EVALUATION OF THE NORTH YORK PUBLIC HEALTH DEPARTMENT DENTAL HEALTH EDUCATION PROGRAM FOR GRADE ONE STUDENTS

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COMMUNITY DENTAL HEALTH SERVICES RESEARCH UNIT

PROGRAM EVALUATION
REPORT NO. 3

1998

The Community Dental Health Services Research Unit is a joint project of the Faculty of Dentistry, University of Toronto and the Dental Services Divisions of the City of North York City of Toronto, Simcoe County District Health Unit, York Regional Public Health Department and Thunder Bay District Health Unit. 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.

Summary

Purpose: To evaluate the effectiveness of two methods of dental health education (DHE) for Grade One students at high risk of dental diseases. **Methods:** Fifty elementary schools in the City of North York were assigned to one of two groups. In one group, students at high risk (n=243) received a classroom-based dental education lesson which was reinforced by two small-group sessions. In the other group, students (n=206) received only a single classroom-based dental education lesson. At pre-intervention and post-intervention, toothbrushing skills and oral health knowledge were measured; and effectiveness was assessed by comparing results from pre- and post-tests. **Results:** At pre-test, few significant differences were found between the groups and many students did not display awareness of basic oral health skills and knowledge. Following DHE interventions, students in both groups demonstrated improvements in most areas, including: toothbrushing competency and knowledge of nutrition and oral hygiene. In several areas, a significantly higher proportion of students who received both classroom and small-group sessions displayed gains in skills/knowledge compared to students receiving a single classroom lesson. These areas included: brushing of anterior and posterior lingual surfaces; and awareness that removal of germs was one of the purposes of oral hygiene. Students receiving only a classroom session did not display greater improvements in skills/knowledge, in any subject areas, compared to students receiving classroom and small-group sessions. Some students in both groups still lacked essential skills and/or knowledge after the completion of the DHE program. Limitations of the evaluation are discussed. **Conclusion:** Findings suggest a classroom-based lesson combined with small-group sessions is a more effective method of improving toothbrushing skills and oral health knowledge compared to a single classroom-based lesson.

1. Introduction

1.1 Purpose and objectives

The purpose of this evaluation was to compare the effectiveness of two methods of dental health education for targeted Grade One students attending public and separate elementary schools in the 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 objectives were to compare the ability of the two methods to improve toothbrushing skills and oral health knowledge.

1.2 Background

Dental health education (DHE) has been defined as a strategy designed to promote understanding, knowledge and attitudes towards preventive dental health behaviours in an effort to improve oral health.[1] DHE has been an integral part of dental health services and has been delivered in many settings such as schools, institutions and dental offices. Various formats have been employed, from simple annual classroom presentations to comprehensive sessions using psychological strategies. The goal of DHE is laudable, but it is unknown whether these programs are an effective means of improving oral health. Only tentative conclusions may be made because of the lack of quality evidence.[1-3]

The Ontario Ministry of Health's "Healthy Growth and Development" program has identified DHE as a mandatory part of its dental component.[4] As with all Ministry programs, it is continually reviewed and this study addresses several of the issues raised in discussions about

DHE: the use of small-group sessions; the targeting of education towards children at high risk; the effectiveness of programs for Grade One students; and the evaluation of DHE programs.

(a) Small-group sessions: Current dental health education literature favours small-group activities over those carried out in the classroom.[2] Several small-group participatory sessions allow repetition and reinforcement of learning because too much information may be covered in a single classroom session, especially for younger children. Small-group sessions also afford the ability to present material at each participant's level of understanding; and to use an active "show-and-do" approach to learning as opposed to the traditional information-oriented "show-and-tell" approach. An active approach to education is consistent with the World Health Organization statement that "participant involvement is essential for success in health education".[5] In studies of older children and adults, small-group sessions with peer groups were effective in improving oral hygiene and attitudes.[6,7]

(b) Targeting DHE to high risk students: The burden of dental diseases among children in Ontario is unevenly distributed; approximately 20% of children experience 80% of the decay. It is therefore justifiable and cost-effective to focus resources on the education of high risk children. At present, the best predictor of risk status is past caries experience[8-10] and clinical criteria are used in the North York DHE program to identify children at high risk.[11] Past caries experience has been associated with immigration status. A recent report stated immigrant children have the highest levels of caries prevalence and the greatest need for urgent care[12]; and an association was found between a mother's immigration history and new dental decay among

8-year-old children living in North York.[10]

(c) DHE programs for Grade One students: Recent Ontario data indicate that, among young children, a reversal in the dental caries decline has occurred in the primary dentition.[13] Consequently, there is a need to investigate the effectiveness of disease prevention programs designed for this age group. Of these programs, school-based DHE for young children is intuitively appealing since it is at this age that health attitudes are developing. Previous studies of DHE have shown knowledge benefits for Grade One[14-18] and for preschool children,[19,20] but these studies have often used cross-sectional study designs and lacked comparison groups.[3] Thus, a better understanding of the effectiveness of DHE programs in improving the oral health knowledge of Grade One children is necessary.

Evaluation studies of Grade One students are difficult because of the problems in assessing knowledge of children at the pre-operational stage of cognitive development.[22] Although young children have the ability to verbalize their ideas about health and self-care, it is critical that the means of assessment be sensitive to developmental stage.[23,24] At the pre-operational stage, children are egocentric and perceive the world only in terms of their own perspective. Children at this stage also tend to rely on intuition and cannot yet apply logical rules to situations. Due to these factors, talking to young children about health-related beliefs and behaviours has been described as a daunting methodological task.[25]

(d) Evaluation of DHE programs: Evaluation is an essential part of the iterative program

planning cycle[26]; and may be divided into two components, process and outcome. Process evaluation refers to the assessment of whether a program was implemented as intended. Outcome evaluation refers to the assessment of the impact of a program on the target group. A program logic model diagrammatically shows the relationship between the desired outcomes of the program and the program activities (Figure 1). This model may be used in the development and evaluation of programs, but it was not used for the present study.

The literature on DHE has been described as "enormous, complex and inconsistent"[1]; and review articles have universally lamented on the diversity and poor quality of research designs and measurements.[1-3,21] Evaluations of DHE programs have been inadequate and the litany of problems with previous studies include: a lack of standardization of measurements; poor descriptions of program activities; small sample sizes; a lack of examiner calibration and reliability measurement; and the use of students' and teachers' opinions as outcomes. Perhaps the best testament to the poor quality of DHE studies is a recent systematic review which identified 143 DHE reports published between 1982 and 1994.[3] Only 37 of these reports met validity criteria for inclusion in a qualitative review, and quantitative meta-analysis included results from only seven studies.

In defense of previous attempts at DHE evaluation, it is helpful to remember a trade-off between scientific rigor and what is feasible is often necessary, given the realities of the situation (e.g., time, expense, and political considerations). For example, a classical control group, which receives no DHE, may not be possible in the evaluation of a tax-supported program.

Figure 1. Prototypical program logic model for dental health education programs (based on reference 26)

GOAL	To improve oral health among children
TARGET GROUP	Students attending public and separate schools
COMPONENTS	School-based education
LONG-TERM OUTCOME OBJECTIVES	To decrease: · % of students with new decay · DMFT and DMFS scores · % of students with CPITN $\geq$ 1
SHORT-TERM OUTCOME OBJECTIVES	· To increase the % of students demonstrating proper toothbrushing skills · To increase oral health knowledge among students
PROCESS OBJECTIVES	· To provide dental health education to meet the needs of students · To hold discussions with schools and teachers
RESOURCES	· Trained dental health educators and public health staff · Resource materials

1.3 Program description

The Community Dental Services (CDS) Division of the City of North York Public Health Department provides education services to students from Junior Kindergarten to Grade 8.[27] The goal of the North York DHE program is to improve the dental health of the target population through the provision of dental education. The objectives of this program are: (a) to provide high quality education programs delivered in a cost effective manner for target populations; (b) to increase the percentage of the target population practising good dental health behaviours; and (c) to increase the dental health awareness, knowledge and skills of the target populations.

For the school year 1996-1997, dental education for Grade One students consisted of an annual 30-minute classroom session for all students; and two follow-up small-group sessions for students identified by the Division's screening program as being at high risk for dental diseases. Both types of DHE use specially trained dental educators who visit schools and present lessons on oral health principles and the prevention of oral diseases. Follow-up small-group sessions are intended as reinforcement visits. The first visit consists of 30 minutes of participatory education followed by 15 minutes of individual toothbrushing instruction. The second visit concentrates on 15 minutes of toothbrushing instruction.

The school-based DHE program is an established program and operates in accordance with the policies of North York CDS. It is subject to ongoing supervision by the DHE manager and complies with the protocol of the health unit's quality assurance program. A full description of this program is provided in Appendix A.

2. Methods

2.1 Study design

A pre- and post-intervention design was utilized with two study groups (Figure 2). Students in one group received one classroom lesson followed by two small-group sessions; students in the other group received only the classroom lesson. The time frame between observations and interventions was the same for both groups. For ethical reasons, students in the classroom session only group received small-group sessions after completion of post-intervention tests and consequently these students were not denied the potential benefits of these sessions.

Figure 2. Study design and time-table

Group:	October		November	January	February
Classroom and small-group sessions	01	X1	X2	X3	02
Classroom session only	01	X1	02		

01 - preintervention observation
02 - postintervention observation
X1 - classroom dental education lesson
X2 - first small-group dental education session
X3 - second small-group dental education session

The 50 public or separate elementary schools selected for the study were allocated to one of the two groups. To prevent a potential spill-over of dental education information, the schools from each of these two groups were not adjacent. Schools were matched according to geographic

planning region. Due to the criteria used to select schools, matched schools would have had students with similar demographic characteristics. A high proportion of students at these schools would have high levels of dental needs, be of low socioeconomic status (SES), and have a history of recent immigration to Canada.

2.2 Description of sample

The target population for this study was Grade One students attending public and separate schools in the City of North York, who had been identified as children at high risk for dental diseases. Children were at high risk if they met one of the following conditions: (a) a need for urgent treatment (open lesion, pain, infection, trauma, or haemorrhage) as defined by the Children in Need of Treatment (CINOT) program; (b) a need for fluoride therapy due to having a smooth surface carious lesion; or (c) a score of 1 or more on the Community Periodontal Index Treatment Need (CPITN).[11]

2.3 Instrument

A survey instrument was designed to collect information on oral health knowledge and toothbrushing competency among Grade One students (Appendix B). An observation tool was used to assess toothbrushing competency in the following skill areas: placement of brush, strokes, and tooth surface scores. A 6-item checklist of brushing skills appropriate to the content of the DHE program was developed. Item #5 assessed the tooth surfaces brushed by students and was arranged in a 6-step hierarchy similar to that proposed by Ogasawara *et al.*[28]

Oral health knowledge was measured in four subject areas: nutrition, oral hygiene, professional services, and injury prevention. Questions were appropriate to the content of the DHE program for Grade One. A 15-item questionnaire which consisted of two question types (10 "tell-me" and 5 "show-me") was developed. "Tell-me" questions required verbal responses which were recorded by reviewers using a list of potential responses on the questionnaire. For questions with more than one possible answer, participants were encouraged to give multiple answers. "Show-me" questions used pictures or visual aids, and required non-verbal responses such as pointing to a photograph or toothbrush. A similar technique was previously used by Hodge *et al.*[17] A total of 14 pictures were included in the survey instrument as well as six visual aids: three different sized toothbrushes (small, medium, large); and three same sized toothbrushes with varying amounts of toothpaste.

The instrument was pilot tested with a sample of high risk Grade One students. Subsequently, revisions were made based on pilot test information, informal discussions with children, and comments from an education consultant and Grade One teachers. After the publication of the revised instrument a final alteration was made, reviewers were told item #4 of the toothbrush checklist should read "at least three circles per tooth" instead of "length of time per tooth".

Oral health indices were not used in this study as these are long-term outcome indicators. Given the short time period between pre- and post-test, dental caries and plaque indices would not have shown any significant differences between study groups. Long-term changes could not

be measured as both groups would have already received two small-group sessions by the end of the school year.

2.4 Procedure

Selected North York elementary schools were placed into one of two groups using a sampling technique described in section 2.1. In September 1996, dental hygienists employed by North York CDS screened students at these schools. High risk students were thereby identified according to criteria outlined in section 2.2. Schools were sampled until the required sample size was obtained.

Parents of selected students were sent letters of invitation, accompanied by consent forms, which asked that their child participate in the study (Appendix C). Telephone follow-up was used to increase response rate. Only students with parental or guardian consent were included. The instrument was then pilot tested with a sample of high risk Grade One students and subsequently revised.

The evaluation was conducted between October 1996 and February 1997. Data were collected by independent interviewers who were trained immediately prior to pre-test and post-test. During one half-day session the DHE manager provided training to independent interviewers on how to administer the instrument in a standardized manner. No children were used as sample cases at these sessions.

The interviewers were blinded to assignment of individual students to the two study groups. At pre- and post-test observations, interviewers took participants one-at-a-time to the dental or health room of schools during regular school hours. The protocol for performing toothbrushing observation and knowledge interviews is outlined on the instrument (Appendix B).

Following pre-intervention tests, DHE sessions were provided by six trained dental health educators employed by North York CDS. 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. Educators were blinded as to the group assignment of schools and children. One educator provided all education sessions for matched schools within each region. A process evaluation of the program was not done, but the DHE manager supervised the educators and the program was regularly assessed (Appendix A).

Post-intervention tests occurred about one month after the last education session. Pre-test and post-test both took place over a two-day period at each school. If a child missed both these days, they would likely have not been included in the study; repeat visits to schools occurred only if several children were missed at that school.

School teachers and dental educators were surveyed to determine if any events occurred in the selected schools throughout the duration of the study which might have potentially influenced the outcome measures. No such events were known to have taken place.

2.5 Data analysis

Data were transferred to computers using Epi Info (V5) software[29] and analysed using the SPSS/PC+ statistical package.[30] Data analysis was confined to those participants who took part in both pre- and post-intervention tests. Participants were deemed to have problems understanding English if they failed to correctly answer the following questions/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. Responses for each question were classified according to four subject areas, as shown in Table 1. Analysis was done on an item-by-item basis; no attempt was made to aggregate items. An aggregate measure of knowledge was not appropriate because different types of questions were asked (e.g, show-me vs. tell-me type) and questions were not of equivalent difficulty.

Statistical analysis, using chi-square tests, was done to compare pre-test scores between the two groups in order to determine whether the groups were equivalent at baseline. Further statistical analysis was done to assess the effect of DHE on skills and knowledge scores at post-test. This analysis was done in two parts: (a) McNemar's test was used to compare differences between pre- and post-test scores for each group separately; and (b) chi-square tests were used to compare the two groups for differences in the proportion of students who displayed increased competency/knowledge at post-test. The above analyses included all study participants. In addition, a separate analysis was done for those participants who did not provide appropriate responses at pre-test. Similar to the analysis in (b), chi-square tests were used to compare the two groups for differences in the proportion of students who displayed increased

competency/knowledge at post-test.

Table 1. Questionnaire items by subject area

Subject area	Item	Tell-me or show-me question
Nutrition	- what is important to do to keep your teeth healthy? (response: nutrition)	- tell-me
	- what foods are good for your teeth?	- tell-me
	-what drinks are good for your teeth?	- tell-me
	- show me the picture of the boy that is doing something to look after his teeth (does not point to: picture of "boy eating candy")	- show-me
	- show me some drinks that are good for your teeth	- show-me
	- show me some foods that are good for your teeth	- show-me
Oral hygiene	- what is important to do to keep your teeth healthy? (response: oral hygiene)	- tell-me
	- why should you brush your teeth?	- tell-me
	- show me the picture of the boy that is doing something to look after his teeth (point to: picture of "boy brushing teeth")	- show-me
	- when is the most important time to brush your teeth?	- tell-me
	- what do your teeth help you do?	- tell-me
	- show me the toothbrush that is the best size for you (response: small or medium)	- show-me
	- when should you throw away your toothbrush?	- tell-me
	- show me how much tooth paste you should use (response: smear or pea)	- show-me
Professional services	- what is important to do to keep your teeth healthy?	- tell-me
	- what person helps you look after your teeth? (response: dentist/hygienist)	- tell-me
	- show me the picture of the boy that is doing something to look after his teeth (point to: picture of "boy visiting dentist")	- show-me
Injury prevention	- what is important to do to keep your teeth healthy?	- tell-me
	- what could you do to protect your teeth?	- tell-me

For program evaluation, the change in demonstrated competency/knowledge for the entire group is a more appropriate measure because it assesses the impact of the intervention on the group as a whole. However, assessing competency/knowledge changes among those participants

who initially did not provide appropriate responses may be useful for determining what subject areas are especially difficult to improve; and for assessing the ability of educators to teach students who had inappropriate pre-test scores. Nevertheless, caution must be exercised when interpreting this type of analysis because results may only be considered in relation to the magnitude of the denominator. In other words, if few students had incorrect pre-test scores for an item, gains in competency/knowledge may appear to be quite high; but gains for the entire group would be minimal.

3. Results

3.1 Characteristics of participants

Seventy percent of the 872 children originally asked to participate in the study returned positive parental consent forms (Table 2). Participants were also lost because they were unable to take part in either the pre-test or post-test, and 16 children were excluded because of problems comprehending English. Reasons for not participating were not recorded.

Students from 50 elementary schools (26 in the "classroom plus small-group sessions" group and 24 in the group receiving only a classroom-based session) were assessed. Table 3 shows the percentage of participants in each planning region.

Table 2. Loss of participants at different phases of study

Phase of study	Group		Overall
	Classroom and small-group sessions	Classroom session only	
Number invited to participate in study	469	403	872
Number of positive consent forms returned	334	273	607
Number which participated in pre-test	306	249	555
Number which participated in post-test	252	213	465
Number able to adequately comprehend English	243	206	449

Table 3. Percentage of participants in each school planning region ('n' refers to the number of participants)

Region	Group		Overall (n = 449)
	Classroom and small-group sessions (n = 243)	Classroom session only (n = 206)	
1	36	35	35
2	29	19	25
3	11	8	10
4	3	12	7
5	13	18	15
6	8	7	8

Only 71% of participants could identify the language spoken by their mother (Table 4). Of those participants who responded, 43 languages were identified, with non-English languages making up the majority of responses. No significant difference between groups was found for the proportion of subjects with a mother whose first language was English (2 X 2 chi-square, $p = 0.08$).

The two groups had similar pre-test results. They significantly differed on only 4 of the 45 knowledge items. The groups significantly differed on only one of 11 toothbrushing competency items. A higher proportion of students receiving classroom plus small-group sessions gave the appropriate response for three of these items. A higher proportion of students in the classroom-only group gave the appropriate response for the other two items.

Table 4. Distribution of participants by language spoken by mother (%). Number of participants responding to this question was 321.

