

Relation between Clinical and Perceived Dental Fluorosis among Adolescents in Arusha, Tanzania

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SUMMARY: It has been indicated that dental fluorosis constitutes a public health problem aesthetically as well as functionally in the East African Rift Valley. This study explores the relationship between clinically observed dental fluorosis and self-assessed oral health among secondary school children in Arusha town, where the fluoride contents in drinking water is 3.6 mg/L. A total of 478 students, age 12-20, completed a questionnaire. Clinical photos of the upper and lower incisors were taken under field conditions. A total of 477 slides were rated under laboratory conditions. Dental fluorosis in the permanent maxillary central incisors was scored according to the Thylstrup-Fejerskov Index (TFI). The prevalence of dental fluorosis at TFI score ≥ 2 among lifetime residents and not lifetime residents in Arusha was 83 % and 55 % respectively. An agreement, in terms of Cohen's Kappa of 0.44, was obtained between dental fluorosis (TFI ≥ 2) and self-reported discoloration of the right maxillary central incisor. Binary logistic regression analyses revealed that, when having dental fluorosis at TFI score ≥ 2 , the risk, in terms of Odds Ratio, of reporting bad oral condition and dissatisfaction with dental appearance was OR = 3.4 95 and OR = 4.8 respectively. In addition, the ORs of reporting oral symptoms of bleeding gums, bad breath and toothache were 1.5, 1.4 and 1.9 respectively. The results indicate that having dental fluorosis at TFI score ≥ 2 , impacts significantly on oral quality of life among adolescents resident in an area where dental fluorosis is endemic.

Key words: Dental fluorosis, TFI, Arusha, Tanzania, oral health, community perception, questionnaire method. Odds Ratio, statistical analysis.

INTRODUCTION

East African Rift Valley: It has been reported that dental fluorosis constitutes functionally and aesthetically a public health problem in the East African Rift Valley. Several studies have demonstrated the prevalence and severity of dental fluorosis in different regions of Tanzania¹⁻³. To date, relatively few studies have investigated the social importance of dental fluorosis. Whereas information about normative needs in populations at risk is available from large-scale epidemiological studies, knowledge of peoples' demand patterns in terms of how they perceive fluoride related dental

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problems is still lacking. This is notable since matching interventions with the felt need of the population concerned is a key to intervention success and sustainability⁴.

Literature background: Traditionally, oral disease has been assessed using purely clinical parameters, such as the Decayed-Missed-Filled-Teeth, DMFT Index, and the Thylstrup-Fejerskov Index, TFI⁵. Recently, a development has taken place, from strictly clinical investigations of oral diseases, to an examination of the functional, social and psychological impacts of oral conditions. Interest in oral disease specific outcome measures is reflected in the number of subjective oral health indicators, developed to assess self-perceived oral health such as ability to chew, pain, discomfort, appearance and relationship with others⁶. The rationale underlying these indicators is based on the WHO International Classification of Impairments, Disabilities and Handicaps, ICIDH⁷. According to the theoretical propositions implicit in this model, there is an ongoing process from disease via impairments to disability.

Subjective oral health indicators have been used successfully with populations comprising a range of socio-economic levels and dental conditions. It is evident, for instance, that oral disease results in substantial levels of loss of work and days of school within the US population⁸. More specific impacts such as pain, impaired speech, taste and appearance, are commonly cited in surveys of oral health status and needs for dental care⁹⁻¹². Studies of the association between subjective oral health and clinical indicators, such as the number of missing teeth, the number of decayed missed and filled teeth and periodontal attachment loss, commonly show weak, but in many cases significant associations¹². Considering that the relationship between disease and its social and psychological consequences might vary greatly with different oral conditions and according to personal and socio-cultural circumstances, there are reasons for the frequent statement of a relative independence between self-perceived and clinically defined indicators of oral health. At the same time there are arguments for a certain amount of congruence between the two types of measures. The most prevalent situation is that disease causes malfunctions and symptoms of various kinds experienced as compromised well being. Thus, pain and dissatisfaction with dental appearance have been found to be positively associated with higher mean scores of tooth decay and two or more missing teeth, respectively¹².

