Community Dental Health (2013) **30,** 249–253
Received 22 January 2013; Accepted 6 August 2013

doi:10.1922/CDH_3165Jodalli05

Aesthetic perceptions regarding fluorosis by children from an area of endemic fluorosis in India

P. S. Jodalli[1], A.V. Ankola[2], M. Hebbal[2] and M.Vikneshan[3]

[1]*Department of Public Health Dentistry, Yenepoya Dental College and Hospital, Mangalore, India;* [2]*Department of Public Health Dentistry, KLE Vishwanath Katti Institute of Dental Sciences, KLE University, Belgaum, Karnataka, India;* [3]*Department of Public Health Dentistry, Sri Sankara Dental College, Akathumuri, Kerala , India*

Objectives: To assess the perceptions of and concerns regarding dental fluorosis among 12-15 year-old schoolchildren in an area where fluorosis is endemic and to find any association with Tooth Surface Index of Fluorosis (TSIF) scores. ***Basic Research Design:*** A cross sectional study. ***Participants:*** 316 children aged 12-15 years with varying level of dental fluorosis selected from 696 children screened for fluorosis. ***Methods:*** The study was undertaken in three villages in rural Gadag, Karnataka, India, with fluoride levels in the drinking water ranging from 2.2 to 4.5 ppm as estimated by the SPADNS spectrophotometric method. Children's fluorosis was assessed under natural lighting conditions on the labial surface of upper anterior teeth using the TSIF 8-point scale. A self-administered questionnaire assessed knowledge, perceptions and concerns. Data were analysed by frequency distributions and Spearman's correlation coefficients. ***Main outcome measures:*** Aesthetic perceptions and TSIF scores. ***Results:*** The children were aware of the fluoride presence and its health effects. TSIF scores correlated with: the appearance of front teeth (r=0.135, p=0.015); feeling fluorosis would hinder smiling (r=0.116, p=0.040); feeling distress due to fluorosis (r=0.111, p=0.048). ***Conclusion:*** Children were aware of fluoride and its health effects. They also perceived dental fluorosis as an aesthetic problem.

Key words: *dental fluorosis, dental aesthetic, TSIF index, perception*

Introduction

Enamel fluorosis is seen as a lack of lustre of the enamel and may appear as white lines that sometimes coalesce into enamel opacities. More severe forms of fluorosis appear as a brown discoloration that occurs post-eruptively and as alterations in tooth morphology (Whelton *et al.,* 2004). In some countries, such as Tanzania, India and South Africa, there are cases of skeletal fluorosis attributable to the high levels of fluoride in some sources of drinking water.

During the past 50 years, fluoride concentrations have increased in a variety of sources. An increase in the prevalence of enamel fluorosis has been observed, but with no appreciable increase in the severity (Szpurar and Burt, 1987). The features of fluorosis cover a continuum of changes from the normal. In the mildest cases, fine white lines lying parallel to the perikymata are apparent in dried enamel; often these are difficult to observe in wet enamel (Thylstrup and Fejerskov, 1978). Mild dental fluorosis does not impair tooth functionally. In more severe cases, the fine white lines merge to produce opaque areas in the enamel which are visible in wet teeth. In the most severe cases, much of the surface of the tooth may be discoloured and pitted, and of an unappealing appearance to many people, but such severe fluorosis is not widespread (Eklund *et al.,* 1987).

Although there are aesthetic concerns associated with dental fluorosis, the phenomenon has commonly been assessed by using exclusively clinical parameters, such as the Thylstrup and Fejerskov (TF) index. Despite the availability of a number of fluorosis indices, only one, the Tooth Surface Index of Fluorosis (TSIF, Horowitz *et al.,* 1984), seemed to address the aesthetic issue (Ripa, 1991).

