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A vicious cycle in the oral health status of schoolchildren in a primary school in rural Cambodia

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Abstract *Objective:* To investigate the oral health status and the risk factors contributing to dental caries and gum disease of schoolchildren in Cambodia. *Methods:* A cross-sectional survey was conducted in a primary school in the Puok District, Siem Reap Province of Cambodia. An oral examination and self-reported questionnaire were used to evaluate oral health status of schoolchildren, ranging in age from 6–16. Of the 512 children that were enrolled in first through sixth grade at the primary school, 332 children (62.8%) participated. *Results:* Of the schoolchildren that were involved in this study, the prevalence of dental caries in permanent dentition was 53.5% and gum disease was present in 46.2%. Among the participants 80% had plaque, 68.6% suffered from tooth pain and only 44.2% of the schoolchildren owned their own toothbrush. There was an association between the schoolchildren that suffered from tooth pain and those that had dental caries ($P < 0.03$). Plaque was related to dental caries in permanent dentition ($P < 0.003$), calculus ($P < 0.0001$) and gum disease ($P < 0.0001$) and was linked to the schoolchildren who did not own a toothbrush ($P < 0.03$) and who suffered from tooth pain ($P < 0.03$). *Conclusion:* The following sequence of events may result in a vicious cycle in the oral healthcare of schoolchildren in rural Cambodia: the lack of a personal toothbrush leads to plaque buildup, which may increase the incidence of dental caries, which has been linked to tooth pain and gum disease. Ultimately, this poor oral healthcare impacts an individual's quality of life and can lead to more serious health issues later in life.

Key words: dental caries; gum disease; oral health; plaque; school health; tooth brush; tooth pain

Introduction

Health programs targeting schoolchildren in rural areas are economically advantageous and promote the spread of health education through the school to the community (1, 2). The benefits of oral health programs for schoolchildren play an important role in growth and development (3). The absence of an oral health program results in poor oral health, which has detrimental effects on a child's quality of life, performance in school and success in later life (4, 5). Furthermore, dental caries is one of the most common and preventable diseases in childhood. The risk for dental caries have known physical, biological, environmental, behavioural and lifestyle-related factors such as the high number of cariogenic bacteria, inadequate salivary flow, insufficient fluoride exposure, poor oral hygiene, inappropriate methods of feeding infants and poverty (6). As for periodontal disease, it is associated with systematic disease such as cardiovascular disease, bacterial pneumonia, diabetes mellitus and low birth weight (7).

Cambodia, one of the most impoverished countries in Southeast Asia, has an inadequate oral healthcare system, in part because of a shortage in dental care experts. However, it is not only Cambodia that has oral health challenges but also other Southeast Asian countries such as North Korea and Vietnam. These countries had poor oral health status in the recent studies (8, 9).

Between 1975 and 1979, Cambodia suffered a massive destruction of its social structure under the Khmer Rouge (10). The dental profession itself was almost annihilated and the dental school in Phnom Penh was closed. Under the Khmer Rouge, education facilities, resources and staff were scarce and they continue to be underdeveloped to this day. Cambodia's public oral health services are concentrated in Phnom Penh and in provincial towns but not in smaller towns or rural areas. The ratio of dentists to the general population remains low; currently, there are two dentists per 100 000 people in Cambodia. Comparatively, the number of dentists in Laos and Malaysia is four and nine dentists per 100 000 respectively. In developed countries, such as the United States, Japan and the Netherlands, the ratio of dentists to the general population is 55, 71 and 48, respectively, per 100 000 people (11).

Recently, many private dental clinics have opened in Phnom Penh, due to the increased demand over the last decade because of the improving economy. While traditional dentists provide dental care in many places, their practice is of poor quality compared with Western standards (10). Also insufficient are the community-oriented oral health programs in Cambodia; however, the one exception is a fluoride mouth-rinsing program that was implemented in some primary schools in Phnom Penh in 1993 (12).

