Cost Effectiveness of Oral Health Care Program implementation in Primary School in Bangkok, Thailand

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ต้นทุนประสิทธิผลของโครงการทันตสุขภาพในกลุ่มนักเรียนชั้นประถมศึกษา กรุงเทพมหานคร ประเทศไทย

น.ส.ณิชา ลักษมีจรัลกุล

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรดุษฎีบัณฑิต
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Thesis Advisor	Professor SATHIRAKORN PONGPANICH, Ph.D.

Accepted by the COLLEGE OF PUBLIC HEALTH SCIENCES, Chulalongkorn University in Partial Fulfillment of the Requirement for the Doctor of Philosophy

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ฉิชา ลักษมีจรัลกุล : ต้นทุนประสิทธิผลของโครงการทันตสุขภาพในกลุ่มนักเรียนชั้นประถมศึกษา กรุงเทพมหานคร ประเทศไทย. (Cost Effectiveness of Oral Health Care Program implementation in Primary School in Bangkok, Thailand) อ.ที่ปรึกษาหลัก : ศ. ดร.สถิรกร พงศ์พานิช

โรคฟันผุเป็นโรคที่พบบ่อยในกลุ่มเด็กปฐมศึกษา การศึกษาย้อนหลังนี้เพื่อวิเคราะห์ปัญหาฟันผุ ปัจจัยเสี่ยงและปัจจัยป้องกันฟันผุในชุดฟันแท้ของกลุ่มเด็กนักเรียนในโรงเรียนประถมศึกษา สังกัดกรุงเทพมหานคร โดยใช้ข้อมูลจากบันทึกการตรวจสุขภาพช่องปากของเด็กนักเรียนจำนวน 433 คน ผลการศึกษาพบความชุกฟันผุสูงในฟันน้ำนมของเด็กชั้น ป.1 ร้อยละ 87.2 ในขณะที่ความชุกฟันผุในฟันแท้ของเด็ก ป.6 พบร้อยละ 51.7 นอกจากนี้การวิเคราะห์ตัวแปรถดถอยพบปัจจัยเสี่ยงที่มีความสัมพันธ์อย่างมีนัยสำคัญทางสถิติกับฟันผุในชุดฟันแท้คือการมีฟันผุในชุดฟันน้ำนม (Adj OR=5.44, 95% of CI = 2.23-13.27) ปัจจัยป้องกันมีความสัมพันธ์อย่างมีนัยสำคัญทางสถิติกับฟันผุในฟันแท้คือการเคลือบหลุมร่องฟันในฟันกรามแท้ซี่ที่ 1 ครบทุกซี่ (Adj OR=0.19, 95% of CI = 0.06-0.63) ชี้ให้เห็นว่าควรมีการตรวจคัดกรองและจัดโครงการทันตกรรมป้องกันเพื่อส่งเสริมสุขภาพช่องปากในเด็กกลุ่มนี้

การวิเคราะห์ต้นทุนประสิทธิผลโครงการทันตกรรมป้องกันในโรงเรียนประถมศึกษาของคณะทันตแพทยศาสตร์ มหาวิทยาลัยมหิดล ในมุมมองของผู้ให้บริการ ต้นทุนทางเศรษฐศาสตร์ของโปรแกรมทั้งหมดคิดเป็นจำนวนเงินเท่ากับ 1,196,839.37 บาท ประกอบด้วย ต้นทุนค่าแรงร้อยละ ต้นทุนวัสดุร้อยละ ต้นทุนค่าเสื่อมอุปกรณ์ครุภัณฑ์ร้อยละ ต้นทุนค่าใช้จ่ายอื่นๆร้อยละ ค่าใช้จ่ายในเรื่องเงินเดือนสำหรับอาจารย์ทันตแพทย์ ค่าวัสดุ และ อุปกรณ์ในการเคลือบหลุมร่องฟันและอุดฟัน คิดเป็นสัดส่วนที่มากที่สุดในต้นทุนค่าแรง ต้นทุนวัสดุ และต้นทุนค่าเสื่อมอุปกรณ์ครุภัณฑ์ ค่าใช้จ่ายรายหัวต่อจำนวนเด็กประถมที่เข้ารับการบริการ คิดเป็นจำนวนเงิน 2,045.88 บาทต่อคนต่อปี อัตราส่วนต้นทุนต่อประสิทธิผลระหว่างกลุ่มเด็กที่ได้รับโปรแกรมครบและกลุ่มที่ได้รับเพียงการตรวจฟันเท่ากับ 2,961.47 บาทต่อการป้องกันฟันผุ 1ซี่

สาขาวิชา สาธารณสุขศาสตร์ ลายมือชื่อนิสิต .....
ปีการศึกษา 2563 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

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Dental caries are common oral diseases in schoolchildren. This retrospective cohort analysis was done to assess caries prevalence, risk and protective factors associated permanent caries among 433 children profiles of school children in selected primary school in Bangkok who received or did not receive a preventive program. Additionally, a cost effectiveness of the program was analyzed. Result revealed that there was high caries prevalence in deciduous teeth (1st grade) 87.2% and mean dmft 6.44 (± 4.4) and caries prevalence in permanent teeth (6^{th} grade) 51.7% and mean DMFT 1.37 (± 1.84). Risk and protective factors associated permanent caries, after logistic regression analysis found only deciduous caries was a significant risk factor associated with caries in permanent teeth (Adj OR=5.44, 95% of CI = 2.23-13.27). Sealant coverage all 1st molars was a significantly protective factor associated with caries in permanent teeth (Adj OR=0.19, 95% of CI = 0.06-0.63). It indicated that early detection and prevention program should be provided for this group of children.

The total estimated costs of school oral health program (SOHP) in provider perspective, was 1,196,839.37 Baht in economic cost. Salaries of supervisor, costs of equipment and material for sealant, PRR and filling were a majority part of labor costs, capital costs and material costs, respectively. Particularly, in capital cost and material costs were accountable for more than half of total costs. Average capitation of SOHP was equal to 2,045.88 baht per child per year. ICER between completed SOHP and examination group was 2,961.47 baht per DMFT avoided.

Field of Study:	Public Health	Student's Signature .....
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I particularly thank all staff members at the College of Public Health Sciences for your convenient help. I would also like to thank my friends. We were not only able to support each other by deliberating over our problems and findings, but also happily by talking about things other than study.

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LIST OF ABBREVIATIONS

dmft(s)	decay missing filling tooth(surface) in deciduous dentition
DMFT(S)	Decay Missing Filling Tooth (Surface) in permanent dentition
OHI-S	Simplified Oral Hygiene Index
DI-S	Simplified Debris Index
CI-S	Simplified Calculus Index
SOHP	School Oral Health Program
CDC	The Centers for Disease Control and Prevention
ADA	American Dental Association
WHO.	World Health Organization
PRR	Preventive Resin Restoration
MoPH	Ministry of Public Health
CAPP	Country/Area Profile Program
CPI	Community Periodontal Index
BMA	Bangkok metropolitan administration
MOE	Thai Ministry of Education
OHI	Oral Hygiene Instruction
ICER	Incremental Cost Effectiveness Ratio

CHAPTER I
INTRODUCTION

1.1 Background and Rationale

Oral disease is very common in children. it is one of the most costly diet- and behavior-related diseases.(1) Untreated oral problem in childhood, if left, it can cause damage, pain, deformity, and more serious general health problems that can lead to poor quality of life. Therefore, oral health in children is an important public health issue. Worldwide epidemiological documents indicated that a number of children affected with dental caries was increasing (2), especially among school children. A large number of children in many low income countries, were affected by dental caries (3), and most were left untreated due to limited access to oral health services (4). In Thailand, dental caries in children still remains a public health problem. The eighth National Oral Health Survey in 2017 reported that 75.6% of 5-to-6-year children and 52.0% of 12-year children were affected by dental caries.(5) Furthermore, the majority of children being affected gingivitis.(6) Oral health problems can affect many aspects of child's life. The delay in treatment not only results in aggravation of disease, but also costs of care are considerably increased as a consequence. Untreated caries not only caused pain but also lost school time, low self-esteem and poor quality of life. The delay in solving the disease not only results in worsening of a problem, but also costs of care are extensively increased as a consequence. Childhood unimpressive dental experience can possibly make impact on dental visiting behaviors together with attitudes to oral health and self-care.

School is an important setting for oral health promotion in Thailand. It can provide a supportive environment, for example, providing place and sanitation facilities for tooth promotion activities. More importantly, schools may be a place where oral health services are provided for high risk children, who had limited access to dental care. This is common situation in many low income countries, compounded by a lack of dental personnel (1). Oral health promotion programs in Thailand have focused on primary school children, there is an important scope for improvement of

dental health among young children, particularly among the underprivileged groups and children who are at high risk of dental cavity, through the optimization of school programs. The supporting an enhanced school program to include oral health education, combined with enabling and monitoring tooth brushing with efficacious toothpaste formulations, should significantly decrease dental decay and improve the dental health of children in Thailand relatively to the current regime.

Oral problems result in considerable costs. Dental treatment costs about 5% to 10% of the total health expenditures or billions of dollars in developed countries each year. At this amount, the cost of dental services could easily use the country's entire health budget in many low-income countries (7-9). These expenditures can be allocated to the social and educational budgets. Additionally, in the US, dental problems cause in losing more than 50 million school hours in learning. The effect on quality of life of children, daily activities, and parents' working hours are considerable high. In terms of financial, personal and social impacts, neglect of dental care also costs high. Progression of the disease may need advance treatment that more complex, costly and possibly more traumatic, for example, root canal therapy, extractions, surgery for abscess drainage, treatment under general anesthesia and hospitalization. Poor oral health in children if continues into adult, will make impact on quality of life and economic productivity. A previous study has indicated investing in prevention and promotion program in oral health reduces costs in health expenditures and, in the long-term, it is more cost-effective. Early diagnosis and timely treatment are therefore essential in efforts to contain the costs of oral diseases. Early onset of diseases is reversible, with appropriate measures and treatment care. Advanced or progress lesions become more serious and difficult to treat. Obviously, it must be emphasized that prevention is better than cure.

Thailand has long experience of school health interventions with extensive school-based tooth brushing and sealant programs. School-based tooth brushing for primary school children has been promoted and is practiced in many schools. However, the project is inconsistent and dependent on the enthusiasm of teachers to ensure that it is correctly carried out (10). Even though oral health promotion programs in school are long-time established, it is stated that teacher-supervised tooth brushing programs were conducted in only 38.5% of primary

schools in the country. Oral health education is a traditionally one of preventive dentistry, there has been a burden of justified criticism that involves considerable investments of time, energy, personnel and money. (11)

Cost analysis of school oral health program related to oral health status improvement. It can be used as a stand-alone technique and not necessary to combine with effectiveness assessment technique, Cost analysis, itself, can be used to compare alternative techniques. This is one of the good tools to evaluate allocation of health resources. In conclusion, to improve oral health of school-children, the effective oral health promotion program in school should be developed and implemented. Community Dentistry Department of Mahidol University has implemented an oral health program in public primary schools for several years. To make the best use of available dental care resources as well as to plan effectively for future service needs, information on resource inputs and service outcomes are essential. Data on the quantities and costs of resource inputs indicate the amount of funds required to continue the program.

This research studied on resource allocation for basic dental services in Mahidol oral health program focusing on preventive treatments. The success of the program was evaluated and the protective factors for preventing dental caries in grade 6 students were identified using the retrospective cohort design. Additionally, we estimated the cost of delivering different dental services in the program to inform decision making about the allocation of resources between different services for studied school children from the total resources, and the cost-effectiveness of the program was evaluated.

1.2 Research questions

- What are the protective factors for permanent caries of Mahidol oral health program in school?
- What are costs of Mahidol oral health program in school?
- Is Mahidol oral health program in school effective?

1.3 Hypotheses

- There were some preventive treatments in Mahidol oral health program as the protective factors for permanent caries.

- Caries prevalence observed in children who received complete preventive treatments in Mahidol oral health program was less than caries prevalence observed in children who did not receive any preventive treatments in the program (the control or comparison group).
- Mean DMFT observed in children who received complete preventive treatments in Mahidol oral health program was less than mean DMFT observed in children who did not receive any preventive treatments in the program (the control or comparison group).

1.4 Research objectives

1.4.1 General objective

To assess the cost-effectiveness of a school based oral health preventive program of Mahidol University in selected primary school in Bangkok.

1.4.2 Specific objectives

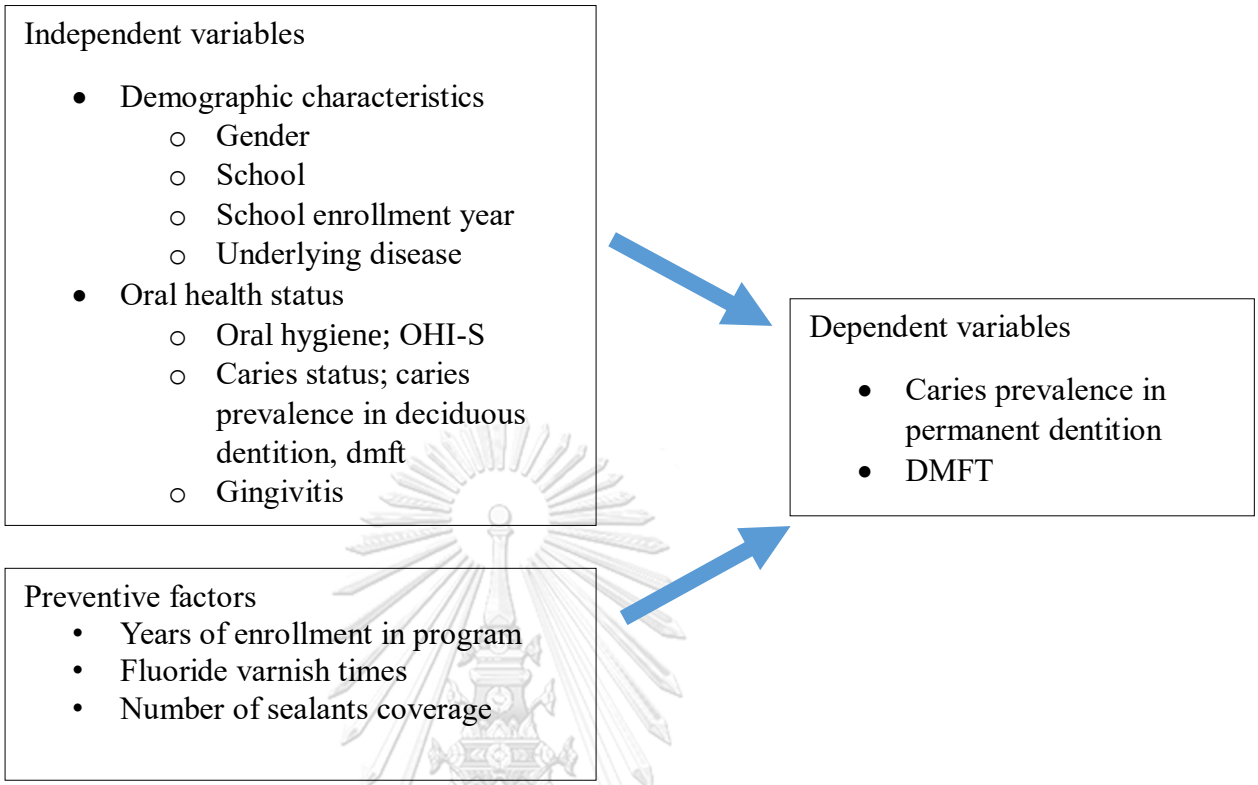
1) To identify protective and risk factors for permanent caries of Mahidol oral health program in school.

2) To estimate the cost of Mahidol oral health program in school including fluoride treatment, sealant and oral health education under academic setting.

- Cost by treatment items
- Average cost per head
- Overall cost each year

3) To compare effectiveness of overall program in caries prevention; Mean incremental caries (DMFT)

1.5 Conceptual framework



1.6 Operational definitions

School: all 4 selected school in Bangkok that use in the Mahidol oral health program

School of enrolment year: academic year that children enroll in school

Underlying diseases: medical history or current condition that concern with individual health, as follows allergy, asthma, drug allergy, food allergy, etc. Classified as present or not present.

Oral hygiene: use "Simplified Oral Hygiene Index" or OHI-S to classify oral hygiene status (good, fair and poor as in Green and Vermillion, 1964)(12), based on the amount of debris and calculus appeared on representative tooth

Caries status: defined by caries prevalence (deciduous/permanent), DMFT for permanent teeth and dmft for deciduous teeth. DMFT and dmft are means to numerically definite the caries experiences count in tooth, obtained by calculating the number of Decayed (D), Missing (M), and Filled (F) 'Caries' (dmft>0) and 'Caries free' (dmft 0) deciduous teeth

Gingivitis: Signs of gingivitis; redness and swollen gums (yes/no)

Years of enrollment in program: exposure to the SOHP; Level of SOHP participation (complete, incomplete, oral examination only)

Fluoride varnish times: fluoride varnish applications (yearly, almost yearly, sometimes, hardly ever)

Number of sealants coverage: sealant applications onto permanent 1st molars (all, few, none).

CHAPTER II
LITERATURE REVIEW

2.1 Dental Caries

Dental caries or cavity is usually called as tooth decay. It is the breakdown of the tooth structure which is a transmissible, infectious disease caused by bacteria in oral cavity.(13) The common causative bacteria are *Streptococcus mutans* (14) and *Lactobacillus* species.(15) These bacteria colonize on the teeth and produce the acid which makes dental cavity on the tooth surface (enamel). The acid is produced by the reaction of sugars that we consume with bacteria present in the dental plaque. The acid leads to a loss of minerals from the tooth surface, such as calcium and phosphate, this is called demineralization process. In general, minerals in saliva are deposited to and lost from an enamel surface all the time. Minerals such as fluoride, calcium, and phosphate from the foods and waters consumed, are re-deposited (remineralization) to repair the enamel layer. When demineralization is excess more than remineralization, tooth cavity occurs. If the process continually occurs, bacteria will destroy tooth structure, eventually infect to the pulp tissue. Pain may occur prior to or subsequent to pulpal infection. Dental cavity has been thought of as multifactorial since it is influenced by dietary and host factors.(14, 16) The role of saliva as a defense mechanism against dental cavity is well documented.(17) These defense mechanisms include salivary flow rate, clearance, buffer capacity, antimicrobial effect, and calcium and phosphate delivery for remineralization.(18)

Figure 1 Multifactorial model of dental caries

Type of dental caries

Based on Anatomical site

Pits and fissures caries

This is the most common patterns of caries. It occurs when bacteria colonize on pits and fissures of the newly erupted teeth, Caries extend as it penetrates in to the enamel. This surface is the highest prevalence of all caries. Their high susceptibility to caries depends on shape, morphological variation and depth of pit and fissures. Entry site may appear much smaller than actual lesion, making clinical diagnosis difficult. Sealing of pits and fissures after tooth eruption may be the most effective in the resistance to caries.

Smooth surface caries

Smooth surface caries or proximal caries usually attaches on the smooth surfaces that are near the gum or are under proximal contact. The proximal surfaces are particularly susceptible to caries due to extra shelter provided to resident plaque due to the proximal contact area which is less favorable site for plaque attachment. In young patients the gingival papilla completely fills the interproximal space under a proximal contact. This condition is less favorable habitat for bacterial plaque. Consequently, proximal caries is less lightly to develop in children.

Root surface caries

Root-surface caries is more common in older patients when gingival recession root surface exposes to the oral environment. The proximal root surface, particularly near the cervical line, where is patients cannot clean properly, since it may have concave anatomic surface contours and surface roughness at the termination of the enamel. The cementum covering the root surface is particularly thin and easily to caries attack. Root caries progress more rapidly because of the lack of protection from and enamel covering.

Based on progression

Acute caries

Acute caries is a rapid process involving multiple of teeth. Both deciduous and permanent can be affected. This type is lighter color compared to the others, being grey or light brown. Sensitive teeth and pulp exposures are usually found in these lesions.

Chronic caries

These are time-developing lesions, affect a less number of teeth, and are often smaller than acute caries. The lesions range in depth and include those that have just penetrated the enamel. Pulp prognosis is better, pain is not a common symptom because of protection afforded to the pulp by secondary or reparative dentin. The decalcified dentin is leathery and dark brown color.

Arrested caries

Caries which does not show any tendency for further progression and becomes stationary. With the change in the oral conditions, even advanced lesions may become arrested. Arrested caries involving dentin shows a marked brown coloration and induration of the lesion. Secondary dentin formation and sclerosis of dentinal tubules commonly occur. Exclusively seen in caries of chewing surface with large open cavity when there is lack of food retention. It is usually found on the proximal surfaces of teeth in cases that the adjacent approximating tooth has been extracted.

Prevalence of caries

Although dental caries is a preventable disease, it remains the most common chronic diseases of children and youths. This is also one of the most costly diet- and behavior-related diseases.[3, 19] While the trend of disease decrease in some countries, a large number of children around the world are still affected from this disease. Statistics indicate that at least 25% of 5- to 6-year-old children, and more than 90% in some low-income countries have experience in tooth decay.[3] There are different numbers across countries and discrepancies between regions, provinces, districts, cities and areas.(4, 20) Eastern Mediterranean and South-East Asia regions, dental caries is an important cause of disability.(21) In Southeast Asia, studies published in 2006–2015 showed the median caries prevalence was 79% and caries experience (dmft) was 5.1.

In Thailand, the prevalence of dental cavity in young children is still high despite efforts to control the disease through public health programs. The 8th Thai national oral health survey found that the prevalence of dental caries of permanent teeth measured at the cavitation level was 52.0% with a mean DMFT of 1.4 in 12 year-old children. For the primary dentition the prevalence was 75.6% with a mean dmft of 4.5 in 5 year-old children. (5)

Factors related to caries

Dental caries is caused from multiple etiological factors. The primary study assessed prevalence of caries in this primary school children, classified by socio-demographic characteristics, oral care and dietary behavior of children. Due to a limited study for school oral health program of Faculty of Dentistry, Mahidol University, this study was done in a population of school children in the 1st and the 6th grade in 3 primary schools attended program. The comparison of dental caries prevalence's median in primary teeth (1st grade school children) show that children with higher and children with lower family income, brushing frequency and sugary beverage consuming frequency were found significantly different, Median difference of caries prevalence in permanent teeth between the 6th grade school children showed significantly different when classified by duration of living in Bangkok of parents, but those classified by other studied variables were found no significant difference, P>0.05.

Gender

Gender was one of factors that had no difference of the presence of dental caries in this study. This result agree with the study which revealed associations between caries in children and several risk factors in Iowa(22) and the result of caries predictors in children.(23) Although, there was no significant difference in several study. The issue of gender is controversial(24). In the studies of Ditmyer M, et al(25) Ismail AI et al(26) and Declerck D et al's study(27), girls were found to have a higher caries risk whereas Lukacs JR (28)and Tadakamadla SK et al's study(29) found that boys having a higher or similar risk. Some studies indicated that trend of caries development rates were higher in females than males. The mechanism can possibly be explained by high possibility of AMELX gene inactivation in X-chromosome in female, lower saliva rate,

lower salivary immune, hormonal fluctuation in female, and earlier teeth eruption of female children (30).

Medical history

The result in this study showed no difference in median of dental caries between students who have medical history and who do not have medical history. Some literature(31) (32) revealed that dental caries associated with systemic disease such as congenital heart disease, asthma and epilepsy which were not found in our sample.

Residences

Also, the median of dental caries between children living in Bangkok and children living in other provinces show no significant difference. Some literatures(33) revealed that children in urban area had lower caries experiences than children in rural area. Nevertheless, other reports in New England (34) found higher prevalence of dental caries in urban children than rural ones. A study about trend of caries prevalence in urban and rural children in Thailand from 1977 to 2017(5), found that declining prevalence of dental caries was observed in urban children. The explanation was rural children may increase in sugar intake and the absence of good oral hygiene. However, detection of decreasing caries prevalence in 3 years old rural children might be a consequence of consuming fluoridated milk and the widespread use of fluoride toothpaste in Thailand.

This study showed the significant difference in caries experience between children with longer or shorter duration of living in Bangkok of parents, which in contrast with the study about dental caries and oral hygiene status among 6-8 years old schoolchildren in Hanoi and Langson cities, Vietnam(35). Schoolchildren in Hanoi city (metropolitan area) that can access to dental care were less affected by dental caries than those live in Langson city (Highland area). However, this study corresponded with the study of 12-year old students in Thailand that showed significant declines in dental caries prevalence in those from urban areas and a significant increase in those from rural areas(36). The reason of having lower caries prevalence in urban schoolchildren was supported by the study in Southern Iran that show higher percentage of children in urban area had regular dental visits or had dental visits when felt pain, while majority of children in rural area never had dental attendance.(33)

Children' daily pocket money

The study about association between daily pocket money and DMFT(37) It is reported that pocket money and DMFT in children aged 12 years in primary school in Buriram, Thailand were related. Children who received pocket money and paid for snack more than 80 bahts per week had significantly higher DMFT than other groups. This result is not correlated to result of the study in India (38) that revealed no significant difference in caries occurrence among school children who receive different amounts of pocket money or not receive at all. However, in our study, it was also found no significance in median caries between children who had higher or lower pocket money. The explanation of this result might be the fact that caries is a diet dependent disease, thus study about influence of pocket money on caries experience has limitation of details of what food item the children consumed.(37)

Guardians

Furthermore, the study showed significant difference in children's caries experience between type of guardians (father or mother or not). This result was similar to the study of Qiu et al. studied about association between caregiver's social support and their children oral health habits. The target population was 5-year-old children and their caregiver in Guangzhou, China. The study revealed that social support among mother, father and grandparent was not significantly different. Child's oral health habits are unrelated to caregiver's social support, but are related to caregiver's oral health habits. For example, children whose caregiver brushed their teeth more frequently were more likely to brush their teeth more frequently.(39) The explanation might be effect of the parent's food preferences and culture.(24)

The result of guardian's marriage status observed in this study showed that children's presence of dental caries was not the same in different group of guardian's marriage status. However, there was a report which revealed that children who had a single mother tended to more frequently experience of caries occurrence(40). Matila, *et al*. (2000) identified families whose children may typically develop caries. These are families where relationships are complicated, and the parents may lack the resources to pay adequate attention to their children(41). Change in family status from a traditional two parent family to single parent families may influence the parents' ability to give the child appropriate oral care.(42)

This study showed the result that guardian's education levels made no difference in children's caries status. However, the study of Engelmann JL, et al[43] showed that guardian's education levels had significant association with the occurrence of dental caries.(43) The group of parents who had lower education tend to have a greater chance of caries experience in their children (44-46). Study from Piovesan, C *et al* (2008) indicated that the level parental education can influence the occurrence of caries in children in early year.(47)

This study showed no significant difference between type of guardian's occupation and dental caries. This result was disagree with other studies (29, 48, 49) which demonstrated that parents in better occupation had children with less caries experience.

Family incomes

This study reviewed significant difference in dental caries prevalence in primary teeth between high and low family incomes. These result are in contrast with the studies of Shalu Verba, 2014.(50) Savara and Suher,1955 (51) which showed no relationship between caries in children and parent income. However, many studies (22, 43, 46) presented children with lower family income had higher caries experiences. Roger K. et al, 2011(52) found correlation of income inequality to dental caries and explained that oral health behaviors might change under stressful situations, such as diet (sugar consumption) and oral hygiene (with fluoridated toothpaste), moreover, less use of dental service might lead to more untreated caries. Children belonging to low income families often had a poor nutrition and rich in sugars, which tend to develop caries in children.(40)

Brushing frequency

We found that children with more brushing frequency had significantly lower dental caries prevalence than children with less brushing frequency. This result was in agreement with several studies. The study about number of times of a child brushes in Scotland(53) found a trend towards a significant association with caries experience. There were many supported literatures for this result, which indicated that children who had more brushing frequency had lower number of dental caries.(22, 24, 33, 54). The study from Esperanza also found that children who have positive oral health attitudes and behaviors brush their teeth more frequent than children who have negative

attitudes(24). The benefit of brushing derives from both the mechanical removal of plaque from the teeth and the exposure of the teeth to fluoride in the toothpaste and water.(55)

Use of fluoride toothpaste

This study showed that children with or without the use of fluoride toothpaste were not differed in dental caries prevalence. A longitudinal study of Chankanka O et al in 2011 about the associations between children's dental caries and risk factors in Iowa, USA(22) found that children with greater tooth brushing with fluoride toothpaste frequency had fewer new caries counts. Fluoride is main mechanism of action is post eruptive, controlling the initiation and progression of carious lesions by promoting remineralization of early caries lesions and reducing demineralization.(54)

Assist brushing

Parental care was observed and found that children with or without it, showed no significant difference of children caries prevalence among the groups. There was some of literature reviews showed that brushing with adult involvement twice a day likely to decrease caries experiences in children.(33) Parental belief and attitudes might be one part of role in moderating oral health related behavior in children.(33)

Between-meal snack and sugary beverage frequency

This study showed that frequencies of between-meal snack in studied children was not statistically different in dental caries prevalence, which in contrast with several studies (56-58), those studied revealed more between meal snacks was significantly associated with increased dental caries. In this study, there was a different median caries between children with higher or lower sugary beverage frequency. There were a lot of studies showed the relationship between dental caries and sugary beverage frequency.(22, 59, 60) Explanation of this result might be consequence of the greater frequency of consumption sugary beverage leading to more period of decreasing pH in oral cavity, causing demineralization of tooth surface. However, Chankanka O et al(56) concluded in their study that frequency of beverage exposures was not found to be significantly associated with increased risk of caries, but greater frequency of 100% juice exposures was related to fewer dental caries. Different compositions of sugars in 100% juice (fructose/sucrose/glucose) compared to other sugared beverages might explain the lower cariogenicity of 100% juice compared with other sugar-added

beverages, especially those with high fructose corn syrup. Additionally, caries median prevalence in children in this study was not statistically different between children who choose snack by their own and who not. There was literature found a significant result for this factor. More importance of snack type choosing than who choose it could be possible explanations for this finding.

Oral health seeking behaviors

Reason for dental care, problem for dental care and type of hospital were the studied variable intended for the access to dental service. The result of this study showed no significant difference of caries presence among studied children classify by 3 variables that corresponded to the result of the study about dental service attendance among children in Italy(46) and the study about access to dental care and past deciduous dental caries experience in Thailand(61). However, there were studies which found the relationship between dental visits and dental caries.(29, 62) They showed that children who had more dental visits had significantly lower ft of dmft index and lower oral hygiene index than children who rarely had dental visits(33, 61). The study of Shyama et al., (2015) and Gussy et al., (2006) indicated that dental attendance did not affect the children's caries experience which supported the result of this study. This could be explained by the common parents' habit of bringing children to the dentist for the reason of toothache or at least one caries, therefore preventive caries investigation and prophylactic interventions were neglected(63, 64). There were studies which showed that only dental care without promoting good oral hygiene habits and balanced sugar intake did not reduce dental caries incidence(65, 66) Qiu RM et al found that the children with more caries were more likely to have had dental visits for treatment of dental problems.(39) These findings indicate that dental caries was the principal reason for children to visit a dentist. Type of attending hospital was observed in this study. The result showed no significant effect between the place of dental service and children's presence of dental caries. However, there was no literature review found for this factor.

Caries Index

Caries Index: use DMFT and DMFS present the number of dental cavity in each individual. *(Klein and Palmer, 1938;1940)* DMFT and DMFS are means to

numerically definite the prevalence of caries, obtained by calculating the number of Decayed (D), Missing (M), and Filled (F) (15, 67, 68)

D: Decayed teeth which include: Carious tooth, filled tooth with recurrent decay or other surface decayed, retained root, Defect filling with caries and Temporary filling

DMFT and DMFS = D+M+F teeth (T) or surfaces (S).

DMFS

Retained root, missing tooth and tooth with crown, each tooth was recorded scored as 4 surfaces for anterior teeth and 5 surfaces for posterior teeth.

The same way for primary teeth dmft(s).

2.2 Gum Disease

Gum disease is a condition of inflamed gingiva, caused by bacterial plaques that accumulate along the gum line over time and secreted toxins. This plaque is a mixture of saliva, food and bacteria. Early symptoms of gum disease (gingivitis) include redness of gum, swelling gum and bleeding per gum without pain. These are very common clinical manifest and most people cannot detect. A pain symptom appears in more advanced gum disease by means of the formation of gum pockets and the loss of bone around the teeth. Advanced gum disease can cause loss of the sound teeth, called periodontitis. Bacteria in gum pockets cause an infection, swelling, pain, and further bone destruction.(15)

GUM DISEASE IN CHILDREN

Four basic signs of gum disease in children consist of bleeding gums during tooth brushing, flossing or any other time, swollen and bright red gums, bad breath (Constant bad breath that does not clear up with brushing and flossing).

Gum disease affects children in all countries, similar to tooth decay, it is one of the most common chronic diseases in many countries. The world prevalence of gum disease in children is very high, the majority of children being affected (69) with 50%

to 100% of 12-year-old children having the signs of gingiva inflammation.(1) The rate of gingivitis is higher in older children and teenagers.

In Thailand, the national oral health survey conducted in 2017 found that the prevalence of gum disease in 12-year-old children was up to 66.3%. The most important preventive step against periodontal disease is to establish good oral health habits.

Simplified Oral Hygiene Index

Simplified Oral Hygiene Index by Green and Vermillion (1964)(12) was used to evaluate cleanliness of teeth, calculated from 2 components:

Simplified Debris Index (DI-S) + Simplified Calculus Index (CI-S)

The six representative teeth that are selected for this index consists of 4 posterior teeth which are the first completely erupted molars. Buccal surfaces are used for scoring on the maxilla and lingual surface on mandible. Other two are labial surfaces of the maxillary right central incisor and mandibular left central incisor, if one of these teeth are missing, the next tooth in the same segment would be used for the index.(12)

The level are: Good = 0 -1.2, fair = 1.3 - 3.0, Poor = 3.1 – 6 .*(70)*

2.3 Poor Oral Health and Effect on Children

Poor oral hygiene together with dietary sugars can cause gum disease and dental cavity. Both may lead to discomfort, pain and loss of tooth. In Thailand, report almost half of twelve year old children came for extraction at their last visit to the dentist and claimed pain or discomfort from teeth within the past year.(71) Results of untreated oral diseases, may have an intense effect on quality of life. Suffering from poor oral health can make children 12 times more likely to have restricted-activity than those who normal including missing school. Each year, more than 50 school million hours are lost due to oral problems.(1) Tooth cavity and gum disease (gingivitis) are among the most common conditions, impacting on a self-appearance. Importantly, loss of functional tooth can affect children’s nutritional intake, subsequently, their growth and

development.(72) Some studies in Bangladesh found the relationship between untreated caries and being underweight in primary school children.(73)

The experience of pain, problems with eating and chewing, embarrassment about the appearance, discoloration, shape of damage teeth can distract children from play and effective learning. Oral health affects general health. If left untreated, oral diseases can have adverse consequences. Oral infection can be life-threatening. It is a risk factor for many general health conditions. Systemic spread of bacterial microorganisms can cause, or seriously worsen, infections throughout the body, particularly among children with low immune systems, congenital heart disease and diabetes. Studies have suggested that oral diseases (such as dental caries and gingivitis) are related with various problems(74) Including malnutrition, impaired speech function, psychological problems, cardiovascular disease, diabetes and even cancer. Several studies have reported the association between oral health and quality of life.(74) A number of oral health related quality of life measures have been developed to assess the functional, psychological, social and economic consequences. In general, poor oral health has an undesirable impact on quality of life, influencing eating abilities, self-confidence, mental health, social interaction, personal relationships, and enjoyment of life, general health and well-being. Low quality of life also relates to oral health problem and less access to dental care.(1)

Early onset of gum disease and dental caries are reversible, with appropriate measures and treatment care. Whereas, most advanced condition are irreversible. For instance, once tooth cavity occurs in permanent teeth, it lasts for a lifetime. Even when the teeth have been restored, the fillings still remain in the mouth for life and may need a replacement from time to time. Advanced or progress lesions become more serious and difficult to treat. Obviously, it must be emphasized that prevention is better than cure.

