Toothbrushing Competency Among High-risk Grade One Students: an Evaluation of Two Methods of Dental Health Education

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Abstract

Objective: *To evaluate the effectiveness of two methods of dental health education (DHE) for improving toothbrushing competency among grade one students at high risk for dental diseases.* ***Methods:*** *Fifty elementary schools in the former city of North York, Ontario, Canada, were assigned to one of two groups. In one group, students received a classroom-based DHE lesson that was reinforced by two small group sessions (n=243). In the other group, students received only a single classroom-based DHE lesson (n=206). Trained examiners assessed 11 toothbrushing skills at pre- and postintervention.* ***Results:*** *At the preintervention test, few significant differences were found between the groups and many students did not display competency in fundamental oral health skills, such as placing a toothbrush at the gum line. Following DHE interventions, students in both groups demonstrated improvements in most skills. A significantly higher proportion of students who received both classroom and small group sessions displayed gains in competency in three skills, compared to students receiving only a classroom lesson. These skills were brushing anterior lingual surfaces, brushing posterior lingual surfaces, and brushing all areas in a routine fashion. Students receiving only a classroom session did not display greater improvements in any skill areas compared to "classroom plus small group" students. Some students in both groups still lacked fundamental skills at the end of the DHE program.* ***Conclusions:*** *While one must exercise caution in interpreting the results due to several methodologic limitations, findings suggest that for high-risk grade one students, a classroom-based lesson combined with small group sessions is a more effective method of improving toothbrushing skills compared to a single classroom-based lesson. [J Public Health Dent 2001; 61(4):197-202]*

Key Words: dental health education, toothbrushing, oral hygiene.

Recent Ontario data indicate that, among young children, a reversal in the dental caries decline has occurred in the primary dentition (1). Consequently, an assessment of the effectiveness of disease prevention programs designed for this age group is needed. School-based dental health education (DHE) for young children is intuitively appealing because their health skills and attitudes are developing at this age. Previous studies have found that DHE may improve oral hygiene knowledge among grade one and preschool children (2-8). However, these studies often used cross-sectional study designs and lacked comparison groups (9); thus, further research on the effectiveness of DHE programs for young children is warranted.

Dental health education has been defined as a strategy designed to promote knowledge of and attitudes toward preventive dental health behaviors to improve oral health (10). DHE is an integral part of dental health services and has been provided in many settings such as schools, institutions, and dental offices. It has been delivered in various ways ranging from annual classroom presentations to comprehensive sessions that use psychological strategies. The current dental health education literature favors small group activities, rather than classroom activities (11). Several small group participatory sessions allow repetition and reinforcement of classroom learning, allow information to be presented at each participant's level of understanding, and use an active "show-and-do" approach to learning as opposed to the traditional "show-and-tell" approach. An active approach to education is consistent with the World Health Organization statement that participant involvement is essential for health education to be effective (12). In studies of older children and adults, small group sessions with peer groups improved oral hygiene and attitudes (13,14).

The Ontario Ministry of Health's "Healthy Growth and Development" program identified DHE as a mandatory part of its dental component (15). For the school year 1996–97, dental education for grade one students in the former city of North York, Ontario, consisted of an annual 30-minute classroom session for all students and two follow-up small group sessions for students identified as being at high

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risk for dental diseases. In both types of DHE, specially trained dental educators presented lessons on oral health principles and the prevention of oral diseases during their school visits. Follow-up small group sessions were intended as reinforcement visits.

The purpose of this evaluation was to compare the effectiveness of two methods of DHE for targeted grade one students attending public and separate elementary schools in the former city of North York. The two methods assessed were a classroom-based dental education lesson reinforced by two small group sessions, and a single classroom-based lesson. The study examined the outcomes of toothbrushing skills and oral health knowledge; however, only the former is discussed in this article because of limited space. This evaluation was conducted as part of the Quality Assurance Program in the Public Health Department in the former city of North York.

Methods

Participants. The target population was grade one students in public and separate (e.g., religious) schools in the former city of North York, who were at high risk for dental diseases. Children were screened during an in-school dental examination and were classified as high risk if they met one of the following conditions: (1) a need for urgent treatment (open carious lesion, pain, infection, trauma, or hemorrhage), as defined by the Children in Need of Treatment (CINOT) program (16); (2) a need for fluoride therapy due to having a smooth surface carious lesion; or (3) a score of 1 or more on the Community Periodontal Index of Treatment Needs (CPITN).

Evaluation Design. Schools were selected for this study if they had a high proportion (greater than 10%) of grade one students at high risk to dental diseases based on data obtained from annual in-school dental screenings. A total of 50 elementary schools were selected. Within each of the six geographic planning regions in North York, selected schools were matched with another school that had students with similar demographic and oral health characteristics (e.g., high dental needs, low socioeconomic status, and a history of recent immigration to Canada). The distance between schools was taken into account during matching to prevent a spillover of dental education information. For each pair of matched schools, one of the schools was randomly assigned to one of the two study groups and the second school of the pair was assigned to the other study group.

