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SELF-APPLIED FLUORIDES
FOR THE
COOK ISLANDS.

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A THESIS SUBMITTED AS A
PARTIAL REQUIREMENT FOR
THE DIPLOMA IN PUBLIC
HEALTH DENTISTRY.



DEPARTMENT OF PREVENTIVE DENTISTRY
FACULTY OF DENTISTRY
UNIVERSITY OF SYDNEY
1982.

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ACKNOWLEDGEMENTS

Thanks are due to Associate Professor Peter Barnard of the Department of Preventive Dentistry, University of Sydney, for his help, patience and much-needed advice and guidance during the preparation of this thesis. His encouragement and understanding have made the difficult times easier to handle.

Thanks are also due to the World Health Organization (WHO) for sponsoring me for this Diploma in Public Health (Dentistry) Course (1982).

I wish to express my gratitude to the Minister of Health of the Cook Islands, Dr. Pupuke Robati and the Secretary of Health of the Cook Islands, Dr. George Koteka, who provided the necessary documents and data on the previous surveys on the oral health status of the school children in that country.

Finally I wish to express my sincere thanks to Miss Janina Oost for doing the final typing of this thesis.

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INTRODUCTION

Dental caries is one of the most prevalent and widespread diseases in the world today. It has been found in countries where dental surveys have been carried out, that, almost the entire population is suffering from dental caries and its consequences. Similarly, from the few surveys conducted in the Cook Islands it was found that there was a high incidence of dental caries in its population. In the Cook Islands, like other countries with high dental caries and highly developed dental health systems, it is not feasible to provide the dental manpower needed to restore all the dental caries that occur.

The dentist/population ratio of the Cook Islands is high by world standards in Rarotonga, but services to the Northern Group islands is limited because of their geographical locations and the shortage in manpower for those areas. Until comparatively recent times, the majority of the islands in the Cook Islands were isolated from the outside world by their remoteness. Early western explorers, such as Cook and Bougainville, in the accounts of their voyages in the eighteenth century, specifically remarked on the excellence of the teeth of the inhabitants, but over the past twenty years or so, high dental caries rates have been reported from several island groups, notably the Cook Islands, and French Polynesia. This deterioration in dental health is due to the increased availability of refined carbohydrate foods and especially, the increased consumption of sugar. It is therefore conceivable that the control of dental caries by treatment methods alone cannot be accomplished and consequently, preventive measures seem to be the ideal solution.

Efforts towards the prevention of dental caries have been in progress for some time now, and several methods have been found effective on an individual basis but their application on a public health basis leaves a lot to be desired. The most practical, effective, well-tested preventive methods that have resulted in a substantial reduction in dental caries

at present is the controlled application of fluorides particularly water fluoridation, and self-applied fluoridation. Studies into the relationship between fluoridation and dental caries have been in progress since the 1940's and the full effect of fluoride on a whole generation of children gives accurate data on the effect of water fluoridation.

Fluoridation to communal water supplies may be defined as the controlled addition of fluoride to reticulated water to adjust the natural fluoride level to a level which has been proven to most effectively reduce the incidence of dental caries. The usual recommended dose is not more than one part of fluoride for every million parts of water. (1 ppm).

The water system on Rarotonga, which is the main island in the Cook Islands, is still under construction. There is no reservoir or catchment where a fluoridation plant can be installed. There is also no big river on Rarotonga except for little streams which usually are dry during the dry seasons. The people on the outer islands of the Cook Islands depend largely on rainwater caught and stored in tanks.

Because of the above problems with the water systems in the Cook Islands, water fluoridation is not practicable, and therefore the alternative method chosen to be introduced for the administration of fluorides to its population is self-applied fluoridation.

The term self-applied fluoride implies to administration of topical fluorides on the surfaces of the enamel of the teeth for the prevention of dental decay. The traditional approach to the administration of topical fluorides requires that each child be treated individually by a dentist or dental hygienist and special equipment and facilities are to be used. Although professionally applied topical fluorides are well adapted for use in private dental practice, the method has disadvantages for public health programs in which preventive benefits are sought for many children. The

increasing shortage and maldistribution of professional dental manpower and the relatively high cost of treatments accentuate the shortcomings of a professionally administered technic as a public health measure.

In the search for methods to overcome these drawbacks, several investigators have evaluated various self application procedures for the delivery of topical fluorides including :

- (i) tooth brushing with solutions and gels containing fluoride.
- (ii) tooth brushing with fluoride containing prophylaxis pastes.
- (iii) the application of fluoride gels in mouth pieces.
- (iv) mouth rinsing with fluoride-containing solutions.

(SOURCE : Newbrun E - 1980)

The aim of this presentation is to review the current literature of the studies and research that has been carried out on self-applied fluorides. Emphasis will be placed on the various methods that have shown a significant reduction in caries increment.

It is considered that : by reviewing the literature of effectiveness of different methods of self-applied fluorides; by studying the planning and implementation of the various methods of self-applied fluorides used in the world; and by reviewing the cost-benefit/cost effectiveness of the various methods of self-applied fluorides, appropriate conclusions can be drawn to suggest the most feasible methods that could be of value in planning a caries-preventive self-applied programme for the Cook Islands.

2. ALTERNATIVES TO WATER FLUORIDATION

2.I. FLUORIDE TABLETS

For children who live in fluoride-deficient areas, the use of fluoride tablets is an effective alternative method for prevention of dental caries. It is a direct alternative to water fluoridation in a systemic effect. The recommended procedure for using the tablet requires that it be chewed or dissolved in the mouth and the resultant solution is swished between the teeth for one minute before swallowing. When used in this manner, fluoride tablets benefit teeth already present in the mouth as well as those teeth that are still developing.

As reported by G.N. Davies in the WHO Geneva 1974 Publication, the status of fluoride tablets in the prevention of dental caries was reviewed by Paulsen and Moller in 1969. After some 30 clinical trials, they concluded that fluoride tablets have a certain value in reducing dental caries by 20 - 40%.

Gedalia. (1967) reported that there were numerous studies done in Germany (Knappwost 1956, Kesler and Solth 1953; Wrzodek, 1960; Pollak, 1961; Schutzmannsky, 1965), Yugoslavia (Krusic, 1960; Jez, 1962;), Poland (Ziemnowicz-Glowacka, 1961; Knychalska Karwan and Laskowska, 1964;), Austria (Binder, 1953; Leonhardt 1964), and to some extent Switzerland (Held and Piquet, 1956) on fluoride tablets.

Knappwost (1956) recommended the administration of either calcium fluoride or magnesium fluoride tablets, since a more constant level of blood fluoride is achieved than when fluoride tablets are taken.

Krusic (1960) observed that there was no increase in dental fluorosis when such tablets were given to 8 to 15 year old children who benefited from a significant reduction in dental caries.

Jez (1962) reported that administrations of calcium fluoride to 7 to 11 year old children, for a period of 2 1/2 years did not reduce the incidence of new caries. He suggested that fluoride should be administered to the pregnant mother and continued in the child, during the period that the teeth are developing. An extensive study, done by the public health authorities of the state of Hessen in Germany, involving over 8,000 kindergarden and 20,000 secondary school children, showed a significant reduction (from 44.4% to 13.9%) in the incidence of new cavities after an observation period of 3 to 4 years. The children were given fluoride tablets containing 1mg F, by their schoolteachers but during the holidays and vacations, they are faced with some difficulty in the supervision of the daily administration. This difficulty seems to have been overcome by the use of dragees with a pleasant taste and attractive appearance. From these, and other numerous studies on fluoride tablets it is seen that the greatest benefit, about 50% - 60% less tooth decay occurs if the fluoride is given to the child by the parent each day from infancy until teenage. This approach is recommended in those situations where the families are highly motivated.

Because many families find the schedule too demanding and, therefore, do not follow it conscientiously, the most practical approach for most children is to give them a fluoride tablet each day in school. Again, from the many research studies done, these school based programmes show a reduction of tooth decay by 20 to 35 per cent. For best results the procedure should be started in the kindergarden and continued until at least the eighth grade.

The following conclusions produced by Davies (Davies, G.N. - 1974) may be drawn from the results reported in the above Table by Binder :

- (a) At age 6 a lifetime's exposure to fluoride tablets produced a substantial reduction in DMFT per child of 0.70. (70%).
- (b) At age 10 a lifetime's exposure to fluoride tablets produced a reduction of 2.40 DMFT per child (55%) whereas in 10 year olds who only received fluoride tablets at school between the ages of 6 and 10 years the reduction was 1.65 DMFT per child 38%.
- (c) At age 14 a lifetime's exposure to fluoride tablets produced a reduction of 3.85 DMFT per child (43%), whereas in 14-year-olds who only received fluoride tablets at school between the ages of 6 and 10 years the reduction was, 1.54 DMFT per child (17%).
- (d) The caries experience of the control group is relatively small; 8.97 DMFT at age 14 compares favourably with a pre-fluoridation baseline at age 14 of 14.35 DMFT at Hastings, New Zealand, and 10.95 at Grand Rapids, U.S.A.

Similarly, it was reported by William S. Driscoll in a Report prepared for oral presentation at the "International Workshop on fluorides and Dental Caries Reduction", held April 28 - May 1, 1974 in Baltimore that fluoride tablets reduces dental caries in deciduous teeth, permanent teeth and in those children who have consumed fluoride supplements pre-natally. His report on the investigations on the cariostatic effects of fluoride tablets on deciduous teeth may be shown by the data in Table 1. (See attached leaflet of copy of Table 1.)

RESULTS FROM THE ADMINISTRATION OF FLUORIDE TABLETS IN VIENNA (reported by Birkder).

AGE (yrs)	CONTROL GROUP		EXPERIMENTAL GROUP		ADMINISTRATION		REDUCTION IN DMFT		PER CHILD
	No.	DMFT per child	No.	DMFT per child	Age (yrs)	No. of years	Mean	%	
6	710	1.08	7133	0.38	0-6	6	0.70	70	
10	232	4.32	6198 273	1.92 2.67	0-10	10	2.40	55	
					6-10	5	1.65	38	
14	7487	8.97	3084 1915	5.12 7.43	0-14	14	3.85	43	
					6-10	5	1.54	17	

(SOURCE : G.N. DAVIES, 1974)

2.1.1 EFFECT ON THE PREVALENCE AND SEVERITY OF DENTAL CARIES.

Binder's long term study of the administration of fluoride tablets in Vienna 1956, was reported by G.N. Davies in the WHO Geneva 1974 Publication. He reported that the fluoride tablets, which were introduced in five districts in Vienna, were administered only to children in the age range 6 - 10 years. The distribution proceeded incrementally starting with 6-year-olds in 1956, 6- and 7-year-olds in 1957, 6-, 7-, and 8-year-olds in 1958, and so on. Since 1960 - 62, however, the tablets have also been recommended for pre-school children (through mother and child welfare centres), and for school children the distribution was continued up to 14 years. Fluoride tablets have been distributed throughout Vienna since 1965.

The results reported by Binder are set out in the Table *on Page 8a.*

(Source : Davies, G.N. - 1974).

2.I.2 EFFECT OF FLUORIDE TABLETS ON DECIDUOUS TEETH.

Table 1 presented by William S. Driscoll 1974, contains data from eighteen studies that have investigated the cariostatic effects of fluoride tablets on deciduous teeth. Dosage generally ranged from 0.25 mg. to 1.0 mg. of fluoride per day depending upon the ages of the subjects. The average initial ages of the participants was about four years or less in all studies. In the majority of studies, fluorides were administered for periods from two to six years.

Caries reductions, expressed as percentages, are shown in the final column of the table. There appears to be little doubt that fluoride tablets are effective in reducing dental caries in deciduous teeth. Positive findings were reported in all but three of the eighteen studies. Percentage reductions in the studies reporting benefits ranged widely from 13 per cent in Schutzmannsky's study in a group of children receiving fluoride only prenatally to 93 percent in the study by Hoskova for children who received fluoride prenatally as well as four years post-natally.

The eighteen studies have been arranged according to the initial ages of the study participants. It is evident that the benefits generally were greater in those studies in which the initial ages of the children averaged near two years or younger. Also, results from these studies were consistently positive. In contrast, each of the three studies that reported no benefits, used children aged three years or older at the commencement of tablet administration. In summary, the data indicate that caries reductions in the approximate range of 50 - 80 percent may be achieved in deciduous teeth when fluoride administration is begun before about two years of age and is continued for a minimum of three to four years.

2.I.3 EFFECT OF FLUORIDE TABLETS ON PERMANENT TEETH.

Data from twenty-eight studies that have investigated the cariostatic effects of fluoride tablets on permanent teeth are presented in Table 2. Dosage generally ranged from 0.25 mg. to 1.0 mg. of fluoride per day, depending upon the ages of the study participants. In the majority of the studies, fluoride administration did not commence until the children were at least five years of age. In most instances the average period of administration was within a range of 2 - 4 years.

Collectively, the data lead to the conclusion that fluoride tablet administration reduces dental caries in the permanent dentition.

Among those studies showing benefits, percentage reductions in about three-quarters of the instances fall within the approximate range of 20 to 40 per cent. The results of studies on permanent teeth also were looked at according to the initial ages of the study participants. There is an indication that children who began fluoride ingestion at younger ages derived greater benefits than children who were older at the start of the study. However, the relationship is not as well defined as it was with deciduous teeth. In summary, the majority of studies have reported caries reductions in permanent teeth of approximately 20 to 40 percent among children initially between 5 and 9 years of age who had consumed fluoride tablets for periods of two to four years.

Table 1

Caries-Preventive Effects of Fluoride Tablets on Deciduous Teeth: A Summary

Study	F Compound	Daily Dosage (mg)	Initial Age of Subjects In Years	No. of Subjects	Years of F Intake	Caries Reduction	
Arnold et al. 1960	NaF	0.5-1	Birth-6	121	1-12	"Comparable to water F" (deft)	[3]
Pollak 1960	NaF+V [†]	1	3	100	2	80% (dmft)	[3]
	NaF+V	1	4	111	2	20% (dmft)	[3]
Ziemnowicz-Glowaka 1960	NaF	0.8* (4x0.2) ^φ	3	139	2	26% (dmfs)	[14]
Lutomska & Koninska 1962	NaF	0.6 (3x0.2)	3-4	154	2	"No significant effect"	[3]
Kamocka et al. 1964	NaF	0.75* (3x0.25)	3	64	3	0% (dmft)	[2]
	NaF	0.75* (3x0.25)	4	79	3	0% (dmft)	[2]
Leonhardt 1965	NaF+V (liquid)	1*	3	?	2	38% (dmft)	[3]
	NaF+V (liquid)	1*	4	?	2	30% (dmft)	[3]
Hennon et al. 1966, 1967, 1970	NaF+V	0.5-1	Birth-5½	85	3	63% (dmfs)	[1]
	NaF+V	0.5-1	Birth-5½	54	4	68% (dmfs)	[1]
	NaF+V	0.5-1	Birth-5½	60	5	66% (dmfs)	[1]
Margolis et al. 1967	NaF+V	0.5-1	Birth	91	5	70% (deft)	[3]
Hoškova 1968	NaF	0.25-1 (1-4x0.25)	Prenatal	78	4	93% (deft)	[1]
	NaF	0.25-1 (1-4x0.25)	Birth-1	151	4	54% (deft)	[1]
Kailis et al. 1968	NaF	?	Prenatal	50	4-6	82% (deft)	[1]
	NaF	?	Birth	92	4-6	56% (deft)	[1]
Stolte 1968	?	1	3	130	3	11% (dmft)	[3]
Prichard 1969	NaF	?	Prenatal	176	6-8	70% (deft)	[1]
	NaF	?	Birth	282	6-8	40% (deft)	[1]

SOURCE: DRISCOLL, W.S., - The Use of Dietary Fluoride Supplements for the Prevention of Dental Caries. - Prepared for oral presentation at the "International Workshop on Fluorides and Dental Caries Reductions," held April 28 - May 1, 1974 in Baltimore, M.D.

Table 1 (Continued)

Caries-Preventive Effects of Fluoride Tablets on Deciduous Teeth: A Summary

Study	F Compound	Daily Dosage (mg)	Initial Age of Subjects In Years	No. of Subjects	Years of F Intake	Caries Reduction	
Hamberg 1971	NaF+V (drops)	0.5	Birth	342	3	57% (decayed teeth)	[3]
	NaF+V (drops)	0.5	Birth	342	6	49% (decayed teeth)	[3]
Hennon et al. 1971	NaF+V	0.5	<1	458	3	78% (defs)	[3]
Kraemer 1971	CaF ₂	1	4	170	2	22% (dmft)	[3]
	CaF ₂	1	5	82	2	18% (dmft)	[3]
Schutzmannsky 1971	NaF	1	Prenatal	100	<1	13% (dmft)	[1]
	NaF	0.25-1 (1-4x0.25)	Prenatal	100	9	30% (dmft)	[1]
	NaF	0.25-1 (1-4x0.25)	Birth	100	9	14% (dmft)	[1]
Hennon et al 1972	NaF+V	1	1½-3	182	1	57% (defs)	[1]
	NaF	1	1½-3	165	1	55% (defs)	[1]
	NaF+V	1	1½-3	95	2	66% (defs)	[1]
	NaF	1	1½-3	91	2	63% (defs)	[1]
Aasenden & Peebles 1974	NaF+V ^{††}	0.5-1	Birth	87	8-11	80% (dfs, 2nd molars)	[1]

† V=Vitamins

†† A NaF+V combination was given up to 3 years of age. Beyond this age some children received NaF+V while others received only NaF.

* Tablets given only on school days.

φ Four 0.2 mg. F tablets given daily.

[1] Statistically significant

[2] Not statistically significant

[3] No statistical test reported

Table 2

Caries-Preventive Effects of Fluoride Tablets on Permanent Teeth: A Summary

Study	F Compound	Daily Dosage (mg)	Initial Age of Subjects in Years	No. of Subjects	Years of F Intake	Caries Reduction	
Schutzmannsky 1971	NaF	1	Prenatal	100	<1	6% (DMFT)	[2]
	NaF	0.25-1 (1-4x0.25)	Prenatal	100	9	43% (DMFT)	[1]
	NaF	0.25-1 (1-4x0.25)	Birth	100	9	39% (DMFT)	[1]
Aasenden et al. 1972	APF (liquid)	1*	8-11	109	3	30% (DFS)	[1]
	NaF (liquid)	1*	8-11	114	3	27% (DFS)	[1]
Plasschaert & Konig 1973	NaF	1	7	190	2	32% (DMFS)	[1]
Assenden & Peebles 1974	NaF+V ^{††}	0.5-1	Birth	100	8-11	80% (DFS, all teeth)	[1]
						77% (DFS, 1st molars)	
Driscoll et al. 1974	APF	1*	6-7	202	2½	6% (DMFS)	[2]
	APF	2* (2x1)	6-7	197	2½	27% (DMFS)	[1]

† V=Vitamins

†† A NaF+V combination was given up to 3 years of age. Beyond this age some children received NaF+V while others received only NaF.

* Tablets given only on school days

φ Two 0.5 mg. F tablets given daily

[1] Statistically significant

[2] Not statistically significant

[3] No statistical test reported

Table 2.

