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School-based intervention for improving the oral health of children in southern Thailand

P.E. Petersen[1], J. Hunsrisakhun[2], A. Thearmontree[2], S. Pithpornchaiyakul[2], J. Hintao[2], N. Jürgensen[1] and R.P. Ellwood[3]

[1]Department for Global Oral Health and Community Dentistry, Centre for Health and Society, University of Copenhagen, Copenhagen, Denmark; [2]Department of Preventive Dentistry, Prince of Songkhla University, Had Yai, Songkhla, Thailand; [3]Colgate Palmolive Company, Piscataway, New Jersey, USA

Objective: A two-year study assessed the benefit of an enhanced oral health promotion program combined with a closely supervised tooth brushing program in schools, using toothpaste containing 1,450 ppm F^- and 1.5% arginine, on oral health and dental caries. ***Methods:*** 15 southern Thailand schools and 3,706 pre-school children were recruited: 8 schools with 1,766 children as controls; 7 schools with 1,940 children in the intervention groups. Of the intervention schools five were classified as cooperative school and two as non-cooperative schools, based on the criteria of 80% participation in the prescribed tooth brushing activities. ***Results:*** The DMFT and DMFS increments *("enamel and dentine")* were 1.19 and 1.91 for the control group and 1.04 and 1.59 for the intervention groups. These represent 12.6% and 16.8% reductions in caries respectively. The DMFT and DMFS increments *("dentine threshold")* were 0.26 and 0.44 for the control group and 0.19 and 0.29 for the intervention group, representing 26.9%, and 34.1% reductions in caries incidence respectively. For the more cooperative schools the benefits were greater: up to a 40.9% reduction in caries for DMFS *("dentine threshold")*. At the 24 month examination there were significant improvements in dental plaque scores with greater improvements seen in the intervention group, greater still in the cooperative schools. ***Conclusions:*** This study documents the positive effect from use of fluoridated toothpaste (1,450 ppm F^- and 1.5% arginine) administered by schoolteachers and undertaken via an enhanced school oral health program. Optimising oral health interventions for young children in Thai schools may have a significant impact on caries incidence resulting in reductions of up to 34% reductions in caries for all schools included in the study and up to 41% for the most cooperative.

Key words: *health education, disease prevention, dental caries, fluoride, arginine, oral health, Thailand, tooth brushing*

Introduction

In Thailand, the level of dental caries in young children is high despite efforts to control the disease through public health programs. The national oral health survey conducted in 2012 (Dental Public Health Division, 2013) found that for 12-year-olds the prevalence of dental caries of permanent teeth measured at the cavitation level was 52.3% with a mean DMFT of 1.3. For the deciduous dentition in 5-year-olds the prevalence was 78.5% with a mean dmft of 4.4 and for 3-year-olds the mean dmft was 2.7. Regional differences were found throughout the country with the prevalence of dental caries in Southern Thailand higher than in other regions.

It is suggested that a holistic approach to development of healthy lifestyles and creation of healthy environments is needed in schools and families to promote oral health of schoolchildren (Jürgensen and Petersen, 2013). To achieve sustainable healthy lifestyles, oral health education for children should ideally be based on problem-based learning and involve the active participation of children, parents and communities. An oral health education component can be provided actively by "significant others" such as school-teachers. Programs of this type are currently unreported in Thailand (Jürgensen and Petersen, 2013).

Thailand has long experience of health interventions at the school level with extensive school-based supervised brushing and fissure sealant programs. In Southern Thailand school-based tooth brushing for primary school children has been advocated and is practiced in many schools. However, the implementation is inconsistent and dependent on the enthusiasm of teachers to ensure that it is correctly carried out (Pithpornchaiyakul *et al.*, 2009). Although school-based health promotion programs are well accepted in Thailand it is reported that only 38.5% of primary schools in the country conduct teacher-supervised tooth brushing programs (Dental Public Health Division, 2002). Therefore, it is important to encourage the significant others to children, especially the schoolteachers, to take the key roles in health promotion of children (WHO, 1995; 2003).

