Peer-led oral health education model for elementary school-aged children in British Columbia, Canada

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PRACTICAL IMPLICATIONS OF THIS RESEARCH

- Dental caries is the most common chronic health condition worldwide.
- Families with modest incomes or without private dental insurance may be unable to afford professional oral health care.
- Delayed treatment of dental caries has an impact on children's overall health and quality of life.
- Peer-led school-based preventive oral health education may improve children's oral self-care and reduce the need for professional oral care referrals.

ABSTRACT

Objective: To examine the effectiveness of peer-led preventive oral health education for elementary school-aged children. **Methods**: A controlled, non-randomized interventional study included children in grades 4 to 6 (N = 372) from 6 schools in British Columbia, Canada. The control group (3 schools) received a class-based lecture on oral health. In the intervention group (3 schools), each sixth grader mentored a small group of fourth and fifth graders. The study outcomes were 1) need for oral care referrals (visual screening); 2) oral health knowledge (self-reports); 3) oral self-care practice (OSC-P); and 4) oral self-care skills (OSC-S). Assessments of OSC-P and OSC-S were based on disclosed dental biofilm levels. Study group comparisons were done at baseline and 8 to 12 months. **Results**: A high need for oral care referrals was found, with a substantial reduction achieved during the study period. Dietary knowledge improved minimally in the intervention group. In both study groups and within age groups, there was a wide variation in OSC-P and OSC-S. Overall, children's OSC-P scores were substantially higher than their OSC-S scores. Oral self-care outcomes improved over time in both groups (except for fourth graders in the control group), with a more substantial improvement in the intervention group. From baseline to study end, the mean OSC-P improved by 11.9% (intervention group) and 5.9% (control group). Improvement values for OSC-S were 12.8% and 5.2%. **Conclusions:** The need for oral care referrals was reduced, but improvement in oral health knowledge was minimal. Oral self-care outcomes improved more in the intervention than in the control group.

RÉSUMÉ

Objectif : Examiner l'efficacité de l'éducation préventive sur la santé buccodentaire menée par les pairs pour les enfants en âge de fréquenter l'école primaire. **Méthodologie :** Un groupe d'intervention, contrôlé et non randomisé comprenait des enfants de la 4e à la 6e année (N = 372) de 6 écoles en Colombie-Britannique, au Canada. Le groupe témoin (3 écoles) a reçu une leçon en classe sur la santé buccodentaire. Dans le groupe d'intervention (3 écoles), chaque élève de la sixième année a encadré un petit groupe d'élèves de la quatrième et de la cinquième année. L'étude a produit les résultats suivants : 1) besoin d'aiguillage vers des soins buccodentaires (dépistage visuel); 2) connaissances en matière de santé buccodentaire (auto-évaluations); 3) pratique en matière de soins buccodentaires personnels (P-SBP); et 4) compétences en matière de soins buccodentaires personnels (C-SBP). Les évaluations de la P-SBP et des C-SBP étaient fondées sur la divulgation des niveaux de biofilms dentaires. Les comparaisons des groupes d'études étaient effectuées au début de l'étude et après 8 à 12 mois. **Résultats :** Un besoin important d'aiguillages vers des soins buccodentaires a été constaté, accompagné d'une réduction substantielle réalisée au cours de la période d'étude. Les connaissances nutritionnelles se sont peu améliorées dans le groupe d'intervention. Il y avait une importante disparité entre la P-SBP et les C-SBP dans les 2 groupes d'étude et au sein des groupes d'âge. Dans l'ensemble, les cotes de la P-SBP des enfants étaient nettement plus élevées que leurs cotes de C-SBP. Les résultats en matière de soins buccodentaires personnels se sont améliorés au fil du temps dans les 2 groupes (à l'exception des élèves de quatrième année du groupe témoin). L'amélioration était la plus importante dans le groupe d'intervention. Entre le début et la fin de l'étude, l'amélioration moyenne de la P-SBP était de 11,9 % (groupe d'intervention) et de 5,9 % (groupe témoin). Les valeurs d'amélioration des C-SBP étaient de 12,8 % et de 5,2 %. **Conclusions :** Les aiguillages vers des soins buccodentaires étaient moins nécessaires, alors que l'amélioration des connaissances en matière de santé buccodentaire était minime. L'amélioration des résultats des soins buccodentaires était plus importante dans le groupe d'intervention que dans le groupe témoin.

