

https://dspace.org/

A theoretical study of cost effectiveness of fluoride-containing caries preventive agents and procedures in Johannesburg

Hadfield, F.; Cleaton-Jones, P.

1983

http://hdl.handle.net/10539/19516

Hadfield, F., Cleaton-Jones, P. 1983. A theoretical study of cost effectiveness of fluoride-containing caries preventive agents and procedures in Johannesburg. Journal of the dental association of South Africa; 38(4):229-32

Downloaded from a DSpace repository. https://dspace.org/

Journal of the Dental Association of SA, 38, 229-232

A theoretical study of cost effectiveness of fluoride-containing caries preventive agents and procedures in Johannesburg

F Hadfield and P Cleaton-Jones

MRC/University of the Witwatersrand Dental Research Institute, Jan Smuts Avenue, Johannesburg.

Key words: caries, cost-effectiveness, fluoride, prevention.

SUMMARY

A theoretical calculation of the cost-effectiveness of the use of several fluoride treatments in private dental practice has been undertaken using a formula suggested by Heifetz (1978). The cost per 1,0 DMFS saved ranged from R10,00 for home tooth-brushing using an 0,1 per cent fluoride dentifrice to R29,91 for daily intake of sodium fluoride tablets. By contrast, water fluoridation would cost between R0,69 and R1,00.

OPSOMMING

'n Teoretiese berekening van die kostedoeltreffendheid van die gebruik van etlike fluoriedbehandelings in die privaat praktyk is gemaak. 'n Formule voorgestel deur Heifetz (1978) is vir dié doel gebruik. Die koste vir die besparing van 1,0 DMFS is R10,00 vir die tuisgebruik van 'n 0,1 persent fluoriedtandepaste en R19,91 vir die daaglikse inneming van natrium fluoried tablette. In teenstelling hiermee sal waterfluoridasie tussen R0,69 en R1,00 kos.

INTRODUCTION

It is clear from voluminous literature that community water fluoridation is the most economical means of dental caries prevention. Although the fluoridation of public water supplies in South Africa was recommended in 1966 by the Commission of Enquiry into Fluoridation, this recommendation has not yet been implemented. Until such time as this occurs, alternative methods of fluoride therapy must be used. Such therapy includes the ingestion of fluoride such as in tablets as well as the topical application of fluoride in different forms. With regard to the latter, Heifetz (1978, 1981) has shown that, in a hypothetical child population in the United States, weekly fluoride mouth rinsing is the most economical topical fluoride treatment for the reduction of dental caries, in public dental health programmes.

Within South Africa fluoride therapy is used at two levels. One consists of programmes used by public health authorities and the second consists of methods used or recommended in private dental practice. This paper is a theoretical examination of the cost-effectiveness in the latter situation.

MATERIALS AND METHODS

No generally accepted method for the calculation of cost-effectiveness exists. It was therefore decided to use a method described by Heifetz (1978) to estimate the direct costs of fluoride therapy to a consumer. The forms of therapy chosen were those readily available to the public, namely, fluoride containing tablets; fluoride solutions and gels applied professionally; and tooth-brushing with a dentifrice containing fluoride. For comparison the estimated costs to the consumer of water fluoridation of Johannesburg drinking water and the costs of amalgam restorations, have been included. Fluoride mouth rinses, although apparently in use in public health programmes in South Africa, are not readily available commercially to consumers and therefore have not been included.

Several assumptions have been made.

1. The hypothetical population considered consists of white schoolchildren, aged 6-13 years in whom the estimated mean caries increment is 2 new decayed, missing or filled surfaces (DMFS)/year.
2. The mean fluoride concentration in Johannesburg drinking water is 0,25 mg/ℓ.
3. The objective of the analysis is to save one new DMFS/year.
4. The mean percentage reduction in caries for each method considered is that reported by Horowitz and Heifetz (1979).
5. The estimated cost is that to the user of the treatment considering only the direct costs of administering the agent. The method of calculation used is that of Heifetz (1978) where

$$\text{Cost effectiveness} = \frac{\text{Cost (in Rands) of procedure/patient/annum}}{\text{Mean number of DMF surfaces saved/patient/annum}}$$

TABLE I: Cost effectiveness of Zymafluor and Dentafluor plus tablets dosage over a 12-year period calculated per year.

