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Comparison of three fluorosis indices in a Namibian community with twice optimum fluoride in the drinking water

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Key words: Fluorosis.

SUMMARY

In Otjiwarongo, a town in Namibia with twice the optimum fluoride in the drinking water (1,56 ppm) the Dean (Dean, Arnold and Elvove, 1942), Thylstrup and Fejerskov (Thylstrup and Fejerskov, 1978) and TSIF (Horowitz *et al*, 1984) indices of fluorosis were compared in permanent teeth of the children aged 11 y living in the region. Fluorosis severety was skewed in all instances to lower scores within each index. With the Thylstrup and Fejerskov and TSIF indices it was possible to compare fluorosis by individual teeth; the former was significantly more sensitive in diagnosis (56 per cent vs 50 per cent prevalence). It is recommended that the aims of a fluorosis investigation be carefully detailed before selecting the fluorosis index to be used. If detailed information on individual teeth related to fluoride ingestion is needed the Thylstrup and Fejerskov index is recommended, especially in areas with raised fluoride intakes where it is anticipated that the fluorosis levels will be mainly in the low levels of severity.

OPSOMMING

Die Dean- (Dean, Arnold en Elvove, 1942), Thylstrup en Fejerskov – (Thylstrup en Fejerskov, 1978) en TSIF- (Horowitz *et al*, 1984) indekse van fluorose is vergelyk in die sekondêre tande van elfjarige kinders woonagtig in Otjiwarongo en omgewing (Namibië), 'n streek met tweemaal die optimum hoeveelheid fluoried in die drinkwater. Die graad van fluorose het in alle gevalle geneig na laer tellings binne elke indeks. Vergelyking van fluorose per individuele tande met gebruikmaking van die Thylstrup en Fejerskov- en TSIF-indekse toon dat eersgenoemde indeks diagnosties betekenisvol meer sensiteif was (56 persent teenoor 50 persent prevalensie). Dit word aanbeveel dat die doelwitte van 'n fluorose ondersoek sorgvuldig uiteengesit moet word voordat die keuse van 'n indeks gemaak word. Indien besonderhede oor individuele tande met betrekking tot fluoried-inname verlang word, word die Thylstrup en Fejerskov-indeks aanbeveel, veral in areas met verhoogde fluoriedinname waar dit verwag word dat die graad van fluorose hoofsaaklik laag sal wees.

INTRODUCTION

The inverse relationship between dental caries and fluoride in the drinking water and direct association between dental fluorosis and fluoride level in the drinking water was well established many years ago (Hodge, 1950). The upper limit of the appropriate range of fluoride in drinking water has been set at 2 ppm (U.S. Environmental Protection Agency, 1985). Up to this fluoride concentration in drinking water, fluorosis is normally not severe and assessment requires defined techniques.

Several methods have been used to classify and evaluate fluorosis. The initial system that was widely accepted was Dean's index (Dean *et al*, 1942). With this index a score is assigned to a mouth based on the two most severely affected teeth in that mouth. Thylstrup and Fejerskov (1978) described an index based on histological changes seen in different degrees of fluorosis. Dean's and Thylstrup and Fejerskov's indices were compared in a study in an African region with 0,98-2,7 ppm fluoride in the drinking water (Burger *et al* 1987). Under such circumstances, Thylstrup and Fejerskov's index was preferred.

More recently another index, the Tooth Surface Index of Fluorosis (TSIF) (Horowitz *et al*, 1984) has been described. This is based on aesthetics and has not been directly compared to the other two indices.

Namibia is a dry country with a shortage of water. In the larger centres fluoride in the drinking water ranges from 0,11-2,63 ppm, and in one, Otjiwarongo, the concentration has been reported to be 1,46 ppm, approximately twice the recommended optimum of 0,7 ppm (Dreyer and Grobler, 1984) although it has varied between 0,15 and 1,46 ppm (Dreyer, 1986). In order to investigate fluorosis in such an area, in which fluorosis would not be expected to be severe, a choice of fluorosis index to be used for cross-sectional longitudinal studies must be made.

The present study was undertaken to compare fluorosis indices in 11-y-old children in Otjiwarongo, Namibia.

MATERIALS AND METHODS

The investigation was approved by the University of the Witwatersrand's Committee for Research on Human Subjects (Clearance 86/1/1).