Keywords: child; health promotion; lay health advisors; peer-led
CDHA Research Agenda category: access to care and unmet needs

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INTRODUCTION

Globally, the prevalence of children's dental caries has not substantially changed in the last 3 decades,[1] and untreated caries in the permanent dentition is still prevalent and remains the most common health condition globally (34.1%).[2] In addition, while oral health-related disparities are commonly observed, oral health has long been insufficiently addressed in public health.[3] As a mostly privatized sector of health care, dental care in Canada is mainly sought by those who are covered under private insurance plans or those with higher incomes.[4] Access to costly private dental care is often limited for those without private or public insurance, and those with financial barriers.[5] Consequently, in Canada, an increased emphasis on oral health prevention, focusing on high-risk populations is urgently required to reduce disparities in children's oral health.[6]

Delayed treatment of dental caries not only places an economic burden on families, but also may impact children's overall quality of life as well as their successful encounters with peers. As consequences of dental caries are cumulative, timing of preventive measures is another important consideration. High rates of dental treatment needs have been observed among American and Canadian elementary school-aged children.[7-8] Thus, school-aged children are a good target population for efforts to establish healthy habits early in life.[9] The concept of "Health Promoting Schools" is not new and was introduced a few decades ago by the World Health Organization (WHO).[10] According to Monajem, "Health Promoting Schools are WHO's brainchild and borne of the wisdom of using schools as 'platforms' for the promotion and delivery of health care to the community."[11]

Schools have great potential in health promotion[12-14] because they are influential settings where children learn and develop. Thus, it is natural to use school settings to teach children about health; in fact, health education can be continued throughout school years, an important development period in children's lives.[15] Moreover, school-based health promotion has been successful in both medical and dental studies.[16,17] However, when compared to other Western countries, the United States, Canada, and Australia have not implemented school-based health programs to the same degree.[9,18] Unsurprisingly, in British Columbia's elementary schools, there has been minimal, if any, focus on oral health to facilitate the maintenance of oral health and health-promoting behaviours. When designing school-based health-promoting interventions, it is also important to acknowledge that conventional brief verbal instructions similar to the ones commonly received in dental offices to convey preventive information have shown little success. Therefore, alternative patient or recipient-centred preventive strategies should be examined.[19-22]

A conceptual model emphasizing action-oriented community engagement has been recommended for sustainable health promotion.[23] For example, lay health advisors (LHAs) (also known as lay health workers, advisors or peer leaders) can play an important role in bridging the gap between the community in need and the health care system.[24] LHAs are non-health workers with personal connections to their community groups, who can be trained by health care professionals to become health educators and promote health among their peers.[25] The key differences between LHA-based and professionally guided preventive interventions are not only the reduced program cost but also its increased relevance to the community members. Evidence shows that the LHA model used to promote health or oral health was successfully implemented outside Canada to benefit underserved population groups.[26-29]

Studies involving children as LHAs for their peers are scarce in oral health research.[27] A Brazilian study demonstrated that peer-led education was successful in modifying oral behaviours in school-aged children.[30] Thus, there is an opportunity to determine whether Canadian children may also be effective LHAs for their peers. Additionally, placing children in leadership roles when they are young may build their self-esteem, self-efficacy, and self-empowerment.[27] It can also be expected that, due to a decreased power differential, the peers educated by the LHAs may be positively influenced socially to be healthy. Previous studies using the LHA approach were successful in improving several oral health-related outcomes.[31-33]

Therefore, this study evaluated the LHA model for oral health education in Canadian elementary school-aged children. As research in this area is limited, the study explored the feasibility of the preventive school-based program (likelihood of being implemented as planned); the program's effectiveness (to decrease the need for oral care referrals, increase students' oral health knowledge, and improve their oral self-care); and sustainability of its post-educational effect (improvements due to the program sustained at least in the short term after discontinuation).

MATERIAL AND METHODS

Study design and ethical considerations

The current controlled, non-randomized study was approved by the University of British Columbia Clinical Ethics Board (H13-03417), 3 health authorities (Vancouver Coastal Health, Island Health, Fraser Health), and 3 school boards (Richmond School Board, Surrey School Board, Nanaimo School Board). The study was based on the LHA strategy that actively involves community members in health promotion as well as on evidence from the successful implementation of a program involving children as educators in a school setting in Brazil.[30] The LHA model of children educating children was chosen for oral health promotion among elementary school-aged students (grades 4 to 6) residing in British Columbia (BC), Canada.

The minimum sample size calculation was based on the mean (SD) % dental biofilm levels of 50.0 (18.2) (based on

pilot data), a minimum 10% expected improvement, α = 0.05 (significance), and β = 0.80 (power) for a one-sided t-test (after education, either no change or improvement was expected). The sample size calculation revealed the need to recruit a minimum of 327 participants.

Recruitment of schools and participants, and their allocation into study groups

To prioritize and benefit children at a higher risk for caries, representatives from health authorities suggested targeting specific schools which were then approached several times in 3 BC locations: Richmond, Greater Nanaimo, and Surrey. Subsequent student recruitment was based on the following eligibility criteria: 1) school's interest in participating; 2) teacher support of the program's implementation during the school day; 3) parental willingness to have their children participate (student recruitment was based on passive parental consent; uninterested parents were required to opt their child out); and 4) students' willingness to participate.

