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Original

Effect of school-based fluoride mouth-rinsing on dental caries incidence among schoolchildren in the Kingdom of Tonga

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Abstract: Since 1998, the authors have been working to improve the oral health of children at kindergartens and primary schools in the Kingdom of Tonga (Tonga). Our primary activity has been a school-based fluoride mouth-rinsing (FMR) program. FMR is performed using 7-10 mL of a 0.2% NaF solution for 1 min once per week at each school. In the present study, we evaluated the effect of school-based FMR on dental caries incidence among Tongan schoolchildren. A total of 109 children aged 10 years were evaluated at six primary schools on Tongatapu Island. The FMR group comprised 46 children who had participated in the school-based FMR program for at least 5 years 6 months; the control group comprised 63 children who had participated in the school-based FMR program for 1 year or less. During standardized dental examinations, decayed, missing, and filled teeth were counted by a single dentist at each school. The school-based FMR program effectively decreased the number of dental caries. A school-based FMR program may thus be very beneficial in preventing caries among children in Tonga. (J Oral Sci 54, 343-347, 2012)

Keywords: fluoride mouth-rinsing; caries preventive effect; school children; Kingdom of Tonga.

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Introduction

Fluoride mouth-rinsing (FMR) is an excellent method for preventing dental caries among people in facilities such as schools, as it is safe, economical, and simple (1). Many reports have shown the benefits of FMR for caries prevention. Daily or weekly FMR reduced decayed/missing/filled-tooth surface (DMFS) scores by 20-50% among children aged 7-14 years (2). Moreover, other research suggests that topical fluorides are more effective when applied to newly erupted teeth than to teeth that have been present for several years (3,4). Similarly, Kobayashi et al. reported that a topical fluoride regimen was more beneficial when it was initiated at younger ages and continued thereafter (5).

The Kingdom of Tonga (Tonga) is part of Polynesia, in the South Pacific Ocean. It consists of 170 islands divided into five main island groups and other islands. The population of Tonga is approximately 104,000, and 35% of the population is younger than 15 years. Because Tongans traditionally ate tubers (taro, cassava, yam, etc.) and chicken and fish seasoned only by salt, the prevalence of dental caries was low. Recently, as the economy

Table 1 Number of students in control and FMR groups

Control					FMR				
School	FMR period	No. of students			School	FMR period	No. of students		
		Male	Female	Total			Male	Female	Total
Nukualoha	≤ 6 months	15	20	35	‘Atele	≥ 5.5 years	8	4	12
Ha’alalo	≤ 1 year	6	10	16	Ngele’Ia	≥ 5.5 years	4	5	9
Kahoua	≤ 1 year	8	4	12	Vaini	≥ 5.5 years	13	12	25
Total		29	34	63	Total		25	21	46

FMR: fluoride mouth-rinsing

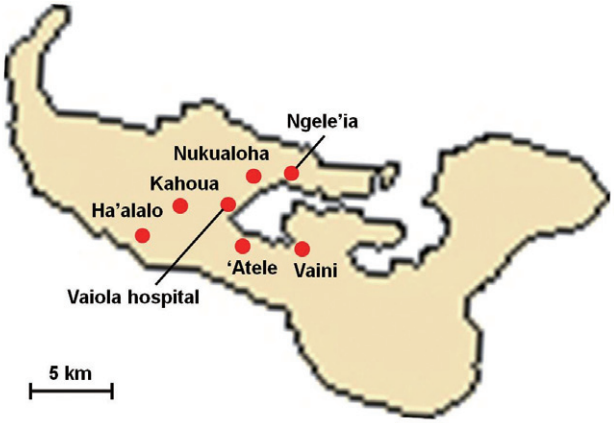

Fig. 1 Locations of target schools on Tongatapu Island

has developed, many types of foods have been imported, and the Tongan diet has changed. Children in particular typically consume snacks, juice, and other beverages that contain high amounts of sugar. As a result, the prevalence of dental caries has increased (6-8).

