

Does the Structure of Dental Hygiene Instruction Impact Plaque Control in Primary School Students?

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Abstract

Purpose: A 6-month pilot study was conducted to test the assumption that an interactive, contextualized tooth brushing education program would impact the oral hygiene of low income students.

Methods: The intervention consisted of an educational program focused on tooth brushing that included interactive sessions with dental professionals and teachers. School 1 students received instruction, toothbrushes, and encouragement to brush their teeth daily after lunch. School 2 students received instruction only. School 3 students only received toothbrushes to remove plaque. Children in all 3 schools were examined by trained dental hygiene students who used plaque disclosing liquid to score the amount of plaque. A predictive correlational design was used to determine the extent that different intervention types and/or demographic/hygiene practices predicted differences in post intervention plaque level, once baseline plaque level was taken into account.

Results: A total of 254 first and second grade students in 3 public elementary schools in Miami participated in the study. Overall, mean plaque scores were significantly lower at the 6 month follow-up. Between-group comparisons of the mean follow-up scores, adjusted for the effect of the baseline scores, revealed greater but non-significant plaque reduction at School 1 compared to the other schools, and the presence of significant age and ethnic effects.

Conclusion: The most intensive intervention instruction accompanied by repeated practice may lead to improved oral hygiene when compared to instruction alone, when oral hygiene practices and demographic characteristics are taken into account. Design changes intended to increase statistical power may help to explicate these effects.

Keywords: contextualized learning, daily toothbrushes in school, dental hygiene instruction, interactive hygiene program, plaque control

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INTRODUCTION

Dental caries (tooth decay) are among the most common chronic childhood diseases, ahead of asthma and hay fever.¹ Additionally, oral health care is the most prevalent unmet health need among U.S. children.² Dental caries are also characterized by profound disparities, in that children from families living below the federal poverty line (FPL) have twice the prevalence of dental caries than higher income children, with greater extent and severity of decay and a greater likelihood their disease will remain untreated.³

While oral health faces challenges throughout the U.S., the problem is perhaps most challenging in Florida. Florida was 1 of 3 states that received a grade of 'F' in 2 consecutive Oral Health Report Cards issued by the Pew Center on the States.⁴ That grade was largely due to extremely low Medicaid reimbursement rates, the nation's lowest dental care utilization by Medicaid recipients, the lack of an oral

health surveillance system and one of the nation's most restrictive state practice acts on dental hygienists' ability to independently provide preventive services. In addition, more than 20% of Florida's population lives in designated dental health profession shortage areas.⁵ The number of dentists needed to remove the shortage designations (869) is higher than for any other state and accounts for 13.6% of the total number of dentists estimated for the entire country (6,374).

Hospitals in the state of Florida experienced more than 115,000 emergency department visits in 2010 for dental-related problems that were largely preventable and resulted in total charges exceeding \$88 million. Visits charged to child-specific payors such as KidCare, Healthy Kids, MediKids and Children's Medical Services more than doubled from 2008 to 2010, and fees for services almost tripled. That pattern is particularly evident in Miami-Dade

County, where charges for dental emergency department visits rose from \$4.6 million in 2008 to \$7 million in 2010; two-thirds of those charges were incurred by Medicaid or uninsured patients. The number of children seen in hospital emergency departments for dental problems rose for all age groups during that time.⁶

Children in Miami face unique sociocultural challenges to oral health. From 2006 to 2010, 22% of the population of Miami-Dade County under age 18 lived below the FPL, and more than 35% of the population aged 5 years or older do not speak English very well.⁷

There is compelling evidence that access to oral health services is a major problem among Miami's children from low-income families, including those insured by Medicaid. Evaluations of Miami-Dade's Medicaid managed care program, which began in 2004, found that that use of dental services by continuously enrolled children declined from 2003 to 2005 from 37 to 22%, the number of dentists who provided care for Medicaid-enrolled children declined by 59%, the proportion of children receiving preventive dental services fell by 60%, but total costs remained fairly constant.^{8,9}

Widespread and effective prevention of oral disease is essential to improving the oral health of Miami's children and reducing the levels of unmet needs. Children receiving oral hygiene instruction are told to brush their teeth 3 times daily for optimal oral health, but it may not be practical for them to accomplish that goal while they are in school. Moreover, if they are not regularly brushing at home, young children might not have sufficient opportunities to learn important oral hygiene skills through repeated practice in daily routines.^{10,11} This situation is especially true for younger children. Without requiring additional time out of the school day and without placing additional responsibility on the teachers, can schools teach oral health as well as provide contextualized opportunities for children to practice oral health skills as part of the educational curriculum and realize meaningful benefits?