Figure 1 presents a flowchart of schools' and children's recruitment, children's allocation into 2 study groups, and their follow-up rates. A total of 15 elementary schools were invited by health authorities, of which 6 schools agreed to participate (40.0% recruitment rate). Barriers to recruitment included a teachers' strike, principals either not being interested in the program or delaying distribution of information about the program to their teachers, or the schools' teachers not being interested in the oral health-promoting program, despite the principal's support, because of concerns that it would disturb students' class time. Based on the aforementioned eligibility criteria, the authors were able to recruit a total of 372 children from 6 participating schools: Walter Lee Elementary, Richmond (n = 87); Tait Elementary, Richmond (n = 90); Uplands Elementary, Nanaimo (n = 39); Ladysmith Elementary, Ladysmith (n = 73); Bayview Elementary, Nanaimo (n = 23); and Hjorth Road Elementary, Surrey (n = 60).

Intervention and control groups were formed by a non-random allocation of participating schools into 2 study groups, each comprising 3 schools. Unfortunately, the random allocation of schools into study groups was not possible as 3 schools (2 in Richmond and 1 in Nanaimo) agreed to participate on the condition of being control schools. Therefore, the remaining 3 schools (2 in Nanaimo and 1 in Surrey) were chosen as intervention schools.

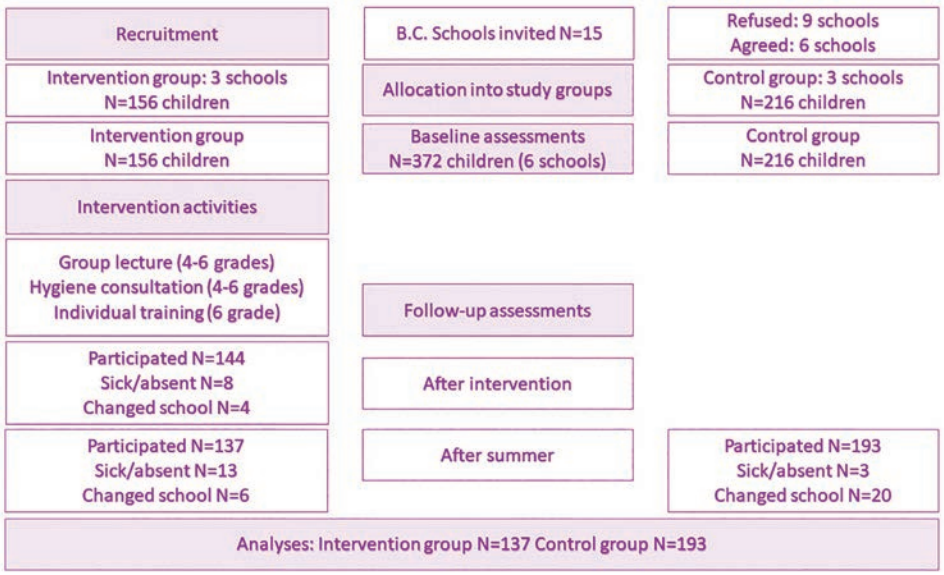
Intervention program procedures

Both study groups including students in grades 4 to 6 received a lecture-based presentation that explained basic knowledge of caries etiology, along with the risks related to a cariogenic diet and lack of quality oral self-care. This presentation included visuals to facilitate inquiries and interaction between students and the presenter (a registered dental hygienist). In the control group, children did not receive any additional individualized oral health-promoting activities until the end of the study. At the final examination, each control group student was informed about his or her quality of oral self-care by explaining that pink areas on his or her teeth (disclosed biofilm) indicated areas of deficient oral self-care.

Training of peer leaders (lay health advisers)

In the intervention group, in preparation for their leadership role, all recruited sixth graders were trained as peer leaders by one of the oral health professionals (dentist or dental hygienist) in both preventive oral health-related knowledge

Figure 1. Peer-led oral health promotion in BC elementary schools: participant flowchart



and oral self-care skills. This training session (intervention schools agreed only to 1 training session for peer leaders) included the following activities: a one-on-one didactic instruction consisting of an oral health professional and a peer leader, oral self-care demonstrations in small groups of 2 to 3 peer leaders using stuffed animals with a full set of permanent teeth, and small-group peer leader-centred discussions. After this training, 2 oral health professionals assessed peer leaders' preventive oral care knowledge and also asked them to demonstrate oral self-care skills. Then, peer leaders were allowed to proceed with the education of their younger peers, where each peer leader was asked to meet every week with their younger peers (a small group of fourth and fifth graders) to train them about tooth-friendly diets and guide them during their toothbrushing practice. For the duration of 1 month, a total of 4 peer-led small-group learning sessions were planned in each of the intervention schools.