Language	Group		Overall
	Classroom and small-group sessions	Classroom session only	
English	23	31	27
Chinese	13	11	12
Arabic	8	3	6
Farsi	6	5	6
Tamil	9	2	6
Spanish	5	4	5
Russian	4	7	5
Punjabi	3	5	4
Korean	3	3	3
Philippine (Tagalog)	4	1	3
Urdu	1	5	3
Vietnamese	5	1	3
Hindu	2	1	2
Indian	3	1	2
Iranian	1	2	2
Italian	2	2	2
Somali	2	2	2
Syrian	0	3	2
Other	6	11	5

3.2 Toothbrushing competency

(a) Comparison of pre- and post-test results within each group: At pre-test, most students demonstrated basic toothbrushing skills such as properly holding a toothbrush and brushing labial tooth surfaces (Table 5). However, few students were observed brushing posterior lingual surfaces (3-4%), anterior lingual surfaces (12%) and brushing all areas in a routine fashion (27-36%). At post-test, "classroom plus small-group" participants showed significant improvements on all skills. Students receiving only a classroom session showed significant improvements for 8 skills.

Table 5. Percentage of participants who demonstrated toothbrushing competency at pre- and post-tests

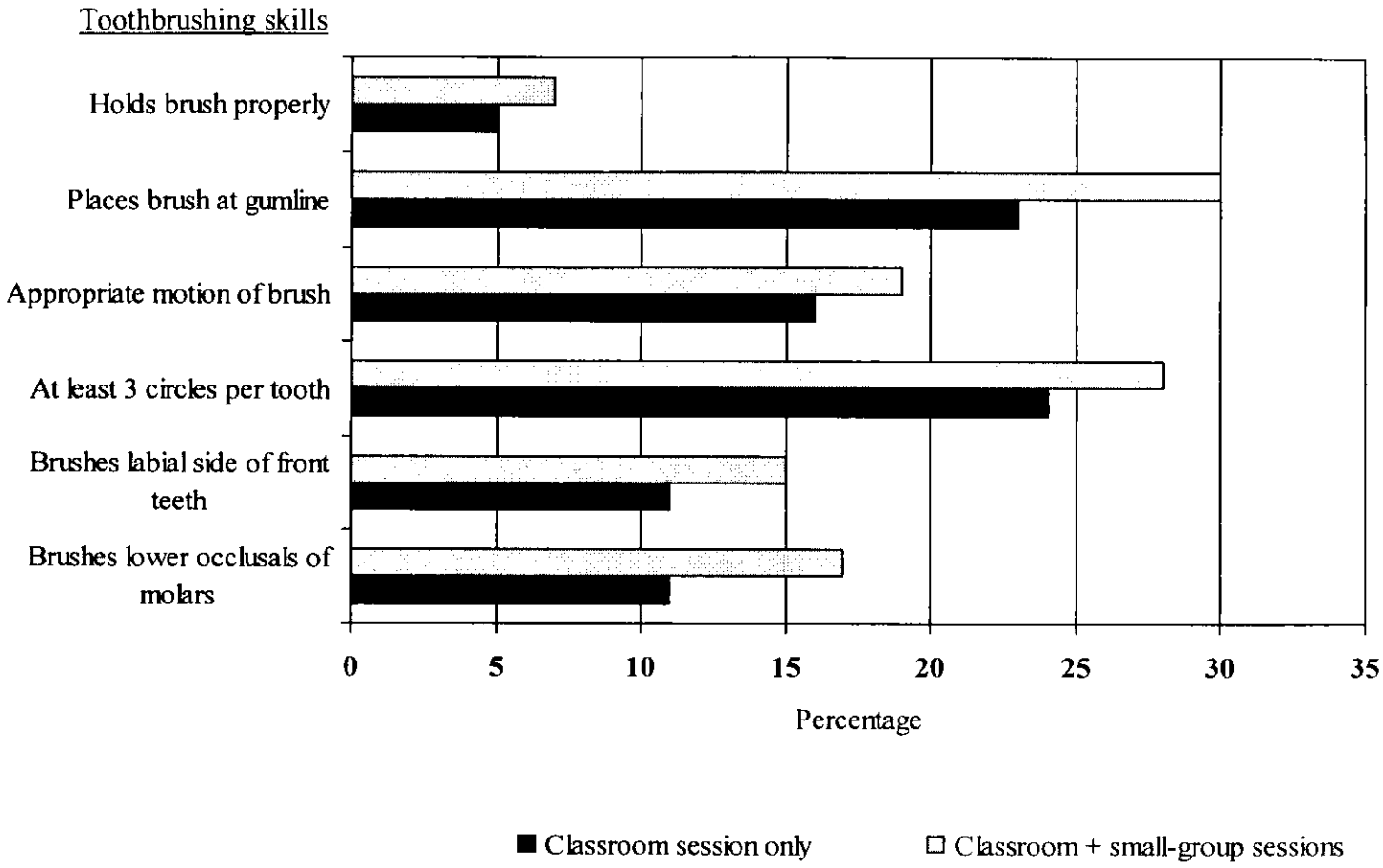
Item	Classroom and small-group sessions		Classroom session only	
	Pre	Post	Pre	Post
1. holds brush properly	93	99 **	95	98
2. places brush at gumline	55	76 ****	63	68
3. appropriate motion of brush	79	93 ****	79	96 ****
4. at least three circles per tooth	46	69 ****	50	62 *
5a. brushes labial side of front teeth	84	93 **	87	88
5b. brushes lower occlusals of molars	82	95 ****	85	92 *
5c. brushes upper occlusals of molars	58	91 ****	57	78 ****
5d. brushes buccal side of molars	69	90 ****	73	82 *
5e. brushes lingual side of front teeth	12	38 ****	12	21 *
5f. brushes lingual side of molars	4	21 ****	3	8 *
6. brushes all areas in routine fashion	27	68 ****	36	53 ***

McNemar test for differences within each group from pre- to post-test: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$

(b) Comparison of gains in toothbrushing competency between the groups: Students in both groups demonstrated increased competency on all toothbrushing skills (Figures 3 and 4). However, a significantly higher proportion of "classroom plus small-group" students displayed gains for lingual brushing of anterior and posterior surfaces, and for brushing all areas in a routine fashion.

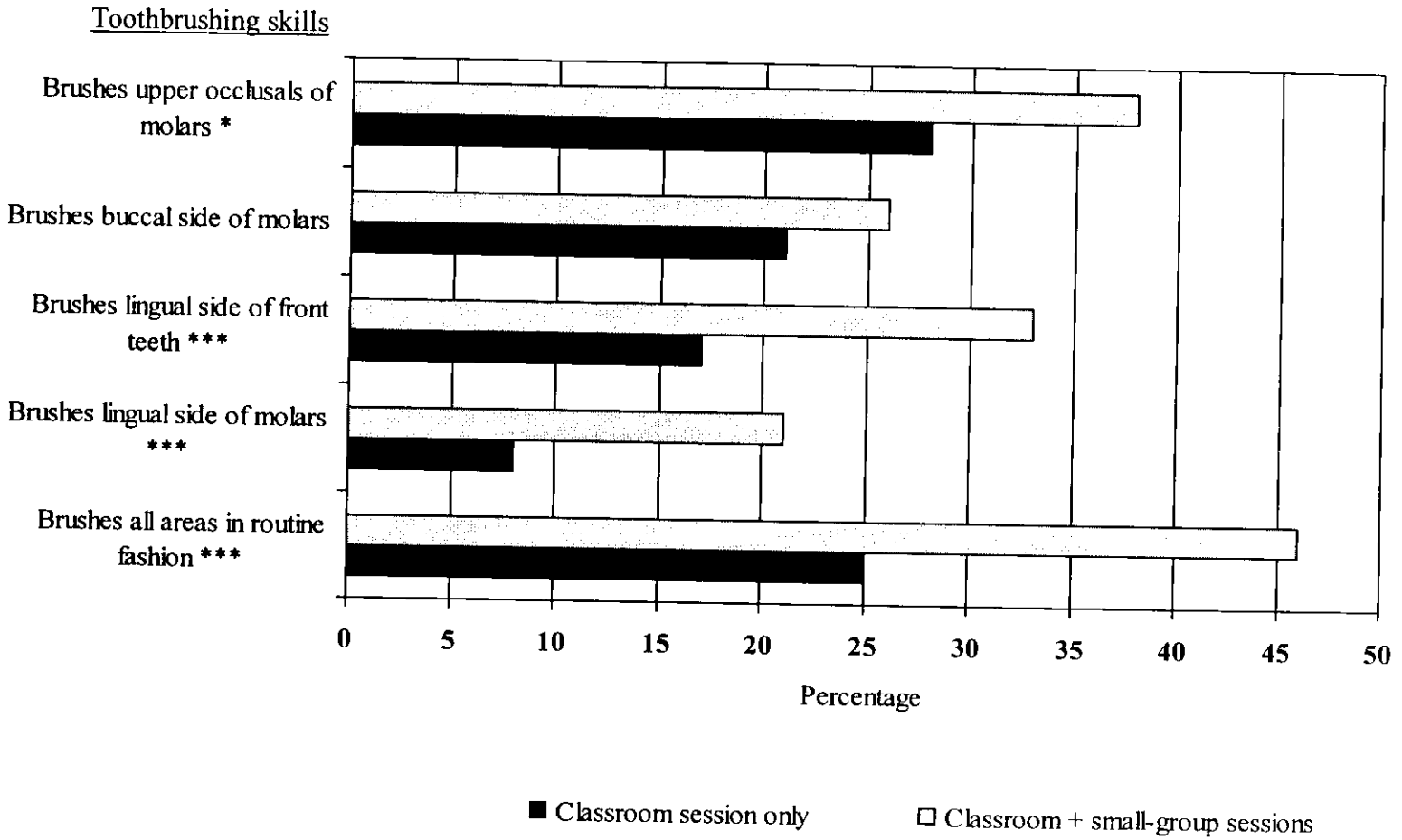
(c) Separate analysis for participants who did not display competency at pre-test: Among participants who did not display competency at pre-test, significant differences between the two groups were found in four skills (Figures 5 and 6). A higher proportion of "classroom plus small-group" students demonstrated improved competency as compared to students receiving only classroom sessions for the following skills: brushing of anterior and posterior lingual surfaces; brushing of upper posterior occlusal surfaces; and brushing all areas in a routine fashion. The findings indicate children had the most difficulty with the brushing of anterior lingual and posterior lingual tooth surfaces.

Figure 3. Percentage of participants who displayed increased competency for toothbrushing skills from pre- to post-test



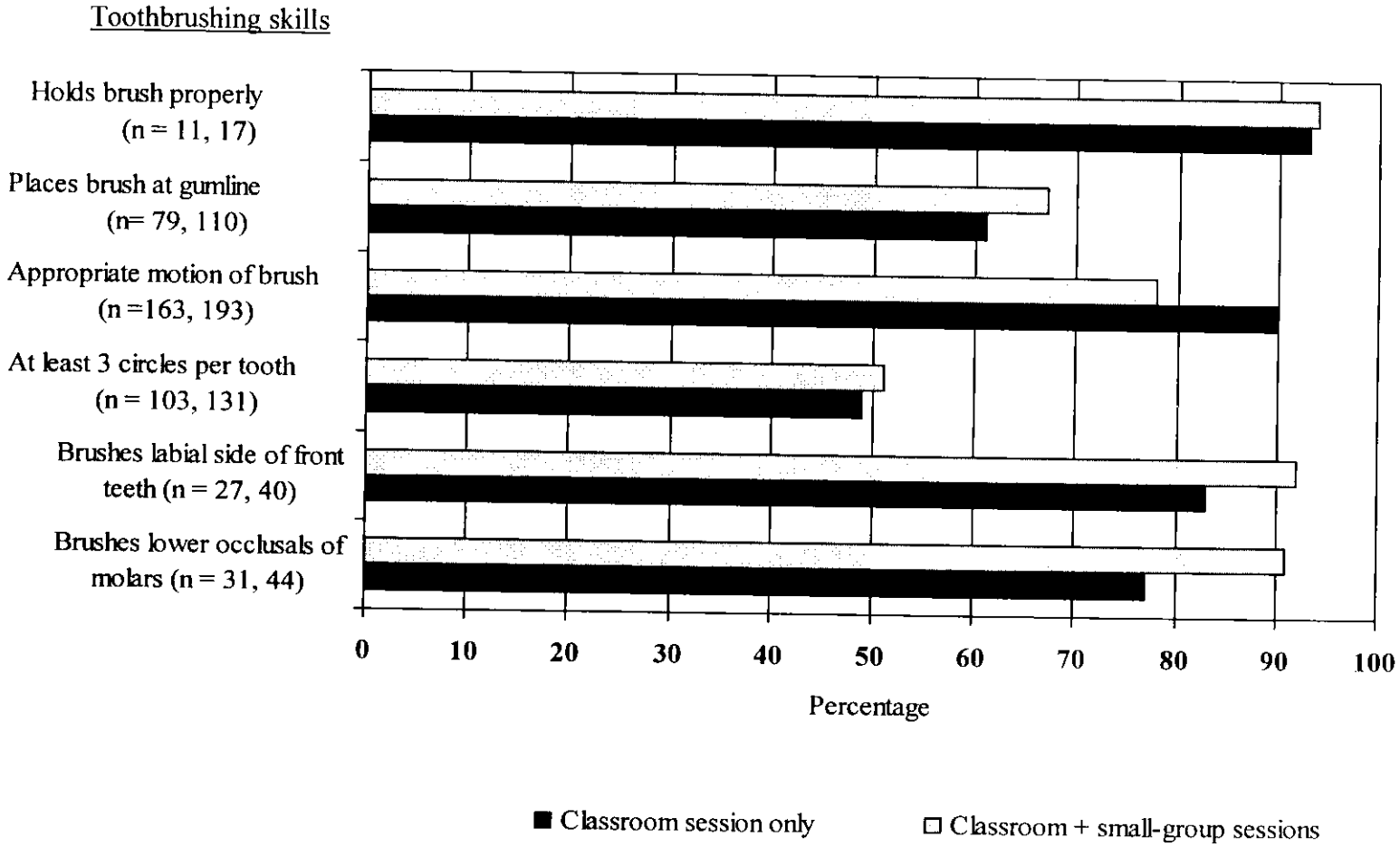
Note: No significant differences were found between the groups

Figure 4. Percentage of participants who displayed increased competency for toothbrushing skills from pre- to post-test



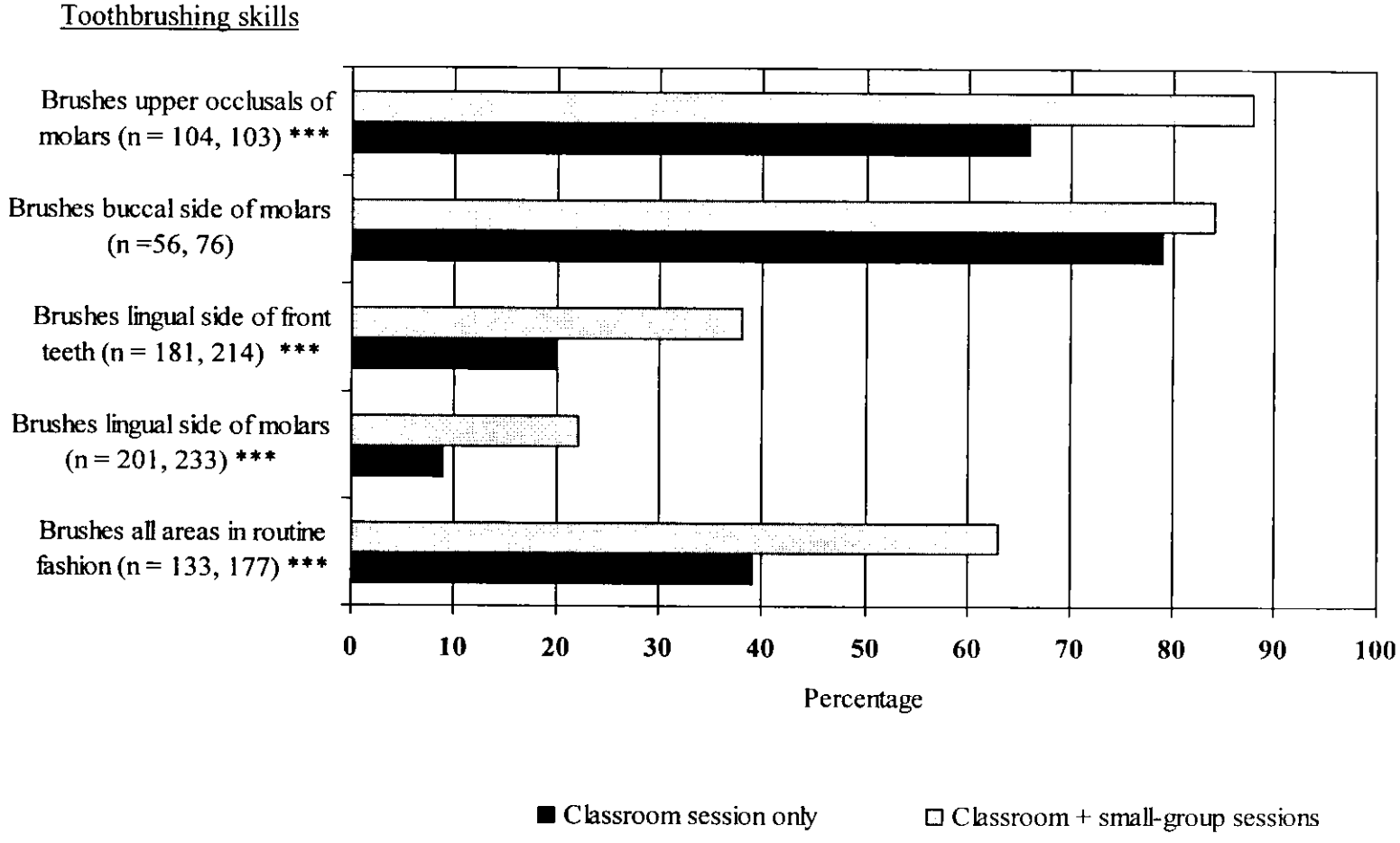
Chi-square test: * $p < 0.05$, *** $p < 0.001$

Figure 5. Of those participants who did not display competency for specific toothbrushing skills at pre-test, the percentage who displayed competency at post-test ('n' refers to the number of participants who did not display competency at pre-test for each skill in the classroom-only group and the classroom plus small-group sessions group, respectively)



Note: No significant differences were found between the groups

Figure 6. Of those participants who did not display competency for specific toothbrushing skills at pre-test, the percentage who displayed competency in those skills at post-test. ('n' refers to the number of participants who did not display competency at pre-test for each skill in the classroom only group and the classroom plus small-group sessions group, respectively)



Chi-square test: *** $p < 0.001$

3.3 Nutrition knowledge

(a) Comparison of pre- and post-test results within each group: At the pre-test interview, only one-third of participants identified nutrition as important to keeping their teeth healthy (Table 6). Students did much better in "show-me" type questions, with the majority correctly identifying healthy foods and drinks as good for their teeth. Yet, there was confusion regarding appropriate snack drinks/foods (e.g., fruit juice, popcorn); only 38-56% correctly identified these items. Interestingly, 27% of children in the group receiving only classroom sessions selected a donut as a food which was good for their teeth.