Most oral health programs in Thailand have focused on primary school children, while there are fewer activities targeted at pre-school (kindergarten/nursery) children. There is significant scope for improvement of oral health among young children, particularly among the underprivileged groups and children at high risk of dental caries, through the optimisation of school programs. The development of an enhanced school program to include oral health education for pre-school children and parents,

Correspondence to: Professor Poul Erik Petersen, University of Copenhagen, Faculty of Health Sciences, School of Dentistry, Department for Global Oral Health and Community Dentistry, Centre for Health and Society, Oester Farimagsgade 5, P.O. Box 2099, DK-1014 Copenhagen K, Denmark. Email: poep@sund.ku.dk

combined with enabling and monitoring tooth brushing with efficacious toothpaste formulations, both in school and at home, should significantly reduce dental caries and improve the oral health of children in Thailand relative to the current regime.

Promoting children's oral health through schools is strongly recommended by the World Health Organization (Petersen, 2003) the potential for actions has been described in detail in the manual "*World Health Organization. Oral health through schools. Geneva: WHO Document 11, 2003*" (WHO, 2003). The appropriate school oral health initiative focuses on oral self-care practices, effective use of fluoride, healthy lifestyles in relation to diet and nutrition, personal hygiene and healthy environments related to the school and access to optimal sanitary facilities. Although the families of young children often have limited awareness of and engagement with oral health, young children tend to deliver to other family members those messages learnt in school. Improved communication of oral health will consequently support the development of sustainable oral and general health practices of children and parents. The essential oral health messages to young children and families reinforced throughout a health education project are: 1, brush your teeth morning and evening; 2, use effective fluoridated toothpaste; 3, reduce the number of sugary snacks and drinks per day; and 4, consume healthy foods such as fruits and vegetables (WHO, 1995; 2003).

A key component to oral health interventions is the provision and use of efficacious toothpaste formulations (WHO, 2003). Fluoride toothpastes with higher levels of fluoride, for example 1,500 ppm F^- as opposed to 1,000 ppm F^-, have been shown to be more efficacious (Walsh *et al*., 2010). Recently, a series of clinical studies suggest that addition of 1.5% arginine in a calcium abrasive system may also improve toothpaste efficacy through effects on oral/plaque pH and provision of calcium to aid remineralisation (Cummins, 2013). For example, a two-year clinical study using this formulation has demonstrated a 20% reduction in cavity formation compared to toothpaste containing the same level of fluoride (Kraivaphan *et al*., 2013). This formulation combined with inclusion of 1,450 ppm F^- could be expected to have an impact on oral health and cavity prevention and enhance the benefits of a school-based brushing program.

The aim of this study was to assess the oral health benefit of a comprehensive oral health intervention program combined with a closely supervised tooth brushing program in schools, using a tooth paste containing 1,450 ppm F^- and 1.5% arginine.

Methods

This study was an examiner blind, parallel group, two intervention community-(school-) based randomised controlled clinical trial conducted in Songkhla Province, Thailand. The fluoride level in the drinking water was assessed by collecting samples of water from the homes of pupils involved in the study. Before the start of the study, the study protocol was reviewed and approved by Prince of Songkhla University Research Ethics Committee.

Schools were selected randomly to take part in the study by ranking on socio-demographic criteria supplied by the education department. Following this, schools were randomly assigned to intervention and control groups. All children initially aged 4-6 years in the schools were then invited to participate. To take part each child had to have a consent form signed by a parent or guardian.

The target sample size for this study was based on an assumption of a mean caries increment of 2.0 teeth in the control group and 1.7 teeth in the intervention group (15% effect size) with a standard deviation of 3.0. A power of 80% and test level of significance of $p<0.05$ were also selected. Based on these assumptions a sample size of 1,575 subjects per group at the end of the study has been calculated. To take account of loss to follow up during the study a total sample size of 3,500 participants was targeted.

