

# Development and testing of a theory-based behavioural change intervention: A pilot investigation in a nursery school in a deprived area of Scotland

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**Objective:** Investigate the effect of a theory-based intervention on oral-health knowledge, attitudes and behaviours of early years staff (EYS), parents and nursery children. **Methods:** Qualitative research with staff and parents from eight nurseries through interviews/focus groups. An intervention was developed and piloted using pre-posttest design. **Clinical setting:** Nurseries in deprived communities in Dundee, Scotland. **Participants:** 111 children aged 3-5 years attending nursery, including 79 parents and 8 nursery staff. **Interventions:** Staff session targeted outcome expectancies, subjective norms and self-efficacy for tooth-brushing in nursery using information provision, modelling and goal-setting, followed by a three-week intervention. Parent-child dyads received a leaflet with instructions for goal-setting, planning and monitoring home brushing. Tooth-brushing self-monitoring materials (e.g. two-minute timer, diaries) were used and certificates provided in the nursery as rewards. **Outcome measures:** EYS knowledge, attitudes and behaviours were assessed before and after the intervention using self-report questionnaires. Parents completed interviews assessing beliefs about tooth-brushing and their children's tooth-brushing behaviour at baseline and post-intervention follow-up. **Results:** Significant improvements in staff knowledge, but not attitudes, self-efficacy, or nursery tooth-brushing were reported. Parent-child dyads completing the intervention were not more likely to report their child carried out twice-daily tooth-brushing at home. The intervention did not improve parents' intentions to brush their child's teeth twice a day or beliefs about the ease of twice-daily tooth-brushing. **Conclusion:** Only past behaviour significantly predicted posttest brushing. Parents who found brushing easier at baseline were more likely to complete the intervention. Recommendations are made regarding implementing psychological theory and methods into oral-health interventions.

*Key words:* child, dental caries, knowledge, behaviour, attitudes, parents, nurseries, intervention, health inequalities.

## Introduction

Dental caries is a common but preventable childhood disease. In Scotland 46% of five-year-olds had obvious dental decay experience though this is not evenly distributed: half being experienced by just 13% of young children predominantly from more socio-economically deprived areas (Merrett *et al.*, 2006). Dental caries can be reduced through twice-daily tooth-brushing, with families from deprived areas being less likely to adhere to this regime (Blinkhorn *et al.*, 2001). Young children's tooth-brushing is primarily directed by parents, however, the recent adoption of supervised tooth-brushing programmes in nurseries throughout Scotland, has resulted in early years staff (EYS) taking on a preventive role in under-fives.

Socio-cognitive factors, such as parental knowledge, attitudes and beliefs are implicated in the prevalence and incidence of dental caries in young children (Gilinsky, 2009; Harris *et al.*, 2004; Poutanen *et al.*, 2006). To understand and improve young children's oral health it can be helpful to identify socio-cognitive factors and implement health promotion programmes that target these constructs. This article describes the development, implementation and evaluation of a pilot tooth-brushing intervention in a deprived area of Scotland. The aim was to improve oral-health knowledge, attitudes and behaviours of EYS, parents and children.

## Method

There were two phases to this study. Firstly, EYS and parents took part in qualitative research to identify barriers and facilitators of preventative oral-health practices. Nurseries were situated within Dundee, Scotland and practiced supervised tooth-brushing. The Consultant in Dental Public Health (CDPH) drew up a list of nurseries to ensure a mix of nursery characteristics. All nurseries were situated in Scottish Index of Multiple Deprivation (SIMD) quintiles 3-5 (5 being most deprived). Nurseries were invited to participate in the study through purposive sampling and were enrolled until an appropriate variation of characteristics (e.g. large/small nurseries, school based/children's centre) had been recruited.

Phase one involved interviews with EYS (n=32) and focus groups with parents (n=37) during nursery using convenience sampling. These lasted 15-20 minutes (interviews) and 30-45 minutes (groups). Questions followed a semi-structured format with open-ended questions on knowledge, attitudes and beliefs about oral-health and experiences of tooth-brushing in nursery and at home, e.g.: "What things make it easier/more difficult for you to look after the teeth of your children at home/in the nursery?" Information was transcribed and thematically analysed according to the process described by Braun and Clark (2006).