The purpose of this pilot study was to test the effectiveness of The Toothbrush Project, a tooth brushing education program provided to children from low-income families in grades 1 and 2 in Miami-Dade County Public Schools (M-DCPS), delivered by dental professionals and elementary school teachers and staff. The primary research question posed by this study was whether there were significant differences in plaque control among participants who received an educational program and then have had an opportunity every day to practice the learned oral health skills, an educational program alone, and no oral health education.

Using a predictive correlational design, the authors sought to determine the extent to which different intervention types and selected demographic/hygiene practice indicators (alone and in combination) predict differences in post-intervention plaque level once baseline plaque level was taken into account. The study was conducted during the 2010 to 2011 school year.

METHODS AND MATERIALS

The Toothbrush Project was spearheaded by EDU-DENTAL, a 501(c)(3) corporation formed in 2009 by Lynda Colaizzi, a general and cosmetic dentist in the Miami area and a children's health care advocate. EDU-DENTAL formed an alliance among Miami-Dade College Dental Hygiene Program, University of Florida College of Dentistry, Howard and Sharon Socol Family Foundation, and The Early Childhood Initiative Foundation, Benco Dental Supply Company, Henry Schein Inc., and GlaxoSmithKline to address oral health needs of children in Miami.

Participants

A convenience sample of 3 elementary schools participated in the study. All participating schools were funded by the Title I program and therefore contained a large proportion of students with family incomes low enough to qualify them for participation in the federal Free/Reduced Price Lunch program. All first and second grade classes at the 3 schools were invited to participate in the study. Therefore, the sample used in the study was a cluster sample. Table I lists the demographic characteristics of the schools and students who participated in the study. A power analysis of a regression model that included predictors for treatment, age and hygiene was conducted on an a priori basis to ascertain the sensitivity of the study given the most basic design. The results of the analysis indicated that conventional levels of power ($1-\beta > 0.80$) and significance ($p < 0.05$) could be achieved if a moderate or larger treatment effect was found.

The table shows that the schools differ in terms of socioeconomic status and minority composition, with School 1 being the least disadvantaged and School 3 being the most disadvantaged. The ethnic breakdown of the participating students shows similar disparities.

Design of the Study

The primary research question posed by this study was whether there were significant differences in plaque control among participants who received an educational program and then had an opportunity every day to practice the learned oral health skills, an educational program alone, and no oral health education.

ucation. A predictive correlational design was used to determine the extent to which the levels of the intervention, oral hygiene practices and demographic characteristics predict differences in post intervention plaque level, once baseline plaque level is taken into account.¹³ The interventions were implemented at the school level with all child participants in each school assigned to the same condition.

Measures

The first measure was the presence of colored plaque revealed through disclosing solution as indicated by the standardized O’Leary Plaque Score Index computed for each student, which expresses the amount of the tooth surface covered with visible plaque after the use of disclosing solution as a percentage of the total tooth surface.¹⁴ Each tooth was divided into 4 or 6 surfaces and the number surfaces containing plaque were divided by the total number of surfaces and expressed as a percentage.

The second measure was a 35 item data collection instrument comprised of an 11 item identification section (i.e. student last name/first name/number, school name/number, teacher, age, gender, ethnicity, siblings and parent/guardian), 1 item to record dental insurance status, a 6 item hygiene information section (i.e. brushing/flossing patterns, toothbrush ownership and prior dental visits), a 16 item section to record oral hygiene indicators at baseline and follow-up (i.e. caries, bleeding, lesions, debris and plaque), and a space to record notes. The hygiene habits of the parents were not measured. The third measure was the Quality of Life (QoL) Survey designed to measure the extent to which each family’s physical, emotional and socioeconomic well-being was impacted by students’ dental problems/treatment. The survey consisted of 15 items: 1 for identification, 13 that adhered to a 5-point Likert-type format with response options that ranged from 1 (never) to 5 (very often) and included space for a 0 (don’t know) response, and 1 item to indicate students’ Medicaid eligibility. A QoL score was determined by computing the mean of the Likert-type items, with higher scores indicative of a QoL that was more negatively impacted by dental problems. The items in the survey were developed by one of the authors and examined for face and content validity by fellow colleagues. The construct validity and reliability of the instrument have not been established.

