Caries Risk Profiles of 12-13-Year-old Children in Laos and Sweden

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Purpose: To analyse caries risk factors of 12-13-year-old children living in Laos, using the computer program Cariogram to illustrate the caries risk profile. In addition, to compare the results with a study performed in Sweden.

Materials and Methods: One hundred Laotian and 392 Swedish children were included. Interviews were performed to obtain information on diet intake and fluoride use. Saliva was analysed for mutans streptococci, lactobacilli and secretion rate/buffering capacity. Oral hygiene was assessed using the Silness and Löe criteria. Caries prevalence was recorded according to WHO. The data were entered into the Cariogram to determine each child's caries risk, expressed as 'the chance of avoiding caries'. The children were divided into five risk groups.

Results: Mean DMFT level of the Laotian children was 4.61 ± 2.95 and 1.38 ± 1.97 in the Swedish group. For the risk factors plaque amount, frequency of food intake, saliva secretion rate, buffering capacity and fluoride, the Laotian children had significantly less favourable values compared to the Swedes. Only 6% of Laotian children belonged to the Cariogram low risk group versus 40% of the Swedish children. The mean DMFT for the five Cariogram groups was (from low to high risk) 0.00, 3.00, 3.56, 5.66, 6.11 for the Lao children and 0.31, 1.39, 2.56, 3.03, 2.91 for the Swedish ones. The mean chance of avoiding caries was 37.3% for the Laotians and 69.2% for the Swedish children ($p < 0.001$).

Conclusion: According to the 'opinion' of the Cariogram, the Laotian children demonstrated significantly higher caries risk than Swedish children.

Key words: cariogram, caries risk factors, Mutans streptococci, lactobacilli, salivary secretion rate, buffering capacity, Lao PDR

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Sathalanalat Paxathipatai Paxaxon Lao – Lao People's Democratic Republic (Laos) is a country located in the Southeast of Asia with a population of about 5.9 million people (The World Factbook, est. July 2003). The information about caries prevalence in Laos is scarce. Searching the PubMed database (March 2004) using the search terms *Laos* combined with *Caries* actually only revealed six papers, five of them dealing with Laotian people living in foreign countries. In addition, the WHO Oral Health database, published on the Internet, presents results of a local study (Phommavongsa, 1992) indicating a mean DMFT of 2.0 in a sample of 12-year olds. In a study of 12-year-olds from Vientiane and Luang Prabang provinces, Tayanin et al (2002) found a mean a DMFT of 4.6 with 9% of the children being caries free. The Significant Caries Index (SiC Index; Bratthall, 2000) was DMFT 8.0. Also, that study tried to map a number of factors believed to be related to caries risk.

In a clinical prospective survey of 10-11-year-olds, performed in Sweden, Hänsel Petersson et al

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(2002) mapped several individual caries risk factors according to a structured protocol. In addition, these factors were used to describe the caries risk profile of the child, using a computer based caries risk assessment program – the Cariogram program. This program operates in such a way that information on a number of individual caries related factors are obtained, which then are transferred into scores and entered in the Cariogram program. The program analyses this information and presents a summarized result – 'chance of avoiding caries' – according to its build-in algorithm, in the form of a pie diagram. Studies have shown that such results correlate both with caries prevalence and incidence among children and elderly (Hänsel Petersson et al, 2002; Hänsel Petersson et al, 2003).

The aims of this paper were to analyse individual caries risk factors and indicators of 12-13-year-old children living in two different areas in Laos, using the Cariogram as an instrument to describe their caries risk profiles. In addition, we wanted to compare the results of these estimations with a study performed in Sweden, where the same methodologies had been used in a corresponding age group (Hänsel Petersson et al, 2002).

MATERIALS AND METHODS

A total of 100 12-year-old Laotian children, 46 boys and 54 girls, were studied. Fifty children were from Vientiane municipality (three sites) and 50 from Luang Prabang province, located in north central Laos (two sites). The socio-economic conditions of these areas were different. The three sites in Vientiane municipality were selected to represent children who lived within the capital city and just outside. They had some access to dental services, while the two sites in Luang Prabang represented children who had very limited access to oral health care. Fluoride concentrations of drinking water were generally low in these areas.

