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Effect of Oral Health Promotion on Caries Experience and Oral Cleanliness of School Children in Kerung, Nepal: A Prospective 6-month Follow-Up Study

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ABSTRACT

Background: A longitudinal oral health promotion project on caries experience and oral cleanliness was performed in a remote village in Nepal. The aim of this 6-month prospective survey was to investigate the impact of an oral health promotion project on caries experience, oral health-related behaviour, and general knowledge about oral health in Kerung, a remote village in Nepal.

Methods: A prospective study was conducted in a convenience sample of children from the local school in Kerung. At baseline and after six months, dental plaque scores and caries experience scores were measured by calibrated examiners. Validated questionnaires on oral health habits and knowledge on oral health were taken. In addition, an oral health promotion program was developed.

Results: At baseline, 359 children were included, of which 266 could be surveyed after six months. A statistically significant decrease in the mean plaque score was found at after six months with a higher reduction for boys. A significant decrease in caries prevalence, as well as a significant increase in knowledge about oral health, was observed. Furthermore, after six months there were significantly more children reporting that they brushed their teeth for at least two minutes.

Conclusions: Dental screenings and a comprehensive educational program resulted in a significant improvement of oral health.

Keywords: Caries experience; Nepal; oral cleanliness; oral health promotion

INTRODUCTION

The prevalence of untreated caries in Nepalese children varies between 25.6 and 67.0%. The DMFT/dmft ranges from 0.20 to 4.00, mostly dominated by the decay component (D/d), suggesting low care levels.[1-3]

In contrast with the high prevalence of tooth decay, there is a relatively low consumption of sugar in Nepal in comparison to the industrialized world.[1] Brushing behaviour of the Nepalese population was extensively reviewed. Brushing once a day was accepted as the standard norm, while brushing twice a day was only reported in a varying percentage between 16.9 and 36.9.[4-11]

The aim of this 6-month prospective cohort survey was to evaluate the caries experience, oral health-related behaviour and general knowledge about oral health in schoolchildren in Kerung, a remote village in Nepal, before and six months after the implementation of an oral health promotion project, consisting of an oral health education programme and emergency treatment.

METHODS

A prospective cohort study with a six-month follow-up was conducted in the Shree Changasthan secondary school in Kerung, situated in the Solukhumbu district of Nepal. Convenience sampling was used as the project was restricted to the Kerung School. Informed consent from the headmaster of the school as well as parental consent were obtained.

The baseline data was collected at the end of April 2018 (T0) and mid-November 2018 (T1). During a 7 days

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period, all children were screened per classroom. The selection of classrooms was done by the principal of the school. Absent children at one day were screened on another day.

Ethical approval was obtained from the Ethical Committee of the University Hospital of Ghent, Belgium (EC 2017/1256) as well as from the Nepal Health Research Council (NHRC Ref nr 2201).

A theoretical lesson supported by the use of self-designed posters was developed. During this session, a clear focus was put on differences between the primary and permanent dentition, caries, and gingivitis development, brushing the teeth twice a day for at least two minutes using a toothpaste with the appropriate fluoride concentration and on the impact of sugar consumption on oral health. The lesson was given in English with consecutive translation in native Nepali by one of the involved dentists. A comprehensive brushing demonstration was given and all children had the opportunity to experience it after plaque disclosure.

Children who required urgent treatment were referred to a Nepalese dental team, consisting of three Nepalese dentists and two dental assistants who were treating in a separated classroom. The practitioners were sitting in a plastic chair while the children were laying on a bench. The Nepalese dental team involved in this project brought all equipment with them: anaesthesia, restorative materials, instruments for caries removal and placement of a filling material, extraction forceps, and sterilization products. When possible and if ethically acceptable, the carious lesions were filled using a hand-mixed glass ionomer (Shofu), placed by using the thumb technique, an adapted version of the Atraumatic Restorative Treatment (ART) technique. When necessary, extractions were executed. If these extractions could not be performed because of the lack of appropriate treating materials, referral to a higher level was made. During the six-month period between T0 and T1, the children were provided with a new toothbrush and additional toothpaste after three months. This allowed the children to maintain good oral health during the intermediate period. Both at T0 and T1, all children and teachers received a summarizing leaflet with oral hygiene instructions. At T1, custom-made teach-the-teacher booklets, including all explanations and figures from the lesson, were provided in order to motivate them to reinforce oral health promotion in the future. The local school library was provided with posters and tools for education.