A pre- and postintervention design with two study groups was utilized. Students in one group received one classroom lesson followed by two small group sessions, whereas students in the other group received only the classroom lesson. The time interval between the last session/lesson and the postintervention observation was approximately 30 days for both groups. For ethical reasons, students in the "classroom-based lesson only" group also received two small group sessions after the postintervention observations.

Sample Size Calculation. The sample size was calculated by selecting, as the main outcome, a 10 percent difference between the proportion of students in each group who would demonstrate improvement in a toothbrushing skill between pretest and posttest observations. With this estimate, approximately 190 children in each group would be required for an 80 percent power to demonstrate a significant difference between groups at the 5 percent level (two-sided). An attrition rate of 50 percent was estimated for the follow-up period; thus, the estimated number of participants who should be invited to participate in the study was 380 per group.

Toothbrushing Competency Measure. An observation measure to assess toothbrushing competency among grade one students was developed and consisted of an 11-item checklist of toothbrushing skills appropriate to the content of the DHE program. The measure assessed placement of brush, strokes, and tooth surface scores. Six of the items, which assessed the tooth surfaces brushed by students, were arranged in a six-step hierarchy similar to that proposed by Ogasawara et al. (17). Interviewers used a simple yes–no scale to assess all 11 items. The measure was pilot tested with a sample of high-risk grade one students. Revisions were made based on pilot test information, informal discussions with children, and comments from an education consultant and grade one teachers.

Oral health indices were not used in this study because they are long-term outcome indicators. It was expected that dental caries indices would not show improvement because of the short time period between pretest and posttest.

Procedure. In September 1996, dental hygienists employed by North York Community Dental Services (CDS) screened children and identified high-risk students according to previously described criteria. Parents of selected students were sent a letter of invitation, accompanied by a consent form asking that their child participate in the study. Telephone follow-up was used to increase response rate. Only students with parental or guardian consent were included in the study. Schools were sampled until the required sample size was obtained.

The evaluation was conducted between October 1996 and February 1997. Data were collected by six independent interviewers who were trained immediately prior to pretest and posttest. During a half-day session, the DHE manager provided training to them on how to administer the instrument in a standardized manner. Interviewers were either dental hygienists or dental assistants who had not previously worked in the DHE program of the North York Public Health Department.

The interviewers were blinded as to which students were assigned to each group. At pretest and posttest, interviewers led participants one at a time to the dental or health room of schools during regular school hours. Interviewers asked each student, "I'd like you to pretend that you are at home. Show me how you brush all your teeth. You can watch in the mirror. Take your time. You don't need to rush." After each student brushed and stopped, interviewers said, "I didn't see. Show me again." Interviewers recorded whether or not the student performed each toothbrushing skill at an acceptable level when brushing his or her teeth.

Six trained dental health educators employed by North York CDS provided DHE sessions after pretests. Classroom-based lessons were given in October. Each student in the "classroom plus small group sessions" group received a follow-up small group session in November and January. The first visit consisted of 30 minutes of participatory education followed by 15 minutes of individual

education, as well as toothbrushing instruction. The second visit was 15 minutes in length and included toothbrushing instruction. The content of these sessions included oral hygiene instruction in brushing and lessons on nutrition, injury prevention, the objectives of oral hygiene, and practical information about oral hygiene (e.g., when you should throw your toothbrush away). In the classroom lessons, equal amounts of time were devoted to these different topics, but more time was devoted to oral hygiene instruction in the small group sessions.

The school-based DHE program was an established program that operated in accordance with the policies of the CDS Division of the North York Public Health Department. The DHE manager continually monitored the program to ensure compliance with the protocol of the health unit's quality assurance program. Educators were blinded as to which schools were assigned to each group. One educator provided all education sessions for matched schools within each region.

Postintervention tests were done about one month after the last education session. Both pretest and posttest took place over a two-day period at each school. If children were absent both of these days, they likely were not included in the study; repeat visits to schools occurred only if several children were absent at that school. Schoolteachers and dental educators were surveyed to determine if any events occurred in the selected schools during the study which might have influenced the outcome measures. They reported that no such events were known to have occurred.