The face reflects the state of one's body and mind, playing important role in social interactions. From an aesthetic stand point dental fluorosis has an impact on overall well-being and health. Studies indicate that physical attractiveness is important psychologically especially in children and young adults (Lalumandier and Rozier, 1998). Children seem to be more aware of their dental facial attractiveness than adults and rate other children's attractiveness more critically than adults do. Dental fluorosis is one condition that may affect facial aesthetics. Hence it is generally believed that a widely prevalent aesthetic disturbance may be significant for children's perception of well-being.

Fluorosis may be viewed from a number of perspectives; that of the affected patient, the parents of affected children, dental professionals, and the general public. To date, studies of the potential disadvantages of fluorosis have been considered mainly in terms of aesthetics. A literature search provided studies that assessed the self-perceptions of fluorosis of children and adolescents (Almeida *et al*., 2013; Kavand *et al*., 2012; McGrady *et al.,* 2012; Williams *et al.,* 2006), parents perceptions (Martins *et al.,* 2010; Levy *et al.,* 2005; Sigurjons *et al.,* 2004), perceptions of others such as dentists and laypersons (Kukleva *et al.,* 2010) and quality of life studies

Correspondence to: Dr Praveen S. Jodalli, Senior Lecturer, Department of Public Health Dentistry, Yenepoya Dental College and Hospital, Mangalore, Karnataka, India 575018. Email: praveenjodalli@gmail.com

(Aguilar-Díaz *et al.,* 2011). A comprehensive review by Chankanka *et al* (2010) reported that severe fluorosis, but not mild fluorosis, was associated with negative effects on one's quality of life.

Though evidence exists about dental fluorosis and aesthetic perceptions, only one study (Bhagyajyothi and Pushpanjali*,* 2009) was reported for India. Hence, we undertook a study with the primary aim of determining the degree of children's aesthetic perception of their teeth and its correlation with the clinical levels of fluorosis.

Methods

This cross sectional study screened for dental fluorosis on maxillary incisors and canines, schoolchildren aged 12-15 years, residing in the rural areas of Gadag, Karnataka, India, an area with endemic dental and skeletal fluorosis. Prior permission to conduct the study was obtained from higher school authorities while ethical clearance was obtained from the Ethical Committee KLE VKIDS, KLE University, Belgaum.

For the estimation of fluoride in the drinking water supply, water samples were collected from six villages known to have endemic fluorosis and with drinking water supplied from bore holes. Samples in 500 ml plastic bottles were labelled and sent to a laboratory for fluoride estimation on the same day. Fluoride content in the water was estimated according to the Bureau of Indian Standards (BIS-3025 SPADNS) specifications using Acid Zirconyl SPANDS reagent and spectrophotometery (Brossok *et al*., 1987). Three of the villages with fluoride levels in water ranging from 2.2 to 4.5 ppm were selected for this study: Harogeri (2.2ppm), Virpapur (4.5ppm), and Kalkeri (4.5ppm).

For the measurement of dental fluorosis using the TSIF scale (ranging from 0, none, to 7, confluent pitting, enamel missing, dark-brown stain), all children who presented with erupted permanent anterior teeth (laterals and centrals), and who consented to further participation, were eligible for inclusion provided they had no missing or filled anterior teeth, excessively large diastema, open bites, malformed teeth (peg laterals), severely rotated teeth, extensive crowding, orthodontic appliances, abundant amounts of plaque or severe gingival inflammation as these factors might also affect perceptions of appearance.

A benchmark ("Gold Standard") examiner (AVA) trained and calibrated the trainee examiner (PSJ) to attain an acceptable level of reproducibility. Forty-five children with fluorosis were examined and the trainee examiner discussed clinical diagnosis, criteria, recording and other errors to reach an acceptable level of agreement (Kappa=0.86). A recorder helped the examiner during the study and the examiner performed repeat examinations of a random 10% of the children during the field examination.