Two school-based oral health programs were assessed. In the first or control group, children in principle followed the policy of tooth brushing with fluoridated toothpaste after lunch. This policy was unstructured with weak or often no supervision by teachers. If children brushed they used fluoride toothpaste with 1,000 ppm F^- or less with uncontrolled amounts of toothpaste applied. This reflects the current practice in Songkhla Province. In the second or intervention group, supervised tooth brushing was carried out in the school after lunch. A soft bristled toothbrush and fluoridated tooth paste were supplied to every child and kept in school. In addition; toothpaste and toothbrushes were provided for use at home by participants. Children in the intervention group were supplied with a tube of 1,450 ppm F^- toothpaste containing 1.5% arginine (Colgate Palmolive, Thailand) and a toothbrush at intervals of eight weeks.

The intervention group also benefited from an enhanced oral hygiene program and classroom-based health education. The research team provided two comprehensive capacity-building workshops for the school teachers. These "Understanding the project and related knowledge for improving oral health of children" workshops focused on the development of skills and positive attitudes to oral health, knowledge of oral disease, awareness of healthy diet and nutrition, disease prevention and the importance of proper oral hygiene. The teachers then provided health education to the children under their supervision and engaged their parents and caretakers. A second workshop was conducted at the end of second semester in order to exchange the teachers' experience on project implementation. This consisted of how to conduct tooth brushing after lunch activities in the schools, how to provide oral health education to school children as well as how to communicate with pupils' parents or caretakers to support oral health care for their children. Teachers shared what they learned with each other at different stages in the process.

The key activities included in the intervention schools were;

1. The teachers should supervise pupils to brush their own teeth after lunch for at least two minutes with pea size of toothpaste (0.25 g) for each age group and finally rinse with a minimal amount of water and spit once after tooth brushing
2. The teachers aimed to provide oral health education to children at least twice in each semester or four times a year

3. The teachers should regularly communicate to parents or caretakers about improving children's oral health.

The research team also provided new materials each year to the teachers. Examples included; dental models or posters regarding effective tooth brushing, music CDs, a flipchart and games related to improving oral health of pupils. At the beginning of the project, a poster demonstrating how to brush children's teeth at home effectively was sent to all parents or caretakers of project children. In addition every two months, a leaflet containing: 1, monitoring questions to check whether the children received project toothbrush and fluoridated toothpaste to use at home and whether children followed the protocol on tooth brushing at home; and 2, various games and information on improving oral health was distributed to every parent or caretaker. Annually a brochure with information on how to improve oral health of children was also sent out to parents. Messages included; the importance of primary teeth, bad and good food for health and oral health, effective tooth brushing for children.

During the implementation period, the research team monitored school activities twice a year. The first monitoring was implemented 2-3 weeks after conducting workshop to ensure that they commenced interventions. A second monitoring visit was conducted in the second semester.

Clinical examination of the study participants was conducted by an examination team of five dentists independent of the health promotion team to help maintain objectivity. Prior to the start of the study the examiners were trained in dental caries diagnostic criteria and recording of dental plaque. Four examiners were calibrated against one trained examiner. To qualify to conduct the examinations examiners had to achieve Kappa scores greater than 0.7.

Teeth were initially assessed for presence of plaque using the criteria of Sillness and Loe (1964). Six surfaces were scored with the Plaque Index (PI); 55/16 buccal, 51/11 labial, 65/26 buccal, 85/46 lingual 71/31 labial and 75/36 lingual. Caries examinations were conducted based on modified WHO criteria (WHO, 1997; 2013) and included enamel lesions. Teeth were cleaned and dried before examination as appropriate by wiping the teeth with a piece of gauze. For heavy debris, the children's teeth were brushed with their toothbrushes. Fibre Optic Trans illumination (FOTI, Microlux, Addent Inc, Danbury, Connecticut, USA) and the WHO probe were used to assist in the detection and assessment of lesions.

For statistical analysis, caries scores for the permanent dentition were calculated for teeth (DMFT) and tooth surfaces (DMFS) affected. Two thresholds for the DMF index were calculated to include: 1, "enamel and dentine" lesions (codes 1-4); and 2, only "dentine" lesions (codes 3-4). The primary outcome for the study was DMFS at the dentine threshold of examination ($DMFS_{3\text{-}4}$). The mean caries increments and change in oral hygiene scores (difference between baseline and 24 month examinations) for the control and intervention groups were compared using two-tailed t-tests with the level of statistical significance set at $p<0.05$.