2.4 Preventive Dental Care

Fluoride

Fluoride is a mineral, found in many foods and water. It helps teeth more resistant to acid from bacterial plaque and prevents tooth cavity. Moreover, it can reverse early tooth lesion (demineralization). In child under 6 years old, systemic fluoride becomes incorporated into the formation of permanent teeth, making it difficult for acids to demineralize the teeth. Fluoride helps promote remineralization together with disrupts acid production in erupted teeth of both children and adults. Apart from food and water, fluoride comes from dentifrice or professionally-applied topical fluoride application. Fluoride is used in two difference ways; Topical and systemic fluorides. Topical fluorides are applied directly to the tooth surface. For instances, fluoride dentifrice, fluoride rinses and in office fluoride treatments. Systemic fluorides are used by oral intake, such as fluoride in food, fluoridated water and dietary fluoride supplements. When fluoride is available both topically and systemically, the effective reduction in dental cavity is achieved. Dentists have recommended the use of fluoride treatments to help protect the tooth from decay, especially high caries risk children. Several studies on topical fluoride applications, which include fluoride toothpaste, mouth rinses, gels and varnishes, found that topical fluorides have been confidently established as beneficial in preventing decay in children aged 5 to 16 years.(75) Among of these topical fluoride applications, fluoride varnish is a common use in school prevention program and effective in preventing cavity on smooth surface of teeth.

The advantages of fluoride varnish program

- Effective in preventing dental cavity on both primary and permanent teeth mention in Cochrane Systematic Review of 2008(76) , reverses early decay.
- Approve by the ADA (2013) fluoride varnish are recommended as the professional application of choice for children younger than 6 years of age.(77)
- Non-invasive technique *(ADA) (78)*
- Ease of application: Easy to manipulate (79)
- Use of smaller amounts of fluoride than required for gel applications *(80)*

The disadvantages of fluoride varnish program

- Should be *applied by a dental or medical professional.* children cannot use it by themselves.
- Non-permanent *should be re-apply* every 6 month for effectiveness.(81)
- *Colored tooth*. Fluoride varnish is usually a caramel-colored, viscous semiliquid
- *Allergy*: allergic reactions can occur in children who sensitivity to colophony/rosin.*(82)*

Sealants

Dental sealants are resin coatings that are applied to the grooves (pit and fissure) on the chewing surfaces of the posterior teeth to protect them from tooth cavity. Most cavities in children and teenagers occur on these surfaces. Sealants protect the chewing surfaces from tooth decay by being a barrio for bacteria and food particles and keep them out of these grooves. Permanent molars are the most likely to benefit from sealants. It is better to apply the sealant as soon as after the teeth have erupted, before they have a chance to decay. A sealant can last for as long as 5 to 10 years. Sealants should be checked at your regular dental appointment and can be reapplied if they are no longer in place.

The effectiveness of sealant had been studied by many reports.(83) CDC had recommended the use of sealants in school-based dental care programs. A cost-effectiveness analysis of a school-based dental sealant program for low-income children estimated that over a 5-year period, costs of care for the group given dental sealants were almost 20 percent lower than for the control group.

The benefits of sealant program

- Prevent pit and fissure caries *CDC* had recommended the use of sealants in school-based dental care programs.
- Effective in reducing cavities, can reduce cavities in 6-year molars up to 80 percent immediately and up to 60 percent for four years or more. *(NIDCR)(84)*
- Sealants are easy and painless
- It’s a simple, painless procedure that usually takes just a few minutes per tooth.

- Usually long-lasting
- They often last for years, and we can check and easily reapply them as needed. (85)

The disadvantages of sealant program

- Must be applied by a dental professional. *(ADA)*
- Not permanent. Can wear and lost, need a replacement generally more than 5 years.(86)
- Not prevent decay between teeth (only prevent occlusal surface)
- Some people have concerns over BPA, sealant contain very small amounts of the bisphenol-A, or BPA. Some studies have linked BPA to health problems.(87)
- Sealants may not be needed for everyone should apply only in high risk children *(CDC)*
- They can't be used in some circumstances. Sealants aren't recommended for teeth that already have signs of decay or fillings. *(ADA).*
- Technique sensitive difficult to manipulate have to control moisture. *(ADA).*

Oral health education

The aims of oral health education are preventing the dental diseases and promoting dental health at early stages.(11) Schools are important places to shape the health, education and well-being of children. there was no conclusion, that oral health promotion activities reduce dental caries, even if changes in behavior were achieved and that, unless fluoride was used in one or other of its forms, oral health promotion activities were ineffective.(88) According to a systematic review on effectiveness of oral health education programs, five studies showed a significant decrease in the caries increment. The results of four other studies were not significant. A study by Blair et al. showed a 20% decrease in caries increment. The review showed that studies done in

schools were effective and health promotion was a prominent feature in most of the effective studies.(89) Oral health education is effective in improving the knowledge, attitude and practice regarding oral health and in reducing the plaque, bleeding on probing of the gingival and caries increment and in improving the gingival health.(90) (88)

In Thailand, a school-based intervention study has demonstrated that optimizing fluoride interventions (tooth brushing) 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 school.(91)

The benefits of oral health education program

- A significant decrease in the caries increment. According to a studies of effectiveness of oral health education programs, some study by showed a 20% decrease in caries increment. (92)
- The review showed that studies done in schools were effective and health promotion was a prominent feature in most of the effective studies. (89)
- Oral health education is effective in improving the knowledge attitude and practice regarding oral health and in reducing the plaque, bleeding on probing of the gingival and caries increment and in improving the gingival health.(90) (88)
- Oral health education is effective in improving the knowledge attitude and practice regarding oral health and in reducing the plaque, bleeding on probing of the gingival and caries increment and in improving the gingival health.(90)

The disadvantages of oral health education program

- Waste time and workforce (93)
- No evidence, that oral health promotion activities reduce dental caries, even if changes in behavior were achieved and that, *unless fluoride was used in one or other of its forms, oral health promotion activities were ineffective.*

- The result was contradicted, five studies showed a significant decrease in the caries increment. The results of four other studies were not significant.(90)

2.5 Access to oral care

Access to health care is a basic human right. Individuals should be able to receive preventive dental treatment and educated in basic oral health care from the right provider at the right time in order to have earlier dental disease detection.(94, 95) The concept of equity in health related to the central human right thread cited from WHO constitution in 1946, “the highest standards of health should be within reach of all, without distinction of religion, race, political belief, economic, or social condition”. Adequate dental visits lead to early detection and diagnosis of caries in children. Parents should bring their children to have a regular dental check-up at least every 6 months or depend on their oral health condition, according to American Academy of Pediatric Dentistry (AAPD).(96)

A study during the year 2008-2010 in south west America, a prospective cohort 25-month median follow-up period of oral health study showed that only 39% of children had a dental visit whereas 13% of their first visit were for emergency dental care.(97) In 2009, 62.5% of children aged 5 years in Australia had untreated dental caries in the deciduous dentition.(98) Similar situation or even worst in low and middle income countries. The major causes of untreated dental disease among children is cannot access to dental care. Limited access to care for school-age children still existed. From study in Thailand, only 20 % of the students in the suburban area received complete dental treatment which was lower than the target indicator, while more than 20 percent of the students in the district town received the service. (99) The survey in 2015 in Bangkok, Thailand, report that though children aged 6-12 years received the dental service more than other age groups, it's only 13.5% of 5.4 million children and the average number dental visits of children aged 6-12 years is only 0.13 times/year.(5)

In several studies referral is described as a specialized treatment rather than an initial oral examination. It is an important step in dental treatment that helps patient to get treated by specialties when necessary.(100) According to study in U.S., the results of 385 kindergartens in 5-6 years old children, and 52% of the children received

baseline referral. Only 19% of the referred children had received follow-up cares. The caregivers whose children were referred had poor education and full-time employment. Moreover, among the children that didn't receive a follow-up care, their parents do not have routine dental checkup in the past five years. The most important reason for lack of dental visit was unconcerned about dental problems, absence of dental insurance, poor transportation and expensive dental treatment.(101)

Health care barrier refers to anything impeding people from gaining access to sufficient health care.(102) Access to dental care in children depends on many factors including family income, caregiver education, parents' attitudes & experiences, excessive waiting time, poor transportation, cost, health insurance, dental anxiety and inconvenient time.

From several studies (61, 103-105), income was found to be one of the barriers to dental access. A study done by Burton et al. reported that among 2-11-year-old children in poverty, only 40% of those with tooth decay got their disease treated compared with 46% of higher-income children.(103) Chu, *et al*. concluded that children whose parents have higher income levels were more likely to seek for dental care than those from low income families. This study confirmed that low income was a barrier to access dental care.(104) Tharasombat S. agreed that family income affected the frequency to get the dental service in children due to 35.1% of the parents whose income lower than 10,000 baht in contrast with 18.3% of the parents whose income higher than 40,000 baht didn't bring their children to get the service.(61) Moreover, the study done by Gao, *et al*. confirmed that the financial status is significant predictor of dental service utilization. Children from low-income family that less likely to utilize the dental service. In order to support the dental access of poor children, free dental services should provide for children at school.(105)

Patients considered "cost" as a factor that had hindered them from approaching to dental care. Curtis et al concluded that the indirect costs such as travel costs in remote areas had effect on access to dental care and was considered as an important barrier. As well as the study of financial barrier to dental care among Canadian adults by Locker David, having low income had been considered as barrier to access dental care among Canadian adults. It could be concluded that the cost of dental care turns into an obstruction to people making general dental visits and comprehensive oral health

check-up.(106) On the contrary, reported from national dental telephone interview surveys of Australian residents, financial barrier to dental care might be insignificant in younger age due to access to school dental administrations.(107)

Parent education is another factor found to be related to dental care access in children.(103, 105, 108) According to the study of Kristina et al. surveyed in randomly selected 7-12 year-old schoolchildren.48.5 % of the children whose parents had high educational level brushed their teeth 2 times per day compare to 42.4% of the children whose parents had a low educational level and deficient income.(108) Moreover, the study done by Gao *et al*. confirmed that children of poorly educated parents utilize the dental services less frequently.(105) As shown by the study of L. Edelstein, Children whose parents obtained college degree tend to visit dentists more than those whose parents obtain less than high school education.(103)

Dental care access is also influenced by parents' attitude.(109-111) The study of oral health status of preschool children attending Head Start in Maryland by Vargas CM, *et al*. showed that the explanation behind not seeking for dental care was not considered it to be necessary. Maryam S. Amin studied about caregiver awareness and dental status of children, 74% of parents rated their child's dental health as good or fair, 52.8% of the children had no caries and 26.4% were not sure whether their children had caries or not, but it was found that 63.7% of the children had untreated caries in dental examination. Among 44% of children whose parents rated their children's dental status to be good or fair, 56.4% had untreated caries. Parent's awareness of child's dental status was low. 61.6% of the parental evaluation did not match with clinical evaluation.(109) Gerreth, *et al*. found that great interaction between children and their parents can provide good cooperation as it provides patients' willingness to come to dental clinic for the preventive cares and check-ups without hospitalization. The study of Problems with Access to Dental Care for Medicaid-Insured Children showed that negative attitudes from parents toward dental care had an adverse impact on their children accessing to dental care.(110) The study conducted by Mahyar Mofidi, *et al.* showed that some participants revealed that the dentists ignored them and didn't have time to explain their children's oral health needs or offer health education and information. Not only parents taken a good care of children's oral health but also dentists. Some of them said that the dentists were not willing to answer their questions or to be bothered.

Negative attitudes from parents toward dental health care had an adverse impact on their children accessing to dental care.(111)

Waiting time period can effect pattern of seeking dental care as found in many studies.(110, 111) Gerreth K., *et al.* studied about the caregivers of children with mild disability. 36.7%of the participants accepted that long waiting time for a dental visit is the most common barrier to obtain dental care.(110) Barbara Aved Associates (BAA) is a Sacramento based consulting firm specializing in evaluation, strategic planning, and capacity building for public and private organizations. This organization's aims to improve health outcomes for diverse populations. Barbara Aved associates reported that for non-urgent care, most of the parents reported that they have to make an appointment for 1-2 months out. Some of the parents explained that long appointment making can cause them forget and miss the appointment.(112) Furthermore, Mofidi M., *et al*. confirmed that one of the serious barrier was excessive waiting time. The participants covered under 'Medicaid' revealed that waiting for 2-4 hours and nonemergency care as an example of problem for Medicaid patients.(111)

Transportation was also considered as one of the barriers to dental care.(111) The study conducted by Mofidi M., *et al.* reported that difficult and uncertain transportation impeded the appointments. Caregiver faced the problem with in organizing transportation to get a dental service. More than a half of the caregiver didn't own a car so they had to depend on free transportation arranged by social services. Free transportation was untrustworthy and uncomfortable lead to being late for the appointment or missing the appointment.(111)

Another factor relates to barrier to dental care access is health insurance.(103, 113) According to a study from Finlayson TL et al children with health insurance are more likely to have a past year dental visit than those without health insurance.(113) Very similar results were also reported by Burton L. et al. A study conducted by Duncan L et al showed that people with dental coverage have lower need for treatment (both urgent and no urgent treatment) than those without coverage. The study from Burton L. also reported the benefit of health insurance in the U.S., State Children's Health Insurance Program (SCHIP) has improved dental coverage for low-income children. The percentage of children with dental coverage increased by 9% in 8 years.(103)

From the study of effect of fear on dental utilization behaviors and oral health outcome, Meng, *et al.* found that dental fear has independent negative effects on dental access and oral health outcome after controlling other sociodemographic and general health factors.(114) The study of fear for dental pain in Italian children by Giovanni D'Alessandro et al reported that children's anxiety was dominated by parental attitude. Therefore, the parents' anxiety toward dental treatment was one of the contributing factors that lead to increasing of children's anxiety toward dentist and dental treatment.(115)

One of the reasons keeping children from visiting dentist is lack of time.(105, 111) Mofidi M., *et al.*, reported that children missing school due to arrangement limitations forced by the dental organization. A few participants said that pain from dental caries had worsen because they didn't have time to get an appointment for their children.(111) Similarly, the study of Gao et al. reported that the major factor for non-utilization of children's dental care is time. Because the parents don't have enough time for dental visit.(105)

2.6 Oral Health Promoting School

Good oral hygiene can help to prevent tooth cavity as well as gum disease. Dental preventive care is an important factor to reach and maintain good oral health. However, a substantial proportion of children, mostly among children in low income countries,(91) have no access to professional care. A large number of children have no chance to visit dentist before starting school.(89) In some areas, a substantial proportion of school children who never have dental visit. Consequently, a small number of children have preventive professional care. Many of them go to the dental office when they have pain, an experience that may have a lasting effect through life and prove to be unfavorable to overall oral health.(116) The purpose of school-based dental screening is to promote dental health service accessibility and reduce untreated caries among primary school children.(117)

At the global level, children attend primary schools around 80% and complete at least 4 years of education 60%, varying between countries and gender. Thus, schools are an important setting to reach over 1 billion children worldwide and, through them,

families and community members.(1) Promoting children's oral health through schools is strongly recommended by the World Health Organization (21, 91), the potential for actions has been described in detail in the manual "World Health Organization. Oral health through schools. Geneva: WHO Document 11, 2003" (21). The 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 school environments and access to optimal sanitary facilities.(91)

In Thailand, the net enrolment rates were 90.05% and 72.22% for primary (6 to 11 years) and secondary school age children (12 to 17 years) in the year of 2009. Oral problem is one of 3 leading health problems among school children in Thailand. Hence, health promotion activities should be provided in schools

There are many oral health prevention programs in school, such as topical fluoride application, the use of fluoride mouth rinses, oral health education, tooth brushing program with a fluoride toothpaste and flossing, healthy diet and regular dental examination. Thailand has long experience of school health interventions with extensive school-based tooth brushing and sealant programs. (Table 1) School-based tooth brushing for primary school children has been promoted and is practiced in many schools. However, this project is inconsistent and dependent on the enthusiasm of teachers to ensure that it is correctly carried out (10).

Table A Dental health care programs implemented for school children in Thailand

Period	Program	Brief activities
1988	Oral Health Surveillance and Dental Health Promotion Program 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 school children

Period	Program	Brief activities
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

Oral health programs in Thailand have focused on primary school children, there is a significant scope for improvement of oral health among young children, particularly among the underprivileged groups and children who at high risk of dental cavity, through the optimization of school programs. The development of an enhanced school program to include oral health education, combined with enabling and monitoring tooth brushing with efficacious toothpaste formulations, should significantly reduce dental caries and improve the oral health of children in Thailand relative to the current regime.

2.7 Bureau of Dental Health

Bureau of Dental Health is the primary organization in the dental health of the country focus on the part of the other contracting party the network toward a learning organization for better oral health of all ages of life, consultant in dental public health in early in school sanitation department Ministry of Justice is responsible for providing dental services for children until 2466, became available to the general public. The Red

Cross asked for cooperation Continue on with the establishment of the Ministry of Health in 2485, dental work, it is under the administration of the School Health Division, Ministry of Health. Or the Department of Health at a later stage. When the Ministry of Health in 2515 to improve the dental work is upgraded as a Dental Department of Medical and Health until 2517, with the restructuring of public administration. The Ministry of Health once again Dental Health Division is transferred to the Department of Health.

Dental Health Plan

Dental plans have been entered in the National Social and Economic Development Plan for the first time during the 2520-2524 or the plan ฉbb 4 onwards, projects and activities in them. Dental services for students is one of the Ministry of Health plan. Health officials issued a dental prevention training for elementary school children in Bangkok to supervise brushing after lunch and serves rinse fluoride every two weeks and provide dental health education to students also collaborated with Health Division Officer Training School Executive Health and operators. The Parent Teacher Training was included and provided the dental health teachers in 72 schools and communities nationwide.

Later, in the long run is distributed by dentists to rural areas of the hospital and the government at the provincial health office. Chief provincial public health department and a director of Dental Public Health Department make public dental services ranging from prevention and treatment to promote a systematic pattern and have produced models. Teeth using different types of materials that are not required in order to save foreign national budget worth tens of millions, and the Department. These models can also support dental hygiene to dental public health departments of every district hospital. Elementary schools in the country and the authorities supported operating dental health. To make many people even in remote country to benefit from the knowledge of the media from the 4th Development Plan, the public dental services of the Department of Health has developed a sequence in order to solve the dental health of citizens.

The preparation of dental health goals

2528 BC Dental Association World Federation jointly targeting international dental conference organized by the Department of Health has the faint dental professionals from across the country to prepare dentists to target the people. Thailand is the main goal, to thinking of dental problems in later stages of the essence. Expected

(1) 30 percent of preschool children have tooth decay.

(2) 12 year olds have cavities and teeth, not more than 1.5 apiece.

(3) 75 percent of the age group 18 must have teeth that could be used for at least 28 spokes.

The mobile dental unit

On August 1, 2527 as the first mobile dental units under the cooperation between Thailand and the Thailand government and the German government provided dental scaling, fillings and dental health education to the public, the Thailand - Cambodia. Surin, Si Sa Ket and Ubon Ratchathani. Province Health Department has issued a prospective of 4800 villages have been provided with the IP rights to 96,000 people and 480,000 people who have been taught the Surveillance and promoted dental health in children of primary school students nationwide. Ministry of Public Health and Ministry of Education have jointly prepared a project in BC. 2531 until now to cover 5,000,000 elementary school children nationwide and cover 30,000 schools of the major activities of the project presented to the teachers. Training is about the oral health of students and recorded in the records of public health reporting. The data will provide an advice and treatment to be trained.

FAO project for public health services

The Department of Health is sponsoring the dental health center level. Starting at the health facilities in East Greenfield projects in 17 provinces of Northeast later was extended to support comprehensive health centers by 4000 of the current public health officials, health centers. The Air Power Scaling will be trained to use the tool to get treatment.

The contest Excellence Dental Health Surveillance, The Department of Health has prepared such a project in collaboration with the Office of the National Primary Education, Provincial Health Office and private companies, Colgate-Palmolive (Thailand) to encourage and promote oral health surveillance, a system of equations. Initiate in primary schools, The School of Excellence will be a good model for other schools and encourages the people involved with the intention of better ways to cooperate with resolve. Dental - Community Health Outstanding features of the school's teachers, students will have oral health surveillance system and add 2 times a year. Record results in students have received dental services, tooth brushing after lunch each day and rinse with fluoride. Consistent and has been sent to hospital for treatment in patients with problems.

Surveillance and promote dental school students belong to the municipality and the city,
the Department of Health is coordinating with the Department of Administrative preparation of the project began in 2536 and was well received cooperation from the Office of Local Education Agency for local government. Alderman Education Dentists and dental nurses from various municipalities included 50 municipalities to participate. Currently, this can be implemented comprehensive schools of the 400-year campaign of World Oral Health of 2537, the World Health Organization has declared the year 2537 as the year of the dental world. In order to comply with the declaration of the World Health Organization. The Department of Health, a project of the campaign with the objective to public diet behavior, brushing correctly and consistently, daily activities are planned in both central and provincial continuously throughout the year including dental outreach activities across the country. Stamp symbol year campaign brushing after meals. Day across the country on September 14, 2537 and an international conference on The Promotion of Lifestyles Conducive to Oral Health.

Dental Health Program Service

- Dental health promotion among school-age children
- Development of a model system for supporting activities
- Fluoridated milk to prevent dental caries

- Learning from research food and tooth decay
- Network alliance to address health problems
- Prevention of oral disease
- Royally-inspired dentures program

2.8 School-based oral health program (SOHP) by Community Dentistry Department of Mahidol University

Department of Community Dentistry, Mahidol University assigned dental students into separating 4 public primary schools. Each group of dental students is responsible to survey oral health, identify the problem and related factors of oral health status of school children. Collected data were analyzed for providing school-based oral health program (SOHP) e.g. preventive treatment, exhibition, and health promotion activity with participation of relevant stakeholders at least once. Each group of dental students has to submit the plan to the Department of Community Dentistry, launch the activities follow the plan, evaluate the activities and submit report of the activities done throughout the year together with data files. Individual dental student has to submit chart record of daily practice every visit. The records are checked by a supervisor who in charge in that particular day. During daily practice in school, dental students do some implementations of preventive program, for example applying sealant, students have to be checked by the supervisor every steps of treatment. The SOHP begin with survey phase, treatment phase and evaluation phase in the end of semester.

This SOHP includes 3 main aspects: oral health service, oral health education and healthy school environment.

1. Oral health service by using mobile dental unit including oral examination, apply fluoride vanish, sealant, preventive scaling, preventive resin restoration (PRR), filling and emergency treatment for instance prolong deciduous tooth extraction. Fluoride varnish application is suggested to be done in the same visit as oral health survey or before other oral health services. Oral health service in school does not cover comprehensive treatments, a referral system to the department of pediatric dentistry, Faculty of Dentistry, Mahidol University has

been set to provide dental treatment for school children. While other school children are referred to nearby public health settings.

2. Oral health education is performed by dental students and dental assistant students. Dental students should inform the topics and objectives of the oral health education before beginning the activity to the responsible supervisor. One session is approximately 20-40 minutes. Oral health education can range from a brief recommendation after dental treatment to using material to teach in class or exhibition. The content of oral health education included oral anatomy, the etiology, progression, prevention and treatment of oral disease. Moreover, oral hygiene instruction and diet counselling were given along annually.
3. Healthy school environment is general environments which promote good health for examples providing facility and place for tooth brushing, place to keep toothbrushes, fluoridated milk, reduce sugar in food and drink, etc.

The first priority is primary care of permanent teeth which refers to fluoride varnish, sealant, PRR, scaling and fluoride application. The following table illustrates criteria for case selection and type of oral health service.(118)

Table B Activities of oral health service, criteria for case selection and goals in SOHP

Type of service	Criteria for select case	Short term goal	Long term goal	Ultimate goal
Oral examination	Every school children (twice a year)	All children receive oral examinations twice a year	Early detection of dental caries	Cavity free in permanent teeth Improve quality of life of children
Oral health education oral hygiene instruction diet counseling	Every school children	• Decrease Debris Index score (DI) • Increase knowledge of cariogenic foods/snacks	• Improve oral hygiene of children • Children choose non-cariogenic foods/snacks	
Cleaning (prophylaxis or scaling)	Poor oral hygiene, Debris Index (DI-S) ≥ 1.9 or presence of gingivitis	Decrease Calculus Index scores (CI)	Improve oral hygiene of children	

Type of service	Criteria for select case	Short term goal	Long term goal	Ultimate goal
Fluoride application varnish or gel	Every grade 1 and 2 school children, other grades if 2 of 3 following criteria should be met ≥ 1 smooth surface caries ≥ 2 new caries teeth white lesions in permanent teeth are found Secondary caries Or every case whom got oral cleaning (DI-S > 1.9)	All children receive fluoride application twice a year	Promote re-mineralization, delay progression of caries	
Sealant	Newly erupted permanent teeth with deep pit and fissure (on first and second permanent molar)	Seal all four first permanent molars	Protect chewing surface from caries	
PRR	Permanent teeth with narrow enamel caries	Treat carious lesion and seal remaining fissure	Protect chewing surface from caries	
Filling	Permanent teeth with dentine caries	Treat carious lesion		
Extraction	Deciduous teeth which prolong retention and mobility	Eliminate un-restorable teeth		
Refer	Permanent teeth: deep caries, large and/or deep lesion, tooth fracture, caries expose pulp, and supernumerary teeth Tooth with symptoms i.e. pain, swollen, abscess Deciduous teeth; prolong retention and not mobility	Treat carious lesion or eliminate un-restorable teeth		

In addition, fluoride application using fluoride varnish as a first choice if children have contraindication consider to use fluoride gel. Sealant were placed,

repaired or replaced at each 12-month interval or on the basis of individualized treatment plans.

Logic Model of SOHP

The below logic model shows the inputs, outputs and outcomes of the SOHP

Logic model

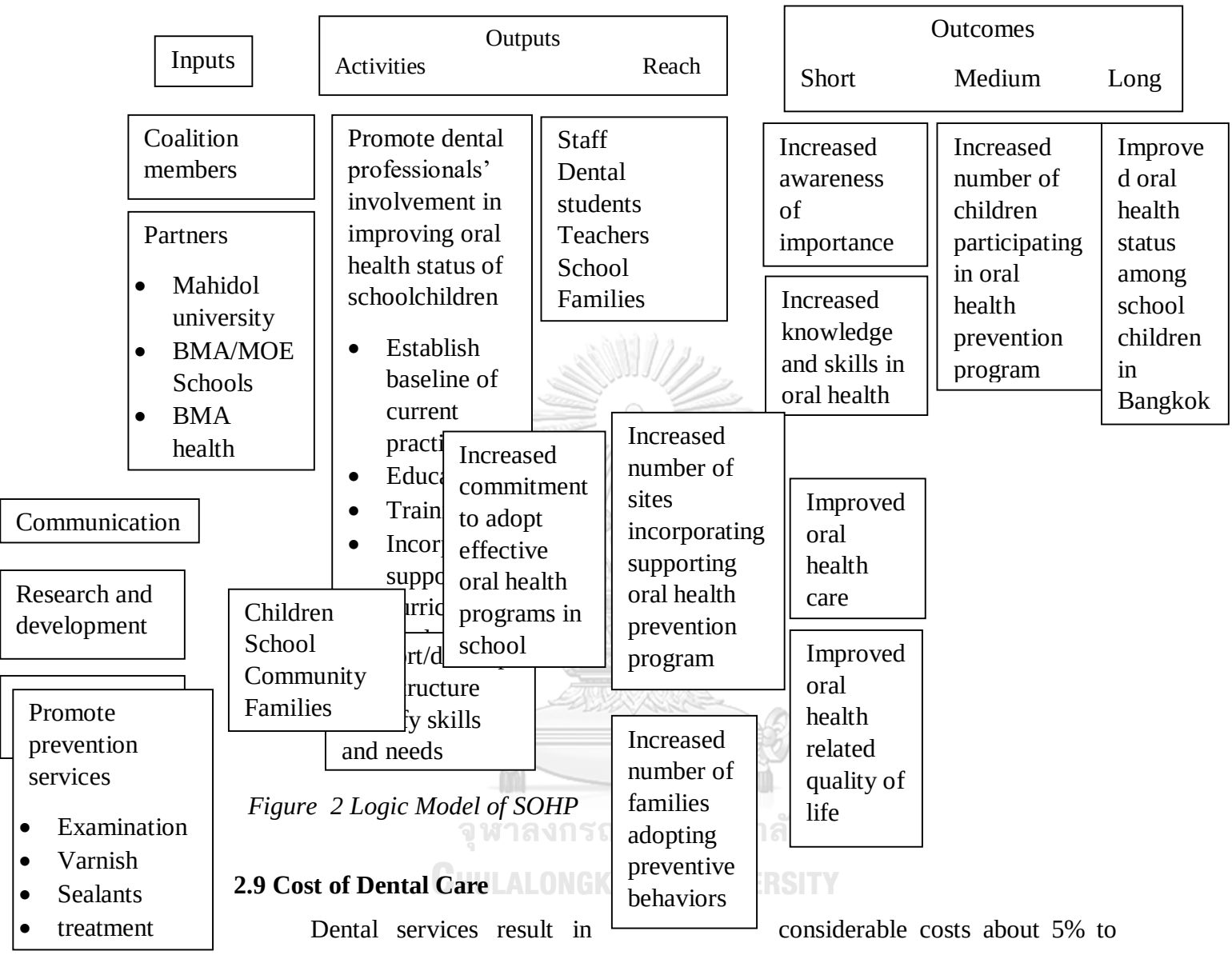


Figure 2 Logic Model of SOHP

2.9 Cost of Dental Care

Dental services result in considerable costs about 5% to 10% of the total health expenditure or billions of dollars in developed countries each year.(7, 8) In many low income countries, the cost of dental treatment could easily exhaust the country's entire health budget. More than 50 million school hours in learning are lost due to dental problems. Preventive program, early diagnosis and timely treatment are important in efforts to contain the costs of oral diseases.

In terms of financial, personal and social impacts, neglect of dental care also costs high. Advanced disease may need more complex, costly and, possibly, more traumatic treatments, for example, surgery, root canal therapy, extractions and

treatment under general anesthesia and hospitalization. Poor oral health in children often continues into adult, impacting on quality of life and economic productivity. A previous study has reported that investment in oral disease prevention and health promotion reduces costs in health expenditure and, in the long-term, it is more cost-effective.

2.10 Cost Analysis

Definition of Cost

Cost can refer to the expense in the monetary form and non-monetary form used in order to produce the product and service. Usually, Cost refers to the amount of money or expense that the producer or service provider must pay in order to obtain the necessary raw material or service to use in producing goods or service. Cost refers to the value of resources used to produce the final products or outputs or service. The cost will not be equal to the service charge.

Cost refers to the loss of resources which can be the value of benefit or monetary value in order to achieve the objective (value of resource used in production process). Cost refers to cash or something equivalent paid out to obtain the goods or services, which bring about the benefit to the organization at the present or in the future. When the benefit has occurred, the accounting will regard cost as an expense.

To summarize, cost refers to the investment made in order to obtain the final product, asset or any service. In accounting viewpoint, the cost that can be measured in the monetary unit will be taken into account whereas in economic viewpoint, opportunity cost, negative consequence and implicit cost are included into cost of the investment.

Unit Cost

Unit cost refers to the comparison between the resource used and result or output. Unit cost can be a tool to measure the efficiency of resource management, budget allocation, service charge determination or the decision to maintain or cancel some services.(119)

Unit cost analysis will be carried out in the period of time. Normally, it will be done on the yearly basis, during the end of fiscal year. However, to gain the better control of the resource, it can be conducted more often than once a year.(120)

Cost classification

Cost can be classifying by many criteria. Cost classification by the disbursement criteria. It can be divided into two groups which comprising tangible or explicit cost, the cost which paid out and can be seen and intangible or implicit cost, the cost which not paid out and cannot be seen.

Cost classification by activity criteria. This can be divided into two groups, which consisting of direct cost and Indirect Cost.

Cost Determination

Determination of cost aims to identify the value of all resource that cost used up. It divides the resource into small units thus that it will be easier to analyze its relation to the final product or output. Cost data of intervention programs are gathered in logical steps depending on the characteristic of each. Total direct cost of each service is found by summing their labor, material and capital cost.(119)

Total Direct Cost = Labor Cost + Material Cost + Capital Cost

1. ***Labor cost*** means the cost that paid to the staffs in exchange of their work. This includes wage, salary, overtime and other expenditure in performing their duty. Additionally, it includes the other allowance that paid out in term of money such as dental education. In accounting viewpoint, it is quite complicate to determine the labor cost as an indirect cost or direct cost. Overtime is generally regarded as indirect cost or overhead cost.(121)

2. ***Material/Supplies Cost*** refers to all kinds of material supplies that each intervention required from the disbursement unit during the study period. Materials are defined as those items that are incorporated into and remain part of the feature or structure. Supplies are defined as those items that are used during construction but do not remain a permanent part of the feature or structure Material and supply costs are an integral part of most cost estimates. The primary disbursement units include. The material cost

also refers to the maintenance cost and utility cost. Estimating the material cost can be done by using material requisition record if the record is particularly accurate. If the requisition record does not exist, the unit cost of material needs to be calculated by finding the price of the materials and their quantity. (119)

3. ***Capital Cost*** or Equipment costs are defined as machinery such as construction equipment, conveying systems, processing plants, tools, and instruments that are required during construction of the project, but do not remain a permanent part of the project. Capital Cost also refers to annual depreciation costs of equipment and building. This kind of cost generally occurs once in a long while. In accounting viewpoint, depreciation cost will be calculated by using Straight-line method.(122)

Straight-line method

This means the depreciation cost will be equally averaged out by their total life. Otherwise it can be calculated by taking the initial cost subtracted by the salvage value (the price when the equipment reaches its total life) and divided by the total life of building or equipment. Total life of building and equipment generally equals to 25 years while total life of vehicle equals to 3 to 5 years. The medical equipment's total life equals to 5 to 15 years depending upon the type of equipment.(123)

$$\text{Depreciation Cost} = \frac{\text{Initial Cost (purchasing price)} - \text{Salvage Value (cost remaining)}}{\text{Total Life (Year)}}$$

In addition to the above 3 medical services cost that are provided for cost analysis not include transportation cost for distant location incur into school based dental services.