A number of studies, conducted predominantly in industrialised countries with extensive water fluoridation, have reported on the aesthetic impact of different levels of dental fluorosis. Osuji et al¹³ concluded that dental fluorosis at TF index 1 and 2 was not a public health problem of any significance. Accordingly, Ripa¹⁴ argued that an increase in mild forms of dental fluorosis did not constitute a public health problem. Clarkson and O'Mullane¹⁵ in a national study, asked 15 years olds subjects whether they had noticed brown or white marks on the front teeth. They found that the agreement with the clinical observations made by the dentist was rather poor. Nevertheless, results from recent studies using the TF index indicate that scores above 2 may be of aesthetic concern; for review see¹⁶. Hawley et al¹⁶ investigated adolescents' acceptability with respect to a range of dental fluorosis scores. They and

found that a total of 20 %, 15 % and 92 % considered dental appearance unacceptable at TF index 0, 2 and 3, respectively.

A few studies conducted in developing countries have indicated that the disfiguring and disabling impacts of dental fluorosis bear significance to peoples perceived well being. Mwaniki et al ¹⁷ highlighted perceptions of young mothers in Kenya and found that 77 % of the respondents considered dental fluorosis as an embarrassing condition. The majority of the mothers surveyed had observed affected people cover their mouth when laughing. Accordingly, Tobayiwas et al ¹⁸ found high levels of dissatisfaction with dental appearance among adolescents affected with dental fluorosis in Zimbabwe. In a study of Tanzanian children aged 9-19 years Yoder et al ¹⁹ observed that more than half of the affected children with TF scores at 7 and 9 abraded their anterior teeth with stone to remove discoloration. Van Palenstein and Mkasabuni ²⁰ surveyed children 13-15 years of age in an endemic fluorosis area of Northern Tanzania. They found that feelings of distress, worry and embarrassment increased significantly with increasing TF scores.

Reduction of severe dental fluorosis is an important national health objective in Tanzania. However, the extent to which this aesthetic problem impacts on peoples well being is less known. Thus, there seems to be a need for more broadly based estimates of the functional, social and psychological impacts of this oral condition known to be prevalent among children raised in areas with high amounts of fluoride in the drinking water.

Study objective: The objective of this study is to investigate the extent to which dental fluorosis has a negative impact on the social and psychological well being of adolescents using drinking water of relatively fluoride content, i.e. 3.6 mgF/L.

MATERIALS AND METHOD

Questionnaire: The eligible target population consisted of 492 secondary school children enrolled in the first year (Form 1) in four secondary schools in Arusha town, where dental fluorosis is endemic ². Arusha is situated in the fluoride belt of the East African Rift Valley system, 1400 m above sea level and has approximately 135,000 inhabitants. A total of 97 % of the eligible sample, 52 % girls, mean age 15.7 years, completed structured questionnaires administered in the schools during May-July 2000, cf. Table 1.

The survey instrument, originally constructed in English, was translated to Swahili, the Tanzania national language, used in the field. Otherwise strict procedures to ensure confidentiality were followed to protect subjects and to minimise response bias. Written informed consent to participate in the study was obtained from students. Ethical clearance to conduct the study was obtained from the Tanzania Ministry of Health.

The oral well being, the perceived oral symptoms, functional disability, the self-reported oral problems and the socio-demographic characterisation are derived through questions A, B, C and D respectively.

A sum score was constructed from the two dummy variables for use in multiple logistic regression analyses. For questions A1 and A2: Response 1-3 $\approx$ 1 “symptom confirmed” and Response 4-5 $\approx$ 0 symptom not confirmed. For question C2: Response 1 & 2 $\approx$ 0 or “no” and response 2 & 3 $\approx$ 1 or “yes”.

Clinical examination: Clinical photos of the maxillary central incisors were taken under field conditions, using a dental eye camera and Kodak colour slides, EPN 200. A total of 477 slides and one refusal were rated under laboratory conditions by the primary investigator. The severity of dental fluorosis on the buccal surfaces of the right and left maxillary central incisors was assessed according to the Thylstrup/Fejerskov Index⁵.

RESULTS

As shown in Table 2 the mean TF scores were 3.9 with respect to the right and left maxillary central incisors. Also the prevalence of dental fluorosis among the respondents, at TF score ≥ 2 was 74 % for both right and left maxillary incisors. At TFI score ≥ 5 the prevalence was 42 % and 43 % with respect to the right and left maxillary incisor, respectively.

Table 3 depicts adolescents' mean TF score with respect to the right maxillary central incisor, according to socio-demographic characteristics. The mean TF score was significantly higher among respondents being lifetime residents in Arusha as compared to those who were not (4.5 versus 2.8, $p < 0.001$).