Intervention schools were also classified as "cooperative" and "non-cooperative" based on their participation in project activities. To be classified as a cooperative school at least 80% of children in the study conducted the tooth brushing with the prescribed method.

Results

A total of 15 schools encompassing 3,706 pupils were recruited to the study. Overall 8 schools with 1,766 pupils were assigned to the control groups and 7 schools with 1,940 pupils to the intervention group. At the 24 month examination, 915 of these pupils were not examined: 380 from the control group, 535 from the intervention group (Figure 1). Reasons for loss to follow up included absence

Table 1. Mean dental caries at baseline and caries increment after 24 months for teeth (DMFT) and surfaces (DMFS). Standard Deviation (sd) indicated in brackets.

DMF	*Baseline*		*Difference from Baseline after 24m*		*% reduction compared to control*	*p*
	Control	*Intervention*	*Control*	*Intervention*		
All schools	n=1,343	n=1,373	n=1,343	n=1,373		
$DMFT_{1\text{-}4}$	0.10 (0.47)	0.10 (0.46)	1.19 (1.46)	1.04 (1.33)	12.6	0.005
$DMFT_{3\text{-}4}$	0.03 (0.24)	0.03 (0.23)	0.26 (0.69)	0.19 (0.57)	26.9	0.005
$DMFS_{1\text{-}4}$	0.16 (0.87)	0.15 (0.78)	1.91 (2.79)	1.59 (2.38)	16.8	0.001
$DMFS_{3\text{-}4}$	0.04 (0.42)	0.03 (0.03)	0.44 (1.25)	0.29 (1.03)	34.1	0.001
Non-cooperative schools †	n=1,343	n=463	n=1,343	n=463		
$DMFT_{1\text{-}4}$	0.10 (0.47)	0.13 (0.52)	1.19 (1.46)	1.22 (1.44)	-2.5	0.719
$DMFT_{3\text{-}4}$	0.03 (0.24)	0.03 (0.27)	0.26 (0.69)	0.24 (0.64)	7.7	0.567
$DMFS_{1\text{-}4}$	0.16 (0.87)	0.18 (0.88)	1.91 (2.79)	1.90 (2.55)	0.5	0.962
$DMFS_{3\text{-}4}$	0.04 (0.42)	0.04 (0.32)	0.44 (1.25)	0.36 (1.07)	18.2	0.206
Cooperative schools †	n=1,343	n=910	n=1,343	n=910		
$DMFT_{1\text{-}4}$	0.10 (0.47)	0.09 (0.43)	1.19 (1.46)	0.95 (1.27)	20.2	<0.001
$DMFT_{3\text{-}4}$	0.03 (0.24)	0.02 (0.20)	0.26 (0.68)	0.17 (0.54)	34.6	<0.001
$DMFS_{1\text{-}4}$	0.16 (0.87)	0.13 (0.72)	1.91 (2.79)	1.43 (2.27)	25.1	<0.001
$DMFS_{3\text{-}4}$	0.04 (0.42)	0.03 (0.29)	0.44 (1.25)	0.26 (1.00)	40.9	<0.001

† Schools of this type in the intervention group compared to the whole of the control group