Procedures

Permission to recruit participants was obtained from the M-DCPS Office of Program Evaluation, the principals of the participating schools and the students’ parents/legal guardians. Permission forms sent to the parent/legal guardians were in English, Spanish and Creole.

Table I: Percentage of Each School’s Student Sample and School Population within Selected Demographic Categories

Student			
	School 1 (n=141)	School 2 (n=80)	School 3 (n=63)
Age			
6	58.87	58.75	63.49
7	39.72	38.75	33.33
8	1.42	2.5	3.17
Gender			
Female	51.06	54.22	44.44
Male	47.52	42.5	53.97
Not Specified	1.42	1.25	1.59
Race/Ethnicity			
Black	31.91	76.25	91.94
Hispanic	51.06	20	6.45
Other	17.02	3.75	1.61
School			
Free/Reduced Price Lunch*	71	96	97
Minority Students*	84	88	99

Note: Student level percentages were computed from primary sources. School level percentages were computed from secondary sources.²¹

*Percentages are reported by the state as whole numbers.

The QoL survey with versions in English, Spanish and Haitian Creole was provided to those students with completed consent forms at the beginning of the study. Students were instructed to bring the survey home to their parents and to return completed survey forms to their teacher.

School 1 received the baseline and 6 month plaque assessment as well as an educational program focused on oral health. The educational component included interactive sessions with dental hygiene students, using puppets and oversized toothbrushes focused on tooth brushing on the day the baseline data was collected. DVDs from the American Dental Association with cartoons about brushing and dental health were shown every week, by the teachers without dental professionals present.¹² These students also received classroom visits every 2 weeks from a dentist, dental hygienist and dental assistants to reinforce learned behavior for the duration of the study, except during holiday intermission. The same team of professionals participated in each session. Before the program started, the team was instructed on the goals and methods of instruction. During these visits take-home booklets, puzzles and stick-

ers were widely distributed to the students. Each intervention session lasted approximately 15 to 20 minutes. These sessions were presented each time in the same manner and style, although the times were not the same as they needed to adjust to the teachers/curriculum schedule. In addition, a mini-toothbrush was provided for each child in participating classrooms for the duration of the study with encouragement to brush their teeth after lunch each school day. The mini pre-pasted toothbrushes were placed on the cafeteria trays of the participating students each day throughout the study. The teacher covering lunch duty each day prompted/reminded the students to brush. The brushes did not contain fluoride, were disposable, recyclable and also low foaming to avoid the need for rinsing and spitting. All the toothbrushes were collected from every student and placed in the recyclable bin by the teachers overseeing the cafeteria that day.

School 2 received baseline and 6 month plaque assessment and an educational program focused on oral health only. Neither a mini-toothbrush nor repeated instruction in brushing of any kind was provided. The educational component included interactive sessions with dental hygiene students, using puppets and oversized toothbrushes focused on tooth brushing on the day the baseline data was collected. DVDs from the American Dental Association with cartoons about brushing and dental health were shown every week by the teachers without dental professionals present.¹² These students also received classroom visits every 2 weeks from a dentist, dental hygienist and dental assistants to reinforce learned behavior for the duration of the study, except during holiday intermission. During these visits take-home booklets, puzzles and stickers were widely distributed to the students. Each intervention session lasted approximately 15 to 20 minutes. These sessions were presented each time in the same manner and style, although the times were not the same as they needed to adjust to the teachers/curriculum schedule.