The cost analysis of mobile services will add transportation cost including car driver salary, car depreciation cost, maintenance cost and fuel cost.

Sum of years' digits method

The sum of years' digits method is a form of accelerated depreciation that is based on the assumption that the productivity of the asset decreases with the passage of time. Under this method, a fraction is computed by dividing the remaining useful life

of the asset on a particular date by the sum of the year's digits. This fraction is applied to the depreciable cost of the asset to compute the depreciation expense for the period.

Sum of years' digits method attempts to charge a higher depreciation expense in early years of the useful life of the asset because the asset is most productive in early years of its life. Also the asset loses much of its productive efficiency in early years.

Formula:

The following formula is used to calculate depreciation expense under sum of years' digits method

$$\text{Depreciation expense} = \frac{\text{Remaining useful life of the asset}}{\text{Sum of the years' digits}} \times \text{Depreciable cost}$$

Double Declining Balance Method of Depreciation

The double declining balance method of depreciation, also known as the 200% declining balance method of depreciation, is a form of accelerated depreciation. This means that compared to the straight-line method, the depreciation expense will be faster in the early years of the asset's life but slower in the later years. However, the total amount of depreciation expense during the life of the assets will be the same.

The "double" means 200% of the straight line rate of depreciation, while the "declining balance" refers to the asset's book value or carrying value at the beginning of the accounting period. Since book value is an asset's cost minus its accumulated depreciation, the asset's book value will be decreasing when the contra asset account Accumulated Depreciation is credited with the depreciation expense of the accounting period.

2.11 Cost effectiveness and strategic planning (WHO-CHOICE)

CostIt

CostIt (Costing Interventions templates) is a software designed to record and analyze cost data. It is not a data-collection tool but can guide the development of instruments for collecting primary data. The main function of CostIt software, completely automated, is to calculate the economic costs of interventions, however, it can also be used to estimate financial costs. It provides a set of separate templates for the reporting and analysis of costs at the program, hospital, primary health facility and household levels. (124)

Features of CostIt include a macro that automatically converts costs from any given year to those of the base year chosen by the analyst; and ability to adjust cost for different levels of capacity utilization. CostIt is a work in progress and will accordingly be updated in an ongoing manner with successive versions and a detailed user's guide. Currently, only a brief user guide is available (downloadable below). Analysts wishing to use CostIt should be familiar with general cost concepts and have a basic knowledge of Excel software.

CostIt software is designed to record and analyze cost data. It is not a data-collection tool but can guide the development of instruments for collecting primary data. CostIt is used mainly to calculate the economic costs of interventions. If financial costs are to be calculated, the columns for financial unit costs may be used. Separate summary tables are provided for economic and financial costs. CostIt software provides a set of separate templates for the reporting and analysis of costs at the following levels:

• Primary health facility: This template uses direct allocation of overhead costs, which is appropriate for costing at small facilities such as primary care centers or laboratory centers.

• Hospital: The hospital-cost template uses step-down allocation of overhead costs; it is recommended for costing of hospital or other large, multiple-output facilities.

• Program: The template for program costs is used to collect costs incurred at different levels of the health system (national, regional and district), which is above the level of direct delivery of care to beneficiaries (recorded in the primary-health-facility or hospital CostIt templates). It may also be used for programs costs borne by

communities, such as for promotion and distribution of bed-nets in malaria control, or for services of village volunteers.

• Household: A spreadsheet recording intervention specific care-seeking costs (e.g., travel time to health facilities, cost of drugs, special food) is included in CostIt template for program level costs. It is mainly intended to report quantities and average costs of different household care seeking costs, but assumes that the analysis done to derive average costs are done elsewhere.

CostIt includes a macro that automatically converts the costs from any given year to those of the base year chosen by the analyst. The base year should be specified early in the data-entry process, in the "intervention information" sheet. The years to which the collected data relate should be entered in the table on the upper right of the sheet. Use the GDP link provided above the table to select and enter local GDP deflators corresponding to each entered year. This is a link to all the local (country-specific) GDP deflators included in the World Development Indicators of the World Bank, 2001. For data entry, it will be sufficient to specify the year to which the data relate to ensure that costs are automatically converted to the base year. A feature of CostIt software is that it allows costs to be adjusted for capacity utilization. The unit costs of a bed day in a hospital with 40% bed occupancy will be different from those for a hospital with 90% occupancy, simply because the capital is spread over fewer beds; the information obtained from a costing study would therefore not be generalizable to the intervention for different occupancy rates. For this reason, the spreadsheet is designed first to record *"actual costs"* and then to adjust them automatically for capacity utilization. Two types of cost may be calculated from the data entered: actual costs, and costs adjusted for a standard capacity level. To calculate capacity adjustment factors, norms are applied to collected data entered in the capacity utilization table. The norms may be based on expert opinion or established from information on the maximum achievable capacity at the study setting. CostIt allows users to also adjust capacity of major inputs directly. However, by making available to other users the information required to calculate adjustment factors, they make it possible for those who wish to do so to determine and change the level of capacity utilization. Users are recommended, therefore, to enter this information systematically; the template may still be used to record costs without this

adjustment. CostIt for Program costs distinguishes between “Start-up’’ and annual “post-implementation” costs. “Start-up’’ costs are all costs incurred in the pre-implementation phase of the program/intervention – capital costs, as well as recurrent-cost categories specific to pre-implementation. All pre-implementation, including recurrent, costs are annualized in the economic analysis. “Annual post-implementation’’ costs comprise capital and recurrent categories and are meant to be the costs of running the program for one year. In computing economic costs, annualization factors, completely automated, are applied to obtain a depreciated value of capital items. For financial costs, the user can choose either to enter the extra costs of adding the program to the current services or to enter all, including infrastructural, costs incurred in running the program. A depreciated value of financial capital costs is obtained by straight-line depreciation, but this step may be omitted by neutralizing the function: the user can then report the financial costs of start-up separately from those of running the program each year, for example. The Community Program Costs include costs borne by the community; these should not include household care seeking costs.

A note on cost data from several facilities: When data originate from a number of health facilities, a new sheet should be used for each facility. This can be done by copying the spreadsheet in the same or new file. The summary tables of total and average costs are placed at the end of each sheet and will provide summary costs automatically. For hospital costs, a new file should be used for each hospital. Finally, average costs across facilities may be computed and entered directly in the general summary sheets (available in the CostIt for program level). For some interventions, different types of activity take place at the facility level. For example, the Expanded Program on Immunization may include vaccination visits to a facility as well as outreach activities. To study the costs of individual intervention activities, a user has two options: to allocate costs to each of the studied activities, using the columns on the right side of the spreadsheet; or, when studies do not require costs to be disaggregated by activity, or are concerned only with total costs of the intervention at facilities, to allocate facility costs directly and once in the designated columns; the right-side columns do not need to be filled in. The summary sheet will provide two summaries

for the two options: the aggregated total intervention costs; and, in the same sheet below, the summary of intervention costs by activity. (125)

CostIt for primary health care facility level, intervention cost incurred at small facilities divided into main two parts; recurrent costs and capital costs, detail as below;

Recurrent costs

1. Personnel costs; Personnel time allocated to each intervention is netted out from time spent by those personnel in other interventions. Personnel time used in the start-up and post start-up periods is expressed in person-months.
2. Non-medical materials & supplies; Media inputs such as radio or television time, leaflets or posters are provided in terms of their unit of measurement (e.g. minutes for radio, or quarter page ads in newspapers).
3. Drugs (name and units)
4. Medical supplies; Materials and supplies in terms of the quantities used for the program. Examples are office supplies that are used by the program.
5. Laboratory supplies
6. Transport operating costs
    1. Transport running cost e.g. vehicle petro, transport is measured in terms of total kilometers traveled per mean of transport.
    2. Other transport cost e.g. vehicle rental or public transport costs (train, plane, taxi etc.)
7. Equipment operating cost; rented equipment/implements In cases when equipment is rented, the number of equipment and the duration of rental (in months) are reported.
8. Maintenance; Maintenance costs (vehicles, building, furniture, equipment) Maintenance costs are listed as a percentage of annual costs.
9. Utilities e.g. Electricity Gas, Fuel, Water, Telephone, Other/Unspecified. The amounts of utility items allocated to the program are listed here. Examples of utility items are electricity, gas, and water. The allocation of the quantities used by the program is based on the square meter surface area used by the program, after applying any further allocation needed if the space is shared with other programs.

10. Other recurrent items

    1. Rental buildings; In case buildings are rented, both the total square meter surface area of the buildings and the duration of rental (in months) are used.

    2. Insurance; Building, Vehicles, Equipment, Public liability, Other/Unspecified. The types of personnel who are entitled for per diems and travel are listed. The types reflect the activity they are involved in, e.g. trainers, trainees, support staff in meetings, participants of meetings, supervisors visiting health facilities etc. Reported by the number of days per type of personnel.

    3. Miscellaneous items; any other category of recurrent resources used that is not provided in the list are reported here by identifying the item and the quantities used.

Capital costs

1. Building costs

    1. Name/function of building e.g. Dispensary

    2. Allocation of building space; Type of service: e.g. office, clinical ward, waiting area, store, not in use. Space used by the program are reported in terms of the total square meter surface area allocated to that program, i.e., if the space used by the program is shared with other activities, the share of the space used for the program under study are estimated and the value are entered here.

2. Transport costs; the number of means of transport used by the program is listed here. If they are only partly used, the estimated share of their use are entered.

3. Equipment/implements costs; Items: Medical, lab, or other diagnostic equipment, maintenance and cleaning as well as office equipment. The number of office equipment, storage and distribution, maintenance, cleaning and other capital equipment are reported here. If they are only partly used, appropriate allocation is made, using the same allocation factors used for building space

4. Furniture costs ; same as Equipment/implements costs

5. Other capital costs; this section is used to report any other capital resources used by the program.

2.12 Cost of dental care in Thailand

Araya W. conducted an analysis of the cost of dental care in Thatum Hospital in 2014. The data was collected through the dental service records, expenditure of personnel remuneration, material requisition, and capital cost logs, Extreme Platform of Hospital Information program (HOS XP) (126). All the costs are organized into 3 mains different categories which are Araya W. conducted an analysis of the cost of dental care in Thatum Hospital in 2014. The data was collected through the dental service records, expenditure of personnel remuneration, material requisition, and capital cost logs, Extreme Platform of Hospital Information program (HOS XP) (126). All the costs are organized into 3 mains different categories which are

2. Labor cost (LC) per min. This will be distributed and added up to each dental procedure.
3. Material cost (MC) is subdivided into 3 sections
   2.2 Non-durable cost over a year is calculated and allocate to each treatment
   2.2 Instruments is calculated as Baht per visit
   2.3 Lab cost
4. Capital cost (CC) that is determined from depreciation allowance.

Total direct cost (TDC) is then calculated from the sum of LC, MC, and CC. Extraction yields the highest cost, followed by composite filling, and scale and polish treatment. Cost of different kinds of treatment are illustrated in terms of unit cost. The unit cost equals the total direct cost divided by numbers visits.

A study of itemized dental service cost of Bankuat hospital in fiscal year 2018 demonstrates dental service cost analysis in terms of itemized analysis cost (127). Similar to the previous study, the data was gathered from HOS XP, wage and salary disbursement, material and equipment records.

Full cost (FC) of dental service is composed of indirect cost (IDC) and direct cost (DC). The direct cost is classified into operating cost (OP) and total directing cost (TDC). Due to lacking operating cost from other departments, TDC is the alternative to analyze dental service cost.

TDC consists of

1. Labor cost including salary, perquisite, and welfare of dentist, dental nurse, and assistant. They are distributed to dental service time.
2. Material cost including

   2.1 Nondurable supplies for example amalgam filling, root canal filling, and tooth color filling

   2.2 Hand instruments with 10 years of lifespan, being used twice a day.

   2.3 Dental equipment's maintenance cost

   2.4 Prosthetic lab cost collected from invoice

3 Capital cost

3.1 Durable equipment cost (baht/visit) for example impression mixing with 7 years of life expectancy and 5-year light cure machine

3.2 Depreciation cost is the clinic sites with 25-year lifespan

Again, dental unit cost is finally presented and compared with fees from the Ministry of Public Health and Comptroller General's Department. This paper explained that dental unit cost equals to TDC divided by number of patients or visits or teeth or mouth.

According to a paper of Estimating cost of school sealant programs with minimal data, it investigated the cost of school sealant program in 1 year. Importantly, methods are described intensely (128). First, researchers arranged the costs into 6 different groups; equipment, instrument, infection control and supply durable items, labor, mileage, and administrative cost. Secondly, the research team worked with school sealant programs experts to get entirely school sealant programs information and also identified the appropriate unit to collect the data. Thirdly, the factors that influence the cost were also indicated. These include types of sealing material and treatment (screening or sealing), and numbers of operators. Lastly, standardized per-unit cost was estimated. For equipment, instruments, and supplies, their own data were used to estimate per unit cost or standardized default values in school sealant programs. While data collection logs were developed for estimation of costs for the remaining resource categories. All the vendors and suppliers were mentioned for the sources of reusable costs. An amortization of 3% discount rate was also mentioned in this paper and only crucial sealant equipment was carried. Infection control items (trash liner, hand sanitizer, washing soap, protective cloth, waterline treatment, evacuation system, and

etc.) cost were guided by CDC infection control guidelines. The disposal costs were obtained from the vendors' website. Owing to traveling to many US schools to provide the sealant, they need to calculate the costs of mileage, fuel, and the cost of compensation through recording daily logs. Labor time on delivering sealants, excluding fluoride gel, was only considered. The calculation of annual labor cost, annual cost per worker category, total labor costs, and hourly compensation were stated understandably. A log again was developed for administrative to record the office's annual cost, administrative mileage, and labor time on meeting, or collecting consent forms. Designed logs help school sealant programs obtain critical information with minimal data entry and time for resource categories that cannot be standardized. But logs were piloted over a few school days, not the entire school year therefore it was not specified all types of administrative costs.

ABC Seals (Annual costs of hypothetical school sealant programs) were used to assume and demonstrate how to estimate the annual costs. For example, the researchers assumed that ABC Seals purchased sealant stations (durable items) from the manufacturer, each station used 4-handed technique, 58 school visits etc.

School sealant programs with standardized (default) cost help in reduction of the amount of data gathering in order to estimate the costs of each category. However, it does not provide an exact estimate of school sealant program resource costs.

2.13 Compare cost across countries

To compare price or cost of something between countries, the value of money in one country are not equal to the same amount of money in another country due to GDP factor. PPPs are price relatives that show the ratio of the prices in national currencies of the same goods and services in different countries.(129) According to World Bank, there are some value used in adjusting cost including Price level ratio of PPP conversion factor (GDP) to market exchange rate in year, Official exchange rate (LCU per US$, period average), PPP conversion factor or private consumption (LCU per international $) should be used to convert Thai Baht to standard value and compare to other countries.(130)

2.14 Cost-Effectiveness Analysis (CEA)

Cost-effectiveness analysis is often used in the field of health services. It estimates the costs and health gains of alternative interventions, provides a method for prioritizing the allocation of resources by identifying projects that have the potential to yield the greatest improvement in health for the least resources. The basic calculation involves dividing the cost of an intervention in monetary units by the expected health gain measured in natural unit. It use as a criterion for deciding how to allocate resources., However, many health interventions yield benefits beyond the immediate improvement of health status, where cost-effectiveness analysis may be inappropriate to monetize health effect. The values people place on non-health benefits are quite high as demonstrated by their willingness to pay for such services, but cost-effectiveness will not measure additional non-health-related benefits. Therefore, comparing interventions according to cost-effectiveness criteria must be done with a clear understanding that it compares interventions only in terms of their efficiency at improving health, and if non-health benefits are going to be introduced into a debate, then they should be considered for all the interventions under discussion and not for a select few. Cost-effectiveness analysis also requires comparable units for measuring costs. For domestic studies, the cost units in domestic currency will have a clear meaning in the absence of unit prices of the inputs into interventions, for comparison across countries.

The scope of the cost units included will also affect the cost-effectiveness analysis. Researchers may choose a narrow definition of costs and focus exclusively on the direct variable costs of providing a service; that is, they may only include the costs of additional materials and staff that are required and exclude costs associated with the use of existing infrastructure or installed capacity. In other cases, researchers may use wider definitions of costs by apportioning some share of the fixed costs of facilities and administration to the costs of the service. *Most research* use only direct costs, because estimates of these other costs are both difficult to obtain and rarely consistent across studies. An ethical problem is also involved if poor people's time is valued only on the basis of their low wages or incomes.

To conduct a cost-effectiveness analysis, researchers also need to specify the health intervention in some details. A health intervention is a deliberate activity that aims to improve someone's health by reducing the risk, the duration, or the severity of a health problem. Such interventions can be defined relative to adverse health events, such as suffering from a disease. Primary prevention seeks to avert an adverse health event, while secondary prevention aims to keep an adverse health event from recurring or causing a related problem once it has occurred. The more detailed and accurate the analysis, the more readily investigators can assess whether it is similar to or diverges from how that intervention is characterized in other contexts. For instance, health interventions might be provided by a less specialized facility or involved more visits in one country than another.

Though the basic cost-effectiveness calculation appears to be simple, choices about units of measurement, definitions of interventions, scope of costs, and prices to be included not only will alter the numerical results but also will affect the interpretation of the cost-effectiveness ratio. In many cases, the differences are so large that refining the underlying analyses is unnecessary. When cost-effectiveness ratios are within a similar range, policy decisions become more difficult. In such situations, closer analysis of the cost-effectiveness ratios may be warranted to improve confidence that the measures are close. This would entail verifying whether the units of measurement, the definition of interventions, and the scope of costs that are included were similar.

Cost-effectiveness analysis is also useful when comparing interventions that address different diseases or risk factors. Scarce resources will generate more health improvements when they are applied to interventions that are more cost-effective. Thus, cost-effectiveness should not be the exclusive basis for making health-related public policy decisions and should be complemented with information about distributional consequences.

Applying resources effectively means spending money on things that influence health, and this requires scientific knowledge about risk factors, diseases, biochemistry, social behavior, and so on, but this scientific knowledge alone does not determine which interventions will have the most impact. To determine the best allocation of public funds, policy makers need information about relative costs to determine what

combination of interventions can yield the greatest improvements in health. Cost-effectiveness analysis is the tool for weighing different costs and health outcomes when policy makers have to make resource allocation decisions. It does this by giving policy makers the "price" of achieving health improvements through different kinds of interventions, and thereby helps them make decisions that get the most out of their financial resources.

strategy	cost	Incremental cost	DMFT increment from baseline	Incremental DMFT	ICER
Preventive program (PP)	a	a-b	x	x-y	a-b/x-y
Compare Gr. (CG)	b		y		

$$\text{Incremental cost per DMFT avoided} = \frac{\text{cost of preventive program} - \text{cost of comparison group}}{\text{DMFT incremental for PP} - \text{DMFT increment for CG}}$$

2.15 Cost-Effectiveness of school based oral health promotion and prevention program

Oral health promotion program

Several studies were done to evaluate the clinical effectiveness and cost-effectiveness of oral-health promotion programs (OHPPs) aiming to improve children's knowledge of favorable oral health behavior to lower decayed/-missing/-filled teeth (DMFT) while reducing the financial cost on health institutions. Systematic Reviews and Meta-Analysis showed the overall pooled impact of OHPPs estimates children suffering from DMFT/S to have 81% lower odds of participating in OHPP (95% CI 61–90%, I 2: 98.3%, p = 0). Furthermore, the program was shown to be effective at lowering the cost in 97 out of 100 OHPPs (95% CI 89–99%, I2: 99%, p = 0). The risk of bias was assessed based on the Drummonds Checklist. A comprehensive analysis of the OHPPs confirmed a reduction effect on child DMFT, hence, lowering the financial burden of dental-care treatment on health institutions.

Oral health prevention program

The National Preventive Dentistry Demonstration Program of America assessed the cost and effectiveness of various types and combinations of school-based preventive dental care procedures. The program involved first, second, and fifth graders from five fluoridated and five non-fluoridated communities. These children were examined at baseline and assigned to one of six treatment regimens. Four years later, they were examined again. Analyses of their dental examination data showed that dental health lessons, brushing and flossing, fluoride tablets and mouth rinsing, and professionally applied topical fluorides were not effective in reducing a substantial amount of dental decay, even when all of these procedures were used together. Sealants prevented one to two carious surfaces in four years. Children who were especially susceptible to decay did not benefit appreciably more from any of the preventive measures than did children in general. Annual direct per capita costs were $23 for sealant or fluoride gel applications and $3.29 for fluoride mouth rinsing. Communal water fluoridation was reaffirmed as the most cost-effective means of reducing tooth decay in children.

CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Design

A *retrospective cohort analysis of school children profiles* in academic year 2009-2018 *was conducted* to investigate protective factors, cost and effectiveness of School-based Oral Health Program (SOHP) run by Community Dentistry Department, Faculty of Dentistry, Mahidol University. Overall 5 cohorts (the first grade of cohort 2009, cohort 2010, cohort 2011, cohort 2012, and cohort 2013) were included. Each cohort was observed 5 years, approximately 530 children, Figure 3.

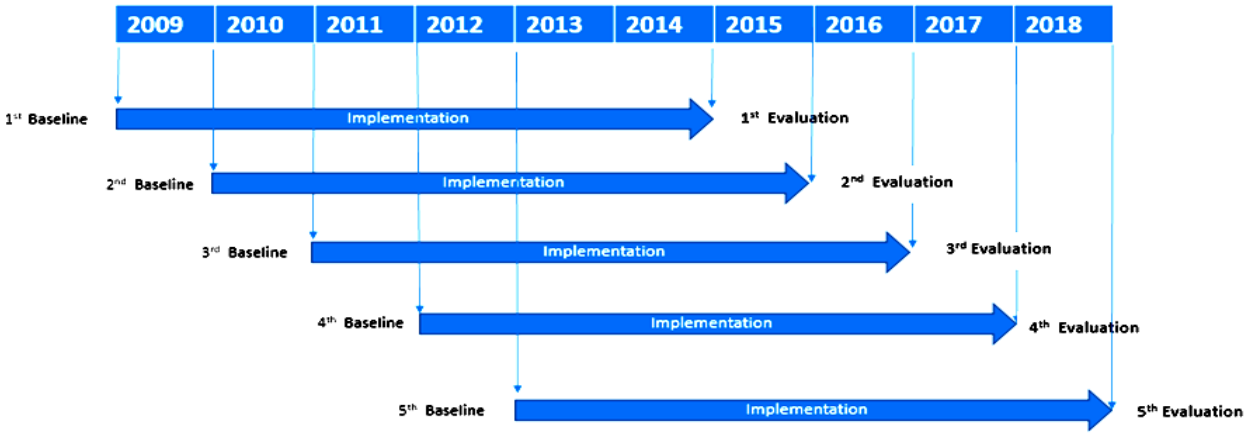


Figure 3 Details of each studied cohort and the analysis

Beginning the SOHP, all school children were invited to participate in the program. As it was unethical to withhold any proven intervention from any child, no control group was created. Children who did not sign consent to receive any preventive treatment from the program or not participate in the program would be natural controls, if that child had dental examination at the end of the study. All consenting children were undergone a detailed dental clinical examination and their basic demography (gender and age), residential history, own general health perceptions.

Children were separately assessed by participation of the intervention: first children who has examination only, those with not completed preventive care and those who fully participate.

1st group; Exam only group

2nd group; Children with not completed preventive care (3-4 years) group

3rd group; Children with completed preventive care (more than 5 years) group

Outcome of the program was measured as number of caries in permanent teeth or DMFT scores at the 6th year of the program or after 5 years, using dental treatment records in SOHP database in this past 10 years (5 cohort series of 6-year program). Data profiles of the subjects who had joined the program in the 1st grade till the 6th grade was based on Mahidol SOHP during academic year 2009 to 2018.

The effectiveness of program measure from mean DMFT scores in children who received complete preventive treatments in the program compared with Mean DMFT scores in children who did not receive any preventive treatments in the program.

Cost of Mahidol Oral Health Program

Total Cost of the program included costs of both course based and school based practice. The economic perspective included tangible cost from Mahidol University provider side, classified as labor cost of all staffs, material cost, capital cost and miscellaneous costs from school-based intervention program. Extensive information on patterns of resource consumption and unit costs for all preventive programs was obtained from procurement section and Department of Community Dentistry. Other details of the analysis such as the price of setting and the use of other utility were reported. The cost estimates were based on retrospective averages in provider perspective. Identification incurred expenses and costs associated with the program including material and equipment cost of Sealant, Fluoride varnish, Oral health education. The total cost of program was calculated and divided by number and time of all tasks to find estimated cost per treatments of fluoride treatment, sealant and oral health education.

- Cost of fluoride treatment: cost that related to fluoride treatment including fluoride varnish and fluoride gel.
- Cost of sealant: cost that related to sealant treatment including resin sealants and glass ionomer (GI) sealants.
- Cost of oral health education cost that related to give knowledge and practice to school-children including brushing (cleaning) technique, eating-behavior and diet counseling.

3.2 Study area

The study area for this research included 4 public primary schools in Bangkok which have contracted with Mahidol University. The studied public primary schools belong to Bangkok Metropolitan Administration (BMA) or Thai Ministry of Education (MOE). Three schools are belonging to BMA, and the last school is belonging to MOE.

3.3 Study Population and study samples

The primary school children grade1-6 (approximately 6-13 years old) who attended school during academic year 2009-2018 (*5 cohorts of the first grade of 2009, 2010, 2011, 2012, and 2013*) in 4 public primary schools, approximately 500 children. Each cohort will be observed 5 years for analyzing the effectiveness of the program.

The eligibility file provided information about the periods of eligibility and demographic characteristics of enrolled children. The dental claims files included information about all dental services and oral examination results each year.

- **Inclusion criteria of study samples:** child's profiles of both gender with completed measurement studied variables and approved by supervisor.
- **Exclusion criteria of study samples:** child's profiles that were not consistent between each year of examination.

3.4 Sampling technique

We used total population of school children who were attending school in academic year 2009-2018 (*5 cohorts of the first grade of 2009, 2010, 2011, 2012, and 2013*). The interested study population was not large, so that, we examined the whole population **who voluntarily participated in the program.**

3.5 Sample & sample size

All child's profiles that met the criteria of study samples. The sample size includes 5 cohorts during period of study (*5 cohorts of the first grade of 2009, 2010, 2011, 2012, and 2013*), each cohort was observed approximately 5 years for the effectiveness analysis of the program (Figure 2).

The consent forms to join the program were sent to all students' parents on the first day of every academic. Students without parental consent received dental examination only and became a control group.

3.6 Data Collection

- Secondary data were obtained from primary data collected by SOHP, Community Dentistry Department, Faculty of Dentistry, Mahidol University.
- All results from the primary oral examination in the program were conducted by the 5th year dental students and confirmed by their supervisors who are dentists.
- The Mahidol dental students were trained to use the WHO diagnostic criteria for caries experience which were calculated into the mean numbers of decayed (d, D), missing (m, M) and filled (f, F) teeth (t, T). The 'dmft' is used for deciduous and 'DMFT' for permanent teeth(131).

- Each child was examined for dental cavity, history of treatment, gingivitis, food debris and calculus deposit. The decay, missing and filling teeth were recorded in dental diagram chart.
- Participating children were interviewed by trained dental students to obtain personal data of underlying diseases. Basic socio-demographic data including age, gender, weight and height, and education level were obtained from teachers of each schools.

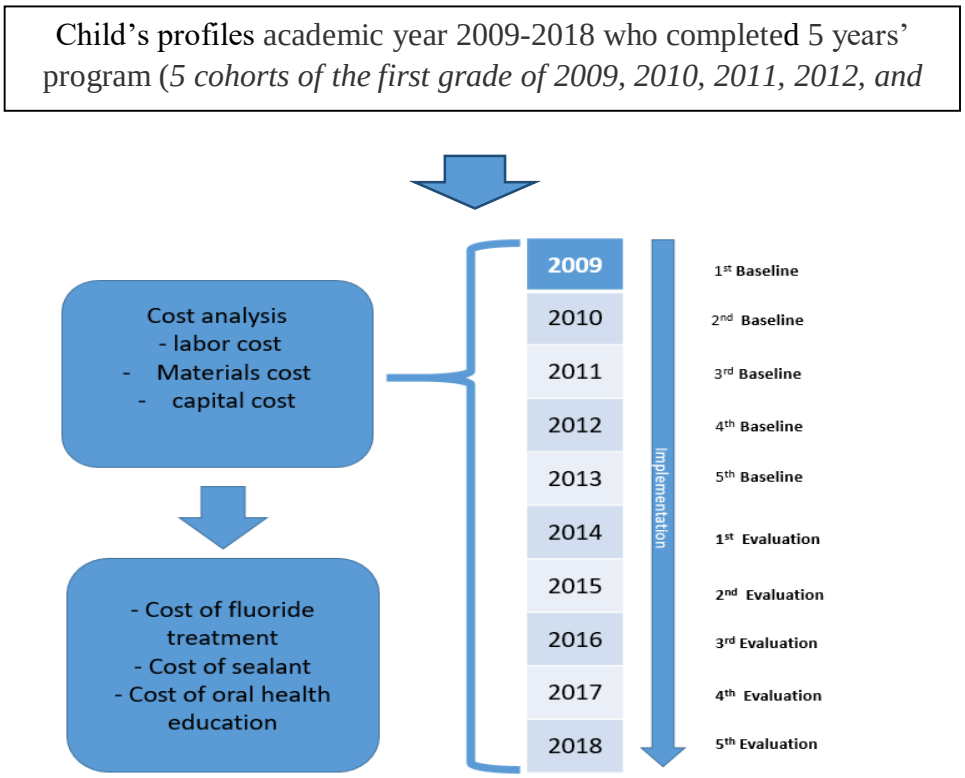


Figure 4 Steps of data collection

3.7 Measurement Tools

Data were collected using the dental chart of Mahidol University and modified by using ID instead of children's name and checklist of intervention for preventive treatment record.

Section 1: Personal characteristics including ID, school name, gender, educational level, age, weight, height, nutritional status and underlying disease.

Section 2: Oral hygiene using Simplified Oral Hygiene Index (OHI-S)

Section 3: Oral health problem including caries index and gingivitis status

Section 4: Preventive dental treatments in the SOHP including sealant, preventive resin restoration, fluoride varnish, fluoride gel, oral health education preventive scaling and extraction.

The estimated costs of school oral program, cost data were kept in 3 main parts; labor cost, material cost and capital cost (with annual depreciation). Labor cost and

material cost are consider as operational or running cost, also called recurrent costs, miscellaneous costs such as electricity cost and maintenance cost were collected. Accordingly, the proportion of the program spend needed to be included in the calculation. For cost estimation, checklist forms were used as follow;

Labor Cost: All staff's salaries (dentists/supervisor, dental assistants, car driver) use Labor cost for Mahidol dental program form.

Material Cost: including dental material (fluoride varnish, sealant material), other disposable accessory materials (cotton roll, pumice powder, articulating paper, disposable saliva ejector, etc.) Office materials (paper, pen, pencil, etc.) were classified in group by type of usage. Estimating the material cost could be done by using data source for consumable cost and stationary cost in Materials cost of Mahidol dental program form (Dental Material Record Form and Office Material Record Form

Capital Cost: including heavy equipment (such as mobile dental unit, dental equipment, portable dental chair, mobile dental light) and hand instruments (such as explorer No.21, mouth mirror, cotton plier, stainless steel tray were classified in group by type of usage. Estimating the capital cost could be done by using data source from capital cost of Mahidol dental program form (equipment and instrumentation lists), calculation adjusted by Annual Percent Change (rate of inflation).

All cost data mention above was re-entry and analyze of cost program was based on the World Health Organization's CostIt software (Costing Interventions template) Version 4.5 developed by: Taghreed Adam, Moses Aikins and David Evans. CostIt for primary health care facilities (direct allocation to overhead) intervention cost incurred at small facilities divided into main two parts; recurrent costs and capital costs in provider perspective.

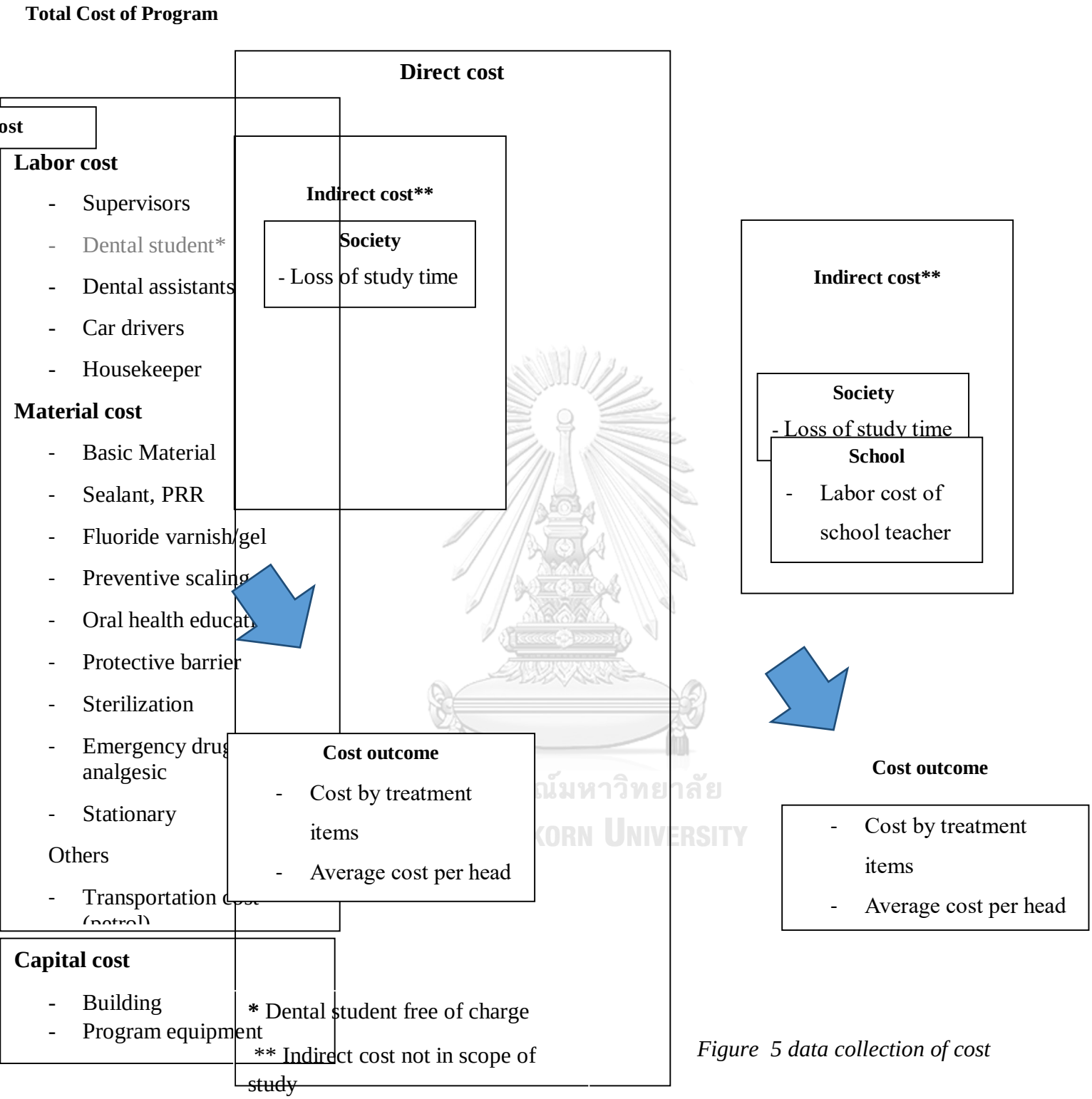


Figure 5 data collection of cost

3.8 Validity and Reliability

All data were recorded by the fifth-year dental students who received similar professional training and used same criteria for screening and recording caries. After

dental students' examination, results were cross- checked by professional supervisors. Additionally, these data were used for the actual treatment and updated every visit. During the examination of the current year, dental charting records in the previous years were using as references for dental charting to improve the accuracy of the record.

