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Comparative School Dental Sealant Program to Alleviate Dental Caries Problem — Thai versus International Perspective

Sukanya Tianviwat

Additional information is available at the end of the chapter

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1. Introduction

The application of dental sealant has been recommended for caries prevention in pit and fissure surfaces. For school dental sealant programmes, the Community Preventive Services Task Force recommends the implementation of school dental sealant delivery programs based on strong evidence of their effectiveness in preventing dental caries among children [1]. In the United States, school-based dental sealant programs have been implemented successfully around the country, and the American Association for Community Dental Programs and the National Maternal and Child Oral Health Resource Center have published the guideline of “Seal America” to promote the implementation of this program [2]. School dental sealant program offer several advantages over other approaches [2, 3]: increasing access to dental service among deprived children, strengthening the relationship between schools and health care institutions, and establishing the follow-up and maintenance system of the dental sealant program.

The implementation of school dental sealant programs differs from country to country. Most of the evidence of effectiveness of these programs are found in well-equipped studies conducted in developed countries. This chapter will present more than fifteen years of scientific experience of the program operating among rural primary school children in Thailand and make comparisons with scientific data published in international journals. The scope of this chapter will include several topics related to school dental sealant programs: their effectiveness, factors related to effectiveness, critical findings and most common failures, and the impact of the program on oral health status.

2. Background

In Thailand, the dental sealant program was initiated in 1996 and has been delivered to children on either a “school-based” or a “school-linked” pattern [3, 4]. In the school-based pattern, dental equipment is carried out by the dental health section of the community hospital, which visits all schools in the area under its responsibility at least once a year. Each school visit lasts 1-2 days. The mobile dental clinic, with portable field equipment, is transported from the hospital to schools by van. The equipment includes a patient chair, a portable artificial light, an operator stool, a master unit with slow-speed and high-speed handpieces with a triple syringe, a portable suction and a light polymerization unit. A temporary clinic is usually set up in an available area at each school (Figures 1 and 2). In the school-linked or hospital-based pattern, by contrast, the children receive dental sealant at the district or sub-district hospital (Figure 3). Children are screened by dentists or dental nurses at school and the parents requested to bring their children to the hospital to receive sealant. Some hospitals, however, request school teachers to bring the group of children whose parents have given permission for the child to receive dental sealant to the hospital. Some hospitals combine the two patterns of dental sealant delivery program – a school-based pattern for children in areas remote from a hospital and a school-linked pattern for children who live nearby.



Figure 1. Mobile dental equipment delivered to school by van.



Figure 2. Mobile dental equipment set up in an available area at a school where dental services are delivered.

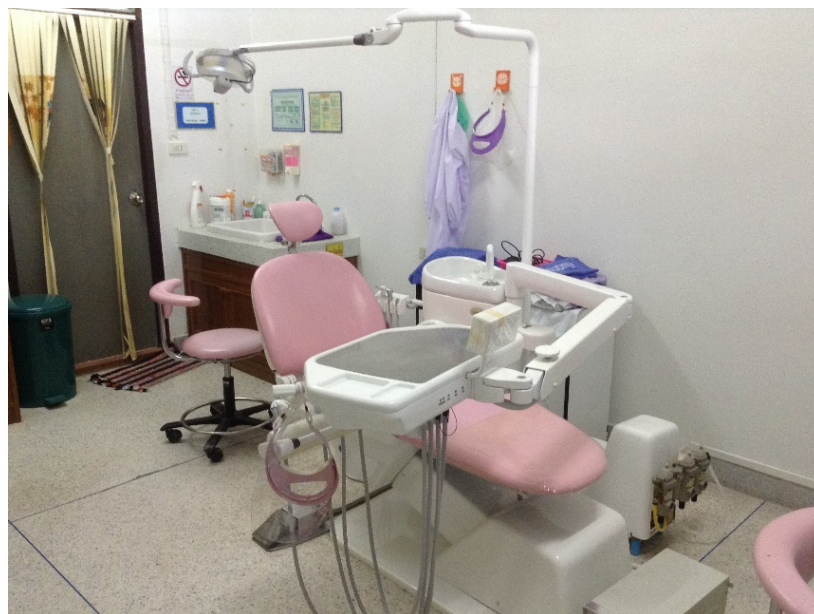


Figure 3. Dental equipment at a district or a sub-district hospital

In 2005, the Dental Health Division, Ministry of Public Health, Thailand, initiated the Oral Health Promotion and Prevention in School Children Project under the National Health Security with the slogan “Yim Sodsai Dek Thai Fun Dee” project, which can be translated as “Bright Smile and Healthy Teeth in Thai Children” [5]. One of the objectives of this project is to achieve 50% of the first grade children with an average 2.5 teeth that have received dental sealant, especially the first permanent molars. Due to this universal coverage project the number of 12-year-old children whose teeth were sealed increased from 12.7% in the year 2007 [6] to 35.2% in the year 2012 [7].

In the following text, the phrase “school dental sealant program” is used to refer to both “school-based and school-linked dental sealant programs”. The content of this chapter is based mainly on reports of the sealant program implementation published since 1996, which was the year of that marked the beginning of the school dental sealant program. Experimental studies, such as those concerned with sealant materials or properties, are not included. The main content is based on resin sealant, which is in widespread use in the school programs.

3. Effectiveness of the school dental sealant program

Evaluation of the effectiveness of school dental sealant programs has been evaluated mostly on the basis of the percentage of full retention sealant and/or percentage of caries on sealed surfaces. Tables 1 and 2 compare such rates between Thailand [8-17, 25] and other countries [18-24]. Because of differences in the pattern of dental sealant delivery, in the summary of the setting, the terms “hospital” or “clinical setting” are used to represent the use of stationery dental equipment and “mobile clinic” to represent the use of mobile van or mobile dental equipment.

