Low Birth Weight and Dental Fluorosis: Is There an Association?

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Abstract

Objective: *The association between low birth weight and dental fluorosis was explored in a cross-sectional study to explain the higher prevalence of dental fluorosis among African-American children.* ***Methods:*** *Birth weight data on 960 children were obtained from the New York State Birth Registry. Data on race, fluoride exposure, sociodemographic characteristics, and dental fluorosis were available from a cross-sectional study conducted in Newburgh and Kingston. Associations among birth weight, race, and fluoride exposure from fluoridated water, regular use of supplements, brushing before the age of 2 years, and subject-level dental fluorosis were explored using logistic regression procedures.* ***Results:*** *The regression coefficients for the main effects and the two-way interaction effects associated with low birth weight, race, and fluoride exposure were not statistically significant. Even after controlling for low birth weight and fluoride exposure, African-American children had a statistically significant higher odds ratio (OR=2.0). An analysis of the data limited to mandibular permanent first molars showed similar effects, except for evidence of effect modification in low birth weight children exposed to fluoride supplements.* ***Conclusions:*** *Lower birth weight did not explain the higher prevalence of dental fluorosis observed among African-American children. [J Public Health Dent 2000;60(3):167-71]*

Key Words: dental fluorosis, low birth weight, African-American, fluoride supplements.

Recommendations to adjust water fluoride concentrations in the United States are based primarily on the studies conducted by Dean on white children (1,2). Dean excluded African-American children from his studies ostensibly to better explore the relationship between fluoride in water and caries. However, some studies conducted since then have shown that African-American children are at higher risk for dental fluorosis compared to children of other racial groups in fluoridated areas. Russell (3) found that dental fluorosis was more likely to occur in African-American children than white children in Grand Rapids, MI, and Butler et al. (4) reported an odds ratio of 2.3 for moderate dental fluorosis in African-American children compared with Hispanic and non-Hispanic white children in Texas. The prevalence of very mild or greater levels of dental fluorosis in fluoridated Newburgh and nonfluoridated Kingston, New York, was 25.6 percent and 16.9 percent, respectively. The adjusted odds ratio for African-American children compared to children of other racial groups was 2.2 (5). This higher prevalence observed among African-American children is by no means universal. Heller et al. (6) did not report a difference in the prevalence among racial groups in their analysis of the 1986 national survey. In a case-control study, Pendrys et al. (7) found a higher risk of fluorosis among whites.

Dental fluorosis is related to dose, timing, and duration of exposure. The generally accepted range of fluoride considered for optimum benefits is estimated to be between 0.05 mg and 0.07 mg per kg body weight (8). The previously recommended fluoride supplement dosage schedule of 0.25 mg beginning at birth exceeded the optimum dose for infants weighing less than 3,400 g (9). According to Fejerskov et al. (10), an increase in the fluoride dose as small as 0.01 mg/kg body weight has the potential to significantly increase the Community Fluorosis Index. Therefore, we hypothesized that children with lower birth weight might be more susceptible to dental fluorosis because they receive a relatively higher dose when exposed to a similar amount of fluoride. Also, the prevalence of low birth weight babies among African-Americans is more than two times that of whites (13.1% vs 6.4%) (11). Therefore, it was intuitively appealing to hypothesize that low birth weight might explain the higher prevalence of fluorosis in African-Americans. A study comparing well-educated African-American and white women showed that this disparity in birth weight remained even after controlling for socioeconomic status (12).

In a review of developmental defects in primary teeth, Bhat and Nelson (13) found an association between low birth weight and developmental defects. Although the exact mechanism is not known, many researchers have speculated the role of both systemic illnesses and local factors. Seow et al. (14) showed that deficiency of calcium and phosphate mineral in the neonatal period is related to enamel hypoplasia in very low birth weight, prematurely born children. Seow (15) also has reported that a persistent systemic derangement in kidney, liver, or gastrointestinal absorption is sufficient to affect the permanent dentition. Factors such as birth trauma, infections, nutritional and metabolic disorders, exposures to drugs and oxygen deprivation, and trauma-related la-

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ryngoscope and endotracheal intubation also have been cited as causing enamel defects in low birth weight children (14-17). While Hall (18) found that premature children were more frequently affected by developmental defects of the enamel than those born after full-term pregnancies, Holm and Anderson (19) found no association between low birth weight and dental fluorosis. Although Wang et al. (20) did not find an association between birth weight and dental fluorosis in Norway in a nonfluoridated area, the question whether lower birth weight modifies the effect of multiple sources of fluoride in the United States has not been explored. In view of these findings, we assessed the association between low birth weight, race, fluoride exposure, and dental fluorosis in Newburgh and Kingston.

