ORIGINAL ARTICLE

Cost-effectiveness of school oral health prevention program: a case study of community dentistry, Mahidol University

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ABSTRACT

School may be the only place where oral health services are provided for high-risk children with limited access to dental care. We found this to be a common situation in many low-income countries, compounded by a lack of dental personnel. A school oral health prevention program is widely implemented in Thailand; however, the program's cost-effectiveness is under-investigated. This research project evaluated the cost-effectiveness of a comprehensive school oral health program implemented in the academic setting from the provider's perspective. The retrospective study was conducted using profile data of primary school children in low socioeconomic areas during the academic years 2009–2018 from the Mahidol school oral health program database. The program's effectiveness was measured as DMFT increment scores from the first to the sixth grade between the intervention and control groups. To estimate unit costs for preventive dental services, cost data were collected according to the WHO CostIt program. The total cost was determined based on two elements: recurrent cost and capital cost.

The economic costs of the program in the 2015 academic year for first- to sixth-grade children were an average of 1,196,839.37 Baht (34,944.42 USD), comprised of recurrent costs (36.1%) and capital costs (63.9%). Personnel costs and equipment depreciation costs were a major part of recurrent costs and capital costs, respectively. Specifically, capital costs were accountable for more than half of total program costs. The incremental cost-effectiveness ratio (ICER) of the completed 5-year program compared with the control group was 4,035.31 Baht per DMFT avoided. The study findings, which suggested the effectiveness of this program, are useful for its extension and expansion. The cost-effectiveness of the oral prevention program indicated that it is worth implementing, especially for outreach and children of low socioeconomic status at high risk of caries.

Key words: cost-effectiveness analysis, preventive dental program, school oral health preventive program

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INTRODUCTION

Oral problems result in considerable costs. Dental treatment comprises approximately 5%–10% of the total health expenditures, or billions of dollars, in developed countries each year.[1] In many low-income countries, the cost of dental services could easily use the country's entire health budget.[2] These expenditures could be allocated to the social and educational budgets. Additionally, dental problems cause lost school learning hours. The effects on the quality of life of children, their daily activities, and parents' working hours are considered high. In terms of financial, personal, and social impacts, the costs of neglect of dental care are also high.[3]

Poor oral health in children often continues into adulthood, impacting the quality of life and economic productivity.[4] Progression of the disease may need advanced treatment that is more complex, more costly and possibly more traumatic, for example, root canal therapy, extractions, surgery for abscess drainage, treatment under general anaesthesia, and hospitalization. The early onset of diseases is reversible with appropriate measures, treatment, and care. Advanced or progressive lesions become more severe and difficult to treat.[5] Obviously, it must be emphasized that prevention is better than cure. The preventive program, early diagnosis and timely treatment are essential in efforts to contain the costs of oral diseases. Investment in oral disease prevention and health promotion reduces health expenditures and, in the long term, is more cost-effective.

Cost determination in health care aims to identify the value of all resources, the prices of products or services. It divides the resource into small units, thus it will make it easier to analyse its relation to the final product or output. Cost data of intervention programs are gathered in logical steps depending on the characteristic of each program. The total direct cost of each service is determined by summing up their labour, material and capital costs.[6]

Cost-effectiveness analysis (CEA) of school oral health programs is related to oral health status improvement, and this is a simple economic evaluation technique. It involves systematic data collection, categorization and analysis of program costs and costs of illness. It is one of the suitable tools to evaluate the allocation of health resources.[7]

There are few studies about cost-effectiveness analysis of school oral health prevention programs,[8] and none of them were performed in an academic setting. Mahidol University Faculty of Dentistry has been setting up a school oral health program for several years, and the cost-effectiveness should be evaluated. This study aims to assess the cost-effectiveness of a comprehensive school oral health program implemented in the academic setting.

MATERIAL AND METHODS

The data for cost analysis were obtained from the community dentistry department and procurement sections, Faculty of Dentistry, Mahidol University. The program was provided for four public primary schools in Bangkok. All schools were used by dental students to practice dental care treatments. The school oral health preventive program included regular campaigns with oral health promotion (including oral hygiene instruction and diet counselling) and prevention, including oral examination, application of fluoride varnish and sealant as prophylaxis. The database included the estimated costs of labour, material, capital, and transportation. Information about staff salaries was collected anonymously from the human resource department. The material cost was estimated by using material requisition forms and historical data records from the department. The cost of fluoride varnish

and sealant in caries prevention was based on the Mahidol school oral health program for 2015 due to limited data records. Equipment/implementation costs were collected by using requisition forms and stock records. Transport operating costs and maintenance cost data were collected from the Vehicle Unit. Other details of the analysis, such as the price of academic setting and other utility use, were reported. The cost estimates were based on retrospective averages and records in the WHO CostIt program. CostIt is a costing interventions template suggested by the World Health Organization.