Major differences in sealant effectiveness between Thailand and other countries are evident. International publications report high percentages of full sealant retention within 1 to 5 years; 52.7-91.0 % [18-20, 22, 24], 74.7-85.0 % [20, 22, 24], 61.7-81.0 % [22, 24], 76 % [22] and 69% [22]. Very high long-term sealant retention at 15 and 20 years of 65% has also been reported [21]. In that study, the children had continuous access to comprehensive dental services. Moreover, the caries rate on sealed surfaces was generally low: 0.8-10.7% of the sealed teeth at one year [18-20]. Within 2 years, 0.9% of sealed surfaces had caries [20] and at 5 years 8% [22]. Very low long-term caries rate has also been reported 5.0 and 13.0% at 15 and 20 years respectively [21]. Results from Australia [23] are difficult to compare because of variation in follow-up time for evaluation of sealant retention in the study.

In Thailand, school dental sealant programs present a major difference from international results. Full sealant retention at one year in Thailand has varied between 19.6 and 67.7% [8, 9, 12, 13, 16] and that at 2 and 3 years from 8.9 to 41.8% [11, 14 - 17] and from 0 to 52.1% [9, 10, 12, 17], respectively. Moreover, higher rates of caries on sealed teeth in Thailand have been reported. At one year, the caries rate on sealed surfaces was 24% [16] and at two years 14.5-32.6% [11, 13-17]. In 2014, the 5-year caries on sealed surface rate was reported to be 13.4% [25].

In a follow-up study of sealant effectiveness in Thailand based on the Markov model [12], in which sealant was evaluated every 6 months for 30 months, the rate of sealant loss decreased with time. The first six months after application was the most vulnerable period of sealant retention, with a loss of 32.8% of teeth while caries incidence surged in the first year and also in the subsequent six months, the caries rates on sealed teeth were 10.2 % and 16.9 % in 1 and 1.5 years.

These data from the Markov model are in concordance with data presented in Tables 1 and 2, which show that school dental sealant in Thailand had relatively short-term retention and most of the caries on sealed teeth develops within 1-1.5 years after application.

4. Factors related to the school dental sealant effectiveness

Sealant retention depends on the time since application. For short-term retention, loss of sealant is related to application technique and saliva contamination. Long-term retention, on the other hand, is related to masticatory function and wear. However, a recent report of the strategy adopted to improve sealant effectiveness indicated that sealant policy also had an effect on sealant effectiveness [26]. Since, in Thailand, most of the studies have examined sealant effectiveness over the short term and have shown rather poor effectiveness, the related factors have included those dealing with basic techniques, sealant delivery conditions and strategies to improve dental sealant performance comprising attitude of the provider and sealant policy [8, 9, 26]. By contrast, international studies have dealt with more advance techniques and policy to increase coverage or access to sealant [27-32].

As mentioned above, loss of sealant in Thailand occurs within 6-12 months; such loss is related with techniques and factors of moisture control. In a study of factors related to short-term sealant retention in Thailand [8], the researcher controlled for sealant type, oral hygiene, child's cooperation and position of the teeth. After reviewing sealant procedure according to manufacturer's instruction, sealant was performed within the routine program, and after sealing for 6 months the sealant retention was examined. It was found that the checking procedure and the presence of an assistant were significant factors influencing full sealant retention. The odds of full sealant retention increased significantly, 2.8 times, when the providers checked for both occlusion and sealant retention compared with checking for sealant retention alone. The presence of an assistant increased the odds of full retention 2.3 times when compared to not having an assistant present. The shortage of dental assistants was also found to be a limitation in optimizing the mix of basic dental services (sealing, filling and extraction) for southern Thai schoolchildren [33]. This study identified the limited number of dental assistants as the crucial constraint for school dental service delivery.

The setting of the Thai school sealant program, i.e., school-based or mobile dental clinic and school-link or hospital-based dental clinic, has also been investigated as a potential factor in sealant effectiveness [9, 26], but with conflicting results. One study reported that the application of sealant in a school-based or mobile setting significantly increased the rate of sealant loss compared to that done in a hospital-based setting [26]. The other study reported a higher

percentage of full sealant retention in school or mobile dental clinics than in hospital-based dental clinics [9]. However, the mobile dental conditions of two studies were different. The latter study employed a split mouth design with high power suction and the presence of a dental assistant. In each child, a dentist provided sealant on the two lower first permanent molars and restricted the number of children to be sealed in order to reduce the providers' stress from working. In this study, the percentage of full sealant retention was the highest among the studies of sealant effectiveness in Thailand (please see Table 1). On the other hand, the former study conducted in an actual situation, employing a mobile dental clinic with saliva ejector, and with no restriction on number of children or number of teeth to be sealed. Therefore, either hospital-based or school-based dental clinic could provide good results if optimal conditions for sealant – good moisture control and no tension of provider – are fulfilled. Moreover, the researcher [9] discussed that children felt more comfortable in school setting than hospital-based setting.

A recent study on strategies to improve sealant performance yielded an interesting result regarding providers' attitude and sealant policy [26]. The study examined whether audit and feedback could improve the quality of application of dental sealant in rural Thai school children. The design was a single-blind, cluster-randomized controlled trial. Sealant qualities (retention and caries), were examined prior to and after the intervention. The intervention consisted of confidential feedback of data and tailor-made problem-solving workshops. After the audit and feedback, focus group discussions (FGD) were conducted in 6 intervention clusters, including 22 dental nurses. The participating dental nurses were asked how they felt about the results from the audit and feedback and what they did when they received feedback indicating poor sealant quality. It became apparent that the participants had two distinct reactions to such feedback. The impression emerging from their direct statements was of a conflict between the quantity of children treated and the quality of service they received. On the other hand, their indirect statements indicated their wish to identify problems and to find ways of solving the problems identified by the data in the feedback. The dental nurses in all the clusters complained that the policy, which aims to maximize the number of cases in whom sealant is applied, has resulted in poor service quality because the goal of the policy does not take account of the actual situation in terms of the available manpower, overall workload, number of children needing to be treated and the condition of their teeth.

In the international perspective, more studies than in Thailand have been conducted on techniques to improve sealant effectiveness. Such studies have examined surface preparation before sealing [28, 29], four-handed sealant condition [30] and type of operator [22].