Table 4 shows the percentage distribution of adolescents' self-perceived oral impacts according to gender. In general there were minor gender differences across the oral impacts. However, a significant higher proportion of females than males reported that they were dissatisfied with their dental appearance (68 % versus 58 %, $p < 0.05$). Contrary, males confirmed bad breath more frequently than did females (42 % versus 27 %, $p < 0.001$). As shown in Table 4, a total of 70 % confirmed that their upper anterior teeth were seriously discoloured and 69 % reported to be dissatisfied with their dental appearance. The proportion of students who confirmed experience with oral impairments (perceived symptoms) varied considerably from 35% (bad breath) to 80 % (stagnation of food particles).

Table 5 shows the percentage distribution of adolescents with dental fluorosis at TF scores ≥ 2 according to self-reported discoloration. The kappa values were in the range 0.15 to 0.44, indicating low to moderate agreement between the two types of measures.

TABLE 1. Illustration of the questionnaire of the study.

A1: How do you consider the present condition of your mouth and teeth?
 1 Excellent ☐ 2 Good ☐ 3 Normal ☐ 4 Poor ☐ 5 Very poor ☐

A2: Are you **satisfied** with the appearance of your teeth?
 1 V. satisfied ☐ 2 Satisfied ☐ 3 Normal ☐ 4 Unsatisfied ☐ 5 V. unsatisfied ☐

A3: Reason for dissatisfaction?
 1 Discoloration ☐ 2 Tooth decay ☐ 3 T. too yellow ☐ 4 Others/ I don't know ☐

B1: How often did you experienced **bleeding gums** during past 6 months:
 1 Often ☐ 2 In between ☐ 3 Seldom ☐ 4 Never ☐

B2: How often did you experienced **sore mouth** during past 6 months:
 1 Often ☐ 2 In between ☐ 3 seldom ☐ 4 Never ☐

B3: How often did you experienced **bad breath** during past 6 months:
 1 Often ☐ 2 In between ☐ 3 seldom ☐ 4 Never ☐

B4: How often did you experienced **toothache** during past 6 months:
 1 Often ☐ 2 In between ☐ 3 seldom ☐ 4 Never ☐

B5: How often did you experienced **stagnation of food** during past 6 months:
 1 Often ☐ 2 In between ☐ 3 seldom ☐ 4 Never ☐

C1: How do affected people usually behave when **laughing**?
 1 laugh freely ☐ 2 Cover mouth with hand ☐ 3 Other ☐ Specify:

C2: How would you describe the **colour** of your upper front teeth
 1 White ☐ 2 Light yell. ☐ 3 Yellow ☐ 4 Light brown ☐ 5 Brown ☐

D1-3: Socio-demographic information:
 Lifetime ☐ or have lived elsewhere ☐ Male ☐ or Female ☐ Age specify _____.

As shown in Table 6 those who had clinically defined dental fluorosis at TFI score ≥ 2 were significantly more likely than their counterparts with TFI score 0 to confirm dissatisfaction with oral condition, dental appearance with dental appearance due to discoloration in bivariate logistic regression analyses. The corresponding odds ratios were 3.4, 4.8 and 3.2 respectively. A total of 36 %, 50 % and 66 % confirmed dissatisfaction with TFI score at 0, 2 and 5, respectively. Moreover, having dental fluorosis at TF score ≥ 2 was significantly related to experience with bleeding gums, bad breath, toothache and tooth decay with corresponding odds ratios of 1.5, 1.4, 1.9 and 2.7, respectively, Table 6.

To control for the effect of possible confounding variables, gender, age, lifetime residence in Arusha, clinically defined dental fluorosis, perceived dental symptom score and self rated discoloration were all regressed upon the overall dissatisfaction score, using logistic regression analyses. Non of the socio-demographic variables turned out to be significant predictors of perceived dissatisfaction. Having dental

fluorosis at score ≥ 2 confirming discoloration of upper anterior teeth and perceiving at least one oral symptom were significantly related to self-perceived dissatisfaction. Self-reported discoloration was by far the strongest predictor of dissatisfaction with oral health (OR = 4.6) followed in descending order by perceived oral symptoms (OR = 2.8) and clinically defined dental fluorosis at TF score ≥ 2 (OR = 1.8). The regression model explained 26 % of the variance in overall dissatisfaction score.

TABLE 2. The distribution of adolescents according to TF score on upper right and left permanent incisors.

TF scores	Maxillary right central incisor		Maxillary left central Incisor	
	No	%	No	%
0	119	25.9	119	25.9
2	6	1.3	7	1.5
3	20	4.3	19	4.1
4	116	25.2	118	25.7
5	77	16.7	67	14.6
6	20	4.3	30	6.5
7	50	10.9	46	10.0
8	30	6.5	32	7.0
9	22	4.8	22	4.8
TF scores	Mean	Standard deviation	Mean	Standard deviation
0 -9	3.9	2.7	3.9	2.8

TABLE 3. Socioeconomic grouping of tested human subjects in and the observed dental fluorosis expressed as mean TFI score on right maxillary central incisor.