Recurrent costs consist of

- Personnel costs: all staff salaries (dentists/supervisors, dental assistants, car drivers, and housekeepers). The proportion of their time spent must be included in the calculation accordingly. The cost of this time was computed initially based on hourly wage rates.
- Non-medical materials & supplies: stationary cost
- Drugs: analgesic drugs
- Medical supplies or material cost: Essentially, all consumable supplies were purchased centrally in bulk for the study and then shipped to the program. The costs of these materials were allocated under preventive procedures and then to regimens in proportion to the number of children who used them.
- Transport operating costs: petrol
- Maintenance cost: vehicle maintenance
- Utilities: electricity cost

Capital cost consists of

- Building costs: lease
- Transport cost: depreciation cost of the car, data were collected from the Facilities & Environment section.
- Equipment/implementation cost: heavy equipment and hand instrument cost. This category included the amortized cost of the equipment, such as portable dental chairs and lights used to provide the preventive procedures (figure 1). These costs were allocated to processes under the use of this equipment.

Figure 1 Equipment used for the school oral health prevention program

- Furniture costs from the department and treasury

The capital cost of the equipment was calculated by using depreciation cost. The initial cost was collected from the Procurement Section, and then the salvage value (the price when the equipment reaches the end of its useful life) was subtracted and the result divided by the total expected functional years of the equipment.

Financial cost: calculates Salvage Value (cost remaining) as 0 after the equipment reaches the end of its total useful years

Depreciation Cost = [Initial Cost (purchasing price) – Salvage Value (cost remaining)] / Total functional Years

The economic cost used Salvage Value (cost remaining) after the equipment reaches the end of its total useful years in the calculation, 6 years for medical equipment; annualization factor 5.42, Annualized cost = Replacement cost ÷ annualization factor,

Depreciation cost = Annualized Cost × % allocation to the program.

The direct cost includes both the recurrent cost and the capital cost, which is related directly to the treatment activities. In this study, the direct costs included (Personnel cost + Material cost) + Equipment cost. The personnel cost plus the material cost can be called the operating cost.

The total cost is all tangible costs occurring in the program.

The program's effectiveness was measured using profile data of primary school children in low socioeconomic areas during the academic years 2009–2018 from the Mahidol school oral health program database. The program's effectiveness was measured as caries increment of permanent teeth (DMFT) from the first to the sixth grade between the intervention and control groups. The program started with first-grade school children (6 years old) as their first permanent teeth had just erupted. We assumed a mean DMFT equal to zero before the program, so the effectiveness was compared between the mean DMFT of each group. Cost-effectiveness was analysed by using the incremental cost-effectiveness ratio (ICER), which refers to incremental cost per DMFT avoided = Cost of the preventive program – Cost of the control group

DMFT increment for the preventive program – DMFT increment for the control group

Data were obtained from the annual dental record charts. Out of 530 students of both sexes, Thai nationals, and clinically assessed by fifth-year dental students under a tutor's supervision, 97 were excluded due to incomplete demographic data (23) and failure to follow-up (74). The study analysed data for the remaining 433 students. Selected students of the present study were classified by levels of preventive treatments received from the program (such as varnish and sealant application), revealing three groups:

- Completely received; complete participation in dental preventive treatments of the school oral health prevention program (5 years)
- Incompletely received; incomplete participation in dental preventive treatments of the school oral health prevention program (≤4 years)
- Not received; oral examination only

The Mahidol dental students were trained to use the WHO diagnostic criteria for caries and calculated the mean numbers of decayed (d, D), missing (m, M), and filled (f, F) teeth (t, T). The 'DMFT' was used for deciduous teeth at baseline measurement (first grade) and permanent teeth[9] (sixth grade). Other oral examinations, including gum disease or gingivitis by physical examination and oral hygiene or cleanliness on the tooth surface, were evaluated using the Simplified Debris Index (DI-S).

For descriptive statistics, categorical variables were presented in frequency and percentage for each group, and the DMFT

was presented in mean (SD). SPSS Statistics, version 22 (IBM Corp., Armonk, NY, USA) was used for data analysis.