The dental clinic system in Tonga has experienced problems such as shortages of staff, tools, materials, and equipment. The ratio of dentists to population in Tonga is 1/8,000 (1/6 that of Japan). Shortages have occurred because almost all dental materials and tools in Tonga are donated from Japan and Australia. Thus, many Tongans undergo tooth extraction to treat dental problems that could have been treated conservatively. Deciduous teeth have also been extracted, and treatment for space maintenance is not performed. Previously, dental treatment was free, but a fee is now charged due to a change in the medical administration system. Unfortunately, many Tongans cannot afford dental treatment.

Due to the above-mentioned conditions, preventive dentistry is extremely important for decreasing the prevalence of dental caries in Tonga. Because Tonga is impoverished, simple, low-cost methods are needed. Therefore, FMR may be an excellent method of preventive dentistry in Tonga.

We have worked to improve the oral health of children in kindergartens and primary schools in Tonga since 1998. Our main activity is the planning and administration of a school-based program known as the MaliMali Program (MaliMali means smile in Tongan). In addition to other activities, the MaliMali Program consists of three main programs: an education program for caries prevention among kindergarten and primary school children; a program offering toothbrushing guidance and encouragement in using fluoride toothpaste; and the FMR program. As of March 2009, the MaliMali Program included over 90% of Tongan children (9). In the present study, we evaluated the effects of school-based FMR on dental caries incidence among Tongan schoolchildren in the MaliMali Program.

Methods

In August 2008, 109 children aged 10 years underwent dental examinations in six primary schools on Tongatapu Island, in Tonga. The locations of the target schools are shown in Fig. 1, and the school name, time period of the school-based FMR program, and number of children by sex are shown in Table 1. The FMR group contained 46 children who participated in the school-based FMR program for at least 5 years 6 months, and the control group included 63 children who participated in the school-based FMR program for 1 year or less. FMR was performed using 7-10 mL of 0.2% NaF solution for 1 min once per week in each school (10). During standardized dental examinations, decayed, missing, and filled teeth (DMFT) were counted by the same dentist at each school. The results for each tooth surface were recorded after a visual examination with a dental mirror and exploration using sunlight or a flashlight. The items examined included number of sealant-treated teeth, number of C_0 and $C_{1\text{-}4}$ teeth, teeth missing due to caries, and number of treated teeth (5,10,11). Sealant-treated/resin-filled teeth and healthy teeth were identified using erythrosine staining. X-ray analyses were not performed.

Table 2 Mean number of teeth of interest in each group

	Anterior			Posterior			Overall		
	Control	FMR		Control	FMR		Control	FMR	
	Mean (SE)	Mean (SE)	Significance	Mean (SE)	Mean (SE)	Significance	Mean (SE)	Mean (SE)	Significance
Sealant-treated	0.00 (0.00)	0.00 (0.00)	ns	0.43 (0.12)	0.52 (0.14)	ns	0.43 (0.12)	0.52 (0.14)	ns
Slight caries	0.16 (0.08)	0.09 (0.07)	ns	1.16 (0.15)	0.46 (0.12)	***	1.32 (0.19)	0.54 (0.15)	***
Severe caries	0.00 (0.00)	0.00 (0.00)	ns	0.41 (0.11)	0.30 (0.12)	ns	0.41 (0.11)	0.30 (0.12)	ns
Treated	0.00 (0.00)	0.00 (0.00)	ns	0.17 (0.06)	0.02 (0.02)	*	0.17 (0.06)	0.02 (0.02)	*
DMFT index	0.16 (0.08)	0.09 (0.07)	ns	1.75 (0.22)	0.78 (0.16)	**	1.90 (0.27)	0.87 (0.20)	**
Difference in mean DMFT index	43.8%			55.4%			54.2%		

Control: children who participated in school-based fluoride mouth-rinsing (FMR) program for ≤ 1 year ($n = 63$).
FMR: children who participated in school-based FMR program for ≥ 5.5 years ($n = 46$).
Comparison of means of two groups was carried out using Student's *t*-test. *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$, ns: not significant.