The questionnaire adopted questions and statements validated by previous research (Bhagyajyothi and Pushpanjali, 2009; Clark and Berkowitz, 1997; Dolan *et al.,* 1991; van Palenstein Helderman and Mkasabuni, 1993; Riordan, 1993). The resulting questionnaire was translated into Kannada, the regional language, to check item comprehension then back translated to English. Experts from the field assessed this questionnaire for completeness, relevance and clarity of the questions (content validity). Later, a pilot study with 12-year-olds used the questionnaire and changes were made to the wording to improve comprehension. This final questionnaire was subjected to test-retest reliability checks: question-to-question reliability was 90% and the internal reliability for the responses to questions was assessed using Cronbach's alpha coefficient at 0.67. Assessment of criterion validity of the items designed to identify whether children were able to perceive dental fluorosis, showed that the professional diagnosis of dental fluorosis was associated with the children's perceptions. (Spearman's correlation coefficient r=0.38). Construct validity was assessed by comparing the degree of concern to the level of fluorosis perceived both by children and by professional using Spearman's correlation coefficient (r=0.27).

The final questionnaire included 13 items (12 closed and 1 open-ended) encompassing: knowledge of fluoride and its presence in drinking water; an assessment of the effect of fluorosis on their appearance and smile and embarrassment; any worry or distress caused by fluorosed teeth; concerns regarding the importance of dental visits for the condition; dental fluorosis as a disadvantage in the future; and, the need for the aesthetic treatment. Responses to four items offered yes/no options. Eight items used 5-point Likert scales: three ranging from *strongly agree* to *strongly disagree*, four ranged *extremely* to *not at all* with *very important* to *not important* for the remaining closed item.

Data were entered onto a computer and cross tabulated by TSIF scores. The TSIF scores and the responses on the Likert scales were treated as ordinal scales and correlations calculated using Spearman's correlation. Frequencies, percentages and correlation coefficients were calculated using SPSS v.16.

Results

Of the 696 12-15-year-olds participating in the initial screening, 316 were diagnosed with a degree of dental fluorosis and all these then completed both the clinical and questionnaire studies. Since only two subjects had TSIF scores of six, for analysis scores of five and six were treated together. The sample's distribution of TSIF scores by age is presented in Table 1. There were 133 (42.1%) girls and 183 boys both having modal TSIF scores of 4. The vast majority, 87%, of the children were roughly evenly distributed across the middle of the TSIF scale with scores of 2, 3 or 4.

Table 1. Distribution of subjects according to age and TSIF scores

Age in years	*TSIF score*					
	1	*2*	*3*	*4*	*5/6*	*All TSIF scores*
12	2	23	12	15	7	59 (18.7%)
13	6	30	20	25	4	85 (26.9%)
14	5	21	31	22	7	86 (27.2%)
15	4	10	26	40	6	86 (27.2%)
All ages	17	84	89	102	24	316
	5%	27%	28%	32%	8%	

Likewise, the 5-point Likert scales were collapsed for ease of interpretation with the two responses at each extreme of the scales being combined to leave three categories in each case, e.g. agree/strongly agree, neutral and disagree/strongly disagree. Some 87% (276) respondents reported having heard about fluoride and 84% (267) were aware of the presence of fluoride in their drinking water supply. Fewer, 131 (41%) subjects were aware of the defluoridation techniques available in that area. The open-ended question regarding beneficial and harmful effects of this fluoride gave a wide expression of respondents' understanding: 32% reported fluoride makes their teeth strong, 24% said it causes discoloration of teeth and dental caries and 28% reported general health problems in their parents such as bone and joint pain, and the remaining 16% said it causes staining of teeth.

Tables 2, 3 and 4 show the results of the responses to the questions on perceptions and concerns of dental fluorosis. Over half the subjects, 56%, considered their teeth to have a pleasing appearance (Table 2) with a similar proportion, 55%, agreeing they need aesthetic dental treatment. Rather fewer, 43%, thought their fluorosis would be a future disadvantage.

Embarrassment due to fluorosis was reported by about a third of subjects with no discernible variation by severity of fluorosis (Table 3). However, distress due to fluorosis was felt by 44% of the sample and the proportion did rise with increase in TSIF score ($r=0.111$, $p=0.048$). The appearance of fluorosed teeth was a worry to 40% of subjects and hindered smiling freely for almost a third, again correlating with TSIF score ($r=0.116$, $p=0.040$).