Table 6. Percentage of participants who demonstrated nutrition knowledge at pre- and post-tests

Item	Classroom and small-group sessions		Classroom session only	
	Pre	Post	Pre	Post
What is important to do to keep your teeth healthy? (response: nutrition)	35	73 ****	32	62 ****
Picture of "Boy eating candy" not identified as "doing something to look after his teeth"	87	97 ****	85	91
Show me some drinks that are good for your teeth				
- Milk	91	99 ****	90	96 *
- Water	87	97 ****	85	91 *
- Pop	89	93 **	84	90 *
- Fruit juice	52	75 ****	56	63
Show me some foods that are good for your teeth				
- Orange	89	99 **	81	91 **
- Donut	82	92 **	73	80 *
- Popcorn	38	40	41	41
- Carrot	86	97 **	81	93 **
- Chocolate	88	96 ***	84	91 *

McNemar test for differences within each group from pre- to post-test: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$

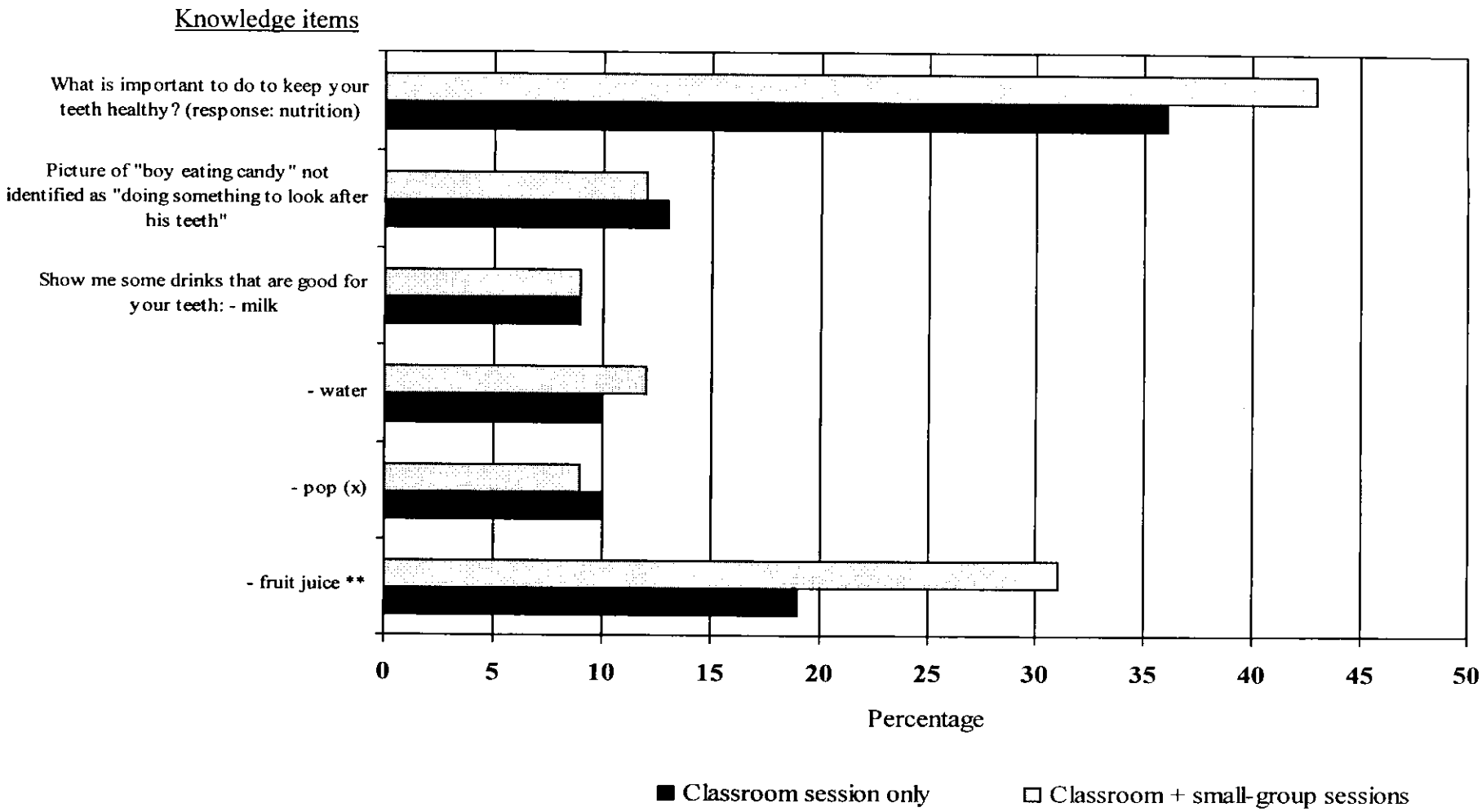
For each group, differences between pre-test and post-test scores were significant for most items. In particular, a higher proportion of "classroom plus small-group" students correctly selected fruit juice as good for their teeth.

Two additional "tell-me" type questions (#2 and #3 in Appendix B) asked participants to name foods and drinks which were good for their teeth. At pre- and post-test, virtually all responses (95-98%) were items which are not cavity causing (i.e., non-cariogenic); and no significant differences were found between or within groups.

(b) Comparison of gains in knowledge between the groups: For changes in knowledge between pre- and post-test, a significant difference between the groups was found for only one response (Figures 7 and 8). A significantly higher proportion of "classroom plus small-group" students demonstrated they had gained awareness that fruit juice was good for their teeth.

(c) Separate analysis for participants who did not display knowledge at pre-test: Five significant differences between the two groups were found in the separate analysis (Figures 9 and 10). A higher percentage of "classroom plus small-group" students, who initially lacked awareness, displayed the knowledge that the following items were healthy: water, fruit juice, oranges, and carrots.

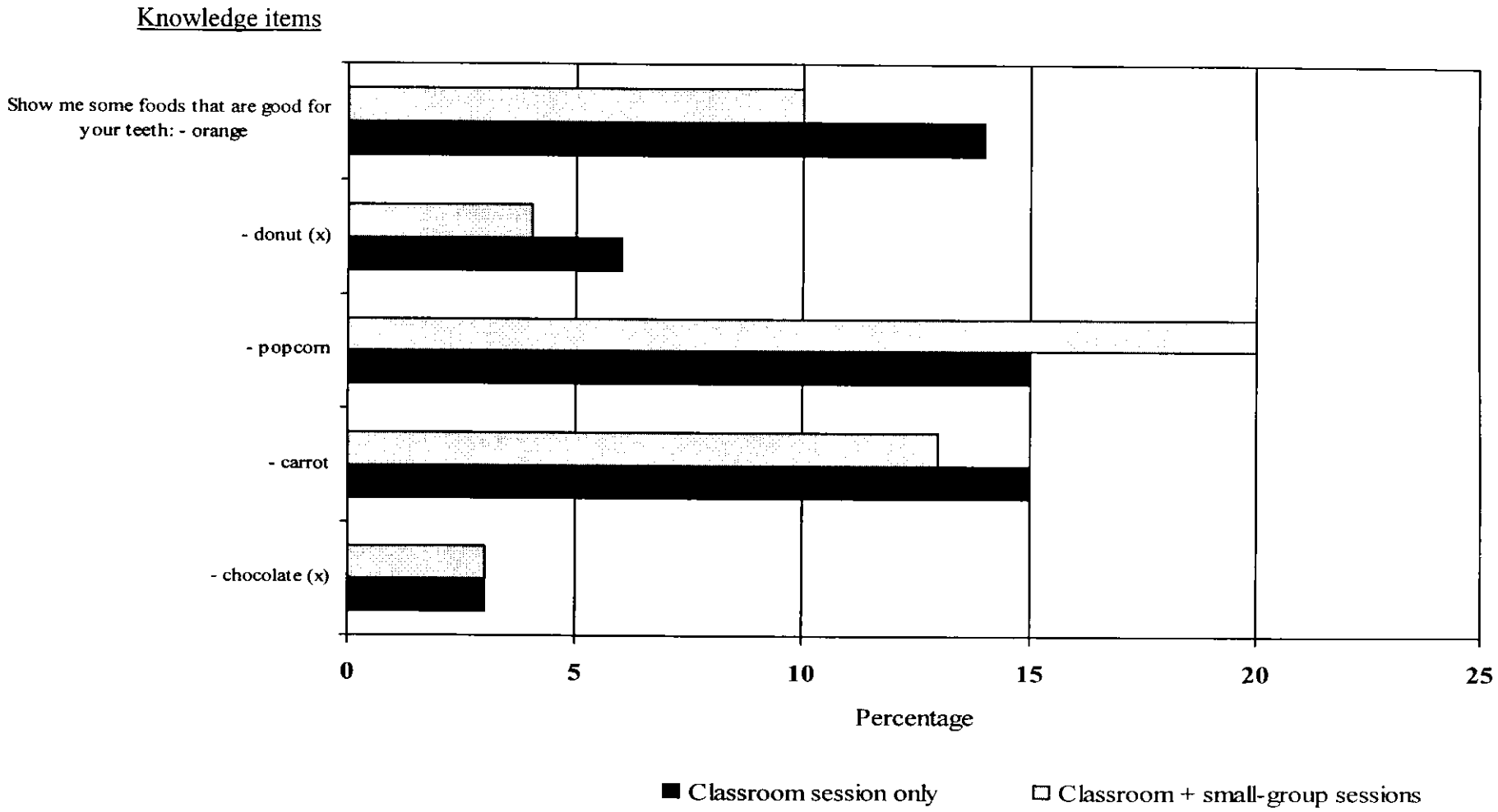
Figure 7. Percentage of participants who displayed gain in nutrition knowledge from pre- to post-test



Chi-square test: ** $p < 0.01$

Note: (x) denotes that not identifying these items would be the correct response. The percentage of students who no longer responded to each of these items is given.

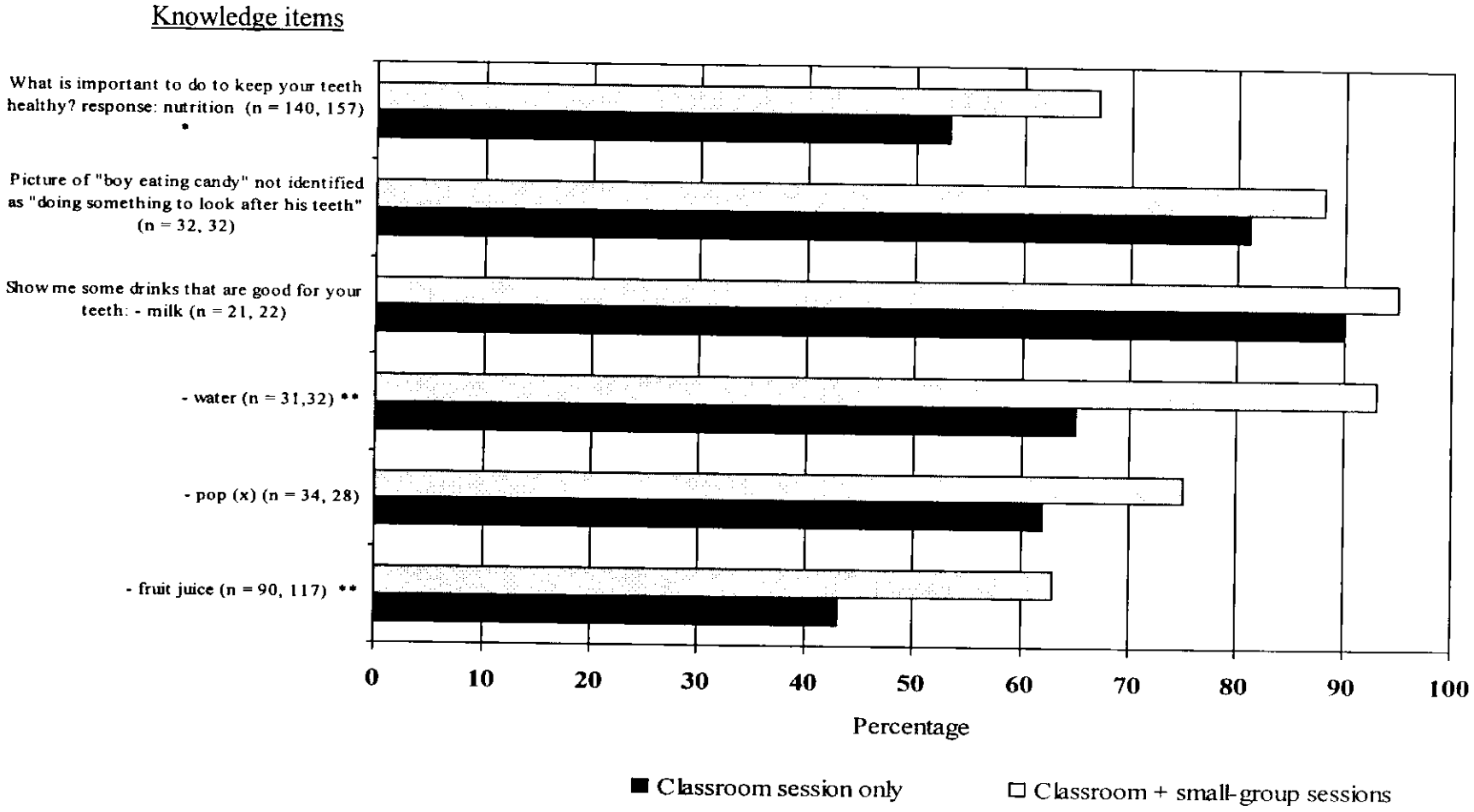
Figure 8. Percentage of participants who displayed gain in nutrition knowledge from pre- to post-test



Chi-square test: ** $p < 0.01$

Note: (x) denotes that not identifying these items would be the correct response. The percentage of students who no longer responded to each of these items is given.

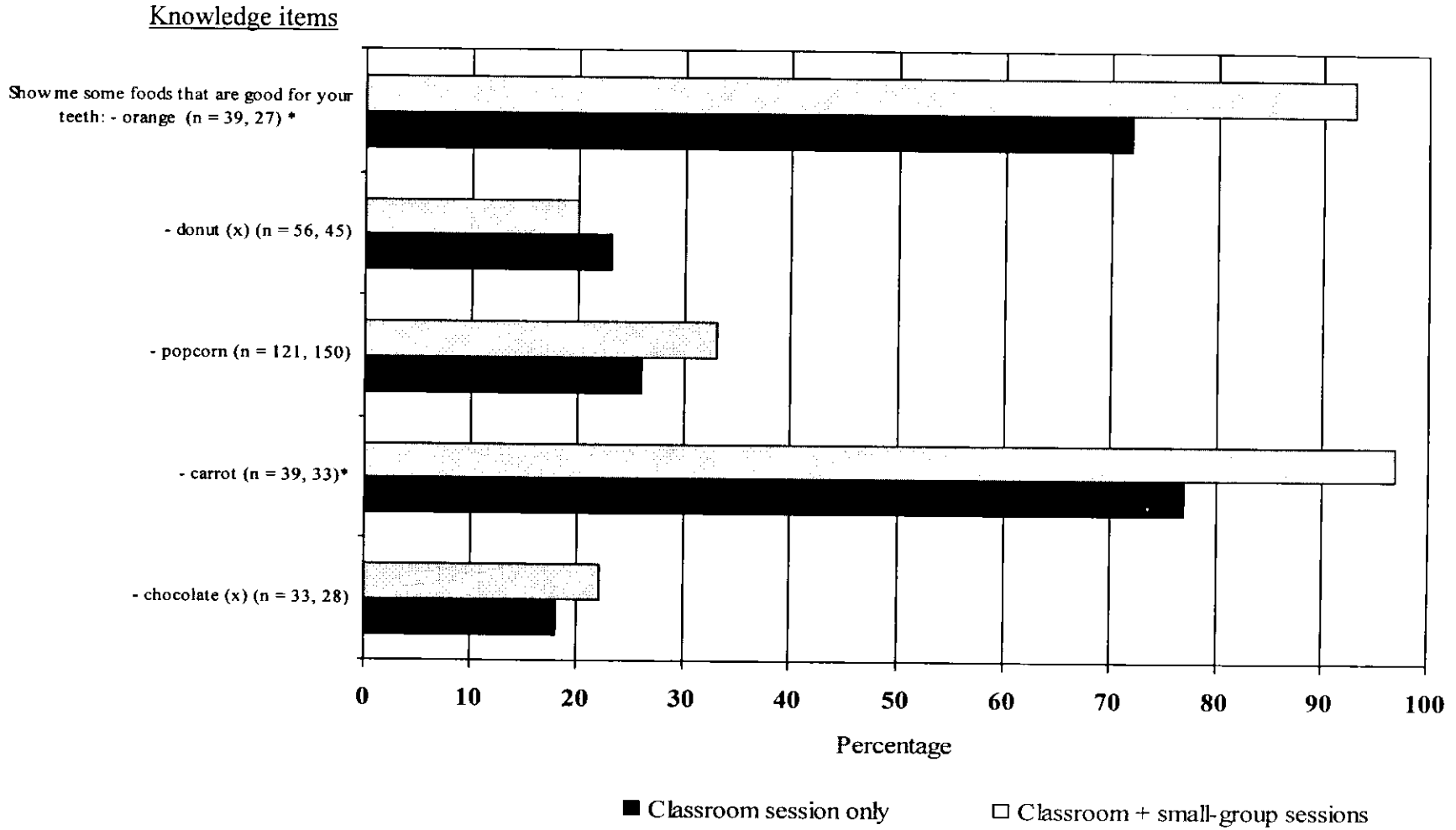
Figure 9. Of those participants who did not display knowledge for specific nutrition items at pre-test, the percentage who displayed gain in knowledge for those items at post-test ('n' refers to the number of participants who did not display knowledge at pre-test for each item in the classroom-only group and the classroom plus small-group sessions group, respectively)



Chi-square test: * $p < 0.05$, ** $p < 0.01$

Note: (x) denotes that not identifying these items would be the correct response. The percentage of students who no longer responded to each of these items is given.

Figure 10. Of those participants who did not display knowledge for specific nutrition items at pre-test, the percentage who displayed gain in knowledge for those items at post-test ('n' refers to the number of participants who did not display knowledge at pre-test for each skill in the classroom-only group and the classroom plus small-group sessions group, respectively)



Chi-square test: * $p < 0.05$, ** $p < 0.01$

Note: (x) denotes that not identifying these items would be the correct response. The percentage of students who no longer responded to each of these items is given.

3.4 Oral hygiene knowledge

(a) Comparison of pre- and post-test results within each group: At pre-test, 67-70% of participants were aware of oral hygiene as an important strategy for oral self-care (Table 7). A large percentage of students (42-49%) believed the purpose of oral hygiene was for aesthetic reasons (i.e., to make teeth clean/white). Relatively few participants mentioned the removal of germs as one reason for brushing their teeth (8-10%). At post-test, "classroom plus small-group" students showed a higher number of significant improvements. For example, a better understanding of the rationale for oral hygiene was found among "classroom plus small-group" students; and more of these students knew the reasons why teeth are important.