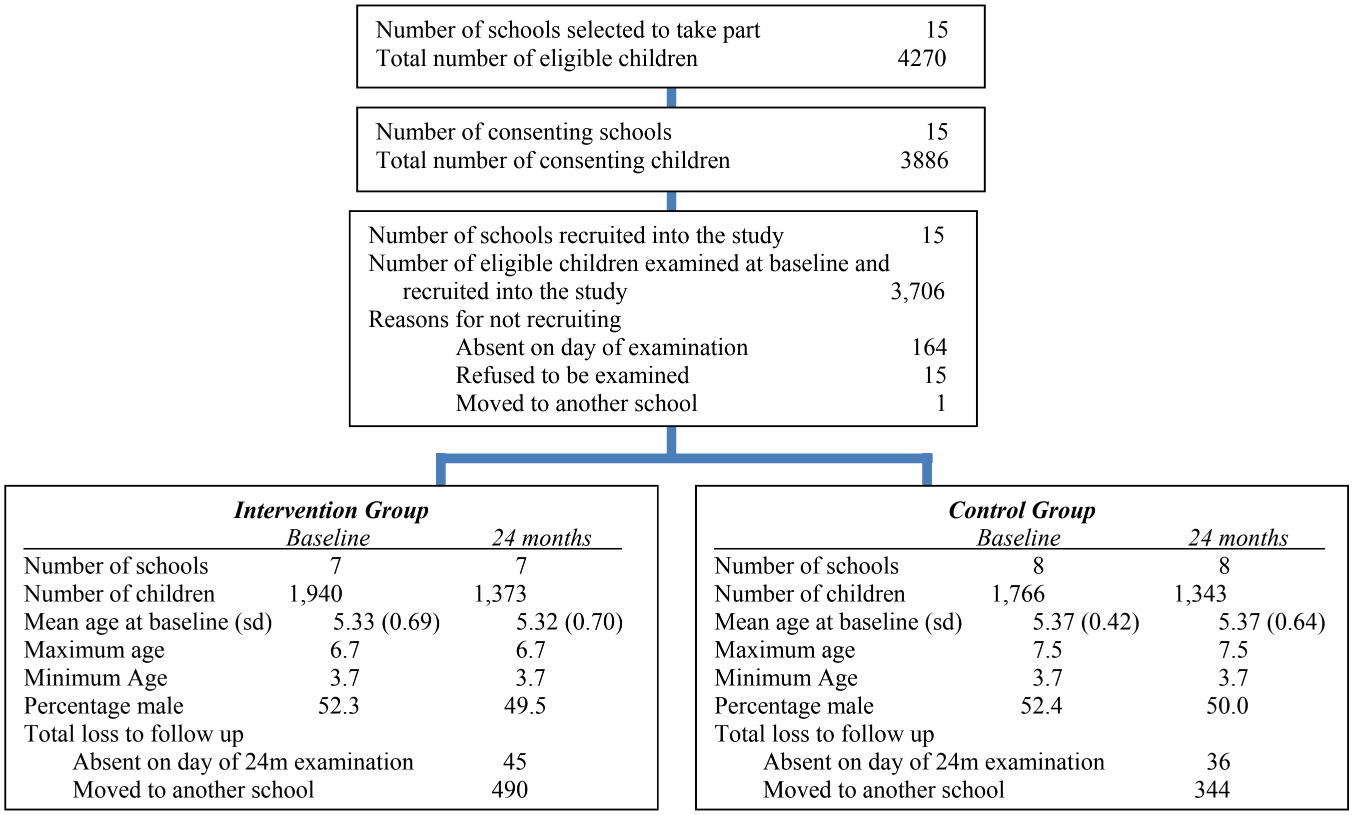

Figure 1. *Disposition of subjects during the course of the study*

Table 2. Mean dental plaque score at baseline and changes in dental plaque scores after 24 months. Standard Deviation (sd) indicated in brackets

	Baseline		*Difference from baseline after 24 months*		*p*
	Control	*Intervention*	*Control*	*Intervention*	
All schools	n=1,343	n=1,373	n=1,343	n=1,373	
All teeth	1.55 (0.56)	1.56 (0.53)	0.01 (0.70)	-0.19 (0.70)	<0.001
Anterior teeth	0.65 (0.73)	0.64 (0.70)	0.38 (0.97)	0.22 (0.95)	<0.001
Posterior teeth	1.99 (0.62)	2.01 (0.59)	-0.17 (0.78)	-0.39 (0.79)	<0.001
Non-cooperative schools†	n=1,343	n=463	n=1,343	n=463	
All teeth	1.55 (0.56)	1.60 (0.52)	0.01 (0.70)	-0.02 (0.64)	0.376
Anterior teeth	0.65 (0.73)	0.72 (0.76)	0.38 (0.97)	0.37 (0.94)	0.911
Posterior teeth	1.99 (0.62)	2.04 (0.57)	-0.17 (0.78)	-0.22 (0.71)	0.230
Cooperative schools†	n=1,343	n=910	n=1,343	n=910	
All teeth	1.55 (0.56)	1.54 (0.53)	0.01 (0.70)	-0.27 (0.71)	<0.001
Anterior teeth	0.65 (0.73)	0.60 (0.67)	0.38 (0.97)	0.14 (0.92)	<0.001
Posterior teeth	1.99 (0.62)	2.00 (0.61)	-0.17 (0.78)	-0.48 (0.81)	<0.001

† Schools of this type in the intervention group compared to the whole of the control group

on the day of examination and moving to other schools. Based on the implementation of the programme five of the seven intervention schools were classified as cooperative schools and two as non-cooperative (before data collection).