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

RESULTS

The students were predominantly female (232 or 53.6%) with no underlying diseases (371 or 85.7%), and only 14.3% had some underlying conditions. The prevalence of caries in deciduous teeth of first graders (6-year-old children) was 87.2%, mean DMFT 6.44 (±4.4), and that of caries in permanent teeth of sixth graders (12-year-old children) was 51.7%, mean DMFT 1.37 (±1.84). Details are shown in Table 1.

The WHO CostIt program was used to estimate the costs of the program, which were classified into two categories, recurrent costs and capital costs.

Table 1 Demographic characteristics, underlying diseases, oral health conditions of studied students (n=433)

Studied characteristics	N (%)	Level of participation in the program			p – value from chi-square test
		Exam only(%)	Incomplete*(%)	Complete**(%)	
Gender					
Boy	201 (46.4)	27 (6.2)	79 (18.2)	95 (21.9)	0.14
Girl	232 (53.6)	46 (10.6)	76 (17.5)	110 (25.4)	
Underlying disease					
No	371 (85.7)	61 (14.1)	131 (30.3)	179 (41.3)	0.64
Yes	62 (14.3)	12 (2.8)	24 (5.5)	26 (6.0)	
Gingivitis by oral examination					
Yes	362(83.6)	8 (1.8)	25 (5.8)	38 (8.8)	0.322
No	71(16.4)	65 (15.0)	130 (30.0)	167 (38.6)	
Caries prevalence in deciduous teeth (6-year-old children) (n=319)					
Caries	278(87.2)	11 (3.4)	105 (32.9)	162 (50.8)	0.94
Caries free	41 (9.5)	2 (0.6)	16 (5.0)	23 (7.2)	
Caries prevalence in permanent teeth (12-year-old children)					
Caries	224 (51.7)	50 (68.5)	86 (55.5)	88 (42.9)	<0.001
Caries free	209 (48.3)	23 (31.5)	69 (44.5)	117 (57.1)	

	Total	Exam only	Incomplete*	Complete**	p-value from ANOVA
Mean DI-S **(n= 433)**	1.63 ± 0.57	1.74 ± 0.55	1.68 ± 0.58	1.56 ± 0.57	0.033
Mean dmft (6-year-old children) (n=319)	6.44 ± 4.4	6.77 ± 4.13	6.69 ± 4.57	6.25 ± 4.34	0.680
Mean DMFT (12-year-old children) **(n= 433)**	1.37 ± 1.84	2 ± 2.02	1.57 ± 2.07	1.00 ±1.83	*<0.001*

* Incomplete participation in dental preventive treatments of school oral health prevention program (≤ 4 years)
** Complete participation in dental preventive treatments of school oral health prevention program (5 years)

Recurrent costs

Personnel costs or labour costs: personnel for this program included academic staff and clinical staff. There are eight supervisors, three dental nurses/assistants, three car drivers, and one housekeeper, totalling 24.2% or 289,999.86 Baht (8,467.20 USD). The cost for supervisors was a major part of personnel costs, and the cost of dental students was free of charge.

The costs of medical supplies were calculated by percentage allocation to preventive procedures. The material cost of this program was separated into groups by the function used in activities as follows: materials for oral hygiene instruction, basic materials for fluoride prophylaxis, sealant, PRR and filling, protective barrier, sterilization, drugs and stationary cost (non-medical materials and supplies). The total cost of materials for the dental prevention program was 6.7% or 80,599.19 Baht (2,353.27 USD). There were no laboratory supply costs because this program did not require any laboratory tests. Transport operating costs or transport running cost; vehicle fuel/petrol cost equal to 1.2% or 13,972.18 Baht (407.95 USD). There was no other transport cost or equipment operating cost due to the absence of rental cars or equipment.

Other recurrent costs for dental prevention programs such as leasehold improvement, electricity, car maintenance, and miscellaneous items are recurrent costs and are not direct costs. The maintenance cost of buildings and cars was 3.9% or 46,329.59 Baht (1,352.70 USD). Utility (electricity) cost data were collected from the Facilities and Environment Section. The community dentistry department has a separate meter. Electricity used in the 2015 academic year was 9,134.7 units (4.27 Baht/unit), equal to 38,986.9 Baht, but allocation to the program was only 3.3% or 1,286.57 Baht (37.56 USD), equal to 0.1% of the program. Other recurrent items, for instance, rental buildings, insurance, and other miscellaneous items, were not collected for calculation. The total recurrent cost was 432,603.88 Baht (12,630.84 USD) per year.