Three items specifically dealt with knowledge of toothbrushing. Baseline results for these items showed that between 58-66% of participants responded correctly to questions about toothbrush size and amount of tooth paste. Conversely, pre-test knowledge about when to change toothbrushes was poor, only 11-13% identified fraying bristles as a criterion for replacement. At post-test, significant differences from pre- to post-test were found for most of these items.

Table 7. Percentage of participants who demonstrated oral hygiene knowledge at pre- and post-tests

Item	Classroom and small-group sessions		Classroom session only	
	Pre	Post	Pre	Post
What is important to do to keep your teeth healthy? (response: oral hygiene)	67	74	70	72
Why should you brush your teeth?				
- not to get cavities	21	40 ****	24	33 *
- to remove food	6	10	8	4
- to remove sugar	1	3	3	1
- to remove germs	10	21 ***	8	8
- to make clean/white	49	38 **	42	42
- to make strong/healthy	18	21	14	15
Picture of "boy brushing his teeth" identified as "boy that is doing something to look after his teeth"	96	100 *	91	98 **
What do your teeth help you do?				
- they help me eat	64	82 ****	62	72 **
- they improve appearance	3	5	3	4
- they help me talk	11	30 ***	13	18
When is the most important time to brush your teeth?				
- before bed	58	76 ****	64	74 *
- in the morning	55	57	65	62
Why is this girl brushing her teeth?				
- not to get cavities	15	33 ***	15	20
- to remove food	7	7	7	7
- to remove sugar	1	3	3	1
- to remove germs	4	17 ****	6	7
- to make clean/white	56	49	53	48
- to make strong/healthy	22	26	19	25

McNemar test for differences within each group from pre- to post-test: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$

Table 7 continued. Percentage of participants who demonstrated oral hygiene knowledge at pre- and post-tests

Item	Classroom and small-group sessions		Classroom session only	
	Pre	Post	Pre	Post
Show me the toothbrush that is the best size for you (correct: small, medium) - % correct	63	81 ****	66	81 ***
When should you throw your toothbrush away? - bristles are frayed	11	46 ****	13	30 ****
- when it is old	19	21	18	21
Show me how much tooth paste you should use (correct: smear, pea) - % correct	65	77 **	58	73 ***

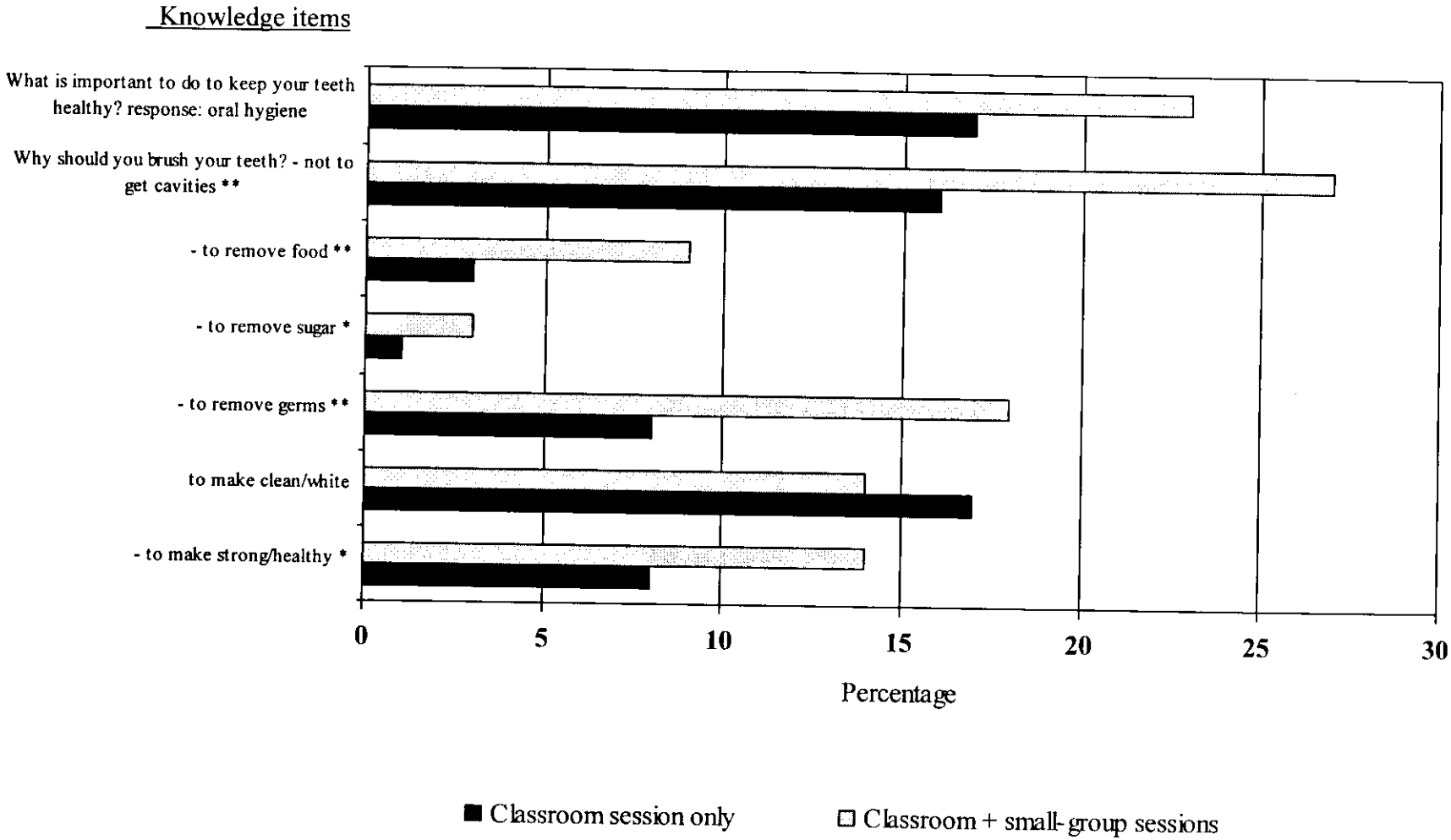
McNemar test for differences within each group from pre- to post-test: ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$

(b) Comparison of gains in knowledge between the groups: Many significant differences were found between the groups for demonstrated oral hygiene knowledge gains (Figures 11 to 14). In all of these instances, a significantly higher proportion of "classroom plus small-group" students displayed a gain in knowledge as compared to students who received only a classroom session. Of particular note, a higher proportion of "classroom plus small-group" students mentioned the removal of germs was an important reason to brush their teeth (18% vs. 8%).

For toothbrushing items, the groups differed significantly on knowledge gains for two items. A significantly higher proportion of "classroom plus small-group" students demonstrated increased awareness about when they should change their toothbrush; and that bedtime was the most important time to brush their teeth.

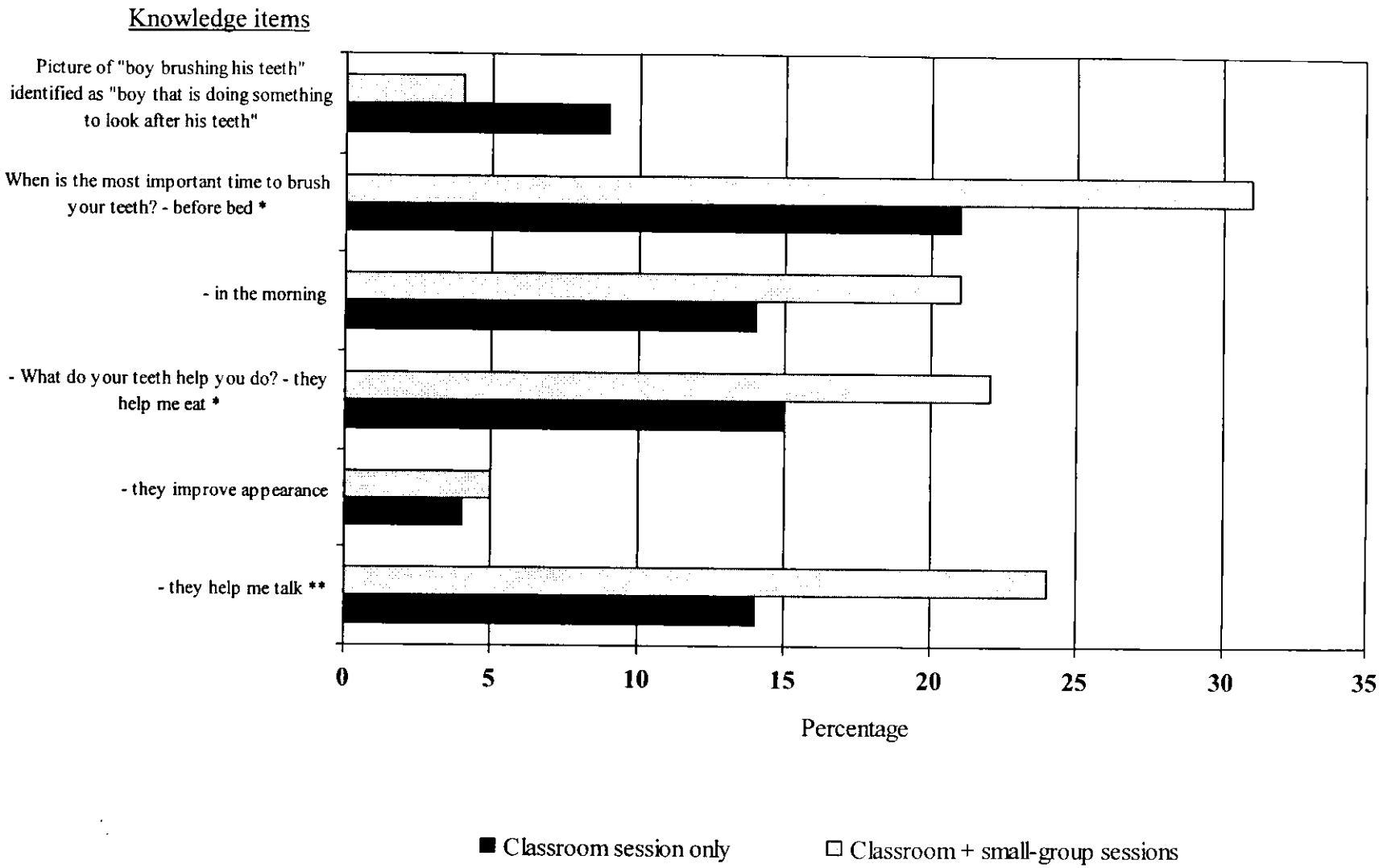
(c) Separate analysis for participants who did not display knowledge at pre-test: Similar results were found in the separate analysis of participants who initially did not demonstrate oral hygiene knowledge (Figures 15 to 18). In particular, a higher proportion of "classroom plus small-group" students, who initially lacked awareness, displayed knowledge for the following items: removal of germs is one reason to brush their teeth; teeth help them to eat; and fraying bristles indicate that they should replace their toothbrush.

Figure 11. Percentage of participants who displayed gain in oral hygiene knowledge from pre- to post-test



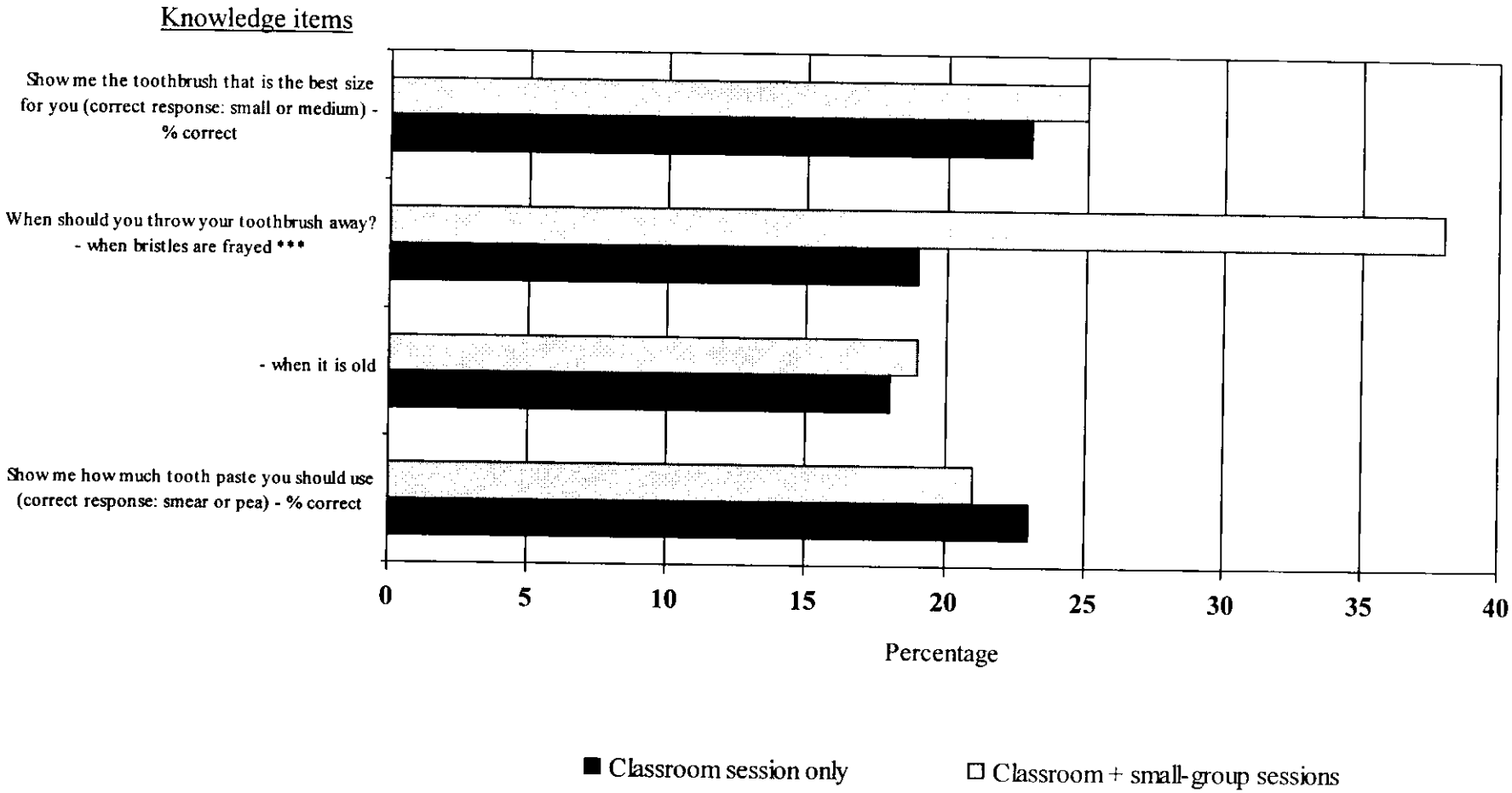
Chi-square test: * $p < 0.05$, ** $p < 0.01$

Figure 12. Percentage of participants who displayed gain in oral hygiene knowledge from pre- to post-test



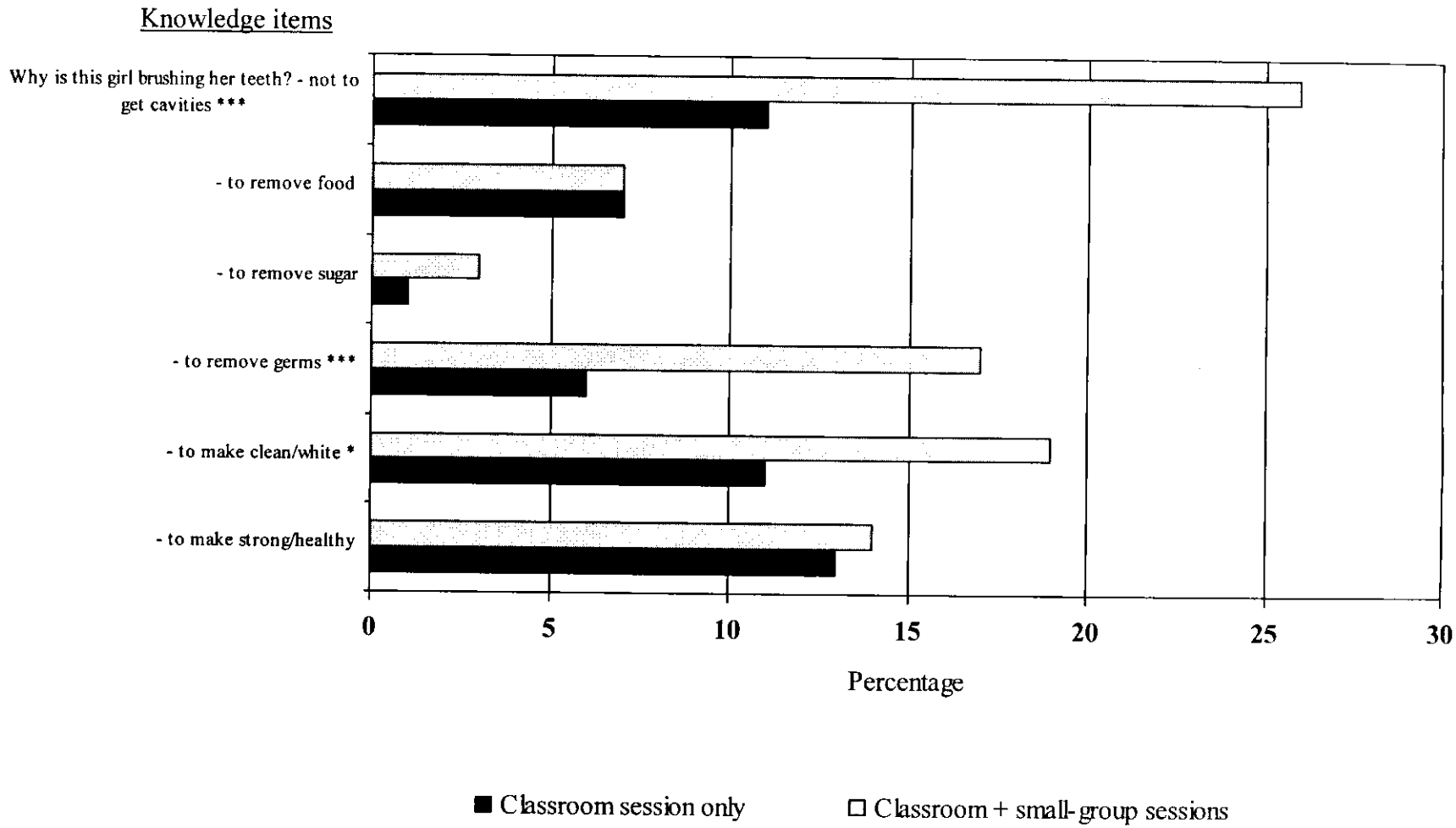
Chi-square test: * $p < 0.05$, ** $p < 0.01$

Figure 13. Percentage of participants who displayed gain in toothbrushing knowledge from pre- to post-test