All clinical examinations were performed by two staff members of the Department of Paediatric Dentistry, University hospital of Ghent (LM and JV at T0, LM, and RC at T1) and two master students of the Ghent University, just before and six months after the intervention. Before every visit, three of the four examiners were trained and calibrated against a benchmark examiner (LM). For this purpose, the International Caries Detection Assessment System (ICDAS) scores were given twice on cases presented via PowerPoint slides, with one month time interval. Cohen's kappa values for intra- and inter-rater reliability were moderate for the first visit and substantial for the second, according to Fleiss[12] and Landis & Koch.[13]

The children were positioned in a chair, while the examiner inspected the mouth standing behind the child. The teeth were examined using a plain mouth mirror, a penlight, and a periodontal probe. Gauze was used to dry the teeth and wipe away gross debris when necessary (after scoring the plaque).

The plaque index, according to Sillness & Loë (1964), was used to measure the plaque levels on the buccal side of the Ramfjord teeth.[14] A score from zero to three was given and the mean plaque score was calculated.

As recommended by WHO, the ICDAS, described by Gugnani et al. (2011), was used to score dental caries.[15] ICDAS scores were translated into matching DMFT/dmft scores, counting the total number of decayed, missing, and filled teeth.[16] The decayed component was derived from the second digit of the measured ICDAS score. ICDAS score 0 was reported as D_0/d_0, ICDAS score 1 and 2 were reported as D_1/d_1, ICDAS score 3 was noted as D_2/d_2 and ICDAS score 4, 5 and 6 were seen as D_3/d_3. Teeth with D_3/d_3 scores were considered as carious lesions in need of curative treatment.

The restorative index was calculated to estimate the proportion of (previously) decayed teeth which had received restorative care. This index was calculated by dividing the filled component of the DMFT by the total DMFT/dmft and multiplying this value by 100. The treatment index was calculated by dividing the sum of the missed and filled component of the DMFT by the total DMFT/dmft and multiplying this value by 100.

Possible complications of untreated dental caries were quantified by the PUFA index, described by Monse et al. (2010).[17] The PUFA index records severely decayed teeth with visible pulpal involvement, ulceration of the oral mucosa due to tooth or root fragments, fistulas, and abscesses respectively with P/p, U/u, F/f, A/a. This is a score on tooth level. Independent from the kind of

infection or pathology (P/p, U/u, F/f, or A/a), the score reports the PUFA for permanent teeth (ranging from 0 to 32) and/or the pufa for primary teeth (ranging from 0 to 20).

Questionnaires were used to collect information on oral health knowledge, attitude towards oral health, reported oral hygiene behaviour, and dietary habits. The used questionnaires contained multiple-choice questions and were content validated and pre-tested in previous research.[18] The questionnaires were originally constructed in English, translated into Nepalese, and back-translated. They were completed by the children in their classrooms, supervised by their teachers.

Data analyses were performed using SPSS 24. In order to test the effects of age and gender on the efficacy of the oral health program, random intercept models were executed with the mean plaque score, D/d, D_3/d_3 and PUFA as within variables respectively, and age and gender as between-subject variables. Subject identification number was treated as a random intercept.

In order to compare the oral health knowledge, oral health habits, the prevalence of decay, the amount of plaque, and other oral health problems between baseline and follow-up, paired tests were performed. Measurements that could be considered scale variables (Likert scales with five or more answer possibilities) were compared using paired T-tests, based on the mean score. Binary measurements were compared with a McNemar test. For all tests, the level of significance was set at $p<0.05$

RESULTS

At T0, a total of 359 children were enrolled in the study, of whom 357 were screened and 354 completed the questionnaire at baseline. At T1, 266 of them were examined a second time, resulting in a 25.9% drop-out. The age within the longitudinal sample ranged between 2 and 20 years old, with a mean of 12.88 (SD = 3.63); 39.8% of the children were 12 years old or younger. The male/female ratio was 1/1.66, with 100 (37.6%) male children and 166 (62.4%) female children. The sample was checked for normality. Table 1 illustrates the descriptive data at T0 and T1 for caries experience, the amount of plaque, pathology and oral hygiene, and nutritional habits.

The results from the paired T-tests are given in table 1. The amount of plaque showed a significant decrease over six months ($p < 0.001$) as well as the mean D/d score ($P<0.001$). The number of decayed teeth decreased significantly, both at initial stage and at cavitation level D_3/d_3 ($p < 0.001$). At white spot level, no statistically significant effect was found for age or gender, and neither an interaction effect between time and age or between time and gender. A Kolmogorov-Smirnov test showed that the residuals were normally distributed ($KS = 0.03$, $p = 0.20$). Regarding cavitated teeth, the random intercept model with D_3/d_3 as the within-subjects variable showed a significant decrease in D_3/d_3 with time and a significant negative effect of age ($p < 0.0001$) meaning that the decrease was the highest in the youngest age group (ie.<12 years old). No statistically significant effect of gender was found. There was no significant interaction effect found between time and age or between time and gender. A Kolmogorov-Smirnov test on the residuals showed non-normality ($KS = 0.10$, $p < 0.001$), meaning that the results should be treated with caution. No statistically significant differences were found for the PUFA index.