Assessments of program feasibility, its effectiveness, and the short-term sustainability of educational effects

The program's feasibility was judged based on success in implementing the program as planned. In addition, to assess the program's feasibility, discussions were held regarding its implementation and associated challenges in brief post-educational interviews with 3 principals of intervention schools and in 2 brief (30-minute) focus groups conducted with peer leaders. The efficiency of the program was determined by the following changes: reduced need for oral care referrals, increased student oral health knowledge, and improvement in oral self-care practice and skills. The sustainability of changes and improvements following educational activities was evaluated at the after-summer assessment (8 to 12 months post-baseline).

Outcome assessments and their follow-up periods

The students from intervention schools were assessed at 3 observation periods, namely at baseline, after the education, and post-summer, while students from the control schools were examined at baseline and post-summer. The researchers focused on 4 outcomes: 1) need for oral care referrals (based on simple clinical visual field-based screening); 2) student knowledge of cariogenic diets and caries etiology (based on self-reports); 3) levels of oral self-care practice (OSC-P) (based on levels of disclosed biofilm); and 4) levels of oral self-care skills (OSC-S) (based on levels of disclosed biofilm). The OSC-P levels refer to the effectiveness of students' toothbrushing on a "normal" day, and levels of OSC-S refer to student's best oral self-care skills while under observation of an oral health professional.

Assessments of need for oral care referrals (Outcome 1)

This simple field-based screening, conducted twice for all study participants by a dental hygienist, identified children with untreated dental caries or suspected caries lesions. At baseline, all children in such need received a letter to take home to their caregivers. In addition, the list of children in need of referrals was given to class teachers to ensure that letters reached students' caregivers. For comparison, the post-summer assessment employed the same type of screening as at baseline.

Assessments of dietary knowledge (Outcome 2)

For these assessments, a sheet was prepared with images of multiple food and drink items. Students were asked to mark all tooth-friendly foods and drinks (non-cariogenic foods) with a happy face and tooth-unfriendly foods and drinks with a sad face (cariogenic foods). Subsequently, the responses of each student about different food or drink items were calculated as his or her total dietary knowledge score (the sum of correct answers; theoretical score range of 0 to 20). For the assessment of knowledge related to caries etiology and caries prevention, 2 open-ended questions were asked: 1) Why are children getting tooth decay? and 2) How can children prevent tooth decay? Based on student responses to these questions, the following knowledge codes were derived: 0—absent knowledge (wrong answers/do not know); 1—partial knowledge; and 2—sufficient knowledge. All participants were assessed at baseline and post-summer.

Assessments of oral self-care practice (Outcome 3) and oral self-care skills (Outcome 4)

These assessments for the intervention group were done at baseline, after the education, and post-summer; for the control group, at baseline and post-summer. To enable assessments of oral self-care, Trace Disclosing Solution (Young Dental Inc.) was used to highlight in pink all dental biofilm that was attached to buccal surfaces. Two sets of photos of teeth with disclosed biofilm were taken, the first before toothbrushing to assess oral self-care practice (OSC-P) and the second set after each student's best toothbrushing to assess oral self-care skills (OSC-S). The first set of photos was taken at the beginning of a priori unannounced school visit. At the same visit, before taking the second set of photos, each child was asked to demonstrate his or her best toothbrushing while imagining that their teachers and parents were watching this toothbrushing.

Digital biofilm estimations of oral self-care levels. Both OSC-P and OSC-S levels were measured as a percentage of the total tooth area covered by disclosed biofilm. Adobe Photoshop Elements software was used to calculate these scores (Figure 2), and the blinded assessment was secured by coding all photos of teeth before their subsequent assessment. As a result, the 2 independent examiners calculating total biofilm scores did not know to which school, study group, age group or observation time the photos of teeth with disclosed biofilm belonged.

Figure 2. Digital biofilm estimation with Adobe Photoshop Elements software

Data analyses

Data were analyzed with SPSS version 26.0 software with the threshold for statistical significance set at $p < 0.050$. A Chi-square test was used to compare the referral rates among participating schools at 2 observation periods (baseline and after summer). Means of dietary knowledge, OSC-P, and OSC-S over time within the same study group were compared with a paired sample t-test, and the study groups at different observation periods were compared with an independent sample t-test.

RESULTS

Rates of recruitment and participant follow-up

Figure 1 presents a flowchart of participant recruitment, student allocation into study groups, and follow-up rates, including reasons for loss at follow-ups. Only 6 of the 15 invited schools agreed to participate in the study (school recruitment rate = 40.0%). As cluster (class-based), rather than individual, non-random allocation into study groups was employed, the numbers of children in the control and intervention groups differed. At baseline and post-summer, both study groups received all assessments (Outcomes 1 to 4). The intervention group had an additional follow-up assessment after the education to evaluate the efficiency of the peer-led dental education (n = 144 children; follow-up rate = 92.3%). The final follow-up (post-summer) included both study groups; the corresponding follow-up rates were 87.8% for the intervention group and 89.4% for the control group. Common reasons for loss at both follow-ups were students being absent or sick on the day of examination or students changing schools. Given that relatively high follow-up rates were achieved and no children refused follow-up examinations (no potential systematic selection bias), the findings should be considered representative of all participating elementary school-aged children.