Population sample

Otjiwarongo is a town of some 7 000 black inhabitants situated in Northern Namibia, 250 km north of the capital Windhoek. The average maximum summer temperature in January is 31,5°C and winter temperature in July is 24,2°C. The fluoride concentration in the water supply which is piped to standpipes available to all inhabitants in the community was 1,56 ppm at the time of the study (measured by Dr S Grobler using the technique described in Dreyer and

Grobler (1984)). With the co-operation of local educational and health authorities the 76 available 11-y-old black children attending the three primary schools who had lived all their lives in the area were examined using portable chairs in good natural light and plane dental mirrors, after concomitant caries examinations were completed. Eleven-y-old children were chosen to match other groups in low fluoride areas being studied by the same investigators, and is a convenient age group to study in primary schools.

Fluorosis indices

Dean's index (Dean *et al*, 1942) was recorded for each mouth according to the two most severely affected teeth. For the Thylstrup and Fejerskov index (Thylstrup and Fejerskov, 1978) and the TSIF (Horowitz *et al*, 1984) the most severe score for buccal, lingual or occlusal surfaces of each individual tooth was recorded. The TSIF and Dean index were recorded first, followed by the Thylstrup and Fejerskov index as this index required drying of the individual teeth which was undertaken with cotton rolls and a chip syringe. A 10 per cent sample was re-examined for consistency of evaluation and any questionable finding was seen by both examiners together. The data were analysed using Statistical Analysis System (1985).

RESULTS

Using the Dean index 67 per cent of children had some level of fluorosis; the scores were no fluorosis 33 per cent, questionable fluorosis 12 per cent, very mild fluorosis 26 per cent, mild fluorosis 7 per cent, moderate fluorosis 12 per cent and severe fluorosis 11 per cent.

If all erupted teeth are considered the prevalence of these with some degree of fluorosis was 56 per cent with the Thylstrup and Fejerskov index compared to 50 per cent with the TSIF. Comparison of these prevalences using the McNemar test (Siegel, 1956) showed that fluorosis of individual teeth was diagnosed significantly more often using the Thylstrup and Fejerskov index $x^2 = 90,3$; $p < 0,001$). This difference in diagnostic sensitivity is shown in Table I, which also emphasises how the scores of the two indices have a weak association with each other. In 98 instances fluorosis was diagnosed with the Thylstrup and Fejerskov index but not with the TSIF, and in only two instances was the opposite pattern present.

Tables II and III list the fluorosis index scores using percentage frequency for maxillary and mandibular teeth, respectively. The prevalence and severity of fluorosis varied by jaw and tooth type. Fluorosis was more frequent in the maxilla than in the mandible and in both jaws more often in incisors and first molars than in other teeth. For all the teeth the fluorosis scores are skewed to the lower values, but severe fluorosis, indicated by higher scores, were present. The relationship of the TSIF and Thylstrup and Fejerskov indices to each other, using percentage values for all erupted teeth, is illustrated in Fig. 1.

DISCUSSION

All these indices were used without difficulty in the field but the examination time required per child increased from the Dean, through the TSIF to the Thylstrup and Fejerskov index. The Dean and TSIF indices were easy to learn and

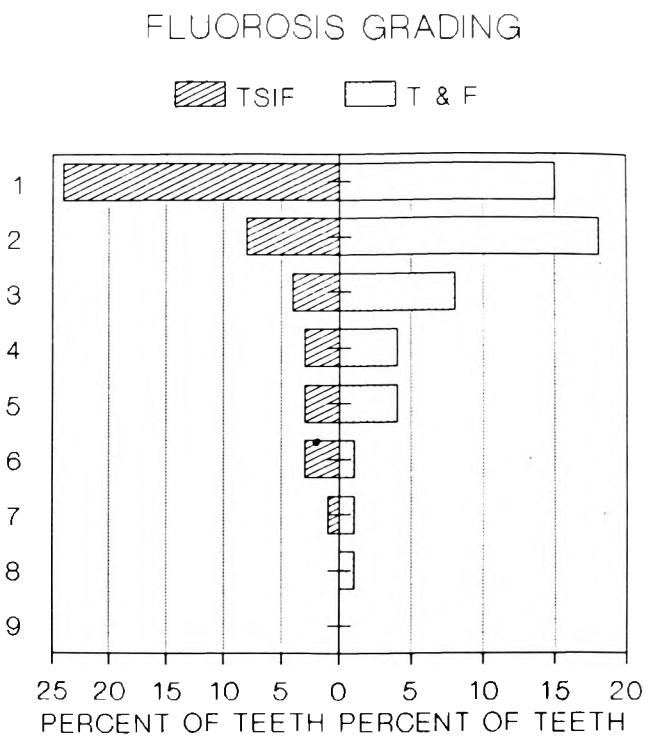


Fig. 1: **Comparison of TSIF and Thylstrup & Fejerskov index gradings by tooth type (1 = central incisor, 8 = 3rd molar).**

remember when compared with the more detailed descriptive index of Thylstrup and Fejerskov. The two examiners were able to easily agree on scores for all three indices when joint examinations were done. Drying with cotton-wool rolls and by airblast from a chip syringe using natural light (in shade, not direct sun) enabled clear diagnosis for the Thylstrup and Fejerskov index.