An intervention was developed by an author (AG) from the qualitative phase through an iterative process - themes were mapped onto constructs from three socio-cognitive models of health behaviour (Socio-Cognitive Theory, Theory of Planned Behaviour and Health Action Process Approach). Constructs from the models were targeted using techniques from a taxonomy of behaviour change (Abraham and Michie, 2008). Techniques were chosen through discussion with a Chartered Health Psychologist (VS), e.g. EYS were provided with information about benefits of tooth-brushing and modelling of tooth-brushing. Parents were encouraged to form twice-daily brushing intentions and monitor their child's brushing. Methods for implementing techniques in the nursery setting were discussed with the CDPH (MM) and Head Teacher. Table 1 illustrates how techniques were implemented with reference to psychological theory.

In phase two, the intervention was piloted in the largest SIMD 5 nursery. This nursery had been practicing supervised tooth-brushing for a shorter period of time and had not received previous oral-health interventions. This nursery provided a large sample of EYS, parents and children who took part in the study. The intervention consisted of one training session for EYS (1.5 hours) to implement techniques described in Table 1 through written materials, a video and practical exercises. Parents received an intervention pack consisting of a leaflet (information about goal setting, planning and monitoring) and a two-minute timer and diary. The intervention was called the 'Toothbrushing Olympics' with the first pack (bronze) being given out on the Friday in week one, with two further packs (silver then gold) given out each week. Parents were advised to return diaries to nursery and children who returned their diaries were given a certificate.

Oral-health knowledge, attitudes and behaviours were assessed using a pre-posttest design prior to the intervention and at follow-up (4-7 weeks post-intervention). EYS completed self-report questionnaires during nursery. Of the eight staff at the nursery, two did not attend the session and one failed to complete follow-up measures, leaving  $n=5$  EYS for before and after comparison. No information on baseline characteristics is available for EYS. EYS knowledge outcomes were assessed with five multiple choice questions about tooth-brushing from the Childsmile website ([www.childsmile.org](http://www.childsmile.org)): e.g. 'What is the safest time to give children food or drinks containing sugar?' Correct responses were awarded one point, total ranging from 0-5. Attitudes were measured through four questions adapted from a validated survey of parent's attitudes towards tooth-brushing (Adair *et al.*, 2004). These measured attitudes, e.g. 'It is important to clean children's teeth in nursery everyday' and outcome expectancies, e.g. 'Cleaning children's teeth in nursery helps prevent tooth decay' using a 5-point Likert scale with 1 (strongly disagree) to 5 (strongly agree). Self-efficacy (perceived behavioural control (PBC)) was measured using three items, two from the Theory of Planned Behaviour (TPB) using the same 5-point scale above, e.g. 'Tooth-brushing in nursery can be easily carried out as part of the daily routine'; and one further question: 'How confident are you that you can carry out nursery tooth-brushing on a daily basis' with a 10-item scale (1=not at

all confident-10=completely confident). Previous authors have suggested PBC can be used interchangeably with self-efficacy (Conner and Norman, 2005). Tooth-brushing practice was measured via diaries for two-weeks prior to the intervention and at follow-up.

Parents were met by the first author (AG) during drop-off and pick-up hours at the nursery. Non-contactable parents were sent a letter requesting they make contact. All follow-up measures were administered by telephone interview. Eighty parents were interviewed at baseline,  $n=79$  with a duplicate parent (both parents interviewed) removed. Demographic information is available from Table 3. Parents' socio-economic status was not gathered, however all parents lived in the catchment area for the nursery (SIMD 5 area). SIMD combines domains (e.g. income, employment, health, education, skills and training, housing, geographic access and crime) to rank local deprivation level with 5 signaling relative deprivation in the worst 20% of all SIMD regions in Scotland (Scottish Government, 2006). Following the intervention, 52 parents were followed-up (66% response rate). Three attempts were made to contact parents and there were no differences in baseline demographic characteristics between the follow-up and non-follow-up group (Table 2). There was a greater proportion of female children in the follow-up group (62%), compared with the non-follow-up group (37%) and this resulted in a modest (but not statistically significant) association ( $\chi^2(1)=4.5$ ,  $p=0.06$ ). Baseline information was available for 82 parent-child dyads and 55 dyads at follow-up as three parents gave information about two children (e.g. twins), and 111 children were registered at the nursery during the intervention period. This is the denominator for intervention participation.