Practically all subjects, 96%, considered fluorosis to be an important matter for them (Table 4).

Discussion

The relatively simple questionnaire in conjunction with the clinical examination used in this study was found to be an adequate means of determining the perceptions and concerns of fluorosis among 12-15 year old children. This study has shown that the subjects were aware of fluoride and 85% were aware of the presence of fluoride in their drinking water. Opinion regarding the beneficial and harmful effects of fluoride was mixed with a third of subjects considering it was beneficial and half concerned that it caused dental caries or other health problems. Only 16% subjects were aware that fluoride causes staining of the teeth. Just 41% were aware of the defluoridation techniques available though we could not establish the reason for this quite surprising finding.

In this study the TSIF scale was used because it provides clearer diagnostic criteria and is useful for analysis based on aesthetic concerns (Rozier, 1994). Also the other commonly used index, the TF index, requires the drying of teeth before scoring, which will result in the dehydration of hypomineralised enamel and a change in refractive index. Hence, minor fluorotic opacities may not be visible when teeth are viewed wet as in typical social interactions.

This study showed that the proportion of youngsters with negative perceptions of dental fluorosis rises with increase in TSIF score, suggesting that dental fluorosis is an aesthetic problem. Even children with low levels of fluorosis, TSIF scores 1 or 2, reported aesthetic concern as in other studies (Alkhatib *et al*., 2004; Bhagyajyothi and Pushpanjali, 2009; Martines-Mier e*t al.,* 2004). This may be because general appearance and socioeconomic status, both attributes unrelated to dental fluorosis, might have influenced the children's aesthetic perceptions.

Feeling distressed, worried and embarrassed all increased with increasing TSIF scores in the present study and these findings are in accordance with those of Tanzanian and Ethiopian children (Åstrøm and Mashoto*,* 2002; Wondwossen *et al.,* 2003). Hindrance from smiling was not a concern for children with the lowest TSIF score confirming the findings of other studies noting low levels of fluorosis were of minimal concern (Bhagyajyothi and Pushpanjali, 2009; Riordan 1993).

Aesthetic problems arising from the presence of dental fluorosis on anterior teeth with the lower scores of TSIF 2 and 3 were identified. This agreed with the some other studies (Bhagyajyothi and Pushpanjali, 2009; Clark and Berkowitz, 1997) but is in contrary to study conducted by Martinez-Mier *et al.* (2004). These results were also similar to the parents' aesthetic perceptions of child's teeth as reported by Woodward *et al.* (1996).

Even though the children felt that the condition is very important to them, only a tiny percentage had approached a clinician as was found by van Palenstein Helderman and Mkasabuni (1993). Perhaps they were not aware of the treatment options or maybe dental services were either unaffordable or inaccessible.

As always, study limitations should be considered when interpreting the results. Variations in the impact of developmental defects of enamel may be related to defining aspects of children's sense of self rather than the enamel defects themselves (Marshman *et al.*, 2009). Further, subjects' socioeconomic status was not assessed though this factor might have played a role in their aesthetic perceptions. The study subjects, predominantly classified as having TSIF scores of 2 to 4, were intentionally drawn from a limited geographic area with endemic dental fluorosis; any generalisations therefore should be made with caution.

Conclusion

This study aimed to obtain perception of dental aesthetics from 12-15 year old children with dental fluorosis and it revealed that the subjects were aware of fluoride in water and were concerned about the effects of fluoride. The results indicate that dental fluorosis was perceived as an oral health problem, and also showed the children's desire for aesthetic treatment. These results also suggest that discolorations due to fluorosis may be a public health problem in areas with a high natural fluoride concentration in drinking water and serves as a guide to the public health authorities for public policy formulation and a plan for disease prevention. Further research is required to assess and interpret the impact of dental fluorosis and other related defects on facial aesthetics.

