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Mixed Dentition Cavitated Caries Incidence and Dietary Intake Frequencies

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Abstract

Purpose—This study examined risk factors for children having new cavitated caries between 5 and 9 years old.

Methods—Subjects were Iowa Fluoride Study cohort children(mostly Caucasian and of relatively high socioeconomic status) with both primary and mixed dentition caries exams and at least 2 diet diaries recorded between 5 and 8 years old (N=198). Using surface-specific transitions, combined counts of new cavitated caries ($d_{2\text{-}3}f$ and/or $D_{2\text{-}3}F$) were determined from 4 primary second molars, 8 permanent incisors, and 4 permanent molars. Food and beverage intake frequencies were abstracted. Other factors were assessed using periodic questionnaires. Logistic regression identified predictors of new cavitated caries.

Results—Thirty-seven percent had new cavitated caries. The mean new cavitated caries count for all children was 1.17 surfaces (±2.28 SD). In multivariable logistic regression, the following were significantly associated ($P<.10$) with having new cavitated caries: noncavitated caries experience at 5 years old (odds ratio [OR]=2.67, P=.03); cavitated caries experience at 5 years old (OR=3.39, P=.004); greater processed starch at snack frequency (OR=3.87, P=.07); being older (OR=1.68, P=.04); and less frequent tooth-brushing (P=.001).

Conclusion—Results suggested that increased tooth-brushing frequency and reduced consumption of processed starches as snacks may reduce caries incidence in younger school-aged children.

Keywords

DENTAL CARIES; INCIDENCE; CARIOGENIC DIET; MIXED DENTITION; CHILD

Dental caries remains a major public health problem for US children. The National Health and Nutrition Examination Survey 1999–2002 reported a national prevalence of 49% of children with dental caries experience in the primary teeth and 20% of children with caries

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experience in the permanent teeth[1] for 6- to 11-year-old children. Early school-age children are at a stage of transition from the primary to the mixed dentition. Moreover, they also begin elementary school, which generally changes beverage and food intake patterns.

Most studies have assessed risk factors for dental caries in the mixed dentition cross-sectionally. Since the dental caries process takes time to develop into clinically detectable lesions, risk factors for dental caries should be assessed by examining factors that occur before and during the time of clinical caries detection. There are a limited number of nonexperimental studies, however, that have assessed caries incidence/increment in the transition period from primary to mixed dentition.

Associations between previous cavitated caries and new cavitated caries in primary school-age children have been investigated.[2–9] Consistently, findings show a strong and significant association between previous caries experience and new caries. Since previous dental caries experience is not a modifiable factor, studies should examine modifiable risk factors for dental caries beyond previous caries experience. Few studies[3,4,9,10] have included modifiable factors, such as dietary intakes, fluoride usage, and tooth-brushing frequency. Two of these studies[3,10] found significant associations between consumption of sweets/ sweetened drinks and new cavitated caries, while the other 2[4,9] found no significant association between dietary consumption (sweets, sugars, or snacks) and new cavitated caries.

The objective of the analyses described in this paper was to examine modifiable and nonmodifiable risk factors for children having new cavitated caries from 5 to 9 years old. The frequencies of dietary intake of specific food and beverage categories and other caries-related factors were compared between 5- to 9-year-olds with and without new cavitated caries.

Methods

The data used in this analysis are part of the ongoing, longitudinal Iowa Fluoride Study (**IFS**). Subjects were recruited immediately postpartum from 8 Iowa hospitals and followed thereafter by mail and periodic assessments/exams. The children were mostly Caucasian and relatively high socioeconomic status (**SES**).[11] Details of the recruitment of IFS subjects have been published elsewhere.[12] This study was approved by the Human Subjects Committee at the University of Iowa, Iowa City, Iowa. Parents of the participating subjects provided informed consent and children provided assent for the exams.

Subjects

Subjects with both primary dentition (~5 years old) and mixed dentition (~9 years old) caries exams and at least 2 diet diaries, including at least 1 from 5 to 6.5 years old and 1 from 7 to 8.5 years old (to ensure at least 1 diary before starting school and at least 1 after) were included in these analyses (N=198).

Dietary information

The food and beverage intakes for 2 weekdays and 1 weekend day were recorded by parents using 3-day diaries that were sent every 1.5 to 6 months (1.5 months to 8.5 years old).[13] Detailed information of consumption times, types of items, and quantities were collected. Annual dietary diaries (ie, at 5–8 years old) were abstracted by trained registered dietitians or diet technicians. If the 5-, 6-, 7-, and/or 8-year-old diary was missing, then a substitution was made using the diaries 6 months succeeding or preceding the yearly diary.