Parent's beliefs about tooth-brushing were measured with one question each: 'I plan to brush my child's teeth twice a day' (intentions) and 'I take steps to brush my child's teeth twice a day' (planning). Parents were given example of steps e.g. buying toothbrushes). Finally, 'I find it easy to brush my child's teeth twice a day' (self-efficacy). These used 5-point Likert scales from 1 (strongly disagree) to 5 (strongly agree). Single-item belief measures were used in this study as parents had limited time. Parents self-reported their child's oral-health habits in the previous two weeks: 'How often in the last two weeks has your child brushed their teeth twice a day at home?' A median split coded: 'Twice-daily brushers' and 'less than twice-daily brushers'. Participation amongst families who attended nursery was measured by collecting intervention packs twice each week. These contained their tooth-brushing diary, which was cross-referenced with log sheets completed by EYS to track return of the diaries.

Data analysis was conducted using SPSS for Windows 17.0. Main analyses were mean comparisons using paired t-tests for EYS outcomes. Following Cronbach's alpha calculation to check reliability of the attitudes scale ( $\alpha=0.61$ ), item 3: 'No matter what we do children in nursery are likely to get tooth decay' was removed. Revised Cronbach's reached 0.72. Attitude score was the summed 3-items, range 3-15. Cronbach's alpha for PBC/self-efficacy items was poor ( $\alpha=0.37$ ), therefore the single self-efficacy item was used in the analysis. Binary logistic regression was used to model the effect

**Table 1.** Phase one themes from parents and staff mapped onto theory-based constructs, techniques and intervention methods

Theme	Example statement	Construct(s)	Technique(s)'	Intervention methods
Beliefs about the benefits of preventative actions in the nursery setting (EYS) or in general (P).	<p>"Over the years I have seen deterioration in children's teeth and now it's really awful. It's hard to say...for the tooth-brushing...is it making children more aware? (EYS)</p> <p>"It's confusing because some of them contradict each other, not knowing what's the right thing to avoid and the right thing to give." (P)</p>	<p>Attitudes (TPB) Outcome Expectancies (SCT, HAPA)</p> <p>Risk Perception (HAPA)</p>	<p>Provide general information on behaviour-health link (EYS). Provide information on consequences (EYS).</p> <p>Provide general information on behaviour-health link (P). Provide information on consequences (P).</p>	<p>Presentation and group exercises during training session to highlight benefits of supervised tooth-brushing and susceptibility to decay amongst young children (EYS).</p> <p>Leaflet to highlight effects of dental caries on young children and how to best prevent caries (P).</p>
Often feeling unable to control children's behaviour in nursery (EYS) and at home (P).	<p>"Maybe we need to be supported better in the early months of nursery so we can get better at managing it. Some of these children have never been away from their parents and they are learning a whole new routine." (EYS)</p> <p>"It is hard. They say brush before bedtime – but so often she just falls asleep." (P)</p>	<p>Perceived behavioural control (TPB)</p> <p>Self-efficacy (SCT, HAPA)</p>	<p>Model/Demonstrate the behaviour (EYS). Provide general encouragement (EYS). Provide contingent rewards (P).</p>	<p>Video modelling supervised tooth-brushing process at nursery shown during training session (EYS). Discussed previous good practice and the group explored factors associated with making successful behavioural changes and identified barriers to behaviour change (EYS). Children received a weekly diary and stickers plus a two-minute timer. A leaflet for parents provided tips for tooth-brushing and parents were encouraged to return completed dairies each week to receive a certificate (P).</p>
Importance of role models for oral-health prevention in the nursery; at home and in the wider community; (EYS, P)	<p>"I think it is an awareness issues, in us as much as the parents really. I mean where did we learn these things?" (EYS)</p> <p>"She enjoys doing it, 'cause they all stand together and brush their teeth." (P)</p>	<p>Socio-structural factors (SCT)</p> <p>Subjective norm (TPB)</p>	<p>Provide information about others approval of behaviour (EYS). Provide opportunities for social comparison (P).</p>	<p>Comments from other EYS and parents about the supervised tooth-brushing programme were highlighted during training session. (EYS) Parents and children received intervention materials and certificates in nursery setting and encouraged to take part each week (P).</p>
Finding time and resources to manage oral-health prevention in nursery (EYS) and at home (P).	<p>"An extra body would make it more practical. It is one of the things that is quite dispensable, especially early on." (EYS)</p> <p>"It is down to us to make sure they are brushing and trying to eating healthier, but it's really hard to get her to do it. Especially with all the other things going on, you know." (P)</p>	<p>Intentions (TPB)</p> <p>Goals (HAPA, SCT)</p> <p>Planning (HAPA)</p> <p>Sociostructural factors (SCT)</p>	<p>Prompt specific goal-setting (EYS). Prompt self-monitoring of behaviour (EYS). Provide instruction (P). Prompt intention formation (P). Prompt specific goal-setting (P). Prompt self-monitoring of behaviour (P).</p>	<p>A homework exercise encouraged staff to write down a supervised tooth-brushing goal, how they would achieve this, possible set-backs and methods to overcome these Staff used diaries to monitor their progress (EYS).</p> <p>Leaflet highlighted importance of making plans to be healthy and the importance of specific goals. Parents advised to use the diaries and two-minute timers to monitor their child's behaviour (P).</p>