Methods

We used the data from a cross-sectional study conducted in Newburgh and Kingston, NY, to explore the effect of birth weight, race, and fluoride exposure on dental fluorosis. The details of this study have been described before, and therefore are not presented here (5,21).

Data on dental fluorosis, lifelong residency, fluoride exposure, race, and other sociodemographic variables were available from the 1995 cross-sectional study. The data on birth weight were obtained by matching the first three letters and the first four letters of the first and the last names, respectively, and the date of birth with the New York State Birth Registry. We were able to obtain birth weight data on only 960 (64%) 7–14-year-old lifelong residents of fluoridated Newburgh or nonfluoridated Kingston. Associations among birth weight, race, and fluoride exposure from water, regular use of supplements, brushing before the age of 2 years (early brushing), and subject-level dental fluorosis were explored using the logistic regression procedures in SAS (22). Other variables not associated with dental fluorosis in the bivariate analysis ($P>.2$) were excluded from further analysis.

The fluoride exposure categories were: (1) continuous residence since birth in Newburgh (fluoridation); (2) reported use of daily fluoride supplements during the first eight years of life in Kingston, with or without a history of brushing before the age of 2 years in Kingston (fluoride supplements); (3) brushing before the age of 2 years in Kingston (early brushing); (4) a reference group consisting of the remaining children who reported none of these exposures. Several logistic regression models were developed for exploring the effect of low birth weight. First, a model consisting of fluoride exposure, race, and birth weight as a continuous variable and their two-way interaction terms was examined. Because none of the interaction terms or the main effect of low birth weight were statistically significant, a model using the traditional definition of low birth weight (<2,500 g) was developed. However, this definition of low birth weight yielded quasi separation of data due to empty cells when interaction effects were in-

TABLE 1
Comparison of Characteristics of All 7–14-year-old Life-long Residents of Fluoridated Newburgh and Nonfluoridated Kingston with Study Subjects

Variable	All Children (%) (n=1,493)	Children w/Birth Weight Data (%) (n=960)
Age group (years)		
7–10	59.5	64.8
11–14	40.5	35.2
Sex		
Male	50.2	48.3
Female	49.8	51.7
Race		
African-American	31.6	30.3
All others	68.4	69.7
School lunch participation		
Free lunch	65.4	62.2
Others	34.6	37.8
Education		
Some college	43.4	44.7
Less than college	56.6	55.3
Fluoride exposure		
Fluoridation and brushing or supplements	27.9	25.6
Fluoridation alone	28.8	27.4
Fluoride supplements and brushing	8.4	10.1
Fluoride supplements alone	4.6	5.9
Early brushing alone	15.1	15.3
Other	15.3	15.6
Dean's Index		
Normal	70.9	71.6
Questionable	13.7	13.2
Very mild	10.6	10.0
Mild	4.4	4.8
Moderate – severe	0.4	0.4
Birth weight		
Mean		
African-American		3,109 g
Whites and others		3,331g
Percent less than 2,500 g		
African-American		15.8
Whites and others		5.7
Percent less than 2,906 g		
African-American		34.4
Whites and others		20.9

cluded. Therefore, the low birth weight category was redefined to include children in the 25th percentile (<2,906 g) to examine the interaction effect. Finally, adjusted odds ratios were derived for fluoride exposure variables, race, and the traditional indicator of low birth weight (i.e., birth weight <2,500 g). For the sake of brevity, only the models consisting of low birth weight as a categorical variable are presented. The dependent variable in these models included questionable or greater degrees of fluorosis at the subject level. The questionable cases were included in the definition of dental fluorosis because our previous report showed that they were associated with fluoride exposure (21). Also, we explored the association between independent variables and dental fluorosis on the first permanent molar tooth to see if the effect was consistent with the subject-level analysis. Because the effect was similar on all molars, we present the analysis of the lower left first permanent molar only.