Program feasibility

Overall, the implementation of the program was only partly feasible. There were no challenges to implement 1 educational session in each of the 3 control schools. However, despite reminders and direct communication with intervention schools, only 1 of them conducted all 4 planned peer-led sessions, while the other 2 schools organized only 2 such sessions. A brief post-educational interview with school principals from intervention schools revealed that schoolteachers were needed for both initiation and subsequent facilitation of peer-led activities. In the intervention school where all 4 sessions occurred (completed the program as planned), the school principal had assigned a role of program supervisor to one teacher. Seemingly, teachers in non-compliant schools were not willing to add more responsibilities to their already busy workdays.

In addition, peer leaders reported during a short post-education debriefing (focus group discussion) that they needed adult support in communicating with younger students about the role peer leaders play in engaging their younger peers in education. Another suggestion resulting from the focus group discussions was that a wider age gap instead of a 1- to 2-year difference between sixth graders (peer leaders) and fifth or fourth graders (younger peers to be trained) might be beneficial. An interesting

side observation during focus group discussions was that, although peer leaders sometimes became frustrated with their younger counterparts, they enjoyed the whole process and felt empowered. A majority of peer leaders commented that they would participate in the program again.

The program's effectiveness was judged by comparing the intervention group Outcomes 2, 3, and 4 from baseline to after the education; the short-term sustainability of the program's educational effects was assessed by comparing the within-study group (either in the control or in the intervention group) changes from baseline to after summer in Outcomes 2, 3, and 4.

Change in need for oral care referrals (Outcome 1)

A substantial and significant reduction from baseline to the after-summer follow-up in the need for oral care referrals was found in both study groups and all participating schools (Table 1). Concomitantly, it is important to consider that the need for referrals varied substantially among the 6 BC schools (3 schools in the intervention and 3 schools in the control group). For example, at baseline, there was 1 school (referral rate = 45.0%) in the intervention group and 1 school (referral rate = 47.8%) in the control group with high referral rates.

Change in knowledge of cariogenic diets (Outcome 2)

Table 2 presents 2 types of comparisons. Rows compare the same study group at different observation times, while columns compare intervention and control groups at either baseline or final follow-up (post-summer). In the intervention group, there was minimal significant improvement in mean knowledge scores from baseline to after the education ($p < 0.001$) or from baseline to post-summer ($p = 0.001$). In the control group, there was no significant ($p = 0.357$) change in dietary knowledge from baseline to post-summer. It is important to note that there were a few children in both study groups who did not have good knowledge of cariogenic diets either at baseline or post-summer. Concerning the knowledge of caries etiology or prevention (open-ended questions were used to avoid potential bias inherent in guided questions), only a low proportion (<25.0% total) of students in either the control or intervention groups knew that 2 main causes of caries are frequent consumption of sugar-containing foods and drinks and lack of quality oral self-care.

Change in oral self-care practice (Outcome 3) and oral self-care skills (Outcome 4)

OSC-P and OSC-S were indicated by percentage of dental biofilm; statistical findings related to these outcomes are presented in Table 3. Detailed comparisons of oral self-care findings as they relate to 3 age groups (grades 4, 5, and 6) can be visualized in Figure 3 (OSC-P) and Figure 4 (OSC-S).

Table 3 presents 2 types of mean comparisons of OSC-P (unannounced assessments of biofilm levels) and OSC-S (biofilm levels remaining after the best toothbrushing). The columns compare the 2 study groups at either baseline or post-summer; the rows compare the same group (intervention or control) over time. At baseline, there were no mean significant differences in either OSC-P ($p = 0.348$) or OSC-S ($p = 0.871$) between the two study groups.

Oral self-care practice (upper half of Table 3). In the intervention group, from baseline to after education, there was a significant ($p = 0.008$) mean 4.7% decrease in OSC-P scores, and a significant ($p < 0.001$) mean 11.9% decrease in OSC-P scores from baseline to post-summer observation. In the control group, there was a significant ($p < 0.001$) 5.9% mean decrease in OSC-P from baseline to the post-summer observation.

Oral self-care skills (lower half of Table 3). In the intervention group, from baseline to after education, there was a significant ($p = 0.015$) mean 3.5% decrease in OSC-S, and a significant ($p < 0.001$) mean 12.8% decrease in OSC-S from baseline to the post-summer observation. In the control group, there was a significant ($p < 0.001$) 5.2% mean decrease from baseline to the post-summer observation.