Capital costs

Capital costs included 1) Building costs – university hospital, 2) Transport costs – vehicle costs, 3) Equipment/implementation costs and 4) Furniture costs – office furniture.

Dental unit and service equipment costs included the amortized cost of the equipment, such as mobile dental units. These costs were allocated to procedures, and then the method of valuing dental equipment was to use straight-line depreciation over a given number of years. The depreciation rate used in this study comes from the revenue department of Thailand. The entire functional life of equipment generally equals 3–5 years. The medical equipment's whole functional years equals 5–15 years, depending upon the type of equipment.[10] The initial cost was also collected from Procurement Section, and then the salvage value (the price when the equipment completes its entire functional life) was subtracted and the result divided by the total life years of the equipment. There were no other capital costs in the calculation. The total capital cost was 764,235.49 Baht per year. Details of the capital cost are shown in Table 2.

Table 2 Economic and Financial costs of school oral health prevention program

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%
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/ implementation 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%

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

The cost of the program was provided for 585 students. Every student received an oral examination. A total of 280 children had sealants for 858 teeth (of which 767 were permanent molars). The total number of preventive resin restorations for 90 children was 156 teeth. Prophylaxis fluoride treatment (fluoride varnish and fluoride gel), preventive scaling, oral hygiene instruction and extraction were conducted and distributed by the studied school.

From the provider's perspective, the total estimated economic cost of the program was 1,196,839.37 Baht. The operating cost included only personnel cost and material cost. The direct treatment cost included the operating cost and equipment cost. The capitation of this program was calculated from the program's overall cost divided by the number of pupils receiving this preventive program. For the academic year 2015, the capitation was 2,045.88 Baht per child per year. Capitation by intervention activity was calculated from the cost divided by the number of task units. Details of estimated costs are presented in Table 3.

Table 3 Total estimated economic cost for school oral health prevention program and Capitation by intervention activity

Intervention activity	Quantity	Total economic costs (Baht)	Total economic costs (US $)	Cost per unit (Baht)	Cost per unit (US $)	Operating cost Total (Baht)	Operating cost Per unit (Baht)	Direct cost Total (Baht)	Direct cost Per unit (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

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

Children of the completed program group received an oral examination an average of 5.4 times, fluoride varnish application an average of 4.5 times and sealant coverage on an average of 3.37 teeth. Calculation of the cost per capita of the completed program group compared with the incomplete program and the control (examination only) group is shown in Table 4.

Table 4 Economic cost per capita and incremental cost effectiveness ratio compare between groups

Programs	**Completed program group Mean DMFT = 1.00 ±1.83**			**Incomplete program group Mean DMFT = 1.57 ± 2.07**			**Examination only group Mean DMFT = 2 ± 2.02**		
	Mean tx. times (SD.)	**Cost (Baht)**		**Mean tx. times (SD.)**	**Cost (Baht)**		**Mean tx times**	**Cost (Baht)**	
		Total	**Direct**		**Total**	**Direct**		**Total**	**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
Fluoride 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			

	Program	Cost per child (Baht)	Incremental cost (Baht)	Effectiveness of intervention (mean DMFT)	Incremental DMFT	ICER (Baht per DMFT avoided)	ICER* (USD per DMFT avoided)	ICER** (USD per DMFT avoided)
Total cost								
1.	Completed program	4,243.67	4,035.31	1.00 (±1.87)	-1.00	4,035.31	$117.82	$310.89
	Examination only	208.36		2.00 (±2.02)				
2.	Incomplete program	3,442.67	3,234.31	1.57 (± 2.07)	-0.43	7,521.65	$219.61	$579.48
	Examination only	208.36		2.00 (±2.02)				
3.	Completed program	4,243.67	801.00	1.00 (±1.87)	-0.57	1,405.26	$41.03	$108.26
	Incomplete program	3,442.67		1.57 (±2.07)				
Direct treatment cost								
1.	Completed program	3,085.26	2,961.47	1.00 (±1.87)	-1.00	2,961.47	$86.47	$228.16
	Examination only	123.79		2.00 (±2.02)				
2.	Incomplete program	2,547.39	2,423.60	1.57 (± 2.07)	-0.43	5,636.28	$164.56	$434.23
	Examination only	123.79		2.00 (±2.02)				
3.	Completed program	3,085.26	537.87	1.00 (±1.87)	-0.57	943.63	$27.55	$72.70
	Incomplete program	2,547.39		1.57 (±2.07)				