Caries-Preventive Effects of Fluoride Tablets on Permanent Teeth: A Summary

Study	F Com- pound	Daily Dosage (mg)	Initial. Age of Subjects in Years	No. of Subjects	Years of F Intake	Caries Reduction	
Grissom et al. 1964	NaF	1*	6-11	178	2	34% (DMFS)	[1]
Kamocka et al. 1964	NaF	0.75* (3x0.25)	3	64	3	17% (DMFT)	[2]
	NaF	0.75* (3x0.25)	4	79	3	60% (DMFT)	[1]
Leonhardt 1964	NaF	1	6	398	4	32% (DMFT)	[3]
	NaF	1	7	429	3	25% (DMFT)	[3]
Hippchen 1965	?	1	6	500	3	32% (DMFT)	[3]
Schutzmannsky 1965	NaF	0.75* (3x0.25)	6	580	4	25% (DMFS)	[3]
	NaF	0.75* (3x0.25)	6	197	6	27% (DMFS)	[3]
Berner et al. 1967, 1968	NaF	0.5-1*	5-7	105	3	84% (DMFS, except 1st molar)	[3]
						33% (DMFS, 1st molar)	
	NaF	1*	7-9	158	4	16% (DMFT)	[3]
	NaF	1*	7-9	160	6	20% (DMFT)	[3]
	NaF	1*	7-9	109	7	24% (DMFT)	[3]
DePaola & Lax 1968	APF	1*	6-8	130	2	23% (DFS)	[1]
Girardi- Vogt 1968	NaF	1	1st grade	?	3	31% (?)	[3]
Stolte 1968	?	1	3	150	3	69% (DMFT)	[3]
Marthaler 1969	NaF	0.5-1* (2-4x0.25)	6-7	450	1-8	36% (DMFT) 47% (DMF sites)	[1]
Hamberg 1971	NaF+V (drops)	0.5	Birth	342	7	70% (decayed teeth)	[3]

Table 2

Caries-Preventive Effects of Fluoride Tablets on Permanent Teeth: A Summary

Study	F Compound	Daily Dosage (mg)	Initial Age of Subjects in Years	No. of Subjects	Years of F Intake	Caries Reduction	
Stones et al. 1949	NaF	1.5	6-14	125	2	0% (caries intensity)	[2]
Bibby et al. 1955	NaF (pill)	1	5-14	133	1	Tentative finding: no reduction (new carious areas)	[3]
	NaF (lozenge)	1	5-14	119	1	Tentative finding: possible reduction (new carious areas)	[3]
Niedenthal 1957	NaF	1* (2x0.5) ^φ	6-7	251	3	22% (DMFT)	[3]
Wrzodek 1959	NaF	1*	6-9	8381	3	21% (DMFT)	[3]
	NaF	1*	6-9	13585	4	22% (DMFT)	[3]
Arnold et al. 1960	NaF	0.5-1	Birth-6	121	1-15	"Comparable to water F" (DMFT)	[3]
Krusic 1960	CaF ₂	?	8-15	480	1-3	70% (?)	[3]
Pollak 1960	NaF+V [†]	1	6-7	300	2	38% (DMFT)	[3]
Ziemnowics-Glowaka	NaF	0.8* (4x0.2)	3-6	704	2	33% (DMFS)	[1]
	NaF	0.8* (4x0.2)	5-6	204	3	28% (DMFS)	[1]
Jez 1962	CaF ₂	?	7-11	7200	2½	0% (?)	[3]
Krychalska-Karwan & Laskowska 1963	NaF	?	grammar school	134	4	5% (DMFS)	[3]
Minoguchi et al. 1963	NaF+W	0.25	Birth-6	75	6	36% (DMFT)	[3]
Binder 1964, 1967	NaF	1*	6	?	4	35% (DMFT)	[3]

Table 3

Caries-Preventive Effects of Fluoride Tablets Used Prenatally: A Summary

Study	F Compound	Daily Dosage (mg)	Initial Age of Subjects in Years	No. of Subjects	Years of F Intake	Caries Reduction	
Hoskova 1968	NaF	0.25-1 (1-4x0.25) ^φ	Prenatal	78	4	93% (deft)	[1]
	NaF	0.25-1 (1-4x0.25)	Birth-1	151	4	54% (deft)	[1]
Kailis et al. 1968	NaF	?	Prenatal	50	4-6	82% (deft)	[1]
	NaF	?	Birth	92	4-6	56% (deft)	[1]
Prichard 1969	NaF	?	Prenatal	176	6-8	70% (deft)	[1]
	NaF	?	Birth	282	6-8	40% (deft)	[1]
Schutzmannsky 1971	NaF	1	Prenatal	100	<1	13% (dmft) 6% (DMFT)	[1] [2]
	NaF	0.25-1 (1-4x0.25)	Prenatal	100	9	30% (dmft) 43% (DMFT)	[1] [1]
	NaF	0.25-1 (1-4x0.25)	Birth	100	9	14% (dmft) 39% (DMFT)	[1] [1]

^φ One to four 0.25 mg. F tablets given daily
 [1] Statistically significant
 [2] Not statistically significant

2.I.4 EFFECT OF PRENATAL USE OF FLUORIDE TABLETS.

Clinical data on the caries-preventive effects of fluoride tablets used prenatally are limited. A review of the literature revealed four studies, which are summarized in Table 3. Hoskova reported a caries reduction of 93 percent in the deciduous teeth of a group of children who had received fluoride tablets daily beginning at four months in utero and continuing for four years after birth, compared with a 54 percent reduction in another group of children who received tablets for four years beginning shortly after birth. Kailiss et al('68) found an 82 percent reduction in def teeth among Australian children who consumed fluoride supplements prenatally and for 4-6 years postnatally compared with a 56 percent reduction for children who received the supplements only postnatally. The difference between these two reductions was statistically significant. In another Australian study, Prichard('69) reported reductions in def teeth of 70 percent and 40 percent, respectively, following prenatal plus postnatal use and postnatal use only of fluoride supplements. The most recent study on the subject conducted in 1971 by Schutzmansky, is particularly interesting for two reasons : it included a group that received only prenatal fluoride supplements and evaluations were made of six-year molars. Because of the age of the children when examined (9 years old) the evaluation of deciduous teeth was limited to cuspids and molars. A small but statistically significant reduction in dmft of 13 percent was found in the group that received fluoride only prenatally. An almost identical (14 percent) reduction was found among children who consumed supplements for nine years, beginning at birth. The highest percentage reduction for deciduous teeth (30 percent) occurred in the group receiving both prenatal and postnatal exposure. With regard to permanent teeth, no benefit was found for the six-year molars of children who received only prenatal exposure. In contrast, however, statistically significant reductions in caries in these teeth of 43 percent and 39 percent, respectively, following prenatal plus postnatal use and postnatal use only, were detected. The similarity of benefits in these two groups plus the lack of benefit in the group receiving only prenatal fluoride suggest that prenatal fluorides are of no value in preventing caries

in permanent teeth.

In summary, the clinical studies with fluoride tablets tend to support the efficacy of prenatal fluoride ingestion for deciduous teeth. However, the studies with tablets are few in number and, in some instances, the significance of the apparent additional benefit from prenatal exposure is not clear. Collectively, the data presented indicate that more proof of efficacy is needed before prenatal dietary supplements of fluoride can be recommended for women as a sound public health measure for prevention of dental caries in permanent teeth. The data further suggest that if any benefits do result from the procedure, they would accrue only for the deciduous teeth.

2.I.5 THE MANPOWER REQUIRED AND THE TIME TAKEN TO IMPLEMENT THE PROCEDURE.

It was shown by the many studies, that, the administration of fluoride tablets can be assumed by parents; but there is evidence to show that, even when tablets are provided free, many participants drop out of the program. (G.N. Davies 1974).

In the study conducted by Hennon, Stookey and Muhler (1967), they found that only about 20% of the original number of subjects were present at the 5 - 1/2 year examination. Similarly in Western Australia Prichard found that although fluoride tablets were distributed free of cost, only 16% of the children aged 6 - 14 years were taking the tablets regularly.

Because the benefits derived from the fluoride tablets are so striking, especially for non-fluoridated areas, doctors, dentists, and child health centres should be encouraged to prescribe tablets.

The alternative procedure for a successful distribution of fluoride tablets is through kindergardens and schools. The many studies of such a procedure provide substantial evidence of the benefit and practicability of this. Giving fluoride tablets in school is a positive program because:

1. The procedure is safe and is effective in reducing tooth decay.
2. The procedure is inexpensive.
3. There are no waste products to dispose.
4. Little time is required for the procedure - approximately 3 minutes per school day for an average classroom.
5. The procedure is easy for school children of all ages to learn and to do.
6. With minimal training, non-dental personnel, such as classroom teachers, aides or volunteers, can adequately supervise the procedure.

2.I.6 COST-EFFECTIVENESS

The calculation of savings per hour of professional time cannot be made since dental personnel are not involved.
(Davies, G.N. - 1974)

2.I.7 COST-BENEFIT ANALYSIS

2.I.7.1 COST OF IMPLEMENTATION.

Costs of fluoride tablets vary from country to country especially between retail, wholesale, and bulk order supplies in each country. The costs of the tablets will also vary according to the recommended dosage and to the age of the child. A commonly accepted dosage for children in a fluoride-free area is 0.5 mg. of the fluorine daily for children under 3 years of age and 1.0 mg. of fluorine daily for children over 3 years of age.

In Australia the most common retail price of fluoride tablets is 75 cents for 200 (1969). Dunning('70) reported that the group purchase of a years supply of fluoride tablet is U.S. \$3.65 per child. (G.N. Davies - 1974).

2.I.7.2 SAVINGS IN THE COST OF DENTAL TREATMENTS.

Assuming the average cost of a restoration to be A \$5.00 in Australia, U.S. \$8.00 in the U.S.A., the total savings in the cost of treatment based on the data in the Table 4. would be as follows.

U.S.A.

Total savings per child in fillings in deciduous and permanent in 5 1/2 years $(10.38 + 3.5) = 13.88$.

Total savings in cost per child at U.S. \$8.00 per restoration = \$111.04

Average savings in cost per child per year = U.S. \$20.19.

U.S.A.

Total savings per child in fillings in permanent teeth in 2 years = 1.00.

Total savings in cost per child at U.S. \$8.00 per restoration = U.S. \$8.00.

Average savings in cost per child per year = U.S. \$4.00.

Australia

Total savings per child in fillings in desiduous teeth
in 6 years = 6.3 - 12.0.

Total savings in cost per child at A \$5 per restoration
= \$31.50 - \$60.00.

Total savings in cost per child per year = A\$5.25 -
A\$10.00

2.1.7.3 COST BENEFIT RATIOSEstimated cost of tablets per child per year

Cost benefit ratio = Average savings in cost of fillings
per child per year.

U.S.A.

(a) 5 1/2 years use of fluoride tablets from birth =

$$\begin{array}{r} \underline{3.65} \\ 20.19 \\ = \underline{1:5.5.} \end{array}$$

(b) 2 years use of chewable fluoride tablets at school =

$$\begin{array}{r} \underline{3.65} \\ 4.00 \\ = \underline{1:1.1} \end{array}$$

Australia.

(a) 6 years use of fluoride tablets from birth to 2 years =

$$\begin{array}{r} \underline{1.02} \\ 5.25 \\ = \underline{1:5.1} \end{array}$$

(b) 4 1/2 - 6 years use of fluoride tablets from birth =

$$\begin{array}{r} \underline{1.02} \\ 10.00 \\ = \underline{1:9.8} \end{array}$$

TABLE 4. SAVINGS IN NUMBER OF FILLINGS PER CHILD RESULTING FROM THE ADMINISTRATION OF FLUORIDE TABLETS

Country	Author	Age at beginning (years)	Age at end (years)	Length of study (years)	Total savings in no. of fillings*	Average savings in no. of fillings* per child per year
Deciduous teeth						
USA Australia	Hennon et al.	0 - 2	5-1/2 - 7-1/2	5-1/2	10.38	1.9
	Prichard et al.	0	6	6	9.6	1.6
	Prichard et al.	0 - 2	6 - 8	6	6.3	1.05
	Kailis et al.	0	4-1/2 - 6	4-1/2 - 6	12.0	2.4
	Kailis et al.	0 - 2	4-1/2 - 8	4-1/2 - 6	8.2	1.6
Permanent teeth						
USA USA Austria	Hennon et al.	0 - 2	5-1/2 - 7-1/2	5-1/2	3.5	0.6
	De Paola & Lux	6 - 10	8 - 12	2	1.0	0.5
	Binder	0	6	6	1.75	0.3
		0	10	10	6.0	0.6
		0	14	14	9.6	0.7
		6 - 10	10	5	4.1	0.8
		6 - 10	14	5	3.8	0.8

* Assuming with Pot¹⁵ that 1 saved dmf tooth equals 2 fillings saved; and 1 saved DMF tooth equals 2.5 fillings saved.

Results from the U.S.A. and Australia for children who have taken fluoride tablets from birth vary from 5.1 to 9.8.

The success of the administration of fluoride tablets in schools is apparent.

(Source : Davies G.N. - Cost and Benefit of fluorides in the prevention of dental caries - Geneva, WHO Offset publication no. 9, 1974).

2.2 SCHOOL WATER FLUORIDATION.

Recognizing the fact that, about 46 million persons or 23% of the population of the U.S.A. (in 1974) reside in areas without a central water supply where fluoridation of community water supplies is not feasible, the Epidemiology Branch of the Division of Dental Health of the United States Public Health Service designed three studies to determine the practicability and effectiveness of fluoridating school water supplies.

Since 1958, fluoride has been added to the water supplies of rural schools in an area of Kentucky and another in Pennsylvania. Fluoride levels greater than the optimum for community fluoridation were used in an attempt to approximate the total fluoride intake of children who drink fluoridated water on a full-time basis. The level of fluoride in Pike County, Kentucky was 3ppm., and in Elk Lake, Pennsylvania, 5ppm.

Davies 1974 reported that there are several reasons for suggesting this particular procedure:

- (a) In the U.S.A. nearly all children aged 6 years and older spend between 20% and 25% of their total waking hours in school each year.
- (b) A considerable uptake of fluoride occurs between the completion of the calcification of permanent teeth and their eruption.
- (c) A considerable portion of the permanent dentition calcifies after age 6 years.
- (d) Erupted teeth derive some benefit from the topical effect of fluoridated water.
- (d) Part time exposure to fluoridated water helps to increase the resistance of enamel to caries.

The most apparent disadvantage of school water fluoridation is that children are usually five or six years old before they begin attending school and consuming the school's water whereas maximum benefits accrue when fluoridated water is

consumed from birth. There are data to indicate, however, that children who are six years old or older, when community fluoridation is initiated, do derive dental benefits. These findings are not surprising when one considers that at age six, there is still a significant amount of calcification to occur in the later erupting permanent teeth. In addition, it has been demonstrated that a notable fluoride uptake occurs between the completion of permanent tooth calcification and eruption. There is also evidence that erupted teeth derive some caries-inhibitory benefits from the topical action of fluoridated water.

Horowitz, 1968 reported the study procedures and the findings of the two studies conducted in Elk Lake, Pennsylvania and Pike County, Kentucky which are produced to reveal the efficiency of school water fluoridation in reducing dental caries.

2.2.I STUDY PROCEDURES.

Children attending the Phelps and Feds Creek schools in Kentucky, and the Elk Lake school in Pennsylvania live in rural areas not serviced by central water supplies. The various drinking water sources available to the children contain negligible amounts of fluoride.

The fluoridation equipment is operated and serviced by the custodian of the Elk Lake school and by a county health department sanitarian at the project schools in Kentucky. General supervision, surveillance and consultation are provided by the Division of Dental Health. Water samples have been collected fairly regularly at each of the schools, and these have been analysed for fluoride content. The average monthly fluoride levels achieved during the eight-year period have been 3.16 ppm at Phelps, 2.90 ppm at Feds Creek and 5.01 ppm at Elk Lake.

An examination for fluorosis among children in grades 7 - 9 was included as part of the 1966 survey of dental caries prevalence. Most of the permanent teeth, except for third molars, of children in these grades were erupted at the time of the examinations - (about 26 teeth per child). The cuspids, bicuspid, and second molars of these children had still been calcifying when they were initially exposed to the higher levels of fluoride at school and therefore could potentially demonstrate signs of fluorosis.

2.2.2 FINDINGS IN ELK LAKE.

Table 5.—Analysis of change in mean DMF teeth from 1958 to 1966, by age—Elk Lake, Pa.

Age	1958 (Baseline)		1966		Difference in mean DMFT		% difference in mean DMFT
	No. of children	Mean no. DMFT	No. of children	Mean no. DMFT	Amount	P†	
Total	1,030	7.72	1,076	4.72	-3.00	—	-38.9
Adj. total*	—	—	—	5.10	-2.62	<.01	-33.9
6	91	0.86	109	0.28	-0.58	<.01	-67.4
7	84	2.17	106	0.98	-1.19	<.01	-54.8
8	64	2.94	98	1.73	-1.21	<.01	-41.2
9	85	3.72	114	2.58	-1.14	<.01	-30.6
10	81	4.48	79	3.56	-0.92	<.01	-20.5
11	123	6.36	103	3.85	-2.51	<.01	-39.5
12	90	8.96	90	5.36	-3.60	<.01	-40.2
13	114	10.89	88	6.07	-4.82	<.01	-44.3
14	85	11.86	93	7.92	-3.94	<.01	-33.2
15	102	13.32	88	9.20	-4.12	<.01	-30.9
16	68	14.93	58	11.21	-3.72	<.01	-24.9
17	43	14.19	50	11.84	-2.35	.02	-16.6

* Adjusted to 1958 age distribution.

† One-tailed t test.

(Source : Horowitz, H.S. et al - 1968)

Table 5. summarizes the data on decayed, missing, or filled (DMF) teeth obtained from the baseline and 1966 examinations at the Elk Lake school, Pennsylvania. The analysis includes only data for children who continually attended the study school from the time they were eight years of age or younger. Data for children, ages five and eighteen, have been eliminated because so few children of these ages were examined.

Figures in the top two lines of Table 5 relate to children of all ages combined. Because the age distribution of children in 1966 differed from that of children in 1958, the overall DMF tooth scores for 1966 have been adjusted to the 1958 age distribution, so that valid comparisons can be made.

The data show the difference in age specific DMF tooth scores for children of each age in 1966 compared with findings for children on the baseline. Differences in average number of DMF teeth range from 0.58 for six-year-olds to 4.28 for

I3-year-olds, with the largest values uniformly occurring among children ages II - I7. For children of seven - ten years of age, differences in average number of DMF teeth are all very similar, about one DMF tooth per child.

In I966, the average number of DMF teeth (adjusted) for all children was 5.I0. Compared with the overall I958 baseline average of 7.72 DMF teeth per child, this represents a reduction of 33.9 percent after eight years of school fluoridation. Overall and age-specific differences in mean number of DMF teeth, with the exception of values for I7-year-olds, were all statistically significant.

2.2.3 FINDINGS IN PIKE COUNTY

Table 6 presents data on age-specific DMF tooth scores obtained from the 1957 (baseline) and 1966 surveys of children in the Phelps and Feds Creek schools combined. A few 5 - and 8-year-olds have been excluded from the data. The 1966 findings have been adjusted to the age-specific distributions of children by school in 1957. As in Elk Lake, the findings show that, after eight years of school fluoridation, children of each age experienced reductions in DMF tooth scores compared with their controls on the baseline.

Table 6—Analysis of change in mean DMF teeth from 1957 to 1966, by age—Pike County, Ky.

Age	1957 (Baseline)		1966		School adjusted mean	Difference in mean DMFT†		% difference in mean DMFT†
	No. of children	Mean no. DMFT	No. of children	Mean no. DMFT		Amount	P†	
Total	1,698	7.17	1,037	4.58	—	—2.59	—	—36.1
Adj. total*	—	—	—	—	4.82	—2.35	<.01	—32.8
6	135	1.01	88	0.43	0.44	—0.57	<.01	—56.4
7	144	2.17	120	1.09	1.12	—1.05	<.01	—48.4
8	136	2.93	101	1.87	1.88	—1.05	<.01	—35.8
9	149	3.90	103	2.17	2.16	—1.74	<.01	—44.6
10	170	5.14	83	3.25	3.22	—1.92	<.01	—37.4
11	158	6.70	80	4.24	4.21	—2.49	<.01	—37.2
12	124	8.18	82	5.16	5.16	—3.02	<.01	—36.9
13	132	8.86	92	5.88	5.83	—3.03	<.01	—34.2
14	179	11.15	84	7.32	7.38	—3.77	<.01	—33.8
15	169	12.27	91	8.36	8.28	—3.99	<.01	—32.5
16	128	12.81	63	10.19	9.66	—3.15	<.01	—24.6
17	74	12.51	50	11.54	10.93	—1.58	.09	—12.6

* Adjusted to 1957 age distribution.