P=Parents, EYS=Early years staff, SCT=Socio Cognitive Theory, HAPA=Health Action Process Approach, TPB=Theory of Planned Behaviour

'Definitions for each technique available from Abraham and Michie (2008).

**Table 2.** Baseline characteristics of parent-child dyads taking part in the evaluation of the intervention by follow-up status (n=82)

Characteristic	Follow-up (Parents=52, Children=55) %	Non follow-up (Parents=27*, Children=27*) %
<i>Parent Gender*</i>		
Male	13	12
Female	87	88
<i>Child gender</i>		
Male	38	63
Female	62	37
<i>Parent's age group*</i>		
19-24	11	19
25-34	54	62
35-44	31	19
>45	4	-
<i>Child's age*</i>		
2	3	-
3	35	35
4	53	50
5	9	15
<i>Parent relationship to child*</i>		
Mother	83	80
Father	13	12
Other	4 <sup>1</sup>	8 <sup>2</sup>
<i>Child tooth-brushing</i>		
Twice-daily brusher	70	70
< twice-daily brusher	30	30
<i>Child sugar consumption</i>		
Once a day or more	65	67
Less than once a day	35	33
<i>Child fizzy drink consumption</i>		
Sometimes consumed	45	59
Never consumed	55	41
<i>Parent registered with a dentist</i>		
Yes	75	73
No	25	27
<i>Child registered with a dentist</i>		
Yes	82	59
No	18	37
Don't know	-	4
<i>Child last attended dental check-up</i>		
Less than 6 months ago	55	37
6-12 months ago	18	15
Has never attended	5	4
Don't know	4	7
Not applicable	18	37

<sup>1</sup>Foster carer and grandmother. <sup>2</sup>Child's aunt.

\*Data missing for one parent-child

**Table 3.** Knowledge, attitudes and self-efficacy scores amongst early years staff (n=5)

	Baseline m (sd)	Follow-up m (sd)	Significance
Knowledge	3.6 (0.6)	4.8 (0.5)	t(4) = -3.2, p=0.03
Attitudes	9.8 (2.5)	10.2 (1.5)	t(4) = -0.4, p=0.7
Self-efficacy	6.8 (2.4)	7.6 (1.5)	t(4) = -0.9, p=0.4

of the intervention and other predictors on twice-daily tooth-brushing after the intervention according to parent's reports of their child's oral-health behaviour.

The Education Department at the local council and Head Teacher agreed to research protocols and the study received ethical approval from the University of Stirling, Department of Psychology Research Ethics Committee.

## Results

After the intervention, EYS showed significantly improved knowledge and no attitude change or self-efficacy improvement (Table 3). Before the intervention, EYS engaged in tooth-brushing on 97% of eligible occasions over two weeks. Tooth-brushing had been practiced in this nursery since the start of the term, approximately 6 months prior to the intervention. This dropped to 83% over the follow-up two weeks. However, the time EYS took to complete tooth-brushing decreased from a mean of 13 minutes to 11 minutes.