Figure 3 illustrates the distribution of OSC-P scores in different age groups at baseline and post-summer. One general trend was a wide variation in the distribution of OSC-P scores in all age groups (ranging from 5.0% to around 90.0% of buccal tooth surfaces covered by biofilm).

Table 1. Need for dental referrals (Outcome 1): comparison between the study groups at baseline and post-summer

Observation	Dental referrals n (% of total)					
	Intervention schools			Control schools		
	School 1	School 2	School 3	School 4	School 5	School 6
Baseline	27 (45.0)	11 (15.0)	7 (30.4)	27 (31.0)	43 (47.8)	7 (17.9)
Post-summer	9 (17.6)	2 (2.9)	3 (17.6)	3 (4.1)	6 (7.1)	2 (5.6)
p values[a]	<0.001	0.006	0.004	<0.001	<0.001	0.002

[a]Chi-square test

Table 2. Dietary knowledge (Outcome 2): comparison between and within intervention and control groups

Dietary knowledge scores (range 0 to 20; min 5, max 20)			
Study groups	**Baseline mean (SD)**	**After education mean (SD)**	**Post-summer mean (SD)**
Intervention group	15.8 (2.2)	17.1 (1.9)	16.7 (2.1)
	Baseline vs after education, $p < 0.001$[a] After intervention vs after summer, $p = 0.100$[a] Baseline vs post-summer, $p = 0.001$[a]		
Control group	16.2 (2.3)		16.4 (2.1)
	Baseline vs post-summer, $p = 0.357$[a]		
Intervention vs control[b]: at baseline, $p = 0.358$ and after summer, $p = 0.121$			

[a]Paired sample t-test
[b]Independent sample t-test

This trend of substantial variation did not disappear after the summer vacation (post-summer observation). A comparison of baseline to post-summer observations in the control group reveals that the OSC-P of the youngest participants (fourth graders) did not change, while the older control group participants (fifth and sixth graders) had a mean reduction in biofilm scores. Similar trends were observed in the intervention group. However, an overall reduction in biofilm scores was more pronounced in this group as compared to the control group.

Figure 4 illustrates the trends in the change of OSC-S. The level of OSC-S was substantially better than the level of OSC-P (Figure 3) in all age groups and at 2 observation points (baseline and post-summer). Seemingly, there was no improvement in OSC-S in the youngest control group participants (fourth graders). All intervention groups (fourth to sixth graders) improved their OSC-S. However, concomitantly, a substantial variation in all age and study groups remained after receiving peer-led and/or simple lecture-based education.

DISCUSSION

Preventive oral health programs delivered by oral health professionals, particularly dentists, are costly, while programs implemented by lay health advisors such as preselected community members trained to deliver preventive health education to their peers can be a more cost-effective approach to oral health promotion. The current study tested the feasibility of a school-based preventive program, its effectiveness, and the short-term sustainability of its educational effects.

The study found that the program was only partly feasible as only 1 of the 3 intervention schools implemented the peer-led training as planned. Following the model of the successful intervention school that completed the program as planned, it is recommended that an adult supervisor be designated for such peer-led school-based preventive programs.

The present study found a relatively high need for oral care referrals, particularly in 2 of the participating schools (≥45.0%). This need for treatment was higher than that reported in a previous similar BC study (32.0%)[8] and in the US National Health and Nutrition Survey data where untreated caries was observed in 15.3% of children ages 6 to 11 years[34]. Of importance, however, is the substantial reduction in the need for oral care referrals over the course of the present study. This finding indicates that a simple screening by a dental hygienist (taking a maximum of 1 to 2 minutes per child), subsequently informing school staff of the results, and sending referral letters to parents can help to reduce the overall treatment needs in high-risk child populations.

Concerning the program's effectiveness or sustainability of its educational effects, only minimal improvements in student oral health-related knowledge were observed in the intervention group. The authors speculate that the expected improvement in oral health-related knowledge was not achieved possibly because peer educators mainly engaged their younger peers in toothbrushing, and took only limited time, if any, for knowledge-related training. To support student training in several oral health-related aspects, the authors recommend preparing teaching plans for peer leaders, including sequencing the steps they need to take to guide their preventive oral care training of their younger peers.