Interview

Interviews took place at schools and villages. Medical history was recorded for all children including their knowledge on caries. Oral health care habits, the use of toothpaste with or without fluoride and local drinking water fluoride were reviewed. A 24-hours dietary recall questionnaire in local languages was used to obtain their knowledge on their diet situation.

Clinical examination

After the interviews, caries prevalence, DMFT and DMFS were recorded using the WHO standard criteria for oral health surveys and caries recording form, available at (http://www.whocollab.od.mah.se/expl/cariesrecordform02.html). Oral hygiene was estimated according to the Silness & Löe (1964) criteria.

Oral microbial and salivary analyses

Paraffin-stimulated whole saliva was collected from all children. The amount of saliva (secretion rate) was expressed in millilitre per minute. The stimulated saliva was also used for estimating Mutans streptococci and lactobacilli and for determining the buffering capacity, using the Dentocult SM, LB and Dentobuff systems (Orion Diagnostica, Espoo, Finland).

Cariogram

The following data were used to create the individual Cariogram

- Diet contents (based on Lactobacillus counts) and frequency
- Bacteria (Mutans streptococci) and oral hygiene (plaque index)
- Susceptibility (fluoride program, saliva secretion and buffering capacity)
- Circumstances (past caries experience, related diseases).

An example of a Cariogram is shown in Fig 1.

The collected information was transferred into scores (see Table 1 and 2) and entered into the Cariogram. Score 0 always indicates a favourable value, and score 3 (or 2) an unfavourable situation. Based on the Cariogram risk assessment, the children were divided into five groups; 0-20% chance of avoiding caries, group 1 (high risk), 21-40% group 2, 41-60% group 3, 61-80% group 4 and group 5 at 81-100% as low risk.