† One-tailed t test.

Source : Horowitz, H.S., et al - 1968.

Unlike the pattern of benefits observed in Elk Lake, however, differences in average number of DMF teeth rise fairly steadily with age; the reductions reach a level of almost four fewer affected teeth per child for both I4 - and I5-year-olds. For the combined study population of the two Kentucky schools in 1966, there was an average decrease of 2.35 DMF teeth, or 32.8 percent, compared with children examined on the baseline. Differences in mean DMF tooth scores between 1957 and 1966 were statistically significant except for the I7-year-olds.

2.2.4 FLUOROSISTable 7.—Distribution of permanent teeth by type of tooth and fluorosis classification—
Elk Lake, Pa., and Pike County, Ky.

Fluorosis classification	Elk Lake, Pa. (281 children)*			Pike County, Ky. (241 children)*		
	All teeth	Cuspids bicuspids and second molars	Incisors and first molars	All teeth	Cuspids bicuspids and second molars	Incisors and first molars
Total teeth	7,180	3,930	3,250	6,124	3,602	2,522
Normal	7,122	3,876	3,246	6,009	3,494	2,515
Questionable	46	46	0	113	106	7
Teeth with fluorosis	12	8	4	2	2	0
Very mild	10	8	2	2	2	0
Mild	0	0	0	0	0	0
Moderate	2	0	2	0	0	0
Severe	0	0	0	0	0	0

* Grades 7 through 9.

SOURCE: Horowitz, H.S., et al - 1968

Table 7. presents findings on fluorosis according to types of teeth for children in grades 7,8, and 9 examined in Elk Lake and Pike County who had attended the study schools continually. The data have been grouped to show the number of permanent teeth exhibiting positive signs of fluorosis as opposed to those with no fluorosis (normal) or with borderline signs, classified as questionable.

A total of 281 children at the Elk Lake School were examined for fluorosis. Of 7,180 teeth scored, only 12 were classified as having positive signs of dental fluorosis. Ten of these teeth were classified as having very mild fluorosis and two received a classification of moderate. The two moderately involved teeth were in the same child and both were upper central incisors. Because a child's central incisors are completely calcified at the time he enters school, the etiology of the observed fluorosis cannot be attributed to the consumption of fluoridated water at school.

In both Pike County schools, 241 children in grades 7 - 9 were examined for fluorosis. A total of 6,124 permanent teeth were examined and classified according to Dean's Index of fluorosis. Of these, only two teeth were judged to have

definite signs of fluorosis; both were upper first bicuspid in the same child, and these teeth received a classification of very mild.

2.2.6 SUMMARY

Since 1958, fluoride has been added to the water supplies of rural schools in Pike County, Kentucky and Elk Lake, Pennsylvania; at levels of 3 ppm and 5 ppm, respectively. Fluoride levels greater than the optimum for community fluoridation were used in an attempt to approximate the total fluoride intake of children who drink fluoridated water on a full-time basis.

Interim dental examinations, conducted in 1966, showed that the level of dental caries for children who had continually attended the study schools was substantially and significantly lower than the caries scores of children enrolled in the schools at the time school water fluoridation was instituted. Compared with baseline findings, study children in Pike County experienced overall reductions in average number of DMF teeth of 32.8% and in Elk Lake 33.9%. Results after eight years of school fluoridation support interim data obtained after four years that indicated the procedure appreciably reduced caries prevalence.

Data on fluorosis demonstrated unequivocally that the levels of fluoride added to the school's water supplies have not produced any forms of objectionable fluorosis. Only 0.13% of cuspids, bicuspid, and second molars, teeth that were still calcifying when initially exposed to the higher levels of fluoride at schools, were found to have positive signs of fluorosis. The few teeth affected were all classified as very mild.

In the Appendix Section, a Cost-Analysis is prepared for Cost Benefit and Cost-Effective in the various preventive methods.

2.3 FLUORIDE DENTIFRICES

Toothpastes with fluoride have long been commercially available to help reduce dental caries and their use is recommended for everyone.

In 1960 the Council on Dental Therapeutics of the American Dental Association began an acceptance program of dentifrices with caries-inhibitory properties. The first dentifrice to receive provisional acceptance (CREST) contained fluoride as its active ingredient. The products effectiveness and safety had to be reviewed by this Council and its consultants before a product could be accepted.

Several studies have reported moderate reductions in incremental DMF surfaces, on the order of 15 to 30 percent, following the normal usage at home of CREST.

Evaluations of dentifrices that contain various fluoride compounds have been the most widely conducted, and generally these evaluations have yielded encouraging results. The compounds that have attracted the most attention so far are stannous fluoride, sodium fluoride, sodium monofluorophosphate, acid phosphate-fluoride and amine fluorides.

2.3.I STANNOUS FLUORIDE DENTIFRICES

Stannous fluoride or divalent tin fluoride has received considerable attention and there were claims of the superiority of this compound partly due to the presence of tin. When tested clinically, several formulas were reported to have significant anticaries properties.

The dentifrice called "Crest" which was 'provisionally accepted' by the Council of Dental Therapeutics of the American Dental Association in 1960, contains 0.4% stannous fluoride and a calcium pyrophosphate abrasive system.

Pigmentation or discoloration, particularly of incipient, chalky carious lesions, has been reported as a result of the regular use of stannous fluoride dentifrices. However, the frequency and intensity of staining with stannous fluoride dentifrices do not appear to be problems of serious concern for the user.

The range of caries reductions from using stannous fluoride dentifrices may be shown by the Table 8. below.

TABLE 8.
STANNOUS FLUORIDE DENTIFRICE TRIALS

PRINCIPAL ABRASIVE	NUMBER OF STUDIES	AGE OF PARTICIPANTS YEARS	DISTRIBUTION OF CARIES REDUCTION.		
			0-19%	20-39%	40-59%
CALCIUM PYROPHOS- PHATE	24	5-36	9	12	3
INSOLUBLE SODIUM META- PHOSPHATE	11	5-21	6	5	

(SOURCE: von der FEHR/MOLLER - Caries-Preventive fluoride Dentifrices.

CARIES RES. 12 (Suppl.I) : 31 - 37 (1978).

2.3.2 SODIUM FLUORIDE DENTIFRICES

In the early 40s, American researchers added sodium fluoride to various dentifrice combinations and tested them clinically. These trials, however, failed to show a significant reduction in dental caries among participants who used the formulations. (Heifetz and Horowitz - 1975, von der Fehr/Moller - 1978).

The caries-inhibiting effect of fluorides is considered to be caused by the fluoride ion. The discovery that the fluoride ion was inactivated and that the enamel fluoride reactions were inhibited by some of the components commonly used in dentifrices stimulated research in the formulation of promising sodium fluoride dentifrices (Ericcson 1961).

It is mainly the calcium - and phosphate - containing abrasives that will bind and inactivate fluoride ions and attempts have been made to develop other abrasive systems. Anticaries effects have been demonstrated for dentifrices containing sodium bicarbonate, various types of phosphates, silicon dioxide and plastic abrasives. This latter principle has received considerable interest, partly because the plastic particles (mostly acrylic particles) are considered chemically inert and partly because of the impressive caries reductions reported by Swedish groups. (von der Fehr/Moller - 1978). The strong anti-caries effect might be partly due to the low abrasiveness of these dentifrices. Table 9 shows a summary of sodium fluoride dentifrice trials.

Table 9 Sodium fluoride dentifrice trials

Principal abrasive	Number of studies	Age of participants, years	Reductions in caries increment
Calcium carbonate	3	4-23	nil
Calcium ortophosphate (heat-treated)	1	4-15	nil
Insoluble metaphosphate	4	9-24	0-20%, 1-2 surfaces/2 years
Dicalcium phosphate	1	11-12	1-2 surfaces/2 years
Calcium pyrophosphate	5	5-15	0-38%
Sodium bicarbonate	1	10	1-2 surfaces/2 years
Plastic particles	5	8-15	38-48%
Silicon dioxide	2	9-11	50%, $\approx$ monofluorophosphate

(SOURCE: von der FEHR/MOLLER - 1978)

2.3.3 MONOFLUOROPHOSPHATE DENTIFRICES

The several clinical trials with the dentifrice conducted by different investigators in different areas showed a statistically significant caries reductions range from 18 to 32%. It has also been reported that the teeth of children in groups who brushed with the mono-fluorophosphate dentifrice have exhibited less staining than those of children who used a stannous fluoride dentifrice.

Monofluorophosphate dentifrices, which has been accepted by the Council on Dental Therapeutics of the American Dental Association, have several advantages over stannous fluoride dentifrice. There is no staining problem, the ptt is close to neutrality, the compound is stable and compatible, and in comparative studies, it appears to be more effective than stannous fluoride (von der Fehr/Moller - 1978).

Table 10. shows a summary of monofluorophosphate dentifrice trials.

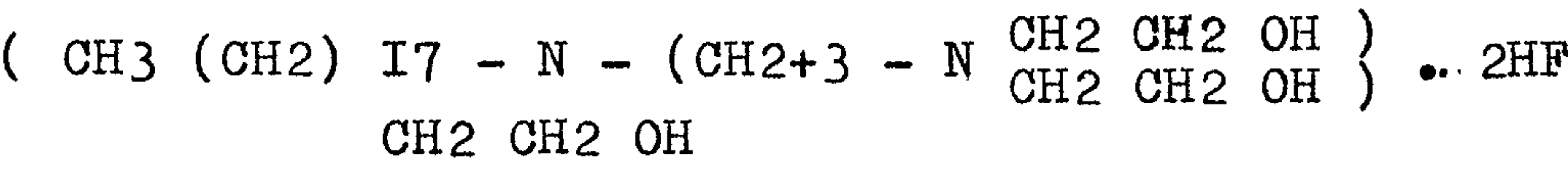
Table 10. Monofluorophosphate dentifrice trials

Principal abrasive	Number of studies	Age of participants years	Distribution of caries reduction		
			0-19%	20-39%	40-59%
Insoluble sodium metaphosphate	9	6-28	4	5	
Calcium carbonate	6	8-12	2	3	1
Dicalcium phosphate	6	7-14	1	4	1
Calcium pyrophosphate	1	7-14		1	
Aluminium oxide	5	5-12	2	3	

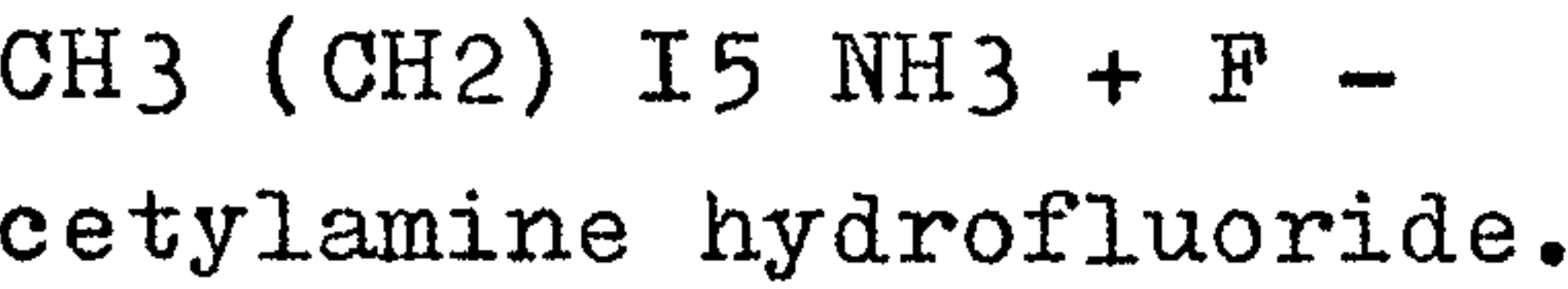
(SOURCE: von der Fehr/Moller - 1978).

2.3.4 AMINO HYDROFLUORIDE DENTIFRICES

The dentifrice Elmex contained two amine-fluoride compounds, diethand aminopropyl - N - ethanol octadecylamine-dihydrofluoride and cetylamine hydrofluoride.



Diethand aminopropyl - N - ethanol octadecylamine - dihydrofluoride.



Both substances have a long aliphatic chain containing I6 or I8 carbon atom, which is responsible for the dentifrices' property of lowering surface tension. This amine fluoride product contains insoluable sodium metaphosphate as the abrasive.

Long term clinical studies have demonstrated significant caries reductions (about 30%) from unsupervised use of the dentifrice (Newbrun - I975).

Table 11 shows a summary of amine fluoride dentifrice trials.

Table 11. Amine fluoride dentifrice trials (principal abrasive: insoluble metaphosphate)

Duration of study years	Age of participants years	Caries reductions	
		tooth surfaces saved	per-centage
3	7	3-4	30
3	11-12	4	24
7	6-8	5-6	26
3	15-18	0.8	7

(SOURCE: von der Fehr/Moller - I978).

TABLE II : Cost-effectiveness of school based distribution of fluoride containing dentifrice (0.1%F) for home use.

COST: All treatments carried out at home.

No. of treatments :	N/A.
Time required :	N/A.
Salaries :	N/A.
Materials :	Fluoride dentifrices and toothbrushes.
	\$4.00/child/yr X 3 yrs = I2/child.
Total cost :	= I2/child.

EFFECTIVENESS :

6 DMFS/child X 20% reduction = I.2 DMFS/child.

COST-EFFECTIVENESS

$\frac{\$I2//child.}{I.2 \text{ DMFS/child.}}$	=	$\frac{\$ 10.00}{I \text{ surface saved.}}$
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SOURCE:

Heifetz, S.B., (1978) - Cost-Effectiveness of Topical Applied Fluorides. In Proceedings of a Workshop at the University of Michigan, June 5 - 8, 1978.

NOTE:

Normal toothpaste - no effect on people buying it; but a fluoride toothpaste is cost-effective on the overall in the savings of fillings, etc.

2.4 SALT-FLUORIDATION

The first publications suggesting salt as a vehicle for fluoride appeared in 1948 and 1950. Their author, Waspi, had been active in the prevention of goitre by promoting the introduction of iodized salt in Switzerland. Results of a clinical study initiated in 1956 were in favour of a cariostatic effect of fluoride-supplemented salt. (Marthaler T.M. et al - 1978).

Carefully planned studies with fluoride-supplemented salt were started in Switzerland 1962, Colombia and Spain 1965, and in Hungary in 1966. The Switzerland study used only 90 mg F/kg until 1970 whereas the other studies used concentrations of fluoride in salt in the range of 200 - 350 mg F/kg.

2.4.1 RESULTS OF STUDIES IN FOUR COUNTRIES

(a) SWITZERLAND

The success of iodization of salt in curing endemic goitre in Switzerland in 1917, led to the introduction of fluoridated salt, which began in 1955. By 1967, three quarters of the 1-kg packages of salt sold for domestic use of a population of 5.5 million were fluoridated to 90 ppm F. (Table 12).

In several cantons, with approximately 2 million inhabitants, only fluoridated salt had been available for up to 10 years.

Production of salt with 250 ppm F was started in 1970 for the canton of Vaud (VD: population 500,000), and in 1975 for the canton of Glarus (GL; population 40,000).

Results of early surveys of caries prevalence associated with the use of domestic salt at the low level of 90 ppm F are given in the upper part of table 12.

Table 12. Data on production of fluoridated salt in Switzerland

1955	F salt at 90 ppm F (by addition of NaF) first produced by VSR
1958	127 t produced, used in 9 cantons (of 25)
1960	313 t produced, used in 20 cantons
1964	598 t produced
1967	746 t produced
	In 13 cantons, 80-100% of all salt in 1-kg packages is fluoridated. VSR produced 9.83 millions of 1-kg packages, and 76% of them contained 90 ppm F. The situation of the 90-ppm salt has changed very little since then
1969	F salt at 100 ppm F by addition of KF first produced by SB for the canton of VD
1970	F salt at 250 ppm F produced by SB. 1-kg packages as well as 50-kg sacs for bakeries are fluoridated
1974	Small-scale production of 250 ppm F salt by VSR for the canton of GL, 1- and 25-kg packages

VSR = Vereinigte Schweizerische Rheinsalinen, producer of salt for 24 cantons with 5.5 million inhabitants; SB = Saline de Bex, producer of salt for the Canton of Vaud with 0.5 million inhabitants. VSR and SB are the only Swiss producers of salt for human consumption.

The data obtained from children up to 9 years of age support the hypothesis of a cariostatic effect of fluoride added to domestic salt. At ages above 12, DMF counts were similar whether or not fluoridated salt had been used; this was expected in view of the fact that the fluoride content was substantially below the optimum level and that fluoridation had been in effect for only 4 - 5 years. Caries prevalence

in the children of the cantons of Fribourg (FR) and Neuchatel (NE) decreased from 1970 to 1974 (lower part of table 13). This decrease was due to the introduction of fluoride tablet distribution at school in the late sixties. In 1970, caries levels in the carton of VD were already as those found in the three communities of FR and NE in 1974. In the carton of VD, DMF levels fell further when daily tablet distribution was replaced in 1970 by salt fluoridation at 250 ppm (Marthaler, M.T. - 1978).

Table 13 Average numbers of DMF surfaces in children examined under blind conditions in various localities after using domestic salt either with or without fluoride supplementation

	Age 8-9, n = 266	Age 12-14, n = 122	
<i>Zürich, May 1960¹</i>			
No fluoridated salt or sometimes	8.1	26.0	
Fluoridated salt (90 ppm) for 4-5 years	6.1	25.4	
	Age 7-9 n = 436	Age 12-14, n = 395	
<i>Wädenswil, May 1961²</i>			
No fluoridated salt or sometimes	4.7	22.2	
Fluoridated salt (90 ppm) regularly since 1956	3.2	22.7	
	Age 10, n = 339	Age 12, n = 208	Age 14, n = 30
<i>Cantons of FR and NE, April 1970 and 1974³</i>			
1970, no organized prevention	7.43	15.41	20.24
1974 F tablets, irregular	5.98	11.17	17.84
	Age 10, n = 266	Age 12, n = 221	Age 14, n = 213
<i>Canton of VD, April 1970 and 1974⁴</i>			
1970, F tablets since 1953	5.36	10.37	16.22
1974 fluoridated salt (250 ppm) since 1970	3.72	7.33	12.62

SOURCE : Marthaler, M.T.
et al - 1978

n = Number of children.

¹ Marthaler [1961].

² Marthaler and Schenardi [1962]; unweighted means of 3-year age-groups.

³ Three communities (Romont, St-Aubin, Châtel St-Denis).

⁴ Three communities (Moudon, Grandson, Yveroy) [Marthaler et al., 1977].

(b) COLOMBIA

The four Colombian communities selected for study were Armenia, Montebello, San Pedro, and Don Matias. The communities have stable populations in the range of 8,000 - 12,000 inhabitants and are not adjacent to each other. Don Matias served as control community. In San Pedro, fluoride was added to the drinking water. In Montebello and Armenia NaF and CaF_2 , respectively, were added to the domestic salt. The first DMFT survey was made in 1964. From 1966 to 1972, surveys were made every year by the same group of examiners who conducted the initial 1964 survey. The examiners were regularly checked, with the result that inter-examiner margins of error were brought down to below 3% when comparing repeated individual DMFT counts. The total number of examinations carried out in the four communities between 1964 and 1972 was 27,032.

DMFT averages for 1964 and 1972 are shown in table 14. In the control community, DMFT averages varied very little. By contrast, they fell strongly in the three fluoride communities. The preventive effectiveness of fluoridated water, calcium fluoride and sodium fluoride was very similar. In the younger children, for whom fluoride supplementation had begun at age I - 3, DMF averages were reduced by more than 50%. For the II - 13 year old children for whom fluoride supplementation started at age 4 - 6, the benefit was slightly less than 50%. The reduction of DMFT averages obtained in the three fluoridated communities was comparable to that previously obtained by water fluoridation when considering the age at which the children started to consume fluoridated water.