TABLET 1:
COST:
500 Zymafluor tablets = R8,21
During 12 years an average of 15 300 tablets will be consumed. Therefore, in 1 year an average of 1 275 tablets will be consumed. 1 275 Zymafluor tablets (1 year's consumption) will cost — R20,94.

EFFECTIVENESS: 2 DMFS/child x 35 per cent reduction = 0,70 DMFS saved/child.

COST EFFECTIVENESS: $\frac{\text{R20,94/child}}{\text{0,70 DMFS/child}}$ = R29,91 to save 1 DMF surface.

TABLET 2:
COST:
500 Dentafluor plus tablets = R5,25
1 275 Dentafluor plus tablets (1 year's consumption) will cost R13,39.

EFFECTIVENESS: 2 DMFS/child x 35 per cent reduction = 0,70 DMFS saved/child.

COST EFFECTIVENESS: $\frac{\text{R13,39/child}}{\text{0,70 DMFS/child}}$ = R19,13 to save 1 DMF surface.

TABLE II: Cost effectiveness of topical fluoride administration.

	Contracted-in	Contracted-out
COST: Topical application on a fluoride preparation (does not include scaling and/or polishing)	R10,00	R11,00

EFFECTIVENESS
2 DMFS/person x 40 per cent reduction = 0,8 DMFS saved/person

COST EFFECTIVENESS
Contracted-in: R10,00/person 0,80 DMFS/person = R12,50 to save 1 DMF surface/year.

Contracted-out R11,00/person 0,80 DMFS/person = R13,74 to save 1 DMF surface/year.

TABLE III: Cost effectiveness of daily use of fluoride containing Dentifrice over one year.

COST:
On average 1 tube of fluoride-containing dentifrice will cost .....R1,00 (50 g)
On average 1 tube of toothpaste will last .....90 days
Therefore 4 tubes are required per annum R4,00

EFFECTIVENESS:
2 DMFS/person x 20 per cent reduction = 0,4 DMFS saved/person

COST EFFECTIVENESS:

$\frac{\text{R4,00/person}}{\text{0,4 MDFS/person}}$ = R10,00 to save 1 DMF surface/year.

Sources of information

1. Fluoride-containing tablets — suggested retail price to pharmacies.
2. Fluoride-containing dentifrices — estimated average at supermarkets.
3. Professional applications of fluoride preparations and amalgam restorations — current tariffs of fees of the Dental Association of South Africa.
4. Water fluoridation
   (i) Water supplied to Johannesburg/day — Rand Water Board.
   (ii) Cost of NaF — Holpro Chemical Industries, Johannesburg.
   (iii) Capital and running estimates for fluoridation of Johannesburg Mr. A.R. Pitman, Water Pollution Control Officer, Johannesburg City Council.
   (iv) Population of Johannesburg, Annual Report of the Medical Officer of Health (1979).

The mean percentage reduction in caries for each method of fluoride therapy is that reported by Horowitz and Heifetz (1979).

1. SYSTEMIC ADMINISTRATION OF FLUORIDE

Fluoride containing tablets

From the birth of the child to at least the age of 12 to 13 years the child should ingest fluoride in the correct dosage. Protection against dental caries may range from 20 to 50 per cent depending on the duration of fluoride ingestion (Bischoff, Van der Merwe and Retief, 1975). A tablet containing fluoride which is currently available in South Africa is *Zymafluor* (Zyma, S.A. Nyon, Switzerland). Each tablet contains 0,25 mg of fluoride in the form of sodium fluoride, and the recommended dosage by the manufacturer is as follows:

Infants ..... 1 tablet daily dissolved in feed (0,25 mg F)

1-2 years old ..... 2 tablets daily (0,50 mg F⁻)
2-3 years old ..... 3 tablets daily (0,75 mg F⁻)
More than 3 years old .. 4 tablets daily (1,0 mg F⁻)

Recently a tablet containing 0,24 mg fluoride as calcium fluoride *(Dentafluor plus,* Naturmade, Ltd., Johannesburg) has become available. As the fluoride content is less than 0,25 mg it is not a scheduled pharmaceutical agent and is available as a health preparation. The comparative cost-effectiveness of both tablets in similar dosages, is detailed in Table I. A similar percentage reduction in dental caries, namely 35 per cent, has been assumed and the costs used are retail costs to the public. No modification in dosage has been made for the 0,25 mg/ℓ fluoride already in the drinking water of Johannesburg.