Dental caries for Cambodian schoolchildren 12 years in age, according to the Decayed and Missing Teeth (DMT) Index, was 1.6 according to the Cambodian National Oral Health Survey conducted throughout eight provinces in 1990–1991. Between 1990 and 1991, the schoolchildren in Phnom Penh had the highest mean DMT of 3.2 (12, 13). The DMT was 2.3 in 2002 among a total of 239 schoolchildren from randomly selected schools in Phnom Penh (14).

In 2001, the exploration of the Siem Reap, a mid-sized province located in northern Cambodia about 300 km from the capital city, Phnom Penh, revealed that the local community was in need of an oral health program, which was initiated in 2002. Prior to 2001, no oral health research had been conducted in the Siem Reap Province, as a result, the oral status of the children was unknown.

The *Earthly Health Cantata*, a non-governmental organization founded in 2001 (15), has implemented informal oral health activities for the residents of one district in Siem Reap Province in Cambodia. It was observed that schoolchildren in the Siem Reap Province had access to sweet foods, such as candies and juices. This availability can be traced to Angkor Wat, a tourist attraction 10 km from the local community. Angkor Wat has begun to change the traditional diet habits of the local people, as more candies have become available to tourists as well as to the local people. The Cambodian Royal Embassy reports that the number of tourists visiting Ankor Wat is increasing annually. Despite this influx of tourists, the Siem Reap Province remains the second poorest province in Cambodia, according to the Cambodian Royal Embassy. According to the Provincial and District Health Offices, there are four dentists in Siem Reap Province but none in the Puok District.

The objective of this study was to investigate the oral health status and the risk indicators contributing to dental caries and gum disease in primary schoolchildren in the Puok District of the Siem Reap Province.

Methods

Design and setting

In 2002, a cross-sectional survey was conducted during the months of June and July. The public primary school with a population of 512 schoolchildren, located approximately 5 km from the provincial town of the Puok District, was selected as the survey site. Additionally, 36 mothers of the schoolchildren completed the survey. Upon completion of the survey, the

schoolchildren were treated at the school or at the local cooperating hospital.

According to the National Institute of Statistics in the Ministry of Planning, the total population of Siem Reap province was 422 959 in 2002. This province is divided into 12 districts, one of which is the Puok District. The population of the district was 109 842 in 2002. According to the District Education Office, the total number of schoolchildren in 62 public primary schools was 25 651 and the schoolchildren's enrollment rate was 76.5% in 2002. Schoolchildren aged 6–12 years attend primary school. About 30% of the schoolchildren delayed beginning primary school education due to being poor. Further, there were also some schoolchildren still in primary school at the age of 15 or 16.

The study design was approved by the school director and all of the primary school teachers. The parents of the schoolchildren were sent consent letters describing the procedure and methods of oral care; due to ethical considerations, the schoolchildren participated voluntarily and their confidentiality was protected.

Survey instrument

The questionnaire was designed by the authors, based in part on the existing Cambodian National Oral Health Survey (12), as well as a form from the World Health Organization (WHO) (16). Prior to conducting this survey, oral examinations and interviews with 74 schoolchildren as a pilot study were conducted twice in 2001.

On the day of data collection, the schoolchildren completed the questionnaire, which took approximately 15–20 min. This questionnaire was self-administered and identified age, gender, quality of life, oral behaviour, knowledge of oral healthcare and general life activities of the schoolchildren in the subject group. The Cronbach α of knowledge (a measure of internal consistency in the questionnaire) regarding oral health was 0.50. The principal author met with the schoolchildren in each class to explain the purpose of the study and to clarify the questionnaire.

The 36 mothers of the schoolchildren were interviewed informally regarding the duration of breastfeeding, as well as the behaviour and knowledge of oral healthcare of their children.

Clinical examinations

The schoolchildren were assessed for dental caries, gum disease, plaque and calculus on their teeth by a visual examination 1 week after completing the questionnaire. This examination used artificial light, while the schoolchildren were seated on a chair beside a window. The criteria for dental examination procedures were used as recommended by the WHO (17). The oral examination was conducted by three Japanese dentists, including the principal author and was assisted by Cambodian nurses.