3.9 Data Analysis

Out of 530 child's profiles of both sexes, Thai nationals and clinically assessed by the 5th year dental students under tutor's supervision, 97 were excluded due to incomplete demographic data (23) and loss to follow up (74). The study analyzed data for the remaining 433 children. Among the Dental Record Chart data, our study used the DMFT Index to create the binary dependent variable 'caries' (DMFT >0) and 'caries free' (DMFT=0) in permanent teeth. The other Dental Record Chart data, we used to create the categorical independent variables were: 1. Demographic characteristics (cohort year, school attended and sex), 2. Underlying diseases (yes/no), 3. Oral health conditions: 3a. Simplified Oral Hygiene Index (OHI-S) (good, fair and poor as in *Green and Vermillion, 1964)*, 3b. Signs of gingivitis: redness and swollen gums (yes/no), 3c. 'Caries' (dmft>0) and 'Caries free' (dmft 0) deciduous teeth and 4. Exposure to the SOHP: 4a. Level of SOHP participation (complete, incomplete, oral examination only), 4b. Fluoride varnish applications (yearly, almost yearly, sometimes, hardly ever) 4c. Sealant applications onto permanent 1st molars (all, few, none). We considered 'control' as students those with: 'oral examination' only (4a Level of participations), 'hardly ever' (4b. Fluoride Varnish) and 'none' (4c. sealant). We considered 'case' students all the remaining grades of exposures.

For descriptive statistics, all cost data were analyzed in descriptive statistic based on WHO CostIt program and present in amount and percentage. Baseline socio-demographic characteristics were described for the selected samples. Categorical variables were presented in frequency, percentage and the mean (SD) DMFT for each category. To analyze the risk and protective factors for caries associated to the SOHP, we used Chi-square and simple logistic regression to test associations of each independent variable and the dependent binary variable 'caries' and "caries free".

Multiple logistic regression was used to test associations between the dependent and several independent variables simultaneously. Into the model, we entered all independent variables significant with $p<0.05$, non-significant variables with $p<0.2$ and oral hygiene by OHI-S level which is frequently and strongly associated with caries experience in literature(132). Statistically significant level for all tests was set with p-value of ≤ 0.05. SPSS statistical program (version 22) was used for data analysis.

Baseline and follow-up caries experience and record related information were reported. Dental caries increment (incidence) was the main outcome measure used to determine the effectiveness of the preventive intervention from the program. The mean caries increment will be compared between the expected and actual findings, and adjusted for known risk factors for dental caries. The hypothesis was that caries increment observed in the program group (SOHP) should be less than the control group. Independent t-test was used to analyzed between 2-sample groups with significance being determined if $p < 0.05$. Children who received only a part of the intervention were separately assessed: for instance, we had children with complete participation, those with only 1-to 2-year participation the program. This 'naturally' further informed us on the most appropriate frequency of this preventive strategy. Both a group and matched analysis were conducted to account for children who received only part of the intervention.

3.10 Ethical Consideration

Ethical approval was sought and obtained from the Chulalongkorn University Ethics Review Committee for Research Involving Human Subjects, Health Science Group. The permission for data utilization by the head of Community Dentistry Department was done, and all data were obtained along with anonymous measures to ensure that their data were safeguarded and not utilized for any purpose outside the purpose of this study. The research protocol was reviewed and approved by the Ethics Committee of Chulalongkorn University

The official letter from College of Public Health Sciences, Chulalongkorn University was delivered to obtain permission either from the Head Department of

Community Dentistry, Faculty of Dentistry, Mahidol University. After the permission, the data of child-profiles were collected and analyzed.

Ethical approval was granted by the Research Ethics Committee of Chulalongkorn University (No.098/62, 23 April 2019: Exemption). A researcher has no conflicts of interest.

CHAPTER IV
RESULT

The retrospective cohort analysis of 530 student profiles from School Oral Health Program (SOHP) records of Mahidol Dentistry Faculty, Community Dentistry Department was revised and 23 student profiles were discarded for missing data and 74 student profiles were exclude because children loss to follow up. The main reason for missing data was the absence of students from the school on the day of dental examination. The student profiles remaining 433 were analyzed and the results are presented below.

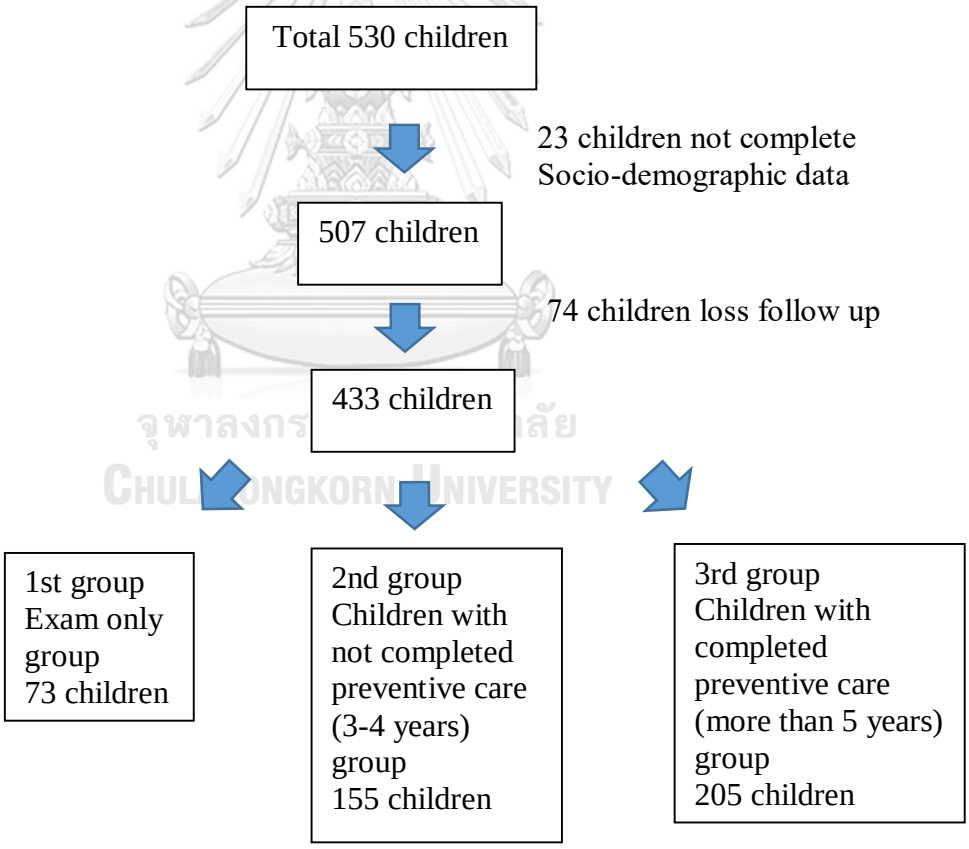


Figure 6 Participants flow chart

4.1 Demographic characteristics, underlying diseases and oral health conditions of students

The years of school enrollment of our cohorts were 2009-2014, 2010-2015, 2011-2016, 2012-2017, and 2013-2018. Students attended four public schools in Bangkok (87 students from School A, 113 from School B, 90 from School C and 143 from School D). They were predominantly females (232 or 53.6%), had no underlying diseases (371 or 85.7%) and only 14.3% had some underlying diseases, such as asthma, allergy, impaired hearing and heart disease (details in Table 1).

The students' oral health conditions, measured as the mean of simplified oral hygiene index scores (OHI-S), was 2.17 (± 0.91) corresponding to the 'fair level (1.3-3.0)' according to *Green and Vermillion, 1964.* Gingivitis affected the majority of students (83.6%), caries prevalence in deciduous teeth (of 6-year-old students) was high (87.2%) as well and 9.5% only were caries free. The mean dmft index was 6.44 (± 4.4).

Additionally, the caries prevalence in permanent teeth at 6^{th} grade students was 51.7%. The mean DMFT was 1.37 (± 1.84) (details in Table 1). When studied students classified by receiving some preventive treatments from the SOHP (such as varnish and sealant application) revealed 3 groups: complete receive, incomplete receive, and no receive (oral examination only), results of mean DMFT showed details in Table 1.

Table 1 Demographic characteristics, underlying diseases, oral health conditions, and SOHP factors of studied students

Studied characteristics	N (%)	Mean DMFT(±SD)
Demographic characteristics (n= 433)		
Year of the cohort		
2009-2014	172 (39.7)	1.37 (±1.69)
2010-2015	71 (16.4)	1.13 (±1.65)
2011-2016	68 (15.7)	1.74 (±2.02)
2012-2017	66 (15.2)	1.44 (±2.27)
2013-2018	56 (12.9)	1.16 (±1.67)
School of enrolment		
A	87 (20.1)	1.32 (±1.49)
B	113 (26.1)	1.44 (±2.00)
C	90 (20.8)	1.09 (±1.76)
D	143 (33.0)	1.52 (±1.94)
Sex		
Male	201 (46.4)	1.15 (±1.63)
Female	232 (53.6)	1.56 (±1.98)
Underlying diseases (n= 433)		
No	371 (85.7)	1.36 (±1.83)
Yes	62 (14.3)	1.47 (±1.91)
Oral health conditions		
Oral hygiene status by OHI-S level (n= 433)		
Mean OHI-S = 2.17 ± 0.91		
Good (0.1-1.2)	59(13.6)	1.47 (±2.18)
Fair (1.3-3.0)	312(72.1)	1.24 (±1.70)
Poor (3.1-6.0)	62(14.3)	1.92 (±2.05)
Sign of Gingivitis (n= 433)		
Yes	362(83.6)	1.39 (±1.88)
No	71(16.4)	1.27 (±1.60)
Caries prevalence in deciduous teeth (1st grade) (n=319) : Mean dmft = 6.44 ± 4.4		
Deciduous caries	278(87.2)	1.32 (±1.82)
Deciduous caries free	41 (9.5)	0.37 (±0.89)
SOHP factors		
Participation in the SOHP (n= 433)		
3rd Group: complete	205(47.3)	1.00 (±1.87)
2nd Group: incomplete	155(35.8)	1.57 (±2.07)
1st Group*: Exam only (ref)	73 (16.9)	2.00 (±2.02)
Varnish times (n= 433)		
Every year or more (> 6 times)	98(22.6)	0.98 (±1.58)
Almost every year (4-5 times)	105(24.2)	1.21 (±2.02)
Sometimes (2-3 times)	148(34.2)	1.46 (±1.76)
Hardly ever*(0-1 time)	82(18.9)	1.89 (±1.92)
Sealant application (n=402)		

Studied characteristics	N (%)	Mean DMFT(±SD)
All 1st molars (4 teeth)	204 (59.7)	0.82 (±1.38)
Partial (1-3 teeth)	107 (26.6)	1.79 (±2.02)
None	55 (13.7)	2.87 (±2.02)
Caries prevalence in permanent teeth (6^{th} grade) (n= 433)		
Caries	224 (51.7)	2.65 (±1.77)
Caries free	209 (48.3)	0.00
Overall Mean DMFT	433 (100.0)	1.37 (± 1.84)

4.2 Homogeneity testing of caries status of permanent teeth in 6^{th} grade cohort students classified by year of the cohort and school of enrolment

Before the analysis of risk and protective factors of caries in permanent teeth in 6^{th} grade cohort students were performed, the homogeneity of caries status in these studied students distributed by years of the cohort and schools of enrolment was tested. It was found that caries status distributed by years of the cohort and schools of enrolment showed no significance, p=0.39 and p=0.23, respectively (Table 2).

Table 2 Homogeneity testing of caries status of permanent teeth in 6^{th} grade cohort students classified by years of the cohort and schools of enrolment (N=433)

Studied characteristics	Caries	Caries free	p- value
Years of the cohort (n = 433)			
2009-2014	92	80	0.39
2010-2015	35	36	
2011-2016	41	27	
2012-2017	31	35	
2013-2018	25	31	
Schools of enrolment (n = 433)			
A	46	41	0.23
B	63	50	
C	38	52	
D	77	66	

* Pearson's chi-squared test Statistical significance at α=0.05

** The dependent (outcome) variable: DMFT with cut of point 0 is used to create the binary outcome variable as caries and caries free

4.3 Risk and protective factors of caries in permanent teeth in 6th grade cohort students by simple logistic regression

4.3.1 Demographic factors and underlying diseases

Totally 433 student profiles were classified into 2 groups by DMFT scores, students with caries (DMFT>0) and students without caries or caries free (DMFT=0). The studied independent variables between 2 groups (demographic factors and underlying diseases) were compared and analyzed using simple logistic regression at the significant level of p=0.05. Results showed that female sex was moderately and significantly associated with higher caries status of permanent teeth than male sex (OR=1.51, 95% CI=1.03-2.20, p=0.034). There was no significant association with underlying diseases, (details in Table 3)

4.3.2 Oral health status factors associated with caries

The oral health conditions in the study were oral hygiene status measured by OHI-S level, gingivitis, caries prevalence (against caries free) and caries status in deciduous teeth, measured by dmft. Caries prevalence in deciduous teeth was strongly, positively and highly significantly associated with carries prevalence in permanent teeth. The chance to have caries in permanent teeth were 4.5 times higher in students with caries in deciduous teeth compared to students' caries free (dmft=0) (OR=4.5, 95% CI=2.0-10.1, p<0.001). Students who had high caries in deciduous dentition, dmft>4 tended to have caries in permanent dentition 5.17 times more than students who had low caries in deciduous dentition, dmft=0 (OR=5.17; 95%CI=2.28-11.73), p<0.001, Similarly students with dmft=1-4 were 3.05 times more likely to have permanent teeth caries compared to students with dmft=0 (OR=3.05, 95%CI=1.24-7.50, p=0.013). Presence of gingivitis and oral hygiene assessed by OHI-S level were not significantly associated with caries in permanent teeth. Details of all above reported results are shown in Table 3.

Table 3 Risk and protective factors of caries in permanent teeth in 6th grade cohort students by simple logistic regression

Studied factors	Caries	Caries free	OR (95% CI of OR)	p-value
Sex (n = 433)				
Female	131	101	1.51 (1.03-2.20)	*0.034*
male	93	108	1.00	
Underlying diseases (n = 433)				
Yes	30	32	0.86 (0.50-1.47)	0.57
No	194	177	1.00	
OHI-S level (n = 433)				
Good (0.0-1.2)	30	29	1.53(0.74-3.15)	0.248
Fair (1.3-3.0)	156	156	0.97(0.55-1.69)	0.905
Poor (3.1-6.0)	38	24	1.00	
Gingivitis (n = 433)				
Yes	188	174	1.05 (0.63-1.75)	0.85
No	36	35	1.00	
Caries prevalence in deciduous teeth (n=319)				
Deciduous caries	145	133	4.5 (2.0-10.1)	*<0.001**
Deciduous caries free (dmft=0)	8	33	1.00	
Caries status in deciduous teeth (n=319)				
High (dmft ≥4)	114	91	5.17 (2.28-11.73)	*<0.001**
Moderate (dmft 1-4)	31	42	3.05 (1.24-7.50)	*0.013**
Low (dmft=0)	8	33	1.00	

** Statistical significance at α=0.05*

4.3.3 Protective factors of the SOHP program associated with caries

The studied explanatory factors of the SOHP program included: level of participation in the program, frequency of fluoride varnish and number of sealant applications. All were analyzed against the outcome variable caries status of permanent

teeth in 6th grade students. All explanatory factors were highly significantly and negatively associated with caries of permanent teeth. The odds of caries after complete participation to SOHP program were 65% less (OR=0.35) than in non-participant students. The odds of caries after yearly or twice a year fluoride varnish application (6 or more applications) and almost every year in (4-5 applications) were 61% (OR=0.39), and 57% (OR=0.43) less respectively than in students who hardly ever applied varnish. Students who have sealant applications for all 1st permanent molar were 0.87 times less likely to have caries in permanent dentition (OR=0.13; 95%CI=0.06-0.28, p<0.001). Details are shown in Table 4.

Table 4 Protective factors from the SOHP of caries in permanent teeth in 6th grade cohort students by simple logistic regression

Studied factors in the SOHP	**Caries**	**Caries free**	**OR (95% CI of OR)**	**p-value**
Participation in SOHP (n = 433)				
3rd Group: complete SOHP	88	117	0.35(0.20-0.61)	*<0.001**
2nd Group: incomplete SOHP	86	69	0.57(0.32-1.03)	*0.06*
1st Group: exam only	50	23	1.00	
Fluoride Varnish applications (n=433)				
Every year (≥6 applications)	41	57	0.39(0.22-0.72)	*0.002**
Almost every year (4-5 application)	46	59	0.43(0.24-0.77)	*0.005**
Some years (2-3 applications)	84	64	0.72(0.41-1.25)	*0.24*
Hardly ever (0-1 application)	53	29	1.00	
Sealant applications (n=402)				
All permanent1st molars (4 teeth)	90	150	0.13(0.06-0.28)	*<0.001**
Partial (1-3 teeth)	72	35	0.46(0.21-1.01)	*0.051*
None	45	10	1.00	

* *Statistical significance at α=0.05*

4.4 Risk and protective factors for caries status in permanent teeth in 6th grade cohort students after multiple logistic regression analysis

The variables from bivariate analysis (Table 3) were combined into a multivariate logistic regression model as described in methodology. Studied factors for caries of permanent teeth in 6th grade cohort students after multivariate analysis showed OR values similar to those in bivariate analysis. Only caries in deciduous teeth and sealant applications onto all 1st permanent molar maintained significant association with caries in permanent teeth with a p-value of p<0.001 and p=0.007, respectively. All other significant variables from the simple logistic regression lost their significance and none of the non-significant variables included in the multiple logistic regression model achieved significance, as shown in Table 5.

Table 5 Significant risk and protective factors for caries of permanent teeth in 6th grade students after multiple logistic regression analysis

STUDIED FACTORS	BIVARIATE ANALYSIS		MULTI-VARIATE ANALYSIS	
	OR (95% CI)	**p-value**	**Adjusted OR (95%CI)**	**p- value**
Sex: Female	1.51 (1.03-2.20)	*0.034*	1.59 (0.96-2.65)	0.70
Male	1.00			
Oral hygiene by OHI-S level				
Poor (3.1-6.0)	1.53(0.74-3.15)	0.248	1.16(0.43-3.08)	0.77
Fair (1.3-3.0)	0.97(0.55-1.69)	0.905	1.10(0.54-2.26)	0.79
Good (0.0-1.2)	1.0			
Caries in deciduous teeth				
dmft ≥1 (deciduous caries)	4.5 (2.0-10.1)	*<0.001*	5.44 (2.23-13.27)	<0.001*
dmft=0 (deciduous caries free)	1.00			
Studied factors from SOHP				
Participation in the program				
3rd Group: Complete SOHP	0.35(0.20-0.61)	*<0.001*	0.46 (0.11-1.94)	0.29
2nd Group: Incomplete SOHP	0.57(0.32-1.03)	0.06	0.76 (0.18-3.23)	0.71
1st Group*: Exam only	1.00			
Varnish times				
Every year of SOHP (≥6	0.39(0.22-0.72)	*0.002*	1.25 (0.45-3.49)	0.68

STUDIED FACTORS	BIVARIATE ANALYSIS		MULTI-VARIATE ANALYSIS	
	OR (95% CI)	**p-value**	**Adjusted OR (95%CI)**	**p- value**
applications)				
Almost every year of SOHP (4-5 application)	0.43(0.24-0.77)	*0.005*	1.62 (0.58-4.53)	0.36
Some years of SOHP (2-3 applications)	0.72(0.41-1.25)	0.24	2.04 (0.74-5.60)	0.17
Hardly ever (0-1 application)	1.00			
Sealant applications				
Onto all 1st molars (4 teeth)	0.13(0.06-0.28)	*<0.001*	0.19 (0.06-0.63)	0.007*
Partial (1-3 teeth)	0.46(0.21-1.01)	0.051	0.68(0.19-2.42)	0.55
None	1.00			

** Statistical significance at α=0.05*

4.5 Cost Analysis of Program Implementation

Cost determination in the program based on cost in academic year 2015. There were 585 children with oral examination, 280 children received sealants for 858 teeth (which 767 were permanent molar). Preventive resin restoration for 90 children, 156 teeth. Prophylaxis fluoride treatment (fluoride varnish and fluoride gel), preventive scaling, oral hygiene instruction and extraction were done and distributed by studied school (Table 6). All tasks in this academic year were used to calculate the ratio in cost program determination.

Table 6 Number of preventive dental programs in an academic year 2015

Program	unit	School A	School B	School C	School D	**Total**
Oral Exam.	child	150	112	153	170	**585**
Sealant	tooth	189	188	159	322	**858**
	child	53	68	50	109	**280**
PRR	tooth	47	26	43	40	**156**
	child	23	17	20	30	**90**
Filling	tooth	22	17	29	25	**93**

Program	unit	School A	School B	School C	School D	**Total**
F gel	child	17	39	30	1	**87**
Fluoride varnish	child	63	66	85	168	**382**
Scaling	child	32	39	50	22	**143**
OHI	child	150	108	153	168	**579**
Ext.	tooth	0	3	4	6	**13**

OHI = Oral hygiene instruction Ext. = Extraction

WHO CostIt estimated costs of school oral health program, Faculty of Dentistry, Mahidol University in provider perspective

Price level ratio of PPP conversion factor (GDP) to market exchange rate 2015: 0.4

Official exchange rate (LCU per US$, period average): /ER 34.25 THB

PPP conversion factor, private consumption (LCU per international $), private consumption PPP: 12.98 LCU/THB)

Recurrent costs

1. Personnel costs; labor costs including
    a. Supervisors (dentists)
    b. Dental students
    c. Dental nurses
    d. Car drivers
    e. House keeper
2. Non-medical materials & supplies; stationary cost
3. Drugs; analgesic drugs
4. Medical supplies; Dental materials for program including material group by function used in activities
    a. Oral Hygiene Instruction and Basic materials
    b. Fluoride prophylaxis
    c. Sealant and PRR
    d. Sealant, PRR and Filling

e. PRR and Filling

f. Protective barrier

g. Sterilization

5. Laboratory supplies; none
6. Transport operating costs
    a. Transport running cost; vehicle fuel cost
    b. Other transport cost; none
7. Equipment operating cost; rental equipment: none
8. Maintenance
    a. Vehicles
    b. Building
9. Utilities; electricity
10. Other recurrent items
    a. Rental buildings; none
    b. Insurance; not applicable
    c. Miscellaneous items

Capital costs

1. Building costs; university hospital
2. Transport costs; vehicle costs
3. Equipment/implements costs; dental unit and service equipment cost including
    a. Department and basic equipment
    b. Equipment for sterilization
    c. Mobile unit
    d. Dental aerator, air motor, light cure
    e. Filling instruments
    f. Instrument for extraction
4. Furniture costs; office furniture

5. Other capital costs; none

Recurrent costs

Personnel costs or Labor cost

In this School Oral Health Promotion Program run by Faculty of Dentistry Mahidol University, the labor cost in the program was not from the operator (5^{th} year dental students) because they did not get and pay by the university. Thus, labor cost for this program (financial cost) included academic staff and clinical staff. There were 9 supervisors, 3 dental assistants, 3 car drivers and 1 house keeper. We excluded labor cost for school teachers, dental students, and other school personnel. Other necessary indirect expenses and time spent in conducting administrative and research activities, such as research staff time, in providing computer data entry were not considered in computing direct labor costs. The total labor cost for dental prevention program per year collected from Human Resource Section, Employee Data Unit, equaled 288,812.37baht. (Table 7)

The cost for supervisors was a majority part of labor costs. It equaled 139,020.63 baht (48.14%), was calculated from each personnel monthly remuneration for academic year 2015 divided by total work hours per year (8 hrs. × 20 days × 12 months =1,920 hrs.), it called personnel pay per hour and then multiplied by working hours for school program (average 63.33 hours) so labor cost of supervisors' allocation to the program 63.33 ÷ 1,929 = 3.3%, this proportion also used as reference %allocation of SOHP.

For dental assistants and car drivers, we used the same method. So, we could get personnel cost for this program. The labor costs of dental student were free of charge, financial costs were equal to zero. But, in economic cost, calculated by using voluntary wage rage (300 Bht. × 20 days × 12 months = 72,000 Bht.) multiplied by 0.5 FTE (full time equivalent) and multiplied by %allocation to program. The housekeeper was not hire specifically to in this program but also responsible for other department. To calculate personnel labor cost for house keeper per year, we used monthly remuneration of one year divided by area of responsibility and then multiplied by areas of community department. Cost per hour estimated from cost per year divided by total

work hours per year (1,920 hrs.). Labor cost of each type of personnel are shown in Table 7.

Table 7 Personnel financial cost for dental prevention program yearly (Thai Baht)

Type of personnel	No.	Wage range per year (avg.)	FTE (full time equivalent)	Working hour per year	**Labor cost per hour**	Hours denote to SOHP	% time allocation to the intervention	Labor Cost of SOHP per year	%
Supervisors	9	468,280.00	1.0	1920	**243.896**	63.33	3.30%	139,020.63	48.14
Assistants	3	171,920.00	1.0	1920	**89.54**	288	15.00%	77,364.00	26.79
Drivers	3	142,480.00	1.0	1920	**74.208**	288	15.00%	64,116.00	22.20
				Area of responsibility (sq.m.)	Labor cost per sq.m.		Area of operating zone		
house keeping	1	90000	1.0	4723.2	19.06	436.2	9.24%	8,311.74	2.88
								288,812.37	100

Personnel cost per tasks were estimated by time use per task (hour.) multiplied by labor cost per hour from previous Table. See details in Table 8.

Table 8 Personnel cost of MU staff for SOHP per intervention activities

task	Time use per task (min.)	Time use per task (hr.)	Supervisors cost (*243.89)	Dental nurses cost (*89.54)	Drivers cost (*74.2)	*Supporting staff cost	**all labor cost**
Oral Exam	10	0.17	40.65	14.92	12.37	27.29	**67.94**
Sealant	17	0.28	69.10	25.37	21.03	46.40	**115.50**
PRR	30	0.5	121.95	44.77	37.10	81.87	**203.82**
Filling	25	0.42	101.62	37.31	30.92	68.23	**169.85**
F treatment	5	0.08	20.32	7.46	6.18	13.65	**33.97**
Scaling	10	0.17	40.65	14.92	12.37	27.29	**67.94**
OHI	5	0.08	20.32	7.46	6.18	13.65	**33.97**
Ext	10	0.17	40.65	14.92	12.37	27.29	**67.94**
total		1.867	455.27	167.14	138.52	305.66	**760.94**

*Supporting staff are dental nurse and drivers

The personnel costs of the program were considering high because the program was not only a service program but also an educational program for dental students. Supervisors' salary were not actual labor cost for the services and labor costs of dental student were free of charge.

To estimated labor cost of program implement in real situation, the labor cost of the program should be dentists or dental hygienists or dental nurse. Dental hygienist cost only 34- 53% of supervisors labor cost(133). The different cost of personnel are shown in table 9.

Table 9 Personnel cost from difference sectors

Operator cost	MU supervisor	Dental division dentist	MOPH		BMA		private 70,000	private 80,000	private 90,000	private 100,000
			dentist	hygienist	dentist	hygienist				
per hour	243.89	331.80	285.60	129.60	247.80	82.80	437.5	500	562.5	625
per min	4.06	5.53	4.76	2.16	4.13	1.38	7.29	8.33	9.38	10.42
Assistant cost	MU	dental division	MOPH		BMA		private 10,000			
per min	1.49	2.39	1.44		1.85		1.04			

MU: Mahidol University MOPH: Ministry of Public Health BMA: The Bangkok Metropolitan Administration

Sensitivity analysis of personnel cost for dental prevention program per intervention activities using cost per hour of both government and private dentists or dental hygienists. After adjusting cost by type of personnel, labor costs of each services are shown in Table 10.

Table 10 Sensitivity analysis of personnel cost for dental prevention program per intervention activities

Task	MU	Dental division	MOPH		BMA		private			
			dentist	hygienist	dentist	hygienist	70,000	80,000	90,000	100,000
Sealant	115.50	134.64	105.40	61.20	101.66	54.91	156.57	159.29	177.14	194.82
PRR	203.82	237.60	186.00	108.00	179.40	96.90	276.30	281.10	312.60	343.80
Filling	169.85	198.00	155.00	90.00	149.50	80.75	230.25	234.25	260.50	286.50
Fluoride	33.97	39.60	31.00	18.00	29.90	16.15	46.05	46.85	52.10	57.30
Scaling	67.94	79.20	62.00	36.00	59.80	32.30	92.10	93.70	104.20	114.60
OHI	33.97	39.60	31.00	18.00	29.90	16.15	46.05	46.85	52.10	57.30
Ext	67.94	79.20	62.00	36.00	59.80	32.30	92.10	93.70	104.20	114.60
Total	760.94	887.04	694.40	403.20	669.76	361.76	1,031.52	1,049.44	1,167.04	1,283.52

MU: Mahidol University MOPH: Ministry of Public Health BMA: The Bangkok Metropolitan Administration

Changing in labor cost for sensitivity analysis using dental hygienist cost instead of dentist cost could reduce labor cost to 34- 53% of Mahidol's supervisor cost.

Medical supplies; Material cost

Medical supplies in this SOHP included drugs, stationary cost and dental material. Material costs for dental prevention program were collected from Procurement Section (consist of Purchasing unit, Stock control unit and Material & Facilities Record unit). Basically, all consumable supplies were purchased centrally in bulk for the study and then shipped to the program. The costs of these materials were allocated to the preventive procedures. Material costs for this program were separated into 5 groups due to types of procedure as follow; materials for oral hygiene instruction and basic materials, fluoride prophylaxis, sealant, PRR and filling, protective barrier, and sterilization. The total cost of materials for dental prevention program was **80,599.19** Baht, Table 11

Table 11 Material cost for SOHP including medical supplies drug and stationary cost

Item lists	Amount (Baht)	% allocation to the intervention	Total cost (Baht)
Medical supplies			
Oral hygiene instruction and basic materials	3,577.60		
Fluoride prophylaxis	9,403.22		
Sealant PRR	6,049.08	100%	
Sealant PRR Filling	7,841.64		
PRR and Filling	27,149.43		
Protective barrier	7,910.15		
Sterilization	18,668.07		80,599.19
Drugs	303.34	100%	303.34
Stationary/ Office Material	3,430.27	3.30%	113.15

Other recurrent costs

Other costs for dental prevention program such as leasehold improvement, electricity, petrol, car maintenance and miscellaneous items were recurrent costs, shown in Table 12.

Transport operating costs included transport running cost; vehicle fuel cost Petrol/gasoline (13,972.18 baht) and other transport cost such as public transport which did not pay by SOHP.

Maintenance cost of SOHP included vehicles and building. The Vehicle Unit gave the data of the maintenance cost of cars was 36,568.80 baht. The building maintenance cost of Mahidol dental hospital was 12,427,137.4 baht. There are 80,756.65 square meters. Community department has 331.2 sq.m allocation to the intervention 3.3% and treasury has 105 sq.m allocation to the intervention 50%. The building maintenance cost of SOHP equal to (331.2/80,756.65) * 3.3% + (105/80,756.65) * 0.5 = 9,760.79 baht. All maintenance cost of SOHP was 46,329.59 baht.

For electricity costs, the data were collected from Facilities and Environment Section. Community dentistry department has separated miter. Electricity used in academic year 2015 were 9,134.7 units (4.27 baht/unit) which equaled to 38,986.9 baht, allocation to program 3.3% or 1,286.57 baht. Details are shown in Table 12.

Table 12 Other recurrent costs

Other recurrent costs							
Laboratory supplies; none Equipment operating cost; rental equipment: none							
TRANSPORT OPERATING COSTS: Transport running cost							
Vehicle	Km. Covered **OR** Fuel used (lt)	% allocation	Fuel cost per km **OR** per litre	Year of cost	GDP Deflator	GDP adj. factor	Total transport operating cost
5ห9340	192.59	100%	24.66	2015	0.70	1.00	4,750.00
9ฒ3341	226.17	100%	20.96	2015	0.70	1.00	4,740.00
ฮจ5492	236.28	90%	21.08	2015	0.70	1.00	4,482.18
							13,972.18
Other transport cost; rental vehicle: none							
MAINTENANCE							

Maintenance costs	Number used if any	% allocation	Unit operating cost per item	Year of cost	GDP Deflator	GDP adj. factor	Total maintenance cost
Vehicle5ห 9340	1	100%	8,065.93	2015	0.70	1.00	8,065.93
Vehicle9ฌ 3341	1	100%	21,392.88	2015	0.70	1.00	21,392.88
Vehicleฮจ5492	1	90%	7,900.00	2015	0.70	1.00	7,110.00
Building	1	0.079 %	12,427,137.4	2015	0.70	1.00	9,760.79
							46,329.59
UTILITIES							
Utility item	Quantity	% allocation	Unit cost or value if unknown quantity	Year of cost	GDP Deflator	GDP adj. factor	Total utility cost
electricity department electricity school	1 not applicable	3.3%	38,986.90	2015	0.70	1.00	1,286.57
							1,286.57
OTHER RECURRENT ITEMS							
Rented buildings ; none Insurance; not applicable Miscellaneous items; none							

Car depreciation, car maintenance cost and petrol cost were considered as cost of the service in SOHP. Car depreciation cost included in capital cost. Car maintenance cost and petrol use were included in material costs. For other treatment programs service in health facility this part were considered as an indirect cost.

