School-Based Educational Intervention to Improve Children's Oral Health–Related Knowledge

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Abstract

Objective. To evaluate a brief oral health promotion intervention delivered in schools by a primary care dental practice, aimed at changing oral health care knowledge and oral health–related behaviors in children.

Design. Cohort study with pretest–posttest design.

Setting. Three primary schools.

Participants. One hundred and fifty children (aged 9-12 years).

Intervention. Children received a 60-minute theory-driven classroom-based interactive educational session delivered by a dental care professional and received take-home literature on oral health.

Main Outcome Measures. All children completed a questionnaire on oral health–related knowledge and self- reported oral health–related behaviors before, immediately after, and 6 weeks following the intervention.

Results. Children's dental knowledge significantly improved following the intervention, with improvement evident at immediate follow-up and maintained 6 weeks later. Significantly more children reported using dental floss 6 weeks

after the intervention compared with baseline. No significant differences were detected in toothbrushing or dietary behaviors.

Conclusions. School-based preventative oral health education delivered by primary care dental practices can generate short-term improvements in children's knowledge of oral health and some aspects of oral hygiene behavior. Future research should engage parents/carers and include objective clinical and behavioral outcomes in controlled study designs.

Keywords: oral health education; children; schools; primary care dentist

INTRODUCTION

Global public health policy advocates a preventative approach to dental health (Department of Health [DH], 2005, 2008; Patel, 2012; Petersen, 2009; Steele, 2009) with children's oral health a particular priority (DH, 2011; World Health Organization [WHO], 2005). Preventative measures in childhood are imperative, not least because of the known social and functional implications of poor oral health (U.S. General Accounting Office, 2000) but also because the presence of cavities in childhood is already known to be the best predictor of tooth decay throughout the life span (Powell, 1998). Data from England shows that onethird of 12-year-olds have already experienced tooth decay (Rooney et al., 2010). The mechanisms for the delivery of oral health promotion are variable. In the United Kingdom, oral health promotion has been found to be inconsistent and unsystematic with low levels of reported exposure to settings-based oral health promotion (34%; Passalacqua et al., 2012). It has been recommended that dental

health education should be delivered to NHS patients when attending for routine examination and treatments (NHS, 2006). However, the practicality of providing this service under the current dental remuneration system has been questioned (Page, Weld, & Kidd, 2010), and dentists report that delivering prevention in practice can be problematic due to insufficient staff, facilities, and time (Witton & Moles, 2013). As a consequence patients infrequently receive preventive health advice from their primary care dental teams (NHS Information Centre, 2011). Concerns for cost-effectiveness suggest that preventative care may be best provided at a community rather than individual level, and indications that one-to-one approaches to oral health education have been shown to be ineffective (Satur, Gussy, Morgan, Calache, & Wright, 2006) may equally indicate the potential for community-level intervention.

With many risk behaviors emanating in childhood and adolescence, schools are globally accepted as an important setting for health education with "Health Promoting Schools" networks existing in many countries, including the United Kingdom (Kwan, Petersen, Pine, & Borutta, 2005; Stokes, Pine, & Harris, 2009). Interventions in the school setting may have benefits to health and well-being, not only for the child, but also for school employees, family members, and community members. Although the WHO strongly advocates the evaluation of school-based health promotion programs to encourage sharing of good practice (WHO, 2003) school-based oral health promotion activities are not always well-documented and evaluated (Jürgensen & Petersen, 2013; WHO, 2003). Few schools and teachers rate their capacity to deal with oral health issues as "high" (9%; WHO, 2003), and teacher's enthusiasm for involvement in oral health can be variable (WHO, 2003). Barriers to the implementation of oral health

education programs in primary schools, such as lack of personal training, have been identified by teachers (Ramroop, Wright, & Naidu, 2011). As a consequence, appropriately trained dental care professionals may play a key role in preventive dental health (Riordan, 1997) as they are viewed as a credible source of health promotion advice (Secker-Walker, Dana, Solomon, Flynn, & Geller, 2000). However, there is a paucity of evidence for oral health interventions that have been designed, delivered and evaluated by primary care dental practices, yet engaging primary care dental professionals in this way is likely to be influential for their "ownership" of research evidence and translation of research into practice.