Figure I. displays for each community overall DMFT means of all children in the age span 8 - 13 years. The overall means in the control community (Don Matias) remained more or less constant while those of the fluoride communities fell progressively as the number of years with fluoride supplementation increased.

Table 14. Average number of carious teeth (DMF permanent teeth, unweighted means of the averages at ages 8-13 as given by Mejia *et al.* [1976] per child in four communities with either no supplement fluoride or fluoride added to water or salt .

Age-groups and years of examination	No fluoride added	Fluoride in water	NaF in salt	CaF ₂ in salt
<i>8- to 10-year-old</i>				
1964	5.53	4.87	4.33	4.89
1972	5.27	1.78	1.71	1.98
<i>11- to 13-year-old</i>				
1964	11.24	9.44	8.74	10.49
1972	11.81	4.74	4.50	5.42

SOURCE : Marthaler, M.T., et al - 1978.

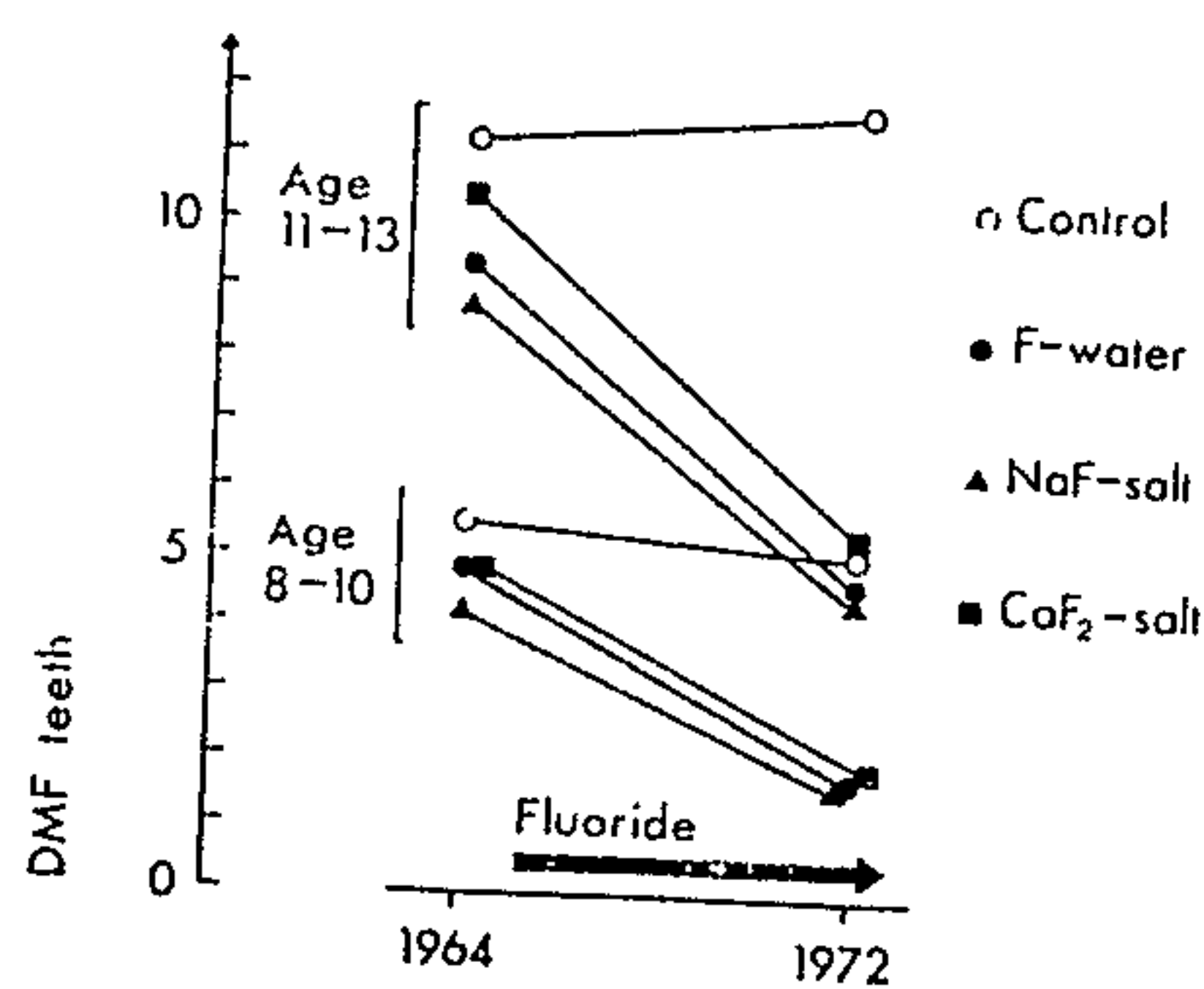


Fig. 1. Average number of DMF per child (ages 8-13) from 1964 to 1972 in four Colombian towns. Fluoridated salt was introduced in summer 1965 [from Mejia *et al.* 1976].

SOURCE : Marthaler, M.T., et al - 1978.

(c) SPAIN

A study of salt fluoridation was started in Pamplona in 1965). Cooperation of a salt production plant for providing fluoridated salt was obtained. A closed institution with some 200 children was chosen for the clinical trial. A study of dietary habits showed that an average of 10 g of salt was used per person and day. Half of this was used in the bakery for bread. Based on these figures, a concentration of 112 ppm F (250 ppm NaF) was considered adequate and has been added to the salt used in this institution since the end of 1965. At that time, examinations for DMF counts were made.

The second examination was carried out in June 1969. At all ages, DMF averages were substantially lower in 1969 than in 1965. The results are shown in table 15.

Table 15. Average number of DMF teeth per child

	Average number of DMF teeth per child					
	8- year- n	9- year- olds	10- year- olds	11- year- olds	12- year- olds	13- year- olds
1965, start of salt fluoridation	150	3.47	3.88	5.06	5.20	6.24
1969, 3.7 years of salt fluoridation	155	2.27	2.72	3.16	3.81	4.42

Data from an institution with children who since 1965 had been consuming fluoridated salt in cooked food and bread. n = Number of children [from Viñes, 1971].

SOURCE : Marthaler, M.T., et al - 1978.

(d) HUNGARY

After preliminary studies in 1965, a clinical trial was begun in 1966, using a 250 ppm F domestic salt. In 1968, domestic salt with 200 ppm F and in 1972, salt with 350 ppm F (by adding Naf in all cases) were introduced in two further experimental villages. The salt for bakeries and other industrial processing was not fluoridated. Results from the study with 250 ppm F in salt are shown in table 16.

Table 16 Average age and number of carious teeth per child (def deciduous teeth at age 2-6 and DMF teeth at ages above 7) [from Toth, 1976]

Age-groups and years of examination	Mean age, years; months		Carious teeth	
	control	fluoride	control	fluoride
<i>2-6 years, def teeth</i>				
1966/1967	4;1	3;10	5.19	4.18
1976	4;0	3;5	4.56	1.43
n	516	219		
<i>7-11 years, DMF teeth</i>				
1966/1967	8;9	8;5	3.85	3.62
1976	8;6	8;7	2.80	1.45
n	1277	348		
<i>12-14 years, DMF teeth</i>				
1966/1967	12;3	12;6	7.33	6.60
1976	12;6	12;8	7.20	3.65
n	818	222		

n = Numbers of children examined; in the control community, children were examined in 1967 and 1976; in the fluoride community, they were examined in 1966 and 1976.

SOURCE : Marthaler, M.T., et al - 1978.

The numbers of carious teeth (def deciduous or DMF permanent teeth) remained fairly constant in the control villages. By contrast caries experience fell by more than 50% in the age-groups 2 - 6 and 7 - 11 years, and by slightly less than 50% in the children aged 12 - 14. With respect to the deciduous dentition, the data suggest that fluoride-supplemented salt is as effective as fluoridated water (fig. 2).

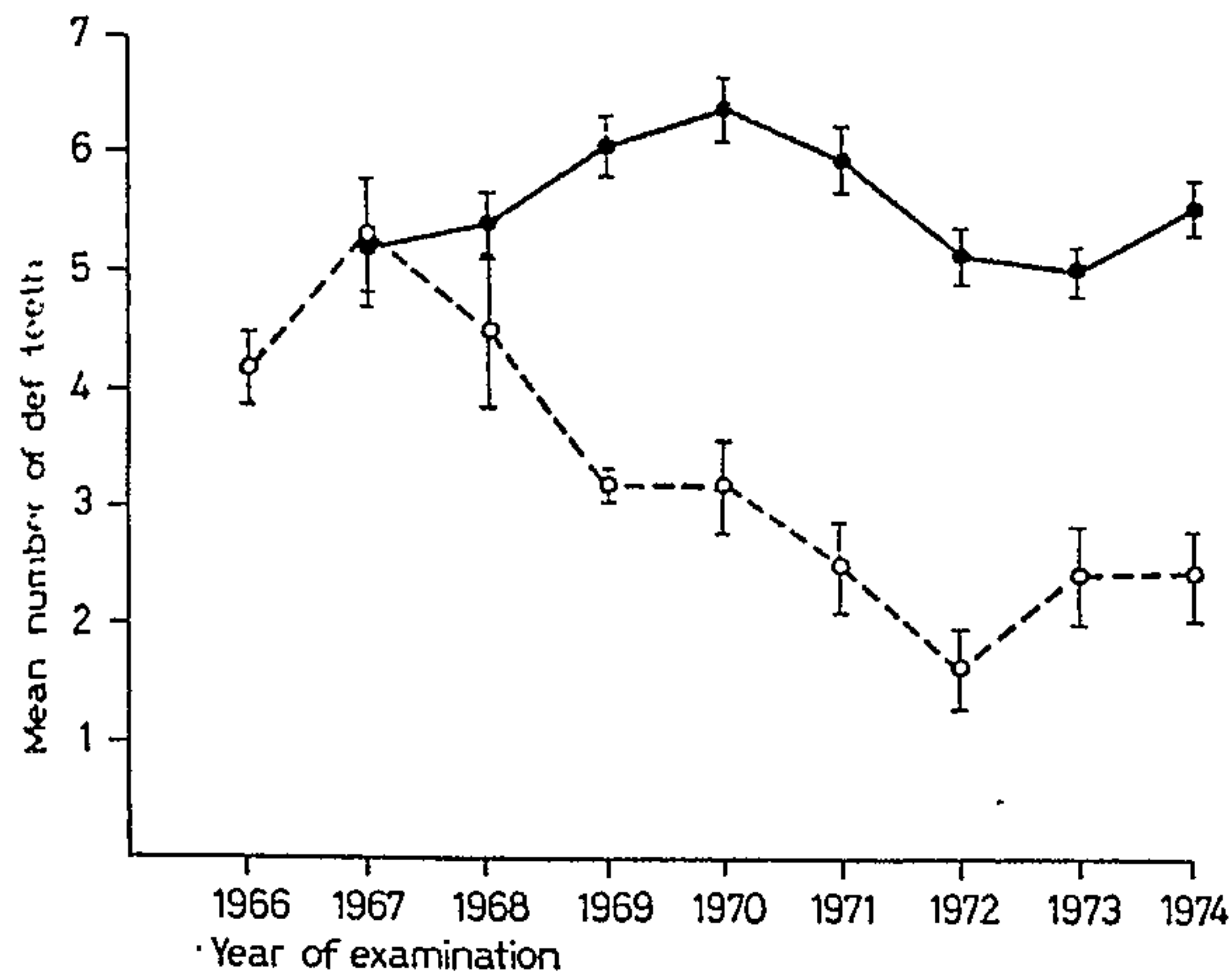


Fig. 2. Average number of def deciduous teeth in children 2-6 years of age of the Hungarian study, — = data from the control children; --- = data from children consuming fluoridated salt since 1966-1967.

SOURCE : Marthaler, M.T. et al - 1978.

2.4.2 CONCLUSIONS

- (i) Fluoride ingested via salt prevents dental caries in man.
- (ii) The cariostatic effectiveness seems to equal that provided by fluoride in water when the fluoride content of salt is adjusted so as to provide urinary fluoride excretion levels similar to those associated with optimal fluoride content of water.
- (iii) It is possible to produce a homogenous, stable salt containing fluoride in the order of magnitude of 250 ppm F. Batch mixing of NaCl and NaF granulates under conditions of controlled temperature and humidity now thoroughly investigated is preferable to continuous-process production methods.

2.5 FLUORIDE MOUTHRINSES

There were more than 8 million children in the United States, in 1974, who were reported to be participating in school-based fluoride mouthrinsing programmes which rank second only to controlled water fluoridation - the largest national caries-preventive public health measure (Ripa, W.R., et al - 1981; Horowitz, A.M., and HOROWITZ, H.Z. - 1980).

This fluoride mouthrinsing programme has also been widely adopted in Swedish children (Forsman B - 1974).

It was reported that a large scale mouthrinse programme was also adopted in Cuba (Siegel, S.R. - 1975) where children rinse 15 times a year in a school-based preventive programme.

2.5.1 RESEARCH BACKGROUND

The use of mouth-rinses as a vehicle by which fluoride is applied in a self-administered preventive programme was first proposed by Bibby and co-workers (1946). Since then, a number of different fluoride solutions and different rinsing frequencies have been tested. Thus, a 0.2% neutral Naf solution has been tested once a week (Horowitz, H.S., et al - 1971) and once every two weeks (Torrell, P., and Ericsson, Y - 1965), a 0.05% Naf solution has been tested once a day (Torrell, P., and Ericsson, Y. - 1965), and different acidulated solutions of Naf have been tested once a day (Packer, M.W., et al - 1975), twice a day (Finn, S.B. et al - 1975), and once a week Heifetz, S.B., et al - 1973). In almost all instances significant reductions in dental caries were achieved in children who participated in the programmes for two years or longer. Indicative of the results were those of Horowitz and co-workers who reported a 16 and 44% caries reduction in first and fifth grade children respectively when rinsing was performed with a 0.2% neutral Naf solution once a week for two school years (Horowitz, H.S., et al - 1971).

The results of 19 clinical trials in which fluoride rinsing was evaluated for at least two years was received by the Council on Dental Therapeutics of the American Dental Association in 1975. Based upon this review, the Council accepted both neutral and acidulated fluoride solutions as "effective agents" for use in reducing the incidence of dental decay (Council on Dental Therapeutics - 1975). The summary of the studies conducted by various investigators using different solutions may be shown by the Table 17.

(Source : Reports of Councils and Bureaus - J.A.D.A. 91 :
I25I - I975.)

Table 17. Summary of results of fluoride mouthrinse studies.

Author	Yr	Compound	Concentration (% F)	Water F	Frequency	Age (Yr)	Rinse (ml/time)	Study length	Caries reduction
Weisz ¹	1960	NaF	0.118	No	2/day	5-9		2-10 yr	80%
Torell and Ericsson ²	1965	NaF	0.0225	No	1/day	11	10/2 min	2 yr	49% DMFS
		NaF	0.09	No	1/14 days	11	10/2 min	2 yr	21% DMFS
Koch ³	1967	NaF	0.225	No	1/14 days	10	10/2 min	3 yr	23% DMFS
		NaF	0.225	No	3-4/yr	10	10/2 min	3 yr	18% DMFS
Hagglund ⁴	1969	NaF	0.09	Yes	1/wk	8	10/2 min	5 yr	30%
Torell ⁵	1969	NaF	0.09 + MFP denti- frice	No	1/14 days	11	10/2 min	2 yr	20% DMFS in relation to F-rinses 1/14 days and F-free dentifrice
Horowitz and co-workers ⁶	1971	NaF	0.09	No	1/wk	6	10/2 min	20 mo	16% DMFS
		NaF	0.09	No	1/wk	11	10/2 min	20 mo	44% DMFS
Aasenden and co-workers ⁷	1972	APF	0.02	No	1/day	8-11	5/1 min (swallow)	3 yr	30% DMFS
		NaF	0.02	No	1/day	8-11	5/1 min (swallow)	3 yr	27% DMFS
Brandt and co-workers ⁸	1972	NaF	0.09	No	2/wk	11	10/1 min	2 yr	36% DMFS
Frank I and co-workers ⁹	1972	APF	0.02	No	1/day	14	5/1 min	2 yr	25% DMFS
Moureira and Tumang ¹⁰	1972	NaF	0.045	No	3/wk	7	2 x 12/30 sec	2 yr	47% DMFS
		NaF	0.045	No	1/wk	7	2 x 12/30 sec	2 yr	25% DMFS
		NaF	0.045	No	1/14 days	7	2 x 12/30 sec	2 yr	23% DMFS
Heifetz and co-workers ¹¹	1973	NaF	0.3	No	1/wk	10-12	2 x 8/1 min	2 yr	38% DMFS
		APF	0.3	No	1/wk	10-12	2 x 8/1 min	2 yr	28% DMFS
Rugg-Gunn and co-workers ¹²	1973	NaF	0.0225	No	1/day	11-12	7.5/2 min	3 yr	36% DMFS
Padron and Maiwald ¹³	1973	NaF	0.09	No	1/14 days	6-7		28 mo	47% DMFS
		NaF	0.09	No	1/14 days	8-9		28 mo	32% DMFS
		NaF	0.09	No	1/14 days	10-11		28 mo	28% DMFS
		NaF	0.09	No	1/14 days	12-13		28 mo	11% DMFS
Radike and co-workers ¹⁴	1973	SnF ₂	0.025	Yes	1/day	8-13	3 x 20/70 sec	20 mo	(1) 33% DMFS (2) 44% DMFS
Kani and co-workers ¹⁵	1973	APF	0.05	No	1/day	10	10/30 sec	3 yr	20%-30%
Gallagher and co-workers ¹⁶	1974	NaF	0.182	No	1/wk	11-13	15/1 min	2 yr	34% DMFS
Finn and co-workers ¹⁷	1974	APF	0.010	No	2/day	9-19	2 x 10/1 min	26 mo	18% DMFS
		APF	0.020	No	2/day	9-19	2 x 10/1 min	26 mo	29% DMFS
Forsman ¹⁸	1975	NaF	0.013	No	1/wk	13	10/2 min	2 yr	Equal increments*
		NaF	0.09	No	1/wk	13	10/2 min	2 yr	
Packer and co-workers ¹⁹	1975	APF	0.02	No	1/day	8-9		28 mo	27% DMFS
		APF	0.10	No	1/wk	8-9		28 mo	41% DMFS

*Comparison study. Nonsignificant trend for weaker solution.

APF, acidulated phosphate fluoride; MFP, monofluorophosphate.

2.5.2 METHODS OF FLUORIDE MOUTHRINSING

There are two basic methods or techniques of rinsing with fluoride solutions as reported in the literature :

- (a) Rinse and Expectorate Method; and
- (b) Rinse and Swallow Method.

(a) RINSE AND EXPECTORATE METHOD

The "rinse and expectorate" method has been largely employed in school-based fluoride mouthrinsing programmes. While there may be differences in the concentrations of solutions used, the frequency of use, the rinse volume and the actual rinsing time for each rinsing session, the procedures have all been basically the same. (TORELL, P., and ERICSSON, Y. - 1966, HOROWITZ, H.S. - 1973, LESKE, G.S., and RIPA, L.W. - 1977). A descriptive account of this method is presented to understand the technique of rinsing - (adapted from Horowitz, H.S. - 1973).

The fluoride mouthrinse solution is prepared just before each rinsing session by the classroom teacher or aide. On the designated days (daily, weekly or fortnightly) school teachers dispense to participating children a paper cup containing the required volume of the solution and an absorbent paper napkin. Under the supervision of the classroom teacher the children carry out the following procedure:

- (i) Starting simultaneously they 'swish' the solution around their mouths for the required duration with their lips tightly closed and their teeth in contact. When 'swishing', the solution is slowly strained back and forth through the spaces between the teeth.
- (ii) When the children have rinsed for the prescribed duration, the contents of the mouth are emptied into the paper cup. Before each rinsing the children are reminded that at no time during the procedure is the solution to be swallowed. The children are then instructed not to eat or drink for a period of 30 minutes following the rinse.