Table 3 Mean number of teeth of interest in each group, excluding data from children with severe caries

	Anterior			Posterior			Overall		
	Control	FMR		Control	FMR		Control	FMR	
	Mean (SE)	Mean (SE)	Significance	Mean (SE)	Mean (SE)	Significance	Mean (SE)	Mean (SE)	Significance
Sealant-treated	0.00 (0.00)	0.00 (0.00)	ns	0.56 (0.15)	0.61 (0.16)	ns	0.56 (0.15)	0.61 (0.16)	ns
Slight caries	0.04 (0.03)	0.00 (0.00)	ns	0.94 (0.16)	0.45 (0.13)	*	0.98 (0.17)	0.45 (0.13)	*
Treated	0.00 (0.00)	0.00 (0.00)	ns	0.17 (0.08)	0.00 (0.00)	*	0.17 (0.08)	0.00 (0.00)	*
DMFT index	0.04 (0.03)	0.00 (0.00)	ns	1.10 (0.17)	0.45 (0.13)	**	1.15 (0.17)	0.45 (0.13)	**
Difference in mean DMFT index	100.0%			59.1%			60.9%		

Control: children who participated in school-based fluoride mouth-rinsing (FMR) program for ≤ 1 year ($n = 48$).
FMR: children who participated in school-based FMR program for ≥ 5.5 years ($n = 38$).
Comparison of means of two groups was carried out using Student's *t*-test. *: $P < 0.05$, **: $P < 0.01$, ns: not significant.

Dental caries was classified by using the $C_{1\text{-}4}$ (C_0: no caries; $C_{1\text{-}2}$: slight caries; $C_{3\text{-}4}$ and missing: severe caries) criteria of the Japanese Association of School Dentists and the Japanese Society for Oral Health. The item "difference (%) in mean DMFT index" was calculated using the numerical formula, [(mean DMFT-index of control group – mean DMFT-index of FMR group)/mean DMFT-index of control group] × 100. The protocol was approved by the Committee on Studies Involving Human Beings of the Nihon University School of Dentistry at Matsudo (EC07-012).

Results

Table 2 displays the prevalence of dental caries in the anterior and posterior regions, and overall, in the FMR and control groups. The indices include mean number of sealant-treated teeth, mean number of teeth with slight or severe caries, mean number of treated teeth, mean DMFT index, and difference (%) in mean DMFT index. The mean number of sealant-treated teeth in the FMR group was higher than in the control group in the posterior region and overall (not significant). The mean number of teeth with slight caries, mean number of treated teeth, and mean DMFT index in the posterior region and overall were significantly lower in the FMR group than in the control group. Additionally, mean number of teeth with slight caries and mean DMFT index in the anterior mouth, and mean number of teeth with severe caries in the posterior mouth and overall, were lower in the FMR group than in the control group (not significant). The difference (%) in mean DMFT index was 43.8% in the anterior region, 55.4% in the posterior region, and 54.2% overall.

Table 3 shows the prevalence of dental caries in the FMR ($n = 38$) and control ($n = 48$) groups, after excluding data from children who had teeth with severe caries in the anterior region, posterior region, or overall. The indices are similar to those in Table 2. The mean number of sealant-treated teeth in the FMR group was higher than in the control group in the posterior region and overall (not

significant). The mean number of teeth with slight caries, mean number of treated teeth, and mean DMFT index in the posterior region and overall were significantly lower in the FMR group than in the control group. In the FMR group, the mean number of teeth with slight caries and mean DMFT index in the anterior mouth tended to be better than in the control group (not significant). The difference (%) in mean DMFT index was 100.0% in the anterior region, 59.1% in the posterior region, and 60.9% overall.