Regarding dietary habits (Table1), the frequency of drinking soft drinks decreased significantly over time ($p < 0.05$). In contrast, the frequency of eating citrus fruits increased significantly ($p < 0.05$). There was no statistically significant difference found for the frequency of drinking fruit juices and the frequency of brushing the teeth between T0 and T1. However, a significantly higher amount of children spent at least two minutes brushing their teeth ($p < 0.05$) (Table 2).

The intervention had an overall significantly positive effect on the children's knowledge ($p < 0.05$)(table 1) especially knowledge of the different types of teeth and tooth-friendly products became obvious (Table 2).

The random intercept model revealed a significant effect of gender (where boys had on average more plaque, and a negative effect of age ($p < 0.001$). Furthermore, there was a significant interaction effect between time and gender ($p < 0.05$), showing that on average boys benefited more from the program than girls (Figure 1). There was no statistically significant interaction effect found between time and age. A Kolmogorov-Smirnov test on the residuals showed non-normality ($KS = 0.30$, $p < 0.001$), meaning that the results should be treated with caution.

Table 1. Prospective statistical analysis: paired samples T-test.(Significant variables in bold).

Pair (T1 - T0)			Paired difference		T	Df	p-value
	T0	T1	Mean difference	95% CI of the difference			
Plaque mean	0.75	0.47	-0.28	[-0.35;-0.21]	7.843	265	< 0.001
D/d mean	8.71	6.95	-1.76	[-2.21;-1.32]	7.813	265	< 0.001
D_3/d_3 mean	3.32	2.00	-1.32	[-1.60;-1.04]	9.317	265	< 0.001
PUFA/pufa mean	0.35	0.30	-0.04	[-0.14;0.06]	0.836	262	0.404
Knowledge total score	1.50	1.77	0.27	[0.05;0.49]	-2.396	179	0.018
Frequency of brushing the teeth	3.87	3.97	0.11	[-0.04;0.26]	-1.448	219	0.149
Frequency of drinking soft drinks	2.14	1.88	-0.26	[-0.47;-0.04]	2.308	234	0.022
Frequency of drinking fruit juices	1.98	1.90	-0.08	[-0.25;0.10]	0.852	236	0.395
Frequency of eating citrus fruits	1.79	1.54	0.25	[0.01;0.49]	-2.065	221	0.040

Table 2. Binary comparison of the knowledge data using McNemar test (significant variables in bold).

Related-samples McNemar test

Pair (T0 vs T1)	p-value	Answer possibilities	Frequencies (%)			
			T0		T1	
			n	%	n	%
Time used to brush their teeth	0.046	< 2 minutes	43	16.9	19	7.8
		≥ 2 minutes	211	83.1	225	92.2
Question 1: What product in toothpaste is important for your teeth?	0.585	Wrong	187	77.3	192	76.2
		Correct	55	22.7	60	23.8
Question 2: Which of the following products are toothfriendly?	0.032	Wrong	141	55.5	111	44.6
		Correct	113	44.5	138	55.4
Question 3: How many times do you need to rinse your mouth after brushing?	1.000	Wrong	231	89.9	229	89.8
		Correct	26	10.1	26	10.2
Question 4: Does coca cola light give tooth erosion?	0.368	Wrong	113	45.2	103	40.6
		Correct	137	54.8	151	59.4
Question 5: Different tooth types.	0.002	At least one wrong answer	199	82.9	163	67.4
		Four correct answers	41	17.1	79	32.6

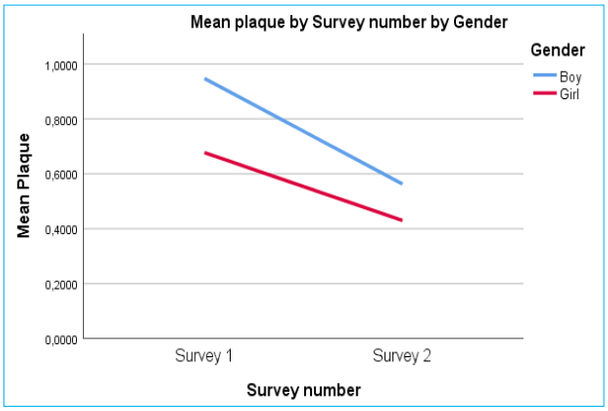

Figure 1. Level and evolution of Mean plaque as a function of gender.

DISCUSSION

Regarding oral cleanliness, significantly less plaque was present at T1. This can be attributed most probably to the oral health educational health program. The mean plaque score at T1 was 0.48, which was in accordance to the findings of Westbacke et al., who found a mean score between 0.5 and 0.8 for children between 5 and 16 years old.[11] The latter study, however, was performed in public schools, which is not directly comparable to a remote village.