Data Analysis. Data were analyzed using the SPSS/PC+ and STATA statistical software packages. Data from participants who took part in both pretest and posttest were analyzed. Chi-square tests were done to determine whether the groups had equivalent pretest scores. McNemar's tests were used to compare pretest and posttest scores for each group separately. To assess between-group differences in improvement from pretest to posttest, logistic regression analysis was performed for each of the 11 skill items. Improvement was defined as having been unable to demonstrate the skill at pretest, but performing the skill at posttest. Children were considered not to have improved if they remained the same, or if they did not demonstrate the skill at posttest, but had done so at pretest. STATA's robust estimator of variance and cluster options were used in logistic regression analysis to account for the design effect (students were clustered within schools). The hypothesis was that a higher proportion of students who received the two small group sessions would demonstrate competency in all toothbrushing skill items and, in particular, the more difficult skill items.

TABLE 1
Number of Participants Remaining at Different Phases of the Study

Phase of Study	Classroom and Small Group Sessions	Classroom Sessions Only
Invited to participate in study	469	403
Positive consent forms returned	334	273
Participated in pretest	306	249
Participated in posttest	252	213
Able to comprehend English adequately	243	206

Results

Eight hundred and seventy-two students were invited to participate in the study (Table 1). However, the sam-

TABLE 2
Percentage of Participants Who Demonstrated Toothbrushing Competency at Pretest and Posttest

	Classroom and Small Group Sessions		Classroom Session Only	
Toothbrushing skill	Pretest	Posttest	Pretest	Posttest
Holds brush properly	93	99*	95	98
Places brush at gum line	55	76†	63	68
Appropriate motion of brush	79	93†	79	96†
At least three circles per tooth	46	69†	50	62‡
Brushes labial side of front teeth	84	93*	87	88
Brushes lower occlusals of molars	82	95†	85	92‡
Brushes upper occlusals of molars	58	91†	57	78†
Brushes buccal side of molars	69	90†	73	82‡
Brushes lingual side of front teeth	12	38†	12	21‡
Brushes lingual side of molars	4	21†	3	8‡
Brushes all areas in routine fashion	27	68†	36	53¶

McNemar's test for differences within each group from pretest to posttest:
*$P<.01$.
†$P<.0001$.
‡$P<.05$.
¶$P<.001$.

ple was reduced to 449 due to parental consent forms not being returned, students not completing both the pretest and posttest, and students having problems comprehending English. Participants were deemed to have problems understanding English if they failed to correctly answer the following questions or requests: "What is your name?," "What grade are you in?," "Point to your teeth," and "Point to the toothbrush." Data from students who did not answer correctly were excluded from the analysis.

Both groups had similar pretest results. They differed significantly on only one of the 11 toothbrushing competency items. Specifically, at pretest, a higher proportion of "classroom-only" students demonstrated that they could brush all areas in a routine fashion than did "classroom plus small group" students. At pretest, most students demonstrated fundamental toothbrushing skills such as properly holding a toothbrush and brushing labial tooth surfaces (Table 2). However, few students were observed brushing posterior lingual surfaces (3–4%), anterior lingual surfaces (12%), and all areas in a routine fashion (27–36%). Five participants (1% of all subjects) demonstrated none of the 11 toothbrushing skills and four participants (1% of all subjects) demonstrated all of these skills.

At posttest, "classroom plus small group" participants showed significant improvements for all skills, whereas students receiving only a classroom session showed significant improvements for eight skills (Table 2). Only two participants (1%), both in the "classroom only" group, continued to display none of these skills. Thirty-three "classroom plus small group" students (14%) and seven "classroom only" students (3%) demonstrated all 11 skills. Many participants in both groups demonstrated improved competency for specific toothbrushing skills (Table 3). However, a significantly higher proportion of students who received small group sessions displayed improvement in three skill areas: brushing anterior lingual surfaces, brushing posterior lingual surfaces, and brushing all areas in a routine fashion.

Discussion

The baseline findings of this study are consistent with similar studies conducted on young children in the United States and the United Kingdom from 1960–86. Most children in this age group are able to demonstrate fundamental brushing skills such as properly holding a toothbrush, brushing labial and buccal surfaces (3,18,19), and brushing occlusal surfaces of lower molars (18,19). They have difficulty with more complex skills such as brushing the occlusal surfaces of upper molars (18), and posterior lingual surfaces (3,19). This was also found in studies of children 11–13 years old (20,21).

Postintervention results showed brushing of lingual surfaces improved significantly, which is in agreement with previous research findings (3). Participants in both groups displayed gains in toothbrushing competency, but a significantly higher proportion of "classroom plus small group" students demonstrated improved competency. This was expected because prior to posttest, these students had received two small group sessions focusing on toothbrushing skills. The benefits of additional reinforcement were evident: a significantly higher proportion of "classroom plus small group" students who initially did not perform complex toothbrushing skills subsequently displayed these skills.

Despite these improvements, many children in both groups still could not execute basic skills at the posttest observation. For example, 24–32 percent of students did not place the brush at the gum line and two students still could not perform any skills. Some of these deficiencies may be due to a lack of manual dexterity or physiological development. One hypothesis for the problems associated with lingual brushing is that this is caused by a difficulty in moving the base of the tongue, thus preventing access to the posterior lingual segment of the arch for young children (22).