At the baseline examination, after examining 24 subjects the intra-examiner reliability Kappa scores ranged from 0.83-0.88 and for inter-examiner reliability 0.82-0.83. At the 24 month examination, after examining 24 children they were 0.87-0.92 and 0.82-0.85 respectively.

At baseline there was good balance between the study groups with respect to age, gender and clinical measures (Figure 1 and Table 1). Summaries of the baseline DMFT and DMFS for the two examination thresholds are shown in Table 1. It can be seen that as would be expected in this young population, with newly erupting first molars, the caries prevalence was initially low with $DMFT_{1\text{-}4}$, $DMFT_{3\text{-}4}$, $DMFS_{1\text{-}4}$ and $DMFS_{3\text{-}4}$ of 0.1, 0.03, ≤0.16 and ≤0.04 respectively. Dental plaque scores were however

Table 3. Mean DMF indices for the 7, 8 and 9 year-old children at baseline who were examined to ensure end point balance for the control and intervention groups Standard deviation (sd) in brackets

Type of school	*Balancing group at baseline (Total)*		*p*
	Control	*Intervention*	
All schools	n=312	n=324	
$DMFT_{1-4}$	0.96 (1.35)	1.15 (1.50)	0.099
$DMF_{T3-}4$	0.32 (0.78)	0.28 (0.72)	0.576
$DMFS_{1-4}$	1.37 (2.23)	1.68 (2.58)	0.098
$DMFS_{3-4}$	0.46 (1.32)	0.39 (1.09)	0.430
Non-cooperative †	n=312	n=105	
$DMFT_{1-4}$	0.96 (1.35)	1.55 (1.71)	0.002
$DMFT_{3-4}$	0.32 (0.78)	0.37 (0.81)	0.543
$DMFS_{1-4}$	1.37 (2.23)	2.41 (3.22)	0.002
$DMFS_{3-4}$	0.46 (1.32)	0.52 (1.26)	0.673
Cooperative †	n=312	n=219	
$DMFT_{1-4}$	0.96 (1.35)	0.95 (1.35)	0.943
$DMFT_{3-4}$	0.32 (0.78)	0.24 (0.67)	0.235
$DMFS_{1-4}$	1.37 (2.23)	1.34 (2.14)	0.869
$DMFS_{3-4}$	0.46 (1.32)	0.32 (0.99)	0.158

† Schools of this type in the intervention group compared to the whole of the control group

high with a mean score of approximately 1.5 for all teeth and scores of 0.6 and 2.0 on the anterior and posterior teeth respectively (Table 2).

In addition to examining the children participating in the study, an additional group of 7-9 year-olds was examined at the start of the study. The purpose of these examinations was to demonstrate that prior to the intervention the children in the two study groups had similar caries levels at both the start and expected end point of the study. It can be seen that there was good balance between the groups at baseline (Table 3).

The mean fluoride level of the drinking water was 0.10 (sd 0.17) ppm F^-. The percentages of samples in the ranges 0-0.3, 0.4-0.7 and >0.7 ppm F^- were similar for the control group's 235 samples and the 131 intervention group's samples (90%, 9% and 1% vs 89%, 10% and 1% respectively).

The differences in caries incidence between the control and intervention groups after two-years participation in the study are presented in Table 1. It should be noted that during the course of this two-year study no teeth were extracted due to caries in either group. The filled (F) component of the DMFT and DMFS indices represented <8% of the increment.