The value of school-based interventions for primary school children is promising (e.g., Chapman, Copestake, & Duncan, 2006; Halonen et al., 2013; Stokes et al., 2009) but inconclusive since previous studies show marked differences in intervention duration, content, mechanisms for delivery, outcomes, and age-range of target audience. A Cochrane review of behavioral interventions for children aged 4 to 12 years found limited positive evidence for the effectiveness of school-based oral health interventions on children's oral health knowledge acquisition and a lack of interventions informed by behavioral theory (Cooper et al., 2013).

The objectives of this study were (1) to assess the feasibility of primary care dental practices delivering school-based single-session oral health education informed by behavioral theory and (2) to assess oral health care knowledge and oral health-related behaviors in children before and after receiving group oral health education designed and delivered by a primary care dental practice.

METHOD

Ethical approval for the study was granted by the local institutional ethics review board. This was a multi-site cohort study adopting a pretest–posttest design. Eligible study participants were children in Years 5 and 6 (average age 10-11 years) of three primary schools in the East Midlands, United Kingdom.

Procedure/Strategies

Head teachers of three schools in Nottinghamshire (n = 1) and Derbyshire (n = 2) were contacted by a primary care dental practice (by telephone and invitation letter) and offered an oral health promotion session to take place within classroom time, on school premises. All schools responded with an expression of interest and were then provided with detailed information about the study and were asked to sign and return a written consent form. Informed consent was received from the head teachers of all three schools and intervention delivery dates for each school (six classes in total) were determined in con- junction with the teaching staff. Children and their parents/carers were notified about the sessions 2 weeks in advance by the schools. We received informed consent for participation from parents/carers and assent from the children.

Parents/carers were invited to discuss the study with the research team prior to the session. All children in the selected classes (n = 150) participated in the oral health education session; provision of a single session to groups of pupils in Years 5 and 6 in three schools reflected the level of provision which was practical given the resources available in a single com- munity-based primary care dental practice. A participation rate of 100% provides data which is truly representative of the research population. Pupils included in this study were

drawn from a range of socioeconomic backgrounds—School 1 with an urban catchment spanning both more and less disadvantaged Census Super Output Areas; School 2 a fee-paying school in the independent sector drawing pupils from a broad geographic area; and School 3 set in a rural village with moderate levels of deprivation. The session was delivered at each school by a single oral health educator between October 2010 and April 2011.

Intervention Applications

The intervention was a single interactive evidence-based educational session lasting approximately 60 minutes, delivered to groups of 20 to 30 children. Session content was developed by practitioners from the participating primary care dental practice, an academic pediatric dentist and a health psychologist, and was approved by teachers who had provided consent for intervention delivery within their allocated teaching time. Content was based on current evidence for the use of fluoride and evidence-based resources for dietary advice and oral hygiene (DH, 2009). We included standardized presentation content in five key areas (general introduction, mechanisms of action of plaque and decay, diet in relation to tooth decay, and dental decay). This was aimed at educating children about oral health and promoting positive oral health behaviors. The intervention was informed by the Theory of Planned Behavior (TPB), which has been shown to predict oral health behavior (Buunk-Werkhoven, Dijkstra, Bink, van Zanten, & van der Schans, 2011); this is a social cognitive model that assumes that three key constructs: perceived behavioral control, attitudes, and subjective norms, influence intention and subsequently behavior (Ajzen & Madden, 1986). The educational session was therefore designed to positively influence attitudes (e.g., instilling knowledge, oral and written information-giving, causes and

consequences), subjective norms (e.g., current recommendations for healthy behaviors; active learning through group discussion), and perceived behavioral control (e.g., provision of anticipatory guidance through tailored discussion and interactive instructions and demonstrations following a predetermined sequence). All children attending were also provided with a supplementary take-home educational pack containing generic oral health leaflets to pass on to their parent/carer. The printed materials were selected to provide information which was consistent with that provided in the educational session, and the pack also included free samples of toothpaste.