A Summary of the "rinse and expectorate" technique is presented in the Table below.
(SOURCE: Ripa L.W. - I98I)

SUMMARY OF FLUORIDE RINSE AND EXPECTORATE TECHNIQUES.

Fluoride Concentration		Type of fluoride					Usual dose	
Rinsing Method	Program	% Naf.	%F.	ppm F.	Fluoride*	Rinse Freq.	Vol.	F.
Low Pot-ency	Individ-ual	0.44	.0I98	I98	APF	daily	5ml (I tsp)	I mg
High freq.	home based	.05	.0225	225	Naf	daily	5ml (I tsp)	I mg
High Pot-ency	Group	.2	.0900	900	Naf	weekly	IO ml (2 tsp)	9 mg
Low fre-quency	School based							

* APF indicates acidulated phosphate fluoride; Naf indicates sodium fluoride.

Fluoride rinsing, in which the solution is swished in the mouth and then expectorated, may involve a low potency/high frequency technique or a high potency/low frequency technique. The former uses a 0.044 % or 0.05 % Naf solution daily and is especially indicated for home-use by individual patients for whom, because of their caries susceptibility, self-applied topical fluoride applications are indicated. The latter technique uses a 0.2 % Naf solution once a week or fortnightly and is the preferred rinse procedure for school based programmes. Swish and expectorate rinses can be used in either fluoride-deficient or optimally-fluoridated communities (Ripa, L.W. - I98I). The Table below shows some of the high potency fluoride rinses available in the United States which are used in weekly or fortnightly rinsing programmes.

HIGH POTENCY FLUORIDE RINSE PRODUCTS FOR USE IN WEEKLY RINSING PROGRAMS.*

BRAND	TYPE OF FLUORIDE	SODIUM FLUORIDE CONCENTRATION
Naf pak ≠	Naf	0.2 %
Pacemaker	Naf	0.2 %
Fluorinse, 0.2% ≠	Naf	0.2 %
Point-Two		
Dental Rinse §		

- * All preparations accepted by American Dental Association.
 - ≠ Marketed in 2- and 3- gm packets of NaF. Two - gm packet should be dissolved in 1,000 ml water, 3-gm packet in 1,500 ml water. Contains additives, but additive-free packets may also be purchased (not listed by ADA in Accepted Dental Therapeutics).
 - # Marketed in 120-ml bottles and packages of 12. 10-ml unit dose trays. Contains additives.
 - § Marketed in 120-ml bottles and 1-gal bottles with 5-ml pump dispenser. Contains additives.
- (SOURCE: Ripa, L.W. - 1981).

(b) RINSE AND SWALLOW TECHNIQUE

This technique involves the use of oral fluoride rinse supplements which are dietary fluoride supplements but available as a rinse. (Ripa L.W. - 1981). The recommended procedure involves "swishing" to produce a topical effect to the teeth already erupted and then swallowed to produce a systemic effect to the unerupted teeth. (Hasenden, R., et al - 1972).

The frequency of rinsing and swallowing is on a daily basis. A teaspoon provides one milligram of fluoride which is equivalent to a standard NaF tablet. Oral rinse supplements are low potency rinses, which are listed in the Table 18. below. (SOURCE: Ripa, L.W. - 1981).

LOW POTENCY FLUORIDE RINSE PRODUCTS FOR USE IN DAILY RINSING PROGRAMS SODIUM FLUORIDES.

Table 18 Low potency fluoride rinse products for use in daily rinsing programs*

Brand	Type of fluoride	Sodium fluoride concentration	Availability
Prescription rinses			
Janar's Sodium Fluoride Rinset	NaF	0.05%	7-ml pouches, boxes of 45
Janar's Acidulated Phosphate Fluoride Rinset	APF	0.045%	7-ml pouches, boxes of 45
Karl Rinse	NaF	0.05%	480-ml bottle
Monoject Fluoride Mouthrinse	NaF	0.05%	480-ml bottle
NaFrinse, 0.05% Neutral	NaF	0.05%	500-ml bottle
Pacemaker Fluorinse, 0.05%	NaF	0.05%	480-ml bottle
Nonprescription rinses			
Fluoriguard	NaF	0.05%	300-ml and 480-ml bottle
Stan Care	SnF2	†	box, 24 and 46 tablets; dispensing cups
Oral rinse supplements			
NaFrinse Acidulated Oral Rinse & Systemic Suppl.	APF	0.044%	500-ml bottle
Phos-flur Oral Rinse Suppl.	APF	0.044%	30-ml, 500-ml cups, 1-gal bottles

* All preparations accepted by American Dental Association and contain additives.

† Currently not commercially available.

‡ 0.1% stannous fluoride.

§ Gallon bottle not for home use.

A rinse and swallow technique can be used for children between approximately 3 and 13 years of age who reside in a fluoride-deficient community. Low potency rinses may be dispensed from the dental office for home use. Recently, low potency rinses have become available to the public (in the U.S.) without prescription (Ripa, L.W. - 1981).

The need for systemic fluoride supplements and the appropriate dose are determined by the patient's age and the concentration of fluoride in the drinking water. Figure A (below) shows oral rinse supplements which is indicated for children 3 years and older who reside in communities with 0.7 parts per million F or less in water. When the level of fluoride in the drinking water is less than 0.3 ppm, the patient is instructed to rinse daily and swallow one teaspoon of oral rinse supplement.

FIGURE A. INDICATIONS FOR ORAL RINSE SUPPLEMENTS

Age (years)	F in drinking water (ppm)		
	Less than 0.3	0.3-0.7	Greater than 0.7
0-2	Use another method of systematic supplementation	Systematic fluoride supplements	
2-3		not indicated	
3-13	Can use oral rinse supplement. Dose: 1 teaspoon provides 1 mg F	Can use oral rinse supplement. Dose: ½ teaspoon provides ½ mg F	

Fig 3 ■ Indications for oral rinse supplements.

(SOURCE: Ripa, L.W. - 1981).

2.5.3 PLANNING AND DEVELOPMENT OF A RINSING PROGRAMME.

The guidelines for planning and developing a rinsing programme as proposed by the U.S Public Health Service (NICR - 1977) will be reviewed in addition to other contributions.

Horowitz and co-workers (1971) have summarized the most obvious advantages of a school-based fluoride mouth-rinsing programme:

- (1.) Little time is involved for the preventive procedures.
- (2.) The technique of application is easy to learn.
- (3.) Few treatment materials are required. - the procedure is inexpensive.
- (4.) Non-dental personnel with minimal training can easily supervise the procedure.
- (5.) Frequent treatments can be administered easily with minimal interruption of a school's academic programme.

The planning and development of a mouth rinsing programme should include the following factors :

- (a) Identification of an appropriate population for rinsing.
- (b) Estimation and securing of funds to underwrite the programme.
- (c) Recruitment and training of staff to administer the programme.
- (d) Programme implementation (Leske, G.S., and Ripa, L.W. - 1977)

(a) POPULATION

Table 19, prepared by the U.S. Public Health Service is an outline and the guide to be followed in determining the need for a school rinsing programme. Generally, a school rinsing programme is based in a community in which the fluoride in the water supply is below therapeutic levels. Since the therapeutic level is based on the estimated daily water consumption, that in turn, is related to the mean temperature, a therapeutic range rather than a single level, is usually started.

TABLE. 19.

OUTLINE FOR DETERMINING THE APPROPRIATE SELF-APPLIED FLUORIDE PROGRAM FOR USE IN SCHOOLS *

Level of fluoride in water supply	Recommended Procedure		Comments
	Tablets (Daily)	Mouthrinse ** (Weekly)	
0.0 - 0.39 ppm	✓ 1 mg. fluoride	✓	Children who live in areas with insufficient levels of fluoride in water should receive dietary supplements (tablets) in grades K-8 and fluoride mouthrinses in grades 9-12 or, if a tablet program is not feasible, fluoride mouthrinses for all grades, K-12.
0.4 - 0.69 ppm	✓ 0.5 mg. fluoride	✓	See above. If fluoride level is 0.7 and above, dietary supplements (tablets) should not be provided.
Optimally fluoridated, but not for sufficient time to provide adequate protection to all children		✓	Children who have not had optimally fluoridated water since birth should receive protection of fluoride rinses.
Optimally fluoridated, but schools have a high proportion of students who either have transferred from fluoride-deficient areas or who currently reside where only trace levels of fluoride exist		✓	Many communities with mobile populations have initiated a fluoride rinse program to provide protection for students who have moved from non-fluoridated areas. Continuous residents are likely to benefit as well (see below).
Optimally fluoridated		?	Limited research suggests that students may benefit from the added protection of a fluoride mouthrinse.

* General guide only, the ultimate decision must be determined by a knowledgeable dentist or physician based upon local needs.
 ** 0.2 percent neutral sodium fluoride solution.

SOURCE: U.S. PUBLIC HEALTH SERVICE

REFERENCE - DHEW Publication No. (NIA) 77 - II96 (I977)

Schools located in communities that have fluoridated water but have a large proportion of children who are transported from fluoride-deficient areas might also be considered for a rinsing programme.

Table 20 shows a valuable guide to classroom participation which usually begins in kindergarden and extending to highest grade within the school system.

After it is decided to implement a school rinsing programme the following steps may be necessary :

1. Obtaining the co-operation and participation of school administrators, the local dental society, and local pediatricians;
2. Preparing a proposal outlining the rinsing programme and describing the obligations and responsibilities of all parties concerned;
3. Obtaining letters of endorsement from the local dental and pediatric societies so that the school board members, school superintendents and principals will be aware of the support of these professional groups;
4. Soliciting additional support from local and state dental health department officials;
5. Delineating the cooperation expected from the school;
6. Apprising school officials that they will have to provide class rolls, aid in the distribution and collection of consent forms, and provide space to store and to mix the fluoride solution;
7. Agreeing on the time scheduled for rinsing and describing the role of homeroom teachers and school nurses if they are to be classroom supervisors.

After approval is obtained from the school administrators, the classroom teachers and other school health personnel are to be apprised of the proposed programme, and their participation and cooperation be secured. Only after all necessary support has been obtained can the rinsing population be truly identified.

EXAMPLE OF INITIATING A SAF PROGRAM ON AN INCREMENTAL BASIS

Table 20

Year of Program	School Grade											
	K	1	2	3	4	5	6	7	8	9	10	11 12
1	X	X	X	X	X	X	X					
2	X	X	X	X	X	X	X	X				
3	X	X	X	X	X	X	X	X	X			
4	X	X	X	X	X	X	X	X	X	X		
5	X	X	X	X	X	X	X	X	X	X	X	
6	X	X	X	X	X	X	X	X	X	X	X	X
7	X	X	X	X	X	X	X	X	X	X	X	X

SOURCE: U.S. PUBLIC HEALTH SERVICE

REFERENCE: DHEW Publication No. (NIH) 77 - I96 (I977)

(b) FUNDING

Before funds are sought, the cost of the programme must be estimated. The overhead of each programme will vary depending upon a multiplicity of local factors, such as the number of children participating in the programme, whether one or several schools are involved, and whether the project personnel are paid or volunteers.

Expenses for the following items are to be anticipated:

1. Office equipment.

- desk
- chair
- typewriter
- filing cabinet
- other standard office supplies, e.g. consent forms.

2. Other equipment (at each participating school)

- locked storage cabinet
- dispensing (mobile) cart

3. Rinsing supplies (at each participating school).

- bottle and pumps (polythene containers with calibrated plunger)
- fluoride (powder or liquid concentrate)
- paper cups
- disposal bags and ties

4. Personnel

- Administrator - Coordinator
- Rinse monitors
- Clerk-typist

5. Other

- printing
- travel

(SOURCE: Leske, G.S., and Ripa, L.W. - 1977)

Office equipment, personnel and other (printing and travel) need only be located at the central location.

Office costs will depend on the available equipment and supplies that can be used for the project. Likewise, the other major equipment, specifically the locked storages cabinet and the mobile dispensing cart for each school may

not be necessary, if a locked closet is available and if another method for dispensing fluoride to the classroom can be devised. (NICR - 1977)

The costs of rinsing supplies are minimal and they can be lower if the fluoride is mixed by the programme personnel. Other costs to consider are printing costs for letters of consent and informational handouts to school personnel describing their participation in the programme. Travel to and from the school for various personnel may be a cost item. This should be estimated and computed on a per-mile basis.

For some programmes, the greatest continuing expense will be for salaries of the personnel. Other programmes may rely heavily on volunteers.

After the expenses have been estimated for each programme year, a source of funding is to be sought. Potential sources of funding include voluntary, professional, or governmental agencies. Thus these programmes might be subsidised by district or state dental societies or by funds provided by a city or country health department. Contribution by parents may be possible. Other alternatives include fund-raising through school and community efforts. (NICR-1977).

(c) STAFFING (NICR - 1977)

The types of personnel needed for the rinsing programme include an administrator - coordinator, one or more rinse monitors, and a clerk-typist. None of the personnel need be professional (dentist, hygienist or nurse), however it is desirable that the administrator - coordinator have some experience in the health field. The size of the programme would determine whether staff should work part-time or full-time. The programme coordinators are responsible for seeing that the following activities are accomplished :

(1) Ordering supplies

(2) Mixing and dispensing solution

(3) Supervising the mouthrinse procedure.

(4) Recording procedure.

Before recruiting personnel to work in the programme, it is best to survey what resources of personnel might already be available to assist in conducting the programme, such as :

- school nurses;
- school hygienists;
- teachers;
- teacher's aides;
- health aides;
- mature students;
- other faculty or staff members.

Those undertaking responsibilities in the programme are required to receive adequate training which may be accomplished through workshops which are relatively easy to conduct.

Leske and Ripa (1977), summarised the responsibilities of rinse monitors and clerk-typist as follows:

RINSE MONITOR -

- (a) Mix and dispense fluoride at each school;
- (b) Maintain local school inventory;
- (c) Maintain current list of participants - receive new participants and identify dropouts;
- (d) Supervise rinse sessions, unless supervision is by classroom teacher, nurse or other personnel.

CLERK-TYPIST -

- (a) Maintain central file for programme, including list of participants in the programme;
- (b) Type all correspondence necessary for maintaining programme;
- (c) Type all required reports to funding agencies, school board, or administrators as needed.

(d) PROGRAMME IMPLEMENTATION (NICR - 1977)

With the successful identification of a rinsing population, assurance of financial support, and the recruitment of staff, the programme can be initiated. Firstly, parents are to be

apprised of the existence of the programme and the benefits that may accrue from their children's participation. A variety of methods may be used for publicising the programme, such as articles in local newspapers and presentations before parent-teacher organizations. Additionally, the letters of consent addressed to the parents can provide information before enrolment of the children in the rinsing programme.

In order to participate, each child has to return a consent form signed by a parent or guardian. The basic elements of information necessary to such consent include:

- (1) An explanation of the procedures to be followed and their purposes;
- (2) A description of any attendant discomforts and risks that may occur.
- (3) A description of any benefits to be expected;
- (4) An offer to answer any inquiries concerning the procedures, and,
- (5) A statement that the parent is free to discontinue participation in the programme at any time, without prejudice.

The actual rinsing procedures have been described in section 2.5.2.

No more than 30 students per supervision has been recommended.

By recording the use of mouthrinses, the information obtained can serve to measure the success of the programme in terms of the number of children participating annually and the frequency. Two types of forms have been designed :

- (a) Fluoride mouthrinse programme - classroom treatment record, and,
- (b) Fluoride mouthrinse treatment record - school session.
(Samples of these forms have been reproduced in Appendix. Page 114 & 117.)

Monitoring of the rinse programmes has been recommended, and it is only logical to observe the actual procedures at periodic intervals. This would provide opportunity to

correct any shortcomings. Periodic visits to the schools by the rinse coordinator would help ensure programme quality and indicate the importance of the programme to the students and the faculty (NICR - 1977).

2.5.4 EFFECTIVENESS OF MOUTHRINSING SOLUTIONS

It has been demonstrated in more than 30 clinical trials that mouthrinsing fortnightly, weekly or daily with dilute solutions of fluoride reduces the incidence of dental caries by about 35% (American Dental Association - 1975. Horowitz, H.S. - 1973., Torrell, P., and Ericsson, Y. - 1974). Some of these clinical trials have been summarised on Pages 68, 69, 67.

These studies reported reductions in incremental caries ranging from 20 to 50 per cent. (Torrell, P., and Ericsson, Y. - 1974).

More than a dozen fluoride concentrations have been clinically tested. These range from a low concentration of 45 ppm F(0.01% Naf) (Bibby, B.G., and Co-workers - 1946; Roberts, Bibby and Wellock - 1948) to a high concentration of approximately 3,000 ppm F (0.66% Naf), (Heifetz, S.B., et al - 1973).

Rinse concentrations of 250 ppm F or less are considered low potency rinses; higher concentrations are called high potency rinses (Ripa, L.W. - 1981). Table 22 shows Page 70 concentration/frequency patterns of fluoride rinse studies in relation to percentage caries reduction.

TABLE 21

SUMMARY OF FLUORIDE MOUTHRINSE STUDIES

Author	Year	Compound	Concentration	Water F	Frequency	AGE Years	RINSE ml/TIME	Study Length	Caries Reduction
Bibby et al	1946	NaF	0.01% F ⁻ pH 4.0	No	2/wk	Dent. SEC.		1 yr	None
Roberts et al	1948	NaF	0.003% F ⁻ pH 4.0	No	2/wk	12	1 min	1 yr	None
Weisz	1960	NaF	0.118 % F ⁻	No	2/day	5-9		2-10 yrs	80%
Torell & Siberg	1962	NaF	0.09%	No	1/mo	7	10/3 min	1 yr	ant. prox. 50-70%
		KF	0.06% F ⁻	No	1/mo	7	10/3 min	1 yr	ant. prox. 20-50%
Torell & Ericsson (1)	1965	NaF	0.0225 F ⁻	No	1/day	11	10/2 min	2 yrs	49% DMFS
		NaF	0.09 F ⁻	No	1/14 days	11	10/2 min	2 yrs	21% DMFS
Koch (2)	1967	NaF	0.225 % F ⁻	No	1/14 days	10	10/2 min	3 yrs	23% DMFS
		NaF	0.225 % F ⁻	No	3-4/wk	10	10/2 min	3 yrs	18% DMFS
Hagglund	1969	NaF	0.09 % F ⁻	Yes	1/wk	8	10/2 min	5 yrs	(30%)
Torell	1969	NaF	0.09 % F ⁻ + NEP dentifor	No	1/14 days	11	10/2 min	2 yrs	20% DMFS in relation to F-rinsees 1/14 days & F-free dentifrice
Horowitz (3)	1971	NaF	0.09 % F ⁻	No	1/wk	6	10/2 min	20 mos	16% DMFS
		NaF	0.09 % F ⁻	No	1/wk	11	10/2 min	20 mos	44% DMFS

(SOURCE: TORELL AND ERICSSON, 1974)

TABLE 21 SUMMARY OF FLUORIDE MOUTHRINSE STUDIES

AUTHOR	YEAR	COMPOUND	CONCENTRATION	WATER F	FREQUENCY	AGE YEARS	RINSE ml TIME	STUDY LENGTH	CARIES REDUCTION
Aasenden et al (4)	1972	APF	0.02 % F ⁻	No	1/day	8-11 yrs	5/1 min	3 yrs	30% DMFS
		NaF	0.02 % F ⁻	No	1/day	8-11 yrs	swallow	3 yrs	27% DMFS
Brandt et al (5)	1972	NaF	0.09 % F ⁻	No	2/wk	11 yrs	10/1 min	2 yrs	36% DMFS
		APF	0.02 % F ⁻	No	1/day	14 yrs	5/1 min	2 yrs	25% DMFS
Moreira & Tumang (7)	1972	NaF	0.045 % F ⁻	No	3/wk	7 yrs	2 x 12/ 30 sec	2 yrs	47% DMFS
		NaF	0.045 % F ⁻	No	1/wk	7 yrs	- "	2 yrs	25% DMFS
		NaF	0.045 % F ⁻	No	1/14 days	7 yrs	- "	2 yrs	23% DMFS
Heifetz et al (8)	1973	NaF	0.3 % F ⁻	No	1/wk	10-12 yrs	2 x 8/ 1 min	2 yrs	38% DMFS
		APF	0.3 %	No	1/wk	10-12 yrs	- "	2 yrs	28% DMFS
Rugg-Gunn et al (9)	1973	NaF	0.0225	No	1/day	11-12 yrs	7.5/ 2 min	3 yrs	36% DMFS
		NaF	0.09 F ⁻	No	1/14 days	6-7 yrs		28 mos	47% DMFS
Padron & Maiwald (10)	1973	NaF	0.09 F ⁻	No	1/14 days	8-9 yrs		28 mos	32% DMFS
		NaF	0.09 F ⁻	No	1/14 days	10-11 yrs		28 mos	28% DMFS
		NaF	0.09 F ⁻	No	1/14 days	12-13 yrs		28 mos	11% DMFS

(SOURCE: TORELL AND ERICSSON - 1974)

TABLE 21

SUMMARY OF FLUORIDE NUTRINTSE STUDIES

AUTHOR	YEAR	COMPOUND	CONCENTRATION	WATER F	FREQUENCY	AGE	RINSE	CARIES
						YEARS	ml/TIME	REDUCTION
Radike et al (11)	1973	SnF ₂	0.025 % F ⁻	Yes	1/day	8-13	3 x 20 .70 sec	(1) 33% DMFS (2) 44% DMFS
Kani et al (12)	1973	APF	0.05 % F ⁻	No	1/day	10	10/30 sec	20-30%
Gallager et al (13)	1974	NaF	0.182 % F ⁻	No	1/wk	11-13	15/1 min	34% DMFS
Finn et al (14)	1974	APF	0.010 % F ⁻	No	2/day	9-19	2 x 10 ⁻ 1 min	17% DFS
		APF	0.020 % F ⁻	No	2/day	9-19	- " -	20% DFS
Forsman	1974	NaF	0.013 % F ⁻	No	1/wk	13	10/2 min	Equal Increments*
		NaF	0.09 % F ⁻	No	1/wk	13	10/2 min	

* non-significant trend for weaker solution
SOURCE : (TORELL AND ERICSSON - 1974)

TABLE 22.