School 3 received baseline and 6 month plaque assessment. All children in this school were given toothbrushes to remove the disclosing solution only. The toothbrushes were then collected and placed in the recyclable bin at the school. This school serves as the reference group. The baseline exams were done in the early morning to accommodate the school schedule and availability of the dental hygiene students. The participants had already been at school long enough to have had an opportunity to eat their subsidized breakfast. The next exams were performed approximately 6 months after the interventions began. Second-year dental hygiene students worked in pairs, with 1 student clinically disclosing and assessing the amount of plaque and the other student recording answers to questions and plaque

scores. The students were assessed weekly by college faculty on their proficiency at conducting these measurements throughout their clinical program to assure the procedure was standardized. Standardization for the faculty was conducted at the beginning of each semester. The students received different examiners for each plaque assessment.

Data Analyses

A QoL score was computed for each participant who completed 10 or more items by taking the mean of the responses to the items in the QoL Survey. Analysis of variance was used to compare mean QoL scores of the respondents in the 3 schools. Further examination of the results of the QoL Survey was limited to descriptive statistics.

Descriptive statistics and paired sample t-tests were used to examine the plaque level, and to gauge the statistical significance of changes from baseline to follow-up. The analyses were conducted overall, and by school, age, gender, race, brushing level and flossing status. The primary data analysis involved a 3-stage process. First, ordinary least squares regression analysis was used to apply the predictive correlational design and to determine the relative influence of treatment level (i.e. school), baseline plaque level; hygiene practices (i.e. brushing and flossing); demographic characteristics (i.e. age (6, 7, 8)), gender (i.e. male, female); and race (i.e. Black, Hispanic, Other) on post intervention plaque level. Interactive effects were also examined to ascertain whether the influence of any of the predictors was affected by the baseline plaque level. Continuous predictors were grand-mean centered. Second, adjusted scores were computed by fitting the baseline plaque score to the follow-up plaque score, then adding the mean predicted score to the residual score of each participant, creating, in effect, the follow-up plaque level that would have resulted had all the participants begun with the same baseline plaque scores. Finally, between-group comparisons of the mean adjusted plaque scores among the various levels of the study subgroups were conducted. Analyses of remaining indicators were limited to descriptive statistics. All data analyses were conducted by using the SPSS version 22.0 computer package.

RESULTS

Of the total of 339 students targeted to participate in the project, completed consent forms were returned by 298, resulting in an 87.9% return rate, which did not differ significantly by school.

Of the 298 students with completed consent forms, the QoL Survey was only completed by 90 of their caregivers, resulting in a return rate of 30.2% for that instrument. QoL scores, determined

Table II: Results of the Quality of Life Survey

Item	Number		Percent				
	Total	Don't Know	Never	Hardly Ever	Occasionally	Often	Very Often
In the past 6 months, has your child:							
Had pain in the teeth, mouth, or jaw*	90	2	55.68	27.27	13.64	2.27	1.14
Had difficulty drinking hot or cold beverages*	89	1	73.86	15.91	9.09	1.14	0
Had difficulty eating some foods*	90	0	73.33	14.44	11.11	0	1.11
Had difficulty pronouncing any words*	90	2	84.09	11.36	3.41	1.14	0
Missed preschool, daycare, or school*	89	0	83.15	13.48	1.12	1.12	1.12
Had trouble sleeping*	90	0	82.22	10	6.67	0	1.11
Been irritable or frustrated*	88	1	78.16	12.64	6.9	1.15	1.15
Avoided smiling or laughing when around other children*	90	0	80	11.11	5.56	2.22	1.11
Avoided talking with other children*	90	1	83.15	12.36	2.25	1.12	1.12
In the past six month how often have you or another family member:							
Been upset because of your child's dental problems**	90	1	71.91	16.85	5.62	2.25	3.37
Felt guilty because of your child's dental problems**	90	0	77.78	11.11	6.67	2.22	2.22
Taken time off from work because of your child's dental problems**	90	1	80.9	12.36	5.62	0	1.12
In the past six months how often has your child had dental problems that had a financial impact on your family**	90	2	78.41	13.64	2.27	1.14	3.41

Note: Question marks are missing in the original instrument.

*Because of dental problems or dental treatments.