Acknowledgements

The authors are indebted to Dr S.B. Javali for his statistical advice and Mr Krishna Kulkarni, JMS engineering services, Dharwad, Karnataka for fluoride content analysis of the water samples. We are grateful to the school administrators, teachers and students of Gadag who have given their time to help with the study.

Table 2. Distribution of subjects according to the TSIF score and responses to the questions related to appearance and treatment needed.

Questions and responses		*TSIF Score n (%)*					*All TSIF Scores*
		1	*2*	*3*	*4*	*5/6*	
The appearance of teeth is pleasing and looks nice *	Agree/Strongly agree	10 (58.8)	52 (61.9)	58 (65.2)	43 (42.2)	14 (58.3)	177 (56.0)
	Neutral	2 (11.8)	9 (10.7)	6 (6.7)	13 (12.7)	1 (4.2)	31 (9.8)
	Disagree/Strongly disagree	5 (29.4)	23 (27.4)	25 (28.1)	46 (45.1)	9 (37.5)	108 (34.2)
Do you think is there any aesthetic treatment needed?	Agree/Strongly agree	10 (58.8)	49 (58.3)	45 (50.6)	56 (54.9)	15 (62.5)	175 (55.4)
	Neutral	1 (5.9)	9 (10.7)	12 (13.5)	13 (12.7)	4 (16.7)	39 (12.3)
	Disagree/Strongly disagree	6 (35.3)	26 (31.0)	32 (36.0)	33 (32.4)	5 (20.8)	102 (32.3)
Will appearance be a disadvantage in future?	Agree/Strongly agree	4 (23.5)	33 (39.3)	42 (47.2)	44 (43.1)	14 (58.3)	137 (43.4)
	Neutral	3 (17.6)	8 (9.5)	9 (10.1)	8 (7.8)	3 (12.5)	31 (9.8)
	Disagree/Strongly disagree	10 (58.8)	43 (51.2)	38 (42.7)	50 (49.0)	7 (29.2)	148 (46.8)

* Significant correlation with Spearman's correlation r=0.135, p=0.015

Table 3 Distribution of subjects according to the TSIF score and responses to the questions related to embarrassment and smile hindrance.

Questions	*Responses*	*TSIF Score n (%)*					*All TSIF Scores*
		1	*2*	*3*	*4*	*5/6*	
Are you embarrassed by the appearance of the front teeth?	Extremely/A lot of the time	6 (35.3)	27 (32.0)	32 (36.0)	27 (26.5)	8 (33.3)	100 (31.6)
	Sometimes/A little of the time	3 (17.6)	20 (23.8)	23 (25.8)	34 (33.3)	9 (37.5)	89 (28.2)
	Not at all	8 (47.1)	37 (44.0)	34 (38.2)	41 (40.2)	7 (29.2)	127 (40.2)
How much distress has the appearance of your teeth has caused?†	Extremely/A lot of the time	5 (29.4)	33 (39.3)	39 (43.8)	44 (43.1)	17 (70.8)	138 (43.7)
	Sometimes/A little of the time	12 (70.6)	45 (53.6)	43 (48.3)	51 (50.0)	7 (29.2)	158 (50.0)
	Not at all	0 (0)	6 (7.1)	7 (7.9)	7 (6.9)	0 (0)	20 (6.3)
How much has the appearance of your teeth worried you?	Extremely/A lot of the time	4 (23.5)	32 (38.1)	35 (39.3)	42 (41.2)	15 (62.5)	128 (40.5)
	Sometimes/A little of the time	13 (76.5)	49 (58.3)	46 (51.0)	51 (50.0)	8 (33.3)	167 (52.8)
	Not at all	0 (0)	3 (3.6)	8 (9.0)	9 (8.8)	1 (4.2)	21 (6.6)
How much has the appearance of your teeth hindered you from smiling freely?*	Extremely/A lot of the time	0 (0)	22 (26.2)	26 (29.2)	34 (33.3)	13 (54.2)	95 (30.1)
	Sometimes/A little of the time	17 (100)	56 (66.7)	52 (58.4)	56 (54.9)	9 (37.5)	190 (60.1)
	Not at all	0 (0)	6 (7.1)	11 (12.4)	12 (11.8)	2 (8.3)	31 (9.8)

† Significant correlation with Spearman's correlation r=0.111 p=0.048
* Significant correlation with Spearman's correlation r=0.116 p=0.040

Table 4. Distribution of subjects according to the TSIF score and responses to the question related to importance of fluorosis.

