lower amounts of other added sugar drinks, such as soft drinks and powdered drinks, and (3) a higher consumption of milk and water.

Dietary patterns can help us understand the relationship of diet to oral health conditions and other health conditions such as obesity and being overweight. Knowing that dietary patterns will also assist in identifying strategies for nutrition intervention programs and planning public health initiatives.

Table 4. FINAL MULTIPLE LOGISTIC REGRESSION MODEL WITH 4 LEVELS OF DMFS* (1=0 DMFS, 2=1-4 DMFS, 3=5-11 DMFS, 4=12-52 DMFS)

Parameter	Level	Odds ratio±(SD)	95% confidence interval	*P*-value
	3	1.00 ± 0.00		
Age	4	1.70 ± 0.29	0.9, 3.1	.09
	5	4.00 ± 0.30	2.3, 7.8	.0001
Child gender	Male	0.80 ± 0.25	0.5, 1.3	.27
	Female	1.00 ± 0.00		
Caregiver type	Mother	0.70 ± 0.36	0.3, 1.4	.31
	Nonmother	1.00 ± 0.00		
Employed	Yes	0.80 ± 0.21	0.5, 1.2	.19
	No	1.00 ± 0.00		
	< $10,000	1.00 ± 0.00		
Income	$10,000 - $19,000	0.90 ± 0.26	0.5, 1.6	.74
	$20,000 +	0.70 ± 0.22	0.4, 1.0	.06
	Not a high school graduate	1.00 ± 0.00		
Education	High school graduate without higher education	0.60 ± 0.30	0.3, 1.1	.12
	High school graduate with some higher education	0.90 0.36	0.5, 2.0	.87
Brushing frequency		1.00 ± 0.03	1.0, 1.1	.58
Milk		1.00 ± 0.01	1.0, 1.0	.07
Soda		1.00 ± 0.02	1.0, 1.1	.07
Powdered drinks and sports drinks		1.00 ± 0.01	1.0, 1.1	.03
Real juice (not orange)		0.90 ± 0.02	0.9, 1.0	.0001

* Includes both noncavitated and cavitated lesions.

Additionally, this information can be used to provide guidance to policymakers, program officials, and the general public regarding the most appropriate foods and beverages for children.

Conclusions

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

1. This homogeneous population of low-income, 3- to 5-year-old children in Detroit, Mich, had unhealthy diets, including high intakes of sugared beverages, cold cereals, potato chips, and cheese. Vegetables were rarely consumed by the children.
2. Unhealthy diets were related to the severity of dental caries, with the consumption of soda and powdered/sport drinks related to a higher level of caries.
3. Conversely, healthier diets consisting of milk and real juice (not orange) consumption were associated with having a lower level of caries. Although all the associations were significant, the relationship may be classified as weak due to the low odds ratios.
4. This evidence clearly supports the need for dietary interventions that address not only healthy eating behaviors, but availability and affordability of healthy foods.

Acknowledgements

This research project was funded by the National Institute on Dental and Craniofacial Research (NIDCR), grant no. U-54 DE 14261-01, the Delta Dental Fund of Michigan, and the Office of the Vice President for Research and the School of Dentistry, both at the University of Michigan, Ann Arbor, Mich.

References

1. Briefel RR, Johnson CL. Secular Trends in Dietary Intake in the United States. Annu Rev Nutr 2004;24:401-31.
2. Guenther PM. Beverages in the diets of American teenagers. J Am Diet Assoc 1986;86:493-9.
3. Cavadini C, Siega-Riz AM, Popkin BM. US adolescent food intake trends from 1965 to 1996. Arch Dis Child 2000;83:18-24.
4. Fisher J, Mitchell D, Smiciklas-Wright H, Birch L. Maternal milk consumption predicts the tradeoff between milk and soft drinks in young girls' diets. J Nutr 2001; 131:246-50.
5. Guthrie JF, Morton JF. Food sources of added sweeteners in the diets of Americans. J Am Diet Assoc 2000; 100:43-51.
6. Rampersaud GC, Bailey LB, Kauwell GP. National Survey beverage consumption data for children and adolescents indicate the need to encourage a shift toward more nutritive beverages. J Am Diet Assoc 2003;103:97-100.
7. Kranz S, Smiciklas-Wright H, Siega-Riz AM, Mitchell D. Adverse effect of high added sugar consumption of dietary intake in American preschoolers. J Pediatr 2005;146:105-11.
8. Gustaffson BE, Quensel CE, Lanke LS, et al. The Vipeholm dental caries study. The effect of different levels of carbohydrates intake on caries activity in 436 individuals observed for five years. Acta Odontol Scand 1954; 11:232-364.
9. Sheiham A. Dietary effects on dental diseases. Public Health Nutr 2001;4:569-91.
10. Burt BA, Pai S. Sugar consumption and caries risk: A systematic review. J Dent Educ 2001;65:1017-23.
11. Ismail AI, Burt BA, Elkund SA. The cariogenicity of soft drinks in the United States. J Am Dent Assoc 1984;109:241-5.
12. Gibson S, Williams S. Dental caries in pre-school children: Associations with social class, tooth-brushing habit, and consumption of sugars and sugar-containing foods. Caries Res 1999;33:101-13.
13. Marshall TA, Levy SM, Broffitt B, Warren JJ, Eichenberger-Gilmore JM, Burns TL, Stubmo PJ. Dental caries and beverage consumption in young children. Pediatrics 2003;112:e184-91.
14. Sohn W, Burt BA, Sowers MR. Carbonated soft drinks and dental caries in the primary dentition. J Dent Res 2006;85:262-6.
15. Pitts N. ICDAS: An international system for caries detection and assessment being developed to facilitate caries epidemiology, research and appropriate clinical management. Community Dent Health 2004;21:193-8.
16. Burt BA, Kolker JL, Sandretto AM, Yuan Y, Sohn W, Ismail AI. Dietary patterns related to caries in a low-income adult population. Caries Res. 2006;40:473-80.
17. Montero MJ, Douglass JM, Mathieu GM. Prevalence of dental caries and enamel defects in Connecticut Head Start children. Pediatr Dent 2003;25:235-9.
18. Autio-Gold JT, Tomar SL. Prevalence of noncavitated and cavitated carious lesions in 5-year-old Head Start schoolchildren in Alachua County, Florida. Pediatr Dent 2005;27:54-60.
19. Albert DA, Findley S, Mitchell DA, Park D, McManus JM. Dental caries among disadvantaged 3- to 4-year-old children in northern Manhattan. Pediatr Dent 2002; 24:229-33.
20. US Department of Health and Human Services. *Oral Health in America: A Report of the Surgeon General.* Bethesda, Md: US Department of Health and Human Services, National Institute of Health, National Institute of Dental and Craniofacial Research; 2000. NIH publication no. 00-4713.
21. Jacobson HN, Stranton JL. Pattern analysis in nutrition research. Clin Nutr 1986;5:249-53.