**Or dental treatments.

by computing the mean of the items responses for each participant who completed 10 or more items, did not significantly differ by school, $F(2, 86)=2.18$, $p=0.12$. An analysis of inter-item response variation showed that nearly 45% ($n=40$) of the respondents selected the same choice for all the items. Across the 90 respondents, the inter-item standard deviation of the QoL score averaged 0.39, suggesting the possibility of acquiescent response bias. As such, caution should be exercised when interpreting the results. Table II lists for each survey item the number of respondents (total and those who chose "Don't know") followed by the percentage of respondents who selected each of the 5 valid response options. The results were mostly positive with the bulk of respondents reported never or hardly ever experiencing any of the listed factors.

Of the 298 students with completed consent forms, 254 had valid pre- and post-measures, and met the criteria for inclusion in the efficacy analysis, representing 74.93% of the target group. Students who were less than 6 years old were excluded from the analysis. Table III lists the number of partici-

pants followed by the mean and standard deviation at baseline and follow-up and the result of paired sample t-tests measuring change from baseline to follow-up, by subgroup.

At baseline, the mean plaque score was 35.47, which did not differ significantly by sex, race/ethnicity or school. Overall, across all 3 schools, the mean plaque scores of 31.17 were significantly ($p<0.05$) lower at follow-up. The largest reductions in mean plaque scores were observed among students classified as Other ($\Delta=19.16$, $p<0.01$) and students who were 7 years old ($\Delta=16.53$, $p<0.01$). Although students at all 3 elementary schools tended to have reductions in plaque scores, that difference was not statistically significant. Least squares regression was conducted to provide a more detailed explication of the differences. An initial regression conducted with backward elimination included all group by baseline interactions. The results give the influence of each predictor with the other predictors taken into account. The final model that resulted from numerous manual stepwise addition and deletion of predictors is presented in Table IV.

Table III: Descriptive Statistics and Paired Sample t-tests

	School 1					School 2				
	Baseline			Follow up		Baseline			Follow up	
	n	M	SD	M	SD	n	M	SD	M	SD
Age										
6	73	31.29	19.3	30.22	23.91	44	38.39	23.74	36.66	27.8
7	48	35.38	23.8	24.25	19.1*	28	42.39	25.79	35.48	27.19
8	2	57.5	60.1	47.5	37.48	2	41	15.56	26	19.8
Gender										
Female	64	31.75	18.59	28.04	21.13	43	39	25.41	37.93	29.5
Male	58	35.17	25.32	28.62	24.09	30	40.07	21.99	32.15	23.44
Race										
Black	39	31.82	23.45	31.3	24.75	56	40.63	23.29	36.35	27.12
Hispanic	62	31.6	17.35	28.02	22.95	15	31.07	24.03	35.6	30.76
Other	22	40.77	29.25	23.05	15.64*	3	72.33	14.64	29.67	1.53*
Brush										
Both	87	33.8	21.94	26.66	21.8*	52	40.38	24.68	38.22	28.82
Evening	5	39.4	30.07	19.8	7.16	1	89	--	100	--
Morning	31	30.94	21.06	33.77	25.12	21	36.62	21.2	27.19	16.53
Floss										
No	88	33.74	22.07	27.92	21.41	60	39.68	24.05	33.13	24.34
Yes	35	32.23	21.89	28.82	25.23	14	41.21	25.65	47.93	35.51
Across Subgroups	123	33.31	21.94	28.17	22.46	74	39.97	24.19	35.93	27.15

Note: The significance levels of paired sample t-tests comparing the change in plaque level from baseline to follow up displayed to the right of the means for each school.

*p<0.05

**p<0.01

The follow-up plaque score for a student whose baseline plaque score is equal to the sample average of 35.47 and who is 6 years old is predicted to be 33.628. A 7-year-old student is predicted to have plaque score at follow-up that is a significant 6.269 points lower than a 6-year-old student does, regardless of his or her baseline plaque level, a weak effect size. An 8-year-old student whose baseline plaque score is equal to the sample mean is predicted to have a plaque score at follow-up that is a non-significant 2.769 points higher than a 6-year-old student does. However, a significant weak interaction effect was found indicating that the difference seen for an 8-year-old changes with his or her baseline plaque level. Each 1 point increase in baseline plaque level predicts a 0.692 point reduction in difference seen between 8-year-old and 6-year-old students. As such, an 8-year-old student would only experience a significant reduction in plaque relative to a 6-year-old-student if his or her baseline plaque scores were outside the limits of the sample. No significant effects for the intervention, hygiene practice or other demographic factors were found.