Questions	*Responses*	*TSIF Score n (%)*					*All TSIF*
		1	*2*	*3*	*4*	*5/6*	*Scores*
How important is the condition to you?	Very important/Important	16 (94.1)	81 (96.4)	86 (96.6)	100 (98.0)	21 (87.5)	304 (96.2)
	Neutral	0 (0)	0 (0)	0 (0)	1 (1.0)	0 (0)	1 (0.3)
	Slightly important/Not important	1 (5.9)	3 (3.6)	3 (3.4)	1 (1.0)	3 (12.5)	11 (3.5)

References

Aguilar-Diaz, F.C., Irigoyen-Camacho, M.E. and Borges-Yanez, S.A. (2011): Oral-health-related quality of life in school-children in an endemic fluorosis area of Mexico. *Quality of Life Research* **20**, 1699-1706.

Alkhatib, M.N., Holt, R. and Bedi, R. (2004): Aesthetically objectionable fluorosis in the United Kingdom. *British Dental Journal* **197**, 325-328; discussion 321.

Almeida, M.E., Teixeira, A.K., Alencar, C.H., Paiva, S.M. and Abreu, M.H. (2013): Agreement between parents and adolescents on dental fluorosis: a population-based study. *Brazilian Oral Research* **27**, 91-96.

Åstrøm, A.N. and Mashoto, K. (2002): Determinants of self-rated oral health status among school children in northern Tanzania. *International Journal of Paediatric Dentistry* **12**, 90-100.

Bhagyajyothi, C.S. and Pushpanjali, K. (2009): Perceptions and concerns about dental fluorosis as assessed by tooth surface index of fluorosis among high school children in an area of endemic fluorosis--Kaiwara. *Oral Health & Preventive Dentistry* **7**, 33-38.

Brossok, G.E., McTigue, D.J. and Kuthy, R.A. (1987): The use of a colorimeter in analyzing the fluoride content of public well water. *Pediatric Dentistry* **9**, 204-207.

Chankanka, O., Levy, S.M., Warren, J.J. and Chalmers, J.M. (2010): A literature review of aesthetic perceptions of dental fluorosis and relationships with psychosocial aspects/oral health-related quality of life. *Community Dentistry and Oral Epidemiology* **38**, 97-109.

Clark, D.C. and Berkowitz, J. (1997): The influence of various fluoride exposures on the prevalence of esthetic problems resulting from dental fluorosis. *Journal of Public Health Dentistry* **57**, 144-149.

Dolan, T.A., Gooch, B.F. and Bourque, L.B. (1991): Associations of self-reported dental health and general health measures in the Rand Health Insurance Experiment. *Community Dentistry and Oral Epidemiology* **19**, 1-8.

Eklund, S.A., Burt, B.A., Ismail, A.I. and Calderone, J.J. (1987): High-fluoride drinking water, fluorosis, and dental caries in adults. *Journal of the American Dental Association* **114**, 324-328.

Horowitz, H.S., Driscoll, W.S., Meyers, R.J., Heifetz, S.B. and Kingman, A. (1984): A new method for assessing the prevalence of dental fluorosis--the Tooth Surface Index of Fluorosis. *Journal of the American Dental Association* **109**, 37-41.

Kavand, G., Broffitt, B., Levy, S.M. and Warren, J.J. (2012): Comparison of dental esthetic perceptions of young adolescents and their parents. *Journal of Public Health Dentistry* **72**, 164-171.

Kukleva, M.P., Kondeva, V.K., Isheva, A.V., Petrova, S.G. and Rimalovska, S.I. (2010): Aesthetic perception of dental fluorosis--opinions of dentists and non-specialists. *Folia Medica* **52**, 43-48.