The $DMFT_{1-4}$, $DMFT_{3-4}$, $DMFS_{1-4}$ and $DMFS_{3-4}$ increments for the control group were 1.19, 0.26, 1.91 and 0.44 respectively compared to 1.04, 0.19, 1.59 and 0.29 for the intervention group (Table 1). These represent 12.6%, 26.9%, 16.8% and 34.1% reductions in caries incidence respectively. For the most cooperative schools the benefits of the program were even more impressive with 20.2%, 34.6% 25.1% and 40.9% reductions in caries incidence for the $DMFT_{1-4}$, $DMFT_{3-4}$, $DMFS_{1-4}$ and $DMFS_{3-4}$ indices respectively.

At the 24 month examination there were significant differences in plaque scores with less plaque seen in the intervention group (Table 2). This was particularly evident for the cooperative schools.

During the course of the 24 months of the study no adverse events were reported.

Discussion

Recently, WHO carried out a global survey of school-based oral disease prevention and health promotion (Jürgensen and Petersen, 2013) demonstrating that adequate fluoride exposure is a cornerstone of numerous school health programs aimed at improving children's oral health status. Within the frame of the school, this is predominantly achieved through the use of fluoridated toothpaste, fluoride rinsing or consumption of fluoridated milk. The choice of vehicle depends on a number of factors related to the specific community context: population of interest, disease pattern, fluoride level in drinking water, available infrastructure, program cost, legal issues and public acceptability (WHO, 1994; Petersen and Lennon, 2004).

As recommended by WHO (1994), affordable fluoridated toothpaste should be made available and used where automatic fluoridation through water, salt or milk is not possible (Jones *et al*., 2005; Petersen and Lennon, 2004). Toothpaste is the fluoride vehicle most widely used globally (Jones *et al*., 2005) and supervised tooth brushing exercises are commonly implemented in schools (Al-Jundi *et al*., 2006; Curnow *et al.*, 2002; Jackson *et al.*, 2005; Petersen and Phantumvanit, 2012; Zero *et al*., 2012). Apart from the regular exposure to fluoride, the supervised tooth brushing at school has the potential to establish a regular oral hygiene practice. Implementing school-based fluoride programs has other benefits as the regular administration can easily be conducted or assisted by teachers (Levin *et al*., 2009; Ohara *et al*., 2000). This is especially relevant in areas with high caries burden, little natural fluoride exposure and shortage of health personnel as is found in southern Thailand. A number of countries have used schools to provide fluoridated milk to children thereby simultaneously addressing healthy diet, nutrition and oral health status of children (Bian *et al*., 2003; Ketley *et al*., 2003; Mariño *et al*., 2001; Riley *et al*., 2005). It must be emphasised that milk fluoridation projects are not implemented in this southern province of Thailand, thus, the exposure to fluoride primarily relates to the use of fluoridated toothpaste.

The efficacy of daily or twice daily brushing with fluoride toothpaste for the prevention of dental caries is supported by some of the strongest clinical trial evidence in dentistry (Ellwood and Cury, 2009; Marinho *et al*., 2003). A meta-analysis of available studies showed that the effect of fluoride toothpaste increased with higher baseline levels of D(M)FS, higher fluoride concentration, higher frequency of use and supervised brushing, and the effect was in addition to the effect of water fluoridation (Marinho *et al*., 2003). The effect of fluoride toothpaste is strongly related to the fluoride concentration and a more recent Cochrane review on fluoride toothpastes of different concentrations confirmed the benefits of using fluoride toothpaste in preventing caries in children and adolescents when compared to a placebo, but only for fluoride concentrations of 1,000 ppm and above (Walsh *et al*., 2010).

In this study we chose to measure caries reductions in the permanent teeth and for this age group this would be primarily based on assessment of newly erupted first molars. There are a number of reasons why this approach was used including; difficulties in longitudinally monitoring caries in the deciduous dentition, when lesions are already present and also the problems associated with naturally shedding teeth and their impact on the missing (m) component of the dmf index. In addition, it would be expected that fluoride toothpaste formulations would have the most benefit on newly developing lesions in the at risk erupting teeth. Other strategies for controlling caries in this group might include fissure sealant programs but these involve significant dental staffing unavailable to this population.