The prevalence of fluorosis diagnosed with all three indices was what had been expected for a hot dry area with twice the optimun fluoride concentration in the drinking water and was similar to the prevalences reported by Horowitz *et al* (1984) in the United States in children aged 8-16 y.

Dean's and the TSIF indices are similar in concept, both being based on aesthetic appearance. The Dean's index score is assigned to a child on the basis of the two teeth with the most severe fluorosis while in the TSIF all teeth are described. Thylstrup and Fejerskov's index, in contrast, is based on the pathology of fluorosis.

All three indices used in this study, when the level of fluoride in the water is up to twice the optimum for the geographic region, show the majority of fluorotic changes in the enamel are at the least severe end of the range. If the aim of an investigation is to find the number of people in a community who have fluorosis, with a general assessment of overall severity, the Dean's index is useful but it is not detailed enough to give individual treatment needs related to aesthetics or subtle changes related to treatment programmes.

The TSIF is quick to use and does allow for individual tooth assessment particularly if needs for aesthetic treatments are being screened.

If the assessment is critically to examine the effects of specific programmes involving different fluoride concentrations over time, the Thylstrup and Fejerskov index has several

advantages. This index, because of the greater number of classification grades in the least severe end of the index range and because the teeth are dried prior to recording which accentuates the least severe changes in enamel, is especially useful in recording all levels of fluoride severity in individual teeth which experienced enamel secretion and enamel maturation at different points in time.

The study outlined here clearly shows the majority of the children have teeth which have fluorosis in the least severe range but also all the indices do indentify children who have severe fluorosis. The aesthetic appearance, as shown for the maxillary anterior teeth by the TSIF and the Thylstrup and Fejerskov index, both give an indication of possible aesthetic concern.

It is recommended from this investigation that the appropriate fluoride index should be chosen for the planned needs of a study. Are the findings for general screening, for aesthetic concerns of individual teeth, or to obtain information on individual enamel changes resulting from fluoride programmes and fluoride availability?

Table I: **Frequency crosstabulation of scores for all erupted permanent teeth by fluorosis index.**

	THYLSTRUP & FEJERSKOV, 1978)									
TSIF	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	697	95	2		1					
1	1	144	199	1						
2	1	5	39	51	8	3				
3			7	23	19	1				
4			1	19	29	6	1			
5				1	1	24	8	5		
6				1		19	10	7	4	
7								2	6	

If all this information is required, the Thylstrup and Fejerskov index appears to be the index of choice.

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Table II: **Percentage frequency distribution of fluorosis scores by tooth type and fluorosis index. (S = TSIF, T = THYLSTRUP & FEJERSKOV), for maxillary teeth.**

	11/21		**12/22**		**13/23**		**14/24**		**15/25**		**16/26**		**17/27**	
No. teeth	**152**		**152**		**78**		**106**		**71**		**151**		**38**	
Score	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**
0	43	40	44	39	67	58	54	53	51	51	45	43	66	66
1	28	16	28	18	20	12	23	7	26	9	27	9	16	11
2	10	16	10	17	6	13	8	23	9	15	9	24	6	11
3	1	15	2	12	5	9	7	7	6	10	4	9	6	6
4	9	5	8	6		3	2	4		6	8	5	6	6
5	1	4	1	4	3	3	3	4	3	9	1	6		
6	7	1	6	1			3		5		5	3		
7	1	1	1	1				1			1	1		
8		2		2		2		1						
9														

Table III: **Percentage frequency distribution of fluorosis scores by tooth type and fluorosis index for mandibular teeth.**

	31/41		**32/42**		**33/43**		**34/44**		**35/45**		**36/46**		**37/47**	
No. teeth	**152**		**152**		**107**		**100**		**85**		**147**		**44**	
Score	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**	**S**	**T**
0	66	42	62	42	59	55	52	52	54	51	46	42	69	59
1	18	41	22	40	24	10	29	8	25	8	27	6	23	18
2	5	4	4	5	11	27	8	26	7	24	8	27	2	9
3	3	4	4	4	2	6	3	4	6	6	4	5		7
4	3	4	3	4				2		2	6	7	4	5
5	4	1	4	1	2		6	6	7	7	4	6		2
6	1	3	1	3	2		2		1		4	4	2	
7		1		1		2		1		1	1	2		
8								1		1		1		
9														