The intervention lesson plan is provided in Table 1.

TABLE 1
Educational Intervention Lesson Plan

Session Objectives
Introductory material
Importance of teeth
Functions of teeth
Connections with general health
Time to start visiting dentist
Importance of baby teeth
Oral hygiene instruction
Brushing teeth—actions and types of toothbrush
Explain use of disclosing tablets
Use of fluoride toothpaste and benefit of fluoride in toothpaste
Importance of spitting not rinsing postbrushing
Interdental cleaning (flossing)
Mechanisms of action of plaque and decay
Diseases caused by improper plaque control
The effect of acidity of plaque
Use of disclosing tablets
Diet and relation to tooth decay
Acidity of plaque pH after food (e.g., sweet and acidic food substances)
Importance of snacking in relation to tooth decay
To reduce frequency of sweet and acidic food substances
Compatible foods and incompatible foods in relation to decay
Dental decay
Progression of decay in tooth and symptoms
Mineralization versus demineralization
Use of xylitol-containing chewing gum
Dental procedures available in dental practices to treat decay
Prevention of decay in dental practice using fissure sealants and fluoride applications

Data Collection

Data were collected from children at three time points (Time 1: at baseline immediately prior to the intervention, Time 2: immediately after the intervention, and Time 3: 6 weeks after the intervention). At the start of the educational session, the oral health educator collected baseline data from the children in the form of a questionnaire "quiz" on oral health knowledge and oral health behaviors. The children then received the 60-minute educational session. At the end of the session, the oral health educator collected immediate follow-up data from the children using the same questionnaire "quiz" on oral health knowledge. The same questionnaire was then used by the oral health educator during classroom time to assess children's knowledge levels 6 weeks later. Because of a scarcity of appropriate standardized measures, questionnaire items were developed by a team of oral health educators, a health psychologist, and pediatric dental professionals, with items developed on the basis of current guidelines for oral health promotion in children and current research evidence (DH, 2009). In addition to the knowledge questions, the questionnaire at baseline and 6 weeks included additional items on oral health behaviors (e.g., dental visits, toothbrushing, sugary food/drink consumption, and use of dental floss) and also self-assessed improvement in knowledge and oral health behavior since the intervention. Questionnaires were pilot tested in a small sample of children within the target population age- range (n = 5) prior to the start of the research.

Data were analyzed using SPSS for Windows Version 18.0. Analysis included descriptive statistics, Wilcoxon signed ranks tests and one-way within-subjects analysis of variance (ANOVA) with Bonferroni correction.

RESULTS

One hundred and fifty children (58.7% boys, 41.3% girls) were present for the classroom-based intervention. Data were collected from 150 at Time 1, 148 at Time 2, and 149 at Time 3. Missing data at follow-up (Time 2 = 2, Time 3 = 1) was due to absence from the classroom, although the demographics of non-responders did not statistically differ from that of responders. Analysis was based on intention to treat.

Oral Health Knowledge

For each dental knowledge questionnaire, the child participant was awarded a score of 1 when the item was answered correctly, and a score of 0 if answered incorrectly. The total dental knowledge score is the sum of the scores. A higher score indicates a greater level of oral hygiene knowledge. The means (M) and standard deviations (SD) of the dental knowledge score for the three time points are shown in Table 2. One-way within-subjects ANOVA showed that time had a significant impact on children's dental knowledge, $F(2, 292) = 49.92$, $p < .001$, partial $\eta^2 = .26$. Post hoc comparisons using related-samples t tests demonstrated that there was a significant increase in children's dental knowledge at Time 2 (immediately after the intervention), $t(147) = -8.01$, $p < .001$, $\eta^2 = .31$, and at Time 3 (6 weeks after the intervention), $t(148) = -8.91$, $p < .001$, $\eta^2 = .35$ compared with Time 1 (baseline). There was no significant difference in dental knowledge between Time 2 and Time 3. Therefore, children's dental knowledge significantly increased immediately following the intervention, and this improved level of knowledge was maintained 6 weeks after the intervention.