Gray et al. (2009) [28] conducted a study to review manufacturers' instructions for surface preparation in sealant use. Ten sealant products from five manufacturers which were commonly used in school sealant programs were included. The use of pumice, prophylaxis paste or prophylaxis brush was included in five products, implying handpiece use. The other five products were nonspecific. Seven products indicated that the use of fluoride-containing or oil-containing pastes should be avoided. None of the products mentioned that the operator should perform enameloplasty, fissureotomy, air abrasion or air polishing to clean the tooth surface before placing the sealant. However, one product directed the operator to remove minimal caries with a small round bur in a slow-speed handpiece after surface cleaning. In the same

study, the authors conducted a review of studies comparing sealant effectiveness between mechanical preparation with pumice and using an air-water spray with sharp probe and found two studies of clinical design. Both studies reported retention rates greater than 96% at one year after sealing. Various modes of fissure preparation in combination with two filling levels were studied by Geiger (2000) [29]. In this *in vitro* study, fissure preparation was divided into three groups; no mechanical preparation, mechanical preparation with a round carbide bur, and mechanical preparation with a tapered fissure diamond bur. Then, sealant filling level in each preparation group was subdivided into minimal filling (just to the border of pit and fissure) or overfilled. The result showed that sealant penetration and retention were significantly improved in mechanically prepared compared to non-prepared fissures and preparation with a tapered fissure diamond bur was superior to that with a round carbide bur. Overfilled fissures caused significantly higher levels of micro leakage. However, nowadays, the sealant placement recommendation developed by an expert working group supported by the Centers for Disease Control and Prevention (CDC) does not recommended additional surface preparation methods, such as air abrasion or enameloplasty [27].

The effect of having a dental assistant or four-handed delivery for sealant application was reviewed after controlling for various factors, namely years since placement, tooth-surface cleaning method, isolation technique, and type of primary operator [30]. The review included 11 studies; eight studies using four-handed delivery and the other three using two-handed delivery. Summary retention rates in studies using four-handed delivery were higher than those in studies using two-handed delivery at 1, 2 and 3 years; 89.8% vs 84.8%, 83.0 % vs 72.4% and 83.0% vs 67.9%, respectively. Multivariate analysis indicated that four-handed delivery increased sealant retention by about 9 percentage points compared with two-handed delivery.

Most school dental sealant application in Thailand is implemented by dental nurses. From Tables 1 and 2, the sealant effectiveness does not obviously differ between dentists and dental nurses. In other countries sealant application in school programs is mostly done by dentists (Table 1 and 2). There was the review to identify the effect of operator and sealant effectiveness [30]. This review showed unexpected finding of the association between having a dentist as the primary operator and lower sealant retention rates. The authors suggested two possible reasons for unexpected results. First, many dentists likely had limited experience with sealant materials and/or placement techniques. And the studies in which dentists were the primary operators may have been less likely to provide training in sealant placement than the studies in which the primary operators were non dentists.

There has been an effort to distribute the simple task of sealant application to other dental personnel, i.e., dental assistants [22] or dental therapists [23]. Very high sealant was achieved when sealing was performed by a dental assistant [22]. In another study, conducted in Australia [23], it was difficult to evaluate the performance of dental therapists owing to variation of follow-up time of the sealant. It seems, therefore, that type of operator is not a critical factor influencing sealant effectiveness.

Table 1. Full sealant retention rates in Thailand and other countries by period of follow-up

First author, year	Age, tooth	Number of children, teeth at baseline	Setting, Provider	Material	Full sealant retention rate (% of teeth)							
					Period of follow-up (years)							
					1	2	3	4	5	10	15	20
Thailand												
Tianviwat, 2011 [8]	Grade 1 ⁵ , M1	206, 347	M, DN with or without DA	Light-cured resin	67.7*							
Choomphupan, 2011 [9]	6-9, M1	212, 848	M, D H, D	Light-cured Helioseal F	62.7 42.5		35.9 24.6					
Charnvanishporn, 2009 [10]	Grade 1 ⁵ , M1	175, 355	M, NA	NA			52.1					
Thamtadawiwat, 2008 [11]	6-8, M1	183, 349	H, DN	Light-cured Prevocare		41.8						
Tianviwat, 2008 [12]	Grade 1 ⁵ , M1	184, 332	M and H, DN	Light-cured resin	54.8		30.7 [†]					
Obsuwan, 2008 [13]	6-8, M1	500, 2000	H, NA	NA	45.6*							
Kongtawelert, 2008 [14]	6-8, M1	865, 2193	H, DN without DA	Light-cured resin		36.0						
Kantamaturapoj, 2008 [15]	6-8, M1	320, 1280	H, NA	Resin (not specific)		33.2**						
Thipsoonthornchai, 2003 [16]	6-7, M1	107, 107	M, NA	Light-cured resin	19.6	8.9						
Tianviwat, 2001 [17]	6-7, M1	102, 260 20-21 months: 86 teeth 32-33 months: 174 teeth	M, DN	NA		18.6**	0***					
Other countries												
Hsieh, 2014 Taiwan [18]	6-9, M1	122, 229	M, 1D:1DA	Light-cured 3M ESPE	86.0							
Muller-Bolla, 2013 France [19]	6-7, M1	253, 421	H, 1D:1DA	Light-cured Delton	52.7							
Francis, 2008 Kuwait [20]	6-8, M1	452, 1372	H, D	Light-cured Delton plus	79.8	75.0						
Wendt, 2001 Sweden [21]	NA, M1 NA, M2	45, 153 45, 161	H, D H, D	Self-cured Delton						65.0	65.0	
Holst, 1998 Sweden [22]	6-10, M1 11-14, M2	976, 3218	H, DA	Light-cured Delton	91.0	85.0	81.0	76.0	69.0			
Messer, 1997 Australia [23]	6-12, All	774, 2875	H, 2DT: 1DA	NA Conceal	56.0 (1-48 months)							
Bravo, 1996 Spain [24]	6-8, M1	104, 416	M, 1D:1DA	Light-cured Delton	87.3	74.7	61.7					
⁵ average 6-8 years old; * follow-up at 6 months; [†] follow-up at 30 months; ** follow-up at 20-21 months; *** follow-up at 32-33 months M1 = first permanent molar; M2 = second permanent molar; All = permanent premolar and molar; NA = not available M = mobile dental equipment or van; H = hospital or clinical dental equipment; DN = dental nurses; D = dentist; DT= dental therapist; DA= dental assistant												