**Using Official exchange rate (LCU per US$, period average): /ER 34.25 THB*
***Using PPP conversion factor, private consumption (LCU per international $), private consumption PPP: 12.98 LCU/THB*

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

Cost effectiveness of the program

The effectiveness of this study was measured from the number of permanent caries using an increment of mean DMFT index, before and after the preventive program was implemented. The program started with first-grade school children (6 years old) as the first permanent teeth had just erupted. We assumed a prior mean DMFT equal to zero and measured DMFT again when they were in sixth grade. The program's effectiveness was evaluated by comparing the mean DMFT of the completed program group, the partial program group, and the control group. The means of DMFT for sixth-grade students were 1.00 ±1.83, 1.57 ± 2.07 and 2 ± 2.02 in the completed group, incomplete group and control group, respectively.

To save one permanent tooth, it was found that implementation of the completed program required an investment of 4,035.31 Baht. The incremental cost-effectiveness ratio of the completed 5-year program was 4,035.31 Baht (117.82 US dollars) per DMFT avoided. For the comparison of ICER of the completed and incomplete

groups and the comparison of ICER of the incomplete group and control group, see the details in Table 4.

DISCUSSION

This research found that capital costs and material costs were accountable for almost half of total costs. Consistent with Khositkaseam,[8] we found that the main part of the program was capital cost, which accounted for more than half of total costs. Her research, which studied the cost effectiveness of dental prevention programs in a primary school in Bangkok in 1995–2000, calculated only the clinical part but did not include the academic domain. Our research also takes into account this part. The cost per capita in her study was similar to that in our study. The different cost occurs due to inflation, the study time frame and the higher cost of money in that period. In both types of research, the capital cost was calculated by using the reference of useful life years of medical equipment from the ministry of public health Thailand according to the WHO CostIt guideline, which was less than the usual life years of equipment used in this program. For instance, in the actual setting, a van is used in the program for more than 6 years, but the Ministry of Public Health designates its use for only 6 years. Thus, this capital cost has overestimated the cost of equipment.

Cost analysis of an oral health outreach program for preschool children in Sweden[11] found that the main part of the budget comprised labour. They mentioned that the costs of manpower constituted 45% of the total costs. In comparison, the labour cost in this study was 24.2% of the total cost. Labour cost is very high in Sweden compared with those in Thailand. In another study in Kerala, cost analysis focused on the direct medical cost, which included labour and material costs apart from dental treatment costs. Their research mentioned indirect costs such as loss of school days and loss of parents' working days.[12]

Cost-effectiveness analysis showed money invested in oral prevention from the provider's perspective. The Incremental Cost-Effectiveness Ratio was compared between groups using the actual cost, and ICER between the completed program and examination group was 4,035.31 Baht per DMFT avoided. This finding was much lower than the ICER between the incomplete program and examination group, which was 7,521.65 Baht per DMFT avoided. The ICER between the completed program and incomplete program group was only 1,405.26 Baht per DMFT avoided. This means that to reduce caries by 0.43 DMFT (from 2.00 to 1.57) starting from doing nothing (examination only) to performing some preventive treatment costs more than performing the full option preventive treatment. The completed program including an oral examination, fluoride application every year, and sealant coverage of all four first molars was more cost-effective than not completing the treatment.

The cost of the incomplete treatment group was considered high due to a lower caries prevention effect. It saved about 18.9% compared with the completed program group but lost about 60% of its effectiveness. These children could not receive sealant applications because they had already developed caries on their molars from the beginning of the program. So, they were excluded from sealant and instead received fillings or other treatment.

This program focused on children in low socioeconomic areas who were at high risk of caries. Although the mean DMFT in sixth-grade children of all three groups was 1.37 (±1.84), the comparison group used the only group, and the mean DMFT was high, 2.00 (±2.02).[13] The effect of the program on the general population would be less impactful than that in the national referent group according to the expected caries increment on oral health surveys

carried out in this area in 2012 and 2017 (by the seventh and eighth national oral health survey), because the mean DMFT was only 1.6 and 1.3, respectively.[14]

There are several studies about the cost-effectiveness of oral health education, fluoride varnish, and sealant programs. However, fewer of them studied the cost-effectiveness of combination programs, and very few studied programs in the academic situation. A study of the cost-effectiveness of a school-based dental check-up program in Melbourne in 2013 from a societal perspective, including the patient's cost of transportation and productivity losses, demonstrated that the ICER was 3,252 $ AUD per DMFT prevented compared with standard care, a dental appointment for the child through the local public health dental service,[15] which is much higher than that of the program in Thailand. Spending 3,252 $ AUD is equal to 2,139.47 USD, using the private consumption (PPP) conversion factor (1.52 LCU/AUD).