Results

Table 1 compares the characteristics of children with birth weight data to all children examined in Newburgh and Kingston. Thirty percent of sub-

TABLE 2
Prevalence of Questionable and Very Mild or Greater Dental Fluorosis

Variable	*N*	% Questionable	% Very Mild or Greater
Age group (years)			
7–10	622	13.0	15.8
11–14	338	13.6	14.2
Sex			
Male	464	15.1	14.2
Female	496	11.5	16.1
Race			
African-American	291	16.5	25.1
Others	669	11.8	10.9
Education			
Some college	429	13.1	15.6
No college	531	13.4	14.9
School lunch participation			
Free	597	14.1	16.6
Others	363	11.9	13.0
Exposure			
Fluoridation	509	18.7	18.5
Fluoride supplements	154	7.1	16.9
Early brushing	147	10.2	11.6
All others	150	4.0	6.0
Birth weight			
Low: <2,500 g	84	10.7	17.9
Normal: ≥2,500 g	876	13.5	15.0
Low: <2,906 g	240	12.5	17.5
Normal: >2,906 g	720	13.5	14.4

TABLE 3
Logistic Regression Analysis for Questionable or Greater Dental Fluorosis at Subject Level and on Mandibular Left Permanent First Molar

	Model 1			Model 2		
Variable	Parameter Estimate	SE	*P*	Parameter Estimate	SE	*P*
Intercept	–2.37	0.35		–2.69	0.41	
Fluoridation	1.56	0.37	<.001	1.28	0.44	.003
Fluoride supplements	1.20	0.41	.004	0.65	0.51	.204
Early brushing	0.99	0.43	.022	0.50	0.53	.346
Low birth weight	–0.45	0.72	.535	–0.54	0.86	.528
African-American	1.06	0.62	.087	1.19	0.69	.085
Fluoridation * African-American	–0.45	0.64	.486	–0.46	0.72	.523
Fluoride supplements * African-American	–0.57	0.82	.486	–0.97	0.98	.320
Early brushing * African-American	–0.42	0.75	.576	–0.02	0.85	.986
Fluoridation * low birth weight	0.34	0.74	.642	0.48	0.87	.577
Supplements * low birth weight	0.18	0.86	.834	1.31	0.99	.188
Early brushing * low birth weight	0.24	0.86	.778	0.62	1.01	.543
African-American * low birth weight	0.21	0.36	.563	0.06	0.41	.888

Note: Model 1 is based on subject level questionable or greater dental fluorosis. Model chi-square=72.86 (P<.001). Change in –2Log L from the full model to a reduced model that excluded low birth weight and the associated interaction terms is 0.869 (P>.9). Model 2 is based on questionable or greater dental fluorosis on lower left permanent first molar. Model chi-square=55.42 (P<.001). Change in –2Log L from the full model to a reduced model that excluded low birth weight and the associated interaction terms is 1.548 (P>.9). Low birth weight is birth weight of <2,906 g.

TABLE 4
Crude and Adjusted Odds Ratios (OR) and Their 95% Confidence Interval (CI) for Questionable or Greater Dental Fluorosis by Selected Variables

	Crude		Adjusted	
Variable	OR	95% CI	OR	95% CI
Fluoridation	5.3	3.0, 9.3	4.5	2.6, 8.0
Fluoride supplements	2.9	1.5, 5.5	3.0	1.6, 5.7
Early brushing	2.6	1.4, 5.0	2.5	1.3, 4.9
None of the above	1.0		1.0	
African-American	2.4	1.8, 3.2	2.0	1.5, 2.7
Other racial groups	1.0		1.0	
Birth weight				
Low (<2,500 g)	1.0	0.6, 1.6	0.8	0.5, 1.3
Normal	1.0		1.0	

jects who had birth weight data were African-Americans. The mean birth weight of African-American children was 3,109 g compared to that of 3,331 g in children of other racial groups. Twenty-five percent of the children had a birth weight of less than 2,906 g, the value we used as the cutoff point to define lower birth weight. Five-hundred and nine children (53%) had lived continuously in the fluoridated area since birth. Of these, 48.4 percent reported either using fluoride supplements on a regular basis or brushing before the age of 2 years. In the nonfluoridated area, 34.1 percent (154/451) and 54.1 percent (244/451) reported fluoride supplement use on a regular basis and brushing before the age of 2 years, respectively.