Table 2. Caries rates on sealed surfaces in Thailand and other countries by period of follow-up

First author, year	Age, tooth	Number of children, teeth at baseline	Setting, Provider	Material	Caries rate on sealed surfaces (% of teeth)							
					Period of follow-up (years)							
					1	2	3	4	5	10	15	20
Thailand												
Plengsringam, 2014 [25]	Grade 1 ^s , M1	473, 1795	NA, NA	NA						13.4		
Charnvanishporn, 2009 [10]	Grade 1 ^s , M1	175, 355	M, NA	NA			21.5					
Thamtadawiwat, 2008 [11]	6-8, M1	183, 349	H, DN	Light-cured Prevocare		16.3						
Tianviwat, 2008 [12]	Grade 1 ^s , M1	184, 332	M and H DN	Light-cured resin			26.1 [†]					
Obsuwan, 2008 [13]	6-8, M1	500, 2000	H, NA	NA		32.6						
Kongtawelert, 2008 [14]	6-8, M1	865, 2193	H, DN without DA	Light-cured resin		14.5						
Kantamaturapoj, 2008 [15]	6-8, M1	320, 1280	H, NA	Resin (not specific)		29.7*						
Thipsoonthornchai, 2003 [16]	6-7, M1	107, 107	M, NA	Light-cured resin	24	25						
Tianviwat, 2001 [17]	6-7, M1	102, 260 20-21 months: 86 teeth 32-33 months: 174 teeth	M, DN	NA		22.1*	21.9**					
Other countries												
Hsieh, 2014 Taiwan [18]	6-9, M1	122, 229	M, 1D:1DA	Light-cured 3M ESPE	6.1							
Muller-Bolla, 2013 France [19]	6-7, M1	253, 421	H, 1D:1DA	Light-cured Delton	10.7							
Francis, 2008 Kuwait [20]	6-8, M1	452, 1372	H, D	Light-cured Delton plus	0.8	0.9						
Wendt, 2001 Sweden [21]	NA, M1 NA, M2	45, 153 45, 161	H, D H, D	Self-cured Delton						5.0	13.0	
Holst, 1998 Sweden [22]	6-10, M1 11-14, M2	976, 3218	H, DA	Light-cured Delton					8			
† average 6-8 years old; * follow-up at 30 months; * follow-up at 20-21 months; ** follow-up at 32-33 months M1 = first permanent molar; M2 = second permanent molar; All = permanent premolar and molar; NA = not available M = mobile dental equipment or van; H = hospital or clinical dental equipment; DN = dental nurses; D = dentist; DT= dental therapist; DA= dental assistant												

[‡] average 6-8 years old; [†] follow-up at 30 months; * follow-up at 20-21 months; ** follow-up at 32-33 months

M1 = first permanent molar; M2 = second permanent molar; All = permanent premolar and molar; NA = not available

M = mobile dental equipment or van; H = hospital or clinical dental equipment; DN = dental nurses; D = dentist; DT = dental therapist; DA = dental assistant

5. Critical findings and most common failures

Most studies of sealant effectiveness have reported sealant retention as full, partial or total loss, and reported caries or no caries on sealed surfaces. However, among these sealant failures, there were a few common or typical types of sealant loss, and these reflect the cause of failures and could suggest how to improve school dental sealant effectiveness [26]. The most common failure scenarios in the Thai context are presented below with illustrations. In each picture, a combination of failures might be seen; however, for explanation purposes the major failure is demonstrated. The causes of failure which were summarized from a problem-solving workshop in the audit and feedback study [26] are also discussed.

5.1. Partial retention with ledge and caries present

The common characteristics of this type of loss are loss of some sealant and a pit/fissure with ledge exposed when exploring with a sharp probe. Caries is present with loss of tissue beyond the boundaries of the pits and fissures on occlusal surfaces and lesions contain demineralized dentine, usually light brown, and have a soft texture when explored with a blunt probe using gentle pressure (Figure 4). This common failure was present in 67.6% of the total caries on sealed surfaces at 6 months follow-up after a single sealant application [26] (data available from author). The same result was found in a long-term follow-up study in the context of high caries risk children in an inefficient school dental sealant program [12]. The effect of partial sealant retention with ledge present is to increase the risk of caries 3.1 times compared with total sealant loss [12]. A study in Scotland [34] confirmed the result: teeth with partially retained sealant at baseline were found to have a significantly higher percentage of caries (22.9%) than teeth with complete sealing (14.4%).



Figure 4. Partial retention with ledge and caries present

One review has addressed the controversy over the caries risk in formerly sealed teeth [35]. The authors examined the risk of caries development in teeth with partially or fully lost sealant relative to the risk in teeth that had never received sealants and concluded that teeth with fully or partially lost sealant were not at a higher risk of developing caries than teeth that had never been sealed. The studies included in the review were conducted in developed countries, where the risk of caries is quite low, the services are provided in well-equipped clinics and the sealant effectiveness is high.

It is obviously important that follow-up and repair of sealant loss should be promoted to increase the effectiveness of any school dental sealant program.

5.2. Loss of sealant at poor oral hygiene surfaces

From observational study, this type of loss accounts for approximately 60.7% of all failures of dental sealant [26]. Poor oral hygiene gauged by the presentation of soft debris covering more than 2/3 of the exposed tooth surface (Figure 5) based on the Debris index of Simplified Oral Hygiene Index [36]. The characteristics are partial or total loss of sealant and the presence of poor oral hygiene. This recent finding indicates a significant effect of poor oral hygiene on failure of sealant retention.