Capital cost

The building cost or lease for the program was calculated in term of opportunity cost or rent cost. We calculated only lease for community dentistry department, not included lease for the primary schools. The rent costs for department area came from the rate that the faculty used for rentals multiplied by square meters of area used and %allocation to the intervention. Community department has 331.2 sq.m allocation to

the intervention 3.3% and treasury has 105 sq.m allocation to the intervention 50%. The rental price was 600-800 bath/sq.m. Consequently, the calculation is {(331.2×0.03) + (105×0.5) × rental price = 37,461.6 to 43,705.2 baht.

According to WHO CostIt program, another way calculates building financial cost by allocation of building space, the Mahidol University hospital has total 80,756.65 square meter surface area (all floors), cost 1,738,061,190 Baht. The useful life is 30 years. The Community Dentistry Department 331.2 sq.m (0.41%) and treasury 105 sq.m (0.13%) used in SOHP 50%, estimated financial cost to the SOHP calculated by

(Cost of all building per year) × %occupied of total space × %allocation to SOHP

= (cost of the building divided by the useful life year) × %occupied of total space × %allocation to SOHP

Financial cost of department = (1,738,061,190 ÷ 30) × 0.41% × 3.3% = 7,840.97 baht.

Financial cost of treasury = (1,738,061,190 ÷ 30) × 0.13% × 50% = 37,663.86 baht.

Building financial cost of SOHP = 7,840.97 + 37,663.86 = 45,504.83 baht.

Building economic cost of SOHP calculated using replacement cost divided by Annualization factor, Annualization factor calculated from discount rate 3% and useful life 30 years equal to 19.60

Economic cost of department = (1,738,061,190 ÷ 19.6) × 0.41% × 3.3% = 12,001.21 baht.

Economic cost of treasury = (1,738,061,190 ÷ 19.6) × 0.13% × 50% = 57,647.47 baht.

Building economic cost of SOHP = 69,648.68 baht.

Transport costs or vehicle costs for SOHP used 3 vans; one for mobilize the equipment, others for supervisors, dental nurses and dental students. The car depreciation was calculated by using straight-line method. There are 3 cars used in this program. These cars have been used for 27, 23 and 9 years and the total life of vehicle equals to 3 to 8 years.[123] The initial cost (purchasing price) and replacement cost of the cars were used for calculation in the same way as building cost, using 6 years useful life year as reference in Ministry of public health.

The initial cost was collected from Procurement Section and then subtracted by the salvage value (the price when the equipment reaches its total life) and divided by the total life of equipment.

$$\text{Depreciation Cost} = \frac{\text{Initial Cost (purchasing price)} - \text{Salvage Value (cost remaining)}}{\text{Total Life (Year)}}$$

Financial cost; calculates Salvage Value (cost remaining) as 0 after reach total life

Van 1 initial price: 434,000.00 baht. allocation to SOHP 100%

Cost van 1 = (434,000 ÷ 6) × 100% = 72,333.33 baht.

Van 2 initial price: 507,715.00 baht allocation to SOHP 100%

Cost van 2 = (507,715 ÷ 6) × 100 % = 84,619.17 baht.

Van 3 initial price: 1,068,400.00 baht allocation to SOHP 90%

Cost van 3 = (1,068,400 ÷ 6) × 90% = 160,260.00 baht.

Total vehicle financial cost equal to 317,212.50 baht

Economic cost used Salvage Value (cost remaining) after reach total life in calculation, 6 years; annualization factor 5.42, Annualized cost = Replacement cost ÷ annualization factor,

Depreciation cost = Annualized cost × %allocation to SOHP

Van 1 allocation to SOHP 100% Salvage Value 30,000.00 baht.

Cost van 1= 5,537.93× 100% = 5,537.93 baht.

Van 2 allocation to SOHP 100% Salvage Value 63,500.00 baht.

Cost van 2 = 11,721.94× 100 % = 11,721.94 baht.

Van 3 allocation to SOHP 90% Salvage Value 500,000 baht (estimate)

Cost van 3 = 92,298.75× 90% = 83,068.88 baht.

Total vehicle economic cost equal to 100,328.74 baht

Equipment costs, this category included the amortized cost of the equipment, such as dental mobile units and lights that were used to provide the preventive procedures. These costs were allocated to procedures and then method of valuing dental equipment is to use a straight-line depreciation over a given period of years. The depreciation rate used in this study come from the revenue department of Thailand. Total life of equipment generally equals to 3-5 years. The medical equipment's total

life equals to 5 to 15 years depending upon the type of equipment.(123) The equipment economic cost was 581,200.23 bath and equipment financial cost was 383,401.56 bath.

Furniture costs including office furniture were calculated same way as equipment costs, the furniture in department office also used for other academic purpose, so allocation for the program 3.3% equal to economic cost 13,057.85 baht and financial cost 11,942.98 baht.

There was no other capital cost in SOHP. The total capital economic cost was 764,235.49 bath and total capital financial cost was 758,061.88 bath. Details are shown in Table 13.

Total estimated costs for dental program were comprised of recurrent costs (36.1%) and capital costs (63.9%). Recurrent costs consist of labor/personnel cost (24.2%), material cost/material supplies (6.7%), transportation operating cost, maintenance cost and utility cost. Capital costs included building cost, transport/vehicle cost, equipment cost (48.6%), and furniture cost as mention above.

In provider perspective, total estimated economical cost for SOHP was 1,196,839.37 Baht in economic cost and 1,189,478.25 baht in financial cost. The operating cost included only personnel cost and material cost. The direct treatment cost included operating cost and equipment cost. Capitation by intervention activity calculated from cost divided by number of task units (Actual capacity) Table 13.

Table 13 Economic costs and financial costs of SOHP

i) Recurrent Costs	**Economic costs**			**Financial costs**		
	Total Costs (in local currency)	Total Costs (in US$)	Cost Profile (%)	Total Costs (local currency)	Total Costs (US$)	Cost Profile (%)
Personnel cost	289,999.86	8,467.20	24.2%	288,812.36	8,432.53	24.3%
Non-medical material & supplies	113.15	3.30	0.0%	113.15	3.30	0.0%
Drug	303.34	8.86	0.0%	303.34	8.86	0.0%
Medical supplies	80,599.19	2,353.27	6.7%	80,599.19	2,353.27	6.8%
Laboratory supplies	0.00	0.00	0.0%	0.00	0.00	0.0%
Transport operating cost	13,972.18	407.95	1.2%	13,972.18	407.95	1.2%
Equipment operating cost	0.00	0.00	0.0%	0.00	0.00	0.0%

i) Recurrent Costs	**Economic costs**			**Financial costs**		
	Total Costs (in local currency)	Total Costs (in US$)	Cost Profile (%)	Total Costs (local currency)	Total Costs (US$)	Cost Profile (%)
Maintenance	46,329.59	1,352.70	3.9%	46,329.59	1,352.70	3.9%
Utility	1,286.57	37.56	0.1%	1,286.57	37.56	0.1%
Other recurrent items	0.00	0.00	0.0%	0.00	0.00	0.0%
Total Recurrent Cost:	**432,603.88**	12,630.84	36.1%	**431,416.38**	12,596.17	36.3%
ii) Capital Costs						
Building costs	69,648.68	2,033.55	5.8%	45,504.83	1,328.62	3.8%
Transport costs	100,328.74	2,929.32	8.4%	317,212.50	9,261.73	26.7%
Equipment/implement costs	581,200.23	16,969.45	48.6%	383,401.56	11,194.27	32.2%
Furniture costs	13,057.85	381.25	1.1%	11,942.98	348.70	1.0%
Other capital costs	0.00	0.00	0.0%	0.00	0.00	0.0%
Total Capital Cost:	**764,235.49**	22,313.58	63.9%	**758,061.88**	22,133.32	63.7%
Grand Total Cost:	**1,196,839.37**	34,944.42	100.0%	**1,189,478.25**	34,729.49	100.0%

* Exchange rate average (2015): 34.25

Capitation of this program calculated from overall cost of the program for the year 2015 divided by number of pupils receiving this preventive program (1,189,478.25÷ 585 = 2,045.88 baht per child) which comprised of capital costs 1,003.47 baths and the operating costs 688.00 baths. Operating costs consisted of labor costs 489.65 baht and material costs 198.35 Baht, shown in Table 14.

Table 14 Capitation of SOHP

		Quantity	Total Intervention Costs (Baht.)	Average Cost (Baht.)	Total Intervention Costs (US $)	Average Cost (US $)
Actual capacity	financial	585	1,189,478.25	2,033.30	34,729.49	59.37
	Economic	585	1,196,839.37	2,045.88	34,944.42	59.73
Standardized capacity			142,604.01	243.77	4,163.65	7.12

To allocate cost per treatment task, amount tasks of each intervention were used for calculate % allocation in SOHP. For personnel or labor cost % allocation, it was

calculated from (time use of each task × No. each intervention of tasks) ÷ overall time of all task

Material cost, % allocation was calculated from No. of each intervention tasks ÷ overall task. No. of each intervention tasks were No. of treatment tooth of child.

Capital depreciation cost, % allocation also was calculated from No. of each intervention tasks ÷ overall task. No. of each intervention tasks were No. of treatment teeth or children. Financial and economical intervention costs by intervention activities are shown in Table 15 and Table 16.

Table 15 Summary of financial intervention costs by intervention activities

i) Recurrent Costs	oral exam	sealant	PRR	filling	fluoride	scaling	OHI	Ext.
Personnel cost	37,487.84	117,806.56	49,993.42	21,285.47	21,458.76	13,083.20	26,512.97	1,184.13
Non-medical material & supplies	56.58	0.00	0.00	-	-	0.00	56.58	0.00
Drug	0.00	0.00	45.05	45.05	-	0.00	-	213.24
Medical supplies	7,626.89	15,560.77	20,299.86	12,011.41	15,517.77	1,864.35	7,548.66	169.49
Laboratory supplies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport operating cost	2,822.42	4,139.55	752.65	448.69	2,262.76	689.92	2,793.47	62.72
Equipment operating cost	0.00	0.00	0.00	-	-	0.00	-	0.00
Maintenance	9,358.70	13,726.10	2,495.65	1,487.79	7,502.96	2,287.68	9,262.72	207.97
Utility	259.89	381.17	69.30	41.32	208.36	63.53	257.22	5.78
Other recurrent items	0.00	0.00	0.00	-	-	0.00	-	0.00
Total Recurrent Cost:	57,612.32	151,614.15	73,655.94	35,319.73	46,950.60	17,988.69	46,431.62	1,843.32
ii) Capital Costs								
Building costs	9,192.10	13,481.75	2,451.23	1,461.31	7,369.39	2,246.96	9,097.82	204.27
Transport costs	64,077.80	93,980.78	17,087.41	10,186.73	51,371.78	15,663.46	63,420.59	1,423.95
Equipment/ implement costs	29,340.35	216,275.09	44,290.56	28,377.37	23,522.43	11,748.09	29,039.42	808.26
Furniture costs	2,412.52	3,538.36	643.34	383.53	1,934.14	589.73	2,387.77	53.61
Other capital costs	0.00	0.00	0.00	-	-	0.00	-	0.00
Total Capital Cost:	105022.77	327275.97	64472.53	40,408.93	84,197.74	30248.23	103,945.61	2490.09
Grand Total Cost:	162,635.09	478,890.12	138,128.47	75,728.67	131,148.34	48,236.92	150,377.23	4,333.41

Table 16 Summary of economic intervention costs by intervention activities

i) Recurrent Costs	oral exam	sealant	PRR	filling	fluoride	scaling	OHI	Ext.
Personnel cost	37,641.98	118,290.94	50,198.98	21,372.99	21,546.99	13,136.99	26,621.99	1,189.00
Non-medical material & supplies	56.58	0.00	0.00	-	-	0.00	56.58	0.00
Drug	0.00	0.00	45.05	45.05	-	0.00	-	213.24
Medical supplies	7,626.89	15,560.77	20,299.86	12,011.41	15,517.77	1,864.35	7,548.66	169.49
Laboratory supplies	0.00	0.00	0.00	-	-	0.00	-	0.00
Transport operating cost	2,822.42	4,139.55	752.65	448.69	2,262.76	689.92	2,793.47	62.72
Equipment operating cost	0.00	0.00	0.00	-	-	0.00	-	0.00
Maintenance	9,358.70	13,726.10	2,495.65	1,487.79	7,502.96	2,287.68	9,262.72	207.97
Utility	259.89	381.17	69.30	41.32	208.36	63.53	257.22	5.78
Other recurrent items	0.00	0.00	0.00	-	-	0.00	-	0.00
Total recurrent cost	57,766.46	152,098.53	73,861.50	35,407.25	47,038.83	18,042.48	46,540.64	1,848.19
ii) Capital Costs								
Building costs	14,069.23	20,634.86	3,751.79	2,236.65	11,279.43	3,439.14	13,924.93	312.65
Transport costs	20,266.68	29,724.47	5,404.45	3,221.88	16,247.99	4,954.08	20,058.82	450.37
Equipment/ implement costs	27,149.43	343,427.21	77,404.41	47,970.96	21,765.95	34,916.21	26,870.97	1,695.09
Furniture costs	2,637.72	3,868.66	703.39	419.33	2,114.69	644.78	2,610.67	58.62
Other capital costs	0.00	0.00	0.00	-	-	0.00	-	0.00
Total Capital Cost:	64,123.06	397,655.20	87,264.04	53,848.82	51,408.06	43,954.21	63,465.39	2,516.73
Grand Total Cost:	121,889.51	549,753.73	161,125.54	89,256.07	98,446.89	61,996.69	110,006.02	4,364.92
Operating cost	45,268.87	133,851.71	70,498.84	33,384.40	37,064.76	15,001.34	34,170.65	1,358.49
Direct treatment cost	72,418.30	477,278.92	147,903.25	81,355.36	58,830.71	49,917.55	61,041.62	3,053.58

From economic intervention costs by intervention activities, they were divided by quantity of each task to calculate estimated economical cost for SOHP and Capitation by intervention activity. Details are shown in Table 17.

Table 17 Total estimated economical cost for SOHP and Capitation by intervention activity

Intervention activity	Quantity	Total Economic Costs				Operating cost		Direct cost	
		(Baht)	($)	Cost per unit		Total (Baht)	Per unit (Baht)	Total (Baht)	Per unit (Baht)
				(Baht)	($)				
Oral exam	585	121,889.51	3,558.84	**208.36**	6.08	45,268.87	77.38	72,418.30	123.79
Sealant tooth	858	549,753.73	16,051.30	**640.74**	18.71	133,851.71	156.00	477,278. 92	556.27
child	280			**1,963.41**	57.33		478.04		1,704.57
PRR tooth	156	161,125.54	4,704.42	**1,032.86**	30.16	70,498.84	451.92	147,903.25	948.10
child	90			**1,790.28**	52.27		783.32		1,643.37
Fill (tooth)	93	89,256.07	2,606.03	**959.74**	28.02	33,384.40	358.97	81,355.36	874.79
F treatment	496	98,446.89	2,874.38	**198.48**	5.80	37,064.76	74.73	58,830.71	118.61
Scaling (child)	143	61,996.69	1,810.13	**433.54**	12.66	15,001.34	104.90	49,917.55	349.07
OHI	579	110,006.02	3,211.87	**189.99**	5.55	34,170.65	59.02	61,041.62	105.43
Ext. (tooth)	13	4,364.92	127.44	**335.76**	9.80	1,358.49	104.50	3,053.58	234.89

* Exchange rate average (2015): 34.25

As mention before, SOHP was not only a prevention program but also an educational program for 5th year dental students to have chance to practice preventive treatment. This research studied the cost of school prevention program which included both academic and clinical parts which 112 Dental students practice oral examination and prevention treatments. This gave dental students experiences and made them confidence to do dental implementation in the future after they graduate from Mahidol dental school. Average capitation of SOHP was 2,045.88 baht per child per year. Each child would receive dental prevention procedure that included oral examination twice a year (before and after program), 1.47 sealants, 0.27 preventive resin restoration, 0.16 filling, 0.80 fluoride treatment, 0.24 scaling, 0.99 oral hygiene instruction and 0.02 extraction as average. Details are shown in table 18.

Table 18 Total estimated cost of treatment tasks in SOHP

Program	Oral exam	Sealant	PRR	Filling	Fluoride treatment	Scaling	OHI	Ext.	Total
unit	child	tooth	tooth	tooth	child	child	child	tooth	
Task per head	**1.00**	**1.47**	**0.27**	**0.16**	**0.80**	**0.24**	**0.99**	**0.02**	
Cost per unit task	208.36	640.74	1,032.86	959.74	209.91	433.54	189.99	335.76	
Total cost per head	208.36	939.75	275.43	152.57	168.29	105.98	188.04	7.46	**2,045.88**
direct cost per unit task	123.79	556.27	948.10	874.79	118.61	349.07	105.43	234.89	
Direct cost per head	123.79	817.72	255.99	139.97	94.89	83.78	104.37	4.70	**1,625.20**

To compare cost of caries preventive treatments, children in complete SOHP group (5-6 years) received oral examination average 5.42 years, fluoride varnish application average 4.55 years and sealant coverage average 3.37 teeth. Cost of oral examination average 5.42 times equaled to 5.42 × 208.36 = 1,129.30 baht, fluoride varnish application average 4.55 times equaled to 2,159.29 baht and sealant coverage average 3.37 teeth equaled to 955.08 baht. Total preventive cost of SOHP was 4,243.67 baht. The incomplete SOHP group was calculated preventive treatment cost in the same way. The examination only group only had examination cost 208.36 baht. Details were shown in Table 19.

Table 19 Economic caries preventive cost per capita of completed SOHP group, incomplete SOHP group and exam only group

Programs	Complete SOHP group			Incomplete SOHP group			Exam only group		
	Mean times (SD.)	Cost (Baht)		Mean times (SD.)	Cost (Baht)		Mean times	Cost (Baht)	
		Actual	Direct		Actual	Direct		Actual	Direct
Oral examination	5.42 (0.52)	1,129.30	670.95	3.53 (0.50)	735.50	436.99	1	208.36	123.79
F treatment	4.55 (2.89)	955.08	539.68	3.77 (1.80)	791.35	447.16			
Sealant coverage	3.37 (1.08)	2,159.29	1,874.63	2.99 (1.49)	1,915.81	1,663.24			
Total		4,243.67	3,085.26		3,442.67	2,547.39			

To compare cost of program, children in complete SOHP group (5-6 years) received not only preventive treatment (oral examination, fluoride varnish application and sealant coverage) but also filling scaling oral hygiene instruction and extraction.

Total program cost of completed SOHP was 6,939.04 baht. The incomplete SOHP group cost 6,265.18 baht. Details were shown in Table 20.

Table 20 Economic program cost per capita of completed SOHP group, incomplete SOHP group and exam only group

Programs	Complete SOHP group			Incomplete SOHP group			Exam only group		
	Mean times (SD.)	Cost (Baht)		Mean times (SD.)	Cost (Baht)		Mean times	Cost (Baht)	
		Actual	Direct		Actual	Direct		Actual	Direct
Oral examination	5.42 (0.52)	1,129.30	670.95	3.53 (0.50)	735.50	436.99	1	208.36	123.79
F treatment	4.55 (2.89)	955.08	539.68	3.77 (1.80)	791.35	447.16			
Sealant coverage	3.37 (1.08)	2,159.29	1,874.63	2.99 (1.49)	1,915.81	1,663.24			
Filling	1.00 (1.47)	959.74	874.79	1.57 (2.07)	1,506.80	1,373.42			
Scaling	1.45 (1.46)	628.64	506.16	1.24 (1.06)	537.59	432.85			
OHI	5.42 (0.52)	1,029.67	571.41	3.53 (0.50)	670.68	372.15			
Extraction	0.23 (0.97)	77.23	54.02	0.32 (1.10)	107.44	75.17			
Total		6,939.04	5,091.64		6,265.18	4,800.98			

4.6 Cost Effectiveness measurement

The effectiveness in this study was measured from increment of mean DMFT index between before and after implementation of the SOHP. The program started in grade 1 school children (six years old) as the first permanent teeth just erupted. We assumed mean DMFT before equaled to zero so the effectiveness was compared between mean DMFT of each group. Calculation of the preventive and all activities actual cost per capita of completed program group equaled 4,243.67 and 6,730.68 Baht. Incomplete SOHP group 3,442.67 and 6,056.82 baht. Control group received only oral examination equal to 208.36 Baht.

Incremental cost per DMFT avoided =

$$\frac{\text{Cost of preventive program} - \text{Cost of control group}}{\text{DMFT incremental for preventive program - DMFT incremental for control group}}$$

Incremental Cost Effectiveness Ratio was compared between groups using actual prevention treatment cost, ICER between completed SOHP and examination only group was 4,035.31 baht per DMFT avoided. ICER between incomplete SOHP and examination only group was 7,521.65 baht per DMFT avoided. ICER between completed SOHP and incomplete SOHP group was 1,405.26 baht per DMFT avoided.

Incremental Cost Effectiveness Ratio was compared between groups using direct prevention treatment cost, ICER between completed SOHP and examination only group was 2,961.47 baht per DMFT avoided. ICER between incomplete SOHP and examination only group was 5,636.28 baht per DMFT avoided. ICER between completed SOHP and incomplete SOHP group was 943.63 baht per DMFT avoided. Details are shown in Table 21

Table 21 Incremental Cost Effectiveness Ratio (ICER) compare between group (preventive cost)

	Program	Cost per child (Baht)	Incremental Cost (Baht)	Effectiveness of intervention (mean DMFT)	Incremental DMFT	ICER (DMFT avoided)
Actual cost						
1.	Completed SOHP	4,243.67	4,035.31	1.00 (±1.87)	-1.00	4,035.31
	Examination only	208.36		2.00 (±2.02)		
2.	Incomplete SOHP	3,442.67	3,234.31	1.57 (± 2.07)	-0.43	7,521.65
	Examination only	208.36		2.00 (±2.02)		
3.	Completed SOHP	4,243.67	801.00	1.00 (±1.87)	-0.57	1,405.26
	Incomplete SOHP	3,442.67		1.57 (±2.07)		
Direct treatment cost						
1.	Completed SOHP	3,085.26	2,961.47	1.00 (±1.87)	-1.00	2,961.47
	Examination only	123.79		2.00 (±2.02)		
2.	Incomplete SOHP	2,547.39	2,423.60	1.57 (± 2.07)	-0.43	5,636.28
	Examination only	123.79		2.00 (±2.02)		
3.	Completed program	3,085.26	537.87	1.00 (±1.87)	-0.57	943.63
	Incomplete SOHP	2,547.39		1.57 (±2.07)		

Incremental Cost Effectiveness Ratio was compared between groups using actual program cost, ICER between completed SOHP and examination only group was 6,730.68 baht per DMFT avoided. ICER between incomplete SOHP and examination

only group was 14,085.63 baht per DMFT avoided. ICER between completed SOHP and incomplete SOHP group was 1,182.21 baht per DMFT avoided.

Incremental Cost Effectiveness Ratio was compared between groups using direct program cost, ICER between completed SOHP and examination only group was 4,967.85 baht per DMFT avoided. ICER between incomplete SOHP and examination only group was 10,877.19baht per DMFT avoided. ICER between completed SOHP and incomplete SOHP group was 509.93 baht per DMFT avoided. Details are shown in Table 22

Table 22 Incremental Cost Effectiveness Ratio (ICER) compare between groups (all activities cost)

	Program	Cost per child (Baht)	Incremental Cost (Baht)	Effectiveness of intervention (mean DMFT)	Incremental DMFT	ICER (DMFT avoided)
Actual cost						
1.	Completed SOHP	6,939.04	6,730.68	1.00 (±1.87)	-1.00	6,730.68
	Examination only	208.36		2.00 (±2.02)		
2.	Incomplete SOHP	6,265.18	6,056.82	1.57 (± 2.07)	-0.43	14,085.63
	Examination only	208.36		2.00 (±2.02)		
3.	Completed SOHP	6,939.04	673.86	1.00 (±1.87)	-0.57	1,182.21
	Incomplete SOHP	6,265.18		1.57 (±2.07)		
Direct treatment cost						
1.	Completed SOHP	5,091.64	4,967.85	1.00 (±1.87)	-1.00	4,967.85
	Examination only	123.79		2.00 (±2.02)		
2.	Incomplete SOHP	4,800.98	4,677.19	1.57 (± 2.07)	-0.43	10,877.19
	Examination only	123.79		2.00 (±2.02)		
3.	Completed program	5,091.64	290.66	1.00 (±1.87)	-0.57	509.93
	Incomplete SOHP	4,800.98		1.57 (±2.07)		

CHAPTER V
DISCUSSIONS

5.1 Oral health status of these studied cohort students

This retrospective cohort study found a high prevalence of caries in deciduous teeth of 6-year-old students (87.2%). The mean dmft index was very high at 6.44 (± 4.4) indicating high caries in deciduous dentition. The caries prevalence in permanent teeth in 12-year-old students was 51.7%, the mean DMFT was 1.37 (± 1.84). These results were similar to the 8th 2018 Thailand National Oral Health Survey which revealed that 75.6% of 5-6 years-old and 52.0% of 12-years- old children affected with caries, with means dmft of 4.5 and DMFT of 1.4, respectively.(5) With a belief that, dental caries in deciduous teeth are a natural part of development and would be resolved by the eruption of permanent teeth.(134), parents do not bring their child to visit a dentist, which is a great act of negligence. Any intervention in the oral health of a child usually begins with seeking help to relieve pain. In addition, there are limited public dental health services in Thailand especially in low socio-economic areas as is the case in many low income countries.(135) Parents, therefore, have very limited access to dental services for their child even if they wanted to.

5.2 Factors associated with caries in permanent dentition

This study identified caries prevalence in deciduous dentition as a key predictor of caries in permanent dentition. In our study children who had caries in their deciduous teeth were 4.5 times more likely to develop caries in their permanent teeth, our finding is much worse although consistent with a prospective study findings, 2002, in Chinese children recruited at the age of 3-5 years and followed till 11-13 years, which reported three times more likelihood to develop caries in their permanent teeth.(136) Caries prevalence in deciduous teeth was one of the key risk factors for caries in permanent dentition.

The studied Mahidol SOHP program showed that applications of fluoride varnish (4-5 times and ≥6 times), together with dental sealant (on all 1st permanent molars) were significant protective factors OR=0.43, OR=0.39, and OR=0.13 respectively) for caries prevention in permanent teeth among 12-year-old students. For

Sealant coverage 1-3 teeth, the preventive effect is statistically marginally significant p value= *0.051* with OR 0.46(0.21-1.01) in a bivariate regression model. This suggests that even a partial number of molar protected with sealant applications is reducing caries in permanent teeth since higher number of sealant applications is accompanied with lower numbers of DMFT.

The complete participation in the SOHP program (five year or more) was also a significant protective factor for caries of permanent teeth among 12-year-old students (OR=0.35). The variable degree of uptake of different elements of the program (oral hygiene instruction, diet counseling, oral examination, fluoride varnish, and sealant applications) depends on the higher or lower numbers of years in SOHP participation. In particular, a longer participation to the program is strictly correlated to receiving higher numbers of fluoride varnish and sealant applications. This correlation may explain why complete participation has lost its significance in multiple logistic regression analysis while dental sealant applications on all 1st permanent molars retained its significance.

Participation level reflected degree of oral hygiene instruction, diet counseling. The result did not show the significant effect in reduce caries in permanent dentition. Similarly a study on a school-based oral health education (OHE) program found no difference in the mean DMFT value between the participating and control schools at baseline and 3 years later.(137) Moreover, the study shows that the implemented school-based OHE program neither resulted in significant reductions of permanent caries nor in improved oral hygiene.

The reason for fluoride vanish to lose its significance may be due to non-regular application. Fluoride varnish applications in the SOHP program may not be regular due to conflict with school attendance time. Fluoride varnish, applied on tooth surfaces, helps prevent caries by promoting re-mineralization along with disruption of acid productions in erupted teeth(138). Several review studies support the role of fluoride varnish is a caries-inhibitory agent. Evidence from the Cochrane systematic reviews in 2003 further confirmed the effectiveness of fluoride varnish, applied professionally 2-4 times a year, for preventing dental caries in both deciduous and permanent teeth.(75) ADA (2006) recommend to apply fluoride varnish at least twice a year at six-month

intervals at as effectiveness in controlling or reducing dental caries in primary or permanent teeth for moderate or high risk children.(80) While one application of fluoride varnish may provide some benefit,(139) the majority of professionally applied fluoride studies demonstrate that at least two applications bi-annually, for at least two years, are necessary to demonstrate effective reductions in dental caries.

Sealants protect the grooves in the chewing surfaces from tooth decay by forming a barrier against bacteria and other food particles, keeping them out of these grooves. Permanent molars are most likely to benefit from sealants. The effectiveness of sealant had been shown by a study of sealing first permanent molar in 2009 and a systematic review in 2013.(83, 140) CDC Atlanta has recommended the use of sealants for permanent molars in school-based dental care programs.(91) As the result showed significantly associated protective factor, only 40% of 6th grade students had sealant coverage. Actually most students in SOHP receive treatment in the beginning of program and their sealant loss later. The retention rate of fissure sealants in SOHP for one year is about 70%, similar to other school program in Alabama.(141) After one year, the sealants retention lesser each year but the retention rate is better compared to other school programs in Thailand(142). The school programs should pay more attention on how to improve retention rates of fissure sealants in the long term.

5.3 Other risk and protective factors for dental caries of permanent teeth

Our study indicates that female sex was a significant risk factor for caries of permanent teeth in 12-year-old students, in simple logistic regression OR=1.51 as above. Our study results are similar to those of a 2012 cohort study conducted in Iowa, among pre-school students (143), stated that the girls have higher caries risk of permanent teeth than boys which might be due to the eating behaviors. Other examples of different male and female eating behavior and carries in Thailand found that girls have more sweets consumption than boys and develop more caries(144). However, sex as a risk factor for caries is controversial. A study in pre-school children,2008(27) and a review article in 2010 (145) indicate that, girls were at higher caries risk, whereas, Metadata in South Asia in 2011 (28) and cross sectional survey study of 6 years old school children in India, 2012(29) were found boys having a higher or similar risk.

In our study, we did not find associations between caries in permanent dentition and attended school, years of school enrollment, underlying disease, oral hygiene status and gingivitis. In particular oral hygiene status, we used OHI-S indices to measure presence of dental plaque and calculus (containing cariogenic bacteria causing dental caries), but we didn't find association with caries in permanent dentition. We were surprised by our findings because poor oral hygiene is associated to tooth decay,(132) since poor oral hygiene is linked to more dental plaques and bacteria that cause caries. A cross sectional study conducted in Vietnam 2014, found that 6 to 8 years old students with poor and fair oral hygiene had twice the caries compared to students with good oral hygiene.(146) Another survey in 2015 found a strong correlation between DMFT and OHI-S index in 10-15 years old children(147). The fact that our study did not find association between oral hygiene and caries in study population may be due to students' behavioral change better after the caries developed.

A history of underlying diseases was not associated with DMFT. The most common underlying diseases of the studied children were asthma and hearing impairment. A literature review in 2010 found a relationship between asthma and caries but no strong evidence suggesting s that causal link between the two exists.(148) For hearing impairment, a cross sectional study in students, 2014, confirmed our results that hearing impairment is not linked to caries prevalence.(149) Finally, instead, a case-matched control study in England, 1996, found that children with severe congenital cardiac disease have moderately high levels of dental caries.(150)

Dietary habits and sugar consumption are related to dental caries. A study in Thailand found that eating sweets before bedtime was significantly related to dental caries in primary dentition(151). Therefore, the program should encourage behavior change amongst children and their families rather than interventions that are professionally driven.

Socio-economic background of the students may associate with caries level. In a systematic review study of family related factors on dental caries in the permanent dentition of 6–12-year-old children found that children belonging to lower socioeconomic classes experienced more caries and children of highly educated, professional and high income parents were at lower risk for dental caries.(152)

5.4 Cost of the program

To estimate cost of Mahidol oral health program, a number of treatment tasks of each academic year were used to calculate % allocation of the use of resources (workforce, material, equipment, etc.). In the study, we used records of academic year 2015 due to the most completed record. The number of unit tasks effected to fixed cost. Fixed cost was calculated by capital cost, and divided by number of tasks: more tasks, lesser fixed cost per unit. Whereas, variable cost came from recurrence cost, cost per unit was constant, for instance, doing a lot of tasks used a lot of materials. So, all material costs were divided by number of tasks, variable cost per unit was equal. It implied that cost of program changes were related to number of tasks each year.

The personnel costs for dental prevention program yearly also were calculated from academic year 2015. The cost would be accurate if along 2009-2018 the personnel who joined the program were unchanged during period of study. The results showed that cost of supervisor was similar to labor costs of dentist at Ministry of Public Health of Thailand which were lower than private sections. The costs of dental assistant per hour were similar in dental division, Ministry of Public Health of Thailand and private sections.

As mention before, the primary purpose of this program was for education the dental student to practice oral preventive care in community based program of Faculty of Dentistry, Mahidol University. Some cost in the study incured for education for instance, salaries of supervisor. In some countries, there were dental nurses working for school based oral health program at primary schools which did not require transportation of dental team. Somewhere dental nurses worked at public dental health service which required transportation in order to provide preventive program to school children under their responsibilities.

Sensitivity analysis, after adjusting cost by types of personnel, changing in labor cost for using dental hygienist cost instead of dentist cost can reduce labor cost to 34-53% of Mahidol's supervisor cost. Personnel cost of SOHP accounted for 24.2%. So, overall SOHP could reduce 8.2-12.8%. Labor costs of each services would cost less if the program was implemented by dental hygienists.

Although, material costs of this program were not high. Some cost item would be reduce in program which not based on teaching and training the dental students. For example, protective barriers and sterilization, in this program, many dental students were practice treatment and checked by supervisors, so a number of examination, glove used would be double compared to the normal practice.

Other recurrent costs including transport operating cost, maintenance cost and utilities cost were accounted about 5% of overall program cost. The cost of transport running cost in this program was petrol consumed by three vans, depending on the distance between Mahidol University and target schools. For educational purpose, two of three vans using for dental students, supervisors and dental nurses transportation, another van using for equipment transportation, in normal service program using only two van was enough. Maintenance cost of vehicle was considered high. To reduce this cost, using rate of rental car instead. Utilities cost in this study was provider perspective, use only electricity bill from department side which was paid by Mahidol University. The main electric use occurs in the study school but cost from school was not applicable.