CONCENTRATION/FREQUENCY PATTERN OF FLUORIDE RINSE STUDIES
IN RELATION TO PERCENTAGE CARIES REDUCTION

FREQUENCY	ppm F ⁻ 100	ppm F ⁻ 200-250	ppm F ⁻ 450-1000	ppm F ⁻ 1800-3000
Daily at home		49 % (1)		
Daily at school	17 % (14)	27 % (4) 30 % (4) * 25 % (6) * 36 % (9) 38 % (11) ** 25 % (12) * 20 % (14) *		
3/wk			47 % (7)	
2/wk			36 % (5)	
1/wk			44 % (3) 16 % (3) 25 % (7) 34 % (13)	28 % (8) * 38 % (8)
1/14 days			21 % (1) 23 % (7) 47 % (10) 32 % (10) 28 % (10) 11 % (10)	23 % (2)
3-4/yr				18 % (2)

* APF

** SnF₂

() numbers within brackets denote cross-reference to the studies of Tables 7, 8, 9 and 10.

(SOURCE: TORRELL AND ERICSSON 1974)

2.5.4.1 LOW POTENCY - HIGH FREQUENCY or LOW CONCENTRATION - FREQUENT APPLICATION.

The low potency/high frequency technique is the method recommended for home use. The most commonly used low potency neutral Naf rinse has a 0.05% Naf concentration (225 ppm F) and the low potency APF rinse has a 0.044 % Naf concentration (198 ppm F). Some of the studies showing anticaries clinical effectiveness are reviewed:

- (1) In a comprehensive trial Torell and Ericsson (1965) showed that unsupervised daily use of an 0.05% Naf rinse over a 2-year period reduced the incidence of dental caries in 10 to 12 year old children by about 50%.
- (2) In 1972, Frankl, Fleisch, and Diodade reported a two-year study with children who rinsed once daily with an APF mouthwash that contained 1 mg. fluoride ion (200 ppm F) at PH4. At the end of two years these children exhibited a significant decrease of 26% in the increment of decayed and filled teeth and 25% in decayed and filled surfaces (see Table 9).
- (3) Aasenden, De Paolo and Brudevold (1972) reported a three-year study in which participants also rinsed once daily either with a 0.02% APF rinse at PH4 or with a neutral Naf rinse of the same concentration (200 ppm F). Results from this study showed that participants in the APF and neutral Naf groups had respectively 30% and 27% less decayed and filled surfaces (see Table 9).
- (4) Rugg-Gunn and co-workers (1973) reported a 36% reduction in caries increment in an English study. This clinical trial using the daily supervised use of a mouthrinse containing 0.05% Naf was carried out over a period of 3 years.

2.5.4.2 HIGHER CONCENTRATION - LESS FREQUENT APPLICATION

The high potency/low frequency technique is the method usually used for school-based programmes. More than a dozen clinical trials in schools have been reported. This method of caries prevention is accepted as effective, with a general caries inhibition of 30% to 40% after participation

for two or more years in the programme. (Ripa, L.W. et al - 1978; Birkland, J.M., and Torell, P. - 1978). Fluoride rinsing appears effective both in fluoride-deficient and optimally fluoridated communities. (Radike, A.W. and others - 1973). Some of the studies showing the anticaries effect of high potency/low frequency fluoride rinses are reviewed:

- (1) In a clinical trial with Swedish school children, Torell and Ericsson showed a significant reduction of dental caries (21%) with 0.2% Neutral NaF rinse after two years. (Torell, P., and Ericsson, Y. - 1965).
- (2) Koch (1967) further established the value of fluoride mouthrinsing in a 3-year trial. He showed a reduction in DMFS increment of 23% with the use of a fortnightly supervised 0.5% NaF mouthrinse.
- (3) Horowitz, H.S. et al (1971), in a 20 month trial in the United States showed a 44% reduction in DMFS increment by weekly rinsing with a solution of 0.2% NaF. Although the percentage reduction was high in this trial, the increments were small, resulting over a 20-month period in the prevention of only one and a quarter DMF surfaces per child at the age of 10 to 12 years.
- (4) Ripa, L.W. et al (1981) gives a list of the available products accepted by the American Dental Association to be used for this high potency/low frequency technique mouthrinses.

Table 23. High potency fluoride rinse products for use in weekly rinsing programs.*

Brand	Type of fluoride	Sodium fluoride concentration
NaFpakt†	NaF	0.2%
Pacemaker Fluorinse, 0.2%‡	NaF	0.2%
Point-Two Dental Rinse§	NaF	0.2%

*All preparations accepted by American Dental Association.

†Marketed in 2- and 3-gm packets of NaF. Two-gm packet should be dissolved in 1,000 ml water, 3-gm packet in 1,500 ml water. Contains additives, but additive-free packets may also be purchased (not listed by ADA in *Accepted Dental Therapeutics*).

‡Marketed in 120-ml bottles and packages of 12, 10-ml unit dose trays. Contains additives.

§Marketed in 120-ml bottles and 1-gal bottles with 5-ml pump dispenser. Contains additives.

SOURCE: (Ripa, L.W. - 1981).

2.5.5 PERSISTENCE OF ANTICARIES EFFECT

Studies have been done to analyse the caries development in individuals after withdrawal of fluoride rinsing programmes. This effect ought to be an important consideration when employing fluoride mouthrinses as a public health measure.

- (1) Koch (1969) registered the caries development following withdrawal of a three-year programme of fortnightly fluoride rinses with 0.5% NaF solutions. He found no difference in caries increment between the former fluoride rinsing group and the former control group during the two-year period following the withdrawal. The findings indicate that continuous exposure is necessary for optimal effect of fluoride rinses.
- (2) Birkeland and Torrell (1978) in their review of fluoride mouthrinsing considered that the benefits of fluoride rinsing especially to teenagers, is likely to be long-lasting.
- (3) Mellberg, J.R., et al - 1974 found that fluoride uptake by sound enamel associated with fluoride rinses is low which indicated that the benefits of this preventive method may be limited to the immediate treatment period.

It appears, therefore, that the beneficial effect of mouthrinsing with fluoride solutions can only be contained if continued.

2.5.6 COST-BENEFIT AND COST-EFFECTIVENESS

Davies G.N. (1974) suggested that cost-effectiveness may be expressed as the number of tooth surfaces protected from caries for each hour of time taken by dental personnel. A realistic cost-effectiveness basis would be a saving of 3 DMF surfaces per hour of dental professional time. It was also emphasized that the cost-benefit ratios indirectly reflect the efficacy of the particular system in preventing caries as well as the cost of conducting the programme. The cost-benefit ratios in programmes for dispensing fluorides by means other than water fluoridation, and for other caries prevention methods, are not as dramatic as they are for water fluoridation but they are significant enough to warrant utilization where water fluoridation is not possible.

An outstanding example of saving in manpower on a community basis was reported from New Zealand in 1966. (Denby G.C., and Hollis, M.J.). It proved possible to alter a long-standing standard ratio of one operator to 475 school children in a comprehensive incremental care service to 1 : 690 in fluoridated areas after 10 years of fluoridation.

The cost-effectiveness ratio as defined by Heifetz is :

$$\frac{\text{Cost (dollars) of procedure/child/year}}{\text{Mean number DMF surfaces saved/child/year.}} \text{ OR } \frac{\text{Cost/child/year}}{\text{I.O DMF surface saved/child/year.}}$$

Heifetz (1978) while assessing the cost-effectiveness of the weekly fluoride mouthrinse indicated that because of wide variation in clinical results it is difficult to make an exact estimate of the effectiveness. He took a conservative stand and assumed a caries reduction of 25%, a level close to the lower boundary of efficacy. Cost for materials were based on a 36-week per year programme. It was also assumed that school personnel administered and supervised the programme, and therefore, no estimation of salary costs were involved. His estimation of cost-effectiveness of supervised weekly mouthrinsing with a 0.2% NaF solution is presented in Table . It shows total costs, which amount to the cost of materials alone or U.S. \$1.50 per child. The low cost of fluoride mouthrinsing, therefore, mainly accounts for its highly favourable cost-effectiveness of \$1.00 per surface

saved. Heifetz considered that even if payment is made for supervision, cost-effectiveness is still only U.S. \$1.60 per surface saved.

To gain insight into specific cost-benefit and cost-effectiveness of mouthrinsing programmes, some of the studies will be briefly reviewed and in view of the fact that cost data for fluoride mouthrinse programmes are sparse:

- (1) In a study conducted by Rugg-Gunn et al (1973), the cost assessment of a 3-year trial of mouthrinses (0.05% Naf, daily) resulted in a saving of 1.25 surfaces per child per year at a cost of 2 newpence (U.K.) per rinse.
- (2) Horowitz in 1971 estimated the cost per child per year was estimated at U.S. \$0.31 for weekly oral rinsing with 0.2% neutral Naf solution in a school dental programme. By mid-1977 the cost per child per year had increased to U.S. \$0.42 (Leske, G.W., and Ripa, L.W., - 1977), and by late 1977 it had increased to U.S. \$0.45 (Ripa, L.W., et al - 1977). These figures represent only the cost and supplies of materials.
- (3) In 1975, 17 standardised school-based programmes were initiated for children in different locations of Guam and U.S.A. for a three-year period to evaluate the effectiveness and economic feasibility of weekly fluoride mouthrinsing. Information on the cost of supplies, equipment, personnel and school overhead was collected for each school year. The mean cost of supplies and equipment for the first two years ranged from 20cents to 82cents. The average of 17 sites was 50cents per child per year. When the salary of paid personnel (if any) is included, the costs range from U.S. \$0.28 to U.S. \$8.78 with a mean of U.S. \$3.49 over all studies. Differences in cost are mainly attributable to different methods of delivering the rinse and different numbers and levels of supervisory personnel. Estimates of cost-benefit based on two years of experience indicate that the procedure is highly cost-effective in a variety of settings. (Brunelle, J.A., and Miller, A.J. - 1978).

Horowitz (1980) assumed that if supervision is done by volunteers, weekly fluoride mouthrinsing can be carried out for as little as 21 pence per child per year.

Table 24.

Cost-effectiveness of supervised weekly mouthrinsing with a 0.2% Naf solution.

Cost

No. of classroom treatments:

8000 childr./yr. X 36 treatments/year X 3 years
= 864,000 child-treatments.

$\frac{864,000 \text{ child-treatments}}{30 \text{ child./class}} = 28,800 \text{ class-treatments}$

Time required:

28,800 class-treatments X 5 min/class-treatment
= 2,400 hrs.

Salaries: existing school personnel = N/C.

Materials :50/child/yr X 3 years = U.S. \$1.50 / child
Total cost = U.S. \$1.50 / child

Effectiveness

$\frac{\text{U.S. \$1.50/child}}{\text{1.5 DMFS/child}} = \frac{\text{U.S. \$1.00}}{\text{1 surface saved}}$

(SOURCE: Heifetz, S.B. - Cost-effectiveness of topically applied fluorides : In "Relative Efficiency of Methods of Caries prevention in dental public health". - Workshop Proceedings, University of Michigan, June 5-8, 1978 (pp 69 - 104).

(4) Horowitz, et al (1971) reported that the cost benefit ratio for weekly mouthrinsing with a 0.2% Naf solution in the U.S.A. was 1 : 16 : 4. The cost of paper cups, paper napkins, and fluoride solutions was \$0.31 per child per year or U.S. \$0.62 in two years. They considered that no additional charges be included for salaries, since the programme was administered in schools by school teachers. Their estimates are shown below: -

The savings in DMFS per child in 2 yrs = 1.27.

Savings in cost of fillings in U.S. \$3 per saved surface
= U.S. \$10.16

$$\begin{aligned}\text{Cost-benefit} &= \frac{\text{Cost of Implementation}}{\text{Savings in cost of treatment}} \\ &= \frac{0.62}{10.16} \\ &= \underline{1 : 16.4}\end{aligned}$$

- (5) Torell, P. (1965) evaluated a fortnightly mouthrinsing programme in Gothenburg, Sweden and his estimates showed a cost-benefit ratio of 1 : 10.6. The programme was initiated in 1960 using 0.2% Naf solution. The costs of the programme have been detailed by Torell as follows : -

Cost of implementation (Swedish kronor)

I dentist at 10 hours/week	=	14600
I head dental nurse	=	33600
10 dental nurses	=	363600
Paper cups and fluoride	=	14600
Travelling costs	=	6600
		<u>Sw. kr. 433000.</u>

Savings in costs of fillings

Decrease in number of fillings per child

per year	=	2.3
Number of children	=	40 000
Total decrease in fillings	=	92 000
Cost per filling	=	Sw. kr. 50.
Total savings	=	<u>Sw. kr. 4 600 000</u>

$$\begin{aligned}\text{Cost-benefit ratio} &= \frac{\text{Cost of Implementation}}{\text{Savings in Cost of Treatment}} \\ &= \frac{433\ 000}{4\ 600\ 000} \\ &= \underline{1 : 10.6}\end{aligned}$$

(Table 25 - Davies G.N. - 1974. Page 76)

TABLE 25 REDUCTIONS IN DENTAL CARIES RESULTING FROM FLUORIDE MOUTHWASHES IN SCHOOLS

Authors	Initial age (years)	Length of study (years)	Agent	Frequency	Absolute reductions per person			
					DMFT		DMFS	
					(Mean)	(%)	(Mean)	(%)
Torell & Ericsson	10	2	0.5% NaF	Once a day			4.92	49
	10	2	0.2% NaF	Once a fortnight			2.15	21
De Paola et al.	6-8	3	1.0% NaF (APF) 0.25% NaF (APF)	Three times a year	0.02	1	0.58	13
Gerdin & Torell	10-11 ^a	4	0.2% KF + MnCl ₂	2 min per week	2.44	21	-	-
	10-11 ^a	4	0.2% NaF + MnCl ₂	2 min per week	0.26	2	-	-
Koch	10	3	0.5% NaF	Once a fortnight	0.93	11	4.36	22
	10	5	0.5% NaF	Once a fortnight for 3 years only	0.93	8	3.75	11
Swerdlow & Shannon	11-15	1/2	0.1% SnF ₂	Once a day	0.19	33 ^b	0.26	31 ^b
Horowitz et al.	6	2	0.2% NaF	Once a week	0.18	25 ^b	0.21	16 ^b
	10	2	0.2% NaF	Once a week	0.84	15	1.27	43

^a - Comparisons with 0.2% NaF as Control.

^b - Not significant.

SOURCE: DAVIES G.N. - 1974.

From the data in Table 25, a summary of conclusions drawn by Davies (Davies G.N. - 1974) is presented below:

- (a) Substantial benefits can be obtained by children aged 10 years and over, and the extent of the benefit appears to be related more to the frequency of rinsing than to the strength of the solution. Daily rinsing with 0.05% Naf solution by 10 year-olds gave a reduction of 4.92 DMFS (49%) in two years; weekly rinsing with 0.2% Naf solution by 10 year-olds gave a reduction of 1.27 DMFS (43%) in two years; fortnightly rinsing with 0.2% Naf by 10 year-olds gave a reduction of 2.15 DMFS (21%) in two years; and fortnightly rinsing with 0.5% Naf by 10 year-olds gave a reduction of 4.36 DMFS (22%) in three years.
- (b) The beneficial effects of mouthrinsing are gradually lost after mouthrinsing is discontinued.
- (c) A combination of $MuCl_2$ and KF appears to be more effective than either Naf or a combination of $MuCl_2$ and Naf.

According to Birkeland and Torell (1973) with daily, weekly, or fortnightly Naf, the benefits are better shown by long-term use of these rinses:

- (1) The caries prevalence is reduced by 50%, the increment by 60-70% and the need for fillings by about 70%.
- (2) The treatment is simpler and the fillings last longer.
- (3) The cariostatic effect improves by combination of rinses and other fluoride regimen.
- (4) The benefits in teenagers are likely to give a long-lasting low caries prevalence.
- (5) Following long-term use of rinses, the expenses for treatment are reduced, and treatment time is saved.
- (6) Fluoride-mouthrinsing procedure has been shown to be a valuable caries-preventive alternative to fluoride-containing drinking water.

RANKING OF TOPICAL FLUORIDE PROCEDURES

In assessing the relative efficiency of various methods of topical fluoride application in dental public health, Heifetz (Michigan Workshop - 1973), ranked their cost-effectiveness

as shown in Table 26. The estimates indicate that some methods are able to protect teeth against caries at decidedly less cost than others. It could be seen that weekly fluoride mouthrinsing is the most economical procedure in terms of public health, professional manpower and money which are usually scarce in many countries. Of the various methods listed in Table I4, weekly Naf rinsing appears to best accomodate these constraints. According to Heifetz when comparison is made between, for example, the self-administered rinsing and the professionally-administered Knutson's technique (although mouthrinse confers less cariostatic effect on a per child basis) implementation of the most cost-effective procedure will result in the largest total number of surfaces saved on a population basis for every dollar spent. However, since these assessments were based on conservative assumptions, there is a need for more realistic approach when dealing with cost-effectiveness of different procedures.

At an international workshop (Maryland - 1974) on fluorides Wei concluded that "the cost-benefit ratios of professionally-applied topical fluoride agents are extremely poor for the U.S.A. due to the high cost of dental personnel manhours". The cost-benefit ratios of self-applied topical fluorides appear to be favourable, especially in public health programmes. The cost-benefit ratios of various methods of topical fluoride application by dentists are listed below. (Davies - 1974) : -

- (1) One application of stannous fluoride for two years by dentists was I : 2.3 in U.S.A. and I : 5.2 in Sweden;
- (2) Professional application of Naf by Swejda's method was I : 2.4 in U.S.A. and I : 3.3 in Sweden;
- (3) One application of APF for two years was I : 1.1 in the U.S.A. and I : 2.5 in Sweden;
- (4) Three agent method for three years (three applications) was I : 1.1 in U.S.A. and I : 2.5 in Sweden;

Cost benefit ratios for self-applied fluorides are listed below. (Source: Davies G.N. - 1974).