22. Hu FB. Dietary pattern analysis: A new direction in nutritional epidemiology. Curr Opin Lipidol 2002;13:3-9.
23. Willett W. *Nutritional Epidemiology.* 2nd ed. New York, NY: Oxford University Press, Inc; 1998.
24. Kirby S, Baranowski T, Reynolds K, Taylor G, Binkley D. Children's fruit and vegetable intake: Socioeconomic, adult, child, regional, and urban-rural influences. J Nutr Educ 1995;27:261-71.
25. Nicklas T. Dietary studies of children: The Bogalusa heart study experience. J Am Diet Assoc 1995;95:1127-33.
26. Tellez M, Sohn W, Burt BA, Ismail AI. Assessment of the relationship between neighborhood characteristics and dental caries severity among low-income African Americans: A multilevel approach. J Public Health Dent 2006;66;30-6.
27. Gleason P, Suitor C. *Food for Thought: Children's Diets in the 1990s.* Policy brief. Princeton, NJ: Mathematica Policy Res, Inc.; 2001:1-11.
28. Krebs-Smith SM. Choose beverages and foods to moderate your intake of sugars: Measurement requires quantification. J Nutr 2001;131:527S-35S.
29. Levy SM, Warren JJ, Broffitt B, Hillis SL, Kanellis MJ. Fluoride, beverages, and dental caries in the primary dentition. Caries Res 2003;37:157-65.
30. Marshall TA, Brofffitt B, Eichenberger-Gilmore JM, Warren JJ, Cunningham MA, Levy SM. The role of meal, snack, and daily total food and beverage exposures on caries experience in young children. J Public Health Dent 2005;65:166-73.
31. Sayegh A, Dini EL, Holt RD, Bedi R. Food and drink consumption, sociodemographic factors, and dental caries in 4- to 5-year-old children in Amman, Jordan. Br Dent J 2002;193:37-42.
32. US Department of Health and Human Services. The Surgeon General's Report on Nutrition and Health. The Surgeon General of the Public Health Service, Washington, DC. Available at: "http://www.mcspotlight.org/media/reports/surgen_rep.html#1". Accessed August 31, 2006.
33. Ogden C, Flegal K, Carrol M, et al. Prevalence and trends in overweight among US children and adolescents, 1999-2000. JAMA 2002;288:1728-32.
34. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: A prospective, observational analysis. Lancet 2001;357:505-8.
35. Troiano RP, Briefel RR, Carroll MD, Bialostosky K. Energy and fat intakes of children and adolescents in the United States: Data from the national Health and Nutrition Examination surveys. Am J Clin Nutr 2000; 72(suppl):1343S-53S.

Abstracts of the Scientific Literature

Using orthodontic expansion to treat night-time bed-wetting

The aim of this study was to evaluate the effect of rapid maxillary expansion (RME) on nocturnal enuresis (NE) in children.Traditional treatments for NE include wetness alarms, biofeedback, arousal treatment, fluid restriction and anti-diuretic medicaments. This study involved 23 healthy patients with NE, 18 males and 5 females aged 6.7 to 15 years with no urological or respiratory problems. All were resistant to previous NE therapy. They were treated with RME (only 7 had cross-bites). Maxillary expansion of 0.45mm per day was achieved with a Hyrax screw turned by the parent twice daily for up to 21 days. After a 6-month retention period, the appliance was removed. The children were monitored for 1 year and followed up after 10 years using a telephone questionnaire. Eleven children showed some improvement in NE with 6 being completely dry. Children under the age of 10 years responded better. No correlations between nasal airway resistance or presence of cross-bites were found. The overexpanded arches relapsed to a normal transverse dimension within the first year after treatment. The cure for NE was stable after 10 years. ***Comments:*** *This paper suggests RME may be considered as a less invasive treatment alternative for treating primary enuresis in children who have not responded well to traditional therapy.* ***AOA***

Address correspondence to Dr Ulrike Schütz-Fransson, Specialisttandvården Ortodonti, Folktandvården, Strandvägen 17 Stenungsund, Bohuslän SE-44431 Sweden; e-mail: Ulrike.fransson@telia.com.

Schütz-Fransson U, Kurol J. Rapid maxillary dxpansion (RME) effects on nocturnal enuresis in children. A follow-up study. Angle Orthodontist 2008; 78:201-8

22 references.