The program was more effective in improving student oral self-care. Interestingly, the most pronounced improvement in oral self-care (program's effectiveness) and the short-term sustainability of post-educational effects was observed among peer leaders (sixth graders). This finding needs further exploration, but student empowerment in a new leadership role may have played a part, and teaching younger peers may have helped the peer leaders to be more accountable, consequently focusing on improving their own oral self-care. The observed improvement in student OSC-S supports the notion of supervised toothbrushing having a positive effect on school-aged children, which is in accordance with previous reports.[35-36] Concomitantly, a considerable variation was observed in student OSC-S at

Table 3. Oral self-care practice (Outcome 3) and skills (Outcome 4) in intervention and control groups

Oral self-care practice (measure: % of tooth surfaces covered by biofilm)				
Observations	**Groups**	**n**	**Mean (SD)**	***p* values[a]**
Baseline	Intervention	156	52.2 (19.8)	Intervention vs control, $p = 0.348$
	Control	216	55.2 (20.4)	
After education	Intervention	144	47.5 (15.7)	
Post-summer	Intervention	137	40.3 (20.5)	Intervention vs control, $p < 0.001$
	Control	193	49.3 (19.7)	
Intervention group: baseline vs after education, $p = 0.008$; baseline vs post-summer, $p < 0.001$[b] Control group: baseline vs post-summer, $p < 0.001$[b]				

Oral self-care skills (measure: % of tooth surface covered by biofilm)[a]				
Observations	**Groups**	**n**	**Mean (SD)**	***p* values[a]**
Baseline	Intervention	156	36.0 (16.2)	Intervention vs control, $p = 0.871$
	Control	216	36.4 (18.5)	
After education	Intervention	144	32.5 (14.6)	
After summer	Intervention	137	23.2 (15.9)	Intervention vs control, $p < 0.001$
	Control	193	31.2 (18.0)	
Intervention group: baseline vs after education, $p = 0.015$; baseline vs post-summer, $p < 0.001$[b] Control group: baseline vs post-summer, $p < 0.001$[b]				

[a]Independent sample t-test
[b]Paired sample t-test

Figure 3. Oral self-care practice (measure: % dental biofilm levels) in different age groups

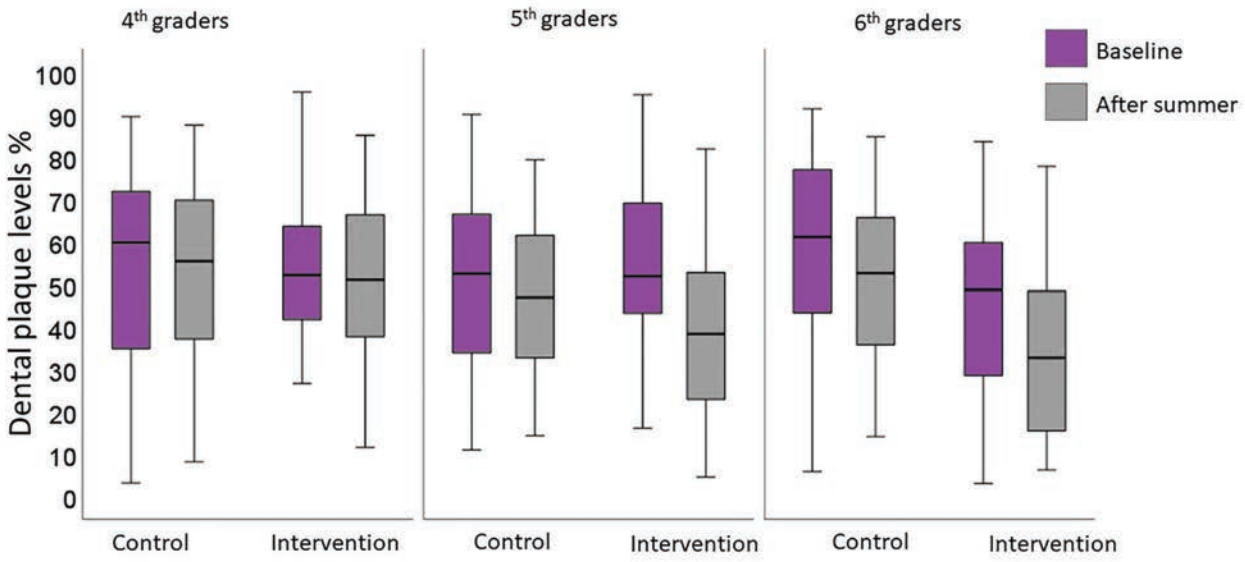
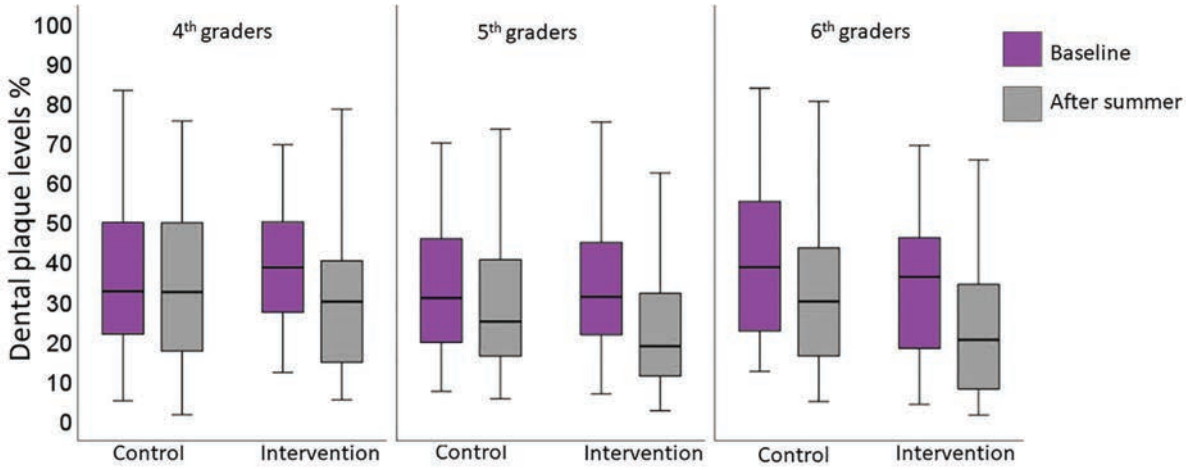