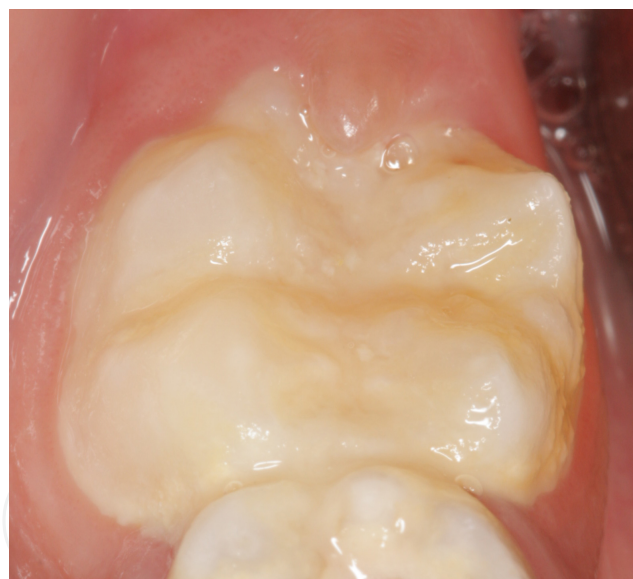


Figure 5. Loss of sealant at poor oral hygiene surfaces

5.3. Loss of sealant at cervical part of buccal pit and groove among lower first permanent molars.

In Thailand, lower first permanent molar is the first priority for the school dental sealant program among grade 1 schoolchildren as the first permanent molars present the highest percentage of caries: 51.4% in 12-year-old children [37]. Among all children, the lower first permanent molars comprised 36.4% and the upper first permanent molars 17.5% of all carious

teeth [5]. The ratio of sealant service between lower teeth and upper teeth varied between 1.4:1 and 2.2:1 [8, 26]. This failure is characterized by a lack of sealant remaining at the lower end of the the buccal pit and groove (Figure 6) and was found in approximately 31.9% of sealed lower permanent molars. The significant concern of the scenario is the frequent presentation of caries development. The causes are related to tooth eruption and policy. Findings from focus group discussion in the sealant study [26] revealed that the policy of achieving 50% of first grade children being sealed placed a considerable burden on providers and had a negative impact on the quality of the program. A study of the eruption pattern in American children [38] found that only 57 % of first graders had all first permanent molars sufficiently erupted for sealing. In Taiwan [18], children aged 6-9 years presented only 46.9% (229 teeth among 488 teeth) of first permanent molars had erupted without decay, and eruption with decay or filling was present in 23.8% (116 teeth among 488 teeth). The loss of buccal surface was higher than that of occlusal surface among lower first permanent molars [23].

A study of eruption pattern of first permanent molar among Thai kindergarten level 2 and grade 1 and grade 2 schoolchildren [39] found that the percentages of at least one first permanent molar eruption were 6.0%, 75.1% and 98.5%, respectively. Among grade-1 children, who are the target group of the school dental sealant program in Thailand, the right lower first permanent molar had erupted 65.3% and caries was found 12.1%, whereas on the left side 64.3% had erupted and caries was present 9.1%. In the context of high caries prevalence, it is likely that the provider might seal teeth that are not in a suitable condition for sealing, such as being insufficiently erupted which more than half of the buccal surface covered by gingival tissue.

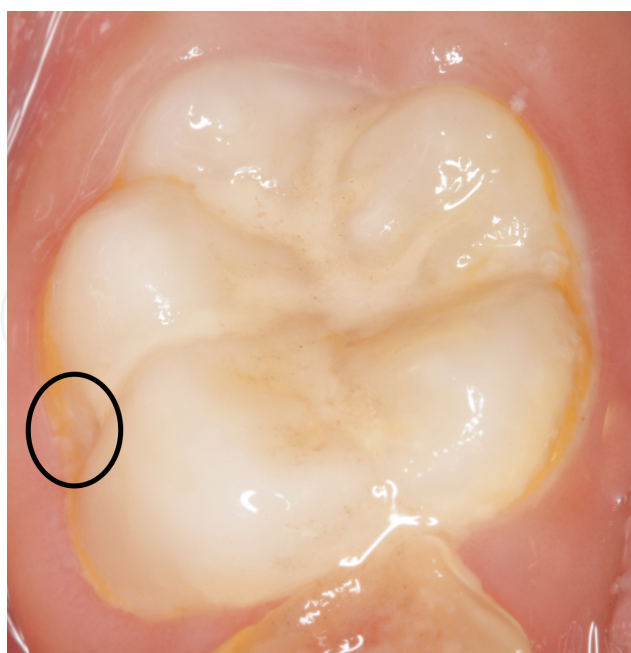


Figure 6. Loss of sealant at cervical part of buccal pit and groove among lower first permanent molars.

5.4. Loss of sealant at distal pit and groove of the occlusal surface of lower molars

The characteristics of this failure were no sealant remaining at the distal pit and groove of the occlusal surfaces of the lower molars and the presence of a ledge (Figure 7). The sealant was often was bulked or thick. This type of failure was seen in 16.3% of sealed lower permanent molars [26] (data available from author). The cause of failure, summarized from the problem-solving workshop, concerned the application technique. The provider used a brush to deliver sealant onto the tooth surface and the excess sealant flowed under gravity collecting in bulk and forming a thick layer at the distal end of the groove. When the children chewed, this area was at risk of fracture.

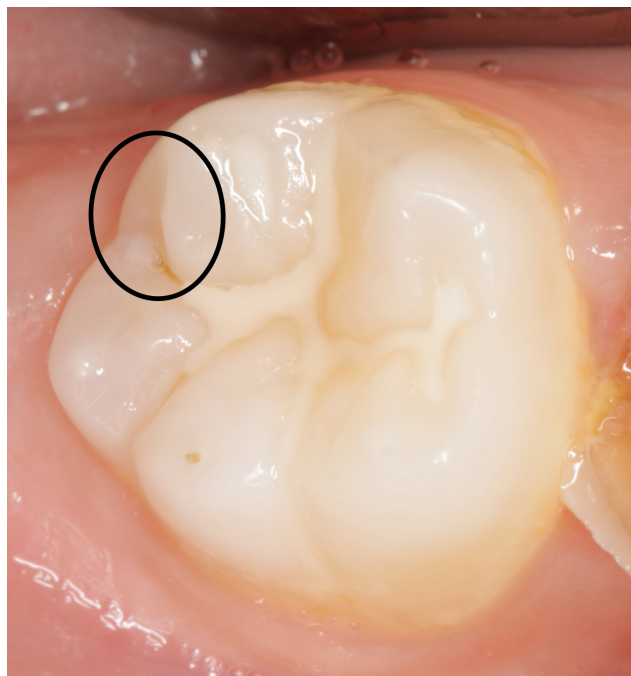


Figure 7. Loss of sealant at distal pit and groove of the occlusal surface of lower molars