Discussion

We evaluated the effects of a school-based FMR program in three primary schools in Tonga in which participants began the procedure at age 5 years and continued for 5 years 6 months or longer. The number of severe dental caries was compared between children who had participated in the program for an extended period of time or for 1 year or less (control). The participants in the control group began the procedure at age 9 or 10 years. Because transfer students were excluded, the ratio of participants to the total number of school children was low; however, the sample was large enough to perform statistical analyses.

School-based FMR is the main program in the Mali-Mali Program, which is commended by the Ministry of Health in Tonga and performed in each school. The number of schools enrolled in the program has increased every year since 1999, and the percentage of schools enrolled was almost 80% in 2007 and 2008 and over 90% in 2009 (9).

When analyzing all participants, including those with severe dental caries, the FMR group had a significantly lower mean number of slight caries, mean number of treated teeth, and mean DMFT index in the posterior region and overall, as compared with the control group. The difference (%) in mean DMFT index was 43.8% in the anterior region, 55.4% in the posterior region, and 54.2% overall (Table 2). The school-based FMR program appears to decrease the number of dental caries in Tongan children. Additionally, many teeth of the children in the control group had already been treated. However, most participants attended the Nukualofa school, which is near the Vaiola hospital, making it easy for them to be treated.

The school-based FMR program significantly decreased the prevalence of dental caries, after excluding children with severe caries. Unfortunately, there are several problems with the MaliMali Program that may diminish the effect of school-based FMR on caries prevalence. Tonga has fewer days of primary school (175 days; 35 weeks) than Japan. Because primary school in Tonga is closed when it is raining, the MaliMali Program may not be offered every day or week. Classroom teachers manage children's toothbrushes at school, so when the teacher is not able to work, the children cannot use their toothbrushes and complete FMR. In addition, toothbrushing and FMR are sometimes withheld as punishment. These factors are associated with the prevalence of severe dental caries. The mean number of teeth with slight caries, mean number of treated teeth, and mean DMFT index in the posterior region and overall in the FMR group were significantly lower than in the control group. The difference (%) in mean DMFT index was 100.0% in the anterior region, 59.1% in the posterior region, and 60.9% overall (Table 3). When evaluating the school-based FMR program, the observed effects were greater after excluding data from children with severe caries.

Several studies suggest that topical fluorides are more effective when applied to newly erupted teeth than to teeth that have been in the mouth for several years (3-5). Enforcement of FMR among preschool children is important in preventing caries in first molars. Additionally, enforcement of FMR among junior high school children is important in preventing caries in second molars. Many reports have shown that fluoride use during the period of permanent tooth eruption is very effective for caries prevention. Some studies in Japan have shown a difference (%) of 33-51% in mean DMFT index among children who started FMR at age 6 years or older and 55-79% among children who started FMR at age 4-5 years or younger (FMR method: 0.2% NaF solution once per week and 0.05% NaF solution once per day, respectively) (11). Because the children in the FMR group began FMR at age 5 years, the school-based FMR program in Tonga may have a positive impact. However, Tongan children tend to grow more quickly than Japanese children; thus, starting a school-based FMR program in preschool might be more effective for caries prevention in Tongan children.

Regardless of whether the data set included or excluded children with severe dental caries, the mean number of sealant-treated teeth was higher in the FMR group than in the control group (not significant). Because children in the FMR group were regularly examined by a dentist and were enrolled in the school-based FMR program, they could be easily treated with a sealant, while the control children could not. This may have resulted in a higher mean number of sealant-treated teeth in the FMR group.

We found that the school-based FMR program significantly decreased the prevalence of dental caries in Tongan school children. School-based FMR has already

spread to Europe and the United States. In the United States, this program was performed in 1988 for 3.25 million school children in 11,683 school districts (12). Additionally, water fluoridation and use of fluoride toothpaste reportedly significantly decrease caries prevalence among children in many countries (13). Therefore, a school-based FMR program may be exceedingly beneficial for caries prevention in Tongan children.

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