This research found capital costs were accountable for almost half of total costs. Consistent with Khositkaseam N.(153) found the main part of program was capital cost accountable for more than half of total costs. Her research studied about cost effectiveness of dental prevention program in primary school in Bangkok in 1995-2000 calculated only clinical part but not included academic part which our research also took account of this part. The cost per capita of her study was similar compared to this study. The different cost occurs due to the time of study and cost of money in that period was much higher than nowadays, a constant price estimates in a time series comparison ref. In both researches, the capital cost was calculated by using the reference useful life year of medical equipment from Ministry of Public Health, Thailand according to WHO CostIt guideline, which were less than the usual life year of SOHP equipment. Thus, this capital cost was over estimated cost of equipment used in SOHP.

Cost analysis of an oral health outreach program for preschool children in Sweden (154) found that the main part of budget was contributing to labor, and they mentioned that the costs of manpower constituted 45% of the total costs. Other studies of cost analysis in Kerala, India focused on only direct medical cost that included labor cost and material cost.(155)

To compare price or cost of something between countries, the value of money in one country are not equal to the same amount of money in another country due to GDP factor. PPPs are price relatives that show the ratio of the prices in national currencies of the same goods and services in different countries.(129) There are some value used in adjusting cost including Price level ratio of PPP conversion factor (GDP) to market exchange rate in year 2015 (0.4), Official exchange rate or LCU per US$, period average (34.25 THB), PPP conversion factor or private consumption or LCU per international $(12.98 LCU/THB) should be used to convert Thai Baht to standard value and compare to other countries.(130)

A study of the burden of restorative dental treatment for children in Third World countries had revealed that more than 90% of the dental caries remains untreated in Third World countries. Calculations revealed that to restore the permanent dentition of the child population of low-income nations using traditional amalgam restorative dentistry would cost between f 1,024 ($US1 61 8) and f 2,224 ($US351 3) per 1,000 children of mixed ages from 6 to 18 years. This exceeds the available resources for the provision of an essential public health care package for the children of 15 to 29 low-income countries.(156)

In Thailand, cost of dental care is considered high, people usually have to pay out of pocket. Oral health insurance or social security coverage, which helped increase the ability to acquire dental care services. Only some dental services are covered by the insurance. When oral health insurance or social security coverage was limited, utilization of dental care services would be affected. For instance, some factory workers were covered by the social security fund, which entitled them for up to 900 baht per year for dental care services. This amount of money can only cover either teeth scaling or fillings or tooth extraction, which is not sufficient for fix all dental problems or cure tooth decay in advance condition.(157)

Cost of dental prevention (sealant and fluoride varnish) is not high, compared to the treatment cost of restoration (endodontic treatment and prosthesis), the preventive cost is much cheaper. Extraction is cheap but not a healthy choice, edentulous or missing teeth can leads to malocclusion and poor quality of life in the future. From a study in Thailand, only 20 % of the students in the suburban area received complete

dental treatment which was lower than the target indicator, while more than 20 percent of the students in the district town received the service. (99) The survey in 2015 in Bangkok, Thailand, reported that though children aged 6-12 years received the dental service more than other age groups, it's only 13.5% of 5.4 million children and the average number dental visits of children aged 6-12 years is only 0.13 times/year.(5)

From several studies (61, 103-105), income was found to be one of the barriers to dental access. A study done by Burton et al. reported that among 2-11-year-old children in poverty, only 40% of those with tooth decay got their disease treated compared with 46% of higher-income children.(103) Chu, *et al*. concluded that children whose parents have higher income levels were more likely to seek for dental care than those from low income families. This study confirmed that low income was a barrier to access dental care.(104) Tharasombat S. agreed that family income affected the frequency to get the dental service in children due to 35.1% of the parents whose income lower than 10,000 baht in contrast with 18.3% of the parents whose income higher than 40,000 baht didn't bring their children to get the service.(61) Moreover, the study done by Gao, *et al*. confirmed that the financial status is significant predictor of dental service utilization. Children from low-income family that less likely to utilize the dental service. In order to support the dental access of poor children, free dental services should provide for children at school.(105)

5.5 Cost effectiveness analysis of the program

The oral health prevention programs usually spend most money at the beginning of program for establishing and operating program. The benefit or effect of program will be happening in the future later. Cost which occurred in the last year of operating the program may not relate with the outcome of observation. The effectiveness came from costs incurred in only first five year of the program. So, cost of the last year program should be discard.

Cost-effectiveness analysis of this SOHP showed that monetary invested in oral prevention in provider perspective. Incremental Cost Effectiveness Ratio compared between groups using actual cost, ICER between completed SOHP and examination group was 2,961.47 baht per DMFT avoided. This was much cheaper than ICER

between incomplete SOHP and examination group which was 5,636.28 baht per DMFT avoided. Consistent to ICER between completed SOHP and incomplete SOHP group was only 943.63 baht per DMFT avoided. It means that to reduce caries 0.43 DMFT (from 2.00 to 1.57) start from doing nothing (examination only) to do some prevention treatment cost more than doing full option preventive treatment. Completed SOHP including oral examination, fluoride application every year and all four 1st molar sealant coverage was more cost effective than not completed treatment. The cost of incomplete treatment group was considered high due to less caries prevention effect. These children may not receive sealant application because they already develop caries on molars from the beginning of program. So, they were excluded from sealant to receive filling or other treatment instead.

SOHP focused on children in low socio-economic areas who were at high risk of caries, although, the mean DMFT of all 3 groups was 1.37 (±1.84) but the comparison group used examination only group, mean DMFT was high, 2.00 (±2.02). The effect of SOHP in general population would be less, compared to the national referent group; use the expected caries increment on oral health surveys carried out in this area; in 2012 and 2017 (by the 7th-8th national oral health survey) because the means DMFT were only 1.6 and 1.3 respectively.(5)

There are several studies about cost effectiveness of oral health education, fluoride varnish and sealant program. However, less of them studied cost effectiveness of combination program and very few studied programs under academic situation. A study of cost effectiveness of school based dental checkup program in Melbourne in 2013 using societal perspective; including patient cost of transportation and productivity losses calculated ICER was 3,252 $ AUD per DMFT prevented compare to standard care which was local public health dental service to make dental appointment for their own child(158) which is much higher compared to our study.

To compare cost effectiveness ratio of SOHP with other studies is difficult because ICER of each study come from different baseline of control group. Usually, it compared the alternative program with the standard care, the standard care of each country was not equal. Thus, ICER could difficult to compare across countries.

Many studies compared cost utility (incremental cost utility ratio/ICUR) instead of cost effectiveness (incremental cost effectiveness ratio/ICER) using disability adjusted life year (DALYs) as a health outcome instead of caries prevented. DALYs were calculated for toothaches by multiplying the likelihood of experiencing a toothaches by the disability weight for a toothaches (0.012).(159) In terms of thresholds for considering an intervention to be cost-effective, WHO-CHOICE has been using criteria suggested by the Commission on Macroeconomics and Health: interventions that avert one DALY for less than average per capita income for a given country or region are considered very cost-effective; interventions that cost less than three times average per capita income per DALY averted are still considered cost-effective; and those that exceed this level are considered not cost-effective.(160)

CHAPTER VI
CONCLUSION

This study investigated the effect of SOHP program on caries development in 6th grade students (approximately 12 years old children) and to identify other risk and protective factors associated with permanent teeth caries prevalence in this age group. The results revealed high caries prevalence (51.7%). The caries prevalence in deciduous teeth was a risk factor (adjusted OR=5.48) for caries of permanent teeth with and the application of dental sealant a protective factor (adjusted OR= 0.19).

Cost-effectiveness analysis of SOHP showed monetary invested in oral prevention in provider perspective. Total estimated economical cost for SOHP was 1,196,839.37 Baht in economic cost. Average capitation of SOHP was equal to 2,045.88 baht per child per year. ICER compared between groups using actual cost, ICER between completed SOHP and examination group was 2,961.47 baht per DMFT avoided. This was much cheaper than ICER between incomplete SOHP and examination group which was 5,636.28 baht per DMFT avoided. Consistent to ICER between completed SOHP and incomplete SOHP group was only 943.63 baht per DMFT avoided. It means that to reduce caries 0.43 DMFT (from 2.00 to 1.57) start from doing nothing (examination only) to do some prevention treatment cost more than doing full option preventive treatment. Completed SOHP including oral examination, fluoride application every year and all four 1st molar sealant coverage was more cost effective than not completed treatment.

This indicates that early detection and prevention programs are worth doing for school children before the onset of dental caries. The study findings suggest the effectiveness of this SOHP program that is useful for the program extension and expansion. The preventive program is worth to do especially for outreach and low socio-economic children who were at high risk of caries. Cost-Effectiveness analysis of SOHP indicated that oral prevention program should include all first molars coverage with sealants.

6.1 The impacts of SOHP at public primary school in Bangkok

Community Dentistry Department of Mahidol University has implemented an oral health program in public primary schools for several years. A significant association between preventive program and permanent caries prevalence or incremental DMFT was found. The effectiveness of SOHP as measured by differences in DMFT increment between completed SOHP group and examination only group was significantly different. The results indicated that SOHP is an effective way of reducing caries, especially in high caries risk children. This program gave a chance to children to access to dental care in low-socioeconomics areas. The reduction in caries in completed SOHP group would be presumably related to the effects of early detection from oral examination, fluoride varnish application, all four first molars sealants coverage and corrective treatment if needed. The results provide an estimate of the effect which could be achieved over a fairly short time period if program of this kind were to be made generally available provided by primary health care center in the community as an alternative to doing nothing to care.

6.2 Strengths

The first strength of the study was long year of observation, overall was 10 years including five cohorts to gather a number of participants (530 school children). The other study strength may be that we minimized/avoided misclassifications due to biases common in retrospective cohort studies. We minimized biases including 1) In selection of ‘cases’ and ‘controls’ because we defined them clearly and used recorded measurements to assign students to the two groups, 2) In inaccurate recordkeeping because although data were collected by others rather than the researchers, recordkeeping was of high quality because data were entered in the students dental charts only after quality certification by their supervisor teacher and 3. We avoided recall biases since all measurements were recorded and not self-reported Additional strengths, typical of all retrospective cohort studies, are the time and money saved in analyzing existing data instead of collecting them.

The study findings can be used as a reference data for improving the school program of Mahidol dental university. Some findings may be useful to other dental

faculties in Bangkok and BMA or Ministry of Public Health, Thailand for running oral health school program. Finally, we investigate estimated costs of oral treatment and school based oral health programs in order to take cost-effectiveness results into considerations. Cost estimation of program will be used for preliminary data to study cost effectiveness of the similar program in the future.

6.3 Policy and program implication

This research project gives information about the estimated cost of the program that may be useful to Mahidol University for program evaluation effectiveness of the procedure. The findings of protective factor may be useful to other dental faculties in Bangkok which provide oral health school program and help to anticipate the favorable decision in the future. Furthermore, policy maker from government or school can use the data findings to develop policies; planning, implementation and evaluation of the preventive dental program.

In particular, we refer to our findings of sealant preventive treatment as a preventive factor of permanent caries and we recommend to do, since a partial number of molars protected with sealant applications is reducing caries in permanent teeth. We also refer to the finding that sealant applications on fewer than 4 permanent molars as an effective although partial preventive measure for reducing caries in permanent teeth.

We suggest that policy makers and school's manager consider our findings to improve policies, planning, implementation and evaluation of the school based dental program. We refer to the feasibility of the SOHP program in reaching low-income children who would otherwise have no or difficult access to dental care.

Although, this study did not study an association of dietary habits and sugar consumption with dental caries in the 6th grade children, generally, these factors are important to reduce dental caries in children. Therefore, the program should encourage behavior change amongst children and their families rather than interventions that are professionally driven.

6.3 Limitations

The limitation of our study is the small sample of four out of about 400 primary schools in Bangkok however, as above discussed, the data available from our students

are comparable to those from national data for the same age group.(5) The high prevalence of caries in children reported compensates for the small sample size and contributes to the effects demonstrated.

Another important limitation was the unavailability of some data in the primary database, for example dietary habits, oral health-related behaviors, oral microorganism, record of caries severity, individualized socio-economic background and oral health related quality of life of the students.

Regarding oral health-related behaviors e.g. use of fluoride toothpaste data have not been collected because it is very common to use fluoride toothpaste in public primary schools in Bangkok, additionally fluoride toothpastes tubes are dispensed to students in schools by SOHP, and most of toothpastes sold in Bangkok containing fluoride, also the shop near those four schools supported by the Mahidol dental school community survey (unpublished data). Moreover, according to the 8th Thailand National Oral Health Survey in the year 2018, there is 87.1% of 12- year-old children using toothpaste containing fluoride(5).

For cost analysis part, all costs in this prevention program are based on Mahidol University faculty of Dentistry which primary propose is for education of the 5th year-dental students. Some costs in this cost analysis including labor cost of dental student could not be calculated due to academic situation and database system of dental hospital not provided. Labor cost in this analysis directly collect from program is salary of supervisors (dentists) and supportive staffs. To calculate total labor cost of the program if use cost from supervisor salary to estimate labor cost of dental student, the cost would be overestimated.

The last limitation of our study, the examiner in this program in baseline data and evaluation data are not the same person due to secondary data conduct from education practice program anyway using same standard training and criterions.

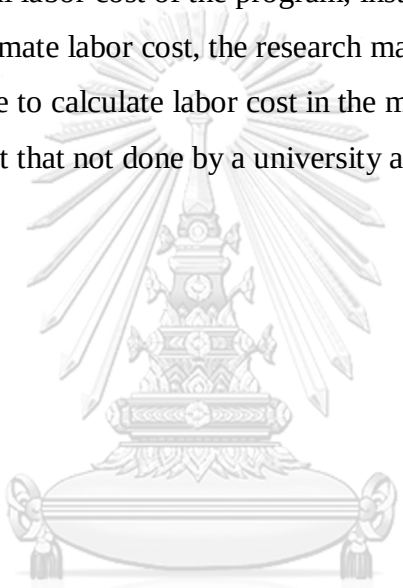
6.4 Recommendation for future research

For future research, we recommend to investigate the said missing variables and use a prospective cohort study design because the latter design offers the advantages of higher accuracy and higher efficiency, usually have fewer potential sources of bias and

confounding. In recommendation for the Mahidol SOHP program, it should include to investigate the behavior changes of students or to include in the Mahidol chart a new entry on behavior change and use caries index that take severity into account with more accuracy.

The primary data with complete design should be conducted for cost analysis. Further investigation should use prospective cohort studies to complete associated variables and estimated costs of oral treatment and prevention program for more accuracy in details.

To calculate total labor cost of the program, instead of using cost from supervisor salary to estimate labor cost, the research may use wage rate of dental hygienist or dental nurse to calculate labor cost in the model, so it can be estimated the cost for other project that not done by a university and avoid overestimated the cost.



ANNEX

Annex 1 Labor cost for SOHP (WHO CostIt)

1	**PERSONNEL COSTS**								Base Year GDP Deflator:	**0.70**					
	Type of personnel	Contri butors	FTE (full time equivalent)	% time allocation to the intervention	Gross salary		Benefits/allowances		Total salary		Year of cost	GDP Deflator	GDP adjustment factor	Total personnel cost	
					Financial	Economic	Financial	Economic	Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=a*b*[c+e]	(h)=a*b*[d+f]		(i)	(j)= BY F/(i)	(k)=(j)*(g)	(l)=(j)*(h)
1	supervisors 9	MU	1.0	3.30%	4,214,520.00	4,214,520.00	0	0	139,020.63	139,020.63	2015	0.70	1.00	139,020.63	139,020.63
2	dental nurses 3	MU	1.0	15.00%	515,760.00	515,760.00	0	0	77,364.00	77,364.00	2015	0.70	1.00	77,364.00	77,364.00
3	car drivers 3	MU	1.0	15.00%	427,440.00	427,440.00	0	0	64,116.00	64,116.00	2015	0.70	1.00	64,116.00	64,116.00
4	house keeper 1	out source	1.0	9.24%	90,000.00	90,000.00	0	0	8,311.74	8,311.74	2015	0.70	1.00	8,311.74	8,311.74
5	students	MU	0.5	3.30%	0.00	72,000.00	0	0	0.00	1,187.50	2015	0.70	1.00	0.00	1,187.50
Total personnel costs									288,812.36					288,812.36	289,999.86

Annex 2 Dental Material Record Form (based on Academic year 2015)

	lists	used	Price/unit (Baht)	Total amount (Baht)
Oral Hygiene Instruction and Basic	Dental floss	2	159.00	318.00
	Pumice 0.5 KG	1	118.86	118.86
	Saliva suction	5	68.00	340.00
	Cotton Roll 450 g	1	95.34	95.34
	Gauze 36” x100yd	1	900.00	900.00
	Mandrel, rubber cup 1:12 (PAC)	6	290.38	1742.28
	Erythrosine	1	45.62	45.62
	Disposable plastic cup	50	0.35	17.50
	Total			3,577.60
Fluoride prophylaxis	Fluoride gel	1	751.22	751.22
	Fluoride paste	2	1050.00	2100.00
	Fluoride varnish	3	1284.00	3852.00
	Fluoride tray	60	45.00	2700.00
	Total			9,403.22
Sealant	Sealant	3	1412.00	4236.00
	GI Fuji VII	1	1813.08	1813.08
	Total			6,049.08
Sealant PRR Filling	Etching solution	1	2,616.82	2,616.82
	Micro Applicators Micro-brush	4	130.38	521.52
	Micro Applicators Ultra-brush	3	280.00	840.00
	Diamond bur 009	24	84.11	2018.64
	Steel bur 008 Round	36	16.82	605.52
	Steel bur 010 Round	0	17.98	0.00
	Steel bur 012 Round	0	16.37	0.00
	Stone bur short shank flame white	18	23.36	420.48

	Stone bur airotor flame white	24	23.36	560.64
	Articulating paper	1	258.02	258.02
	Total			7,841.64
PRR and Filling	Composite Z350 A3D	2	898.80	1797.60
	Composite Z 250 A305	0	898.80	0.00
	Composite (Flow)	3	1502.72	4508.16
	Bonding single bond	2	2610.00	5220.00
	GI Fuji II LC	2	3925.23	7850.46
	GI Fuji IX	1	2411.21	2411.21
	Calcium hydroxide 24gm	1	580.00	580.00
	Vitrebond Plus	1	3600	3600
	IRM standard pack ivory	1	1182	1182
	Total			27,149.43
Protective barrier	Mask surgical	18	51.55	927.90
	Cover head (1/50)	17	34.25	582.25
	Disposable glove, non-powder XS	12	120.00	1440.00
	Disposable glove, non-powder S	10	120.00	1200.00
	Disposable glove, non-powder M	8	120.00	960.00
	Disposable glove, powder XS	2	100.00	200.00
	Disposable glove, powder S	18	100.00	1800.00
	Disposable glove, powder M	8	100.00	800.00
	Total			7,910.15
Sterilization	Autoclave Tape ¾”	1	221.49	221.49
	Dry heat Indicatorlabel	1	150.00	150.00
	Eo Indicator Tape	1	385.00	385.00
	Hydrex surgical scrup 5l	2	800.00	1600.00
	Gobble plus 2l	2	860.00	1720.00

	Sterile envelope 5cm.	1	480.00	480.00
	Sterile envelope 7.5cm.	1	640.00	640.00
	Sterile envelope 10cm.	0	800.00	0.00
	Extended Sterile envelope	2	1448.60	2897.20
	Code ring (red)	1	346.11	346.11
	Caviwipes	4	238.00	952.00
	Rapidmalti enzyme cleaner	1	2746.33	2746.33
	Alcohol 70 %	1	255.00	255.00
	Alcohol hand gel (1:1000 ml)	1	85.00	85.00
	Disinfection towe lettes 11b.130Oz. (can)	12	238.00	2856.00
	Napkin 45x30cm (bag)	1	693.36	693.36
	Tissue paper 1:24roll (pac)	2	639.36	1278.72
	Sterile water 1,000 ml	14	29.00	406.00
	Plastic bag (PAC)	1	305.47	305.47
	Plastic apron 28 x25 inch (PAC)	1	48.00	48.00
	Rubber glove	2	35.00	70.00
	Foil	2	40.00	80.00
	Bag for cover sterile bur	7	2.72	19.04
	Black garbage bags 20x20 inch	6	48.15	288.90
	Black garbage bags 24x28 inch	1	48.15	48.15
	Red garbage bags 24x28 inch	1	48.15	48.15
	Plastic bag 6X14 inch	1	48.15	48.15
	Total			18,668.07
Drugs	Para 500mg	6	0.50	3.00
	Benzocaine	1	300.34	300.34
	Total			303.34
Stationary/ Office Material				3430.27

Annex 3 Other recurrent cost (WHO CostIt)

2)	**NON-MEDICAL MATERIALS & SUPPLIES**										
Sr. No	Materials & supplies	Contributors	Quantity	% allocation	Unit cost per item		Year of cost	GDP deflator	GDP adjustment factor	Total cost	
					Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=BYF/(f)	(h)=a*c*g*b	(h)=a*d*g*b
1	Stationary cost	MU	1	3.30%	3,430.27	3,430.27	2015	0.70	1.00	113.15	113.15
	Other/Unspecified							0.00	1.00	0.00	0.00
Total non-medical cost:										**113.15**	**113.15**
3)	**DRUGS**										
Sr. No	Drug (name and units) e.g. Ampicillin 250mg capsules	Contributors	Quantity	% allocation	Unit cost per item		Year of cost	GDP deflator	GDP adj. factor	Total cost	
					Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=BYF/(f)	(h)=a*b*c*g	(i)=a*b*d*g
1	Para 500mg	MU	6	100%	0.50	0.50	2015	0.70	1.00	3.00	3.00
2	Benzocaine	MU	1	100%	300.34	300.34	2015	0.70	1.00	300.34	300.34
Total drug cost:										**303.34**	**303.34**
4)	**MEDICAL SUPPLIES**										
Sr. No	Medical supply	Contributors	Quantity	% allocation	Unit cost per item		Year of cost	GDP deflator	GDP adj. factor	Total cost	
					Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=BYF/(f)	(h)=a*b*c*g	(i)=a*b*d*g
1	Dental floss	MU	2	100%	159.00	159.00	2015	0.70	1.00	**318.00**	318.00
2	Pumice 0.5 KG	MU	1	100%	118.86	118.86	2015	0.70	1.00	**118.86**	118.86
3	Saliva suction	MU	5	100%	68.00	68.00	2015	0.70	1.00	**340.00**	340.00
4	Cotton Roll 450 g	MU	1	100%	95.34	95.34	2015	0.70	1.00	**95.34**	95.34
5	Gauze 36” x100yd	MU	1	100%	900.00	900.00	2015	0.70	1.00	**900.00**	900.00
6	Mandrel ,rubber cup 1:12	MU	6	100%	290.38	290.38	2015	0.70	1.00	**1,742.28**	1,742.28
7	Erythrosine	MU	1	100%	45.62	45.62	2015	0.70	1.00	**45.62**	45.62
8	Disposable plastic cup	MU	50	100%	0.35	0.35	2015	0.70	1.00	**17.50**	17.50
9	Fluoride gel	MU	1	100%	751.22	751.22	2015	0.70	1.00	**751.22**	751.22
10	Fluoride paste	MU	2	100%	1,050.00	1,050.00	2015	0.70	1.00	**2,100.00**	2,100.00
11	Fluoride varnish	MU	3	100%	1,284.00	1,284.00	2015	0.70	1.00	**3,852.00**	3,852.00
12	Fluoride tray	MU	60	100%	45.00	45.00	2015	0.70	1.00	**2,700.00**	2,700.00
13	Sealant	MU	3	100%	1,412.00	1,412.00	2015	0.70	1.00	**4,236.00**	4,236.00
14	GI Fuji VII	MU	1	100%	1,813.08	1,813.08	2015	0.70	1.00	**1,813.08**	1,813.08
15	Etching solution	MU	1	100%	2,616.82	2,616.82	2015	0.70	1.00	**2,616.82**	2,616.82
16	Micro Applicators.microbrush	MU	4	100%	130.38	130.38	2015	0.70	1.00	**521.52**	521.52
17	Micro Applicators.ultrabrush	MU	3	100%	280.00	280.00	2015	0.70	1.00	**840.00**	840.00
18	Diamond bur 009	MU	24	100%	84.11	84.11	2015	0.70	1.00	**2,018.64**	2,018.64
19	Steel bur 008 Round	MU	36	100%	16.82	16.82	2015	0.70	1.00	**605.52**	605.52
20	Steel bur 010 Round	MU	0	100%	17.98	17.98	2015	0.70	1.00	**0.00**	0.00
21	Steel bur 012 Round	MU	0	100%	16.37	16.37	2015	0.70	1.00	**0.00**	0.00
22	Stone bur short shank,flame white	MU	18	100%	23.36	23.36	2015	0.70	1.00	**420.48**	420.48

23	Stone bur airotor, flame white	MU	24	100%	23.36	23.36	2015	0.70	1.00	**560.64**	560.64
24	Articulating paper	MU	1	100%	258.02	258.02	2015	0.70	1.00	**258.02**	258.02
25	Composite Z350 A3D	MU	2	100%	898.80	898.80	2015	0.70	1.00	**1,797.60**	1,797.60
26	Composite Z 250 A305	MU	0	100%	898.80	898.80	2015	0.70	1.00	**0.00**	0.00
27	Composite (Flow)	MU	3	100%	1,502.72	1,502.72	2015	0.70	1.00	**4,508.16**	4,508.16
28	Bonding single bond	MU	2	100%	2,610.00	2,610.00	2015	0.70	1.00	**5,220.00**	5,220.00
29	GI Fuji II LC	MU	2	100%	3,925.23	3,925.23	2015	0.70	1.00	**7,850.46**	7,850.46
30	GI Fuji IX	MU	1	100%	2,411.21	2,411.21	2015	0.70	1.00	**2,411.21**	2,411.21
31	Calcium hydroxide 24gm	MU	1	100%	580.00	580.00	2015	0.70	1.00	**580.00**	580.00
32	Vitrebond Plus	MU	1	100%	3,600.00	3,600.00	2015	0.70	1.00	**3,600.00**	3,600.00
33	IRM standard pack ivary	MU	1	100%	1,182.00	1,182.00	2015	0.70	1.00	**1,182.00**	1,182.00
34	Mask surgical	MU	18	100%	51.55	51.55	2015	0.70	1.00	**927.90**	927.90
35	Cover head (1/50)	MU	17	100%	34.25	34.25	2015	0.70	1.00	**582.25**	582.25
36	Glove Disposable ,non-powder no.xs	MU	12	100%	120.00	120.00	2015	0.70	1.00	**1,440.00**	1,440.00
37	Glove Disposable ,non-powder no.s	MU	10	100%	120.00	120.00	2015	0.70	1.00	**1,200.00**	1,200.00
38	Glove Disposable ,non-powder no.m	MU	8	100%	120.00	120.00	2015	0.70	1.00	**960.00**	960.00
39	Glove Disposable ,powder no.xs	MU	2	100%	100.00	100.00	2015	0.70	1.00	**200.00**	200.00
40	Glove Disposable ,powder no.s	MU	18	100%	100.00	100.00	2015	0.70	1.00	**1,800.00**	1,800.00
41	Glove Disposable ,powder no.m	MU	8	100%	100.00	100.00	2015	0.70	1.00	**800.00**	800.00
42	Autoclave Tape ¾"	MU	1	100%	221.49	221.49	2015	0.70	1.00	**221.49**	221.49
43	Dry heat Indicatorlabel	MU	1	100%	150.00	150.00	2015	0.70	1.00	**150.00**	150.00
44	Eo Indicator Tape	MU	1	100%	385.00	385.00	2015	0.70	1.00	**385.00**	385.00
45	Hydrex surgical scrup 5l	MU	2	100%	800.00	800.00	2015	0.70	1.00	**1,600.00**	1,600.00
46	Gobble plus 2l	MU	2	100%	860.00	860.00	2015	0.70	1.00	**1,720.00**	1,720.00
47	Sterile envelope 5cm.	MU	1	100%	480.00	480.00	2015	0.70	1.00	**480.00**	480.00
48	Sterile envelope 7.5cm.	MU	1	100%	640.00	640.00	2015	0.70	1.00	**640.00**	640.00
49	Sterile envelope 10cm.	MU	0	100%	800.00	800.00	2015	0.70	1.00	**0.00**	0.00
50	Extended sterile envelope	MU	2	100%	1,448.60	1,448.60	2015	0.70	1.00	**2,897.20**	2,897.20
51	Code ring (red)	MU	1	100%	346.11	346.11	2015	0.70	1.00	**346.11**	346.11
52	Caviwipes	MU	4	100%	238.00	238.00	2015	0.70	1.00	**952.00**	952.00
53	Rapidmalti enzyme cleaner	MU	1	100%	2,746.33	2,746.33	2015	0.70	1.00	**2,746.33**	2,746.33
54	Alcohol 70 %	MU	1	100%	255.00	255.00	2015	0.70	1.00	**255.00**	255.00
55	Alcohol hand gel(1:1000 ml)	MU	1	100%	85.00	85.00	2015	0.70	1.00	**85.00**	85.00
56	Disinfection towe lettes 11b.130Oz.	MU	12	100%	238.00	238.00	2015	0.70	1.00	**2,856.00**	2,856.00
57	Napkin 45x30cm	MU	1	100%	693.36	693.36	2015	0.70	1.00	**693.36**	693.36
58	tissue paper 1:24roll (pac)	MU	2	100%	639.36	639.36	2015	0.70	1.00	**1,278.72**	1,278.72
59	Sterile water 1,000 ml	MU	14	100%	29.00	29.00	2015	0.70	1.00	**406.00**	406.00
60	Plastic bag (PAC)	MU	1	100%	305.47	305.47	2015	0.70	1.00	**305.47**	305.47
61	Plastic apron 28 x25 inch (PAC)	MU	1	100%	48.00	48.00	2015	0.70	1.00	**48.00**	48.00
62	Rubber glove	MU	2	100%	35.00	35.00	2015	0.70	1.00	**70.00**	70.00
63	Foil	MU	2	100%	40.00	40.00	2015	0.70	1.00	**80.00**	80.00
64	Bag for cover sterile bur	MU	7	100%	2.72	2.72	2015	0.70	1.00	**19.04**	19.04
65	Black garbage bags 20x20 inch	MU	6	100%	48.15	48.15	2015	0.70	1.00	**288.90**	288.90
66	Black garbage bags 24x28 inch	MU	1	100%	48.15	48.15	2015	0.70	1.00	**48.15**	48.15

67	Red garbage bags 24x28 inch	MU	1	100%	48.15	48.15	2015	0.70	1.00	**48.15**	48.15
68	Plastic bag 6X14 inch	MU	1	100%	48.15	48.15	2015	0.70	1.00	**48.15**	48.15
Total medical supplies cost:										**80,599.19**	80,599.19
5)	**LABORATORY SUPPLIES**										
Sr. No	Supplies	Contributors	Quantity	% allocation	Unit cost		Year of cost	GDP deflator	GDP adj. factor	Total cost	
					Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=BYF/(f)	(h)=a*b*c*g	(i)=a*b*d*g
1	none		0		0.00	0.00		0.00	1.00	0.00	0.00
	Other/Unspecified							0.00	1.00	0.00	0.00
Total laboratory supplies cost**:**										**0.00**	**0.00**
6)	**TRANSPORT OPERATING COSTS**										
i)	Transport running cost										
Sr. No.	Vehicle	Contributors	Km. Covered **OR** Fuel used	% allocation to the intervention	Fuel cost per km **OR** per litre		Year of cost	GDP deflator	GDP adj. factor	Total transport operating cost	
					Financial	Economic				Financial	Economic
			(a)	(b)	I	(d)	I	(f)	(g)=BYF/(f)	(h)=a*b*c*g	(i)=a*b*d*g
1	5ท9340	MU	192.59	100%	24.66	24.66	2015	0.70	1.00	**4,750.00**	4,750.00
2	9ฒ3341	MU	226.17	100%	20.96	20.96	2015	0.70	1.00	**4,740.00**	4,740.00
3	ฮจ5492	MU	236.28	90%	21.08	21.08	2015	0.70	1.00	**4,482.18**	4,482.18
Sub-total:										**13,972.18**	13,972.18
ii)	Other transport costs										
Sr. No.	Items e.g. vehicle rental or public transport costs (train, plane, taxi etc)	Contributors	Number	% allocation to the intervention	Rent **OR** charge per unit of duration (months)		Duration of use if rented	Transportation cost		Year of cost	GDP Deflator
					Financial	Economic		Financial	Economic		
			(a)	(b)	(c)	(d)	(e)	(f)=a*b*d*e	(g)=a*b*d*e	(h)	(i)
1	none		0		0.00	0.00		0.00	0.00		0.00
Sub-total:											
Total transport operating cost:											
7)	**EQUIPMENT OPERATING COST**										
Rented equipment/implements											
Sr. No.	Equipment/Implements	Contributors	Number	% allocation to the intervention	Rented charge per month		Duration of use (months)	Rented equipment cost		Year of cost	GDP Deflator
					Financial	Economic		Financial	Economic		
			(a)	(b)	(c)	(d)	(e)	(f)=a*b*d*e	(g)=a*b*d*e	(h)	(i)
1	none		0					0.00	0.00		0.00
Total equipment operating cost:											
8)	**MAINTENANCE**										

Sr. No.	Maintenance costs (vehicles, building, furniture, equipment)	Contributors		% allocation to the intervention	Unit operating cost per item		Year of cost	GDP deflator	GDP adj. factor	Total maintenance cost	
					Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=BYF/(f)	(h)=a*b*c*g	(i)=a*b*d*g
1	Vehicle5พ9340	MU	1	100%	8,065.93	8,065.93	2015	0.70	1.00	8,065.93	8,065.93
2	Vehicle9ฒ3341	MU	1	100%	21,392.88	21,392.88	2015	0.70	1.00	21,392.88	21,392.88
3	Vehicleสข5492	MU	1	90%	7,900.00	7,900.00	2015	0.70	1.00	7,110.00	7,110.00
4	BUILDING	MU	1	0.079 %	12,427,137.40	12,427,137.40	2015	0.70	1.00	9,760.79	9,760.79
Total maintenance cost:										**46,329.59**	**46,329.59**

9)	**UTILITIES**										
Sr. No.	Utility item	Contributors	Quantity	% allocation to the intervention	Unit cost or value if unknown quantity		Year of cost	GDP Deflator	GDP adj. factor	Total utility cost	
					Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=BYF/(f)	(h)=a*b*c*g	(i)=a*b*d*g
1	electricity deparment	MU	1	3.30%	38,986.90	38,986.90	2015	0.70	1.00	1,286.57	1,286.57
2	electricity school	BMA			0.00			0.00	1.00	0.00	0.00
Total utilities cost:										**1,286.57**	**1,286.57**