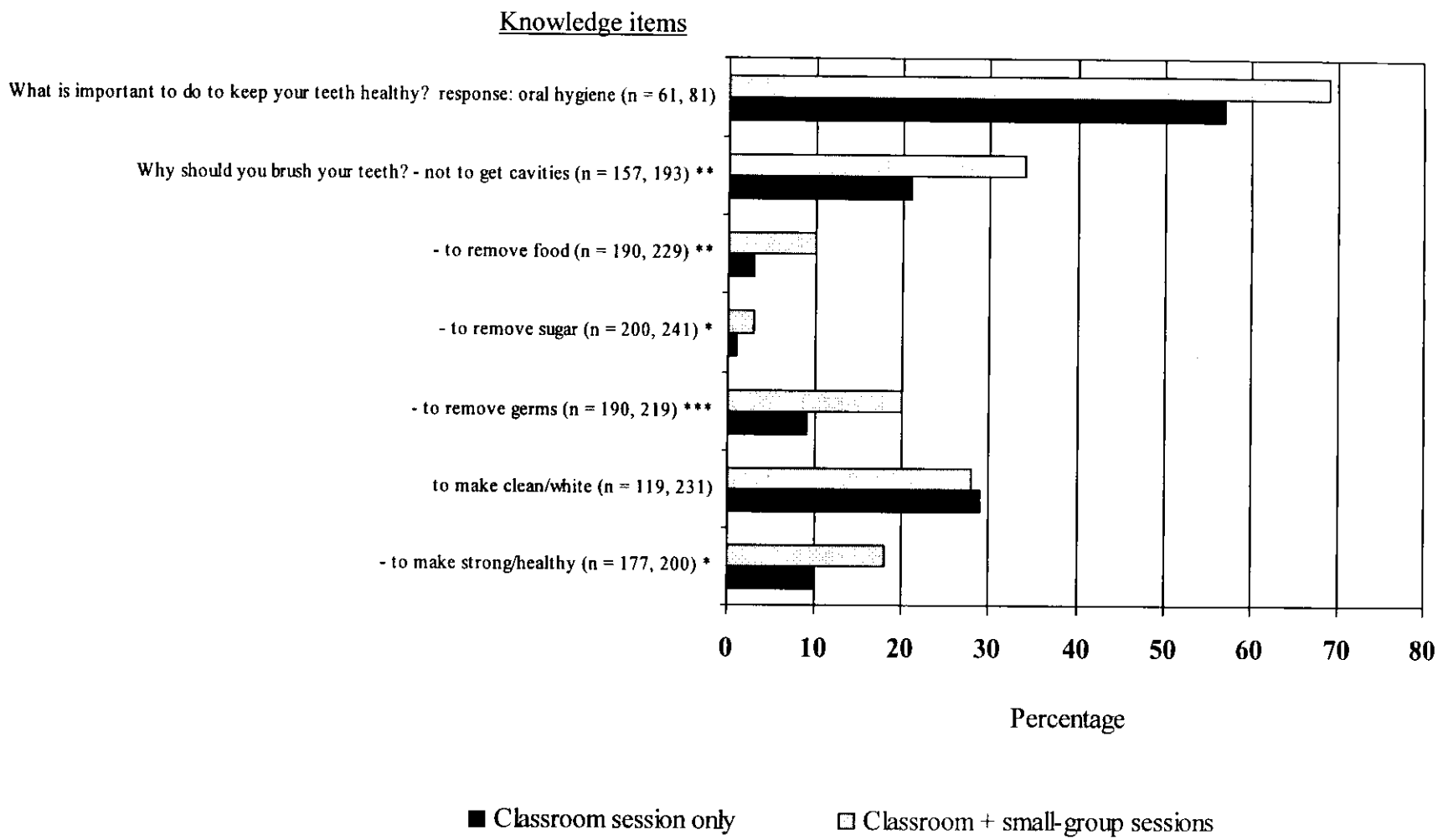
Chi-square test: *** $p < 0.001$

Figure 14. Percentage of participants who displayed gain in oral hygiene knowledge from pre- to post-test



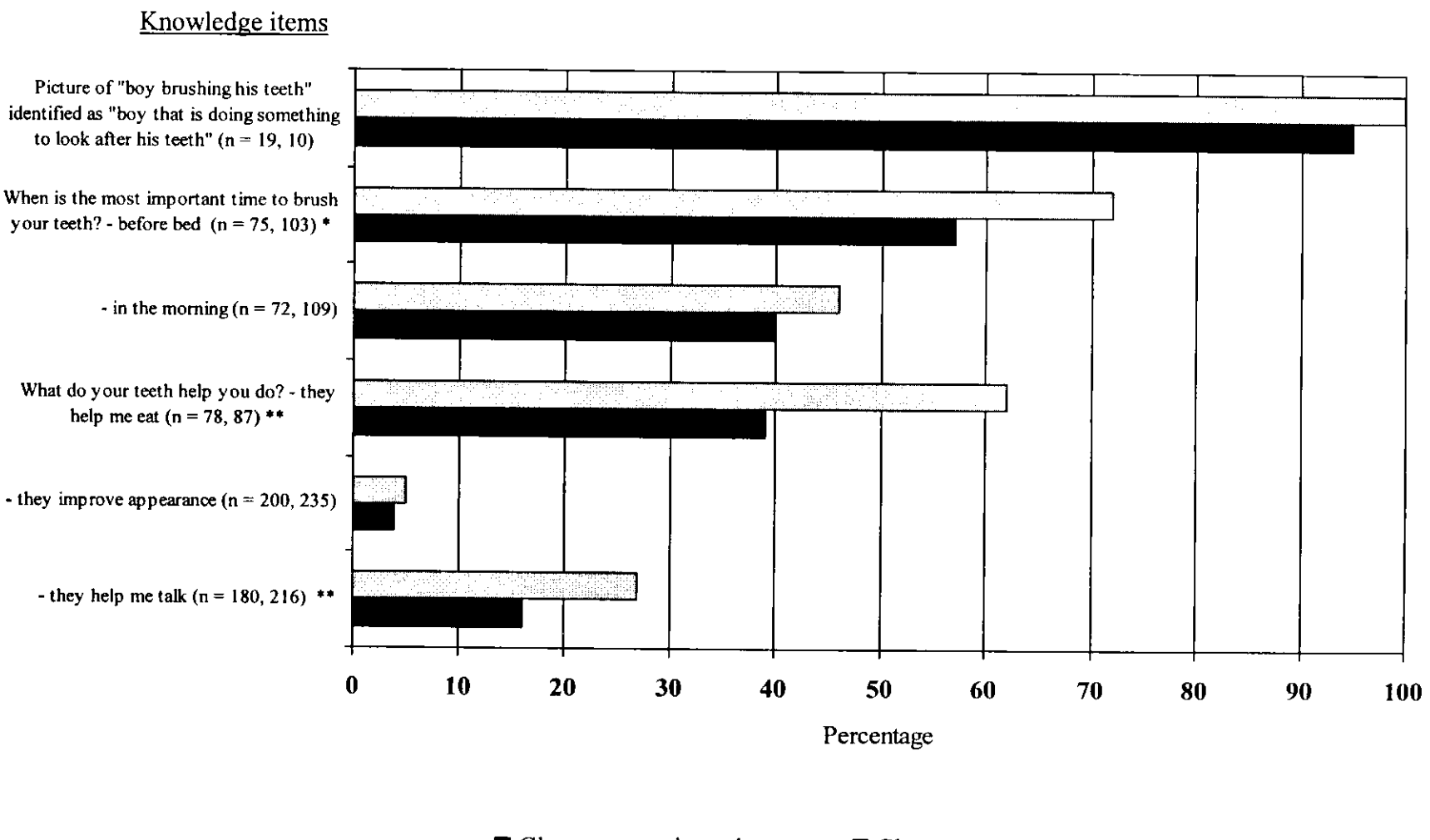
Chi-square test: * $p < 0.05$, *** $p < 0.001$

Figure 15. Of those participants who did not display knowledge for specific oral hygiene items at pre-test, the percentage who displayed gain in knowledge at post-test ('n' refers to the number of participants who did not display knowledge at pre-test for each item in the classroom-only group and the classroom plus small-group sessions group, respectively)



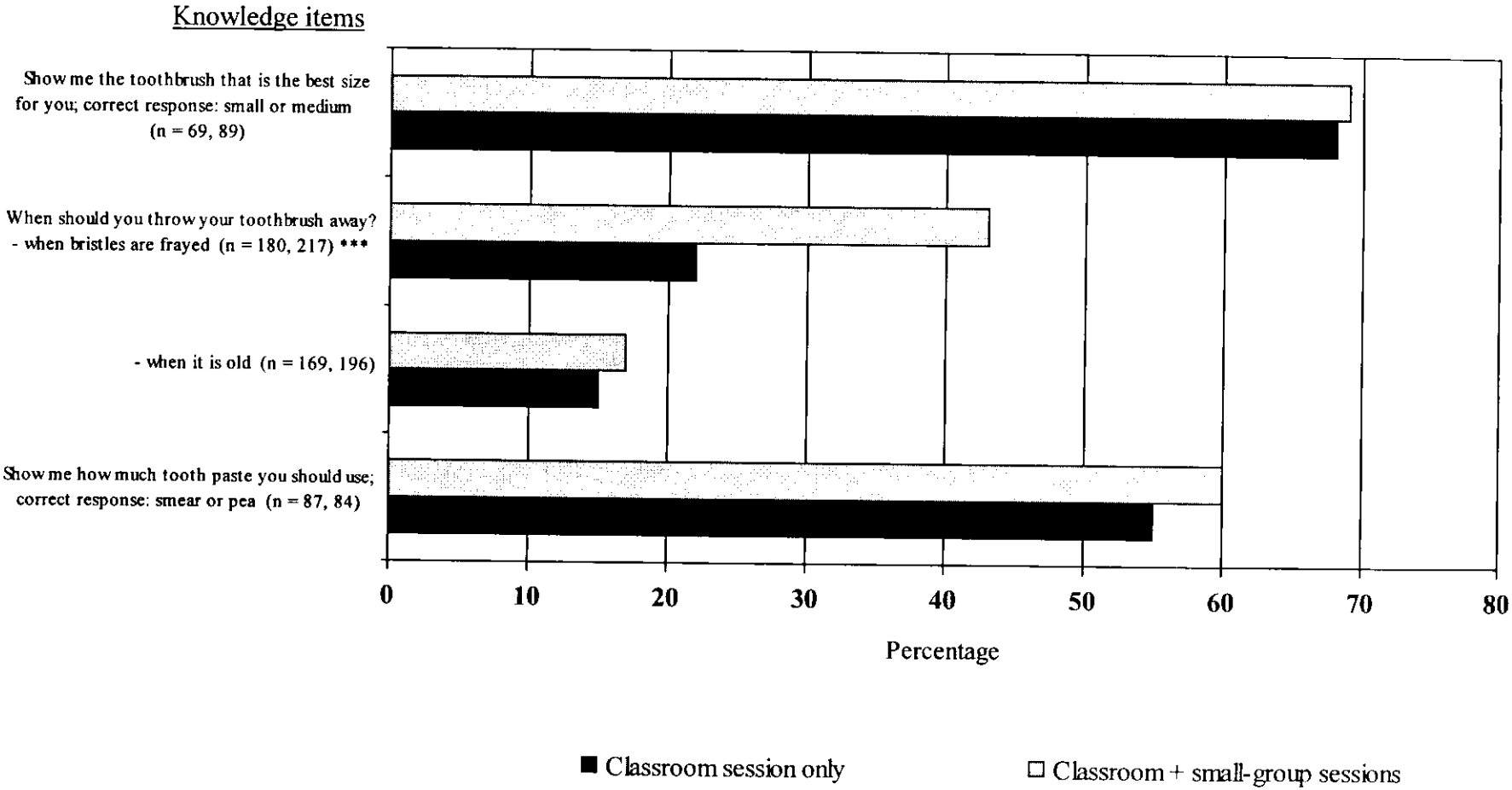
Chi-square test: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 16 Of those participants who did not display knowledge for specific oral hygiene items at pre-test, the percentage who displayed knowledge for those items at post-test ('n' refers to the number of participants who did not display knowledge at pre-test for each item in the classroom-only group and the classroom plus small-group sessions group, respectively)



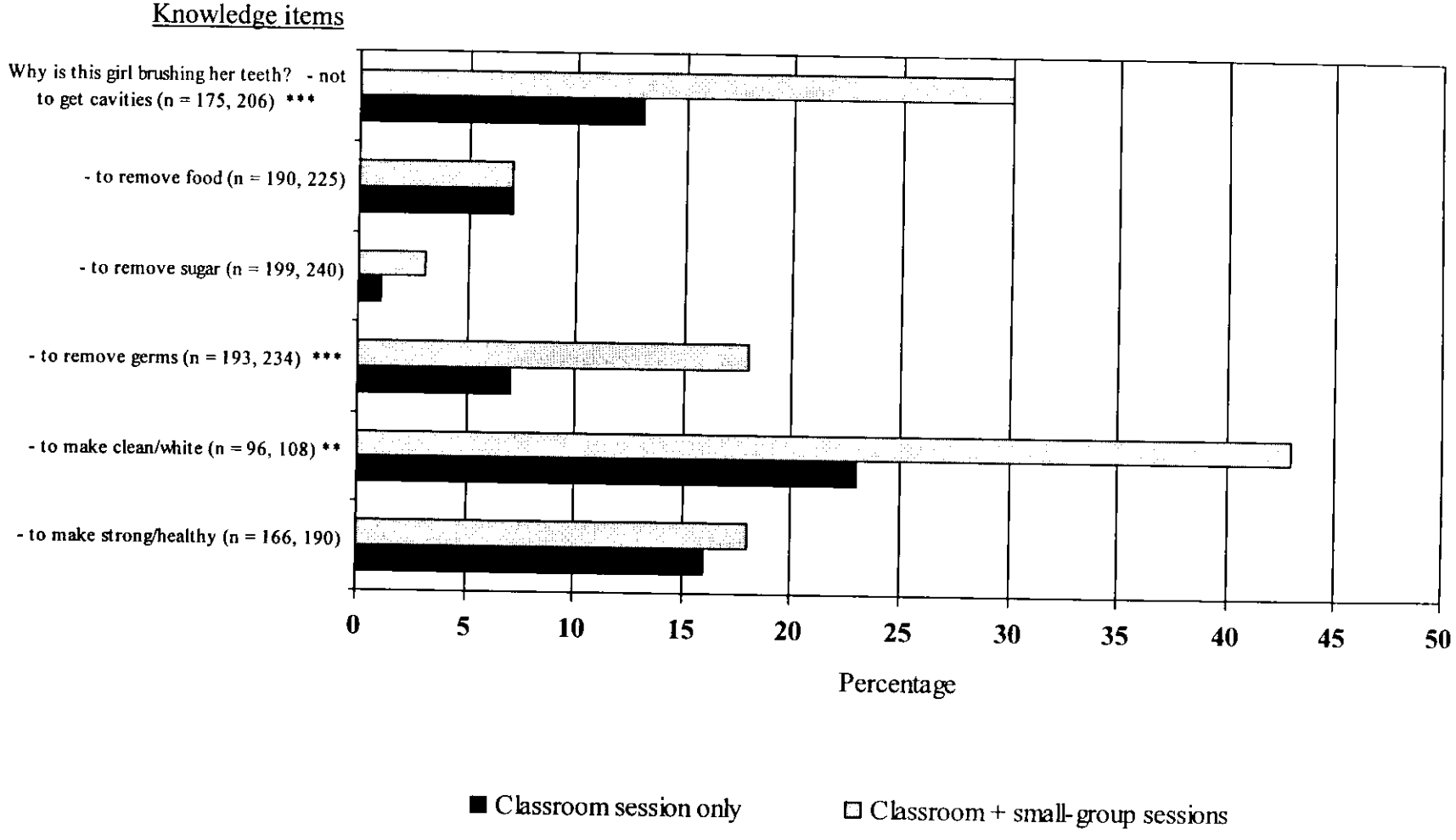
Chi-square test: * $p < 0.05$, ** $p < 0.01$

Figure 17. Of those participants who did not display knowledge of specific toothbrushing items at pre-test, the percentage who displayed knowledge for those items at post-test ('n' refers to the number of participants who did not display knowledge at pre-test for each item in the classroom-only group and the classroom plus small-group sessions group, respectively)



Chi-square test: *** $p < 0.001$

Figure 18. Of those participants who did not display knowledge for specific oral hygiene items at pre-test, the percentage who displayed gain in knowledge for those items at post-test ('n' refers to the number of participants who did not display knowledge at pre-test for each item in the classroom-only group and the classroom plus small-group sessions group, respectively)



Chi-square test: ** $p < 0.01$, *** $p < 0.001$

3.6 Knowledge of professional services

(a) Comparison of pre- and post-test results within each group: In an open-ended "tell-me" question, few students identified professional services as important for keeping their teeth healthy at both pre- and post-tests (Table 8). Furthermore, at pre-test only 27-29% of students mentioned a dentist/hygienist as a person who helps them look after their teeth. These values did not increase significantly at post-test for either group. However, in a "show-me" question, the majority of participants in both groups identified, at pre-test, a picture of a boy visiting a dentist as someone who was doing something to look after his teeth. At post-test, the percentage of students responding correctly to this item increased significantly within both groups.