- (1) Cost-benefit ratios for fluoride brushing programme conducted four times a year in Norway was I : 3.9.
- (2) After eight years of brushing with fluoride solution was I : 13.9 to I : 4.6 in Switzerland.

Table 26

Ranking of estimated cost-effectiveness of alternative topical fluoride procedures.

<u>Procedure</u>	<u>Estimated percent reduction</u>	<u>\$ Cost per I.O DMFS saved</u>	<u>Rank</u>
Weekly mouthrinses 0.2% NaF solution	25	\$ 1.00	I
Semiannual "brush- in" 9% SnF Zirate paste	25	\$ 2.50	2 (tie)
Prof-applic. 2.0% NaF sol. multiple- chair method	40	\$ 2.60	2 (tie)
Annual prof-applic. APF gel (1.23% F) in preformed trays	40	\$ 4.40	4
Toothbrushing 5 x yr APF sol (0.6% F)	20	\$ 5.60	5
Toothbrushing at home 0.1% fluoride dentifrices	20	\$10.00	6
Annual prof-applic. 8.0% SnF	20	\$21.00	7 (tie)
Daily self-applic. APF gel (0.5% F) in custom trays	80	\$21.30	7 (tie)

(SOURCE: Heifetz, S.B. - Cost-effectiveness of topically applied fluorides : In "Relative Efficiency of methods of Caries Prevention in dental public health" - Workshop Proceedings, University of Michigan, June 5 - 8, 1978 (pp 69 - 104).

3. ORAL HEALTH STATUS AND DENTAL HEALTH SERVICES IN THE COOK ISLANDS

3.1 ORAL HEALTH STATUS

Reports of oral health status surveys conducted in the Cook Islands since 1956 (Davies G.N. - 1956; Hanson W.W. - 1970; Speake J.D. - 1976) indicate that, although data are not available for all islands, the indications are that in Rarotonga at least, dental caries constitutes the most prevalent of all diseases. Survey data published in 1970 showed that all school children were affected by the age of 13 years. On Mangaia 89.6% of 13 year-olds were similarly affected. On an individual basis, it was found that, on the average, school children on Rarotonga had 10.42 decayed, missing or filled permanent teeth (DMFT) by 14 years of age although on Mangaia the comparable figure was only 4.92. Only limited sample numbers were available from Pukapuka in the Northern Group, so that strict statistical comparisons could not be made. However, the data which was collected would seem to indicate that caries rates was much lower there, being less than one tooth per child at 14 years of age. It must be stressed that although this information was published in 1970 the actual data were collected some years earlier and should therefore now be regarded as being about fifteen years out-of-date.

The DMFT data collected by J.D. Speake during his survey (October 1976) is limited to Rarotonga and confined to eight- and eleven-year-olds. When comparisons are made between the same age groups in the pre-1970 survey and the 1976 samples, an increase in dental caries rates which is statistically significant can only be demonstrated between the two eight-year-old age groups.

RAROTONGA

MEAN DMFT.

MEAN DMFT.

PRE - 1970

1976

8 years	1.68 $\pm$ 2.05	2.67 $\pm$ 1.67
11 years	5.7 $\pm$ 2.56	5.92 $\pm$ 4.08

(SOURCE: J.D. Speake - 1976)

The difference between the two 11 year old groups is not statistically significant. Such a comparison is based on the assumption that the same criteria were used for the diagnosis of caries in both the pre-1970 and 1976 studies.

NOTE: The data published in 1970 gave means and standard errors which have been converted to standard deviations to match 1976 data.

There can be little doubt that the caries rates in the Cook Islands are high. This is particularly so in Rarotonga and probably Aitutaki the two main concentrations of population. The situation in the outer islands remains obscure because of the lack of survey data. The usual pattern in the Pacific has been for the amount of caries to decrease with distance from the main centres and it is believed that this is related directly to access to imported refined foodstuffs.

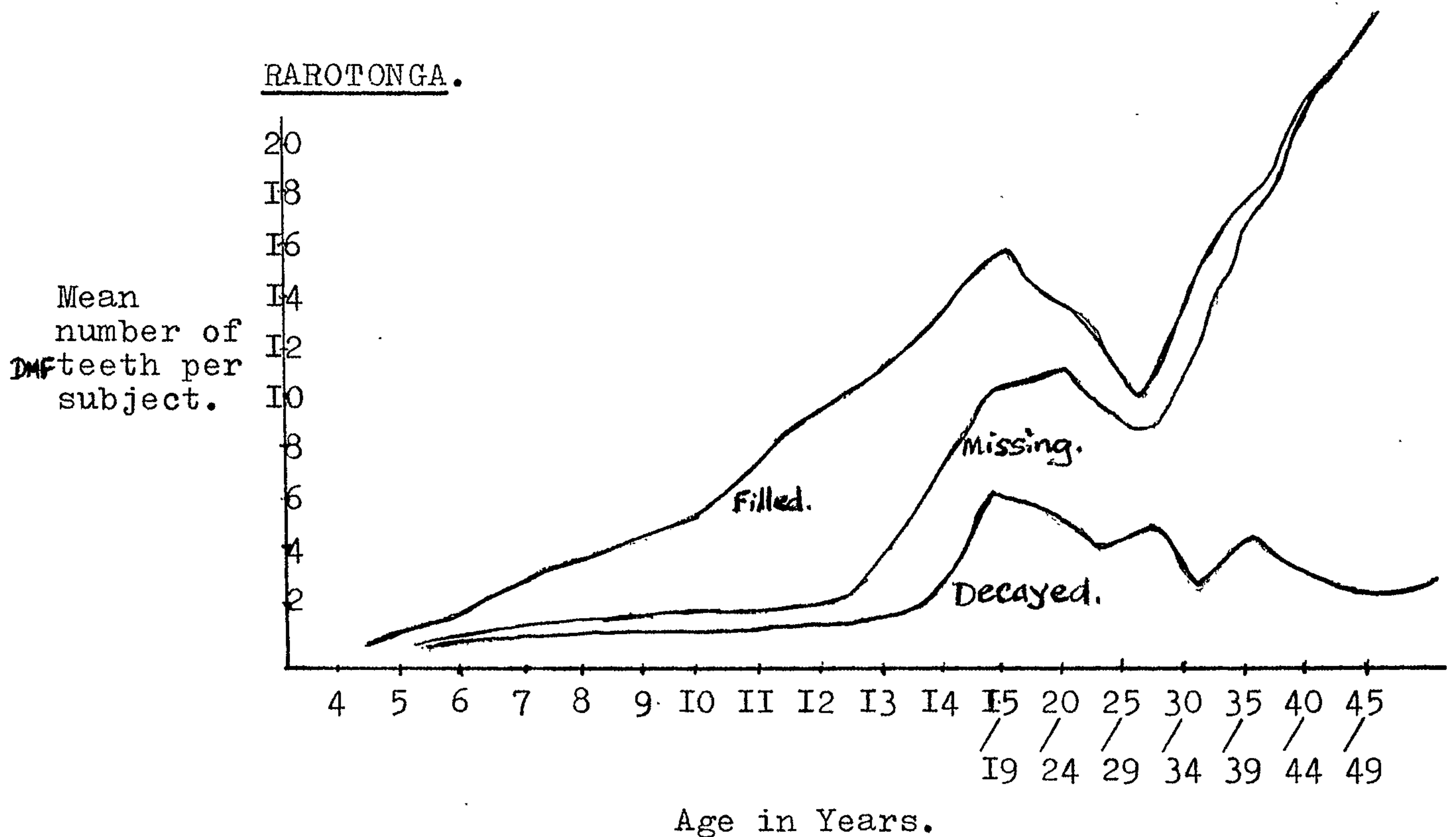
There are three indications that caries rates have risen during the past ten years : the increase in consumption of cariogenic foodstuffs, (see Table on Family Budget Survey), the increase in caries rates amongst eight year old school children and the increase in the average number of extractions per patient in the School Dental Service.

There are numerous approaches to the problem of dental caries. The first is the one already being employed by the Cook Islands Dental Service, which is the detection of caries and the restoration of teeth (fillings) through regular inspection and treatment in the schools. Such a service already exists in Rarotonga, where the school dental nurses are based, and to a certain extent in other islands with dental personnel. Visits to islands without dental personnel are, however, very infrequent. The disadvantages of this restorative approach by itself, particularly in high caries situations, are that the benefits of treatment do not last very long after the child leaves school and is no longer under regular care. New fillings are required and old fillings break down and need replacement. By the time the individual reaches late teens or early adulthood little advantage has been gained.

The Table on Mean Number of DMF teeth per subject/Age in years which has been taken from the pre 1970 survey illustrated what happens on Rarotonga. There is a rapid increase in the number of missing teeth from the age of approximately 20 years onwards.

The second approach to the caries problem is through prevention measures; that is, taking steps to increase the resistance of the teeth to decay. In practical terms this means increasing the fluoride content of the enamel and this may be achieved by fluoridating the water supply where practical and by using topical fluoride on an individual or group basis.

Another approach is by reducing the sugar intake in the diet. Again, the high consumption of sugar in the Cook Islands in the last ten years is clearly shown by the Table from the Family Budget Survey Table.



(Source : Hanson W.W. - 1970).

3.2 THE DENTAL SERVICE IN THE COOK ISLANDS

A total of twenty-four persons are employed by the Dental Service. Of these nine are dental officers and six New Zealand trained school dental nurses. This gives a national patient to operator ratio of 1277 : 1. There are also two dental technicians and six locally trained hygienists whose instruction has included some elements of health education, prophylaxis and the extraction of deciduous teeth as well as chairside assisting. In practice it would seem that the activity of the hygienists is largely confined to chairside assisting. In addition to the hygienists there are three chairside assistants who carry out this function. One cleaner is also employed.

Five of the dental officers together with all the dental nurses, technicians, hygienists and assistants are based in Rarotonga. The remaining dental officers are posted on the islands of Aitutaki, Atiu, Mangaia and Mauke.

Estimates for the cost of the Dental Service in 1976/77 put the cost at approximately \$N.Z. 114,080. This is made up as follows :

Personnel	68,710
Transport	3,270
Maintenance of property	5,500
Materials and supplies	26,500
Other	500
Capital equipment	9,600

In addition to the main clinic on Rarotonga there are eight clinics situated in schools on the island. There is also a mobile clinic although this was not operational due to broken down equipments. There is a total of eight clinics on the outer islands situated mainly in schools.

Equipment used on Rarotonga are of reasonable standard and plans are in hand to re-equip the main clinics at Avarua with more modern chairs and units.

At the present time the Dental Service has no transport of its own on Rarotonga and staff working in school clinics use their own cars and motor bikes to commute between the main clinic and the schools.

At the end of each month, a monthly report is submitted by dental officers and dental nurses of the services done. An example of such a report is made available from a summary of all monthly reports submitted by dental officers and dental nurses of the service for the period January to August 1976. (See Monthly Report Form Summary). Although there are certain dangers inherent in trying to read too much into such activity reports, certain general conclusions may be drawn from this document :

(i) ADULTS

A fairly wide range of treatment is provided for adults on demand including amalgam, gold and synthetic fillings, pulp treatments, oral surgery and acrylic dentures. Services are concentrated to extractions and fillings rather than to prevent procedures. For example the ratio of extractions to fillings during the eight month period was 1.2 to 1 and some 285 full and partial dentures were constructed. Amongst this group, payment for services are on a fee for treatment basis.

(ii) CHILDREN

Amongst this group, which is covered by the free School Dental Service, the ratio of permanent extractions to fillings is much more encouraging at 0.078 to 1. There is evidence that in recent years the average number of extractions per patient has been rising in the Cook Islands School Dental Service, from 0.3 during the period 1969 - 72 to 0.4 in 1973 and to 0.5 in 1974. A similar figure of 0.5 is apparent for the first eight months of 1976. During this same period some 3859 children were examined and of these 3227 or 84% had been completed. However, despite the space provided on the monthly reporting form, no record had been made of any preventive activity including dental health education. It would therefore seem reasonable to conclude that the emphasis in the School's Service is on the detection and treatment of caries through fillings but that in recent years there has been a slight increase in the average number of teeth extracted per patient.

3.3 OTHER FACTORS RELATED TO ORAL HEALTH STATUS

3.3.1 CHANGES IN FOOD CONSUMPTION PATTERNS

In May 1976 the Cook Islands Statistical Office conducted a "Family Budget Sample Survey". When this is compared with the results of a similar survey conducted nine years previously, it is apparent that there have been marked increases in the consumption of many potentially cariogenic foodstuffs. Some examples from the two surveys are cited in the Table below :

ITEM : DRINKS, SWEETS etc. (By Weight)

	I967	I976	Change by weight	% change
Sweet item	.45	I.49	+ I.04	+ 23I %
Chewing gum	.05	.3	+ .25	+ 500 %
Lemonade tinned	0	I.5I	+ I.5I	+ 00 %
Ice cream	.47	8.9	+ 8.43	+I793 %
Orange juice tinned.	.02	2.2	+ 2.I8	+I0900%
White sugar	2.2	2.43	+ 0.23	+I0.45%

(SOURCE : Family Budget Sample Survey - I976).

3.3.2 WATER SUPPLY

The present reticulated water supply system on Rarotonga employs a ring main which runs around the island and which is fed by a total of seven sources located at Avatiu, Takuvaine, Turangi, Avana, Titikaveka, Papua and Arorangi. Plans are however in hand to reduce the number of sources to five (Avatiu, Takuvaine, Turangi, Avana and Papua) and to introduce chlorination plants located at easily accessible places along the feeding mains down from the intakes. However, at the presentation of this thesis, no changes have taken place to the water supply system on Rarotonga as planned.

Typical analyses regularly undertaken by the Government analyst in Auckland (New Zealand) since 1970 have shown that one source (Avatiu) produces water with a fluoride content of 0.2 parts per million fluoride whilst the remainder contain 0.1 p.p.m fluoride. Neither of these concentrations is sufficient to afford any appreciable protection against dental caries.

3.3.3 THE EDUCATION SYSTEM

Education between the ages of 6 and 16 is compulsory and therefore virtually universal in the Cook Islands. This is of great potential advantage to the Dental Services in its efforts to provide services because it allows ready access to the children from the time when their first permanent teeth erupt right through to the eruption of the second and in some cases third permanent molars. Particularly therefore in Rarotonga, and perhaps to a lesser extent in some outer islands, the opportunity exists not only to provide restorative services but also to strengthen the teeth against dental caries.

Information supplied by the Education Department showed that there were approximately 6488 children attending school in the Cook Islands, in 1976. Of these, 3373 (52%) were attending schools in Rarotonga whilst the remainder - 3115 (48%) were located in schools on the outer islands.

If we assume that there are approximately nine months during the year when children are at school and available for dental attention, it would seem probable that the Dental Service working at its present pace (1976) would expect to complete about 3630 children, which amounts to about 60% of the total school population in one year.

4. DISCUSSION

4.1 GENERAL

The implementation of well-planned properly executed, objectively evaluated, economically and clinically feasible primary preventive programmes would ensure an adequate measure of success in the prevention and control of dental caries.

In the review of literature on the effectiveness of the various self-applied procedures (in clinical trials and demonstration programmes) it was shown that fluoride tablets were effective in reducing the increment of dental caries in permanent teeth by about 20 - 40% in 5-9 year old school children who had consumed tablets for periods of two to four years. Substantial reductions in the prevalence of caries in the permanent dentition can be obtained when fluoride tablets are consumed during the pre- and post-eruptive period of the permanent dentition. Caries reductions were reported in the studies done on the deciduous dentition which ranged from 13% in those children receiving fluoride tablets only pre-natally to 93% for children who received fluoride tablets prenatally as well as four years post-natally.

Similarly, it was shown that the fluoride mouthrinses carried out daily, weekly and fortnightly were effective in reducing the increment of dental caries by about 35% in school children who had participated in such programmes for two or more years. The studies further revealed that the daily (frequent) rinsing with 0.05% Naf solutions appeared to be more cariostatic than 0.2% Naf solutions used weekly or fortnightly (less frequently). Although the daily rinses have been used in school programmes they are not particularly feasible for use in schools.

On the other hand, the daily use of fluoride tablets and the weekly and fortnightly rinsing frequencies have been considered to cause less disruption to school curriculum, require little motivation and are more acceptable to the teachers and children. In most clinical trials supervised compliance was necessary for achieving greater participation and thus contributed towards ultimate success of the programmes.

The major costs involved in a fluoride tablet programme would consist of the expenses on the tablets and plastic cups, and salaries paid to the co-ordinator if employed. Similarly, for a rinsing programme, the major costs would include expenses on rinsing materials, transportation, office equipment and stationery. Again, a remuneration in terms of salaries should be paid to the rinse co-ordinator if employed.

Brushing with fluoride dentifrices can also be recommended in school programmes and for home care, but as yet, the supply of fluoride dentifrices into the Cook Islands is not favourable. The government should look closely into this problem ensuring that only fluoride dentifrices be allowed to reach the Cook Islands which can be of great benefit in reducing the high prevalence of dental caries in its population.

4.2 METHODS OF CHOICE

The Cook Islands Government is the main organization responsible for the delivery of dental care to the school children. It has been a known fact that the caries rate amongst school children in Rarotonga (10.4 DMF teeth in Rarotonga for fourteen year olds) is increasing despite the introduction of oral health education and tooth-brushing schemes. Some studies have shown that toothbrushing schemes in the schools can prevent or control periodontal disease to a large extent, in particular gingivitis, amongst school children may provide partial control of dental caries only if it is used with a therapeutic fluoride toothpaste.

The South Pacific Commission in collaboration with the Cook Islands Government have initiated a self-applied mouth-rinsing programme in one school on Rarotonga and the self-applied topical fluoride programme in two other schools. As yet, there has been no surveys conducted to evaluate the effectiveness in Rarotonga of the procedures but the results from other overseas studies can be used to predict the effectiveness of these procedures. There should be a great reduction in the caries increment in the school children attending these schools compared to other school children who have not yet used this "brush-in" and "mouth-rinse" programmes. The "mouth-rinsing" projects together with the tooth brushing and oral health education schemes plus the use of fluoride tablets are expected to be the major caries preventive efforts in the Cook Islands.

The most effective method if a school is going to adopt a mouth-rinsing programme is the high potency/low frequency rinses. (0.2% NaF weekly). Oral health education and tooth-brushing schemes especially if the fluoride toothpastes can be available in the Cook Islands may provide further prevention to caries prevalence in the school children.

Fluoride tablets may be readily distributed and administered to the school children before the school begins every morning.

COST OF MOUTH-RINSING MATERIALS

The materials used are few : Naf powder or tablets; plastic containers; calibrated pumps; plastic cups; and napkins. It has been shown to be inexpensive in other countries. Horowitz (1980) estimated that if supervision is to be done by volunteers, weekly fluoride mouthrinsing can be carried out for as little as 21 pence per child per year. Daily rinsing with 0.05% Naf appears no more efficacious than the weekly or fortnightly rinsing with 0.2% Naf, and is clearly more expensive and less practical.

COST OF FLUORIDE TABLETS

Costs of fluoride tablets vary from country to country especially between retail, wholesale, and bulk order supplies. In Australia, the price of fluoride tablets was 75 cents for 200 in 1969. Dunning (1970) reported that the group purchase of a years supply of fluoride tablets is U.S. \$3.65 per child.

SUPERVISION OF MOUTHRINSING AND FLUORIDE TABLET PROGRAMMES

If school teachers, teachers aides, volunteers are to be used for supervising the programmes, there should be no direct cost incurred. The co-operation of school teachers is necessary. School nurses working in the primary schools in Rarotonga can be used where teachers and volunteers are not used. The actual application of rinse solutions and the taking of fluoride tablets is done by the children themselves, and therefore there is no need for professional manpower (dentists and other auxiliaries) in order to apply fluoride solutions. Supervisors will require minimal instruction.