10) OTHER RECURRENT ITEMS											
i)	Rented buildings										
Sr. No.	Items	Contributors	Number	% allocation to the intervention	Rental cost per month		Duration of use (yrs)	Rented building cost		Year of cost	GDP Deflator
					Financial	Economic		Financial	Economic		
			(a)	(b)	(c)	(d)	(e)	(f)=a*b*c*e	(g)=a*b*d*e	(h)	(i)
1	none		0		0.00	0.00		0.00	0.00		0
Sub-total:											
ii)	Insurance										
Sr. No.	Items	Contributors	No. used	% allocation to the	Total cost		Year of cost	GDP Deflator	GDP adj. factor	Total insurance recurrent cost	
					Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=BYF/(f)	(h)=a*b*c*g	(i)=a*b*d*g
1	none		-					0.00	1.00	0.00	0.00
Sub-total:										0.00	0.00
iii)	Miscellaneous items										
Sr. No.	Items	Contributors	No. used	% allocation to the	Total cost		Year of cost	GDP deflator	GDP adj. factor	Total miscellaneous recurrent cost	
					Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=BYF/(f)	(h)=a*b*c*g	(i)=a*b*d*g
	Other/Unspecified		-					0.00	1.00	0.00	0.00
Sub-total:										0.00	0.00
Total other recurrent costs:										0.00	0.00

Annex 4 Capital Cost of Mahidol dental program

Inventory number	Asset description 1	∑Curr.acq.value	Quantity	total amount	Acq. year	Useful life years
Basic equipment						
DT-19-003-1/6	ถาดสแตนเลสพร้อมฝาปิดขนาด 8"x12"	300	6	1,800.00	2519	6
DT-26-060	ชุดนอนสนาม	1,200.00	1	1,200.00	2526	6
ร-40-082	เก้าอี้สนาม	9,000.00	1	9,000.00	2540	6
ร-40-083	โคมไฟส่องปากสนาม	7,000.00	1	7,000.00	2540	6
ร-46-099-1/6	หมอนรองศีรษะผู้ป่วยชนิดปรับองศาได้	4,500.00	6	27,000.00	2546	6
DT-48-003-2-1/1	เครื่องอัดอากาศ ขนาด 1.5 แรงม้า	27,500.00	1	27,500.00	2548	15
DT-49-003-2 (อ-49-005)	เครื่องอัดอากาศขนาด 1.5 HP	25,000.00	1	25,000.00	2549	15
DT-50-061-1/8	โคมไฟส่องปากสำหรับปฏิบัติการนอกสถานที่ยี่ห้อ Waldmann	28,000.00	6	168,000.00	2550	6
DT-51-042-1/6	โคมไฟส่องปากสำหรับปฏิบัติงานนอกสถานที่ยี่ห้อ Waldmann รุ่น HI 20	28,000.00	5	140,000.00	2551	6
Sterilization						
บ-39-002	หม้อต้มเครื่องมือไฟฟ้า	9,000.00	1	9,000.00	2539	6
ร-40-079	เครื่องปิดผนึกถุงใส่เครื่องมือฆ่าเชื้อ	19,500.00	1	19,500.00	2540	6
DT-41-010	เครื่องล้างและหล่อลื่นหัวกรอยี่ห้อ W&H	45,000.00	1	45,000.00	2541	6
ร-45-053-1/2	รถเข็นสเตนเลส	4,600.00	2	9,200.00	2545	6
DT-51-041	เครื่องนึ่งไอน้ำแบบตลับยี่ห้อ Scican รุ่น Statim 2000	198,000.00	1	198,000.00	2551	6
	เครื่องปิดผนึกซองพลาสติก B.A.INTERNATIONAL รุ่น ULTIMATE SEAL BASE700	30,000.00	1	30,000.00	2557	6
Scaling sealant PRR fill						
DT-52-014	เครื่องกรอฟันเคลื่อนที่พร้อมเครื่องอัดอากาศและเครื่องขูดหินน้ำลายไฟฟ้า	240,000.00	1	240,000.00	2552	15
Sealant PRR fill						
ร-37-051-1/2	เครื่องกรอฟันความเร็วสูง (Airotor)ยี่ห้อ W&H แบบ topair 798	10,500.00	2	21,000.00	2537	6
ร-37-052-1/2	ข้อต่อเครื่องกรอความเร็วสูง (Coupling Joint)	3,500.00	2	7,000.00	2537	6

ร-37-053-1/2	เครื่องขัดฟันความเร็วต่ำ (AR-ES)	2,250.00	2	4,500.00	2537	6
DT-44-014-07/10	ชุดเครื่องกรอฟันยี่ห้อ T.D.P. รุ่น Portable Dental Unit	161,000.00	4	644,000.00	2544	6
บ-44-014-1/2	เครื่องฉายแสง	17,073.50	2	34,147.00	2544	6
ร-44-077-1/2	เครื่องฉายแสงวัสดุอุดฟันยี่ห้อ 3 M รุ่น XL 2500	17,173.50	1	17,173.50	2544	6
บ-47-025-1/4	เครื่องฉายแสง Elipar FreeLight	44,940.00	3	134,820.00	2547	6
DT-48-003-1-1/2	เครื่องกรอฟันเคลื่อนที่ยี่ห้อ T.D.P.	193,250.00	2	386,500.00	2548	6
DT-48-003-3-1/2	เครื่องฉายแสง	15,000.00	2	30,000.00	2548	6
DT-49-003-1-1/2 (อ-49-005	เครื่องกรอฟันเคลื่อนที่	201,500.00	2	403,000.00	2549	6
DT-53-092-01/27	เครื่องฉายแสงชนิดไร้สายยี่ห้อ Ivoclar vivadent รุ่น Bluephasenew	37,000.00	4	148,000.00	2553	6
DT-53-039	ชุดปฏิบัติการทางทันตกรรมเคลื่อนที่ พร้อมเครื่องอัดอากาศและเครื่องฉายแสง วัสดุอุดฟัน	230,000.00	1	230,000.00	2553	15
PRR fill						
คก109-001	เครื่องมืออุดฟัน	1,800.00	2	3,600.00	2522	6
DT-53-027	เครื่องปั่นและผสมสารอุดฟันยี่ห้อ Silamat S6	23,500.00	1	23,500.00	2553	6
Extraction						
DT-26-061	เครื่องมือถอนฟัน	5,000.00	1	5,000.00	2526	6

		Total square meter surface area (all floors (m^2)) = 80,756.65						**DISCOUNT RATE:** 0.03							
1	**BUILDING COSTS**								**Base year GDP Deflator: 0.7**						
Sr. No.	Items	Contributors	Purchase price	Replacement cost	Useful life (yrs)	Annualization factor	Annualized cost	Building cost		Year of cost	GDP Deflator	GDP adj. factor	Total building cost	
			Financial	Economic				Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)=(b)/(c)	(f)=(a)/(c)	(g)=(e)	(h)	(i)	(J)=BYF/(i)	(K)=(f)*(J)	(L)=(g)*(J)
	Name/function of building													
1	**University hospital**	MU	1,738,061,190.00		30	19.6	88,674,594.57	57,935,373.0	88,674,594.57	2015	0.7	1.00	57,935,373.00	88,674,594.57
2	**school**	BMA	NA	0.00		0.00	0.00	0	0.00		0.0	1.00	0.00	0.00
Total building cost:						19.6	88,674,594.57	57,935,373.0	88,674,594.57				57,935,373.00	88,674,594.57

	Allocation of building space						
Sr. No.	**Type of service**: e.g. office, clinical ward, waiting area, store, not in use	Contributors	Square meter surface area (m^2)	% occupied of total space	% allocation to the intervention	Total costs of space allocated to the intervention	
						Financial	Economic
1	community department	MU	331.2	0.41%	0.03	**7,840.97**	12,001.21
2	community unit treasury	MU	105	0.13%	0.50	**37,663.86**	57,647.47
3						**0.00**	0.00
Total allocation of building space:				0.54%		**45,504.83**	**69,648.68**

2) TRANSPORT COSTS																
Sr. No.	Items	Contributors	Number	% allocation to the	Purchase price	Replacement cost	Useful life	Annualization factor	Annualized cost	Transport cost		Year of cost	GDP Deflator	GDP adj. factor	Total transport cost	
					Financial	Economic				Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=(d)/(f)	(h)=(a*b*c)/(e)	(i)=(a)*(b)*(g)	(j)	(k)	(L)=BYF/(K)	(M)=(L)*(h)	(N)=(L)*(i)
1	5ท9340	MU	1	100%	434,000.00	30,000.00	6	5.42	5,537.93	72,333.33	5,537.93	2015	0.7	1.0	72,333.33	5,537.93
2	9ฒ3341	MU	1	100%	507,715.00	63,500.00	6	5.42	11,721.94	84,619.17	11,721.94	2015	0.7	1.0	84,619.17	11,721.94
3	ฮจ5492	MU	1	90%	1,068,400.00	500,000.00	6	5.42	92,298.75	160,260.00	83,068.88	2015	0.7	1.0	160,260.00	83,068.88
Total transport cost:															317,212.50	100,328.74
3)	**EQUIPMENT/IMPLEMENTS COSTS**															
Sr. No.	Items: Medical, lab. or other diagnostic equipment, maintenace and cleaning as well as office equipment	Contributors	Number	% allocation to the intervention	Purchase price	Replacement cost	Useful life (yrs)	Annualization factor	Annualized cost	Equipment cost		Year of cost	GDP Deflator	GDP adj. factor	Total equipment cost	
					Financial	Economic				Financial	Economic				Financial	Economic

			(a)	(b)	(c)	(d)	(e)	(f)	(g)=(d)/(f)	(h)=(a*b*c)/(e)	(i)=(a)*(b)*(g)	(j)	(k)	(L)=BYF/(K)	(M)=(L)*(h)	(N)=(L)*(i)
1	ถาดสแตนเลสพร้อมฝาปิด	MU	6	100%	300.00	300.00	39	22.81	13.15	46.15	78.92	2015	0.7	1.0	46.15	78.92
2	ชุดนอนสนาม	MU	1	100%	1,200.00	1,200.00	32	20.39	58.86	37.50	58.86	2015	0.7	1.0	37.50	58.86
3	เก้าอี้สนาม	MU	1	100%	9,000.00	9,000.00	18	13.75	654.38	500.00	654.38	2015	0.7	1.0	500.00	654.38
4	โคมไฟส่องปากสนาม	MU	1	100%	7,000.00	7,000.00	18	13.75	508.96	388.89	508.96	2015	0.7	1.0	388.89	508.96
5	หมอนรองศีรษะผู้ป่วยชนิดปรับองศาได้	MU	6	100%	4,500.00	4,500.00	12	9.95	452.08	2,250.00	2,712.48	2015	0.7	1.0	2,250.00	2,712.48
6	เครื่องอัดอากาศ ขนาด 1.5 แรงม้า	MU	1	100%	27,500.00	27,500.00	10	8.53	3,223.84	2,750.00	3,223.84	2015	0.7	1.0	2,750.00	3,223.84
7	เครื่องอัดอากาศขนาด 1.5 HP	MU	1	100%	25,000.00	25,000.00	9	7.79	3,210.85	2,777.78	3,210.85	2015	0.7	1.0	2,777.78	3,210.85
8	โคมไฟส่องปากสำหรับปฏิบัติการนอกสถานที่	MU	6	100%	28,000.00	28,000.00	8	7.02	3,988.78	21,000.00	23,932.67	2015	0.7	1.0	21,000.00	23,932.67
9	โคมไฟส่องปากสำหรับปฏิบัติงานนอกสถานที่	MU	5	100%	28,000.00	28,000.00	7	6.23	4,494.18	20,000.00	22,470.89	2015	0.7	1.0	20,000.00	22,470.89
10	หม้อต้มเครื่องมือไฟฟ้า	MU	1	100%	9,000.00	9,000.00	19	14.32	628.32	473.68	628.32	2015	0.7	1.00	473.68	628.32
11	เครื่องปิดผนึกถุงใส่เครื่องมือฆ่าเชื้อ	MU	1	100%	19,500.00	19,500.00	18	14.32	1,361.37	1,083.33	1,361.37	2015	0.7	1.0	1,083.33	1,361.37
12	เครื่องล้างและหล่อลื่นหัวกรอ	MU	1	100%	45,000.00	45,000.00	17	13.75	3,271.89	2,647.06	3,271.89	2015	0.7	1.0	2,647.06	3,271.89
13	รถเข็นสเตนเลส	MU	2	100%	4,600.00	4,600.00	13	13.17	349.38	707.69	349.38	2015	0.7	1.0	707.69	349.38

14	เครื่องนึ่งไอน้ำแบบตลับ	MU	1	100%	198,000.00	198,000.00	7	10.63	18,617.85	28,285.71	37,235.70	2015	0.7	1.00	28,285.71	37,235.70
15	เครื่องปิดผนึกซองพลาสติก	MU	1	100%	30,000.00	30,000.00	1	6.23	4,815.19	30,000.00	4,815.19	2015	0.7	1.00	30,000.00	4,815.19
16	เครื่องกรอฟันเคลื่อนที่พร้อมเครื่องอัดอากาศและ scaler	MU	1	100%	240,000.00	240,000.00	6	0.97	247,200.00	40,000.00	247,200.00	2015	0.7	1.0	40,000.00	247,200.00
17	เครื่องกรอฟันความเร็วสูง (Airotor)	MU	2	100%	10,500.00	10,500.00	21	5.42	1,938.27	1,000.00	1,938.27	2015	0.7	1.0	1,000.00	1,938.27
18	ข้อต่อเครื่องกรอความเร็วสูง (Coupling Joint)	MU	2	100%	3,500.00	3,500.00	21	15.42	227.05	333.33	454.10	2015	0.7	1.0	333.33	454.10
19	เครื่องขัดฟันความเร็วต่ำ (AR-ES)	MU	2	100%	2,250.00	2,250.00	21	15.42	145.96	214.29	291.92	2015	0.70	1.00	214.29	291.92
20	ชุดเครื่องกรอฟัน	MU	4	100%	161,000.00	161,000.00	14	15.42	10,444.36	46,000.00	20,888.71	2015	0.7	1.0	46,000.00	20,888.71
21	เครื่องฉายแสง	MU	2	100%	17,073.50	17,073.50	14	15.42	1,107.59	2,439.07	2,215.18	2015	0.7	1.0	2,439.07	2,215.18
22	เครื่องฉายแสงวัสดุอุดฟัน	MU	1	100%	17,173.50	17,173.50	14	15.42	1,114.08	1,226.68	2,228.15	2015	0.7	1.0	1,226.68	2,228.15
23	เครื่องฉายแสง Elipar FreeLight	MU	3	100%	44,940.00	44,940.00	11	11.30	3,978.37	12,256.36	15,913.49	2015	0.7	1.0	12,256.36	15,913.49
24	เครื่องกรอฟันเคลื่อนที่	MU	2	100%	193,250.00	193,250.00	10	11.30	17,107.72	38,650.00	34,215.43	2015	0.7	1.0	38,650.00	34,215.43
25	เครื่องฉายแสง	MU	2	100%	15,000.00	15,000.00	10	11.30	1,327.90	3,000.00	1,327.90	2015	0.7	1.0	3,000.00	1,327.90
26	เครื่องกรอฟันเคลื่อนที่	MU	2	100%	201,500.00	201,500.00	9	9.25	21,777.61	44,777.78	65,332.82	2015	0.7	1.0	44,777.78	65,332.82
27	เครื่องฉายแสงชนิดไร้สาย	MU	4	100%	37,000.00	37,000.00	5	8.53	4,337.53	29,600.00	8,675.06	2015	0.7	1.0	29,600.00	8,675.06
28	ชุดปฏิบัติการทางทันตกรรมเคลื่อนที่ พร้อมเครื่อง	MU	1	100%	230,000.00	230,000.00	5	8.53	26,963.02	46,000.00	53,926.03	2015	0.7	1.0	46,000.00	53,926.03

29	เครื่องมืออุดฟัน	MU	2	100%	1,800.00	1,800.00	36	7.79	231.18	100.00	462.36	2015	0.7	1.0	100.00	462.36
30	เครื่องปั่นและผสมสารอุดฟัน	MU	1	100%	23,500.00	23,500.00	5	4.58	5,131.33	4,700.00	20,525.33	2015	0.7	1.0	4,700.00	20,525.33
31	เครื่องมือถอนฟัน	MU	1	100%	5,000.00	5,000.00	32	4.58	1,091.77	156.25	1,091.77	2015	0.7	1.0	156.25	1,091.77
Total equipment cost:															**383,401.56**	**581,200.23**
4)	**FURNITURE COSTS**															
Sr. No.	Items	Contributors	Number	% allocation to the intervention	Purchase price	Replacement cost	Useful life	Annualization factor	Annualized cost	Furniture cost		Year of cost	GDP Deflator	GDP adj. factor	Total Furniture cost	
					Financial	Economic				Financial	Economic				Financial	Economic
			(a)	(b)	(c)	(d)	(e)	(f)	(g)=(d)/(f)	(h)=(a*b*c)/(e)	(i)=(a)*(b)*(g)	(j)	(k)	(L)=BYF/(K)	(M)=(L)*(h)	(N)=(L)*(i)
1	โซฟา	MU	1	3.3%	920.00	920.00	41	23.41	39.30	0.74	1.30	2015	0.7	1.0	0.74	1.30
2	ตู้เหล็กบานเปิด	MU	1	3.3%	850.00	850.00	38	22.49	37.79	0.74	1.25	2015	0.7	1.0	0.74	1.25
3	ตู้เหล็กเก็บเอกสาร 4 ลิ้นชัก	MU	1	3.3%	850.00	850.00	37	22.17	38.34	0.76	1.27	2015	0.7	1.0	0.76	1.27
4	ตู้เก็บของพร้อมตู้ลอยติดผนังกำแพง	MU	1	3.3%	5,000.00	5,000.00	34	21.13	236.61	4.85	7.81	2015	0.7	1.0	4.85	7.81
5	ตู้เหล็กเก็บหนังสือ	MU	1	3.3%	3,690.00	3,690.00	31	20.00	184.50	3.93	6.09	2015	0.7	1.0	3.93	6.09
6	ตู้เหล็กบานเลื่อน	MU	1	3.3%	3,400.00	3,400.00	31	20.00	170.00	3.62	5.61	2015	0.7	1.0	3.62	5.61

7	ตู้ไม้บุฟอไมก้าเคลื่อนที่ได้	MU	1	3.3%	1,500.00	1,500.00	29	19.19	78.17	1.71	2.58	2015	0.7	1.0	1.71	2.58
8	ตู้เหล็กเก็บเอกสาร 2 บานเปิด	MU	1	3.3%	1,800.00	1,800.00	26	17.88	100.69	2.28	3.32	2015	0.7	1.0	2.28	3.32
9	โต๊ะวางคอมพิวเตอร์	MU	1	3.3%	3,846.00	3,846.00	25	17.41	220.87	5.08	7.29	2015	0.7	1.0	5.08	7.29
10	เครื่องรับโทรทัศน์สี ขนาด 14 นิ้ว	MU	1	3.3%	9,250.00	9,250.00	25	17.41	531.21	12.21	17.53	2015	0.7	1.0	12.21	17.53
11	โทรศัพท์	MU	1	3.3%	1,337.50	1,337.50	21	15.42	86.77	2.10	2.86	2015	0.7	1.0	2.10	2.86
12	เก้าอี้ ระดับ 7-9	MU	8	3.3%	1,300.00	1,300.00	21	15.42	84.33	16.34	22.26	2015	0.7	1.0	16.34	22.26
13	เก้าอี้	MU	3	3.3%	1,300.00	1,300.00	21	15.42	84.33	6.13	8.35	2015	0.7	1.0	6.13	8.35
14	โต๊ะตรงขนาด 2 ที่นั่ง	MU	1	3.3%	3,063.82	3,063.82	21	15.42	198.76	4.81	6.56	2015	0.7	1.0	4.81	6.56
15	ตู้เก็บเครื่องมือ (Carbinet)	MU	3	3.3%	19,191.52	19,191.52	21	15.42	1,244.99	90.47	123.25	2015	0.7	1.0	90.47	123.25
16	ตู้เหล็กบานเลื่อน 2 ตอน	MU	1	3.3%	4,280.00	4,280.00	20	14.88	287.68	7.06	9.49	2015	0.7	1.0	7.06	9.49
17	ตู้เก็บแบบฟอร์ม 15 ลิ้นชัก	MU	1	3.3%	1,900.00	1,900.00	20	14.88	127.71	3.14	4.21	2015	0.7	1.0	3.14	4.21
18	ตู้เก็บแบบฟร์อม 15 ลิ้นชัก	MU	1	3.3%	2,300.00	2,300.00	19	14.32	160.57	3.99	5.30	2015	0.7	1.0	3.99	5.30
19	โต๊ะวางคอมพิวเตอร์	MU	1	3.3%	45,381.78	45,381.78	17	13.17	3,446.86	88.09	113.75	2015	0.7	1.0	88.09	113.75
20	โต๊ะวางเครื่องคอมพิวเตอร์	MU	2	3.3%	1,765.50	1,765.50	15	11.94	147.89	7.77	9.76	2015	0.7	1.0	7.77	9.76
21	ตู้เหล็กบานเลื่อนทึบ	MU	1	3.3%	2,108.76	2,108.76	15	11.94	176.64	4.64	5.83	2015	0.7	1.0	4.64	5.83

22	ตู้เหล็ก 2 บาน	MU	1	3.3%	2,100.00	2,100.00	15	11.94	175.91	4.62	5.81	2015	0.7	1.0	4.62	5.81
23	เครื่องฉายภาพและแสดงผล	MU	1	3.3%	162,000.00	162,000.00	14	11.30	14,341.27	381.86	473.26	2015	0.7	1.0	381.86	473.26
24	จอรับภาพขนาด 100 นิ้ว (60"*80") ควบคุมด้วยมอเตอร์	MU	1	3.3%	55,000.00	55,000.00	14	11.30	4,868.95	129.64	160.68	2015	0.7	1.0	129.64	160.68
25	เครื่องเล่นและบันทึกวิดีโอเทป	MU	1	3.3%	7,500.00	7,500.00	14	11.30	663.95	17.68	21.91	2015	0.7	1.0	17.68	21.91
26	เครื่องผสมสัญญาณเสียง ขนาด 12 ช่อง	MU	1	3.3%	26,000.00	26,000.00	14	11.30	2,301.68	61.29	75.96	2015	0.7	1.0	61.29	75.96
27	เครื่องปรับแต่งเสียง ชนิด 31 ช่อง	MU	1	3.3%	27,000.00	27,000.00	14	11.30	2,390.21	63.64	78.88	2015	0.7	1.0	63.64	78.88
28	เครื่องเลือกสัญญาณภาพ	MU	1	3.3%	14,000.00	14,000.00	14	11.30	1,239.37	33.00	40.90	2015	0.7	1.0	33.00	40.90
29	เครื่องขยายเสียง ขนาด 160W + 160W	MU	1	3.3%	26,000.00	26,000.00	14	11.30	2,301.68	61.29	75.96	2015	0.7	1.0	61.29	75.96
30	ลำโพง 2 ทาง ขนาด 160 วัตต์	MU	4	3.3%	11,000.00	11,000.00	14	11.30	973.79	103.71	128.54	2015	0.7	1.0	103.71	128.54
31	เครื่องเล่นและบันทึกเทปคลับคู่	MU	1	3.3%	12,650.00	12,650.00	14	11.30	1,119.86	29.82	36.96	2015	0.7	1.0	29.82	36.96
32	ขายึดลำโพงติดผนัง (Local)	MU	4	3.3%	1,000.00	1,000.00	14	11.30	88.53	9.43	11.69	2015	0.7	1.0	9.43	11.69
33	เครื่องบันทึกแผ่น CD	MU	1	3.3%	11,513.20	11,513.20	14	11.30	1,019.22	27.14	33.63	2015	0.7	1.0	27.14	33.63
34	เครื่องพิมพ์เลเซอร์	MU	1	3.3%	16,966.15	16,966.15	13	10.63	1,595.32	43.07	52.65	2015	0.7	1.0	43.07	52.65
35	เครื่องสแกนเนอร์ (Scanner)	MU	1	3.3%	5,500.00	5,500.00	13	10.63	517.16	13.96	17.07	2015	0.7	1.0	13.96	17.07
36	ตู้บานเลื่อนกระจก 2 ตอน พร้อมแผ่นไม้หลังตู้	MU	1	3.3%	10,374.00	10,374.00	12	9.95	1,042.19	28.53	34.39	2015	0.7	1.0	28.53	34.39

37	กล้องถ่ายรูประบบดิจิตอล	MU	1	3.3%	38,948.00	38,948.00	12	9.95	3,912.80	107.11	129.12	2015	0.7	1.0	107.11	129.12
38	ตู้บานเลื่อนกระจกพร้อมแผ่นไม้หลังตู้	MU	3	3.3%	3,000.00	3,000.00	12	9.95	301.39	24.75	29.84	2015	0.7	1.0	24.75	29.84
39	ตู้บานเลื่อนกระจกพร้อมแผ่นไม้หลังตู้และขารองตู้	MU	4	3.3%	3,200.00	3,200.00	11	9.25	345.85	38.40	45.65	2015	0.7	1.0	38.40	45.65
40	โต๊ะวางเครื่องคอมพิวเตอร์ขนาด 80x60x75 ซม.	MU	1	3.3%	1,960.00	1,960.00	11	9.25	211.83	5.88	6.99	2015	0.7	1.0	5.88	6.99
41	เครื่องไมโครคอมพิวเตอร์ชุด ก.	MU	1	3.3%	33,405.00	33,405.00	10	8.53	3,916.09	110.24	129.23	2015	0.7	1.0	110.24	129.23
42	เครื่องไมโครคอมพิวเตอร์	MU	1	3.3%	35,096.00	35,096.00	10	8.53	4,114.32	115.82	135.77	2015	0.7	1.0	115.82	135.77
43	โต๊ะวางเครื่องคอมพิวเตอร์	MU	1	3.3%	1,284.00	1,284.00	10	8.53	150.52	4.24	4.97	2015	0.7	1.00	4.24	4.97
44	รถเข็นของสแตนเลส 2 ชั้น	MU	1	3.3%	4,000.00	4,000.00	10	8.53	468.92	13.20	15.47	2015	0.7	1.0	13.20	15.47
45	ตู้บานเลื่อนกระจกพร้อมฐานรอง	MU	1	3.3%	2,835.00	2,835.00	9	7.79	364.11	10.40	12.02	2015	0.7	1.0	10.40	12.02
46	ตู้บานเลื่อนกระจกพร้อมฐานรอง	MU	5	3.3%	2,663.00	2,663.00	9	7.79	342.02	48.82	56.43	2015	0.7	1.0	48.82	56.43
47	ตู้บานเลื่อนทึบพร้อมขารอง	MU	1	3.3%	2,628.00	2,628.00	9	7.79	337.52	9.64	11.14	2015	0.7	1.0	9.64	11.14
48	ตู้บานเลื่อนกระจกพร้อมฐานรอง	MU	1	3.3%	2,835.00	2,835.00	9	7.79	364.11	10.40	12.02	2015	0.7	1.0	10.40	12.02
49	จอรับภาพแบบเคลื่อนที่	MU	1	3.3%	5,992.00	5,992.00	8	7.02	853.60	24.72	28.17	2015	0.7	1.0	24.72	28.17
50	เครื่องคอมพิวเตอร์แบบพกพา (Note Book)	MU	1	3.3%	36,380.00	36,380.00	8	7.02	5,182.56	150.07	171.02	2015	0.7	1.0	150.07	171.02
51	เครื่องไมโครคอมพิวเตอร์ประมวลผลทั่วไป	MU	1	3.3%	33,705.00	33,705.00	8	7.02	4,801.49	139.03	158.45	2015	0.7	1.0	139.03	158.45

52	เครื่องไมโครคอมพิวเตอร์ประมวลผลทั่วไป	MU	1	3.3%	33,705.00	33,705.00	8	7.02	4,801.49	139.03	158.45	2015	0.7	1.0	139.03	158.45
53	เครื่องมัลติมีเดียโปรเจคเตอร์	MU	1	3.3%	44,940.00	44,940.00	7	6.23	7,213.16	211.86	238.03	2015	0.7	1.0	211.86	238.03
54	เครื่องพิมพ์เลเซอร์	MU	1	3.3%	11,235.00	11,235.00	7	6.23	1,803.29	52.97	59.51	2015	0.7	1.0	52.97	59.51
55	โทรทัศน์สี ขนาด 21 นิ้ว	MU	1	3.3%	4,990.00	4,990.00	7	6.23	800.93	23.52	26.43	2015	0.7	1.0	23.52	26.43
56	เครื่องคอมพิวเตอร์แบบพกพา	MU	1	3.3%	21,507.00	21,507.00	6	5.42	3,970.14	118.29	131.01	2015	0.7	1.0	118.29	131.01
57	เครื่องเข้าเล่มสันกาวระบบความร้อน	MU	1	3.3%	5,760.00	5,760.00	5	4.58	1,257.72	38.02	41.50	2015	0.7	1.0	38.02	41.50
58	เครื่องไมโครคอมพิวเตอร์	MU	1	3.3%	34,989.00	34,989.00	5	4.58	7,640.01	230.93	252.12	2015	0.7	1.0	230.93	252.12
59	เครื่องไมโครคอมพิวเตอร์	MU	1	3.3%	19,999.99	19,999.99	5	4.58	4,367.09	132.00	144.11	2015	0.7	1.0	132.00	144.11
60	เก้าอี้ Visitor พนักพิงขนาดเล็ก หุ้มหนังเทียม	MU	2	3.3%	4,405.77	4,405.77	4	3.72	1,185.27	72.70	78.23	2015	0.7	1.0	72.70	78.23
61	PARTITION แผงทึบรวมอุปกรณ์ปิดริม	MU	6	3.3%	4,615.57	4,615.57	4	3.72	1,241.71	228.47	245.86	2015	0.7	1.0	228.47	245.86
62	โต๊ะครึ่งวงกลมต่อข้างปิดผิว MELAMINE	MU	1	3.3%	3,146.98	3,146.98	4	3.72	846.62	25.96	27.94	2015	0.7	1.0	25.96	27.94
63	อุปกรณ์ PARTITION เสา 3 ทาง-ต่างระดับ	MU	2	3.3%	629.40	629.40	4	3.72	169.33	10.39	11.18	2015	0.7	1.0	10.39	11.18
64	อุปกรณ์ PARTITION เสา 4 ทาง-ต่างระดับ	MU	2	3.3%	734.30	734.30	4	3.72	197.55	12.12	13.04	2015	0.7	1.0	12.12	13.04
65	PARTITION แผงทึบ	MU	38	3.3%	4,405.77	4,405.77	4	3.72	1,185.27	1,381.21	1,486.33	2015	0.7	1.0	1,381.21	1,486.33

66	อุปกรณ์ PARTITION เสา 2 ทาง-ต่างระดับ	MU	7	3.3%	629.40	629.40	4	3.72	169.33	36.35	39.11	2015	0.7	1.0	36.35	39.11
67	อุปกรณ์ PARTITION ขาที (STABILIZER)	MU	25	3.3%	419.60	419.60	4	3.72	112.88	86.54	93.13	2015	0.7	1.0	86.54	93.13
68	โต๊ะทำงาน TD-5	MU	6	3.3%	5,018.30	5,018.30	3	2.83	1,774.12	331.21	351.28	2015	0.7	1.0	331.21	351.28
69	โต๊ะประชุมมีล้อเลื่อน	MU	2	3.3%	6,548.40	6,548.40	3	2.83	2,315.06	144.06	152.79	2015	0.7	1.0	144.06	152.79
70	โต๊ะประชุมมีล้อเลื่อน	MU	10	3.3%	6,066.90	6,066.90	3	2.83	2,144.83	667.36	707.80	2015	0.7	1.0	667.36	707.80
71	เก้าอี้พักคอย (SF-COF1)	MU	8	3.3%	5,756.60	5,756.60	3	2.83	2,035.13	506.58	537.28	2015	0.7	1.0	506.58	537.28
72	ตู้เอกสารสูง (บน 2 บาน กระจกล่าง 2 บานเปิดไม้)	MU	2	3.3%	11,131.21	11,131.21	3	2.83	3,935.22	244.89	259.72	2015	0.7	1.0	244.89	259.72
73	เครื่องไมโครคอมพิวเตอร์	MU	1	3.3%	33,344.74	33,344.74	3	2.83	11,788.38	366.79	389.02	2015	0.7	1.0	366.79	389.02
74	เครื่องพิมพ์เลเซอร์	MU	1	3.3%	19,900.00	19,900.00	3	2.83	7,035.25	218.90	232.16	2015	0.7	1.0	218.90	232.16
75	เครื่องปริ้นเตอร์	MU	1	3.3%	16,990.00	16,990.00	3	2.83	6,006.48	186.89	198.21	2015	0.7	1.0	186.89	198.21
76	เก้าอี้ CH-1	MU	9	3.3%	4,012.50	4,012.50	3	2.83	1,418.54	397.24	421.31	2015	0.7	1.0	397.24	421.31
77	เก้าอี้ CH-5	MU	24	3.3%	4,012.50	4,012.50	3	2.83	1,418.54	1,059.30	1,123.48	2015	0.7	1.0	1,059.30	1,123.48
78	ตู้เอกสาร บานโล่ง	MU	13	3.3%	2,744.55	2,744.55	3	2.83	970.28	392.47	416.25	2015	0.7	1.0	392.47	416.25

79	ตู้เอกสาร 2 บานเลื่อน	MU	13	3.3%	4,370.95	4,370.95	3	2.83	1,545.26	625.05	662.92	2015	0.7	1.0	625.05	662.92
80	Harddisk External	MU	4	3.3%	4,390.00	4,390.00	3	2.83	1,552.00	193.16	204.86	2015	0.7	1.0	193.16	204.86
81	เครื่องถ่ายเอกสาร	MU	1	3.3%	16,900.00	16,900.00	2	1.91	8,832.12	278.85	291.46	2015	0.7	1.0	278.85	291.46
82	ค่าเชื่อมต่อและทดสอบระบบโทรศัพท์ตู้สาขาอัตโนมัติ	MU	1	3.3%	2,833.32	2,833.32	2	1.91	1,480.72	46.75	48.86	2015	0.7	1.0	46.75	48.86
83	เครื่องไมโครคอมพิวเตอร์	MU	1	3.3%	24,990.00	24,990.00	2	1.91	13,060.04	412.34	430.98	2015	0.7	1.0	412.34	430.98
84	เครื่องพิมพ์ผล	MU	1	3.3%	9,650.00	9,650.00	2	1.91	5,043.19	159.23	166.43	2015	0.7	1.0	159.23	166.43
85	เครื่องไมโครคอมพิวเตอร์	MU	1	3.3%	23,212.00	23,212.00	2	1.91	12,130.84	383.00	400.32	2015	0.7	1.0	383.00	400.32
86	เครื่องโทรศัพท์	MU	1	3.3%	1,500.00	1,500.00	2	1.91	783.92	24.75	25.87	2015	0.7	1.0	24.75	25.87
87	เครื่องโทรศัพท์	MU	24	3.3%	500.00	500.00	2	1.91	261.31	198.00	206.95	2015	0.7	1.0	198.00	206.95
88	ระบบตอบรับและโอนสายอัตโนมัติแบบ 3 ข้อความ	MU	1	3.3%	2,000.00	2,000.00	2	1.91	1,045.22	33.00	34.49	2015	0.7	1.0	33.00	34.49
89	ชุดแบตเตอรี่สำรองไฟ	MU	1	3.3%	1,500.00	1,500.00	2	1.91	783.92	24.75	25.87	2015	0.7	1.0	24.75	25.87
90	จอคอมพิวเตอร์	MU	1	3.3%	3,690.00	3,690.00	2	1.91	1,928.43	60.89	63.64	2015	0.7	1.0	60.89	63.64
91	Western My Passport	MU	1	3.3%	2,890.00	2,890.00	2	1.91	1,510.35	47.69	49.84	2015	0.7	1.0	47.69	49.84
92	Western My Passport	MU	1	3.3%	2,890.00	2,890.00	2	1.91	1,510.35	47.69	49.84	2015	0.7	1.0	47.69	49.84
Total furniture cost:									197,261.53	11,942.98	13,057.85				11,942.98	13,057.85

Annex 6 Dental chart of Mahidol University

Faculty of Dentistry, Mahidol University

Department of Community Dentistry

School Name

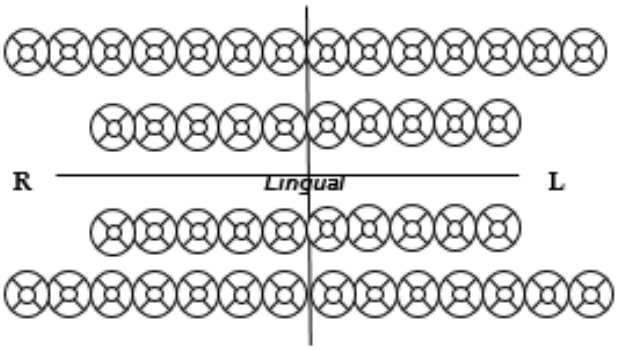
Name.....**Date of Birth** ..... **Gender**.....