The diagnoses were annotated using mean DT[1] for permanent dentition and mean dt for primary dentition. The gums, plaque and calculus were evaluated by a visual examination of the six anterior teeth, using the Health Diagnosis Form recommended by the Ministry of Education, Culture, Sports, Science, and Technology in Japan (18). A simple method was used to diagnose the six anterior teeth without the use of a probe as follows:

Status of plaque (remarks about labial surface of six anterior teeth)

0 (good): little plaque,

1 (some plaque): less than one-third of anterior tooth has attached plaque and

2 (much plaque): more than one-third of anterior tooth has attached plaque.

Status of gums (remark about labial surface of six anterior teeth)

0 (normal): no inflammation,

1 (needs observation): slight infection and needs regular observation and

2 (needs accurate examination): needs diagnosis by a dentist for periodontal disease.

Status of calculus (remarks about labial surface of six anterior teeth)

0 (good): little calculus,

1 (some calculus): less than one-third of anterior tooth has attached calculus and

2 (much calculus): more than one-third of anterior tooth has attached calculus.

Anthropometric details

The height and weight of all the schoolchildren were measured without shoes in the light uniform on the same day as the oral examination. Height and weight values were collected from the schoolchildren: from these values the body mass indices [BMI: weight (kg)/height (m^2)] were determined. The BMI for these schoolchildren were computed to reference values (19). All anthropometric measurements were taken by trained local teachers and a nurse.

[1]Note that DMT, decayed and missing teeth is used but only two schoolchildren had missing teeth and were excluded from this study. So, only DT is noted in this study.

Data analysis

The data was analysed using the Statistical Package for Social Sciences (SPSS, version 11.0); SPSS Inc., Chicago, IL, USA (20). A descriptive analysis including the mean and standard deviation was computed for all items on the questionnaires and for the oral health status, such as dental caries, gum disease, plaque and calculus for the teeth. Median and quartiles were calculated based upon the duration of tooth pain. Based on the components of dentitions, the age group of 6–16 years was divided into three age groups: 6–9, 10–12 and 13–16. The Mann–Whitney U-test was used to show the significance of the relationship between the three age groups and the prevalence of dental caries. Also, the chi-squared test, odds ratios (OR) and a 95% confidence interval (95% CI) were used to show that oral health status was associated with independent variables and that plaque was associated with dental caries, calculus and gum disease. Regression analysis (21) was used to assess the association of the level of plaque and these independent variables. Age was used for the covariate. The level of significance used was $P \le 0.05$. Before the study, none of the schoolchildren had seen a dentist, except for two 11-year-old schoolchildren that had previously undergone a single tooth extraction. As mentioned earlier, they were not included in the results of this study.

Results

Demographics of the participants

Of the 512 registered schoolchildren, 389 schoolchildren participated in this study. On the first day, 366 schoolchildren completed the questionnaire and on the second day, 335 schoolchildren participated in the oral examination. The total number of schoolchildren that participated in both activities was 332, with an overall attendance rate of 64.8%. There were 124 (37.4%) female and 184 (55.4%) male schoolchildren; 24 (7.2%) participants did not denote a gender on the questionnaire. The mean age of the participants was 11.1-years old (SD = 2.3) and the range was from 6- to 16-years old. Based on the calculated BMIs for the schoolchildren, the prevalence of those with BMIs that were considered underweight was 94.6% (BMI = 14.7 ± 1.7).

Dental caries and level of plaque, gum disease and calculus

The prevalence of dt among schoolchildren aged 6–7 years was 100%. The mean dt of 6- and 7-year olds was 4.7

(SD = 4.1, range = 11–1) and 6.2 (SD = 4.0, range = 13–0) respectively. The prevalence of DT among subjects aged 12 was 62%. The mean DT of 12-year olds was 1.6 (SD = 1.7, range = 3–0) (Table 1).

Eighty percent of all the schoolchildren had plaque from levels one to two on their teeth. The prevalence of gum disease was 46.2%. The proportion of the schoolchildren who had gum disease with level two was 4.5%, and 61.9% of them had calculus from levels one to two (Table 2). After the age of 13 prevalence of level two plaque, gum disease and calculus decreased among increasing age groups. In contrast, the percentage of plaque, gum disease and calculus with a level one tended to increase in schoolchildren who were over 13 years of age.