There were other failures related with case selection and sealant technique; for instance, operculum covered on sealed surfaces (Figure 8), and void in sealant with or without caries (Figure 9). Most of the failures could be prevented by following the correct sealant procedure and instructions. The study of audit and feedback showed that these common failure scenarios and their own performance data as reflected in retention and caries rates could change the provider's attitude toward dental service quality [26]. The result from focus group discussion showed that they realized the poor quality of the dental service and felt they had to achieve a balance between quantity and quality of school dental sealant. They identified the means of solving their problems of service quality in terms of reallocating manpower, increasing their awareness, and improved equipment maintenance and sealant technique.

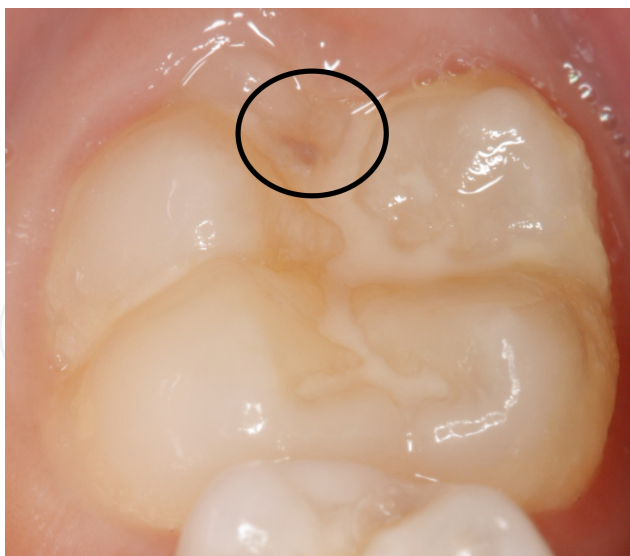


Figure 8. Operculum cover on sealed surface



Figure 9. A void in sealant with caries

6. Impact of school dental sealant on oral health status

Evidence showing the effectiveness of dental sealant for caries prevention is drawn from several scientific papers [27, 40, 41]. Data from the evaluation of the school dental sealant program under the universal coverage of health care service in Thailand are presented. The macro scale data from Ministry of Public Health and data from each area and published in Thai journals are included. The impact of the program on the dental status of children as

reflected in reports of the National Oral Health Survey before and after implementation of the school dental sealant program is also discussed.

As mentioned at the beginning of the chapter, the school sealant program was first implemented in Thailand in 1996 on a small scale [17]. By 2001, the coverage of dental sealant was still very low; only 4.5% of 12-year-old children received dental sealant [42]. In 2005, the Oral Health Promotion and Prevention in School Children Project under National Health Security “Yim (smile) Sodjai (Bright), Dek Thai (Thai Children) Fun Dee (Health Teeth)”, which was a joint project of the Dental health division, Department of health, and the National Health Security Organization was launched [5]. This project was managed as a vertical program by signing a contract between chief executive officers of the Provincial Health Office and the Department of Health. The project included prevention and promotion activities; full mouth examination of first grade and third grade students, sealant for the first grade students, and after-lunch tooth brushing for primary school children. Sealant activities of the project during 2005-2007 were evaluated based on monthly reports via a web-based system. After-lunch tooth brushing activity is an on-going activity which has been conducted since 1988 in the Oral Health Surveillance and Dental Health Promotion Program for primary school children [43].

The percentages of dental examination and sealant activities are presented in Table 3. The data were retrieved from 75 provinces in Thailand. Among first grade primary school children 35.9 – 48.8% had access to dental sealant in the period 2005-2007. In 2007, the number of sealed children was lower than in 2005-2006, partly explained by the diminished incentive for sealant service providers. However, the proportion of sealed children was still lower than that in other countries, for example, Slovenia with 62-100% (1988) [44], Ireland with 50-80% (1997) [45], and the United States with 51.1-88.0% and an extremely low coverage in one area of 41.0% (2002) [46].

The impact of the program was evaluated after two years of implementation based on the number of carious teeth among third grade children who had received sealant when they were in grade 1. Table 4 compares data between grade 3 sealed and unsealed children. Number of caries in first permanent molars among sealed children was 33.1% - much lower than that in unsealed children (66.9%). Nevertheless the number of caries in sealed group was quite high compared to other studies at the same follow-up period in Thai context (please see table 2). Evidence to support dental sealant effectiveness has been reported in several international publications. However, reports of the impact of the school dental sealant program at the macro level are few. In Slovenia, the most recent caries decline during 1987-1998; i.e. from 5.1 to 1.8 for 12-year-olds, and from 10.2 to 4.3 for 15-year-olds, was most likely due to supervised brushing with concentrated fluoride gel taking place several times a year in primary schools attended by children aged 7–15 years, improved oral hygiene, and a comprehensive program of applying fissure sealants, particularly on first molars. The Cochran database published a review of pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents [40]. The review showed that the probability of sealed teeth remaining non-carious in patients who had received resin sealant at 24 months was 4.5 times less than that in the corresponding teeth of unsealed children (relative risk= 0.22; 95% confidence interval 0.34 to 0.22).