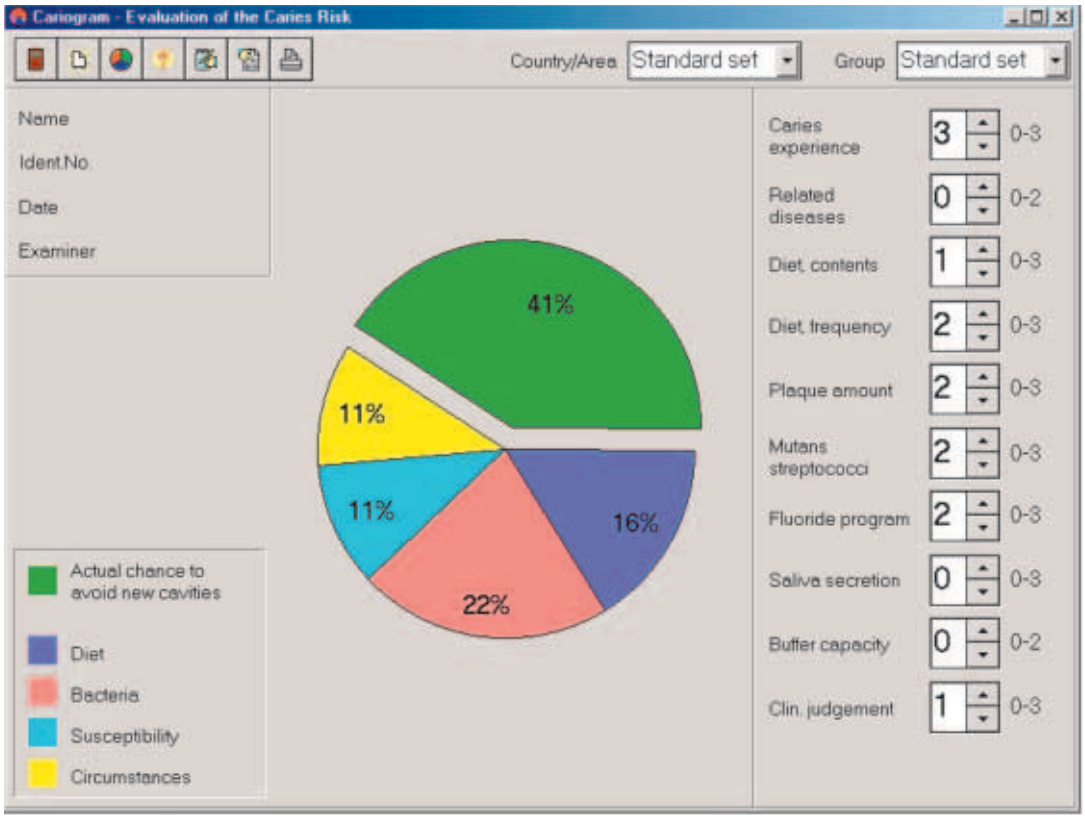

Fig 1 Example of a Cariogram. When all data have been entered into the Cariogram program*, the program expresses the risk as 'Chance of avoiding caries' and a green sector will appear as an extracted sector from the pie diagram. In this example, the sector illustrates an individual having 41% chance of not developing caries in the near future, an intermediate risk person. The bigger the green sector is, the bigger the chance of avoiding cavities. The bacteria (red sector: plaque amount and Mutans streptococci) and diet (dark blue sector: contents and frequency) sectors are unfavorable here.

Footnote: * The Cariogram program can be downloaded free of charge from the Internet page:
http://www.db.od.mah.se/car/cariogram/cariograminfo.html
In addition, the Manual of the program, explaining many more details, can also be obtained from that page.

The Swedish material, used for comparison, was a group of 392 children, 12-13 year-olds, living in and around a midsize city at the West coast of Sweden. The methods used in this study were presented in detail in Hänsel Petersson et al. (2002). The study population had been examined twice: firstly when the children were 10-11 years old (N = 438) and secondly two years later (follow-up study). The children came from different socio-economic areas and were randomly selected. The follow-up sample consisted of 183 girls and 209 boys. The actual caries increment for each child during the two-year period was calculated. The Ethical Committee, Lund University, Sweden approved the study.

The Swedish study consisted of several steps: a questionnaire, an interview, estimation of oral hygiene, saliva sampling, reviewing records and x-rays and creating a Cariogram for each child. The

Table 1 Distribution of DMFT in the Laotian and Swedish groups according to the Cariogram scores

Cariogram scores*	Caries experience	Laos (n = 100) (%)	Sweden (n = 392) (%)
0	DMFT = 0, caries free and no fillings	9	48
1	DMFT = 1	7	18
2	DMFT = 2	14	13
3	DMFT ≥ 3	70	21

* Due to the age group, the scores for Caries experience differ from the explanation seen in the Cariogram manual.

Table 2 Distribution of the Laotian and Swedish children according to the Cariogram scores with corresponding mean DMFT/DMFS values