There were no significant differences in oral health knowledge between pupils from Schools 1, 2, or 3 at Time 1 (p = .147), Time 2 (p = .803), or Time 3 (p = .160).

TABLE 2
Means and Standard Deviation of Dental Knowledge Scores

	N	*Minimum*	*Maximum*	M	SD	*Skew*	*Kurtosis*
Time 1	150	4	10	7.01	1.16	−0.10	0.13
Time 2	148	3	10	7.99	1.39	−0.93	1.12
Time 3	149	5	10	8.03	1.15	−0.51	0.23

NOTE: Time 1 = before intervention; Time 2 = immediately after intervention; Time 3 = 6 weeks after intervention.

One-way within-subjects ANOVAs were performed on the individual dental knowledge items to investigate improvement in particular areas before, immediately after, and six weeks after the intervention (Table 3).

There were significant knowledge increases on 7 of the 10 knowledge items. Related-samples t tests were conducted to explore changes in each question item across each time point (Table 3).

On six items, children significantly improved their knowledge from baseline to immediate follow-up, and this increase in knowledge was maintained 6 weeks later. These items included (1) the relationship between oral health and general health, (2) the importance of rinsing after brushing, (3) the effects of sugar on teeth, (4) the comparison between acidic fruit and sugary foods between meals, (5) the relationship between decay and pain, and (6) the importance of saliva as a defense against tooth decay.

One further item was significantly improved at 6 weeks compared with baseline and immediate follow- up. This item related to the need to clean between the teeth with floss or small brushes.

TABLE 3
Knowledge Change for Each Question Item

Analysis of Variance: Knowledge Change for Each Question Item

Items	*Time*	M	SD	f	df	p	*Partial* η^2
General oral health							
Teeth are important for speech, eating and appearance	1	0.96	0.20	2.65	2,294	.07	N/A
	2	0.99	0.08				
	3	0.99	0.12				
Good oral health and good general health are not connected	1	0.77	0.42	6.72	2,296	**.00**	**0.04**
	2	0.87	0.34				
	3	0.91	0.28				
Oral hygiene							
It is best to rinse off your toothpaste after brushing	1	0.28	0.45	102.59	2,296	**.00**	**0.41**
	2	0.90	0.30				
	3	0.42	0.50				
Tooth brushes cannot reach in between teeth so there is also a need to clean with floss or small brushes	1	0.83	0.38	10.46	2,296	**.00**	**0.07**
	2	0.90	0.30				
	3	0.98	0.14				
Dental plaque							
Sugar is converted into acid by bacteria, which attack the tooth surface	1	0.97	0.16	2.01	2,296	.14	N/A
	2	0.95	0.23				
	3	0.99	0.12				
Dental plaque is not present if you cannot see it	1	0.91	0.29	9.66	2,296	**.00**	**0.06**
	2	0.82	0.39				
	3	0.95	0.23				
Diet							
Eating apples and oranges between meals is much better for teeth than cakes and biscuits	1	0.89	0.31	2.96	2,294	**.05**	**0.02**
	2	0.96	0.20				
	3	0.93	0.25				
Sugar-free fizzy drinks are safe for teeth	1	0.79	0.40	0.61	2,296	.55	N/A
	2	0.79	0.41				
	3	0.75	0.43				
Dental decay							
Decayed teeth always cause some pain	1	0.19	0.40	5.54	2,296	**.00**	**0.04**
	2	0.33	0.47				
	3	0.27	0.45				
Saliva ("the spit") in your mouth is the body's natural defense against tooth decay	1	0.41	0.49	69.61	2,296	**.00**	**0.32**
	2	0.83	0.38				
	3	0.85	0.36				