Most (77%) children took part in the intervention in at least 1 of the 3 weeks. Half (49%) completed all three weeks. There was a significant relationship between completing the intervention and being followed-up,  $\chi^2(1)=3.8$ ,  $p=0.05$ . Compared with those who were could not be contacted (37%), follow-up parents were more likely to have completed all three weeks (62%). Chi-square analyses found parents who were followed-up after the intervention were significantly more likely to have reported at baseline that their child was registered with a dentist than non-follow-up parents,  $\chi^2(1)=3.9$ ,  $p<0.05$ . However, no differences were found in tooth-brushing behaviour at baseline.

Factors predictive of twice-daily brushing after the intervention were investigated using stepwise binary logistic regression analysis using the forward method. Twice-daily brushing post-intervention was the dependent variable. The likelihood of children being twice-daily brushers (1) or less than twice-daily brushers (0) was assessed based on predictors: twice-daily brushing pre-intervention (past behaviour); whether the parent-child dyad completed the intervention and whether the child was registered with a dentist, entered as dichotomous predictors. Change in parental beliefs about tooth-brushing at home was entered as a continuous predictor. Stepwise regression was chosen to reduce the risk of multicollinearity as two continuous predictors (intentions and planning) were correlated (e.g.  $r=0.6$ ,  $p<0.01$ ). There was also a significant positive correlation between intentions and how easy parents found tooth-brushing twice a day ( $r=0.4$ ,  $p<0.01$ ).

Past behaviour significantly added to the model and the omnibus test of model coefficients was,  $\chi^2(1)=8.73$ ,

**Table 4.** Parents' intentions to brush their child's teeth twice a day at home (n=52)

	Baseline m (sd)	Follow-up m (sd)
Completers	4.7 (0.5)	4.9 (0.3)
Non-completers	4.6 (0.7)	4.7 (0.5)
Significance	t(51)=1.2, p=0.2	t(51)=1.6, p=0.01

$p < 0.01$ . Before adding other predictors, correct classification occurred in 75.5% of cases. The estimated variance explained by the regression model with past behaviour added was 23% (Nagelkerke  $R^2$ ), with correct classification of 77.4% of cases. Parents reporting their child brushed less than twice daily before the intervention were 0.1 (95% confidence interval: 0.03–0.53) times less likely to report their children brushing twice a day after the intervention. None of the other predictors significantly contributed to the model.

Parents' beliefs about tooth-brushing were compared before and after the intervention using repeated measures analysis of variance (ANOVA) with completion as an independent factor. Interaction effects between completion and time were tested. Planned comparisons using paired and independent t-tests were used to test for significant differences in parental beliefs over time and between completers and non-completers. To reduce the likelihood of Type 1 errors occurring the significance level was corrected to an overall significance of 5% (i.e.  $p < 0.05$ /number of tests being conducted). For each belief four tests were conducted with a significance level of  $p \leq 0.01$  required to reject the null hypothesis. Additionally, as the scales were positively skewed the data was also tested with non-parametric tests with no difference in the results using this method.

There were significant main effects for completion status and time for intentions to carry out twice-daily brushing. These increased over the intervention period,  $F(1, 51) = 5.4$ ,  $p = 0.03$ , and completers were more likely than non-completers to intend to brush their child's teeth twice a day at home,  $F(1, 51) = 5.1$ ,  $p = 0.02$ . Independent t-tests for the difference in beliefs for completers and non-completers after the intervention were significant whilst there were no significant differences before the intervention (Table 4). This interaction did not reach significance in the repeated measures model. Paired t-tests for beliefs scores before and after the intervention were non-significant,  $t(51) = -2.2$ ,  $p = 0.03$  at the more conservative p-value. Analysis of parents' plans for twice-daily tooth-brushing at home showed no main effects or interactions for completion status or time and no further analysis was conducted. Parents' beliefs about how easy it was to carry out twice-daily brushing for their child at home showed only a main effect for completion,  $F(1, 51) = 13.3$ ,  $p < 0.01$ . The completers were more likely to find twice-daily tooth-brushing with their child at home easy before the intervention, completers mean 4.6 (sd 0.8); non-completers mean 3.8 (1.3) and after the intervention, 4.7 (0.7) and 3.8 (1.2) respectively.