Socioeconomic grouping criteria	Mean	Standard deviation
Grown up in rural area	3.9	2.7
Grown up in urban area	4.0	2.8
Lifetime resident in Arusha	4.5	2.6
Not lifetime resident in Arusha	2.8	2.9
12-14 years of age	4.2	2.7
15-20 years of age	3.8	2.8
Males	3.8	2.8
Females	4.0	2.7
Main source of drinking: water tap	4.1	2.7
Main source of drinking: rain water, river water, others	3.8	3.0

TABLE 4. Distribution of adolescents' subjectively defined oral health indicators according to gender.

Indicator	No	Male 225	Female 245	Total 450
Self-reported oral problems		%	%	%
Upper front teeth yellow to brown		67	70	69
Upper front teeth discoloured		58	65	62
Upper front teeth seriously discoloured		70	70	70
Perceived oral well being				
Poor oral condition		47	47	47
Dissatisfied with dental appearance		58	68	63
Dissatisfied due to discoloration		66	71	69
Perceived oral symptoms				
Bleeding gums		42	36	40
Bad breath		42	27	35
Toothache		60	60	61
Sore mouth		38	36	37
Stagnation of food particles		78	82	80
Hindered smiling		56	66	61

TABLE 5. Dental fluorosis at score on maxillary right incisor of adolescents and corresponding self-reports on tooth discoloration.

	Self-report: Upper front teeth yellow to brown?			
	Yes		No	
Clinical examination	No	%	No	%
Dental fluorosis (TF score ≥ 2)	274	87	62	44
No dental fluorosis (TF score = 0)	41	13	76	55
Statistical analysis: Crude agreement CA: 77%. Chi square: $p < 0.001$. Kappa: 0.44.				
	Self-report: Upper front teeth seriously discoloured?			
	Yes		No	
Clinical examination:	No	%	No	%
Dental fluorosis (TF score ≥ 2)	197	88	69	575
No dental fluorosis (TF score = 0)	27	12	23	25
Statistical analysis: Crude agreement CA: 0.69. Chi square: $p < 0.05$. Kappa: 0.15				

TABLE 6. Oral well being among adolescents in terms of dissatisfaction with given parameters as compared to clinical examination; TFI ≥ 2 versus TFI = 0.

From the bivariate logistic analysis:

R is regression coefficient, OR is odds ratio and CI is 95% confident interval

Perception	r	OR	95 % CI
Poor oral condition	1.23	3.4	2.1 – 5.4
Dissatisfied with appearance	1.56	4.8	3.1 – 7.4
Dissatisfied with appearance	1.2	3.2	1.8 – 5.8
Bleeding gums	0.42	1.5	1.0 – 2.4
Bad breath	0.35	1.4	0.9 – 2.2
Toothache	0.66	1.9	1.3 – 2.9
Tooth decay	0.96	2.7	1.6 – 4.3

TABLE 7. Overall dissatisfaction with oral health as compared to indicated parameters. From the bivariate logistic analysis:

OR is odds ratio and CI is 95 % confident interval.

Nagelkerkes R squared: 0.26 (26%).

	OR	95 % CI
Male versus female	0.8	0.5 – 1.3
Lifetime resident in Arusha versus not	1.5	1.1 – 2.5
15 – 20 years old versus 12 – 14 years	1.1	0.6 – 1.9
TFI score ≥ 2 versus TF score = 0	1.8	1.1 – 3.0
Perceived discoloration versus no discoloration	4.6	2.7 – 7.9
At least one symptom versus no symptoms	2.8	1.1 – 7.1

DISCUSSION

The present results indicate a weak to moderate correspondence between self-reported and clinically assessed dental fluorosis. Thus, the agreement between self-reported discoloration of upper anterior teeth and clinically defined dental fluorosis at TF scores ≥ 2 , as measured in terms of Cohen's kappa, ranged from 0.15 to 0.44. This observation accords with previous studies of adolescents conducted in industrialised countries (15). Stephen et al (21) reported in a Scottish study that lay people were more concerned with dental fluorosis than were the dentists. We consider the deviation from good or perfect correspondence to be due to possible misunderstanding of the questionnaire. An alternative and obvious explanation to the

observed disagreement is that much of the disease detected upon clinical examination was less serious and thus likely to be unknown by the individuals concerned.