Food and beverage intake frequencies were estimated from the diaries[13] and categorized so that consumption within a 30-minute interval counted as 1 eating event. More than 1 serving of the same beverage or food consumed within 30 minutes was considered 1 event. The eating events then were identified as either meals or snacks, based on the time of consumption and nature of the food. Only 3 meals per day were allowed: 1 during the morning; 1 at the middle of the day; and 1 during evening hours. Unlimited eating events, however, were allowed for snacks.

Foods and beverages were then classified into categories. Beverages were categorized by type of beverage and included: milk; 100% juices; juice drinks; powder-sugared beverages; regular (sugared) soda pop; diet soda pop; sports drinks; and water. Foods were categorized based on sugar and/or starch content and included: sugar-based desserts (jelly, pudding, etc); candy; added sugar (table sugar, honey, brown sugar, etc); baked starch with sugar (cookies, cake, etc); unsweetened cereals; presweetened cereals; unprocessed starches (boiled potato, bread, rice, etc); and processed starches (potato chips, etc). The intake frequency of each food and beverage category was counted and averaged for each child across the 3 days for each annual diary (at 5, 6, 7, or 8 years old). Results at 5 and/or 6 years old and at 7 and/or 8 years old were averaged separately, and these 2 means were subsequently averaged to form an overall measure for each child. The dietary variables were presented in order by percentage of children with some intake (5–8 years old) at snacking occasions in each of the beverage, sugar-based, and starch-based food groups.

Other related factors

Daily tooth-brushing frequency and composite water fluoride intakes were determined based on data from IFS questionnaires that were sent to parents at the same time as the diaries. Composite water fluoride levels were determined from all sources, including available public water documentation and an assay of multiple sources of water (ie, home/school, bottled/filtered/tap water) at each time point for each individual child.[11,14] Composite water fluoride levels and daily tooth-brushing frequency[15] from all available 5- to 8-year-old data for each child were averaged.

Three categories of SES were created based on family income and mother's education data from baseline questionnaires (completed at birth). The high SES category included children from families with incomes from $30,000 to $49,999 a year whose mothers had a graduate/professional degree, or from families with incomes of more than $50,000/year (regardless of the mother's educational level). Children from families with incomes less than $30,000 a year whose mother had 2 years or less in college were categorized as low SES. All other children were placed in the middle SES category.

Dental data

Children were examined for dental caries at 5 years old (primary dentition) and 9 years old (mixed dentition) by the same trained and calibrated examiners. The examinations were conducted using a portable chair, halogen headlight and a DenLite mirror (Welch-Allyn Medical Product, Inc, Skaneatele Falls, NY).[16] The teeth were dried and examined primarily by visualization. Any questionable lesions, however, were confirmed by an explorer.[16] This study used the diagnostic criteria that were modified from the D_1-D_4 system of Pitts and colleagues.[17,18] The examiners did not differentiate cavitated enamel (D_2/d_2) and dentine lesions ($D_{3\text{-}4}/d_{3\text{-}4}$), thus those lesions were categorized together as $D_{2\text{-}3}/d_{2\text{-}3}$.16

Combined count of new cavitated caries ($d_{2\text{-}3}f$ and/or $D_{2\text{-}3}F$) included cavitated lesions and restored lesions from 4 primary second molars, 8 permanent incisors, and 4 permanent first molars. The counts of new cavitated caries were determined using surface-specific transitions during exams taken between 5 and 9 years old. Having new cavitated caries was used as the dependent binary variable (none vs 1 or more new lesions and/or restorations) in these analyses.

Data analysis

Logistic regression analyses were used to explore the relationships between having or not having new cavitated caries from 5 to 9 years old and other variables: dietary intakes; gender; SES; age at mixed dentition exam; cavitated caries experience at 5 years old; noncavitated caries experience at 5 years old; tooth-brushing frequency; and composite water fluoride level.