This school-based intervention study has demonstrated that optimising fluoride interventions can have a significant impact on oral health with up to 34 % reductions in caries incidence for all schools included in the study and up to 41% for the most cooperative. Sound understanding of disease prevention, engagement and involvement of teachers were important factors in development of cooperative schools. The study was integral part of an enhanced school oral health program. This benefit is the result of a combination of several interventions including oral health education, training and monitoring in optimal brushing technique, ensuring appropriate regular tooth brushing provision of toothpaste for use at home and use of an optimal toothpaste formulation containing 1,450 ppm F^- toothpaste and 1.5% arginine. The improvements in dental plaque scores for subjects in the intervention group would result in not only reductions in bacterial load and hence possibly caries risk but also suggest more regular and efficient tooth brushing which would result in better delivery of fluoride and arginine from the toothpaste.

The relative contribution of each of these interventions is difficult to assess; however, the contribution of an enhanced toothpaste formulation is likely to have been significant. Many clinical studies have established the benefit of 1,450 ppm F^- toothpaste over and above 1,000 ppm F^- pastes with an approximate 6-12% improvement in efficacy (Walsh *et al*., 2010). It is also not possible in this study to determine what the relative contribution of the fluoride and arginine is to the reductions, however, the inclusion of 1.5% arginine in a toothpaste formulation has been shown to significantly boost fluoride toothpaste efficacy by 20% in a two year clinical study conducted in Thailand (Kraivaphan *et al*., 2013); Other clinical studies have documented the enhanced ability to remineralise enamel lesions and root caries compared to toothpastes containing fluoride alone (Cummins, 2013).

National guidelines for use of fluoridated toothpaste by 4-6 year-old children vary by country. The recommendation made by the UK Dental Public Health in 2009 emphasises that 4-6-year-old children should use a pea-sized of 1,500 ppm F^- toothpaste (Department of Health, 2009). Similar guidelines for use of fluoridated toothpaste are given by WHO (1994). WHO (2010) highlights the importance of achieving an optimal balance of fluoride exposure so that the health benefit is maximised and the risk of enamel fluorosis is minimised. It is suggested that national guidelines for Thailand for use of quality toothpastes are formulated to ensure that the population would have optimal exposure to fluoride for prevention of dental caries.

In 2011, an international conference was organised in Thailand by the Thammasat University and the Thai Dental Association, in collaboration with WHO (Petersen and Phantumvanit, 2012). The meeting focused on Asian experiences from use of fluoride through community-oriented administration (Petersen *et al.,* 2012), use of fluoride by professionals (Lo *et al.,* 2012), and through self-care (Zero *et al.,* 2012). As regards toothpastes, the meeting established that suboptimal fluoridated toothpastes are widely used in several countries of Asia and therefore there is an urgent need for setting of international guidelines for administration of effective fluoridated toothpastes.

Regarding experience sharing after the end of the project, teachers who were trained by this project reported that they felt more confident to provide oral health education to their pupils directly as well as to discuss this with pupils' parents. In addition, the teachers especially in preschool level continued to encourage their new pupils to brush following the project's suggestion even after the project had finished. The teachers also reported that the project's pupils have more discipline and ability to brush their own teeth more than the non-project's pupils who are in the same age. It is noteworthy that providing oral health education by teachers to young children is a key strategy to encourage the pupils enjoy and practice tooth brushing in an efficient way as the academic schedules are more flexible and based on learning by doing and playing rather than when they are in primary school level. Furthermore, some parents reported that the printed material they received, especially a poster about tooth brushing for children, was particularly helpful to ensure that children brushed optimally.

Conclusion

Across the world, the school is considered an important platform for oral health promotion and disease prevention. Healthy lifestyles including regular toothbrushing with use of fluoridated toothpaste are essential to achieve better dental health of children. This can be more readily achieved when the family and schools are involved in oral health promotion. This study carried out in Southern Thailand documents the positive effect from use of fluoridated toothpaste (1,450 ppm F^- and 1.5% arginine) administered by schoolteachers and undertaken within the context of an enhanced school oral health program. It is concluded that enhancing oral health interventions for young children in schools in Thailand can have a real impact on the incidence of dental caries resulting in reductions of up to 34% for all participating schools and up to 41% for the more cooperative.

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