Post Hoc Comparisons for Knowledge Changes Between Time Points

	Time[a]	t	df	p	η^2
OH2. Good oral health and good general health are not connected	1-2	−2.24	149	**.03**	**.03**
	1-3	−3.40	148	**.00**	**.07**
	2-3	−1.41	148	.16	N/A
OHy1. It is best to rinse off your toothpaste after brushing	1-2	−5.56	149	**.00**	**.17**
	1-3	−3.02	148	**.00**	**.06**
	2-3	−1.81	148	.22	N/A
OHy2. Tooth brushes cannot reach in between teeth so there is also a need to clean with floss or small brushes	1-2	−1.91	149	.06	N/A
	1-3	−4.41	148	**.00**	**.12**
	2-3	−2.90	148	**.00**	**.05**
DP2. Dental plaque is not present if you cannot see it	1-2	−2.77	149	**.01**	**.04**
	1-3	−2.61	148	**.01**	**.04**
	2-3	−1.12	148	.42	N/A
D1. Eating apples and oranges between meals is much better for teeth than cakes and biscuits	1-2	−2.40	148	**.02**	**.04**
	1-3	−2.28	148	**.04**	**.02**
	2-3	0.24	148	.60	N/A
DD1. Decayed teeth always cause some pain	1-2	−3.40	149	**.00**	**.07**
	1-3	−2.00	148	**.04**	**.03**
	2-3	1.41	148	.16	N/A
DD2. Saliva ("the spit") in your mouth is the body's natural defense against tooth decay	1-2	−9.41	149	**.00**	**.37**
	1-3	−9.29	148	**.00**	**.37**
	2-3	−0.41	148	.69	N/A

NOTE: OH = oral health; OHy = oral hygiene; DP = dental plaque; D = diet; DD = dental decay; N/A, not applicable. Bold text indicates significance at $p < 0.05$.
a. 1 = before intervention; 2 = immediately after intervention; 3 = 6 weeks after the intervention.

Children's Perceptions of the Session

Immediately after the intervention, the children were asked to assess how much they had learned from the session, and how much they thought they would change the way they would look after their teeth and gums as a result of what they had learned from the session. Two thirds of the sample (68%, n = 102) reported that they had learned a lot from the session; 27.3% (n = 41) reported that they had learned a little. Over half of the children (53.3%, n = 80) expected that they would change their future oral health behaviors a lot as a result of the learning; 39.3% (n = 59) expected that they would change their future health behaviors a little.

Self-Reported Oral Health Behaviors

Six weeks after the intervention, the children were asked how much they thought they had actually changed the way they looked after their teeth and

gums as a result of what they had learned at the oral health session. Eighty-five percent reported that they had changed their health behaviors either a little (55.7%) or a lot (28.9%). The proportion of children reporting actual behavioral changes to the way in which they looked after their teeth at Time 3 (93.8%) was significantly greater than the proportion that reported an intention to change at Time 2 (58.8%), ($\chi^2 = 23.84$, df = 4, $p < .001$).

Children's self-reporting of dental visits, toothbrushing, sugary food/drink consumption, and use of dental floss before and after the intervention is presented in Table 4.

Wilcoxon signed-ranks tests showed no significant difference in reports of when the child last visited the dentist ($Z = 0.53$, $p = .60$), the frequency of toothbrushing ($Z = 0.65$, $p = .52$), or the frequency of eating sweets, sugary food/drinks ($Z = 0.09$, $p = .93$) between baseline and 6 weeks after the intervention. However, there was a significant increase in the percentage of children who reported using dental floss 6 weeks after the intervention compared with baseline ($Z = -3.99$, $p < .001$). There were no significant differences between pupils of Schools 1, 2, or 3 on any of the reported oral health behaviors.

TABLE 4
Self-Reported Health Behaviors: Dental Visits, Toothbrushing, Sugary Food/Drink Consumption, and Use of Dental Floss