2. TOPICAL ADMINISTRATION OF FLUORIDE

Fluoride solutions and gels

Once crown formation is complete and the permanent teeth have erupted, the enamel fluoride content may be increased by various methods of topical fluoride treatment. The professional administration of topical solutions and gels when used as directed reduces the increment of dental caries by approximately 40 per cent in non-fluoridated areas. Various solutions and gels are available and may contain either 2 per cent sodium fluoride, 8 per cent stannous fluoride or acidulated fluorophosphate (APF) 1,23 per cent (Heifetz, 1978). For caries-prone individuals semi-annual applications of APF solution or gel are recommended. However, it is probably sufficient if it is applied annually to the teeth of a person with average yearly caries increment. Calculations of the cost effectiveness of the professional application of solutions and gels for both contracted-in and contracted-out dentists are shown in Table II. It has not been necessary here to calculate the cost of the actual amount of solution or gel used per person per treatment as an inclusive fee is charged by the dentist for the fluoride treatment.

Tooth brushing with a dentifrice containing fluoride

This is a home based procedure and is self-applied. As fluoride dentifrices cost no more than most non-fluoride dentifrices, the use of a fluoride-containing dentifrice with tooth brushing at home is not considered an added expense. If used from an early age it will result in a reduction of dental caries of approcimately 20 to 30 per cent. The cost-effectiveness is shown in Table III.

TABLE IV: Cost effectiveness of fluoridating the Johannesburg Water Supply.

COST:

A. Chemical

Average amount of water supplied to Johannesburg per day ..... 550 490 kℓ/day
0,75 mg/ℓ (0,75 g/kℓ of fluoride added to 550 490 kℓ of water per day ..... 412 868 g fluoride/day
to provide 412 868 g fluoride/day requires 913 425 g NaF/day
= 18,3-50 kg bags NaF/day
= 6680-50 kg bags NaF/year
50 kg bag of technical NaF (96-98 per cent) costs R55,00
therefore 6 680 — 50 kg bags NaF costs R367 400 per year

B. Capital and operating costs — assuming Johannesburg fluoridates its own water supply

Estimate includes:

Buildings, access roads, dosage pumps, monitors, feedback alarms, holding tanks, pipework, maintenance mechanic's salary, laboratory technicians' salaries, laboratory costs, overheads, spares and maintenance, transport, redemption and interest.

(i) to fluoridate 100 per cent water supplies — R600 000/year
(ii) to fluoridate 90 per cent water suplies — most practical method R300 000/year

Estimated total population in Johannesburg	2 089 167
— Comprised of Black	1 500 000
White	435 586
Coloured	101 769
Asian	46 718
Other	5 094
Estimated population up to 18 years of age	970 529

Therefore, estimated cost/child
= (i) if 100 per cent water fluoridated $\frac{R367\,400 + R600\,000}{970\,529}$ = R1,00

(ii) if 90 per cent water fluoridated $\frac{R367\,400 + R300\,000}{970\,529}$ = R0,69

EFFECTIVENESS:

2 DMFS/person/year x 50 per cent reduction = 1,0 DMFS saved/person/year

COST EFFECTIVENESS:

(i) $\frac{R1,0/person}{1,0\ DMFS\ saved/person/year}$ = R1,00 to save 1 DMFS

(ii) $\frac{R0,69/person}{1,0\ DMFS\ saved/person}$ = R0,69 to save 1 DMFS

TABLE V: Comparison of cost effectiveness.

	Estimated % reduction in decay	Cost in Rands per 1,0 DMFS saved
Toothbrushing at home using an 0,1 per cent fluoride dentifrice	20	R10,00
Professional application of topical fluoride preparations — contracted-in	40	R12,50
Professional application of topical fluoride preparations — contracted-out	40	R13,75
Daily intake of CaF_2 tablets	35	R19,13
Daily intake of NaF tablets	35	R29,91
CONTRAST GROUPS:		
Fluoridation of the drinking water to a concentration of 1 ppm	50	
(i) 90 per cent of water supplies		R 0,69
(ii) 100 per cent of water supplies		R 1,00
Restoration of 1 DMFS		
(a) Not interstitial (i) contracted in		R 7,50
(ii) contracted-out		R12,50
(b) Interstitial (two surface restoration necessary)		
(i) contracted-in		R 9,40
(ii) contracted-out		R17,00

3. CONTRAST COSTS

Water fluoridation

The average natural concentration of fluoride present in the Johannesburg water is approcimately 0,25 mg/ℓ. Therefore to raise the concentration of fluoride to 1,0 mg/ℓ (1 part/10^6) 0,75 mg/ℓ of fluoride must be added. The chemical of choice according to the Rand Water Board, would be sodium fluoride (NaF).