Table 2 shows the prevalence of questionable and very mild or greater levels of dental fluorosis. Table 3 shows the coefficients derived from the logistic regression analyses. None of the two-way interaction terms for subject-level questionable or greater dental fluorosis were statistically significant at $P \leq .2$. An analysis of tooth-level data showed similar findings, except for a suggestion of an interaction effect between fluoride supplement use and low birth weight (Table 3). Table 4 shows the crude and adjusted odds ratios for subject-level dental fluorosis. While African-American children and those who received fluoride from water, supplements, or early brushing were at higher risk for dental fluorosis, lower birth weight (<2,500 g) was not associated with dental fluorosis. Elevated odds ratios observed among African-American children persisted even after adjusting for fluoride exposures and birth weight.

Discussion

The results of this study show that birth weight is not an explanation for the higher prevalence of dental fluorosis at the subject level among African-American children in the fluoridated community. These results are consistent with the study of Holm and Anderson (19), who also reported no effect for low birth weight. There are many factors that may explain the lack of the effect in the fluoridated area. First, fluid consumption in this fluoridated area might have been proportional to infants' weight and therefore the exposure to fluoride from water did not exceed the optimum dose for many of these children. Second, the exposure to low levels of fluoride in the first few months of life may not be crucial to the development of fluorosis and most children gain sufficient weight by their first birthday. Finally, some of the earlier studies that showed an association between low birth weight and enamel defects focused on very low birth weight (<1,500 g) children and only seven such children were included in our study.

The results support our earlier findings that African-American children were at higher risk for dental fluorosis in the fluoridated area. Even in the nonfluoridated area, there was a suggestion that African-American children were at higher risk (5,21). Whether this higher risk for African-American children is the result of their lower threshold for fluoride or due to other unknown sources of fluoride is not known. It has been reported that African-American children in the United States drink more water and less milk compared to white children (23). In Newburgh, this difference in the fluid consumption may have resulted in a higher prevalence of fluorosis in African-American children. Indirect evidence for such an observation can be found in an earlier Newburgh-Kingston study. African-American children did not have a higher level of fluorosis compared to children of other racial groups in the 1986 study, possibly because of a three-year interruption in water fluoridation in Newburgh that occurred during enamel development in many subjects (5,21,24).

Some studies have reported an increased susceptibility to dental fluorosis for children in Africa compared with North American children; however, such an ecological comparison should be made with caution because of obvious differences in the methods used, temperature levels, nutritional status, altitude of residence, and exposure to other dietary sources of fluoride (25,26). In Nairobi, 72 percent of the 13–15-year-old children using water containing 0.2–0.4 ppm of fluoride had dental fluorosis (27). Recently, a study in Nigeria found the prevalence of fluorosis to be 43 percent to 58 percent in areas with fluoride levels in water ranging between 0.1 and 0.4 ppm (28). Yoder et al. (29) reported that the severity of dental fluorosis observed in a study in Tanzania was not consistent with the low fluoride concentration in drinking water, and that it was more severe than would be expected from the observed urinary fluoride levels.

Our analysis also confirmed a risk of fluorosis associated with fluoride supplements when used according to previous guidelines. Results suggested that lower birth weight children were at higher risk for developing dental fluorosis on early forming permanent molars than other birth weight children when given fluoride supplements. However, the implication of the higher risk associated with fluoride supplement use is less cause for concern because the fluoride supplement dosage schedule has been adjusted and they are no longer recommended for children at birth to 6 months of age (30).

Although we observed a higher

prevalence of dental fluorosis among African-American children compared to children of other racial groups, most of the cases were in the questionable or very mild categories, and our analysis of tooth-specific data showed that the difference in the occurrence of dental fluorosis in the esthetically important maxillary anterior teeth was smaller compared to the posterior teeth (21,31). Therefore, studies should be undertaken to assess the esthetic significance and public perception of dental fluorosis. Because a race-fluorosis association could have important policy implications, a large-scale study in a representative sample should be conducted to test specifically the hypothesis that African-American children are at higher risk for fluorosis. Finally, studies also could be undertaken to evaluate possible racial differences in the fluid consumption patterns and fluoride intake of children in Newburgh and Kingston. These recommendations are consistent with those of a subcommittee of the National Research Council, which stated that the reasons for the higher risk for fluorosis among African-American children are unknown and do not appear to have been fully explored (32).

A limitation of this study is that we excluded 36 percent of the children because of the missing birth weight data. The reasons for the lack of birth weight data are the discrepancy in the reporting of place of residence and/or data of birth, and differences in the last names between the birth registry and the school record. However, Table 1 shows there is no reason to believe these missing observations caused a bias in this sample.

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