Table 8. Percentage of participants demonstrating knowledge of professional services at pre- and post-tests

Item	Classroom and small-group sessions		Classroom session only	
	Pre	Post	Pre	Post
What is important to do to keep your teeth healthy? (response: professional services)	1	1	2	2
What person helps you look after your teeth? (response: dentist/hygienist)	29	33	27	25
Picture of "Boy visiting dentist" identified as "boy doing something to look after his teeth"	68	91 ****	68	85 ****

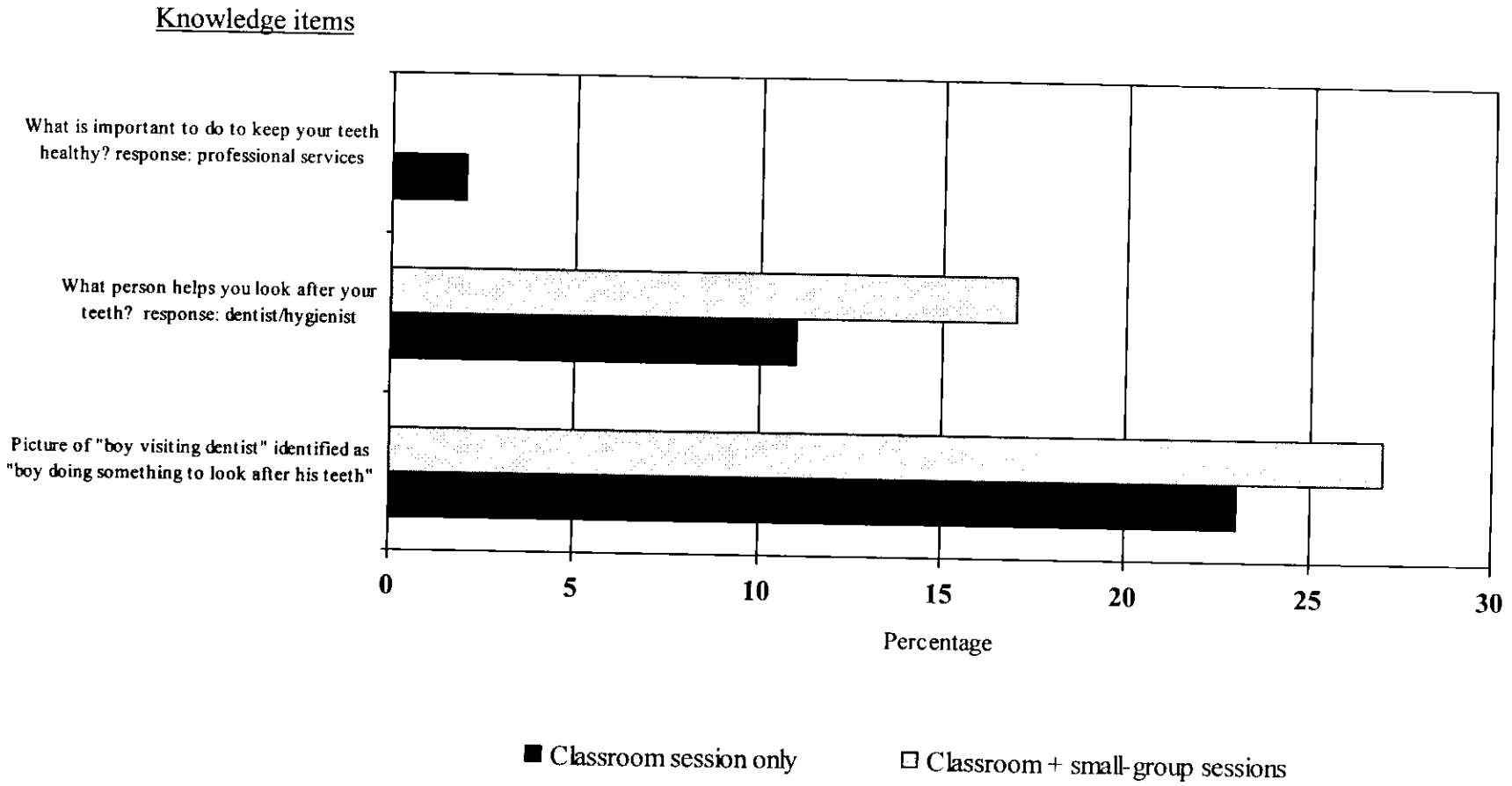
McNemar test for differences within each group from pre- to post-test: **** $p < 0.0001$

(b) Comparison of gains in knowledge between the groups: For all items in this section, there were no significant differences in knowledge gain between the two groups (Figure 19). In

both groups, the largest gains occurred for a "show-me" type question which asked about visiting the dentist. Smaller gains were found for a similar type of question which was "tell-me".

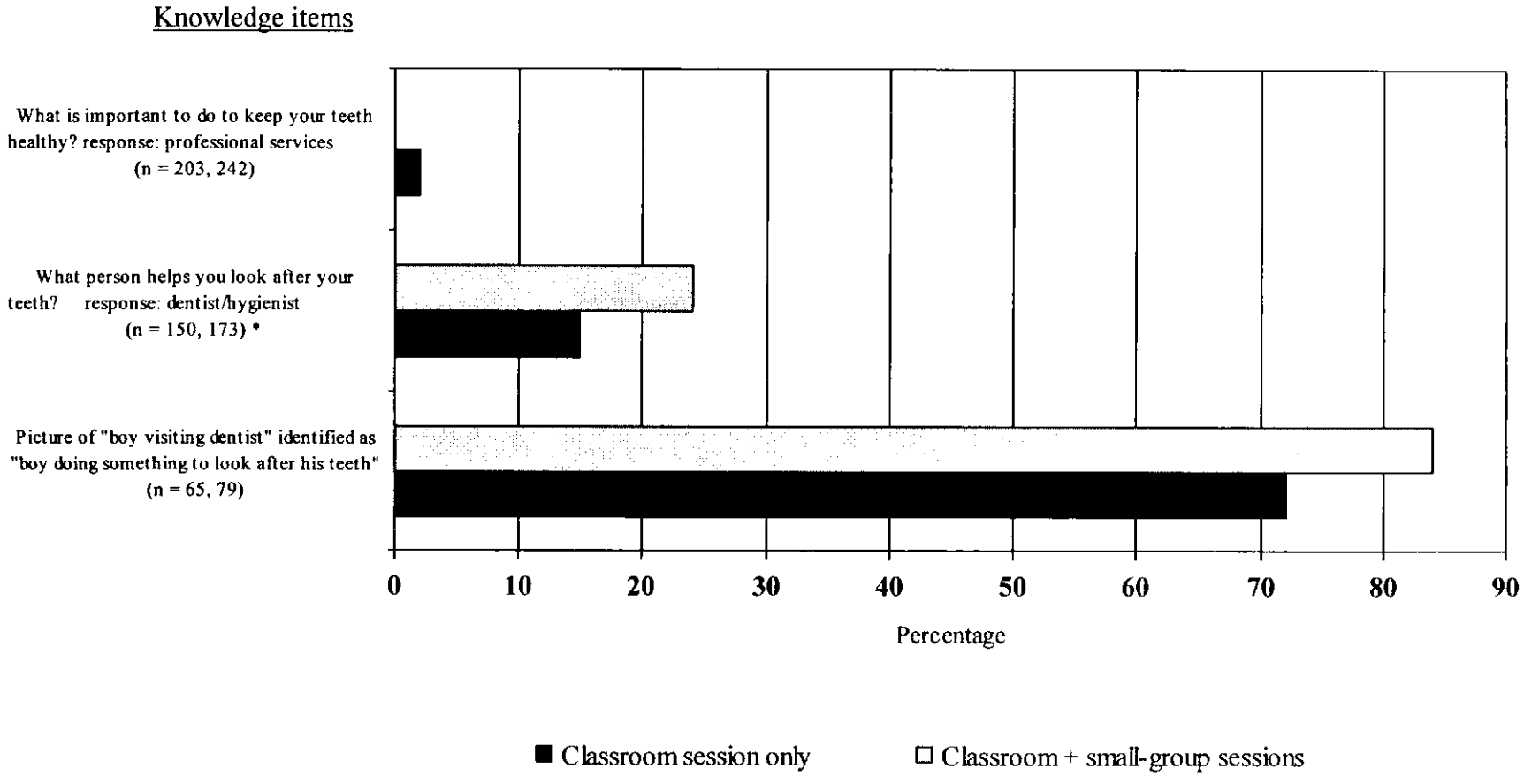
(c) Separate analysis for participants who did not display knowledge at pre-test: In the analysis of participants who did not show knowledge of professional services at pre-test, one significant difference between the two groups was found (Figure 20). A higher proportion of "classroom plus small-group" students, who initially did not demonstrate awareness, displayed knowledge that a dentist/hygienist was a person who helps them look after their teeth.

Figure 19. Percentage of participants who displayed gain in knowledge of professional services from pre- to post-test



Note: No significant differences were found between the groups

Figure 20. Of those participants who did not display knowledge of specific professional services items at pre-test, the percentage who displayed gain in knowledge for those items at post-test ('n' refers to the number of participants who did not display knowledge at pre-test for each item in the classroom-only group and the classroom plus small-group sessions group, respectively)



Chi-square test: * $p < 0.05$

3.7 Injury prevention knowledge

(a) Comparison of pre- and post-test results within each group: Awareness of injury prevention was quite low at pre-test and post-test when measured by two "tell-me" questions (Table 9). For both groups, significant differences between pre- and post-test were found for two items: awareness that a mouth guard/helmet is a means of protecting their teeth; and awareness that playing safely is a way to protect their teeth.

Table 9. Percentage of participants who displayed injury prevention knowledge at pre- and post-tests

Item	Classroom and small-group sessions		Classroom session only	
	Pre	Post	Pre	Post
What is important to do to keep your teeth healthy? (response: injury prevention)	1	0	2	0
What could you do to protect your teeth?				
- wear mouth guard/helmet	1	17 ****	0	4 **
- wear seat belt	0	2	0	0
- don't push at water fountain	0	1	0	1
- play safely	4	7 **	3	8 *
- don't grind them	0	1	0	1
- don't use to tear tape	0	0	0	0
- fluoride protection	0	0	1	0

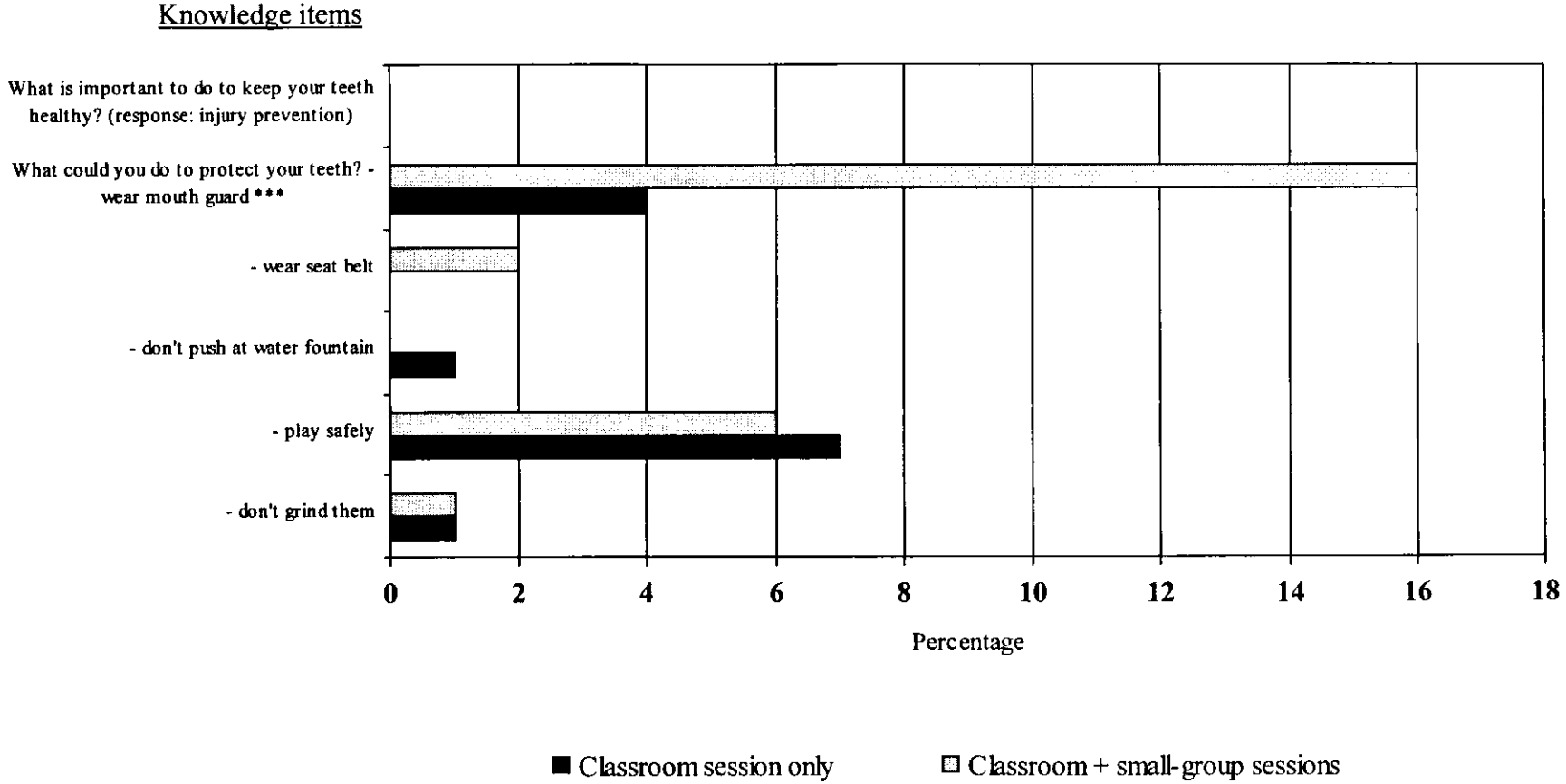
McNemar test for differences within each group from pre- to post-test: * $p < 0.05$, ** $p < 0.01$, **** $p < 0.0001$

(b) Comparison of gains in knowledge between the groups: Only one significant difference was found between the groups for demonstrated gains in knowledge (Figure 21). A higher proportion of "classroom plus small-group" students displayed a gain in the knowledge that mouth guards/helmets were a means of protecting their teeth compared to "classroom only"

students.

(c) Separate analysis for participants who did not display knowledge at pre-test: Similar results were found in analysis of those participants who initially did not display knowledge of injury prevention (Figure 22). However, the percentage of students demonstrating increased awareness was very low at post-test.

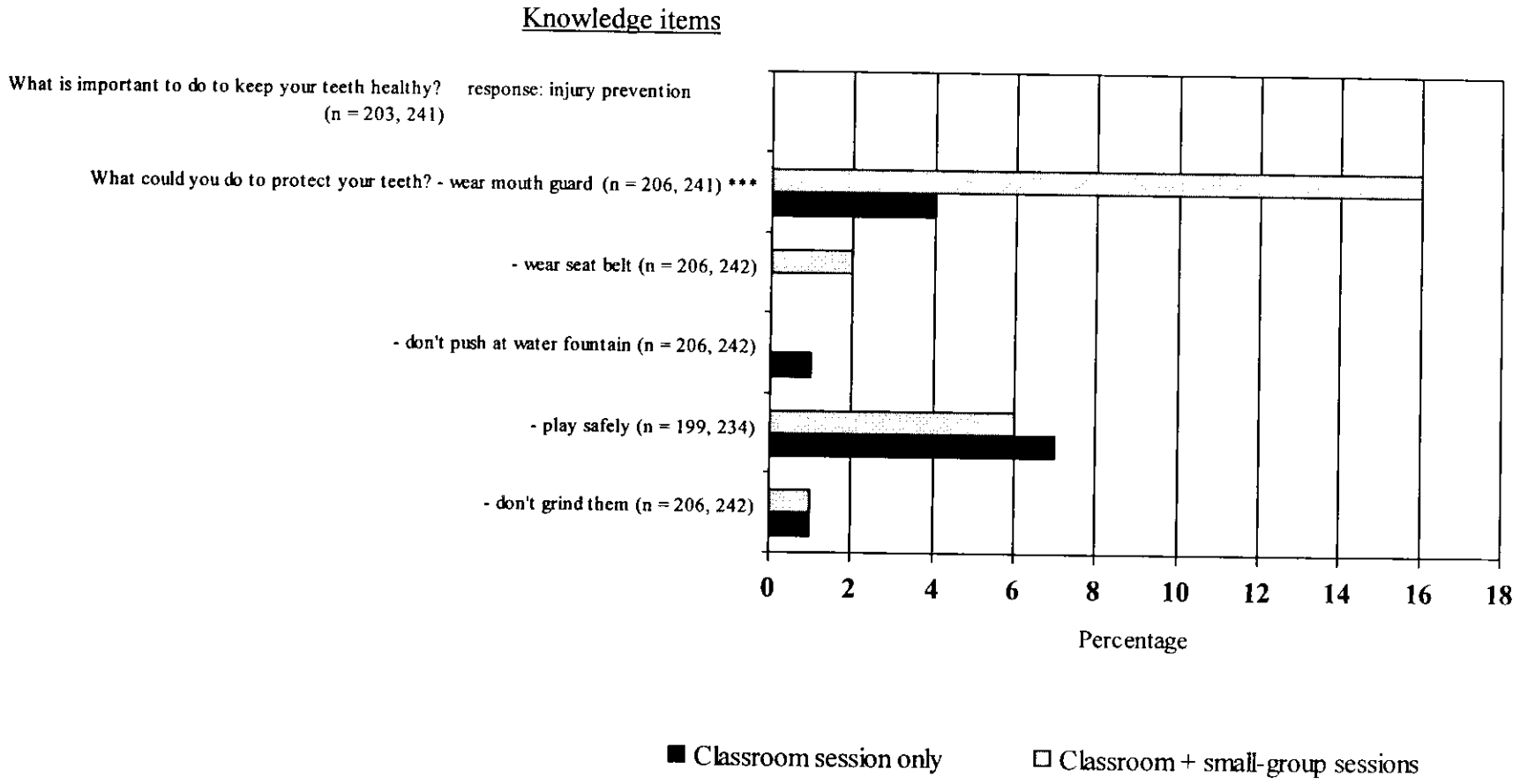
Figure 21. Percentage of participants who displayed gain in knowledge of injury prevention from pre- to post-test



Chi-square test: *** $p < 0.001$

Note: for the question, what could you do to protect your teeth?, no participants displayed gain in knowledge for two possible responses (don't use them to tear tape, and have fluoride protection).

Figure 22 Of those participants who did not display knowledge for specific injury prevention items at pre-test, the percentage of subjects who displayed gain in knowledge for those items at post-test ('n' refers to the number of participants who did not display knowledge at pre-test for each item in the classroom-only group and the classroom plus small-group sessions group, respectively)



Chi-square test: *** $p < 0.001$

Note: for the question, what could you do to protect your teeth?, no participants displayed gain in knowledge for two possible responses (don't use them to tear tape, and have fluoride protection).

4. Discussion

4.1 Toothbrushing competency

The baseline findings of this study are consistent with similar studies conducted on young children in the UK and US from 1960-1986. Most children of this age group are able to demonstrate basic brushing skills, such as properly holding a toothbrush and brushing labial and buccal surfaces;[15,31,32] and brushing occlusal surfaces of lower molars.[31,32] Difficult skills are more often neglected, such as brushing the occlusal surfaces of upper molars[31] and posterior lingual surfaces.[15,32] This was also found in studies of older children (11-13 years-old).[33,34]

Post-intervention results showed that brushing of lingual surfaces improved significantly, as was found by Shove & Blinkhorn.[15] Gains in toothbrushing competency were displayed by participants in both groups, but a significantly higher proportion of "classroom plus small-group" students demonstrated improved competency. This was expected as these students had received, prior to post-test, two small-group sessions which focused largely 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, displayed these skills.

Despite these improvements, many children in both groups still could not execute basic skills at the post-test observation; 24-32% of students did not place the brush at the gumline. 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.[35]

4.2 Oral health knowledge

(a) Pre-test results: For most subject areas at pre-test, the percentage of students providing appropriate answers was quite low when measured by "tell-me" type questions. Knowledge of oral hygiene appeared to be higher than for other subject areas; awareness was lowest for professional services and injury prevention. In "show-me" type questions, the percentage of students with correct responses was extremely high for most questions (over 80%). These high levels of knowledge are similar to the pre-test levels found by Towner using verbal questions.[16] Three exceptions to this pattern were the relative lack of awareness that: popcorn is good for your teeth; fruit juice is good for your teeth; and going to the dentist is a way to look after your teeth.

(b) Knowledge at post-test: Although both groups showed improvements at post-test, for many subject areas, a significantly higher proportion of students who had received classroom plus small-group sessions displayed increased knowledge. Four of these areas are discussed below.