First, univariable logistic regression analyses were modeled separately for each dietary variable or other related factor. For dietary variables, only variables with $P<.15$ from the univariable logistic regression were selected for the next steps. The pairwise correlations between all pairs of continuous variables of selected dietary variables and other variables were determined. For those pairs with moderate to high correlations (Pearson’s coefficients >0.3), only the variable with the stronger association with caries incidence would be included in an initial model for multivariable logistic regression analysis. All 2-way interactions were then assessed in bivariable models, except for those based on a product of 2 continuous variables. Dietary variables other related variables and interaction terms with $P<.15$ (and the corresponding main effects) were considered in the multivariable modeling and were used to create 2 separate models. The 2 models were initially based on:

1. dietary and other variables (tooth-brushing frequency, composite water fluoride level, gender, age at mixed dentition exam, and SES) excluding previous dental caries experience; and

2. all variables (including previous caries experience).

For each of these model formulations, a backward elimination procedure was performed to determine the final model. Variables that did not retain significance at $P<.10$ were omitted sequentially based on the associated P-value. All data were analyzed using Proc Logistic in SAS 9.1 (SAS Institute Inc, Cary, NC).

Results

There were 198 children (55% girls) who met the inclusion criteria of having both exams and a sufficient numbers of diet diaries. Mean (±SD) ages at the primary dentition and mixed dentition exams were 5.1 (± 0.4) and 9.2 (± 0.7), respectively. Most were in the middle or high SES categories (35% and 42%, respectively). The prevalences of noncavitated caries at the primary and at the mixed dentition exams were approximately 19% and 39%, respectively. Cavitated caries prevalence at the primary and at the mixed dentition exams were approximately 21% and 49%, respectively. Sixty-three percent of the children had no new cavitated caries (zero surfaces of new cavitated caries). Among the 37% of children with some new cavitated caries, more than half (20%) had only 1 to 2 surfaces of new cavitated caries, approximately one fourth (9%) had 3 to 4 surfaces of new cavitated caries, and less than one fourth (8%) had 5 or more surfaces of new cavitated caries. The overall mean new cavitated caries for all children was 1.17 surfaces (±2.28 SD; range=0–15), with a mean only among those affected of 3.2 surfaces (±2.8 SD; range=1–15).

Descriptive analyses presenting medians and 25th and 75th percentiles of food and beverage intake frequencies at meals and at snacking occasions for individuals’ intakes for each year (5–8 years old) and averaged from the 2 to 4 diaries (5–8 years old) are presented in Table 1.

This table also presents the percentages of children who had consumed from each specific food/beverage category at 5 to 8 years old and at any of the 2 to 4 available time points (5–8 years old). Based on these percentages, milk was the most common drink for this age group (99%). Other common beverages were: 100% juice; regular soda pop; and juice drinks. Approximately one fourth of the children consumed diet soda pop. Sports drinks were not a common beverage for these children (≤10%).

Medians, means, and standard deviations of other related factors at 5 to 8 years old and averages of any available data from 5 to 8 years old are presented in Table 2. On average, children brushed 1.5 times per day, and water fluoride levels fell into the optimal range of 0.7 to 1.2 ppm. More than three fourths of the children did not have noncavitated or cavitated caries at the primary dentition exam (81% and 79%, respectively). Mean surfaces of noncavitated caries and cavitated caries experience at approximately 5 years old were 0.5±1.6 and 1.2±4.3, respectively.

Table 3 summarizes the univariable logistic regression analyses assessing the associations between having new cavitated caries and the numbers of occasions for the dietary variables. These analyses were used to screen the dietary variables for inclusion in the multivariable logistic regression. Significant variables ($P<.15$) were snacktime intake of regular soda pop, unprocessed starches, and processed starches.

The univariable logistic regression analyses of factors other than dietary variables are presented in Table 4. Low SES was significantly associated with having new cavitated caries. Greater tooth-brushing frequency was significantly associated with not having new cavitated caries, while gender, age at mixed dentition exam, and composite water fluoride level were not significantly associated with having or not having new cavitated caries. Having noncavitated caries experience at 5 years old (odds ratio [**OR**]=4.00, 95% confidence interval [**CI**]=1.91, 8.39, $P<.001$) and having cavitated caries experience at 5 years old (OR=4.44, 95% CI=2.16, 9.12, $P<.001$) were significantly associated with having new cavitated caries from 5 to 9 years old.

The multivariable logistic regression analyses are presented in Table 5. Three dietary variables were initially included: snacktime intake of regular soda pop, unprocessed starches, and processed starches. There was no pairwise collinearity concern with the 6 continuous variables (2 food variables, 1 beverage variable, tooth-brushing frequency, age at mixed dentition exam, and composite water fluoride level).