In the Cook Islands, the dental officer or the dental nurse working in that particular school could act as rinse-co-ordinator - administrators and therefore the need for employing one does not arise.

TRANSPORT

There is no dental transport in the Cook Islands but Health Department transport is available if there is a need to take dental personnel to the outer schools if the programmes are to be conducted. In the school where a dental nurse is posted

transport would only be needed to take the dentist who would be the programme administrator to visit the schools at infrequent intervals to ensure all is well.

The use of dental service personnel for supervisory role in rinsing and fluoride tablet programmes would definitely mean higher costs in terms of transport to supervise the procedure if the programme is to reach every primary school on each island in the country. The worst affected schools would be those located on the Northern Group islands, where there are no airstrips, and where a boat calls only once every three months to these islands. There has been the problem in the past, with providing dental services to these Northern Group islands, and if these programmes are to be introduced on a long term there will be higher costs incurred but greater benefits conferred. The supervision of the rinse and tablet programmes essentially by teachers would be a far sighted approach towards minimizing costs. The only overall administrative personnel, the rinse-coordinator or the (programme co-ordinator) will have to liaise with the rinse supervisors and in particular the school teachers to obtain full co-operation and ensure that the programme is carried out as scheduled and the recommended techniques applied.

PRACTICALITY

- (1) The efficiency of the rinsing methods in reducing dental caries has been demonstrated in numerous clinical trials. Caries increments can be reduced by about 35% after two or more years of participation.
- (2) Fluoride tablets also reduce dental caries increment by about 20-40% in the permanent teeth of 5-9 years old school children who had consumed tablets for periods of two to four years.
- (3) Few materials are required and the cost is low for both procedures.
- (4) Little time is involved per session so that frequent treatments (weekly mouthrinses) can be accomplished with minimum disruption of classroom time. The average time is about five minutes per classroom rinse.
- (5) Fluoride tablet administration takes 3 minutes per day per week and because the tablet is to be taken before

the school begins, there is no disruption to school time.

- (6) Non-dental personnel with minimum training can easily supervise the procedures. The programmes can use classroom teachers who, with minimum training can act as rinse supervisors. One supervisor can supervise about 30 children who are required to rinse simultaneously.
- (7) The techniques for administration are easy. For mouth-rinsing, the procedure involves swishing with 10 ml. of the rinse solution for one minute and then expectorate under the direction of the supervisor. For kindergartens, however, a 5 ml. rinse volume would be suitable. For fluoride tablets, the recommended procedure requires that the tablet be chewed or dissolved in the mouth, and the resultant solution is swished between the teeth for one minute before swallowing.
- (8) No side effects have been attributed to the unintentional swallowing of the rinse solution.

5.

SUMMARY

This presentation is to review the current literature of the studies and research that has been carried out on self-applied fluorides. Emphasis will be placed on the various methods that have shown a significant reduction in caries increment.

It is considered that : by reviewing the literature of effectiveness of different methods of self-applied fluorides; by studying the planning and implementation of the various methods of self-applied fluorides used in various countries of the world; and by reviewing the cost benefit/cost effectiveness of the various methods of self-applied fluorides, appropriate conclusions can be drawn to suggest the most feasible methods that could be of value in planning a caries-preventive self-applied programme for the Cook Islands.

The term self-applied fluoride implies to administration of topical fluorides on the surfaces of the enamel of the teeth for the prevention of dental decay. The traditional approach to the administration of topical fluorides requires that each child be treated individually by a dentist or dental hygienist and special equipment and facilities are to be used. Although professionally applied topical fluorides are well adapted for use in private dental practice, the method has disadvantages for public health programs in which preventive benefits are sought for many children. The increasing shortage and maldistribution of professional dental manpower and the relatively high cost of treatments accentuate the shortcomings of a professionally administered technic as a public health measure.

In the search for methods to overcome these drawbacks, several investigators have evaluated various self application procedures for the delivery of topical fluorides, including :-

- (i) tooth brushing with solutions and gels containing fluoride.
- (ii) fluoride tablets.
- (iii) tooth-brushing with fluoride containing prophylaxis pastes.
- (iv) mouth-rinsing with fluoride-containing solutions.

The Cook Islands, consisting of fifteen small islands are scattered over a large area of sea. It is an isolated group of islands lying about 1,700 miles North East of New Zealand. Rarotonga, which is the capital island and the largest in the group, has a ring main water system which runs around the island and is fed by a total of seven sources. Much of the water sources depend on the amount of rainfall that the island receives each year. The future for communal water fluoridation in Rarotonga is still in doubt as there is still a great need for improvement in its present water system. Communal water fluoridation is not practicable for the outer islands, as there is no water sources on these islands. Rainwater, caught in tanks is the main source of water for the people on these islands.

Fluoridation to communal water systems may be defined as the controlled addition of fluoride to reticulated water to adjust the natural fluoride level to a level which has been proven to most effectively reduce the incidence of dental caries. The usual recommended dose is not more than one part of fluoride for every million parts of water. The use of fluorides in the prevention of dental caries is the most effective way of controlling the dental disease. Communal water fluoridation continues to be the cornerstone of an ideal caries prevention programme.

As the reports of oral health status surveys conducted in the Cook Islands show a very high incidence of dental caries e.g. DMFT of a 14-year-old in Rarotonga is 10.42 (Speake, J.D. - 1974), the writer sees that there is an urgent need for some prevention measures to overcome this problem. As communal water fluoridation is impracticable in the Cook Islands, the bulk of this thesis, deals with the various alternatives to water fluoridation. The emphasis, as mentioned before, will be placed on the various methods that have shown a significant reduction in caries increment.

An effective method of providing the benefits of systemic fluoride in geographical areas that lack central water fluoridation systems is by fluoride tablet supplements. It was reported that after some 30 clinical trials,

conclusions were drawn that fluoride tablets have a certain value in reducing dental caries in permanent teeth by 20 - 40 % in 5 - 9 year old children who had consumed tablets for periods of 2 - 4 years. (G.N. Davies - 1974).

Fluoride solutions, gels or prophylactic pastes can be professionally-applied but it is an expensive method both from the standpoint of dental manpower and cost compared to other approaches and, therefore, are more suitable for private practice settings.

Since 1958, fluoride has been added to the water supplies of rural schools in an area of Kentucky and another in Pennsylvania; at levels of 3 ppm and 5 ppm respectively. Fluoride levels greater than the optimum for community fluoridation were used in an attempt to approximate the total fluoride intake of children who drink fluoridated water on a full time basis. A survey conducted four years later showed an over-all reductions in average number of DMF teeth of 32.8 % in Kentucky and in Pennsylvania, 33.9 %.

The first publications suggesting salt as a vehicle for fluoride appeared in 1948 and 1950 when iodized salt was introduced to prevent goitre. The results of a clinical study initiated in 1956 were in favour of a cariostatic effect of fluoride-supplemented salt. This cariostatic effectiveness seems to equal that provided by fluoride in water when the fluoride content of salt is adjusted so as to provide urinary fluoride excretion levels similar to those associated with optimal fluoride content of water.

The numerous studies that have been conducted on fluoride dentifrices (especially stannous fluoride-calcium pyrophosphate) reported moderate reductions in incremental DMF surface on the order of 15 to 30 percent following the normal usage at home of 'Crest'. Greater benefits, a 54 % reduction in new DMF surfaces have been observed among groups of students in a military school who were directed to brush

their teeth three times a day and who received special instruction in oral hygiene. There is little doubt that new and better dentifrices will continue to be developed. Existing therapeutic dentifrices classified as effective by the Council on Dental Therapeutics of the American Dental Association have been shown to provide limited protection against the development of dental caries, and therefore, the public should be encouraged to use these products. Fluoride dentifrices are available for home use.

Self-applied fluorides, such as tablets, mouthrinses, pastes, gels and solutions are particularly suitable for use in schools.

The use of fluoride mouthrinses in school programmes have been shown to reduce dental caries increment in children by about 20 to 50 percent. In more than 35 clinical trials conducted in the United States and Scandinavian countries, the investigators evaluated different methods of rinsing under a variety of conditions. The results of these trials have led to the acceptance of the following methods of rinsing :

- (1) Low potency/high frequency rinses (0.05% Naf, 0.44% APF, 0.1% Sn F2) have been recommended for daily home-use by persons highly susceptible to caries. Involves a rinse and expectorate technique (5 ml of solution swished for one minute). The method has been shown to reduce dental caries increment in school children by about 40% when used for more than two years. However, this is not particularly suitable for school-based programmes.
- (2) High potency/low frequency rinses (0.2% Naf solutions) have been recommended for weekly and fortnightly school-based programmes. This technique involves rinsing with 5 - 10 ml. of the solution for one minute and then expectorating (under supervision). Effective in reducing dental caries increment in children by about 35%.

Most investigators have concluded that the beneficial effect of mouthrinsing with fluoride solutions can only be maintained if continued. The combined use of fluoride tooth-

pastes with the less frequent mouthrinses have been suggested once the children have completed primary school education.

Conservative estimates show that weekly or fortnightly rinsing with 0.2% Naf solution can be cost-effective (45 cents/child/year in the U.S. in 1977) and the cost-benefit ratios are impressive (1 : 16.4 for weekly rinsing in the U.S. in 1971 and 1 : 10.6 for fortnightly rinsing in Sweden in 1965).

The benefit of daily, weekly or fortnightly rinsing according to Birkeland and Torell (1973) can be summarised as follows :

- (1) The caries prevalence is reduced by 50%, the increment by 60 - 70% and the need for fillings by about 70%.
- (2) The treatment is simpler and the fillings last longer.
- (3) The cariostatic effect improves by combinations of rinses and other fluoride regimen.
- (4) The benefits in teenagers are likely to give a long-lasting low caries prevalence.

In planning and developing a programme for mouthrinses, there is need for identification of an appropriate population for rinsing estimation and securing of funds to underwrite the programme, recruitment and training of staff to administer the programme and implementing the programme through supervision, monitoring and follow-up, thus ensuring maximum participation.

The discussion was based on the methods of choice for the Cook Islands. Administration of fluoride tablets showed a caries reduction in the approximate range of 50 - 80% in deciduous teeth when fluoride administration is begun before about two years of age and is continued for a minimum of three to four years. The effect of fluoride tablets on permanent teeth as reported in the many studies, showed caries reductions of approximately 20 to 40 per cent among children, initially between 5 and 9 years of age, who had consumed fluoride tablets for periods of two to four years. The few studies conducted on the effect of prenatal use of fluoride

tablets reported a caries reduction of 93% in the deciduous teeth of a group of children who had received fluoride tablets daily beginning at four months in utero, and continuing for four years after birth; compared with a 54% reduction in another group of children who received tablets for four years beginning shortly after birth. These studies further suggested that the benefits from the prenatal use of fluoride tablets accrue only for the deciduous teeth.

The use of high potency/low frequency rinses (0.2% Naf solutions either weekly or fortnightly under supervision) in schools should be considered in terms of costs, supervision, and practicality in order to achieve maximum reduction in caries increment.

The use of non-dental personnel may also be considered, especially the school teachers; who would be the most appropriate personnel for supervising the rinsing procedures, so that the professional dental staff time could be saved for secondary prevention. Finally, it has been suggested that a weekly mouth-rinsing is more advantageous than the fortnightly rinses. The many trials done in giving fluoride tablets in schools, and the weekly mouthrinsing with a fluoride solution in schools are both attractive and positive programmes because :

- (1) The procedures are safe and are effective in reducing dental caries.
- (2) The procedures are inexpensive.
- (3) Little time is required for the procedures - approximately 5 minutes per week for an average class in mouthrinsing and approximately 3 minutes per school day for an average classroom for fluoride tablets.
- (4) The procedures are easy for school children of all ages to learn and to do.
- (5) With minimal training, non-dental personnel, such as classroom teachers, parents, aides or volunteers, can easily supervise the procedures.

6. CONCLUSIONS

Communal water fluoridation continues to be the cornerstone of an ideal caries prevention programme.

The many research studies that have been carried out, show that fluoride mouthrinses have gained importance in the caries-preventive armamentarium of public health dentistry. With the current increasing trend in the high dental caries prevalence amongst school children in the Cook Islands and the stringent economical measures being exercised in the government Dental Health Service; it is necessary to adopt some preventive approaches to dental services. It would seem most reasonable to implement fluoride mouthrinsing and fluoride tablet programmes in the schools.

The methods of choice for mouthrinsing programme would be the use of a high potency/low frequency fluoride regimen. It is considered that weekly rinsing with 0.2% neutral Naf solution would be more advantageous than the fortnightly frequency. Both from the clinical point of view that frequency of application is more important than concentration and from practical standpoint that schoolteachers are more likely to follow it as a weekly routine this method appears to be more promising.

The method involves weekly rinsing with a 0.2% Naf solution using the "rinse and expectorate" technique. Under the supervision of the classroom teacher the children "swish" with 10 ml. of the solution for a duration of one minute and then expectorate into a paper cup. The younger children could use a rinse volume of 5 ml. for practical reasons. In this way about 30 children could rinse simultaneously under one supervisor keeping the "rinse session time" to a minimum (about 5 minutes).

Similarly, the distribution of fluoride tablets should be done in the schools. The studies of Vratraler, Binder and De Paola and Lux provide substantial evidence of the benefit and practicability of this procedure. Like the mouthrinse programme, the daily issuing of tablets may be placed in the hands of schoolteachers or dental assistants seconded

to schools for that purpose. The time taken for the procedure is about 3 minutes per day.

The clinical effectiveness of weekly fluoride mouth-rinses have been well documented. Children participating in long-term (two or more years) rinsing programmes can expect 35% reductions in dental caries increments. The benefits are better when the programme is continued, and therefore, long term programs would be needed to confer maximum benefits.

Estimates of cost-benefit based on long-term programmes indicate that the procedure is highly cost-effective in a variety of settings. The cost of rinsing materials is minimal. In the Cook Islands, the costs could be further lowered if the Dental Department stocks all necessary materials. To ensure continuity of the programme the Naf tablets/powder may be supplied to the schools without costs. However, it is possible to encourage schools to raise funds for purchasing the other rinse materials. (Plastic cups, paper napkins), and storage facilities (cabinets).

The supervision of the rinsing procedures and the distribution of the fluoride tablets is an important aspect of the programme. It is considered that the schoolteachers could be the most appropriate personnel for supervision. Non-operating dental auxiliaries and volunteers could also be suitable. Adequate, but minimal training is required for them to efficiently carry out the supervision.

It is also considered that dental officers, and dental nurses could best serve as rinse co-ordinators - administrators. They could ensure continued participation by visiting each school once a month, thus reducing the need for the use of government transport which is not always readily available. Moreover, these clinical operators would be largely involved in the treatment programmes in the light of the mounting backlog of unmet dental treatment needs and the unfavourable manpower ratio for school children.

These methods (i.e. fluoride tablets and mouthrinses) of administering fluoride would seem to be both promising public health measures when adopted in conjunction with oral health education, toothbrushing schemes and treatment programmes in the schools and thus could provide an effective means of preventing and controlling dental caries prevalence amongst the school children of the Cook Islands.

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8. APPENDICES.

A SUMMARY OF COST ANALYSIS OF VARIOUS PREVENTIVE PROCEDURES.

COST EFFECTIVENESS USING HEIFETZ'S METHOD AND COST BENEFIT AFTER DAVIES METHOD are defined as :-

$$\text{COST EFFECTIVENESS} = \frac{\text{Cost of Procedure/person/unit of time}}{\text{Mean DMFS saved/person/unit of time}}$$

$$\text{COST BENEFIT} = \frac{\text{Cost of implementing the procedure}}{\text{Cost of restoring teeth "saved" by the procedure}}$$

ESTIMATED COST/BENEFIT OF FLUORIDE PREVENTIVE PROCEDURES

METHOD	COST/CHILD/ YEAR \$U.S.	COST-BENEFIT RATIO (RANGE)	% CARIES REDUCTIONS (EFFICACY).
WATER FLUORIDATION	0.15-0.20	1:2.5-65.0	30-70
SCHOOL WATER FLUORIDATION	UP TO 1.50	1:0.06-4.1	33-40
FLUORIDE RINSING (WEEKLY)	1.50-7.00 *	1:5.3-25.0	2-49

* Salaries included.

ESTIMATED COST-EFFECTIVENESS OF FLUORIDE PREVENTIVE PROCEDURES

METHOD	% CARIES REDUCTION	DMFS SAVED/ PERSON/YEAR *	COST/PERSON/ YEAR \$U.S.	COST(U.S.\$) /SURFACE SAVED.
WATER FLUORIDATION	50	1.0	0.20	0.20
SCHOOL WATER FLUORIDATION	40	0.8	1.50	1.90
WEEKLY MOUTH RINSE	25	0.5	0.50	1.00

* assuming normal increment of 2 DMFS/person/
year in a non-fluoride area.

SOURCE : Cooper, M.H. - 1982.

Prevention:

1. Primary Prevention:

Steps taken to ensure that disease does not occur.

2. Secondary Prevention:

Detection of incipient disease and halting its progression by simple repair or remedial measures. Sometimes at this stage there may be 'reversal' to the normal (as in gingivitis).

3. Tertiary Prevention:

Treatment of well-established disease in order to minimize or eliminate the gross destructive effects, to restore healthy function and to resist further attacks of the disease process.

Dentists have in general, started their disease control at stage 2 above. Their training equipped them to search carefully for early caries, and dealing with this was thought to be the best approach possible. The result was a mouth with numerous small fillings in the pits and fissures. At stage 3 above or later the presence of periodontal disease was noted but all too often this awareness came too late.

(The different stages of prevention as relating to the approach to disease control).

SOURCE: FORREST, J.D. Editor - Preventive Dentistry : Dental Practitioner Handbook No.22, John Wright & Sons Limited, Bristol, 1976.

PREVENTION OF ORAL DISEASES BASED UPON DISEASE LEVEL

DISEASE LEVEL	TREND	PREVENTIVE APPROACH
Very low to low	Stable	. None (surveillance);
	Increasing	. Dental health education; . Improvement of oral hygiene; . Dietary counselling.
Moderate	Decreasing	. Dental health education; . Improvement of oral hygiene;
	Stable	. Dietary counselling; . Community programs;
	Increasing	. School programs.
High to Very High	Decreasing	. Reinforcement or supplementation of existing preventive programs.
	Stable	. Dental health education; . Improvement of oral hygiene;
	Increasing	. Dietary counselling; . Community programs; . School programs; . Individual approach; . Combination programs.

SOURCE: MOLLER I.J. (1979) -
Preventive Responses to various National Problems.
Int. Dent. J., 29.3, 208-214 (September)

FLUORIDE MOUTHRINSE
TREATMENT RECORD

19__ - 19__ SCHOOL SESSION

School _____ Teacher _____ Grade _____

Participants	Rinsed? Yes (+) No (—)										School Week																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
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SOURCE: Dept. of Health, Education and Welfare

Ref: U.S. Public Health Service : DHEW Publ. (No. NIH) 77 - 196.

EFFECTIVENESS OF VARIOUS METHODS OF
ADMINISTERING FLUORIDES

METHOD	CONCENTRATION OR DOSE	% REDUCTIONS IN DENTAL CARIES
Community water fluoridation	0.7 - 1.2 ppm	50-65
School water fluoridation	4.5 x's optimum	40
Dietary Fluoride supplements	Depends on age of child and F concentration of water.	50-65
• Home	2.2 mg NaF (daily)	30-35
• School		
Mouthrinses	0.05% NaF (daily) 0.20% NaF (weekly)	20-50
Dentifrices	0.40% SnF ₂ 0.76% MFP 0.22% NaF	20-30
Professionally applied applications	2.0% NaF 8.0% SnF ₂ APF (1.2%F)	30-40

SOURCE: HOROWITZ, H. - 1980

Established methods of prevention.

Brit. Dent. J., 149 : 11, 311 - 317 (2 Dec) 1980.