(1) At pre-test, there was confusion about whether different drinks and foods, commonly regarded as snacks, were dentally healthy. Both groups demonstrated improvements in knowledge; however, a significantly higher proportion of "classroom plus small-group" students displayed awareness that fruit juice is a healthy drink. These results are consistent with the

findings of Towner[16], who found a significantly higher percentage of children at post-test were able to make the distinction between snacks containing sugar and those not containing sugar. Unsweetened fruit juice is considered a healthy drink by Canada's Food Guide; 125 ml (1/2 cup) is a sample serving for the category, fruits and vegetables, and 4-5 servings per day from this category are recommended[4]. Fruit juice is also considered a suitable snack for children if they snack appropriately; the continual sipping of fruit juice is not advised due to its acid content. "Fruit-flavoured" drinks are not recommended because they are high in sugar and lower in other nutrients normally found in juices.[4]

(2) Initially, almost one-half of children responded that the purpose of toothbrushing was to make teeth clean or white. This may be partly the result of television advertisements. At post-test, a higher percentage of students who received small-group sessions displayed awareness for the other reasons why teeth should be brushed, such as the removal of germs and to avoid getting cavities. Nevertheless, more students still responded that the purpose was to keep teeth clean or white. Perhaps the concept of germs (or "small bugs") is not easily acquired by young children. Even among older children, misconceptions about plaque are common.[36]

(3) Small-group sessions also proved beneficial for learning about when to throw away a toothbrush; and about when is the most important time to brush your teeth. Demonstrated knowledge in these areas was initially moderate to poor; very few students were aware fraying bristles were a reason for replacing a toothbrush. It is possible that many participants were not aware a toothbrush should ever be changed. Post-test results showed improvements for students

in both groups, but again significantly higher proportions of "classroom plus small-group" students demonstrated improved knowledge as compared to students receiving only a classroom session.

(4) For injury prevention measures, a significantly higher percentage of "classroom plus small-group" students displayed improvement for one item: awareness that a mouth guard or helmet was one means of protecting their teeth. In a single classroom lesson, this type of information may not be understood by high risk children who are unfamiliar with the basics of oral hygiene.

For a few subject areas, a single classroom-based lesson appeared to be adequate as improvements from pre- to post-test were found within each group, but no significant differences between the two groups were found. These areas included: knowledge of the correct toothbrush size, and knowledge of the correct amount of toothpaste to place on a toothbrush. However, both of these items were tested using "show-me" type questions; and students who received only a single classroom lesson performed much better on "show-me" questions as compared to "tell-me" questions.

Finally, both groups did not show increased awareness that popcorn is a healthy food for your teeth. A possible explanation is that this result is due to the inconsistent messages children receive about foods and the fine distinctions which sometimes must be made between healthy and unhealthy foods. Three examples illustrate this point: (1) fruit is healthy but dried fruit can be

dentally unhealthy (e.g., raisins); (2) popcorn is a good snack but caramel-coated popcorn is not, nor is popcorn coated in simulated-butter; and (3) fruit juice is healthy but fruit drinks with added sugar are unhealthy.

(c) Summary: Similar to the results for toothbrushing competency, the magnitude and direction of results for oral health knowledge support the conclusion that the group which received classroom and small-group sessions had benefitted from a more effective method of DHE as compared to students who received only a classroom lesson. The following general statements are based on the results from both sections of the questionnaire:

- both groups showed significant improvement from pre- to post-test;
- in many subject areas, a significantly higher proportion of "classroom plus small-group" students showed improvement compared to those receiving only a classroom lesson; and
- in no subject areas did a significantly higher proportion of classroom-only students demonstrate improvement compared to "classroom plus small-group" students.

A positive finding was that many children at post-test displayed a greater awareness that they were responsible for caring for their oral health. Students also displayed increased knowledge about the different ways they may care for their oral health. The baseline results indicated most children associated taking care of their teeth only with oral hygiene. About one-third of children mentioned nutrition and very few noted professional services or injury prevention measures. At post-test, students in both groups had gained awareness of the importance of nutrition in oral health care, but awareness of other areas had increased minimally.

Overall, the findings suggest participants had gained a greater sense of self-responsibility towards oral health, especially "classroom plus small-group" students. The concept of self-responsibility among young children has just begun to be examined in dental research, and has been more fully studied for children with asthma and seizure disorders.[37]

4.3 Limitations

The validity of comparisons between the two study groups is a critical issue. Baseline data suggest the two groups are comparable for several reasons.

(1) Pre-test skill and knowledge results were equivalent between the groups (i.e., few significant differences were found).

(2) No significant difference between the groups was found for the proportion of participants with a mother whose spoken language was English.

(3) The sampling procedure matched schools based on high dental needs; thus, groups would likely have been of equivalent SES and immigration history. The language distribution shown in Table 4 is consistent with information from a recent social profile of North York.[38]

While baseline data support the legitimacy of comparisons between the two groups, limitations existed which may have compromised validity. First, independent interviewers may be a source of bias for several reasons. (1) Examiners were blinded to the group assignment of schools, but they may have became aware of group assignment as students may have told examiners about the small-group sessions they had received; or examiners may have been aware

students in a particular school performed much better than students in another school. (2) Although interviewers were trained prior to pre- and post-tests, inter-rater and intra-rater reliability were not assessed. Systematic differences between examiners may, therefore, have accounted for differences between the groups. (3) Interviewers would likely have been conscious of the pre-post design of the study. Thus, they could have unintentionally lowered baseline scores and raised post-test scores; this would have affected the accuracy of results.

Second, post-test observations for the group which received small-group sessions were done about three months after the other group's post-test observations. Consequently, "classroom plus small-group" students had received several more months of lessons and tests at school which may have resulted in these students being more familiar with verbal questions and testing situations. This may account for some differences on open-ended questions which called upon a child's verbal skills.

Third, "classroom plus small-group" students may have felt more comfortable interacting with interviewers because of the small-group sessions they had attended. These students may have been more willing to respond to "tell-me" type questions. Most of the significant differences between the group were found for "tell-me" questions, but only one significant difference was found for a "show-me" type item.

Fourth, students may have received additional sources of oral health information and these sources may have differed between the groups. No known events occurred in schools during the

study period, but outside sources were not assessed (e.g., television, dental visits).

Fifth, few independent variables were collected at pre- and post-tests. Groups may have differed significantly in important areas (e.g., the ability to understand and/or read English), but these could not be determined. Some of this information may have been difficult to obtain as the study population was quite young.

Sixth, another concern may be the refusal of some students to participate and the loss of some participants at different phases of the study. Although approximately equal numbers of students in both groups were lost at each phase (Table 2), the characteristics of participants lost to follow-up were not compared between the two groups. Therefore, differences between the two groups for improvements in skills and/or knowledge may be partly due to differences between the two groups in the characteristics of those students who were lost to follow-up or who decided not to participate in the study.

Finally, no process evaluation occurred during this study and it is unknown whether dental education was provided in the intended manner. As six dental health educators provided the DHE sessions, some degree of variation between educators in the quality of lessons would be expected; and day-to-day variations in quality can be assumed to occur for each educator. However, school-based DHE is an established program and is subject to quality assurance measures, and any differences in educator performance would likely be minimal and inconsequential.

4.4 Challenges of this study

Methodological problems are commonplace in evaluation studies of DHE programs, as noted in section 1.2(d). In this study, steps were taken to overcome some of these weaknesses (e.g., a comparison group was used, and the sample size was not small). Yet, some problems did exist and these reduce the strength of the conclusions reached.

Interviewers were found to adhere to most aspects of study protocol. One exception concerned question #1 which asked, "What is important to do to keep your teeth healthy?". For this question, many interviewers did not record the number of wrong answers and the percentage of correct answers could not be calculated. Furthermore, for several questions, interviewers often circled "other" as a response, but did not write in the participant's response when a child gave a response other than those listed on the questionnaire. One reason for these compliance failures may be the questionnaire was too long and interviewers omitted what they perceived as extraneous. Interviewers may also have varied in the manner they probed for multiple answers to open-ended questions. In future studies, adherence to study protocol needs to be further underscored during training. The assessment of intra-rater and inter-rater reliability may also help to reduce variations between interviewers.

Several limitations were evident in the study instrument, which was developed specifically for this study. First, a "ceiling effect" was found for certain items because of the high pre-test scores which occurred. These questions did not allow a significant number of children to show improvement from pre- to post-test. Conversely, the number of students with extremely low pre-

test scores on some knowledge questions suggests the terminology used in these questions may have been beyond a Grade One child's level of comprehension.

Second, the manner in which toothbrushing skills were assessed may be criticized by outside reviewers who are familiar with plaque disclosure indices. Although plaque indices may be a better measure of oral hygiene behaviour, visual monitoring of toothbrushing has been used previously in studies of young children.[17,28] This method is easier and more acceptable to young children than the use of plaque disclosure tablets; and it is consistent with the emphasis on teaching children to reach all tooth surfaces areas.

Third, young children were sampled and this presented difficulties in obtaining consistent responses. Most notably, some children who responded correctly at pre-test were found to either respond incorrectly at post-test, or not to give a response. This finding was expected and had been previously found by McIntyre *et al.*[18] who dubbed these children as "regressing". It should not be inferred that DHE has caused a loss of knowledge.

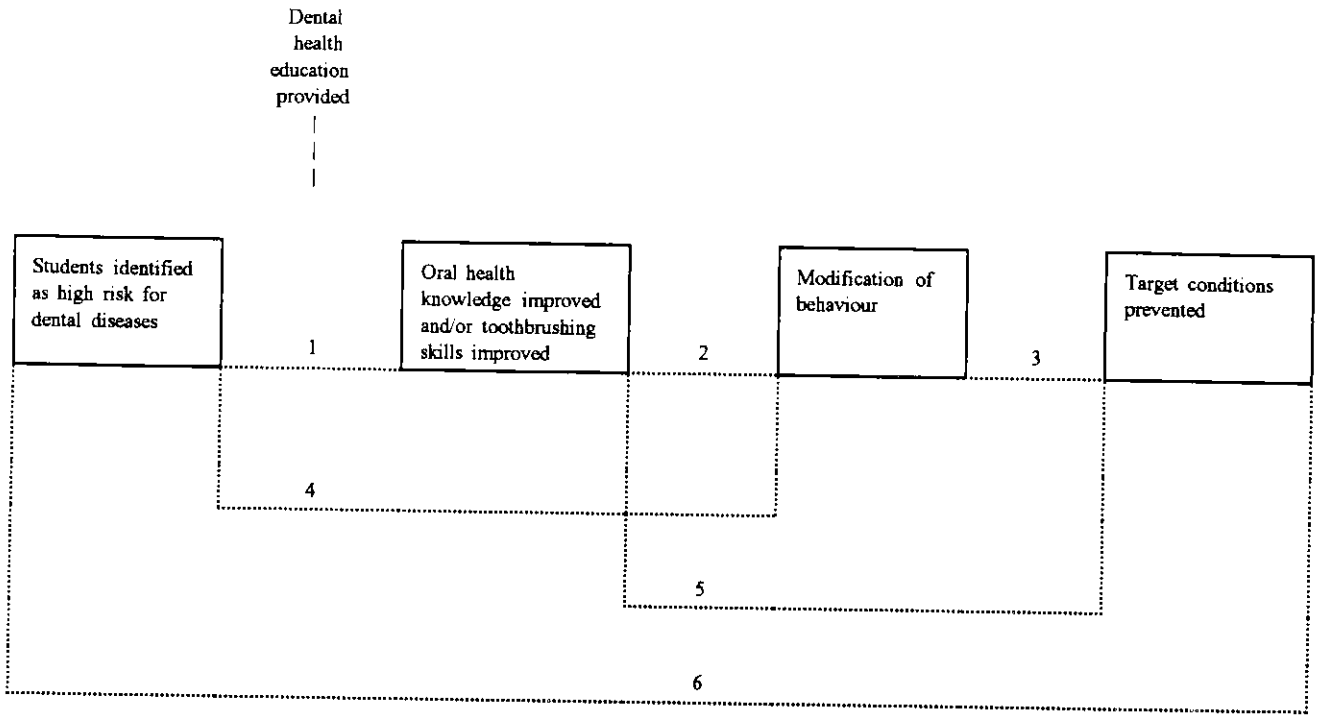
4.5 Benefits and costs of dental health education

An evaluation of a public health program must consider both the benefits and costs of the program. In this instance, high risk children who had DHE showed improved toothbrushing skills and oral health knowledge. Knowledge acquired through this program may result in long-term benefits, such as improved oral health and oral health-related quality of life. The major costs of this program are the expense of staff, dental educators, equipment and supplies. This program

poses no risk to any individuals; the only cost to students is their time (90 minutes per year). A cost-effectiveness analysis of this program is not possible at this time because of insufficient data. Indeed few, if any, DHE programs have been assessed using cost-effectiveness analysis. Nevertheless, debates about the worthiness of DHE are ongoing and often revolve around the theory underlying DHE and the equivocal nature of published results.

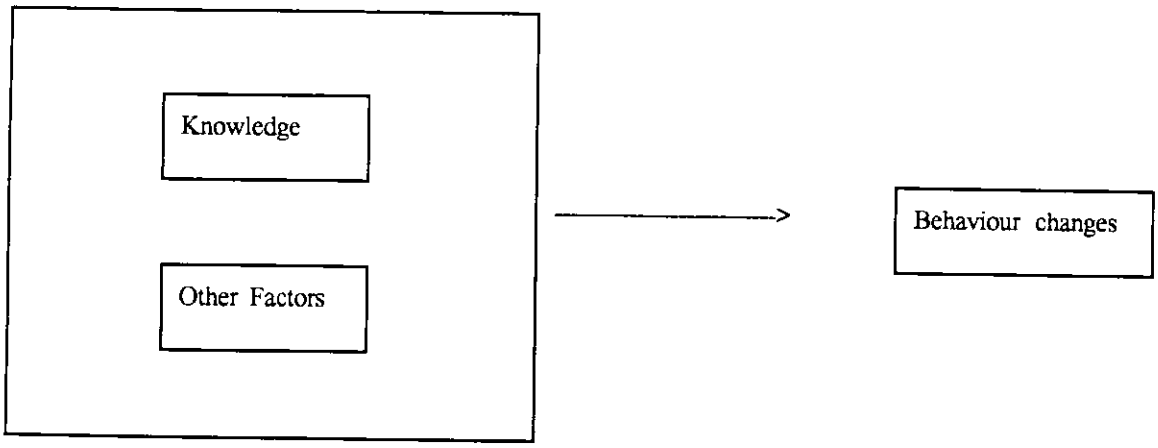
The theory of DHE is that improvements in knowledge will result in long-term positive changes in preventive behaviours and this will ultimately lead to improved oral health (Figure 23). Despite the intuitive appeal of this theory, reviews of DHE have universally acknowledged the process of changing behaviour and improving oral health is not as straightforward as this theory implies.[1-3] Although DHE programs have repeatedly been successful at improving knowledge (causal link 1);[18,36,39-41] studies of oral health outcomes (causal link 6) have found both improvements[16,19,20,42,43] and minimal, or no, improvements.[44-50] A mixture of results is not surprising if one considers the complex nature of human behaviour and the critical role played by factors other than knowledge (e.g., economics)[51] and the influence of various socialization agents upon children's health attitudes and behaviour (e.g., families, peers, media).[52]

Figure 23. Proposed causal pathway for dental health education: numbers (1 to 6) represent causal links within the pathway



Knowledge *per se* is obviously not sufficient for behavioural change, but knowledge should be regarded as a necessary factor for positive change (Figure 24). "Other factors" do play a role and DHE programs are not designed to ameliorate these "other factors". Additional public health programs (e.g, healthy public policy) should be designed to deal with these "other factors". Based on this reasoning, oral health indices should only be used as outcome measures of a complete package of dental health programs.

Figure 24. Knowledge is a necessary factor, but not sufficient, for behaviour changes



5. Future directions

(a) Improvements to DHE programs: A shortened version of the survey, with an easier scoring format, may be useful as a screening tool to determine which children are in need of DHE. The results of this study indicate that certain items should be deleted from the survey because they failed to differentiate between students with low and high levels of knowledge (e.g., items which all students answered correctly and items which very few students answered correctly). 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 and/or knowledge. A previous study of North York students in Grades 4-8 found 72% of students with low dental knowledge had not been selected for DHE based on clinical criteria.[53]

Results may also assist managers and educators in the planning of more effective education lessons and the identification of subject areas where further reinforcement is necessary. In particular, the separate analysis of participants who did not display knowledge at pre-test

revealed these students had great difficulties in learning to brush lingual surfaces.

(b) Dissemination of study information: Due to the paucity of published studies on DHE programs for Grade One students, the results of this study should be submitted to dental and public health journals. It may be worthwhile to publish the survey instrument and a discussion of its merits and areas where improvements are necessary. Further data analysis may be done to examine whether there is evidence of a hierarchy of toothbrushing skills similar to the developmental stages of toothbrushing proposed by Ogasawara *et al.*[28] Also, participants' responses to verbal ("tell-me") questions may be compared with their responses to corresponding picture ("show-me") questions.

(c) Further research: This subject has been under-investigated and many avenues of further research are possible. An investigation may be done of the source of children's oral health information[54] and who helps them look after their teeth. Given the changing nature of Canadian society, it may be helpful to gain a better understanding of how the dental health of children is affected by different macro- and meso-level factors (e.g., family structure, advertising). For example, DHE interventions for higher grades may target older siblings who care for their younger sisters and/or brothers.

Future studies should attempt to collect additional independent variables. Some of this information may be relatively easy to obtain (e.g., sex, ESL status and cultural background), but other types of information will be more difficult, if not impossible, to determine (e.g., SES and

previous exposure to fluoride). In a 1985 study, no sex differences in oral health knowledge were found at baseline for 6-7 year-olds, but differences were found after DHE; girls showed greater improvement.[17] For SES differences, 5-7 year-old children of high SES have been found to have higher pre-test levels of oral health knowledge than low SES children, and to show greater improvement after DHE.[17,55]

Finally, many students in this study benefitted from DHE, but some children in both groups still lacked basic skills and/or knowledge at the completion of the Grade One DHE program. It may be beneficial to investigate those children who continued to have poor knowledge and the reasons why this occurred.

6. Conclusion

The effectiveness of two methods of dental health education for high risk Grade One students in the City of North York was evaluated. At baseline, the majority of children lacked fundamental oral health knowledge and skills which are necessary for the prevention of dental diseases. Following DHE interventions, students in both study groups showed favourable changes in knowledge and toothbrushing skills, especially in key subject areas. Overall, the greatest improvements occurred for those students which received two small-group sessions in addition to a single classroom-based lesson. Thus, the results indicated the more effective means of DHE for high risk Grade One students was the provision of small-group sessions as well as an annual classroom lesson. One must exercise caution in interpreting the results because several methodologic limitations may have influenced study outcomes.