Model 1 initially considered 8 variables, including 3 dietary variables and 5 other variables (daily tooth-brushing frequency, composite water fluoride level, gender, age at mixed dentition exam, and SES), and 2 interaction terms (between gender and composite water fluoride level and between low SES and age at mixed dentition dental exam). Snacktime intake frequency of greater processed starches (OR=1.50, $P=.04$) and low SES (OR=2.27, $P=.04$) were significantly associated with having new cavitated caries. Greater daily toothbrushing frequency was significantly associated with not having new cavitated caries (OR=0.32, $P<.001$). A higher composite water fluoride level was significantly associated with not having new cavitated caries in girls; however, it was not significantly associated with not having new cavitated caries in boys. The P-value for the Hosmer and Lemeshow goodness-of-fit test was 0.72, indicating an adequate fit of the final model.

Model 2 initially included 10 variables (8 variables from model 1, noncavitated caries experience at 5 years old (yes/no) and cavitated caries experience at 5 years old (yes/no), and 2 interaction terms (between gender and composite water fluoride level and between low SES and age at mixed dentition dental exam). Having noncavitated caries experience at

5 years old (OR=2.67, *P*=.03), having cavitated caries experience at 5 years old (OR=3.39, *P*=.004), greater snacktime intake frequency of processed starches (OR=3.87, *P*=.07), and being older (OR=1.68, *P*=.04) were significantly associated (*P*<.10) with having new cavitated caries from 5 to 9 years old. Greater daily tooth-brushing frequency was significantly associated with not having new cavitated caries (OR=0.28, *P*=.001). A higher composite water fluoride level was significantly associated with not having new cavitated caries in girls (OR=0.88, *P*=.08); however, it was not significantly associated with cavitated caries incidence in boys. The P-value for the Hosmer and Lemeshow goodness-of-fit test was 0.93, indicating adequate fit of the final model.

Although the main analyses have focused on intake frequency data, additional analyses were conducted using quantity of intake data. These generally showed similar directions and strengths of association to the analyses using frequency data. For example, in additional univariable analyses, both greater regular soda pop intake frequency and quantity at snacking occasions tended to increase the risk of having new cavitated caries (*P*<.05 and *P*=.12, respectively). Both greater regular pop intake frequency and quantity at meals tended to increase the risk of having new cavitated caries, but were not statistically significant (*P*=.37 and *P*=.43, respectively).

Although not our first emphasis, the relationship between SES and previous noncavitated caries and the relationship between processed starches intake frequency at snacking occasions and previous cavitated caries experience were explored. Thirty-three percent of children of low SES families had previous noncavitated caries experience, while only 15% of children of middle/high SES families had previous noncavitated caries experience. Additionally, 11% of children who had reported no intake frequency of processed starches at snacking occasions had previous cavitated caries experience, while 24% of children with some intake of processed starches at snacktime had previous cavitated caries experience.

Discussion

This study sample was predominantly Caucasian, of relatively high SES, and had low-moderate caries risk. More than one third, however, had new caries in the 4-year period and nearly 10% had an average of more than 1 new surface per year. Even in a low-moderate-risk population, caries in school-age children is still a public health problem.

Infection by cariogenic bacteria and the demineralization process on tooth surfaces are part of the true dental caries disease processes, but noncavitated caries and cavitated caries are signs of the chronic disease that can be more reliably assessed clinically. Routine assessments of dynamic changes in bacteria and/or tooth demineralization that can be reversed or remineralized in a short time are not feasible clinically. Thus, the present study assessed signs of dental caries (clinical exam) and used them in determining the outcome variable of new cavitated caries.

From the descriptive analyses of the dietary variables, more than three-fourths of these children consumed regular soda pop, and approximately one-fourth consumed diet soda pop. Diet soda pop has been available in the United States for more than 50 years. The results, however, reveal that many more children consumed regular vs diet soda pop. In addition, consumption of presweetened cereal was more common among children than consumption of unsweetened cereals.

Several other studies found a strong association between previous caries experience of the primary dentition and new caries of the mixed dentition.[2–9] Our findings strongly support this conclusion. While presence of caries experience is a predictor of future caries, it is not possible to intervene and change previous caries experience. Therefore, studies should assess other risk factors besides previous caries experience.