The present results showed significant but only moderately strong bivariate associations between adolescents' clinically defined dental fluorosis status and perceived impacts of oral problems in terms of symptoms and satisfaction with oral condition and dental appearance. In other words, students having dental fluorosis at TF scores ≥ 2 were significantly more likely to confirm dissatisfaction with their oral condition, dissatisfaction with their dental appearance, bleeding gums, bad breath and toothache, than were their counterparts having no dental fluorosis (TF score at 0). A total of 36 % 50 % and 66 % confirmed dissatisfaction at TFI scores 0, 2 and 5, respectively. Similar results have been reported previously in studies of Tanzanian children and adolescents, Yoder et al (19) found that children and adolescents affected with dental fluorosis at TF score 7 and 9 abraded their teeth with a stone to remove disturbing discoloration. Moreover, Van Palenstein (20) in a study of children resident in Kibosho, Northern Tanzania provided evidence that the worse the clinically defined oral health status in terms of increasing TF scores, the worse the subjective oral health indicators in terms of feelings of distress, worry and embarrassment.

Even when potential confounding effects were controlled in multivariate analysis, the clinically defined indicator turned out to be the weakest significant predictor of the overall dissatisfaction score. The explanatory power of the regression model increased markedly when self-reported discoloration and the perceived symptom score were included. Self-reported discoloration and perceived impacts were the most consistent predictors of dissatisfaction with oral condition. This seems to imply that those adolescents who are aware the disturbing impairments of dental fluorosis are those most likely to be dissatisfied. This evidence accords with those of most previous investigations focusing on satisfaction with oral health status and other subjectively defined oral health indicators in that clinical measures of disease are often weak predictors of self-perceived oral health status.

The results of the multivariate analysis also tend to support the theoretical proposition implicit in the International Classification of Impairments, Disabilities and Handicaps, ICIDH ⁷, proposed by WHO and amended for dentistry by Locker ²². According to this model, it has been argued, there is a good reason for the weak relationship commonly observed between clinically and subjectively defined oral health indicators. Following the ICIDH model, disease and its socio-psychological impacts represent dimensions of human experience that conceptually and often empirically distinct. Moreover, functional and socioeconomic issues mediate the link between clinical conditions and their social and psychological consequences so that not all people whose lives are compromised by oral disorders are necessarily dissatisfied. A possible explanation for the stronger relationship observed between dissatisfaction score and other subjective oral health indicators is the fact that both measures were questionnaire based and thus might share common method variance.

This means that the measurement method itself might have given rise to spurious associations ²³.

A total of 74 % of the adolescent population investigated was affected with dental fluorosis at TF score ≥ 2 , whereas 42 % had severe dental fluorosis at TF score ≥ 5 . In a previous study of Arusha children, Awadia et al (1992) ⁴ found that the prevalence of dental fluorosis at TFI score ≥ 1 and TF scores ≥ 5 was respectively, 67 % and 21 % among vegetarians and 95 % and 35 % among non-vegetarians. Considering that the adolescents investigated were members of a community with endemic fluorosis, an unexpectedly high proportion confirmed compromised psychological well-being in some way. Although the majority of adolescents were satisfied with their oral condition, a total of 63 %, and girls more frequently than boys confirmed dissatisfaction with their dental appearance, Of those who confirmed dissatisfaction with dental appearance, 74 % said it was because of discoloration. Moreover a total of 80 %, 61% and 61% reported problems with food impact, toothache and hindered smiling. Thus, the present findings indicate that the quality of life of a substantial proportion of these young people is compromised in some way by their oral condition. It should be noted that adolescents enrolled in secondary school comprise a selected group of highly educated in Tanzania. Since it is almost always the case that there is an inverse relationship between education and oral health, the prevalence of subjectively reported oral health problems found in this survey might be an underestimate. Although there were no significant gender difference with respect to TF score, females scored more highly on some subjectively defined indicators, males more highly on others and on many measures there was no gender difference. Concepts of health, expectations and attitudes concerning health and body awareness might differ according to gender and lead to differences in the subjective awareness and reporting of oral health status ²⁴.

CONCLUSION

The present results indicate that dental fluorosis is perceived as an oral health problem by secondary school children in Arusha. Having dental fluorosis at TF scores ≥ 2 seem to impact differently on people's well-being. This seems to imply that both clinically and subjectively defined indicators of oral health should be assessed whenever dental care needs are considered. To what extent adolescents who are discontent with their dental condition want and actually seek dental treatment is an important issue for future research. Further studies based on qualitative research is also needed to improve our understanding of why some adolescents are satisfied with their oral condition despite having a diagnosis of dental fluorosis at TF ≥ 2 .

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