Estimation of the cost of fluoridation of Johannesburg's drinking water is complicated by the fact that there are many points of water entry into the municipal area. The easiest and cheapest method would be for the Rand Water Board to fluoridate at source. The cost of this would be shared by all municipalities to which water is supplied. In this paper it is assumed that fluoridation of the water of Johannesburg only will be done by the city. Two possibilities exist. To fluoridate all water supplies 45 dosage points will be needed. A more practical approach would be to fluoridate 90 per cent of the water supplies which will reduce the number of dosage points to 15. The non-fluoridated areas would be the central city area and small areas of the southern suburbs. The costs of both methods will be given.

A second difficulty concerns the calculation of the population of Johannesburg, information on which ranges widely. This article uses the estimates of the Medical Officer of Health of Johannesburg. Since maximum benefit from fluoridation is held to be to children and adolescents, these groups form the denominator in the calculation (Table IV). In the developed population of the United States, children and adolescents comprise about one third of the population (Horowitz and Heifetz, 1974). In South African population pyramids, the same proportion holds for the white group. In black, coloured and Asiatic groups, children and adolescents are approximately half of the population (Stewart 1978). These proportions have been included in the calculations. No allowance has been made for ethnic differences in caries prevalence and increment, nor for the time lag before maximum caries reduction would occur.

Restoration of DMFS

The single DMFS reduction aimed for in this paper may be contrasted with the cost of restoration. It has been assumed that amalgam would be used. Four costs have been considered. These are a single surface restoration, a two surface restoration since the DMFS may be interstitial and in both instances, at contracted-in and contracted-out rates. (Table V).

DISCUSSION

The cariostatic effect of fluoride is well established and will not be discussed in this paper. While it is accepted that the costs calculated for this article are estimates, we believe that the relative costs of the various types of fluoride treatment are clearly shown. The use of systemic fluoride in the form of sodium fluoride tablets is an expensive method of prevention for the hypothetical population. In comparison topical fluoride treatments appear more practical with regard to cost-effectiveness. Dentifrices containing fluoride are the most cost-effective in ranking order but their effect is dependent on regular frequent use such as is maintained in clinical trials and supervised brushing programmes. This may not be the case in reality for home use.

This paper emphasizes the high cost-effectiveness of water fluoridation for Johannesburg, even under the least favourable circumstances. If fluoridation occurs at the source of Johannesburg's water supply in Vereeniging, then the cost would be reduced to about one-tenth of that presented. A further point for noting is that the cost of treatment for one DMFS is less than the use of sodium fluoride tablets in private practice.

ACKNOWLEDGEMENTS

We thank Mrs. R. Norman for her expert typing.

REFERENCES

Annual Report of the Medical Officer of Health, Johannesburg (1979), Johannesburg City Council. p.7.

Bischoff, J.I., van der Merwe, E.H.M. & Retief, D.H. (1975) Products available for topical fluoride therapy. *Journal of the Dental Association of South Africa* **30**, 333-337.

Heifetz, S.B. (1978) Cost effectiveness of topically applied fluorides. In *"Proceedings of a Workshop on the Relative Efficiency of Methods of Caries Prevention in Dental Public Health"*, ed. Burt, B.A., pp.69-104. Ann Arbor: University of Michigan.

Heifetz, S.B. (1981) Alternative methods of delivering fluorides: An update. In *Dental Caries Prevention in Public Health Program*, eds. Horowitz, A.M. and Thomas, H.B. pp. 25-42. N.I.H. Publication, No. 81-2235.

Horowitz, H.S. & Heifetz, S.B. (1979) Methods for assessing the cost-effectiveness of caries preventive agents and procedures. *International Dental Journal* **29**, 106-116.

Report of the Commission of Enquiry into Fluoridation (1966) RP 17/67 Pretoria: Government Printer.

Stewart, T.H. (1978) An Introduction to Public Health, 2nd ed. Durban: Butterworth. pp. 15-24.