The present analyses did not use a traditional 5% significance level but instead used a 10% significance level. The univariable results showed strong relationships between caries incidence and previous caries experience and weaker relationships between caries incidence and certain other explanatory factors, such as SES and processed starches intake at snacking occasions. In the multivariable logistic regression analyses, when a 0.05 significance level was used in the backward elimination procedure, dietary variables were not retained in the final multivariable model. Because previous caries experience and the dental caries outcome is the same disease, it is possible that they share the same risk factors. Thus, we further explored the relationship between these factors and previous noncavitated and cavitated caries experiences. The results indicate associations between: SES and noncavitated caries experiences; and frequency of snacktime intake of processed starches and cavitated caries experience. Because of these relationships, the simultaneous inclusion of previous caries experience in a multivariable model containing the other explanatory factors reduced the contribution of the other factors. Therefore, the dietary variables which had weaker relationships with caries incidence would have been dropped out from the model with the traditional *P*-value of.05. Thus, we decided to use a larger *P*-value to allow those variables with weaker relationships to be considered in the multivariable logistic regression. These approaches allow us to examine other related factors, such as dietary and fluoride-related factors, which are modifiable factors, in contrast with previous caries experience, which is not modifiable.

A study by Leroy et al.,[9] which included previous caries experience and other related factors in the multivariable model, reported similar findings in which other related factors that were significantly associated with new caries in the univariable analyses were not retained in the final model. Tagliaferro et al.[4] discussed their study's findings that oral hygiene habits variable did not reach statistical significance in the final model because of the strong association between previous caries experience and caries incidence.

To show how explanatory variables affected each other in the model, we developed 2 separate models. Model 1 initially included all potential variables other than previous caries experience. In the backward elimination procedure, the results of using a level of significance of 0.05 or 0.10 were identical. In the final model, 3 modifiable factors, daily tooth-brushing frequency, composite water fluoride level, and frequency of snacktime intake of processed starches were significantly associated with having new cavitated caries. SES was also significant in the final model.

Model 2, which initially included all potential variables, including previous caries experience, showed that both previous caries experience variables (noncavitated and cavitated) and daily tooth-brushing frequency were significantly associated with new caries. Processed starch intake frequency at snacking occasions and composite water fluoride level are the 2 variables in the final model that had *P*-values between. 05 and. 10. These 2 variables would have been trimmed from the model with a.05 significance level. Including previous caries experience in the model strengthened the association between the age at mixed dentition exam variable and new caries, which was found statistically significant in the final model. Low SES consistently has been found to be related to caries outcome in published studies. In model 2, SES was not significantly associated with caries incidence, probably because SES was highly correlated with caries experience at 5 years old (already in the model).

Processed starches are common snacks in developed countries. The association between caries incidence and processed starches is not surprising. No studies, however, have found this association in early school-aged children. Possibly there are no other studies that have detailed information on dietary intake at this level. Also, processed starch intake frequency at snacking occasions might be counted with other snack intakes in other studies. Thus, the effect of processed starch exposures on new caries might be part of the association between a combined dietary variable such as frequency of snack intake and new cavitated caries. Developmentally, children in this age group still need to have snacks. Thus, the defined findings of which snacks would increase the chances of having new caries can be very useful for making recommendations.

Daily tooth-brushing frequency is a strong preventive factor in this group of children. This confirmed the finding of other studies.[3,9] Some other studies[4,10] that assessed children's oral hygiene, however, did not find significant associations with caries incidence. In this study, more than 99% of children used fluoridated toothpaste. Thus, the daily tooth-brushing frequency was the major factor concerning the effect of fluoride exposure from toothpaste. Daily tooth-brushing frequency is the modifiable factor that had the strongest relationship with new caries.

In model 2, there was a statistically significant interaction effect between gender and composite water fluoride level. Specifically, increased composite water fluoride level showed a significant protective effect in girls, but not in boys. Additional studies are needed to confirm and explain these findings.

Most other studies of caries incidence and diet collected dietary information at only one point (either at the beginning or the end of this period) and related it to the new caries. This study collected the dietary information longitudinally to evaluate the relationship between the dietary intake during the period between the 2 dental examinations and cavitated caries incidence, which is a major strength of the present study. There were limitations to this study, however, including a relatively small sample size, a predominance of subjects with high SES, and a low to moderate disease level in the cohort. Thus, results should be interpreted in light of these limitations. This study did not assess cariogenic bacteria. Thus, the results of this study did not control for differences in the cariogenic bacteria among individuals. Additionally, no analyses considered duration of exposures to foods and beverages.

For practicality, future research should focus more on modifiable factors. Moreover, it should assess risk factors at a detailed level that could lead to practical preventive measures.