In sum, no significant effects for the intervention or for hygiene practice were found. However, 7-year-old students were predicted to have significant but weak lower plaque scores at follow-up than 6-year-old students, regardless of their baseline plaque levels. Although a significant weak interaction between 8-year-old status and baseline plaque levels was found, significant differences between the follow-up plaque levels of 8-year-old and 6-year-old students were not found within the sample limits. No other significant demographic effects were found. Finally, adjusted scores were computed by fitting the baseline plaque score to the follow-up plaque score, then adding the mean predicted score to the residual score of each participant. Because of the complexity resulting from the interaction and the small number of students affected, 8-year-olds were excluded from this phase of the analysis. Table V lists for each subgroup the descriptive statistics of each level followed by the results of independent sample t-tests and the effect sizes resulting from each comparison.

Table III: Descriptive Statistics and Paired Sample t-tests (continued)

	School 3					Total				
	Baseline			Follow up		Baseline			Follow up	
	n	M	SD	M	SD	n	M	SD	M	SD
Age										
6	36	31	19.37	34.72	27.39	153	33.26	20.81	33.13	25.9
7	17	40.24	25.51	26	16.75	93	38.38	24.66	27.95	21.85**
8	2	42	26.87	19.5	12.02	6	46.83	31.37	31	23.66
Gender										
Female	23	35.04	23.54	23.7	10.73*	130	34.73	22	30.54	23.47
Male	31	34.32	20.62	37.48	29.98	119	36.18	23.28	31.82	25.64
Race										
Black	49	34.24	21.81	29.55	22.9	144	36.07	22.99	32.67	25.11
Hispanic	4	45	19.3	55.5	37.83	81	32.16	18.8	30.78	25.73
Other	1	18	--	38	--	26	43.54	29.46	24.38	14.77**
Brush										
Both	34	35.71	21.91	33.35	27.56	173	36.16	22.84	31.45	25.61
Evening	1	18	--	48	--	7	43.43	32.72	35.29	30.97
Morning	20	32.6	21.93	27.45	18.18	72	33.06	21.18	30.1	21.04
Floss										
No	42	34.33	22.14	32.95	24.82	190	35.75	22.77	30.67	23.15*
Yes	13	34	20.97	26.69	23.12	62	34.63	22.52	32.69	28.25
Across Subgroups	55	34.25	21.68	31.47	24.37	252	35.47	22.67	31.17	24.46*

Note: The significance levels of paired sample t-tests comparing the change in plaque level from baseline to follow up displayed to the right of the means for each school.

*p<0.05

**p<0.01

The comparisons of the adjusted means generally mirror the results found in the predictive analysis in that a significant weak effect for age is seen. In addition, a significant moderate ethnic effect is also seen, that may have been previously been obscured due to multi-colinearity within the sample. Moreover, adjusted plaque reduction at School 1 was found to be greater than that seen at the other schools and approach but not breach the threshold for significance in at least 1 comparison, potentially due to numerous power and design considerations as revealed through a post-hoc power analysis.

DISCUSSION

Dental plaque biofilm is a major etiologic factor for dental caries, and effective plaque control may reduce children's risk for dental caries and gingival inflammation.¹⁵⁻¹⁸ Findings from this study suggest that a tooth brushing educational program augmented with contextualized cues (i.e. pre-pasted toothbrush on cafeteria trays suggesting brushing

after eating) and opportunities to practice oral hygiene skills following a meal shows promise for reducing dental plaque levels. The largest improvement in plaque scores occurred in the school that received the educational intervention and distributed mini-toothbrushes to the children, although there was not a statistically significant difference between schools in the mean reduction in plaque scores. There have been other intervention studies that incorporated oral hygiene instruction and periodic follow-up to improve plaque control among school-aged children. These interventions were primarily intended to educate families and promote oral hygiene practiced in the home.^{10,11} A unique feature of the present study was the addition of the pre-pasted toothbrushes included on the cafeteria trays. The toothbrushes were intended to provide contextualized cues about when to brush (i.e. following a meal) and opportunities to practice brushing embedded as part of a logical and appropriate lunchtime routine. Embedded learning approaches offered children opportunities to prac-