The magnitude and direction of the results suggest that classroom and small group sessions is a more effective method of DHE than only a classroom lesson. The validity of the between-groups comparison is supported because: (1) the sampling procedure matched schools based on high dental needs and, thus, participants in each group would likely have had equivalent socioeconomic status and immigration history; and (2) both groups had similar toothbrushing competency at pretest, with the exception of one skill item.

Limitations. Several limitations may have compromised the validity of the results. First, there could have been interviewer bias. Examiners were blinded as to which schools were assigned to each group; nevertheless, some students could have told examiners about the small group sessions they had received. Also, interviewers were trained prior to pretest and posttest, but intra- and interrater reliabili-

TABLE 3
Percentage of Participants Displaying Improved Toothbrushing Competency at Posttest

Toothbrushing Skill	Classroom and Small Group Session	Classroom Session Only	P-value
Holds brush properly	7	5	NS*
Places brush at gum line	30	22	NS
Appropriate motion of brush	16	18	NS
At least three circles per tooth	27	24	NS
Brushes labial side of front teeth	15	11	NS
Brushes lower occlusals of molars	17	10	NS
Brushes upper occlusals of molars	38	27	NS
Brushes buccal side of molars	27	21	NS
Brushes lingual side of front teeth	33	17	$P<.001$
Brushes lingual side of molars	20	4	$P<.05$
Brushes all area in routine fashion	45	25	$P<.0001$

*Logistic regression analysis, with robust variance estimation, to assess differences between groups: NS=not significant.

ties were not assessed. Finally, interviewers would have likely known the pretest–posttest design of the study, which could have influenced their scores.

Another limitation may be the refusal of some students to participate and the loss of some participants at different phases of the study. An approximately equal number of students in each group were lost at each phase (Table 1); the characteristics of participants who refused to participate or were lost to follow-up were not examined.

Third, a process evaluation was not done to determine whether dental education was provided in the intended manner. Considering that six dental health educators provided the DHE sessions, some degree of variation in program delivery by educators would be expected. However, school-based DHE is an established program and subject to quality assurance measures.

Fourth, young children were evaluated, which presented difficulties in obtaining consistent responses. Some children who performed skills correctly at pretest were found to perform them incorrectly at posttest. This finding had been anticipated, as it was found previously by McIntyre et al. (6). However, it should not be inferred that DHE has caused a loss of competency in toothbrushing skills. Conversely, for each child who demonstrated an improvement, the improvement may not be due to a gain in competency.

Lastly, the manner in which toothbrushing skills were assessed may be criticized because visual monitoring is a more subjective measure than plaque disclosure indices. Although plaque indices may be a better measure of oral hygiene behavior, visual monitoring of toothbrushing has been used previously in studies of young children (5,17). Visual monitoring is easier and more acceptable to young children than the use of plaque disclosure tablets and is consistent with an emphasis on teaching children to reach all tooth surfaces areas.

The above limitations may have influenced our findings in several ways. The first limitation, interviewer bias, would likely have increased between-group differences if interviewer blinding had been compromised. In contrast, a decrease in between-group differences would have been expected if the small group DHE sessions had not been implemented as intended. Lastly, attrition bias may have changed results in either direction. Although steps were taken to reduce bias, these results should be interpreted with caution due to these limitations.

Implications. A shortened version of the observation measure may be useful as a screening tool to determine which children are in need of DHE. This form of screening would help to identify children who are not at high risk based on clinical criteria, but who have poor oral health skills. The results also may assist managers and educators in planning more effective education lessons and identifying subject areas where further reinforcement is necessary (e.g., learning how to brush lingual surfaces). Also, although many students in this study benefited from DHE, some children in both groups still lacked basic toothbrushing skills at the end of the grade one DHE program. It would be worthwhile to investigate those children who continued to have poor competency and to determine why this occurred. As a first step, the sociodemographic characteristics of these children may be examined to determine the relationship between changes in toothbrushing competency and cultural and language factors. If barriers to learning existed, it may be necessary to design future interventions that are culture-specific and include the involvement of parents or other family members.

In terms of disease prevention, the potential value of adding small group sessions is unknown. Although these sessions provide children with a greater opportunity to achieve optimal oral health, long-term studies using disease outcome measures are needed to answer this question.

Acknowledgments

The Community Dental Health Services Research Unit is a joint project of the Faculty of Dentistry at the University of Toronto and the Community Dental Services Division at the Toronto Public Health Division. It is a Health Systems-linked Research Unit funded by the Ontario Ministry of Health (grant #04170). The opinions expressed in this report are those of the authors, and no official endorsement by the ministry is intended or should be inferred.

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