Conclusions

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

1. Snacktime intake of processed starches, tooth-brushing, and socioeconomic status are variables associated with caries, consistent with other studies in preschool and school-age children.
2. In school-age children, many of those associations with modifiable factors are absent from multivariable models, which include previous caries experience. Studies concerning risk factors for dental caries should be focused to include and emphasize modifiable factors.
3. Results suggested that tooth-brushing with fluoridated toothpaste and dietary counseling could help decrease the risk of new cavitated caries in young school-aged children.

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Table 1

DESCRIPTIVE ANALYSIS OF DIETARY VARIABLES*

Variable		Median (25th, 75th percentile)					Children with some intake (%)†				
		5–8 ys old (N=198) OR (95% CI)	5 ys old (N=171) OR (95% CI)	6 ys old (N=173) OR (95% CI)	7 ys old (N=164) OR (95% CI)	8 ys old (N=150) OR (95% CI)	5–8 ys old (N=198) %	5 ys old (N=171) %	6 ys old (N=173) %	7 ys old (N=164) %	8 ys old (N=150) %
Beverage (occasions)											
Milk	Snack	0.2 (0.1, 0.4)	0.3 (0, 0.7)	0.3 (0, 0.7)	0 (0, 0.3)	0 (0, 0.3)	80	56	55	40	37
	Meal	1.6 (1.2, 1.8)	1.7 (1.0, 2.0)	1.5 (1.0, 2.0)	1.3 (1.0, 2.0)	1.7 (1.0, 2.0)	99	94	97	96	95
100% juice	Snack	0.1 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0)	0 (0, 0)	65	47	33	23	17
	Meal	0.3 (0.1, 0.6)	0.3 (0, 0.7)	0.3 (0, 0.7)	0 (0, 0.7)	0 (0, 0.7)	80	58	52	48	41
Regular soda pop	Snack	0.1 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	65	30	34	32	30
	Meal	0.3 (0.1, 0.4)	0.3 (0, 0.5)	0 (0, 0.3)	0.3 (0, 0.3)	0 (0, 0.5)	80	55	47	57	49
Juice drinks	Snack	0.1 (0, 0.2)	0 (0, 0.3)	0 (0, 0)	0 (0, 0.2)	0 (0, 0)	57	26	23	25	23
	Meal	0.2 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	69	32	36	37	36
Powder-sugared beverages	Snack	0 (0, 0.1)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	41	18	15	17	12
	Meal	0 (0, 0.1)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	39	18	17	13	12
Sport drinks	Snack	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	8	2	2	1	2
	Meal	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	5	4	2	2	5
Diet soda pop	Snack	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	19	6	8	8	6
	Meal	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	23	5	8	9	11
Water	Snack	0.8 (0.3, 1.5)	0.7 (0, 1.3)	0.7 (0, 1.3)	0.7 (0, 1.7)	0.7 (0, 1.7)	93	71	73	74	73
	Meal	0.2 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	62	39	38	40	39
Food (occasions)											
Sugar-based desserts	Snack	0.3 (0.1, 0.5)	0.3 (0, 0.5)	0.3 (0, 0.7)	0.3 (0, 0.7)	0 (0, 0.3)	86	55	61	51	48
	Meal	0.2 (0.1, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	78	42	47	39	42
Candy	Snack	0.3 (0.1, 0.5)	0 (0, 0.3)	0.3 (0, 0.7)	0.3 (0, 0.7)	0 (0, 0.3)	81	46	51	55	48
	Meal	0.04 (0, 0.2)	0 (0, 0)	0 (0, 0)	0 (0, 0.3)	0 (0, 0)	50	22	23	27	19
Added sugars	Snack	0 (0, 0.2)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	46	19	21	14	15
	Meal	0.3 (0.2, 0.6)	0.3 (0, 0.7)	0.3 (0, 0.7)	0.3 (0, 0.7)	0.3 (0, 0.7)	86	58	65	60	55