Table 1. Components of the dt and DT, and prevalence of dental caries experience

Age (total = 355)	6–9 (n = 95)	10–12 (n = 143)	13–16 (n = 117)	Significance
Primary dentition				
The prevalence of dt (%)	83.2	58.0	10.3	$P \le 0.001$
dt mean*	4.7	2.2	0.2	$P \le 0.001$
SD	3.7	2.8	0.6	
Permanent dentition				
The prevalence of DT (%)	38.9	60.1	57.3	$P \le 0.004$
DT mean**	0.7	1.4	1.6	$P \le 0.001$
SD	1.0	1.5	2.0	

*dt: d, decayed in primary dentition and t, teeth.
**DT: D, decayed in permanent dentition and T, teeth.

Table 2. Distribution of schoolchildren* by the level of plaque, gum disease and calculus

Level†	Plaque		Calculus		Gums	
	Number of students	%	Number of students	%	Number of students	%
0	71	20.0	135	38.0	191	53.8
1	204	57.5	184	51.8	148	41.7
2	80	22.5	36	10.1	16	4.5

*n = 355.
†Status of plaque: Level 0 (good) = little plaque, Level 1 (some plaque) = less than one-third of anterior tooth has attached plaque and Level 2 (much plaque) = more than one third of anterior tooth has attached plaque. Status of calculus: Level 0 (good) = little calculus, Level 1 (some calculus) = less than one third of anterior tooth has attached calculus and Level 2 (much calculus) = more than one third of anterior tooth has attached calculus. Status of gums: Level 0 (normal) = no infection, Level 1 (needs observation) = slight infection and needs regular observation and Level 2 (needs accurate examination) = needs diagnosis by a dentist for periodontal disease.

Association with oral health status and independent variables such as quality of life, oral health behaviour and general life activities

One question addressed the quality of life, which was determined by the incidence of tooth pain. At the time the questionnaire was administered, 68.6% of the schoolchildren suffered from tooth pain. Of all the variables evaluated (such as general life activities, oral behaviour, knowledge of dental caries and knowledge of gum disease), only two were found to be significant: (i) dental caries were related to tooth pain (chi squared test: $P < 0.031$, OR = 1.66, 95% CI = 1.05–2.65) and (ii) dental caries were related to knowledge of the cause of dental caries in the second significant finding. This implied that schoolchildren associated such things as candy with the incidence of dental caries (chi squared test: $P < 0.003$, OR = 2.26, 95% CI = 1.31–3.98). In addition, according to the clinical record of 100 schoolchildren, the median duration of tooth pain was 90 days (quartiles = 172–60, range = 730–6). The prevalence of the induced pain was 100% of schoolchildren and the occlusal pain was 99% of schoolchildren. Of the participants, 52.2% ($n = 191$) of the schoolchildren liked sweet foods such as candy and 81.7% ($n = 299$) of the schoolchildren understood that one of the causes of tooth decay was sweet foods. However, 77.3% ($n = 286$) of the schoolchildren did not understand that gum infection was caused by sweet foods. More than half of them [from 51.9% ($n = 176$) to 63.4% ($n = 232$)] answered that daily brushing prevents dental caries and gum disease. One of the more interesting findings from the results of the survey was the proportion of schoolchildren who reported brushing their teeth. In the questionnaire, 82.3% of the schoolchildren reported brushing their teeth more than twice per day ($n = 283$), 75.1% ($n = 275$) reported using a toothbrush for cleaning their dentition, 44.2% ($n = 172$) reported having their own toothbrushes, 3.0% ($n = 11$) reported never brushing their teeth, and 21.8% ($n = 80$) of the schoolchildren used a coconut skin or ash for cleaning their dentition. Eighty-four percent ($n = 291$) of the schoolchildren reported that they had heard oral health advertisements on a television or radio.