The significant decrease in caries experience, specifically reflected by a decrease of the D_3/d_3 was in accordance with most previous studies indicating that the decayed

component made up the biggest proportion of the found DMFT score.[3-5,7,10,19,20] In contrast, the mean PUFA index did not change, which reflects the fact that a large amount of pathology referred to a higher level was never treated. There is only minor availability for medical care and no dental care at all in the remote village of Kerung.

With respect to health care, there is a lack in accessibility. Although the number of graduating dentists increased from 125 in the year 2000 to 691 in 2015 and the number of specialists increased from almost zero to 270 in the same period, the majority of all registered dentists work in the Kathmandu valley (capital area) or in the major cities.[21] As a consequence there is a shortage of availability of affordable dental care in rural areas.[4,5,7,19,20] In a study conducted by Prasai Dixit et al. (2013) in five primary schools, 93.0% of the children have never been to a dentist[5] and Fukai et al. (2012)[10] reported that 77.4% of the investigated children visited a dentist only when having pain, while only 5.6% got a regular check-up.[4] One of the predominant factors is the absence of a public oral healthcare system with free or subsidized dental care. This implies that all services are provided within a private care system.[22]

At T1, 85.7% of the children reported to brush twice a day and 91.5% confirmed to brush for two minutes or longer. The latter significantly increased ($p<0.05$) and can possibly be attributed to the oral health program. The majority of the children reported to use their own toothbrush to brush their teeth and smaller percentages stated they use a family toothbrush, their finger, a wooden stick or datiwan, which is similar to findings in the literature.[4-7,11,23] In the present study, 42.5% reported to use toothpaste during brushing, which is lower than earlier reported findings where values varied between 65.0% and 86.1%.[1-3,5,7,8,11,24] This could possibly be a consequence of the fact that not every child marked all the appropriate answers on the question about which products they use to brush their teeth, although the question clearly stated that more than one answer could be ticked. Regarding sugar intake, a substantial decrease to 23.3% was noted at T1, which can most probably be attributed to the oral heath educational program where the negative effects of sugar were taught. The latter findings confirm that schools or a dental camp are an effective platform for oral health promoting education as suggested in other Nepalese studies.[25-28]

Although a significant improvement in knowledge was found at T1, which could be assigned to the oral health promotion program, the mean score at T1 was still low (1.81/5). This is in accordance with earlier findings.[9] Especially the poor knowledge about fluoride and its benefits for oral health correlates with other studies.[2,3,5,6] The reason for this moderate improvement in oral health knowledge can most probably be attributed to the language barrier and the level of the program, which could be considered too high for certain children. Probably, also teachers did not emphasize oral health anymore in the interim period.

In contrast to most existing data, the present study consisted of a prospective case series, with a six-month follow-up. A comprehensive screening was done to gather maximal data. Before the clinical examination, all investigators were calibrated, in order to screen as uniformly as possible. The screening of the children was approached in a systematic manner, using a screening format. The questionnaires were content and pre-test validated. They were translated into the Nepalese language and back-translated.

Although the methodology of the study showed many strengths, some weaknesses were encountered. Only a convenience sample could be obtained and having a control group was not possible. There is no strong scientific proof that the significant differences found at T1 could be considered as the effect of the oral health educational program. As a consequence, the findings should be interpreted with caution, taking into account that no conclusion can be extrapolated for the entire Nepalese population. Besides, it should be kept in mind that in the six months' time between T0 and T1, the oral health behaviour of the children was supported by providing them with a toothbrush and toothpaste, which most probably has had its influence on the brushing habits of the children. While interpreting the data, the Hawthorne effect should also be taken into account.

As a consequence of the limited dental infrastructure (no dental chair, no electrical engine, no materials for surgical extractions and only glass ionomer as a filling material) the quality of the treatments was restricted. When no treatment seemed appropriate because of the circumstances, the children were referred to a higher level without any guarantee that children ever reached this. As a consequence, the authors of this study are aware that pathology was left behind.

For future studies, it is recommended to use a randomized study design, including a control group. Taking into account all D1/d1 and D2/d2 lesions, pit and fissure sealants would also be beneficial to implement. To improve the quality of delivered treatment a mobile dental chair including an electrical engine to treat cavitated carious lesions, as well as the availability of biocompatible and bioactive materials to treat deep

caries lesions, could be most valuable.

CONCLUSIONS

It became clear that there was a significant decrease in caries experience as well as in the amount of plaque. Moreover, significantly more children brushed ≥ 2 minutes. Taking into account that also the knowledge increased significantly, it can be conclude that in a remote village emergency treatments and an in-depth educational program can result in significantly improved oral health after 6 months.

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