BLACK : Restoration Present RED CROSS : Exfoliated / Extracted Tooth BLUE : Caries Present , Fracture BLUE P : Need PRR

BLACK CIRCLE : Unerupted Tooth BLACK S : Sealant Present BLUE S : Need Sealant

Grade ..... Examination date ..... Examiner ..... Supervisor .....

Weight ..... Height .....Congenital disease.....



DI-S =..... **CI-S** =.....

16B	11La	26B
46Li	31La	36Li

16B	11La	26B
46Li	31La	36Li

OHI-S = _____

Gingivitis ☐ Yes ☐ No

dt =_____ mt =_____ ft =_____ dmft =_____(ฟันผุ+ถอนเพราะฟันผุ)

B =_____Li =_____M =_____D =_____Occ =_____ (ฟัน caries experience ของฟันที่ขูดหิน)

DS =_____MS =_____FS =_____DMFS =_____

DT =_____MT =_____FT =_____DMFT =_____

Others .....

Treatment Record

Date	Tooth	Surfaces	Record	Student	Instructor
.....	.....	.....	.....	.....	.....
	.....	.....	.....		
	.....	.....	.....		
.....	.....	.....	.....	.....	.....
	.....	.....	.....		
	.....	.....	.....		

Date	Tooth	Surfaces	Record	Student	Instructor
.....	....	....	....	.....	.....
.....	....	....	....	.....	.....
.....	....	....	....	.....	.....

Evauation Sealant , PRR. and OHI -S

Tooth	Treatment		Sealant condition			Caries present	Mat	F/L
	Sealant	PRR	C	PL	TL			
16								
26								
36								
46								
.....								
.....								
.....								
.....								

DI-S =..... **CI-S =.....**

16B	11La	26B
46Li	31La	36Li

16B	11La	26B
46Li	31La	36Li

OHI - S = _____

Gingivitis ☐ Yes ☐ No

Examiner .....Date .....

C = Sealant with Completed retention

PL = Partial loss sealant

TL = Total loss sealant

Caries = Dentine caries

Mat = - Sealant : Resin Sealant = 0 GI Sealant = 1

- PRR : fill with resin composite = 0 Filling with GI = 1

F/U = Follow up period after operation

REFERENCES

1. World Health Organization. Oral health promotion through schools Oral Health Promotion: An Essential Element of a Health-Promoting School. 2003;Geneva.
2. Bagramian RA, Garcia-Godoy F, Volpe AR. The global increase in dental caries. A pending public health crisis. American journal of dentistry. 2009;22(1):3-8.
3. World Health Organization. Global Oral Health Data Bank. Geneva: WHO; 2000.
4. David J, Åstrøm AN, Wang NJ. Prevalence and correlates of self-reported state of teeth among schoolchildren in Kerala, India. BMC Oral Health. 2006;6:10-.
5. Ministry of Public Health. The 8th national oral health survey in Thailand 2017. Nonthaburi: Department of Health, Ministry of Public Health, Thailand. 2018.
6. Nicha Lukssamijarulkul AP. Oral Health Problems among Children in selected primary School children in Bangkok, Thailand. Journal of Health Research. 2016;Vol 30 No Suppl. 1
7. Scully C. A Report of the Surgeon General-- Executive Summary . Rockville, MD: US Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health,. 2000.
8. Welfare AIoHa. Australia's Health 1998: the Sixth Biennial Report of the Australian Institute of Health and Welfare. Canberra: AIHW. 1998.
9. Listl S, Galloway J, Mossey P, Marcenes W. Global economic impact of dental diseases. Journal of dental research. 2015;94(10):1355-61.
10. Pithpornchaiyakul W, Pitpornchaiyakul, S., Thitasomakul, S.,, Thearmontree A, Akarachaneeyakorn, N., Arkasuwan, N. Tooth brushing activities and related factors among primary schools in Songkhla, Thailand. Journal of the Dental Association of Thailand. (2009):;59,:190-9.
11. Hartono SWA, Lambri SE, Helderman WHvP. Effectiveness of primary school-based oral health education in West Java, Indonesia. International Dental Journal. 2002;52(3):137-43.
12. Greene JG, Vermillion JR. The simplified oral hygiene index. The Journal of the American Dental Association. 1964;68(1):7-13.
13. Selwitz RH, Ismail AI, Pitts NB. Dental caries. The Lancet. 2007;369(9555):51-9.
14. Loesche WJ. Role of Streptococcus mutans in human dental decay. Microbiological Reviews. 1986;50(4):353-80.
15. Vladimir W. Spolsky, Caren J. Kamberg, Kathleen N. Lohr, Feldman BG. measurement of dental health status. september 1983.
16. Al-Darwish M, El Ansari W, Bener A. Prevalence of dental caries among 12–14 year old children in Qatar. The Saudi Dental Journal. 2014;26(3):115-25.
17. Tagliaferro EP, Ambrosano GM, Meneghim Mde C, Pereira AC. Risk indicators and risk predictors of dental caries in schoolchildren. J Appl Oral Sci. 2008;16.
18. Van Nieuw Amerongen A, Bolscher JGM, Veerman ECI. Salivary Proteins: Protective and Diagnostic Value in Cariology? Caries Research. 2004;38(3):247-53.
19. Ditmyer M, Dounis G, Mobley C, Schwarz E. A case–control study of determinants for high and low dental caries prevalence in Nevada youth. BMC Oral Health. 2010;10.

20. Cypriano S, Hoffmann RHS, de Sousa MdLR, Wada RS. Dental Caries Experience in 12-year-old schoolchildren in Southeastern Brazil Journal of Applied Oral Science. 2008;16(4):286-92.
21. Petersen PE. The World Oral Health Report 2003 Continuous improvement of oral health in the 21st century – the approach of the WHO Global Oral Health Programme.
22. Chankanka O, Cavanaugh JE, Levy SM, Marshall TA, Warren JJ, Broffitt B, et al. Longitudinal associations between children's dental caries and risk factors. Journal of Public Health Dentistry. 2011;71(4):289-300.
23. Masood M, Yusof N, Hassan MIA, Jaafar N. Assessment of dental caries predictors in 6-year-old school children-results from 5-year retrospective cohort study. BMC public health. 2012;12(1):989.
24. Martinez-Mier EA, Zandona AF. The impact of gender on caries prevalence and risk assessment. Dental Clinics. 2013;57(2):301-15.
25. Ditmyer M, Dounis G, Mobley C, Schwarz E. Inequalities of caries experience in Nevada youth expressed by DMFT index vs. Significant Caries Index (SiC) over time. BMC Oral Health. 2011;11(1):12-22.
26. Ismail A, Sohn W, Lim S, Willem J. Predictors of dental caries progression in primary teeth. Journal of Dental Research. 2009;88(3):270-5.
27. Declerck D, Leroy R, Martens L, Lesaffre E, Garcia-Zattera MJ, Broucke SV, et al. Factors associated with prevalence and severity of caries experience in preschool children. Community Dentistry and Oral Epidemiology. 2008;36(2):168-78.
28. Lukacs JR. Gender differences in oral health in South Asia: metadata imply multifactorial biological and cultural causes. American Journal of Human Biology. 2011;23(3):398-411.
29. Tadakamadla SK, Tadakamadla J, Tibdewal H, Duraiswamy P, Kulkarni S. Dental caries in relation to socio-behavioral factors of 6-year-old school children of Udaipur district, India. Dental Research Journal. 2012;9(6):681-7.
30. Ferraro M, Vieira AR. Explaining gender differences in caries: a multifactorial approach to a multifactorial disease. International journal of dentistry. 2010;2010.
31. Pimentel ELC, Azevedo VMP, Castro RdAL, Reis LC, Lorenzo AD. Caries experience in young children with congenital heart disease in a developing country. Brazilian oral research. 2013;27(2):103-8.
32. Anjomshoaa I, Cooper ME, Vieira AR. Caries is associated with asthma and epilepsy. European Journal of Dentistry. 2009;3(4):297.
33. Rad AB, Joulaei H, Vossoughi M, Golkari A. Assessing Oral Health Status and Behaviors in 6-Year-Old School Children in Rural and Urban Areas of Shiraz, Southern Iran. International Journal of School Health. 2016;3(1).
34. Maserejian NN, Tavares MA, Hayes C, Soncini JA, Trachtenberg FL. Rural and urban disparities in caries prevalence in children with unmet dental needs: the New England Children's Amalgam Trial. Journal of public health dentistry. 2008;68(1):7-13.
35. Ngeonwiwatkul Y, Bhuvapanich V, Satitvipawee P, Loc H, Truong D. Dental caries and oral hygiene status among 6-8 years old schoolchildren in Hanoi and Langson cities, Vietnam. 2014.
36. Srisilapanan P, Nirunsittirat A, Roseman J. Trends over time in dental caries status in urban and rural Thai children. Journal of clinical and experimental dentistry. 2017;9(10):e1201.

37. Phuangrach N, Khiewyo J, Weraarchakul W. The Association Between Daily Pocket Money and DMFT among Children Aged 12 Years in Primary School at Khumuang District, Buriram Province. Thai Dental Nurse Journal. 2014;25(1):1-13.
38. Punitha V, Amudhan A, Sivaprakasam P, Rathnaprabhu V. Pocket money: influence on body mass index and dental caries among urban adolescents. Journal of clinical and diagnostic research: JCDR. 2014;8(12):JC10.
39. Qiu RM, Tao Y, Zhou Y, Zhi QH, Lin HC. The relationship between children's oral health-related behaviors and their caregiver's social support. BMC oral health. 2016;16(1):86.
40. Johansson I, Holgerson PL, Kressin N, Nunn M, Tanner A. Snacking habits and caries in young children. Caries research. 2010;44(5):421-30.
41. Mattila M-L, Rautava P, Sillanpää M, Paunio P. Caries in five-year-old children and associations with family-related factors. Journal of Dental Research. 2000;79(3):875-81.
42. Wigen TI, Espelid I, Skaare AB, Wang NJ. Family characteristics and caries experience in preschool children. A longitudinal study from pregnancy to 5 years of age. Community Dentistry and Oral Epidemiology. 2011;39(4):311-7.
43. Engelmann JL, Tomazoni F, Oliveira MDM, Ardenghi TM. Association between dental caries and socioeconomic factors in schoolchildren-a multilevel analysis. Brazilian Dental Journal. 2016;27(1):72-8.
44. Vargas CM, Crall JJ, Schneider DA. Sociodemographic distribution of pediatric dental caries: NHANES III, 1988–1994. The Journal of the American Dental Association. 1998;129(9):1229-38.
45. Oliveira LB, Sheiham A, Bönecker M. Exploring the association of dental caries with social factors and nutritional status in Brazilian preschool children. European journal of oral sciences. 2008;116(1):37-43.
46. Cianetti S, Lombardo G, Lupatelli E, Rossi G, Abraha I, Pagano S, et al. Dental caries, parents educational level, family income and dental service attendance among children in Italy. Eur J Paediatr Dent. 2017;18(1):15-8.
47. Sujlana A, Pannu PK. Family related factors associated with caries prevalence in the primary dentition of five-year-old children. Journal of Indian Society of Pedodontics and Preventive Dentistry. 2015;33(2):83.
48. Vanobberge J, Martens LC, Lesaffre E, Declerck D. Parental occupational status related to dental caries experience in 7-year-old children in Flanders (Belgium). © BASCD 2013. 2001;18(4):256-62.
49. Kato H, Tanaka K, Shimizu K, Nagata C, Furukawa S, Arakawa M, et al. Parental occupations, educational levels, and income and prevalence of dental caries in 3-year-old Japanese children. Environmental health and preventive medicine. 2017;22(1):80.
50. Bhardwaj SV, Bhardwaj A. Early childhood caries and its correlation with maternal education level and socio-economic status. Journal of Orofacial Sciences. 2014;6(1):53.
51. Sen Savara B, Suher T. Dental caries in children one to six years of age as related to socioeconomic level, food habits, and toothbrushing. Journal of dental research. 1955;34(6):870-5.

52. Al-Rudainy O. Role of acculturation, social capital and oral health literacy on access to dental care among preschool children of Arabic-speaking immigrants in Toronto, Canada 2011.
53. Macpherson L, Anopa Y, Conway D, McMahon A. National supervised toothbrushing program and dental decay in Scotland. Journal of dental research. 2013;92(2):109-13.
54. Pine CM, Adair PM, Nicoll AD, Burnside G, Petersen PE, Beighton D, et al. International comparisons of health inequalities in childhood dental caries. © BASCD 2013. 2004;21(1 Suppl):121-30.
55. Frencken JE, Peters MC, Manton DJ, Leal SC, Gordan VV, Eden E. Minimal intervention dentistry for managing dental caries–a review: report of a FDI task group. International dental journal. 2012;62(5):223-43.
56. Chankanka O, Marshall TA, Levy SM, Cavanaugh JE, Warren JJ, Broffitt B, et al. Mixed dentition cavitated caries incidence and dietary intake frequencies. Pediatric Dentistry. 2011;33(3):233-40.
57. Marshall TA, Broffitt B, Eichenberger-Gilmore J, Warren JJ, Cunningham MA, Levy SM. The roles of meal, snack, and daily total food and beverage exposures on caries experience in young children. Journal of public health dentistry. 2005;65(3):166-73.
58. Campain AC, Morgan MV, Evans RW, Ugoni A, Adams GG, Conn JA, et al. Sugar–starch combinations in food and the relationship to dental caries in low-risk adolescents. European journal of oral sciences. 2003;111(4):316-25.
59. Du M, Luo Y, Zeng X, Alkhatib N, Bedi R. Caries in preschool children and its risk factors in 2 provinces in China. Quintessence International. 2007;38(2).
60. Lewis C, Riedy C, Grossman D, Domoto P, Roberts M. Oral health of young Alaska Native children and their caregivers in Southwestern Alaska. Alaska medicine. 2002;44(4):83-7.
61. S. T. Access to Dental Care and Past Deciduous Dental Caries Experience among the 1st Grade Students, Nonthaburi Municipality. J Dent Assoc Thai. 2015;65(2):116-30.
62. Biordi DL, Heitzer M, Mundy E, DiMarco M, Thacker S, Taylor E, et al. Improving access and provision of preventive oral health care for very young, poor, and low-income children through a new interdisciplinary partnership. American journal of public health. 2015;105(S2):e23-e9.
63. Shyama M, Al-Mutawa S, Honkala E, Honkala S. Parental perceptions of dental visits and access to dental care among disabled schoolchildren in Kuwait. Odonto-stomatologie tropicale Tropical dental journal. 2015;38(149):34-42.
64. Gussy MG, Waters EG, Walsh O, Kilpatrick NM. Early childhood caries: current evidence for aetiology and prevention. Journal of Pediatrics and Child Health. 2006;42(1-2):37-43.
65. Bracksley-O'Grady SA, Dickson-Swift VA, Anderson KS, Gussy MG. Health promotion training in dental and oral health degrees: a scoping review. Journal of dental education. 2015;79(5):584-91.
66. Drugan C, Downer M. Dental health in the United Kingdom and influencing variables. Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz. 2011;54(9-10):1027-34.

67. Shirazi U-E-R, Naz F, Yousuf M. Dmft Index among Dental Undergraduates of Lahore Medical and Dental College in Different Professional Years of Dentistry. Pakistan Oral & Dental Journal.33,No. 1.
68. Oral Health Surveys-Basic Methods. Book Oral Health Surveys-Basic Methods. Geneva, Switzerland: WHO; 1997.
69. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. Bull World Health Organ. 2005;83.
70. PB S, Raju O. A comparison of oral hygiene status and dental caries in children on long term liquid oral medications to those not administered with such medications. J Indian Soc Pedo Prev Dent. 2002;20(4):144-51.
71. Moynihan P, Petersen PE. Diet, nutrition and the prevention of dental diseases. Public health nutrition. 2004;7(1a):201-26.
72. Acs G, Lodolini G, Kaminsky S, Cisneros G. Effect of nursing caries on body weight in a pediatric population. Pediatric dentistry. 1992;14(5):303.
73. Mishu MP, Hobdell M, Khan MH, Hubbard RM, Sabbah W. Relationship between untreated dental caries and weight and height of 6-to 12-year-old primary school children in Bangladesh. International journal of dentistry. 2013;2013.
74. Scully C. Oral Health in America: A Report of the Surgeon General. Rockville, MD: U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institute of Health. 2000.
75. Marinho VCC HJ, Logan S, Sheiham A. Topical fluoride (toothpastes, mouthrinses, gels or varnishes) for preventing dental caries in children and adolescents (Cochrane Review). Cochrane Library 2003(4).
76. Azarpazhooh A, Main PA. Fluoride varnish in the prevention of dental caries in children and adolescents: a systematic review. Journal (Canadian Dental Association). 2008;74(1):73-9.
77. Pollick H. The role of fluoride in the prevention of tooth decay. Pediatric Clinics. 2018;65(5):923-40.
78. Holmgren C, Gaucher C, Decerle N, Doméjean S. Minimal intervention dentistry II: part 3. Management of non-cavitated (initial) occlusal caries lesions–non-invasive approaches through remineralisation and therapeutic sealants. British dental journal. 2014;216(5):237-43.
79. Weintraub JA, Professor LH. Fluoride varnish for caries prevention: comparisons with other preventive agents and recommendations for a community-based protocol. Special Care in Dentistry. 2003;23(5):180-6.
80. Affairs ADACoS. Professionally applied topical fluoride: Evidence–based clinical recommendations. The Journal of the American Dental Association. 2006;137(8):1151-9.
81. Bonetti D, Clarkson JE. Fluoride varnish for caries prevention: efficacy and implementation. Caries Research. 2016;50(Suppl. 1):45-9.
82. Jones CM, Walker A. The role of extended duties dental nurses in applying fluoride varnish for the prevention and control of dental caries. Dental update. 2010;37(8):549-54.
83. Oulis C, Berdouses E. Fissure sealant retention and caries development after resealing on first permanent molars of children with low moderate and high caries risk. European Archives of Paediatric Dentistry. 2009;10(4):211-7.

84. Beltrán-Aguilar ED, Barker LK, Canto MT, Dye BA, Gooch BF, Griffin SO, et al. Surveillance for dental caries, dental sealants, tooth retention, edentulism, and enamel fluorosis; United States, 1988-1994 and 1999-2002. 2005.
85. Naaman R, El-Housseiny AA, Alamoudi N. The use of pit and fissure sealants—A literature review. Dentistry journal. 2017;5(4):34.
86. Kühnisch J, Mansmann U, Heinrich-Weltzien R, Hickel R. Longevity of materials for pit and fissure sealing—results from a meta-analysis. Dental Materials. 2012;28(3):298-303.
87. Azarpazhooh A, Main PA. Is There a Risk of Harm or Toxicity in the Placement of Pit and Fissure Sealant Materials? A Systematic Review. Journal of the Canadian Dental Association. 2008;74(2).
88. Julie G Satura MGG, Michael V Morgana,, Wrightd HCaC. Review of the evidence for oral health promotion effectiveness. Health Education Journal. 2010.
89. Rad AB, Joulaei H, Vossoughi M, Golkari A. Assessing Oral Health Status and Behaviors in 6-Year-Old School Children in Rural and Urban Areas of Shiraz, Southern Iran. International Journal of School Health. 2015;3(1).
90. Nakre PD, Harikiran AG. Effectiveness of oral health education programs: A systematic review. Journal of International Society of Preventive & Community Dentistry. 2013;3(2):103-15.
91. N. Jürgensen PEP. Promoting oral health of children through schools – Results from a WHO global survey 2012. © BASCD 2013. 2013(30,):204-18.
92. Nakre PD, Harikiran A. Effectiveness of oral health education programs: A systematic review. Journal of International Society of Preventive & Community Dentistry. 2013;3(2):103-15.
93. Östberg A-L, Jarkman K, Lindblad U, Halling A. Adolescents' perceptions of oral health and influencing factors: a qualitative study. Acta odontologica Scandinavica. 2002;60(3):167-73.
94. Council NR. Improving access to oral health care for vulnerable and underserved populations: National Academies Press; 2012.
95. Saurman E. Improving access: modifying Penchansky and Thomas's theory of access. Journal of health services research & policy. 2016;21(1):36-9.
96. Amin MS, Perez A, Nyachhyon P. Parental awareness and dental attendance of children among African immigrants. Journal of immigrant and minority health. 2015;17(1):132-8.
97. Divaris K, Lee JY, Baker AD, Gizlice Z, Rozier RG, DeWalt DA, et al. Influence of caregivers and children's entry into the dental care system. Pediatrics. 2014;133(5):e1268-e76.
98. Nguyen T. Is the current model of public dental care promoting the oral health of young children in Australia?2017.
99. Pothidee T, Sringernyuang L, Tuongratanaphan S. Inequity in access to oral health service of primary students: A case study of a dental fund in a central region province. Kasetsart Journal of Social Sciences. 2016;37(3):175-81.
100. Harris RV, Pender SM, Merry A, Leo A. Unravelling referral paths relating to the dental care of children: a study in Liverpool. Primary Dental Care. 2008;15(2):45-52.

101. Nelson S, Mandelaris J, Ferretti G, Heima M, Spiekerman C, Milgrom P. School screening and parental reminders in increasing dental care for children in need: a retrospective cohort study. Journal of public health dentistry. 2012;72(1):45-52.
102. Association ASD. Barriers to Care https://wwwasdanetorg/index/get-involved/advocate/issues-and-legislative-priorities/Barriers-to-Care2017.
103. Edelstein BL, Chinn CH. Update on disparities in oral health and access to dental care for America's children. Academic pediatrics. 2009;9(6):415-9.
104. Trabue KR. Barriers to Accessing Primary Dental Care for the Uninsured/Underinsured Population in the City of Cincinnati. 2010.
105. Onyejaka NK, Folayan MO, Folaranmi N. Barriers and facilitators of dental service utilization by children aged 8 to 11 years in Enugu State, Nigeria. BMC health services research. 2016;16(1):93.
106. Bahadori M, Ravangard R, Asghari B. Perceived barriers affecting access to preventive dental services: Application of DEMATEL method. Iranian Red Crescent Medical Journal. 2013;15(8):655.
107. Chrisopoulos S, Luzzi L, Brennan DS. Trends in dental visiting avoidance due to cost in Australia, 1994 to 2010: an age-period-cohort analysis. BMC Health Services Research. 2013;13(1):381.
108. Saldūnaitė K, Bendoraitienė EA, Slabšinskienė E, Vasiliauskienė I, Andruškevičienė V, Zūbienė J. The role of parental education and socioeconomic status in dental caries prevention among Lithuanian children. Medicina. 2014;50(3):156-61.
109. Vargas CM, Monajemy N, Khurana P, Tinanoff N. Oral health status of preschool children attending Head Start in Maryland, 2000. Pediatric dentistry. 2002;24(3):257-63.
110. Gerreth K, Borysewicz-Lewicka M. Access barriers to dental health care in children with disability. A questionnaire study of parents. Journal of Applied Research in Intellectual Disabilities. 2016;29(2):139-45.
111. Mofidi M, Rozier RG, King RS. Problems with access to dental care for Medicaid-insured children: what caregivers think. American Journal of Public Health. 2002;92(1):53-8.
112. associates BA. What Parents Are Saying About...Fear,Misconceptions and Other Barriers to children's Use of Dental Services. First 5 Sacramento. 2016;November 2016:1-36.
113. Finlayson TL, Asgari P, Dougherty E, Tadese BK, Stamm N, Nunez-Alvarez A. Child, caregiver, and family factors associated with child dental utilization among Mexican migrant families in California. © BASCD 2013. 2018;35(2):89-94.
114. Meng X, Heft MW, Bradley MM, Lang PJ. Effect of fear on dental utilization behaviors and oral health outcome. Community dentistry and oral epidemiology. 2007;35(4):292-301.
115. D'alessandro G, Alkhamis N, Mattarozzi K, Mazzetti M, Piana G. Fear of dental pain in I talian children: child personality traits and parental dental fear. Journal of public health dentistry. 2016;76(3):179-83.
116. Petersen PE. Global policy for improvement of oral health in the 21st century – implications to oral health research of World Health Assembly 2007, World Health Organization. Community Dentistry and Oral Epidemiology. 2009;37(1):1-8.

117. Alayadi H, Sabbah W, Bernabé E. Effectiveness of school dental screening on dental visits and untreated caries among primary schoolchildren: study protocol for a cluster randomised controlled trial. Trials. 2018;19(1):224.
118. Community Dentistry Department FoD, Mahidol University. Clinical Guiline Practices for 5th year Dental student. 2015.
119. Introduction to cost analysis of health fachties. [Internet]. 1996. [cited Retrieved March 10, 2010, fi-om]. Available from: http: / /dspace. hsri.or. th/dspace.
120. Riewpaiboon A, Malaroje S, Kongsawatt S. Effect of costing methods on unit cost of hospital medical services. Tropical Medicine & International Health. 2007;12(4):554-63.
121. Klein SP, Bohannan HM, Bell RM, Disney JA, Foch CB, Graves RC. The cost and effectiveness of school-based preventive dental care. American Journal of Public Health. 1985;75(4):382-91.
122. Prescott WP. Business, Legal, And Tax Planning for the Dental Practice: PennWell Books; 2001.
123. Office of Permanent Secretary. Table of useful life years and depreciation rate of assest.2011. (Thai version). Thailand: Ministry of Public Health, ; 2554.
124. Adam T, Murray C. Making choices in health: WHO guide to cost-effectiveness analysis: World Health Organization; 2003.
125. CHOICE W. CostIt (Costing interventions templates) software. Geneva: World Health Organization (http://www who int/choice/toolkit/cost_it/en/).
126. Wannapoglang A. Itemized Dental Service Costvof Thatum Hospital in 2014. Journal of Health System Research. 2014;10(1):34.
127. Kanokkaew S. Itemised dental service cost of Bankuat hospital in fiscal year 2018. Th Dent PH J. 2018;23(2):17-27.
128. Griffin SO, Jones K, Naavaal S, O'Connell JM, Demopoulos C, Arlotta D. Estimating the cost of school sealant programs with minimal data. J Public Health Dent. 2018;78(1):17-24.
129. Lorenzoni L, Koechlin F. International comparisons of health prices and volumes: New findings. Health Division. 2017.
130. Indicators [Internet]. 2020. Available from: https://data.worldbank.org/indicator.
131. World Health Organization. Oral health surveys: basic methods: World Health Organization; 2013.
132. Axelsson P, Lindhe J. Effect of oral hygiene instruction and professional toothcleaning on caries and gingivitis in schoolchildren. Community Dentistry and Oral Epidemiology. 1981;9(6):251-5.
133. Phenkhae Lapying VC, Prapa Sangla, Wannapa Srithong. The unit cost of pit-fissure sealing on permanent first molar in fiscal year 2007. Thai Dental Public Health Journal,. 2007;12(2):38-50.
134. Sutthavong S, Taebanpakul S, Kuruchitkosol C, Ayudhya T, Chantveerawong T, Fuangroong S, et al. Oral health status, dental caries risk factors of the children of public kindergarten and schools in Phranakornsriayudhya, Thailand. J Med Assoc Thai. 2010;93(Suppl 6):S71-8.
135. Petersen PE. Sociobehavioural risk factors in dental caries–international perspectives. Community Dentistry and Oral Epidemiology. 2005;33(4):274-9.
136. Li Y, Wang W. Predicting caries in permanent teeth from caries in primary teeth: an eight-year cohort study. Journal of Dental Research. 2002;81(8):561-6.

137. Van Palenstein Helderman W, Munck L, Mushendwa S, Van't Hof M, Mrema F. Effect evaluation of an oral health education programme in primary schools in Tanzania. Community Dentistry and Oral Epidemiology. 1997;25(4):296-300.
138. Bonetti D, Clarkson JE. Fluoride Varnish for Caries Prevention: Efficacy and Implementation. Caries Research. 2016;50(suppl 1)(Suppl. 1):45-9.
139. Weintraub JA, Ramos-Gomez F, Jue B, Shain S, Hoover CI, Featherstone JDB, et al. Fluoride Varnish Efficacy in Preventing Early Childhood Caries. Journal of Dental Research. 2006;85(2):172-6.
140. Condò R, Cioffi A, Riccio A, Totino M, Condò SG, Cerroni L. Sealants in dentistry: a systematic review of the literature. ORAL & implantology. 2013;6(3):67-74.
141. Dorantes C, Childers NK, Makhija SK, Elliott R, Chafin T, Dasanayake AP. Assessment of retention rates and clinical benefits of a community sealant program. Pediatric Dentistry. 2005;27(3):212-6.
142. Tianviwat S, Hintao J, Thitasomakul S, Sirisakulveroj B, Chongsuvivatwong V. The effectiveness of a school-based sealant program and common failures in southern Thailand. Journal of the Dental Association of Thailand 2015;65(2):107-15.
143. Wang X, Willing MC, Marazita ML, Wendell S, Warren JJ, Broffitt B, et al. Genetic and Environmental Factors Associated with Dental Caries in Children: The Iowa Fluoride Study. Caries Research. 2012;46(3):177-84.
144. Kaewkamnerdpong I, Krisdapong S. The Associations of School Oral Health-Related Environments with Oral Health Behaviours and Dental Caries in Children. Caries Research. 2018;52(1-2):166-75.
145. Ferraro M, Vieira AR. Explaining gender differences in caries: a multifactorial approach to a multifactorial disease. International Journal of Dentistry. 2010:643-9.
146. Loc H, Ngeonwiwatkul Y, Bhuvapanich V, Satitvipawee P, Truong D. Dental caries and oral hygiene status among 6-8 years old schoolchildren in Hanoi and Langson cities, Vietnam. Mahidol Dental Journal. 2014;34:13-8.
147. Shabani L, Begzati A, Dragidella F, Hoxha V, Cakolli V. The correlation between DMFT and OHI-S index among 10-15 years old children in Kosova. Journal of Dental and Oral Health. 2015;5:2002-5.
148. Medina Solís CE. Is there a relationship between asthma and dental caries? A critical review of the literature. 2010.
149. Vichayanrat T, Kositpumivate W. Oral Health Conditions and Behaviors Among Hearing Impaired and Normal Hearing College Students at Ratchasuda College, Nakhon Pathom, Thailand. The Southeast Asian Journal of Tropical Medicine and Public Health. 2014;45(5):1228-35.
150. Franco E. Dental disease, caries related microflora and salivary of children with severe congenital cardiac disease: an epidemiologlcal and oral microbial survey. Pediatric Dentistry. 1996;18:228-35.
151. Lueangpiansamut J, Chatrchaiwiwatana S, Muktabhant B, Inthalohit W. Relationship between dental caries status, nutritional status, snack foods, and sugar-sweetened beverages consumption among primary schoolchildren grade 4-6 in Nongbua Khamsaen school, Na Klang district, Nongbua Lampoo Province, Thailand. Journal Medical Association of Thailand 2012;95(8):1090-7.
152. Kumar S, Tadakamadla J, Kroon J, Johnson NW. Impact of parent-related factors on dental caries in the permanent dentition of 6–12-year-old children: a systematic review. Journal of Dentistry. 2016;46:1-11.

153. Khositkaseam N. Cost-Effectiveness Analysis of school-Based Oral Health Preventive Program at Public

Primary School in Bangkok Bangkok: Chulalongkorn University; 2005.
154. Wennhall I, Norlund A, Matsson L, Twetman S. Cost-analysis of an oral health outreach program for preschool children in a low socioeconomic multicultural area in Sweden. Swed Dent J. 2010;34(1):1-7.
155. Retna K. Assessment of dental treatment required and analysis of cost in the management of dental caries among semiurban primary school children of Kerala. Journal of the Indian Society of Pedodontics and Preventive Dentistry. 2000;18(1):29-37.
156. Kathmandu RY. The burden of restorative dental treatment for children in Third World countries. International dental journal. 2002;52(1):1-9.
157. Jaidee J, Ratanasiri A, Chatrchaiwiwatana S, Soonthon S. Prevalence and factors associated with the utilization of dental care services among factory workers in Nava Nakorn Industrial Estate, Pathumthani Province, Thailand. J Med Assoc Thai. 2015;98(suppl 6):S73-80.
158. Nguyen T, Hsueh Y-S, Morgan M, Mariño R, Koshy S. Economic Evaluation of a Pilot School–Based Dental Checkup Program. JDR Clinical & Translational Research. 2017;2(3):214-22.
159. Huang S, Ruff R, Niederman R. An economic evaluation of a comprehensive school-based caries prevention program. JDR Clinical & Translational Research. 2019;4(4):378-87.
160. Hutubessy R, Chisholm D, Edejer TT-T. Generalized cost-effectiveness analysis for national-level priority-setting in the health sector. Cost effectiveness and resource allocation. 2003;1(1):8.

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