Cambodia only has one science textbook explaining basic dental health, so we asked the schoolchildren if they liked science; 47.3% ($n = 173$) of the schoolchildren responded positively. Almost all the schoolchildren in this study [from 97.7% ($n = 350$) to 98.3% ($n = 343$)] engaged in basic sanitary behaviour such as daily bathing and washing hands after going to the bathroom.

From the interviews with the 36 mothers, it was found that the most common duration of breastfeeding was 1–3 years.

Twenty-five mothers had both a son and a daughter, 17 mothers had only a son and four mothers had only a daughter. Forty-three percent ($n = 27$) of sons and daughters were breastfed for 1 year, and 57.1% ($n = 36$) of them were breastfed for more than 2 years. Beyond 2 years of age, more sons were breastfed than daughters.

Associations between plaque and oral health status

Plaque in the 6- to 16-year-old age group was related to the schoolchildren who had dental caries, calculus and gum disease. The plaque was found to produce gum disease (chi squared test: $P < 0.03$, OR = 8.28, 95% CI = 3.96–17.3) and calculus (chi squared test: $P < 0.001$, OR = 3.73, 95% CI = 2.17–6.43) two to four times more than did dental caries (chi square test: $P < 0.001$, OR = 2.20, 95% CI = 1.29–3.74).

Multivariate association of plaque to selected variables

Two models were developed to evaluate the level of plaque deposition. The first model used dental caries in primary and permanent dentition, calculus and gum disease. The plaque in the age groups of 6- to 16-years old was associated with three variables: dental caries in permanent dentition, calculus and gum disease. Dental caries, calculus and gum disease were shown to have a significant relationship with each other. However, if the schoolchildren did not have plaque then they were more likely not to have dental caries, calculus or gum disease. Unfortunately, the validity of this first model as demonstrated by the Goodness-of-fit was 0.064 (Table 3). The second model used five variables: tooth pain, having their own toothbrush, number of brushing times per day, the presence of television or radio in the home and lack of knowledge of dental caries. In the age groups of 6- to 16-years old, plaque was observed in those who did not have their own toothbrushes; these children also suffered from tooth pain. In this model, the level of plaque and degree of knowledge of dental caries were not associated. The validity of the second model was much better showing a Goodness-of-fit of 0.523 (0.659) (Table 4).

Discussion

This study revealed two significant findings related to the status of oral health in a Cambodian primary school. First, approximately 50% of the schoolchildren suffered from dental caries and gum disease. Eighty percent of the schoolchildren had plaque on their dentition. The plaque prevalence in the 6- to 16-year-old age group was associated with the school-

Table 3. **Ordinary regression analysis of the plaque levels to selected variables**

	Estimate	SE	Wald	Significance	95% CI	
					Lower bound	Upper bound
Threshold						
Plaque = little plaque	0.57	0.71	0.63	0.43	−0.83	1.97
Plaque = some plaque	3.85	0.75	26.23	0.01*	2.37	5.32
Location						
Age	0.04	0.06	0.57	0.45	−0.07	0.16
DMT = Yes	0.48	0.22	4.67	0.03*	0.05	0.92
dt = Yes	0.24	0.27	0.76	0.38	−0.30	0.77
Calculus = Yes	1.11	0.24	21.82	<0.001*	0.65	1.58
Gum disease = Yes	1.58	0.25	41.08	<0.001*	1.10	2.07

SE, standard error; CI, confidence interval; DMT, decayed and missing teeth; *$P < 0.05$.

Table 4. **Ordinary regression analysis of the plaque levels to selected variables**

	Estimate	SE	Wald	Significance	95% CI	
					Lower bound	Upper bound
Threshold						
Plaque = little plaque	−0.06	0.63	0.01	0.92	−1.29	1.17
Plaque = some plaque	2.66	0.65	16.84	<0.001*	1.39	3.93
Location						
Age	0.09	0.05	3.47	0.06	<0.001	0.18
Toothpain = Yes	0.51	0.24	4.69	0.03*	0.05	0.97
No own brush = Yes	0.50	0.24	4.53	0.03*	0.04	0.96
Less than one time = Yes	0.53	0.31	2.78	0.10	−0.09	1.14
Television or radio = Yes	−0.36	0.30	1.41	0.24	−0.95	0.23
Lack of knowledge of dental caries = Yes	<0.001	0.29	<0.001	0.99	−0.57	0.56