	Before Intervention (n = 150)		*6 Weeks After Intervention (n = 149)*	
	n	%	n	%
Last visit to dentist				
<1 year ago	120	80.0	118	79.2
1-2 years ago	19	12.7	19	12.8
2-5 years ago	8	5.3	5	3.4
>5 years ago	3	2.0	7	4.7
Toothbrushing				
Morning only	13	8.7	10	6.7
Before sleep only	9	6.0	3	2.0
After eating only	1	0.7	0	0
Morning and before sleep	110	73.3	120	80.5
Morning, before sleep, and after eating	17	13	16	10.7
Frequency of sweets, sugary food and/or drinks (per week)				
<1 day	28	18.7	28	18.8
1-2 days	37	24.7	34	22.8
3-4 days	37	24.7	41	27.5
5-6 days	23	15.3	25	16.8
7 days	25	16.7	21	14.1
Frequency of flossing (per week)				
Never	103	68.7	76	51.0
Very occasionally	29	19.3	37	24.8
1-2 days	9	6.0	16	10.7
3-4 days	5	3.3	7	4.7
5-6 days	3	2.0	6	4.0
7 days	1	0.7	7	4.7

Parents/Carers

One hundred and fifty parents/carers were sent questionnaires at baseline and 6 weeks following the intervention. Of these only 27 parents/carers (18% response rate) completed the questionnaire at both time points (before and 6 weeks after the intervention), due to the small sample only brief findings are reported here.

Wilcoxon signed-ranks test showed a statistically significant increase in the percentage of responding parents/carers who reported using dental floss 6 weeks after the intervention compared with baseline ($Z = -2.178$, $p = .03$).

DISCUSSION

Dental diseases and their complications can be costly to individuals and society (Patel, 2012) and therefore preventive measures in childhood are globally

advocated. Supporting the national drive toward “settings” approaches to health promotion, this study demonstrates that brief, single-session, evidence-based oral health education, which is informed by behavioral change theory can be feasibly delivered to pediatric populations in schools by dental care professionals from a primary care dental practice, with limited resources. This supports the campaign for increased efforts to pro- mote oral health worldwide. While primary care-based services provide around 95% of services for oral health care in the United Kingdom, interventions driven by primary care dental professionals are extremely limited, infrequently evaluated and rarely based on behavioral theory. Efforts are underway to foster a research culture within primary care dental practices UK-wide, this study supports this mission since there are few existing evaluations of oral health promotion initiatives that have been delivered and evaluated by primary care dental teams in school settings, yet dental professionals are key to successfully implementing research findings. This study shows that primary care oral health educators can design and deliver health intervention that indicates improvement in oral health knowledge and can effectively collect research data with children at multiple time points with little loss to follow-up; this form of practice-based intervention provides applicability and relevance of our intervention to the real-world dental setting. This study demonstrates that schools with pupils from a range of socioeconomic backgrounds are receptive to the involvement of primary care dental practices in oral health promotion. Health promotion initiatives that seek to address health inequalities are important since it has been shown that low-income children lose 12 times more school days due to dental illness than children from higher income families (U.S. Department of Health and Human Services, 2000).

Nevertheless, in this study we found no differences between pupils from urban, rural, or fee-paying schools in oral health knowledge or oral health behaviors either before or after the intervention, which suggests that there may be equal benefits of oral health education irrespective of socioeconomic status.

Previous studies indicating that oral health promotion can generate positive changes in oral health knowledge and behaviors in primary school children have been based on longer, multicomponent interventions (e.g., Friel, Hope, Kelleher, Komer, & Sadlier, 2002), and there is a lack of published evidence for the usefulness of brief educational interventions designed to reflect the level of provision that could routinely be provided by primary care dental professionals, despite this approach being commonly employed. Although we identified no difficulties for our primary care dental professionals in delivering the intervention, it is currently unclear whether teachers would either want to or feel equipped to deliver the same materials; we need to better understand teacher's barriers to delivery of oral health promotion since it has been shown that provision of oral health promotion educational materials can lead to more comprehensive teaching of oral health promotion in those who already teach it but does not lead to an increase in the proportion of teachers who choose to include this subject area (Kankaanpää et al., 2013).

This before-and-after study indicates that brief educational intervention, which is theoretically informed by the TPB (Ajzen & Madden, 1986), can promote immediate changes in oral health-related knowledge and some aspects of oral health behavior, which are maintained over time. Improving oral health knowledge in children (even in the short term) is important since research has shown a positive relationship between oral health–related knowledge and oral

health- related behavior in children (Poutanen, Lahti, Tolvanen, & Hausen, 2006). Furthermore, healthy behaviors that are developed at a young age are known to be more sustainable in the long term (Kwan et al., 2005).