Cariogram scores	Factors	Laos (n = 100)			Sweden (n = 392)			Mann Whitney U test p value
		(%)	Mean DMFT	Mean DMFS	(%)	Mean DMFT	Mean DMFS	
	Diet, content of fermentable carbohydrates *(lactobacillus test)*							Comparison of the distribution of individuals in the different Cariogram scores, Laos -Sweden p = 0.093
0	very low, ≤ 10^3 CFU/ml	42	3.33 ± 2.66	4.45 ± 3.80	49	1.22 ± 1.78	1.58 ± 2.61	
1	low, 10^4 CFU/ml	27	5.07 ± 3.03	7.30 ± 5.20	26	1.35 ± 1.88	1.63 ± 2.55	
2	moderate, 10^5 CFU/ml	20	6.15 ± 2.83	9.05 ± 4.67	21	1.67 ± 1.99	2.15 ± 2.70	
3	high, ≥ 10^6 CFU/ml	11	5.55 ± 2.30	7.91 ± 3.73	4	2.07 ± 3.88	3.27 ± 7.18	
	ANOVA p value		p = 0.001	p = 0.001		p = 0.189	p = 0.094	
	Diet, frequency *(questionnaire, 24-hour dietary recalls)*							p < 0.001
0	maximum 3 meals per day	0	–	–	0.5	1.50 ± 0.71	1.50 ± 0.71	
1	4 – 5 meals per day	9	2.11 ± 1.69	2.67 ± 2.69	49.5	1.34 ± 1.80	1.69 ± 2.60	
2	6 – 7 meals per day	91	4.86 ± 2.94	6.90 ± 4.70	30	1.38 ± 2.20	1.78 ± 3.35	
3	> 7 meals per day	0	–	–	20	1.49 ± 2.05	1.97 ± 3.05	
	ANOVA p value		p = 0.007	p = 0.009		p = 0.946	p = 0.909	
	Plaque amount *(clinical examination)*							p < 0.001
0	very good oral hygiene	0	–	–	7	0.46 ± 0.76	0.54 ± 0.99	
1	good oral hygiene	10	4.60 ± 3.37	5.90 ± 5.20	64	1.13 ± 1.64	1.39 ± 2.15	
2	poor oral hygiene	52	4.52 ± 2.80	6.54 ± 4.64	24	2.11 ± 2.68	2.91 ± 4.43	
3	very poor oral hygiene	38	4.75 ± 3.13	6.66 ± 4.79	5	2.30 ± 1.75	2.95 ± 2.46	
	ANOVA p value		p = 0.943	p = 0.903		p < 0.001	p < 0.001	
	Mutans streptococci *(Strip mutans test)*							p = 0.125
0	Strip mutans class 0	20	2.95 ± 2.72	3.85 ± 3.86	35	0.80 ± 1.38	0.93 ± 1.59	
1	Strip mutans class 1	11	2.18 ± 1.60	2.91 ± 2.51	12	1.64 ± 1.85	2.13 ± 2.58	
2	Strip mutans class 2	44	5.18 ± 2.81	7.32 ± 4.56	22	1.36 ± 1.78	1.72 ± 2.55	
3	Strip mutans class 3	25	6.00 ± 2.69	8.84 ± 4.59	31	1.96 ± 2.48	2.64 ± 4.02	
	ANOVA p value		p < 0.001	p < 0.001		p < 0.001	p < 0.001	
	Fluoride exposure programme *(interview)*							p < 0.001
0	maximum fluoride programme	0	–	–	3	1.83 ± 2.73	2.50 ± 3.92	
1	fluoride supplements	0	–	–	35	1.64 ± 2.14	2.08 ± 3.31	
2	only fluoride toothpaste	86	4.63 ± 2.92	6.66 ± 4.79	62	1.21 ± 1.81	1.57 ± 2.61	
3	no fluoride toothpaste	14	4.50 ± 3.30	5.64 ± 4.20	0	–	–	
	ANOVA p value		p = 0.881	p = 0.445		p = 0.093	p = 0.175	
	Salivary secretion-amount *(stimulated saliva test)*							p < 0.001
0	> 0.7 ml/min (normal)	72	4.14 ± 2.97	5.90 ± 4.87	87	1.37 ± 1.98	1.75 ± 2.94	
1	0.3 – 0.7 ml/min (low)	27	5.74 ± 2.60	8.00 ± 3.94	12	1.32 ± 1.88	1.74 ± 2.63	
2	< 0.3 ml/min (very low)	1	8.00 ± 0.00	11.00 ± 0.00	1	3.00 ± 2.65	4.33 ± 4.51	
	ANOVA p value		p = 0.027	p = 0.089		p = 0.355	p = 0.313	
	Salivary buffering capacity *(Dentobuff test)*							p < 0.001
0	pH ≥ 6, normal or good, *high – blue*	73	4.34 ± 2.85	6.10 ± 4.68	87	1.34 ± 1.93	1.70 ± 2.86	
1	pH 4.5 – 5.5, *medium – green*	17	4.18 ± 3.11	6.00 ± 4.76	12	1.70 ± 2.23	2.30 ± 3.35	
2	pH ≤ 4.0, *low – yellow*	10	7.30 ± 2.16	10.50 ± 2.92	1	1.25 ± 1.89	1.75 ± 2.87	
	ANOVA p value		p = 0.009	p = 0.017		p = 0.489	p = 0.423	