Variable		Median (25th, 75th percentile)					Children with some intake (%)†				
		5–8 ys old (N=198) OR (95% CI)	5 ys old (N=171) OR (95% CI)	6 ys old (N=173) OR (95% CI)	7 ys old (N=164) OR (95% CI)	8 ys old (N=150) OR (95% CI)	5–8 ys old (N=198) %	5 ys old (N=171) %	6 ys old (N=173) %	7 ys old (N=164) %	8 ys old (N=150) %
Baked starches with sugar	Snack	0.5 (0.3, 0.8)	0.7 (0.3, 1.0)	0.7 (0.3, 1.0)	0.3 (0, 0.7)	0.4 (0, 0.7)	96	80	77	69	69
	Meal	0.5 (0.3, 0.7)	0.3 (0, 0.7)	0.3 (0.3, 0.7)	0.6 (0.3, 0.8)	0.6 (0.3, 0.7)	95	64	75	79	77
Processed starches	Snack	0.3 (0.1, 0.4)	0 (0, 0.3)	0.3 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	81	45	52	43	45
	Meal	0.3 (0.2, 0.5)	0.3 (0, 0.7)	0.3 (0, 0.7)	0.3 (0, 0.7)	0.3 (0, 0.7)	95	65	69	68	64
Unprocessed starches	Snack	0.2 (0.1, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0.3)	81	44	44	39	42
	Meal	2.5 (2.3, 2.8)	2.3 (2.0, 3.0)	2.5 (2.0, 3.0)	2.7 (2.0, 3.0)	2.7 (2.3, 3.0)	100	100	99	100	99
Presweetened cereals	Snack	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	24	8	9	9	7
	Meal	0.3 (0.2, 0.5)	0.3 (0, 0.7)	0.3 (0, 0.7)	0.3 (0, 0.7)	0.3 (0, 0.5)	87	56	61	59	56
Unsweetened cereals	Snack	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	16	6	6	5	2
	Meal	0.1 (0, 0.2)	0 (0, 0.3)	0 (0, 0.3)	0 (0, 0)	0 (0, 0.3)	55	29	22	23	23

*To compute these measures, mean dietary intakes from 5 and/or 6 years old and 7 and/or 8 years old were calculated, and these 2 means were subsequently averaged.

OR=odds ratio; CI=confidence interval.

Note: There were 22% additional abstracted dietary diary responses at ages 5½, 6½, 7½, and 8½ that are not included in the year-specific data, but are included as substitutes when 5- to 8-year-olds were missing.

†Percentage of children with some intake from diaries (among 2–4 annual time points per child).

Table 2

DESCRIPTIVE ANALYSIS OF OTHER RELATED FACTORS

Variable	Median					Mean±(SD)				
	5–8 ys old (N=198)	5 ys old (N=171)	6 ys old (N=173)	7 ys old (N=164) (N=150)	8 ys old	5–8 ys old (N=198)	5 ys old (N=171)	6 ys old (N=173)	7 ys old (N=164)	8 ys old (N=150)
Daily tooth-brushing frequency	1.50	1.0	1.0	2.0	2.0	1.5±0.5	1.4±0.6	1.5±0.6	1.5±0.6	1.5±0.6
Composite water fluoride level (ppm)	0.93	0.94	0.95	0.98	0.94	0.8±0.4	0.8±0.4	0.8±0.4	0.8±0.3	0.8±0.4

Table 3

UNIVARIABLE LOGISTIC REGRESSION MODELS USING DIETARY VARIABLES TO PREDICT OCCURRENCE OF NEW CAVITATED CARIES FROM 5 TO 9 YEARS OLD* (N=198)

Variable		Odds ratio (95% confidence interval)	*P*-value
Beverages (occasions)			
Milk	Snack	1.29 (0.64, 2.62)	.48
	Meal	0.87 (0.52, 1.46)	.60
100% juice	Snack	0.90 (0.19, 4.40)	.90
	Meal	0.79 (0.35, 1.78)	.57
Regular soda pop	Snack	5.15 (1.003, 26.43)	<.05†
	Meal	1.75 (0.52, 5.94)	.37
Juice drinks	Snack	1.09 (0.28, 4.19)	.90
	Meal	0.53 (0.16, 1.78)	.31
Powder-sugared beverages	Snack	2.04 (0.47, 8.89)	.35
	Meal	0.44 (0.04, 5.14)	.51
Diet soda pop	Snack	0.48 (0.03, 7.03)	.60
	Meal	1.92 (0.05, 70.26)	.72
Water	Snack	1.03 (0.75, 1.41)	.18
	Meal	1.30 (0.56, 3.04)	.34
Food (occasions)			
Sugar-based desserts	Snack	1.33 (0.48, 3.72)	.59
	Meal	0.38 (0.08, 1.76)	.22
Candy	Snack	0.77 (0.31, 1.95)	.59
	Meal	0.54 (0.07, 4.14)	.56
Added sugar	Snack	4.42 (0.42, 47.10)	.22
	Meal	0.50 (0.19, 1.34)	.17
Baked starch with sugar	Snack	0.91 (0.38, 2.18)	.83
	Meal	0.79 (0.31, 2.03)	.63
Processed starches	Snack	2.85 (0.83, 9.83)	.10†
	Meal	0.79 (0.25, 2.49)	.69
Unprocessed starches	Snack	3.16 (0.76, 13.15)	.12†
	Meal	1.16 (0.62, 2.18)	.64
Presweetened cereals	Snack	0.43 (0.01, 23.54)	.68
	Meal	1.72 (0.56, 5.28)	.35

*Cavitated caries from exam at approximately 9 years old that was not present at 5 years old.