Notably, this study demonstrates that for some of the children there was scope for improvement at baseline in all areas of oral heath knowledge, which were assessed by our questionnaire including: general oral health, oral hygiene, the mechanisms of action of plaque and decay, diet in relation to tooth decay, and dental decay. In our sample, children's knowledge was significantly improved following the intervention on a wide range of items including: knowledge of the relationship between good oral health and good general health, knowledge of toothbrushing behaviors (e.g., not rinsing after toothbrushing), the use of dental floss, the potential for dental plaque to be present without visible signs, the relationship between dietary factors and plaque acids, the relationship between decayed teeth and pain (or lack of pain) and the importance of saliva as a defense against tooth decay. These issues should be targeted in future oral health promotion programs for children, especially since oral health knowledge has been shown to be a significant predictor of intention to improve oral health behaviors (Dumitrescu, Wagle, Dogaru, & Manolescu, 2011). Further research should investigate whether improvements in knowledge result in objective modifications in health-related behavior and clinical outcomes, such as caries incidence and plaque levels. More recent studies have targeted preschool children and their parents, to study the impact of supplementing health information with motivational interviewing, client centered counseling and interactive caries risk assessment tools, on caries increment in children and

parental efficacy for protecting children's oral health (Gao, Lo, McGrath, & Ho, 2013).

In our study, there was a need for brief measures to be used, to ensure that collection of pre- and post- assessments were feasible within the timescale of a session delivered by a primary care dental team, and to minimize burden for the participating children. Although there are oral health measures in existence, there is a paucity of high-quality, reliable, and valid standardized tools for the measurement of oral hygiene knowledge and oral health behaviors in children (Watt et al., 2006). Therefore, the questionnaire used in this study was developed by a team of oral health professionals and a health psychologist in line with evidence- based resources and current guidelines, as such had content validity. Future studies should seek to use validated measures of oral health knowledge and behaviors designed for a pediatric population and validate self-reports alongside clinical concurrence.

The primary objective of this study was to assess the feasibility of primary care dental practices delivering single-session, theory-based oral health education in schools, and the secondary objective was to assess the potential for changes in oral health-related knowledge and self-reported expected and actual oral health behaviors. Therefore, the timescale did not allow for objective clinical measures of change in dental health status (e.g., caries, plaque). Nonetheless, this approach is in keeping with other school-based oral health pro- motion research where it has been recognized that intermediary risk factors such as reported awareness, knowledge or behavior are often the primary focus (Friel et al., 2002); measurement of these factors may precede the assessment of long-term behavioral changes and clinical outcomes. This cohort study demonstrates the

potential of such interventions to improve oral health-related knowledge and behavior, and as such, the efficacy of the intervention in improving oral health-related knowledge, oral health-related behaviors, clinical and economic outcomes should be tested in a well-designed randomized controlled trial with repeated measures and longer follow-up periods.

Regarding health behavior change, a high proportion of children in our sample thought that they would change some aspect of their oral health behaviors following the intervention. Interestingly, an even greater proportion of children reported actual behavioral changes at 6 weeks than reported behavioral intention at immediate follow-up. Although self-report questionnaires are subject to recall and social desirability bias, predictors of behavioral change should be more fully investigated, since school-based oral health education may lead to behavioral action even in those who do not express intention to change. The scope for actual improvement in oral health behaviors at 6 weeks was limited, partially due to the high ceiling detected in this sample on some of the questionnaire behavioral items at baseline. For example, at the outset the majority of children reported brushing their teeth twice per day and having visited the dentist in the last year. Nevertheless, data collected in adult populations has shown that while 75% of adults report brushing their teeth twice per day, plaque and calculus levels are still high in dentate adults (NHS Information Centre, 2011); this suggests that an assessment of how effectively individuals brush their teeth may be more pertinent in future research than a simple assessment of frequency.