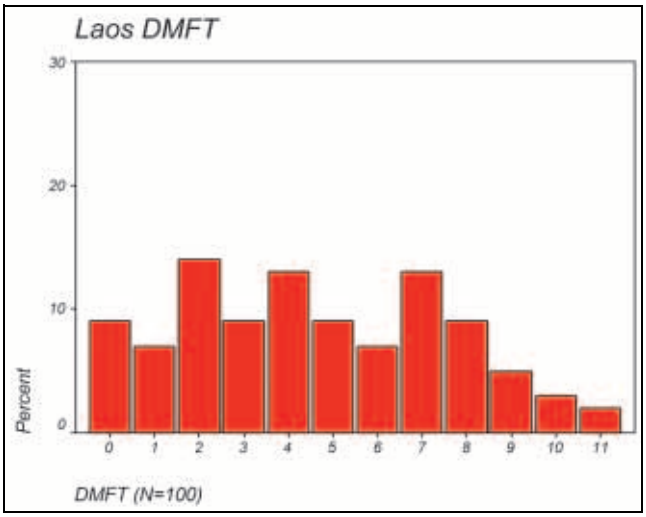

Fig 2 DMFT frequency distribution in the Laotian sample.

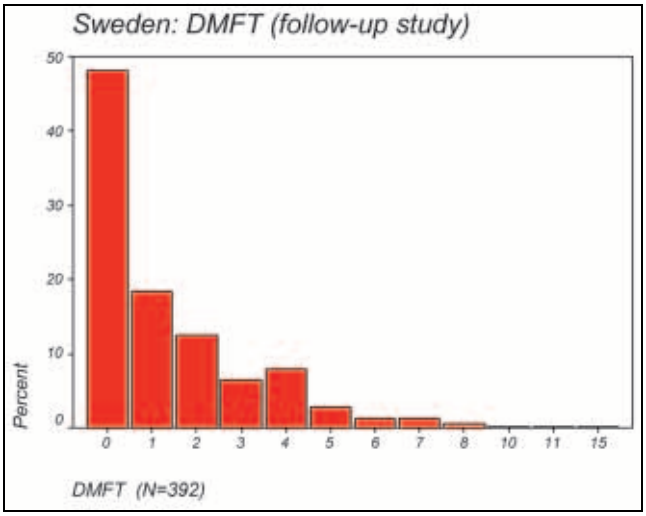

Fig 3 DMFT frequency distribution in the Swedish sample.

Silness and Löe plaque index (1964) was used and the saliva secretion rate estimated. For buffering capacity of saliva, mutans streptococci and lactobacilli counts, the Orion Diagnostica tests were used, in other words, identical to the Laos study. The information was entered into the Cariogram computer program to calculate the caries risk for each child. Two such calculations were made: at the start of the study and at the follow up. The Cariogram results, as well as the data for the different individual factors presented in this study, refer only to the follow up study to make the comparison in corresponding age groups possible.

Statistical methods

Statistical evaluations were used to compare caries data (interval scale) between Laos and Sweden (t-test), for comparing distribution of scores (ordinal scale) for the different factors of the two countries (Mann Whitney U test), and for comparing scores of the different factors and caries (ordinal/interval scales) (one-way analysis of variance, ANOVA). The individual Cariogram value was considered being on the interval scale, while the grouped Cariogram score was on the ordinal scale. P-value less than 0.05 was considered significant. Analysis of data was conducted using SPSS version 11.0 statistical program (SPSS Inc. Chicago, Ill., USA).

RESULTS

Dental caries

The mean DMFT level of the Laotian children was 4.61 ± 2.95 and 6.52 ± 4.71 for DMFS. The children from Vientiane municipality had higher DMFT (5.00 ± 2.83) and DMFS (6.90 ± 4.26) values compared to those from Luang Prabang (DMFT 4.22 ± 3.04 and DMFS 6.14 ± 5.13). As these differences were statistically non-significant, the Lao' children were grouped together in the further analyses. In Swedish group, the mean caries prevalence was 1.38 ± 1.97 and DMFS was 1.77 ± 2.92, the differences, compared to the Laotian children, being statistically significant ($p < 0.001$; t-test). The distribution of DMFT values for the two samples is presented in Figs 2 and 3 and in Table 1. It appears that only 9% of the children were caries free in the Laotian group, compared to 48% in the Swedish group. Seventy per cent of the Laotian children had 3 or more DMFT versus 21% of the children from Sweden.