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APPENDIX A - PROGRAM DESCRIPTION

CITY OF NORTH YORK
PUBLIC HEALTH DEPARTMENT COMMUNITY DENTAL SERVICES

NORTH YORK PUBLIC HEALTH DENTAL EDUCATION PROGRAM
SCHOOL PROGRAM 1996-1997

The program description was composed using information obtained from discussions with the manager of Community Dental Services and from material contained in the following sections of the North York Community Dental Services manual (revised 1993):

· Prevention: Education manual
  - page 3.10.1: goals and objectives
  - pages 5.10.1 and 5.10.2: policy of school program
  - pages 6.10.1 and 6.10.2: procedure for school program
  - pages 6.30.1 and 6.30.2: administration

· Program administration and delivery
  - pages 11.10.1 to 11.10.3: program model
  - page 11.20.1: role of staff

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1. Goals and Objectives

(a) Goal of the North York Public Health Dental Education Program: To improve the dental health of the target population through the provision of dental education.

(b) Objectives: To provide high quality education programs delivered in a cost-effective manner for target populations.

To increase the percentage of the target population practising good dental health behaviours.

To increase the dental health awareness, knowledge and skills of the target populations.

2. Policy

The philosophy of the Division in providing dental education within the community is a "train-

the-trainer" approach. In that it is not possible to attend all classes within the school community to provide dental education; education will be provided through staff and curriculum development. General resources will be made available to teachers. Educators enter into a partnership with the teachers and act as consultants.

(a) Eligibility for targeted dental education: Through the screening process, the hygienist will identify students eligible for treatment, CINOT, prevention and education. Students will be deemed eligible for targeted education if they meet the criteria of:
1) eligible for CINOT; or
2) score of 1 or more on CPITN; or
3) eligible for fluoride treatment.

(b) Classroom dental education: Eligibility for classroom education will be based on epidemiological information.

(c) School dental education: Each educator will be assigned and is responsible for, the annual provision of education to schools within his/her region. There will be some equalization of work load to ensure all service objectives are met annually.

(d) Classroom lessons: Grade One children in North York Schools will receive one classroom dental education lesson annually, subject to availability of resources. As of 1998, classroom lessons will not be provided universally to SK and Grade One (i.e., only selected classes will receive lessons).

Teachers must remain in the classroom during dental education presentations.

(e) Small-group education: Education will be offered in small groups (First Visit) to those children identified as requiring targeted education at the time of screening. Targeted dental education lessons will be provided annually for children in North York schools from Junior Kindergarten to Grade 8 with the concurrence of each school board, and to complement current legislation.

(f) Oral hygiene instruction: Oral hygiene instruction will be provided to those children eligible for education. Oral hygiene instruction will consist of brushing and/or flossing. Targeted oral hygiene instruction will be provided twice annually for eligible children in North York schools from Junior Kindergarten to Grade 8. The first session will be in conjunction with a small group education session (First Visit), with a second follow-up (Second Visit) at a later date.

3. Procedure

(a) Eligibility for dental education: Targeted education will be provided for students satisfying the policy of the Division.

(b) Classroom dental education: Education will be provided once annually to selected Grade One classes using the appropriate lesson plan.

(c) Small-group dental education: Students identified through the screening process for targeted education will be seen twice annually in small-group sessions: First Visit and Second Visit. Dates of First and Second Visits will be recorded on the nominal roll and on the Education Report. Educators will group students eligible for targeted education in age appropriate groups of five students. Form 17-606 Dental Education Program is available to expedite the process of grouping students.

(d) First Visit: The first visit will consist of half-an-hour of hands-on, participatory education followed by fifteen minutes of oral hygiene instruction. The lesson plans for Junior Kindergarten to Grade 8 are used and modified as necessary provided that the objectives are met. Age specific education and instruction shall be provided to achieve the learning objectives and age appropriate materials shall be employed for reinforcement and follow-up.

(e) Second Visit: The second visit consists of fifteen minutes of oral hygiene instruction. The minimum time between the first and second visit should be three months.

(f) Oral hygiene instruction: Topics covered in OHI include: brushing, flossing, fluoride, dentifrice, type of brush and tooth safety. The program will take place in the dental room, health room or a suitable room with access to a sink. In small groups, students are instructed in brushing and/or flossing techniques employing the O.S.P.H.D. and North York standards. At the end of the oral hygiene instruction session all supplies are discarded neatly.

(g) Schedules: Each educator prepares a timetable for his/her allocated school allowing sufficient time to complete classroom education and targeted education in First and Second Visits.

4. Administration

(a) Program model: Education programs will be provided to groups of individuals identified using the "gatekeeper" approach, as being at risk of experiencing dental disease. The general school population will have access to education resources through materials either for classroom use or for library use. The actual components are as follows:

Targeted identified "at risk" populations:
- small-group presentations, JK to Grade 8
- classroom education for selected grades (SK and Grade 1)

General school body:
- provision of resources for librarians and classroom teachers dependent on available development funds.

Teachers:
- *train the trainer* approach with priority to English Second Language (ESL) teachers
- professional development for all teachers

(b) Role of staff: The responsibilities of dental educators are:
- classroom education for selected grades
- education for small groups of identified "at risk" children only, JK-G8
- oral hygiene instruction for small groups of identified "at risk" children only, JK-G8
- professional development, inservice and resource development for teachers and school librarians
- *train-the-trainer* for daycare centre staff, staff of CLCs and parents of preschool children
- classroom sessions for adult ESL students
- Seniors program for CLC residents and community residents

(c) Management and documentation

i. Workload responsibility: Each educator is responsible for the provision of education to all school and community programs within his/her assigned region. There will be equalization of workload to ensure annual education is provided. Scheduling, to ensure all education is completed, is the responsibility of the educator.

ii. Scheduling requirements: When scheduling, educators should inquire what programs operate out of any given location. All education programs (daycare, tiny tot, drop-ins, English Second Language, classroom) should be scheduled while the educator is at that location to eliminate time wasted returning to a location.

It is the responsibility of each educator to submit a monthly schedule to the Manager prior to the beginning of each month.

The standard of the Division requires that each educator schedule per day: a minimum of 6 classes or 5 First Visits or 9 Second Visits or 3 Community presentations or an equivalent combination of the above. Adequate administration time has been allowed in this standard.

iii. Education time allotment: Time allotted for classroom instruction is:

Junior and Senior Kindergarten	20 minutes
Grade 1 through Grade 5	30 minutes
Grade 6 through Grade 8	40 minutes

Time allotted for a First Visit consists of half-an-hour of education and fifteen minutes of oral hygiene instruction. Time allotted for a Second Visit consists of fifteen minutes of oral hygiene instruction.

iv. Education reports: Education reports 17-020 are completed by each Educator and submitted weekly to Central Office.

5. Quality Assurance

The education program adheres to a quality assurance (QA) process. The ongoing components of this process are:
- peer review
- management review
- random site and staff visits by the supervisor
- observation within classroom and community settings by the supervisor
- productivity assessments
- compliance with set standards
- compliance with team and program responsibilities
- public relations and accountability

At specified times in the year the following are undertaken:
- performance appraisals
- program review
- program evaluation using qualitative and quantitative measures
- completion assessment
- progress report
- distribution of evaluation forms to target groups (e.g., seniors, ESL, parent and preschool, schools).

APPENDIX B - STUDY INSTRUMENT

Student ID _____
School name: _____
School ID: _____

EVALUATION OF THE NORTH YORK DENTAL EDUCATION PROGRAM FOR TARGETED GRADE ONE STUDENTS

MEASURE OF DENTAL HEALTH KNOWLEDGE

INTRODUCTION:
MAKE ARRANGEMENTS IN THE SCHOOL FOR A QUIET PLACE TO CONDUCT THE SURVEY WHERE YOU WILL NOT BE INTERRUPTED. (THE DENTAL OR HEALTH ROOM). ARRANGE THE PROPS IN ORDER ON A SUITABLE SURFACE IN THE ROOM. ENSURE THE STUDENT WILL BE ABLE TO SEE A TOOTHBRUSH DURING YOUR INTRODUCTION. ALL OTHER PROPS/PICTURES SHOULD BE HIDDEN

GO TO THE CLASSROOM AND ASK THE TEACHER FOR EACH STUDENT.

AS YOU WALK TO THE DENTAL OR HEALTH ROOM:
Hello _____ My name is _____. I would like to talk to you to find out what you know about your teeth and I would like you to show me how you brush your teeth.

WHEN YOU GET TO THE CLINIC TELL THE STUDENT WHERE THEY CAN SIT.

FOR THE NEXT (6) ITEMS:
PLACE A CHECKMARK IN THE BLANK IF THE ITEM IS ANSWERED CORRECTLY
PLACE AN "X" IF THE ITEM IS NOT ANSWERED CORRECTLY

01) INTERVIEWER ASKS:
What is your name? _____

02) INTERVIEWER ASKS:
What grade are you in? _____

03) INTERVIEWER SAYS:
Point to your teeth _____

04) INTERVIEWER SAYS:
Point to the toothbrush _____

05) INTERVIEWER SAYS:
What language does your mother speak? _____

06) INTERVIEWER SAYS:
Do you speak (REPEAT THE LANGUAGE THE STUDENT SAID)**?**
_____

CHECKLIST FOR TOOTHBRUSHING COMPETENCIES

INTERVIEWER CIRCLES YES OR NO FOR EACH QUESTION.

PRIOR TO STARTING:
SHOW STUDENT THE DIFFERENT COLOURED TOOTHBRUSHES AND SAY: WHAT COLOUR TOOTHBRUSH WOULD YOU LIKE? _____ 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 student has brushed and stopped) say: I DIDN'T SEE. SHOW ME AGAIN.

1.	Holds brush properly	Yes No
2.	Places brush at gumline. (places the ends of the bristles straight on to the tooth where the teeth and gums meet)	Yes No
3.	Appropriate motion of brush (moves the brush back and forth with a vibratory or small circle motion)	Yes No
4.	Length of time per tooth (counts of three or more)	Yes No
5.	Brushes labial side of front teeth (upper or lower)	Yes No
	Brushes lower occlusals of molars	Yes No
	Brushes upper occlusals of molars	Yes No
	Brushes buccal side of molars (upper or lower)	Yes No
	Brushes lingual side of upper front teeth	Yes No
	Brushes lingual side of molars (upper or lower)	Yes No
6.	Brushes all areas of mouth in a routine fashion	Yes No

INTERVIEWER: READ THE BOLDED QUESTIONS/STATEMENTS.
CIRCLE THE CODES FOR EACH RESPONSE TO THE QUESTION.
IF YOU ARE UNSURE OF AN ANSWER WRITE IT DOWN UNDER: OTHER
FOR EACH QUESTION WHEN THE STUDENT HAS FINISHED RESPONDING THE INTERVIEWER CAN PROMPT TWICE BY ASKING: **Can you think of anything else?**

SAY TO THE STUDENT:_____ **I want to know what you know about your teeth and if you don't know it's OK to say that.**

1. **What is important to do to keep your teeth healthy?**
   Can you think of anything else? x2

   STUDENT ANSWERS:
   01) ORAL HYGIENE:
   BRUSH YOUR TEETH, CLEAN YOUR TEETH, REMOVE SUGAR BUGS
   02) NUTRITION:
   DON'T EAT TOO MUCH CANDY, SUGAR, JUNK FOOD
   EAT FRUITS/VEGETABLES, DRINK MILK
   03) PROFESSIONAL SERVICES:
   VISIT THE DENTIST/HYGIENIST
   04) INJURY PREVENTION:
   WEAR A MOUTHGUARD/SEAT BELT/HELMET
   05) OTHER (SPECIFY) _____
   97) STUDENT DOES NOT ANSWER
   98) STUDENT SAYS: I DON'T KNOW

2. **What foods are good for your teeth?**
   Can you think of anything else? x2

   STUDENT ANSWERS:
   01) _____
   97) STUDENT DOES NOT ANSWER
   98) STUDENT SAYS: I DON'T KNOW

3. **What drinks are good for your teeth?**
   Can you think of anything else? x2

   STUDENT ANSWERS:
   01) _____
   97) STUDENT DOES NOT ANSWER
   98) STUDENT SAYS: I DON'T KNOW

4. **What person helps you look after your teeth? Can you think of anyone else? x2**

   STUDENT ANSWERS:
   01) THE DENTIST, THE HYGIENIST
   02) MY MOTHER OR FATHER
   03) OTHER (SPECIFY) _____
   97) STUDENT DOES NOT ANSWER
   98) STUDENT SAYS: I DON'T KNOW

5. **What could you do to protect your teeth?**
Can you think of anything else? x2

STUDENT ANSWERS:
01) WEAR A MOUTH GUARD OR HELMET WHEN PLAYING SPORTS
02) WEAR A SEAT BELT
03) DON'T PUSH AT THE WATER FOUNTAIN
04) PLAY SAFELY
05) DON'T CHIP OR GRIND THEM
06) DON'T USE THEM TO TEAR TAPE, OPEN ENVELOPES
07) HAVE FLUORIDE PROTECTION
08) OTHER (SPECIFY) _____
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

6. **Why should you brush your teeth?**
Can you think of anything else? x2

STUDENT ANSWERS:
01) NOT TO GET CAVITIES
02) TO REMOVE FOOD
03) TO REMOVE SUGAR
04) TO REMOVE GERMS
05) TO MAKE THEM CLEAN/WHITE
06) TO MAKE THEM STRONG AND HEALTHY
07) OTHER (SPECIFY) _____
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

7. THREE PICTURES OF A BOY ARE PLACED IN FRONT OF THE STUDENT. THE INTERVIEWER SAYS:

Show me the pictures of the boy that is doing something to look after his teeth?
STUDENT CHOOSES THE:
01) BOY VISITING THE DENTIST
02) BOY EATING CANDY
03) BOY BRUSHING HIS TEETH
04) BOY PLAYING
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

8. THREE DIFFERENT SIZED TOOTHBRUSHES OF THE SAME COLOUR ARE PLACED IN FRONT OF THE STUDENT. THE INTERVIEWER SAYS:

Show me the toothbrush that is the best size for you.
STUDENT CHOOSES THE:
01) SMALL TOOTHBRUSH
02) MEDIUM TOOTHBRUSH
03) LARGE TOOTHBRUSH
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

9. **When is the most important time to brush your teeth?**

STUDENT ANSWERS:
01) BEFORE BED / AT NIGHT
02) AFTER MEALS / AFTER EATING
03) IN THE MORNING
04) AFTER LUNCH
05) AFTER SUPPER
06) OTHER (SPECIFY) _____
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

10. PICTURES OF DRINKS ARE PLACED IN FRONT OF THE STUDENT. THE INTERVIEWER SAYS:

Show me some drinks that are good for your teeth.

STUDENT CHOOSES:
01) MILK
02) WATER
03) POP
04) FRUIT JUICE
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

11. **What do your teeth help you do?**
Can you think of anything else? x2

STUDENT ANSWERS:
01) THEY HELP ME EAT / CHEW / BITE
02) THEY IMPROVE APPEARANCE/SMILE/LOOK/NICE
03) THEY HELP ME TALK
04) OTHER (SPECIFY) _____
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

12. **When should you throw your toothbrush away?**

STUDENT ANSWERS:
01) WHEN THE BRISTLES ARE FRAYED
02) WHEN IT IS OLD
03) AFTER 3 MONTHS
04) OTHER (SPECIFY) _____
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

13. PICTURES OF FOOD ARE PLACED IN FRONT OF THE STUDENT. THE INTERVIEWER SAYS:

Show me some foods that are good for your teeth.
Can you think of anything else? x2

STUDENT CHOOSES THE:
01) ORANGE
02) DONUT
03) POPCORN
04) CARROT
05) CHOCOLATE
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

14. THREE SAME SIZED TOOTHBRUSHES OF THE SAME COLOUR WITH VARYING AMOUNTS OF TOOTHPASTE ON EACH BRUSH ARE PLACED IN FRONT OF THE STUDENT. THE INTERVIEWER SAYS:

Show me how much tooth paste you should use.

STUDENT CHOOSES THE BRUSH WITH:
01) TOOTHPASTE SMEARED ON BRUSH WITH FINGER TO COVER BRISTLES
02) PEA SIZE OR 1/4" OF TOOTHPASTE
03) TOOTHPASTE 1/4" THICK THE LENGTH OF THE BRISTLES
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

15. A PICTURE OF A GIRL BRUSHING HER TEETH IS PLACED IN FRONT OF THE STUDENT. THE INTERVIEWER SAYS:

Why is this girl brushing her teeth?
Can you think of anything else? x2

STUDENT ANSWERS:
01) NOT TO GET CAVITIES
02) TO REMOVE FOOD
03) TO REMOVE SUGAR
04) TO REMOVE GERMS
05) TO MAKE THEM CLEAN/WHITE
06) TO MAKE THEM STRONG AND HEALTHY
07) OTHER (SPECIFY) _____
97) STUDENT DOES NOT ANSWER
98) STUDENT SAYS: I DON'T KNOW

APPENDIX C

LETTER OF INVITATION AND CONSENT FORM

CITY OF
North York
PUBLIC HEALTH DEPARTMENT

5100 Yonge Street
North York, Ontario
M2N 5V7

Tel: (416) 395-7700
Fax: (416) 395-7691

Dental Education Study Consent Form

Please complete this consent form and return it in the stamped, enclosed envelope, whether or not you agree to include your child in the dental education study. Thank you for your co-operation.

Child's name: _____

Please check one of the following:

( ) **Yes** I have read the attached letter and will let my child participate in the Dental Education Study. I understand that my child can withdraw from the study at any time. The services my child receives from the North York Public Health Department will not be affected by participation in the study. All information will be confidential.

( ) **No** I do not want my child to participate in the Dental Education study. I understand the services my child receives from the North York Public Health Department will not be affected.

Parent's name: _____
Please print

Parent's signature: _____

Date: _____

CITY OF
North York
PUBLIC HEALTH DEPARTMENT

5100 Yonge Street
North York, Ontario
M2N 5V7

Tel: (416) 395-7700
Fax: (416) 395-7691

Fall 1996

Dear

As a Grade One student, your child receives dental education lessons from the Community Dental Services Division of the North York Public Health Department. The University of Toronto and the Community Dental Services Division of the North York Public Health Department would like to know how well the dental education program is working. With the permission of the School Board and the principal, your child's school has been picked to participate in a dental education study. The study will take place between October 1996 and June 1997.

We would like to include your child in the dental education study to find out what your child knows about dental health and how well he or she can brush his or her teeth. To do this, a member of the research team will show your child some pictures and ask your child some questions about dental health. Your child will be given a free toothbrush and the research assistant will ask your child to show her how they brush their teeth. The study will take place before and after the dental lessons and will take approximately 30 minutes in total. This dental education study is important to continue to improve our dental education lessons.

Your child's answers will not be identified by name. Your child may withdraw from this study at any time. The services your child receives from the North York Public Health Department will not be affected.

Please indicate whether you will or will not allow your child to be included in the study on the enclosed consent form and return it in the stamped, enclosed envelope as soon as possible.

Thank you very much for considering our request. If you have any questions or would like more information about the study please contact our research assistant, Mrs. Rosy Pimentel at (416) 395-7750, Monday to Friday, 8:00 am. to 1:00 pm..

Yours sincerely,

Debbie Zanetti
Manager, Community Dental Services
North York Public Health Department

Dr. David Locker
Director
Community Dental Health Research Unit
University of Toronto