Note: Each line of this table represents a separate regression model.

†P<.15 used as a criterion to screen dietary variables for multivariable logistic regression.

Table 4

UNIVARIABLE LOGISTIC REGRESSION MODELS USING DEMOGRAPHIC VARIABLES AND OTHER VARIABLES TO PREDICT OCCURRENCE OF NEW CAVITATED CARIES FROM 5 TO 9 YEARS OLD* (N=198)

Variable	Odds ratio (95% confidence interval)	*P*-value
Gender • Boys • Girls	1.01 (0.59, 1.89)	.85
Age at mixed dentition dental exam (year)	1.24 (0.83, 1.85)	.29
Age interval between 1st and 2nd exam (year)	1.20 (0.82, 1.74)	.35
Socioeconomic status • Low • Middle/high	2.07 (1.04, 4.13)	.04
Daily tooth-brushing frequency from 5-years old (time/day)	0.37 (0.20, 0.69)	.002
Composite water fluoride level (ppm) from 5–8 years old	0.91 (0.40, 2.04)	.81
Non-cavitated caries experience at 5 years old • Yes • No	4.00 (1.91, 8.39)	<.001
Cavitated caries experience at 5 years old • Yes • No	4.44 (2.16, 9.12)	<.001

*Cavitated caries from exam at approximately 9 years old that was not present at 5 years old.

Note: Each line of this table represents a separate regression model.

Table 5

MULTIVARIABLE LOGISTIC REGRESSION MODELS TO PREDICT OCCURRENCE OF NEW CAVITATED CARIES FROM 5 TO 9 YEARS OLD* (N=198)

Models	Estimate	Odds ratio (95% confidence interval)	*P*-value
Model 1 (all variables excluding previous caries experience† initially included)			
Intercept			
• Girls	2.77		
• Boys	0.38		
Snacktime intake of processed starches	1.50	4.48 (1.14, 17.70)	.04
Daily tooth-brushing frequency among 5- to 8-year-olds (time/day)	−1.15	0.32 (0.16, 0.63)	<.001
Socioeconomic status			
• Low	0.41	2.27 (1.08, 4.80)	.04
• Middle/high (Reference category)			
Composite water fluoride level (0.1 ppm) among 5- to 8-year-olds			
• Girls	−0.16	0.86 (0.75, 0.98)	.03
• Boys	0.06	1.06 (0.93, 1.20)	.39
Model 2 (all variables‡ initially included)			
Intercept			
• Girls	1.91		
• Boys	−3.79		
Snacktime intake of processed starches	1.35	3.87 (0.93, 16.16)	.07
Daily tooth-brushing frequency among 5- to 8-year-olds (time/day)	−1.29	0.28 (0.13, 0.59)	.001
Non-cavitated caries experience among 5-year-olds			
• Yes	0.49	2.67 (1.11, 6.42)	.03
• No (Reference category)			
Cavitated caries experience among 5-year-olds			
• Yes	0.61	3.39 (1.48, 7.78)	.004
• No (Reference category)			
Age at mixed dentition exam (year)	0.52	1.68 (1.04, 2.73)	.04
Composite water fluoride l (0.1 ppm) among 5- to 8-year-olds			
• Girls	−0.13	0.88 (0.76, 1.01)	.08
• Boys	0.05	1.05 0.93, 1.20)	.44

*Cavitated caries from exam at approximately 9 years old that was not present at 5 years old. Note: The other variables initially considered for inclusion (not shown in the table) were removed in the backward elimination (P<0.10 to remain).

†All variables excluding caries experience: snacktime intake of regular soda pop; snacktime intake of processed starches; snacktime intake of unprocessed starches; tooth-brushing frequency; composite water fluoride level; gender; age at mixed dentition exam; and socioeconomic status

‡All variables: snacktime intake of regular soda pop; snacktime intake of processed starches; snacktime intake of unprocessed starches; tooth-brushing frequency; composite water fluoride level; gender; age at mixed dentition exam; socioeconomic status; previous noncavitated caries; and previous cavitated caries