The individual factors

The results of the individual factors are presented in Table 2. Both the Laotian and the Swedish children were considered healthy. For 'diet contents', which in these studies was based on lactobacillus

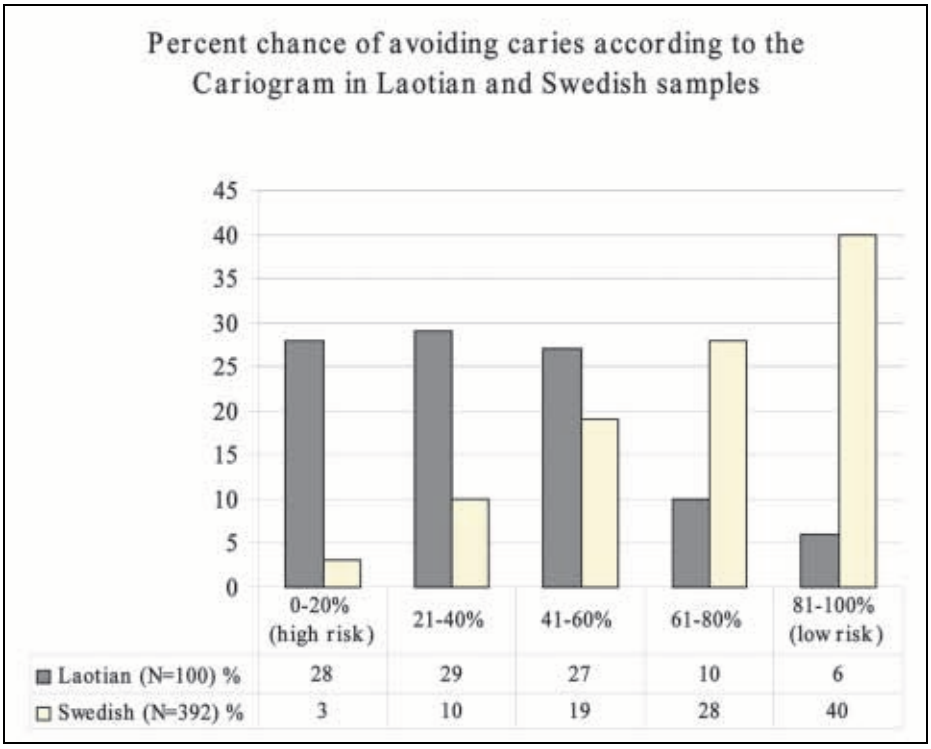

Fig 4 Distribution of the children in the two-study groups in high to low Cariogram risk groups.

counts, the results were rather similar, although 11% of the Laotian children fall in the highest lactobacillus class, versus 4% for the Swedish group. The diet contents had a significant association to caries experience in the Laotian children (ANOVA, $p < 0.001$). For frequency of diet intakes, 50% of the Swedish group had a maximum of five intakes per day, compared to 9% of the Laotians. The oral hygiene was inadequate in the Laotian sample, with 90% having poor or very poor oral hygiene. Statistically significant differences were observed between the Laotian and Swedish children (Mann Whitney U test, $p < 0.001$) for diet frequency and for oral hygiene scores, with less favorable values for the Laos group.

The *Mutans streptococci* estimations revealed no clear difference between the two population samples. The mutans class was directly related to the DMFT and DMFS in both country samples (ANOVA, $p < 0.001$). The proportion of children having lowest buffering class was larger among the Laotians. None of the Laotian children had received fluoride supplements and 14% did not use fluoride toothpaste. All Swedish children used fluoride toothpastes and 38% had had supplements. The statistical evaluation is given in the Table 2.

Cariogram

All the factors were entered into the Cariogram, and the children were divided into five groups ranging from high to low risk (Fig 4). Only six of the Laotian children (6%) belonged to the low risk group 'chance of avoiding caries', versus 40% of the Swedish children. The Cariogram high risk group included 28% of the children from Laos and 3% of the Swedish group. The mean chance of avoiding caries in the study samples was 37.3% for the Laotians and 69.2% for the Swedish children. Statistically, there was a significant difference between the two samples ($p < 0.001$) when calculated on the individual per cent values (t-test) and $p < 0.001$ when calculated on the grouped values (Mann Whitney U test).

The relationship of the Cariogram and past caries experience is shown in Table 3. In the highest risk group, the mean DMFT was 6.11 ± 2.85 for the Laotians and 2.91 ± 2.95 for the Swedish group. Six of the Laotians had 81-100% chance of avoiding caries (low risk group) and they were all caries free. There was a significant correlation between Cariogram groups and caries prevalence in the two study groups, both for DMFT and for DMFS.