Table IV: Regression Analysis of the Follow up Plaque Scores

Predictor	Coefficient	f2
Constant	33.628**	
	-1.945	
School 2	6.22	0.012
	-3.556	
School 3	2.495	0.002
	-3.897	
Baseline Plaque Level	0.212**	0.038
	-0.069	
Seven Year Old	-6.269	0.015
	-3.173	
Eight Year Old	2.769	0
	-10.696	
Baseline Plaque x Eight Year Old Interaction	-0.692	0.015
	-0.349	
R2=0.039		

Note: The school exposed to the oral hygiene intervention (School 1) serves as the reference group in this analysis. Each coefficient gives the influence of a one unit change in each predictor on the outcome variable when all the other predictors are taken into account. Standard errors are shown in parenthesis. Continuous variables are referenced to their sample mean (grand-mean centered). Coefficients of dichotomous predictors yield mean differences between the labeled group and a reference group comprised of participants classified as six-year-old students. Non-significant predictors are excluded. f2 is the effect size of the predictor obtained when adding it to a model containing the remaining terms: 0.02 (weak), 0.15 (moderate) and 0.35 (strong).

*p<0.05
**p<0.001

tice existing and develop new skills in everyday activities, particularly in those activities where use of the skills are logical and appropriate. Rather than only instruct children in how to brush and to model brushing skills as part of the educational program, children in School 1 were provided opportunities to practice brushing as part of a meaningful and functional routine (i.e. lunchtime). These types of embedded and contextualized learning opportunities have been shown to promote skill generalization and maintenance.^{11,19} Other findings included significantly greater plaque reduction among older children. This may be due in part to better listening and reading comprehension skills and/or better dexterity when handling toothbrushes and/or dental floss due to more developed fine-motor skills.^{22,23} Plaque reduction was also found to be significantly greater among Hispanic children when compared

Table V: Between-Group Comparisons of the Adjusted Means

	n	M	SD	t	d
Age					
6	153	33.51	25.62	2.059*	0.271
7	93	27.32	21.02		
Gender					
Female	127	30.73	23.54	-0.295	-0.037
Male	116	31.65	25.01		
Race#					
Black	139	32.49	25.55	0.317	0.044##
Hispanic	81	31.38	23.89	2.521*	0.548**
Other	25	23.32	14.59	2.042	0.467+
Brush#					
Both	169	31.69	25.49	-0.201	-0.078##
Evening	7	33.67	28.22	0.583	0.083**
Morning	70	29.69	20.31	0.477	0.189+
Floss					
No	185	30.88	22.86	-0.329	-0.048
Yes	61	32.06	27.81		
Intervention#					
School 1	121	28.3	21.9	-1.951	0.29##
School 2	72	35.27	27.16	-1.037	0.171**
School 3	53	32.17	24.19	0.661	0.119+

Note: Statistics are based on adjusted means with d effect sizes used to gauge practical significance
#Bonferroni correction used to adjust significance levels for the effect of multiple comparisons
##First-second line
**First-third line
+Second to third line
*p<0.05

to their African American counterparts. Cultural factors, customs and educational differences have been found to produce such disparities in other studies.^{24,25}

There are a number of inherent limitations to this study. First, it did not use a randomized allocation design or masking of the examiners, so measurement bias cannot be ruled out. Because this study was designed to only measure an intermediate outcome in the dental caries disease process (visible plaque level), the degree to which the intervention truly reduced disease risk remains unknown. Age and ethnic differences manifesting as maturational differences in coordination/fine motor skills and disparities in oral hygiene, respectively, may also have served to obscure the treatment effects in this study. Statistical power, though not sufficient to de-

tect relatively modest declines in plaque scores in this study, can be substantially improved through design changes. Given findings related to the age and grade of the students, these include blocking (i.e. randomly assigning classrooms to each treatment within a grade), measuring students 3 or more times a year, and using precisely recorded age as a covariate, then analyzing the resulting data using a k-between, one-within subjects analysis of variance.^{13,20}

CONCLUSION

Findings from this study suggest that intensive toothbrushing instruction, particularly when accompanied by daily distribution of free pre-pasted toothbrushes, may lead to improved oral hygiene among our most vulnerable children, those living below the federal poverty level.

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DISCLOSURE

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