Lalumandier, J.A. and Rozier, R.G. (1998): Parents' satisfaction with children's tooth color: fluorosis as a contributing factor. *Journal of the American Dental Association* **129,** 1000-1006.

Levy, S.M., Warren, J.J., Broffitt, B. and Nielsen, B. (2005): Factors associated with parents' esthetic perceptions of children's mixed dentition fluorosis and demarcated opacities. *Pediatric Dentistry* **27**, 486-492.

Marshman, Z., Gibson, B., Robinson, P.G. (2009): The impact of developmental defects of enamel on young people in the UK. *Community Dentistry and Oral Epidemiology* **37**, 45–57.

Martinez-Mier, E.A., Maupome, G., Soto-Rojas, A.E., Urena-Cirett, J.L., Katz, B.P. and Stookey, G.K. (2004): Development of a questionnaire to measure perceptions of, and concerns derived from, dental fluorosis. *Community Dental Health* **21**, 299-305.

Martins, C.C., Feitosa, N.B., Vale, M.P. and Paiva, S.M. (2010): Parents' perceptions of oral health conditions depicted in photographs of anterior permanent teeth. *European Journal of Paediatric Dentistry* **11**, 203-209.

McGrady, M.G., Ellwood, R.P., Goodwin, M., Boothman, N. and Pretty, I.A. (2012): Adolescents' perceptions of the aesthetic impact of dental fluorosis vs. other dental conditions in areas with and without water fluoridation. *BMC Oral Health* **12**, 4.

Riordan, P.J. (1993): Perceptions of dental fluorosis. *Journal of Dental Research* **72**, 1268-1274.

Ripa, L.W. (1991): A critique of topical fluoride methods (dentifrices, mouthrinses, operator-, and self-applied gels) in an era of decreased caries and increased fluorosis prevalence. *Journal of Public Health Dentistry* **51**, 23-41.

Rozier, R.G. (1994): Epidemiologic indices for measuring the clinical manifestations of dental fluorosis: overview and critique. *Advances in Dental Research* **8**, 39-55.

Sigurjons, H., Cochran, J.A., Ketley, C.E., Holbrook, W.P., Lennon, M.A. and O'Mullane, D.M. (2004): Parental perception of fluorosis among 8-year-old children living in three communities in Iceland, Ireland and England. *Community Dentistry and Oral Epidemiology* **32** Suppl 1, 34-38.

Szpunar, S.M. and Burt, B.A. (1987): Trends in the prevalence of dental fluorosis in the United States: a review. *Journal of Public Health Dentistry* **47**, 71-79.

Thylstrup, A. and Fejerskov, O. (1978): Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. *Community Dentistry and Oral Epidemiology* **6**, 315-328.

van Palenstein Helderman, W.H. and Mkasabuni, E. (1993): Impact of dental fluorosis on the perception of well-being in an endemic fluorosis area in Tanzania. *Community Dentistry and Oral Epidemiology* **21**, 243-244.

Whelton, H.P., Ketley, C.E., McSweeney, F. and O'Mullane, D.M. (2004): A review of fluorosis in the European Union: prevalence, risk factors and aesthetic issues. *Community Dentistry and Oral Epidemiology* **32** Suppl 1**,** 9-18.

Williams, D.M., Chestnutt, I.G., Bennett, P.D., Hood, K. and Lowe, R. (2006): Characteristics attributed to individuals with dental fluorosis. *Community Dental Health* **23**, 209-216.

Wondwossen, F., Åstrøm, A.N., Bårdsen, A. and Bjorvatn, K. (2003): Perception of dental fluorosis amongst Ethiopian children and their mothers. *Acta Odontologica Scandinavica* **61**, 81-86.

Woodward, G.L., Main, P.A. and Leake, J.L. (1996): Clinical determinants of a parent's satisfaction with the appearance of a child's teeth. *Community Dentistry and Oral Epidemiology* **24**, 416-418.