Comparing the program's cost-effectiveness ratio with that of other studies is difficult because the ICER of each study is calculated from a different baseline of the control group. Usually, it compares the alternative program with the standard care, and the standard care of each country is not equal. Thus, the ICER could be 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 years (DALYs) as a health outcome instead of caries prevented. DALYs were calculated for toothaches by multiplying the likelihood of experiencing toothache by the disability weight for toothache (0.012).[16] In terms of thresholds for considering an intervention to be cost-effective, WHO-CHOICE has been using the 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 regions are considered very cost-effective; interventions that cost less than three times average per capita income per DALY averted are still regarded as cost-effective; those that exceed this level are considered not cost-effective.[17]

In Thailand, dental care costs are considered high, and people usually have to pay out of pocket. Oral health insurance or social security coverage helps to increase the ability to acquire dental care services but covers only some dental services. When oral health insurance or social security coverage is limited, dental care services would be affected.

The cost of dental prevention (sealant and fluoride varnish) is not high: compared with the treatment cost of restoration (endodontic treatment and prosthesis), the preventive cost is much less. Extraction is affordable but not a healthy choice; edentulous or missing teeth can lead 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. In contrast, more than 20% of the students in the district town received the service.[18] A survey in 2015 in Bangkok, Thailand, reported that though children aged 6–12 years received more dental care than other age groups, it was only 13.5% of 5.4 million children and the average number of dental visits of children aged 6–12 years was only 0.13 times/year.[14] Children from low-income families are less likely to utilize a dental service. Free dental services should be provided for low-income children at school.[19]

CONCLUSION

From the provider's perspective, the cost-effectiveness analysis of the program showed monetary investment in the oral prevention program. The total estimated economic cost for the program was 1,196,839.37 Baht. The average capitation of the program was equal to 2,045.88 Baht per child per year. ICER was compared between groups using actual cost, with ICER between the completed program and examination group found to be 2,961.47 Baht per DMFT avoided. It was much less expensive than the ICER between the incomplete program and the examination group, which was 5,636.28 Baht per DMFT avoided. Consistent with this, the ICER between the completed program and the incomplete program group was only 943.63 Baht per DMFT avoided. This means that to reduce caries by 0.43 DMFT (from 2.00 to 1.57), starting from doing nothing (examination only) to performing some preventive treatment cost more than performing full option preventive treatment. The complete program, including an oral examination, fluoride application every year, and sealant coverage of all four first molars was more cost-effective than the incomplete treatment. This finding indicates that early detection and prevention programs are worth performing for school children before the onset of dental caries.

As mentioned earlier, the primary purpose of this program was to educate dental students. All costs in this program benefit school children who received treatment and dental students practicing oral preventive care. The program's cost for personnel was considered high because the program was not only a service program but also an educational program for dental students. Some incurred costs in the study are for education, for example, departmental building costs, furniture costs and supervisory costs. The supervisors' salary was not an actual labour cost for the services, and the dental students' labour was free of charge. The program's cost in the real setting tends to be lower; the labour cost should be that of dentists, dental hygienists or dental nurses. Dental hygienists' costs are only 34%–53% that of supervisors' labour costs.[20]

The effectiveness of the program as measured by differences in the DMFT increment between the completed program group and the examination-only group was significant. The results indicated that the program was effective in reducing caries, especially in children with a high risk of caries. This program gave children of socio-economic areas a chance to access dental care.

LIMITATION

This study used data from 2015 for cost calculations instead of using the actual costs each year due to insufficient data, so the researchers used the most comprehensive information possible. Some costs in this cost analysis, including the cost of dental students' labour, could not be calculated due to the academic situation and the database system of the dental hospital not being provided.

RECOMMENDATION

A primary study with a complete design should be conducted. Further investigations should use prospective cohort studies with all associated variables and estimate oral treatment and prevention program costs in more detail.

This research project gives information about the program's estimated cost that may be useful for the program evaluation efficiency of the procedure. Some findings may be helpful to other dental faculties in Bangkok, which provide oral health school programs and help to anticipate favourable decisions in the future. Furthermore, policymakers from government or schools can use the data findings to develop policies, planning,

implementation and evaluation of the preventive dental program. In particular, we refer to the effectiveness of the school oral health program in reaching low-income children who would otherwise have no or difficult access to dental care.

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