Activities	Educational year 2005		Educational year 2006		Educational year 2007	
	Number	Percent	Number	Percent	Number	Percent
Examination grade 1 and 3 (children)	1,299,959	81.3	1,257,486	78.6	941,968	58.9
Sealant grade 1 (children)	414,827	48.6	430,044	48.8	316,404	35.9
(teeth)	1,051,542	NA	1,212,398	NA	901,704	NA
Brushing (school)	28,647 [§]	91.8	27,771 [#]	94.1	27,432 [#]	95.4
(children)	4,604,179 [§]	87.5	4,190,561 [#]	88.6	4,194,000 [#]	92.5

NA = not available; [§] data from 75 provinces; [#] data from 70 provinces

Source: Modified from Jirapongsa W, Prasertsom P. [5]

Table 3. Percentage coverage of dental examination and dental sealant in the Oral Health Promotion and Prevention in School Children Project under National Health Security

Group	Number of examined children	Percent of children who had carious in first permanent molars
Children who receive sealant	149,837	33.1
Children who did not received sealant	303,023	66.9

Source: Jirapongsa W, Prasertsom P. [5]

Table 4. Number of children and percentage of carious first permanent molars classified by sealed and unsealed grade 3 primary school children

An area-based study in Thailand found a marginally significant impact of the program regarding the proportion of children in whom caries was prevented [13]. This was a cohort study comparing sealed and unsealed groups of children. Both groups were enrolled in after-lunch tooth brushing with fluoride toothpaste. Table 5 presents the frequency of caries on first permanent molars in the two groups. A high percentage of early sealant loss was found in this study; at 6 months only 45.6% had full sealant retention – a value that is quite low compared to the data for the same period in Thailand, 54.8-67.7 % (Table 1). Therefore, in the high and early sealant loss area, the caries preventive effect was difficult to reach.

Group	Number of children	Number of children with caries (%)	Caries teeth	
Children who receive sealant	500	163 (32.6)	p-value 0.052	p-value < .001
Children who did not received sealant	500	159 (31.8)		

Source: Obsuwan K. [13]

Table 5. Caries on first permanent molars at 24 months between sealed and unsealed group

The percentages of sealed and unsealed surfaces having caries have been compared in several cross-sectional studies using baseline data from the web-based system and examined caries at the end of the study. Table 6 summarizes the caries data from three studies comparing children who received dental sealant with others who did not. The differences were only marginally significant (rows 1 and 3) or non-significant (row 2). The sealant retention rates in these studies were quite low (please see Table 1). In two of the studies; 42% at 2 years [11] and 33.2% at 20 months [15], although somewhat higher in the third study, 52.1% at three years [10]. Thus, under low effectiveness conditions, caries preventive effect was low.

First author	Number of sealed children at last follow up	Number and percent of caries	Number of unsealed children at last follow up	Number and percent of caries	p-value
Charnvanishporn, 2009 [10]	130	28 (21.5%)	130	54 (41.5%)	0.038
Thamtadawiwat, 2008 [11]	183	57 (16.3%)*	215	56 (13.3 %)*	0.14
Kantamaturapoj, 2008 [15]	300	85 (28.3 %)	300	108 (36.0 %)	0.044

*only carious data at teeth level are available: 57 from 349 teeth (16.3%) among sealed group and 56 from 422 teeth (13.3%) among unsealed group

Table 6. Percentage of caries in sealed and unsealed children

In Thailand, the Dental Health Division, Department of Health, has conducted a National Oral Health Survey every 5 years, the most recent one was the 7th survey conducted in 2012. The data from 4 surveys were used to reveal the impact of dental sealant on the oral health status of children (Figure 10). As the target group of the school dental sealant project was grade 1 primary-school children, aged 6-8 years, the data of 12-year-olds were used. The number of examined children and caries experience in permanent teeth of each survey are shown in Table 7. The survey data did not report caries experience in first permanent molars (only the 4th survey reported caries by tooth), therefore the total caries experience in permanent teeth is present as proxy for caries experience of first permanent molars since 51.4% of caries teeth in 12 years old children were in first permanent molars [37].

The 4th, 6th and 7th surveys were conducted in 17 provinces, 4 provinces from each region (north, south, north-east and central) and Bangkok, the capital province. The sample size of the 5th survey was very large because the Dental Health Division expanded the survey from 17 to 48 provinces and increased the size of the sample for improved representativeness at the provincial level (Table 7). The 4th survey was conducted before the small scale implementation of school dental sealant activity, therefore the data from this survey together with other dental health programs could be used as baseline data. Data from the 5th survey were used to assess the impact of the small scale school dental sealant pro-

gram. The 6th and 7th survey data were used to assess the impact of the large scale program. Caries experience of 12-year-old children from the four surveys is presented in Table 7. Coverage of dental sealant is shown in Table 8. Other dental health care programs implemented during 1994 to date are summarized in Table 9.

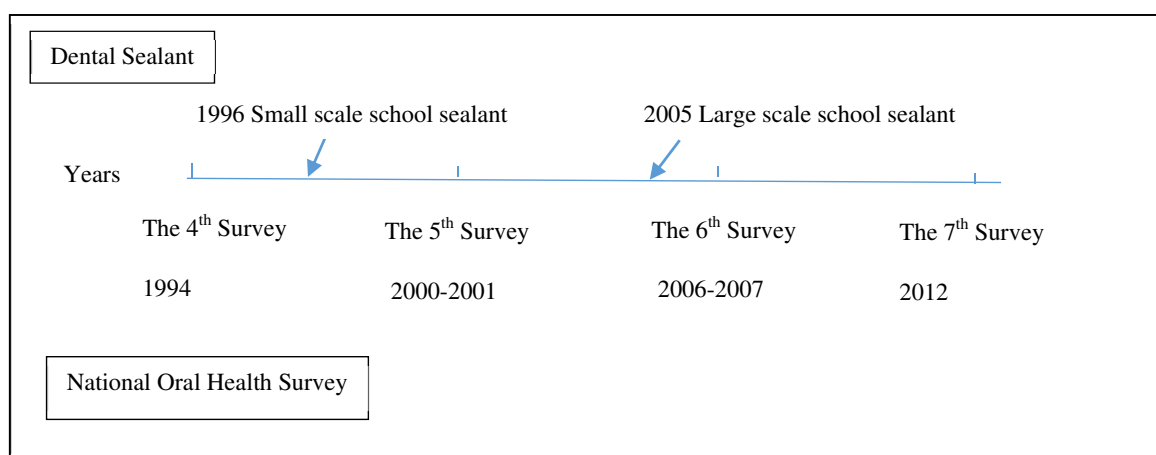


Figure 10. Summary of implementation timeline of National Oral Health Surveys and the dental sealant program

During the period 1994 to 2000/2001 [42, 47], the percentage of children affected by caries increased but the average caries experience in permanent teeth was quite stable (Table 7). The oral health program at that time comprised school dental sealant on a small scale, ongoing after-lunch tooth brushing and oral health education (Tables 8 and 9). However, from the 5th survey, the proportion of children who enrolled every day in the after-lunch tooth brushing program was low, only 26.3%. The proportion of children who brushed their teeth every day was 86.2% in the morning and 34.6% in the evening.