SE, standard error; CI, confidence interval; *$P < 0.05$.

children who had dental caries and gum disease. Second, 70% of the schoolchildren suffered from tooth pain. The duration of tooth pain such as occlusal pain was about 3 months. The schoolchildren who suffered from tooth pain related to who had the dental caries in the permanent dentition. In addition, the plaque from in 6- to 16- year-old age group was associated with the schoolchildren who did not own their own tooth brushes and who suffered from tooth pain. These three findings suggest a vicious cycle of plaque, dental caries, gum disease, tooth pain and lack of personal toothbrush (Fig. 1).

The mean DT of 12-year olds was 1.6, which was comparable to the WHO and the International Dental Federation formulated goals for oral health. The dental missing and filled teeth goal was at most 3.0 and was expected to be achieved by the year 2000 for 12-year-old schoolchildren (22); this primary school had met this expectation. At the 1991 National Dental Conference in Cambodia, two goals related to the status of oral health were established: DT in the 12-year old age group should exceed 1.5, and 50% of 6-year olds should be free of dental caries in the provinces by the year 2000 (12). By comparing these goals with the study results, it is clear that the goals have not been achieved because the targeted primary school had a DT of 1.6 for 12-year olds, and the prevalence of dental caries in primary dentition was 100% for the 6-year-old population.

In regards to oral health status, plaque deposition was associated with dental caries and gum disease. The schoolchildren that simultaneously had plaque, dental caries and gum disease had a poor oral health status. The periodontal status showed improvement in plaque, gum disease and calculus of level 2 in schoolchildren over 13 years of age. It appeared as though schoolchildren were able to clean their permanent dentition more efficiently than their mixed dentition. Two Japanese studies have demonstrated that plaque is related to cleaning the complete teeth arch (all their teeth front to back) (23, 24). As previous studies have shown, there is evidence that mechanical removal of plaque with a toothbrush can reduce gum disease; however, this removal is not effective for dental caries (25). Furthermore, one study identified the main determinant of dental caries to be the frequency of daily sugar intake and the use of fluoride protection (26).
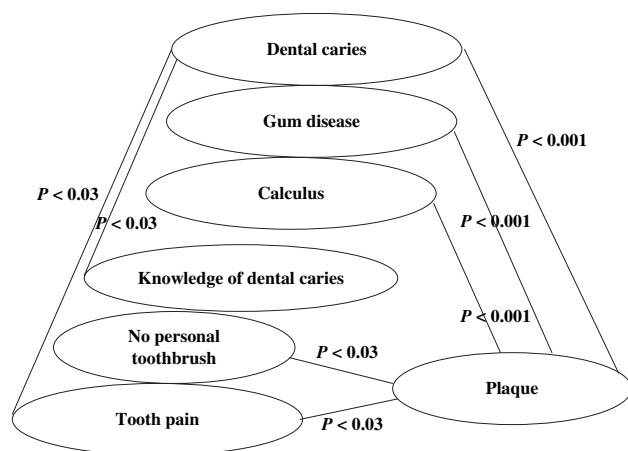
Fig. 1. The vicious cycle of plaque, dental caries, gum disease, tooth pain and the lack of a personal toothbursh.

There was a great prevalence of dental caries in the schoolchildren's primary teeth. There exist 106 risk factors for primary dental caries (27). These risk factors include the duration of breastfeeding and the lack of knowledge regarding oral hygiene practices, which are considered to be the main contributors to the high prevalence of dental caries. During interviews with the mothers of schoolchildren in villages, most mothers reported that they had breastfed their children until the ages of 1–3. The mothers believed that primary dentition was unrelated to permanent dentition. As a result, they did not take adequate care of their children's primary dentition. After the mothers stopped breastfeeding their children, they gave the children condensed milk with hot water every day. Even though the mothers knew that sweet food causes dental caries, they were unaware that condensed milk causes dental caries and does not provide proper nutrition. The long duration of breastfeeding and the mother's poor knowledge of oral health were major factors that led to the formation of dental caries. While breastfeeding is a good source of nutrition, it can also contribute to the formation of dental caries. In particular, breastfeeding during the night leads to the formation of dental caries. The irregularity and deficiency in the diets of the children was indicated by their BMI results; over 90% of the schoolchildren were underweight. Also, the national survey revealed that breastfeeding and complementary feeding behaviour were important predictors of infant and child nutrition, health and survival. Poor nutritional status has been shown to increase the risk of illness and death among children (28). When designing a plan for an oral health program, the program must include the improvement of the nutritional status.