Table 3 The relationship between the Cariogram risk groups and caries experience in 12-13 years old Laotian and Swedish schoolchildren

Percentage chance of avoiding caries according to the Cariogram	Laos			Sweden		
	n = 100 (%)	Mean DMFT	Mean DMFS	n = 392 (%)	Mean DMFT	Mean DMFS
0 – 20% (high risk)	28 (28)	6.11 ± 2.85	8.64 ± 4.45	11 (3)	2.91 ± 2.95	4.09 ± 5.15
21 – 40%	29 (29)	5.66 ± 2.22	8.10 ± 3.93	40 (10)	3.03 ± 2.72	4.08 ± 4.68
41 – 60%	27 (27)	3.56 ± 2.79	5.07 ± 4.71	73 (19)	2.56 ± 2.18	3.40 ± 3.30
61 – -80%	10 (10)	3.00 ± 1.70	3.80 ± 2.70	109 (28)	1.39 ± 1.60	1.69 ± 2.16
81 – 100% (low risk)	6 (6)	0.00 ± 0.00	0.00 ± 0.00	159 (40)	0.31 ± 0.81	0.35 ± 0.96
ANOVA p value		$p < 0.001$	$p < 0.001$		$p < 0.001$	$p < 0.001$

DISCUSSION

Two samples of children with clearly contrasting living conditions and life styles have been compared in this study. One group came from a country with minimal dental health resources, while the other group belonged to a country with a long tradition of oral health preventive programmes and services. Some of the Laotian children were not sure in which month they were born, which is why a definite mean age level could not be calculated. The caries situation was significantly different, although it has to be understood that the investigators were not calibrated. On the other hand, all the examiners had been educated at Swedish dental schools. In addition, the majority of the caries lesions in Laos were found in the molar's occlusal surfaces. For Laos, the caries frequency distribution showed almost a tendency for a normal distribution, while the Swedish sample showed a strongly skewed distribution, with a large proportion of the children being caries free. This latter type of distribution is commonly seen in developed countries (Burt, 1998; Hugoson et al, 2000; Nadanovsky and Sheiham, 1995; Petersson and Bratthall, 1996; Renson, 1989).

Secondly, a number of factors generally associated with caries prevalence and incidence were mapped. These factors include aspects of diet (frequency of intakes and composition), bacteria (mutans streptococci and plaque amount), susceptibility related factors such as saliva secretion rate and buffering capacity and fluoride exposure. When comparing the scores for the two groups, it appeared that significantly less favourable values (from a cariological point of view) were found for the Laotian children for frequency of diet intake, plaque amount, saliva secretion rate and buffering capacity. That oral hygiene values were poor for the Lao group is not surprising considering lack of dental resources for education and motivation. A survey in 1992 showed that three of the seventeen provinces did not have dental services. Laos has only one dentist per about 26,000 inhabitants (Phommavongsa, 1992).

The Laotian children had more frequent intakes of caries-inducing food than the Swedish ones. Detailed interview (data not shown in results) revealed intakes of local sweet snacks, chips and soft drinks for 85-90 per cent of the children. Sweet shops were frequently seen located near schools and in the middle of Laotian villages. The total sugar consumption in Laos is however low. The Sugar Year Book 2000 (International Sugar Organization, 2001) reported a sugar consumption of 1.7 kg/person in 1991 in Laos. At year 2000, the consumption was more than doubled, 3.8 kg/person. This value is still low by international comparison, but if the increase in use of sugar mainly is found in caries-inducing snacks, it may be an important observation. The influences from neighboring countries like Thailand and Vietnam are strong, and these countries have sugar consump-

tion around 30 and 10 kg per person and year, respectively.

The *Mutans streptococci* count was assessed by the Strip mutans method. This method was chosen as there are results from a large number of international studies to compare with, and because the method is excellent for field surveys. Almost 70% of the Laotian children had Strip mutans scores 2 or 3. This value is rather close to what has been found in other studies – for example, in rural areas in Sri Lanka (Saparamadu et al, 1993), but it was higher than in the Swedish group, although not significantly different. There was a strong significant correlation to caries both in the Laos and the Swedish groups, an observation paralleled by numerous studies (Bratthall, 1991).