Between 2000/2001 and 2006/2007 [42, 6], caries experience in terms of percentage of children affected by caries and average carious teeth per child among 12-year-olds was slightly decreased (Table 7). Sealant service was increased 2.8 times from the 5th to the 6th survey. This period included the first phase of the large scale implementation of school dental sealant and the campaign to control of sugar consumption, which emphasized the creation of networks and activities in childcare centers. However, the number of sealed children was still low (Table 8). Other dental health activities, such as after-lunch tooth brushing and oral health education, were ongoing. The proportion of children who brushed their teeth every day at school decreased to 21.7% and that of children who did not brush increased to 57.9%. Brushing at home seemed to increase slightly (Table 8).

During the 6th and 7th surveys [6, 7], the proportion of children having caries decreased approximately five percentage points and the average number of carious teeth decreased from 1.55 to 1.3 teeth per child. The percentage of children with sealant at 12 years of age increased from 12.7% to 35.2% (Table 8). The large scale dental sealant was implemented for nearly 7 years. The percentage of tooth brushing occasion continued on the rise. However, snack consumption also increased during the same period (Table 8).

	The 4 th survey [47] (1994)	The 5 th survey [42] (2000-2001)	The 6 th Survey [6] (2006-2007)	The 7 th Survey [7] (2012)
Number of children	2,801	35,623	2,208	2,618
Percent caries	53.9	57.3	56.9	52.3
Mean DMFT and SE	1.6± 0.04	1.64*	1.55*	1.30*

*SE data are not available

Table 7. Number of children, percentage and mean caries experience of 12-year-olds from four surveys

Activities	The 4 th survey [47] (1994)#	The 5 th survey [42] (2000-2001)	The 6 th Survey [6] (2006-2007)	The 7 th Survey [7] (2012)
Dental sealant*	NA	4.5	12.7	35.2
Daily tooth brushing after-lunch	NA	26.3	21.7	17.8 [§]
Tooth brushing occasion [@]	NA	Morning 86.2 Evening 34.6	Every day 89.6 Mean 2.2 times a day	Morning 97.7 Evening 71.5
Use Fluoride toothpaste	NA	94.1	89.9	91.4
Eating snack everyday		NA	28.2	38.8

NA = not available

* received dental sealant and dental sealant presence at 12 years old

Data of 12 years-old were not available since oral health care behavior interviewed in 17 years and older.

§ The question was not specific to after-lunch tooth brushing program at school

@ In each survey, different questions were applied - the 5th and 7th asked whether he/she brushed every day in the morning and evening, the 6th survey asked whether he/she brushed his/her teeth every day and how often

Table 8. Percentage of 12-year-old children enrolled in the oral health prevention and promotion activities

It is difficult to draw conclusion with certainty on the reasons explaining the decline of caries [44]. In Thailand, among 12-year-old children, the important factors related to caries decline seem to be the large scale school dental sealant and frequent tooth brushing with fluoride toothpaste [7]. Since the number of children with sealants in the survey was the number of children who received dental sealant and in whom the dental sealant was still present at 12 years of age, the actual coverage should be larger than the reported figures of 12.7% and 35.2% at the 6th and 7th surveys, respectively. The percentages of children having tooth-brushing behavior with fluoride toothpaste were high. The percentage with normal gingival condition also increased from 18.0% to 29.9% from the 6th to the 7th survey. This increase could be ascribed

to the tooth brushing behavior [7]. However, the eating habit is a major problem that remains to be solved.

Period	Program	Brief activities
1988	Oral Health Surveillance and Dental Health Promotion Programme for primary school Children	Dental examination by school teachers
		After-lunch tooth brushing program
		Oral health education
1996	Small scale school dental sealant	Sealant in grade 1
1999	Health Promoting School (Oral health integrated in health promotion)	Key indicators for oral health; dental examination, no caries on permanent teeth (fillings are acceptable), no gingivitis
		After-lunch tooth brushing with fluoride toothpaste
		Healthy food in school
2003	Sweet enough project	Creating network and campaign to reduce sugar consumption
2005	Oral Health Promotion and Prevention in School Children Project under National Health Security (Large scale school dental sealant)	Full mouth examination grade 1 and 3 children
		Sealant grade 1 children
		After-lunch tooth brushing in primary school

Table 9. Dental health care programs implemented for school children in Thailand

7. Conclusion and suggestion

Although the effectiveness of school dental sealant program in Thailand has continuously improved, there is still much room for further improvement. This chapter has presented the findings on effectiveness and on failures in context of the actual school programs, where more factors are operating than in the context of experimental research. Looking at failures may provide valuable information. In this case, the types of failure could reflect their causes, and be used to improve performance. In the Thai context, short-term retention is still a problem. Improvement in the related factors such as equipment, application technique and presence of chair-side assistant might result in increased effectiveness. Important improvement measures may include adjusting the goal or key performance indicators of the sealant program based on actual workload, adding in some indicator to reflect the quality of the program and initiating evaluation by an external evaluator. The quality indicator must not place additional pressure on providers; evaluation should be reward-based rather than punishment-based. The guideline and recommendation on sealant application should be strictly followed and emphasized to providers.

A school dental sealant program alone could not have much impact on oral health status since its effect is only on pit and fissure surfaces. Comprehensive prevention and promotion should be strengthened, inclusive of dental sealant, tooth brushing with fluoride toothpaste and eating behavior.

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Author details

Sukanya Tianviwat^{1,2}

Address all correspondence to: Sukanya.ti@psu.ac.th

1 Faculty of Dentistry, Prince of Songkla University, Songkhla, Thailand

2 Common Oral Diseases and Epidemiology Research Center, Faculty of Dentistry, Prince of Songkla University, Songkhla, Thailand

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