Although more than 80% of schoolchildren brushed their teeth twice daily, the same percentage of schoolchildren had plaque. Informal oral health activities, such as a picture-story show, songs and a donation of toothbrushes for the schoolchildren, teachers and residents, were implemented during two pilot studies. These activities may have been responsible for the schoolchildren's report that they had brushed their teeth twice daily. While the schoolchildren reported brushing their teeth, they may not have had sufficient skills to brush their teeth properly; consequently, the majority of the schoolchildren had plaque. Seven in 10 schoolchildren suffered from tooth pain, especially induced and specifically occlusal pain. The long duration of this tooth pain was more than 3 months. However, the schoolchildren were unable to receive treatment due to the inadequate number of dentists. As mentioned, there were only two schoolchildren who had their teeth treated by extraction. When the schoolchildren experienced tooth pain and, as a result, they did not brush the teeth with carries. Because pain prevented the schoolchildren from properly brushing their teeth, over half of the schoolchildren had dental caries and gum disease. Additionally, because the schoolchildren did not have their own toothbrush, they used the toothbrush of other family members. When schoolchildren have their own toothbrush, they clean their teeth better and are more motivated to take care of their oral health. As mentioned previously, it is not simply enough to own and use a toothbrush, it is important for schoolchildren to understand how to clean their teeth. In a previous study in Cambodia, Dr Teng O reported that using a personal toothbrush may improve the effectiveness of the oral health program (14). Thus, it is very important for schoolchildren to have a personal toothbrush. However, because of parents' knowledge, socioeconomic status and other factors having an individual toothbrush in Cambodia can be very difficult. In Cambodia, the cheapest toothbrush is $0.25 US dollars and the most expensive brush is more than 2 US dollars. All the toothbrushes available in Cambodia are imported. The salary of Cambodian office workers is $25 US dollars per month. Most schoolchildren receive only $0.05 US dollars per day as pocket money, which is only enough for fruit and cakes; as a result, the schoolchildren cannot easily afford a toothbrush. Furthermore, there is a limited availability of toothbrushes, as most are usually attainable far from their communities.

As a result of this survey, two complementary school-based oral health programs were implemented in 2002. The first program produced educational materials depicting the proper use of toothbrushing and methods of eating food, including sweets. The parents and schoolchildren were encouraged to own a personal toothbrush. The second program focused on a prevention technique that emphasized the importance of using

fluoride mouth rinse to prevent dental caries. However, the implementation of a fluoride toothpaste program was difficult in this area because of the economic conditions. As a result, fluoride mouth rinse was introduced in two schools. These programs were implemented by the school directors and schoolteachers. The local hospital also participated in the programs. When the schoolchildren required dental treatment, they were referred to the local hospital to receive assistance. The oral health program began in 2001 and continues today with the hope that it will be further supported and developed by the local community in the near future.

Conclusion

This study concludes that the schoolchildren in rural Cambodia were caught in a vicious cycle. Deposited plaque on the teeth was associated with the schoolchildren who suffered from tooth pain and did not own a personal toothbrush. Tooth pain was related to dental caries, which is an irreversible disease. Additionally, the schoolchildren suffering from dental caries and gum disease had plaque deposition. This vicious cycle of plaque build-up continues as the result of tooth pain, which may cause the schoolchildren to avoid brushing their teeth. It is important to recognize the existence of this vicious cycle, as it will affect the schoolchildren's quality of life and perhaps their longevity.

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