As to why saliva values were more unfavorable in the Asian population is difficult to explain. This may be related to climate, diet or to the fact that, in general, Laotian people are smaller than Swedes, as the secretion rate to a certain extent was related to size of the glands (Dawes et al, 1978). The mean secretion rate for the children from Laos was 1.06 ml/min, which is lower compared to for example a Finnish group (Swanljung et al, 1992) who found the corresponding value to be 1.4 for a group of 12-18 year olds. This mean value was indeed very similar to our Swedish group, 1.36 ml/min. Another explanation, based on observations at the collection, may be that several Laotian children expressed signs of 'hesitation' when chewing the paraffin, which is why stimulation of saliva became less pronounced. Maybe Swedish children, who are familiar with chewing gums, more easily follow the instructions to chew and spit than their Laotian counterparts. The proportion having low buffering capacity in the Laotian group (10%) was rather similar to results in a Hungarian study, which reported 6.3% with this condition (Gabris et al, 1999).

In the Laos group, no child had access to fluoride supplements. A majority used fluoride toothpastes, but the children did not really know why they were using it, according to the interview. In addition, fluoride-toothpaste is expensive in Laos for local people. Some children used bamboo for brushing teeth. Thus, a main source of fluoride intake, in particular in the rural areas, was from drinking water, and the concentration of fluoride in the drinking water is low in Laos. The observation in the Swedish group, that there was no correlation between use of fluoride supplements and (low) caries prevalence, can be explained by the fact that such supplements are mainly recommended for children already showing high caries activity.

Of the selected caries risk factors, five were significantly correlated to DMFT in the Laotian group, and two in the Swedish. However, also for the non-significant factors, the results over-all pointed in the "expected" direction, with higher caries experience accompanying unfavorable values. Therefore it is not surprising that the Cariogram evaluation showed strong correlations to caries experience, and that the Laotian children had much higher caries risk values. The Cariogram looks at all individual factors, and if there are several risk factors, additional weight in terms of risk is added. It should be observed that the Cariogram is an expression for risk, i.e. an estimation of a situation that will come in the future, if factors are not changed. If this risk estimation is applicable to Laos, or for other developing countries, needs to be evaluated in future longitudinal studies. Nevertheless, already now several factors have been identified which need to be improved in order to reduce the caries risk in these populations.

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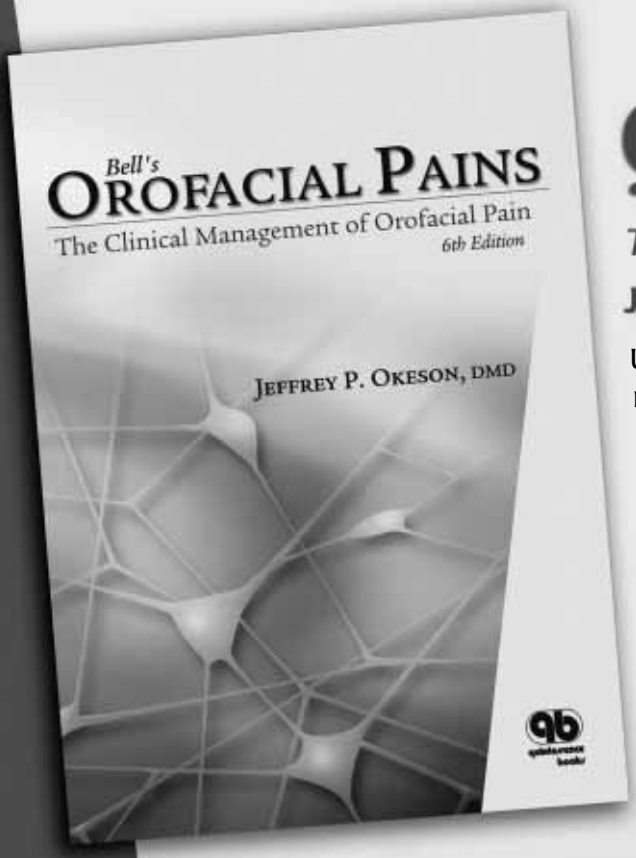

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