Figure 4. Oral self-care skills (measure: % dental biofilm levels) in different age groups



all observation periods. This finding raises the possibility that short-term intervention (only 1 month in duration) may be insufficient at least for younger students to acquire proper oral self-care skills.

There is a long-standing discussion about the exact timing, namely, deciding the age-specific threshold, when children may be left unsupervised in their toothbrushing. The Canadian Dental Association[37] recommends that children from 3 to 6 years of age should be assisted by an adult in brushing their teeth, while a 2018 systematic review recommends extending parental supervision of their children's toothbrushing until 8 years of age[38]. The findings of the present study indicate that even fourth graders (children around 9 or 10 years of age) need more guidance to improve their oral self-care practice and skills, as demonstrated by minimal improvement. The broader interpretation of such findings is that, without proper guidance, younger children may not acquire adequate oral self-care skills. This study demonstrated that even children older than 8 years still need supervision and assistance from either their parents or guardians and/or oral health professionals to support the development of proper oral self-care skills. Supporting families in maintaining children's oral health should also be one of the top priorities for health promotion as family environment has been strongly associated with child oral self-care behaviours.[39]

Another important, consistent pattern observed in all age groups was that OSC-P scores were substantially higher than OSC-S scores and that a large variation in both practice and skills was observed in all age groups. This finding suggests that oral self-care skills need to be developed before improvements in children's everyday oral self-care practice can be expected.

Study strengths and limitations

This study demonstrated the importance of having a control group particularly when measurements (in this case, oral self-care assessments) may have an unexpected impact on the study findings. It is possible that, without having a control group, the efficiency of the education might have been overestimated. The authors speculate that self-care improvements in the control group participants may be due to repeated oral self-care assessments (here disclosing biofilm in pink several times, indicating insufficient oral self-care). Other strengths of the current study are that schools from 3 different communities were included, there was relatively low loss at follow-ups, a simple visual clinical screening was used to identify children in need of oral care referrals, assessments of 2 oral self-care-related outcomes were blinded, and an after-summer follow-up was done to assess sustainability of the educational efforts.

The study's limitations are a relatively low recruitment rate of schools (40.0%), non-random allocation of participants into study groups (3 schools preselected themselves to be part of the control group), and the use of self-reports to evaluate students' oral health-related knowledge. Regarding non-random allocation into study groups, the authors believe this deficiency would not have had a substantial impact on the findings as baseline comparisons indicated no significant mean differences in scores for either OSC-P or OSC-S between the control and intervention groups.

Suggestions for future studies

The present findings need to be validated by future studies, and the authors recommend considering the following revisions: increasing the training time to at least 2 sessions for students serving as peer leaders (lay

health advisors), identifying adult champions (either school staff or volunteering parents) who could support peer leaders in organizing their educational sessions for younger counterparts, and increasing the total time allocated for oral health education (e.g., adding 1 or 2 shorter reinforcement sessions during the school year that might contribute to sustaining the benefits gained from preventive education over a longer period). Future studies should also examine potential determinants that might either increase or decrease the likelihood of improving oral health-related knowledge and modifying student oral self-care behaviours. A recent systematic review recommended the inclusion of children as active partners by employing participatory research methodology where children play an important role in their own oral health education.[40]

CONCLUSION

The peer-led school-based preventive oral health education program was effective in improving children's oral self-care (both practice and skills), but only minimal improvement in student oral health knowledge was achieved. The post-educational improvement in oral self-care was sustained in the short term, but a substantial variation in both student oral self-care practice and skills was observed in both study groups and at all observation times. Therefore, schools choosing the peer-led strategy for promoting oral health in elementary school-aged children should consider adding a reinforcement session and designating an adult who will support peer leaders in educating their fellow students.

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CONFLICTS OF INTEREST

The authors have declared no conflicts of interest.

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