The significant increase in the proportion of children reporting using dental floss following the intervention demonstrates the potential for oral health education

in children to influence some aspects of oral health behavior change in school-aged children. The significance of this is debatable. While the relative importance of children engaging in tooth-flossing is not well established; regular flossing of children's teeth by a trained adult is thought to dramatically reduce inter-proximal caries in those children at high risk of caries (Longbottom, 2006). However, the evidence does not yet support a link between caries risk and self-flossing behaviors in children, despite the fact that in adults, flossing in combination with toothbrushing has been associated with improvements in periodontal health (Sambunjak et al., 2011).

It could be argued that this potential change in behavior is beneficial given that the benefits of flossing are already established for adults, and habits learned in childhood are more likely to sustain into adulthood. However, since factors such as using the correct dosage of fluoride toothpaste, oral rinsing, and eating behaviors after brushing have been clearly associated with caries experience and caries increment, these factors might be considered in future studies as appropriate measures of children's behavioral change.

Since parents are gatekeepers to a child's health behaviors, in this study, we invited parents to complete baseline and 6 week knowledge and behavior questionnaires. Although the observed increase in the proportion of parents/carers reporting use of dental floss 6 weeks after the intervention compared with baseline was promising, response rates were too low to generate meaningful findings. Recent studies have demonstrated positive outcomes of school-based interventions that include parental presence during the instructional sessions (Halonen et al., 2013). Future research may there- fore seek to fully engage parents and caregivers within the intervention, especially

since parents'/carers' knowledge and attitudes about the importance of oral health care influences their children's dental care and dental health habits (Castilho, Mialhe, Barbosa, & Puppin-Rontani, 2013). This study demonstrates a need to further consider methods of engaging parents/carers in data collection for research, which might involve sending reminders to questionnaire non-responders via their children, offering telephone interviews for completion of questionnaires, having a dental care professional present at parent's evenings to provide study information to parents prior to commencement, and/or involving teaching staff in data collection from parents. Parental engagement in oral health educational intervention may increase the likelihood of positive and sustained behavior change in both children and their families. This might be achieved through active participation of parents in educational sessions targeted at their children or provision of interventions targeted to parents with encouragement and incentives for engagement in oral health promotion activities.

In this practice-based study, the development of our intervention was informed by behavioral change theory that is pertinent since oral health interventions are infrequently derived from behavioral theory (Cooper et al., 2013; Richards, 2013). Initiatives informed by behavioral change theory aim to help children to learn about the importance of oral health, to develop skills in personal care and lifestyle behaviors, which influence the development of dental caries (e.g., toothbrushing and sugar control), and to develop healthy attitudes toward self-care, which is imperative because those behaviors that are developed as "habitual" in childhood tend to be more sustainable. Behavior change theory–driven programs are particularly useful in instigating and observing individual-

level changes, although health behavior is subject to multiple levels of influence in the realms of the environment, social context, policy, and culture (Moore, de Silva-Sanigorski, & Moore, 2013), which broaden the picture of social determinants of health. The socioecological health promotion frame- work (McLeroy, Bibeau, Steckler, & Glanz, 1988), based on Ecological Systems Theory, has been recommended as an appropriate theoretical driver to inform the design, implementation, and evaluation of health promotion interventions (Moore, Murphy, & Moore, 2011).

CONCLUSION

School-based oral health promotion that is informed by behavioral theory can be feasibly delivered by primary care dental practices and may improve children's knowledge of oral hygiene and some aspects of oral hygiene behavior. Future intervention should focus on instilling knowledge relating to oral health behaviors that are known to be associated with caries increment (e.g., fluoride dosage, rinsing, and eating after brushing). Research is needed to investigate the economic viability of interventions delivered by primary care dental practices and to consider a wider socioecological approach to assessing the impact of social, cultural, and environ- mental conditions that may influence oral health–related knowledge and behaviors. Well-designed randomized trials are needed to test the efficacy of brief oral health education delivered by primary care dental practices, on oral health-related knowledge and behavior, and measurable clinical and health benefits in the long term.

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