## Discussion

The training session for EYS provided information about benefits of nursery tooth-brushing and consequences of poor oral-health behaviours in the early years. This did not lead to changes in attitudes or behaviour, possibly reflective of the limitations of health education. Despite using theory-based psychological approaches, at follow-up EYS decreased their supervised tooth-brushing practice. Possible contributing factors to this failure are: staff absences and adverse weather decreasing staffing ratios;

training may not have adequately targeted attitudes and beliefs or encouraged planning and self-monitoring and the short training session did not include follow-up to review staff goal attainment (Abraham and Michie, 2008). Further research is required on how to encourage EYS to adopt evidence-based interventions (e.g. supervised tooth-brushing); possibly through an intervention to address the practical barriers.

Despite reasonable participation there was no evidence of oral-health behaviour change amongst nursery children. Previous research with five years olds in a school environment used tooth-brushing diaries as a method of reinforcing positive behaviours during holiday periods (Pine *et al.*, 2000). However, the results are not comparable as no information was provided about oral-health habits before and after the self-monitoring period. Completing the current intervention did not predict children's brushing status at follow-up. Only children's past brushing behaviour (self-reported by parents) predicted twice-daily tooth-brushing after the intervention. Possible explanations are that the intervention failed to engage families who were not previously twice-daily tooth-brushing or that brushing is part of a habitual response pattern, making it difficult to change, particularly amongst deprived communities where home-based routines may be more chaotic (Scottish Government, 2008). A more intensive individual-level intervention might be required here. Given that parents' intentions and self-efficacy did not change, it is unsurprising there was no effect on behaviour. It is possible the constructs targeted are not the most important predictors amongst parents from deprived areas. External factors, such as availability and cost of brushing equipment, may be equally important. However, this seems unlikely as there had been a public health programme in the area for several years, providing free toothpicks over the early years. Also parents completing the intervention had greater intentions to carry out tooth-brushing and found tooth-brushing easier, both before the intervention and at follow-up period. A socio-cognitive approach is supported by other studies, suggesting that parents of children from less affluent areas have less positive attitudes towards tooth-brushing and are less confident about their ability to brush (Adair *et al.*, 2004; Pine *et al.*, 2000).

Limitations to this pilot study include: evaluation without a control group, reliance on self-report measures, no long-term follow-up and a reasonably high-drop-out rate. Future interventions could use a stratified-controlled design, including randomly allocated separate nursery sites to avoid contamination. As parent's accounts of their child's tooth-brushing is likely to be sensitive to social desirability and recall bias, validated objective measures should be used where possible, e.g. caries incidence. Long-term follow-up is also required to demonstrate effectiveness (or ineffectiveness) of future interventions. The high drop-out rate experienced by EYS and parents in this study, although not uncommon in deprived communities (Yancey *et al.*, 2006), is problematic. Although parents who were followed up were more likely to have completed the intervention, there were no differences in baseline oral-health behaviour between groups. The number of parents who stated their child was registered with a dentist at baseline was higher in the 'completion'

group; however, in the logistic regression analysis this factor did not predict follow-up brushing behaviour suggesting it did not bias results.

In conclusion, the present study used a novel design and recent advances in behaviour change science to explicitly target socio-cognitive factors. The approach made use of qualitative research with the target population in order to identify predictors of oral-health behaviours. Notwithstanding this approach, the intervention did not improve oral-health attitudes and behaviours of EYS, parents and children. However delivery was feasible in a deprived community and well-received by participants. Targeting individuals who would most benefit from psychological interventions to improve health behaviours continues to be a challenge. As seen here, families are more likely to take up preventative health interventions where they have more favourable attitudes and oral-health habits to begin with. The failure to find a significant intervention effect in the present study may be due to problems engaging with 'difficult to reach groups'. Continued research to identify how best to target socio-cognitive factors is important (e.g. Ashford *et al.*, 2010), and should involve the use of theory-based behaviour change techniques to change oral-health attitudes and behaviours.

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