Original Article

The Effect of Dental Fluorosis on the Quality of Life of Female High School and Precollege Students of High Fluoride-Concentrated Area

Firoozeh Nilchian[1], Imaneh Asgary[1], Fatemeh Mastan[2]

[1]Department of Community Oral Health, Dental Materials Research Center, School of Dentistry, Isfahan University of Medical Sciences, [2]Dental Materials Research Center, School of Dentistry, Isfahan Univesity of Medical Sciences, Isfahan, Iran

ABSTRACT

Aims and Objectives: Colored and deformed fluorotic teeth may affect the quality of life (QOL). The present study, therefore, evaluates the effect of dental fluorosis on the QOL of female high school and precollege students of Behbahan district in 2014.

Materials and Methods: One hundred 15–18-year-old female students with dental fluorosis were selected from the high schools of Behbahan district by random cluster sampling technique. Dental fluorosis was measured clinically using Dean's index after analyzing the drinking water of the affected district. The effect of dental fluorosis on the QOL was then evaluated through a questionnaire. The data from Dean's index, condition-specific oral impact on daily performance (CS-OIDP) questionnaire, and the mean score of QOL questionnaire were analyzed in SPSS version 20 using Pearson's and Spearman's correlation analyses ($\alpha = 0.05$).

Results: The mean values of age and the QOL regarding appearance were 16.5 years and 61.5 ± 20.8 from 100, respectively. Spearman's correlation showed a positive correlation between CS-OIDP total score and the severity of fluorosis ($P = 0.0001$, $r = 0.342$). Spearman's correlation also showed a negative correlation between the QOL and the severity of fluorosis ($P < 0.001$, $r = -0.496$) so that by increasing the severity of fluorosis, the QOL was decreasing.

Conclusions: Increasing the severity of fluorosis is associated with increasing the dissatisfaction and decreasing the QOL.

KEYWORDS: *Condition-specific oral impact on daily performance questionnaire, Dean's index, fluoride, fluorosis, quality of life*

INTRODUCTION

Overexposure to fluoride during tooth formation, even for a short period of time, results in ameloblastic function disorder and consequently hypomineralization of enamel which is called fluorosis.[1] Fluorosis is a dental lesion caused by the destructive effect of fluoride on the tooth making cells in the forming and mineralizing stages. The affected enamel is also called mottled enamel.[2] Severity of fluorosis depends on the duration of exposure to fluoride. Specific body response, weight, activity, diet, and bone growth factors result in variable severity of dental fluorosis in response to similar dose of fluoride.[3]

The field of oral health-related quality of life (OHRQOL) relates to the subject that oral anomalies disrupt the natural function of the individual.[4] To understand the patients' needs in the field of oral and dental health, evaluating the OHRQOL along with clinical examinations has been developed.[5] The oral impact on daily performance (OIDP) index is one of the important indices in evaluating OHRQOL.[6]

Roman in a study on adolescents in Kibosho showed that dental fluorosis has social and psychological effects on the QOL, and discontent with their appearance

Address for correspondence: Dr. Firoozeh Nilchian,
Department of Community Oral Health, Dental Materials
Research Center, School of Dentistry, Isfahan University of
Medical Sciences, Isfahan, Iran.
E-mail: f_nilchian@dnt.mui.ac.ir

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rises as the severity of dental fluorosis increases.[7,8] Ellwood and O'Mullane showed a relationship between patient's satisfaction and the degree and also the size of enamel hypomineralization.[9] In the study of Rustagi *et al*. feeling of being unbeautiful and other unpleasant perceptions might be associated with dental fluorosis.[10] In a study on Colombian students with dental fluorosis, they not only recognized an unusual appearance in their teeth but also reported the feeling of embarrassment and concerning their appearance. Sixty percent of these children hesitated to smile because of the appearance of their teeth.[11] OHRQOL has become the focus of interest to estimate the impact of oral situation on the QOL and health and also the effectiveness of clinical health-care outcomes.[6] Although the incidence of dental fluorosis increased in recent years, a few studies on the relation between this disease and QOL exist. Discoloration in fluorotic enamel and deformation of tooth may have a negative effect on OHRQOL.[12]

This study, therefore, was aimed to determine the effect of dental fluorosis on the QOL in high school and precollege female students of Behbahan districts in 2014. The hypothesis of the study was that the dental fluorosis influences QOL.

MATERIALS AND METHODS

This analytical cross-sectional study included sampling and analysis of the fluoride content of the drinking water, clinical examination, and questionnaire completion. Random cluster sampling was used in this study, and the research population was the female high school and precollege students of Behbahan district who were drinking high fluoride content water. This study conducted as an undergraduate study thesis approved ethical and scientific by the Research Office of the Isfahan University of Medical Sciences (Ethical approval and Research No. 396396). This study carried out during 1 year.

FLUORIDE CONTENT ANALYSIS

Drinking water from the study area was sampled by a community health provider of Behbahan health-care network. In this way following determining the households in the target area, the sample size calculated through sample size calculated formula as:, $N = \dfrac{(Z1-a/2)^2 P(1-P)}{D2}$ and the households were selected through cluster sampling and coded. Water specimens were then collected by the health provider system's staffs from the drinking water of the households and the water source received the related codes. The specimens were then sent for fluoride content analysis to the Torabinejad Research Center, Isfahan University of Medical Sciences, Isfahan, Iran.

To analyze the fluoride content of the specimens, 0.1 ml of TISAB3 was added to 1 ml of specimen and mixed carefully. The fluoride ion concentration of mixture was then measured in the fluoride ion analyzer (Thermo Scientific™ Orion™ 2109XP fluoride analyzer, USA) following calibrating the device by 0.1, 1, and 10 ppm fluoride ion content solutions. All the specimens were analyzed twice for more precision, and the average was recorded as the fluoride ion concentration of the specimen.

EVALUATION OF THE ORAL HEALTH-RELATED QUALITY OF LIFE

Two girl's high schools were selected on cluster sampling basis of those towns and villages around the city of Behbahan which had girl's high school. The nine students were from the selected school in the village of Dodangeh and 61 students were from Tashan district. ($d = 0.2$). The informed consent form was signed by the participants.

The inclusion criteria were having bilateral fluorotic anterior teeth. The students with filled, nonfluorotic opaque, or dental caries of anterior teeth were excluded from the study.

All the students were examined by a senior dental student under supervision of a pediatric dentist after becoming calibrated (kappa = 0.8) in scoring the severity of dental fluorosis based on the Dean's index, recommended by the WHO.

Facial surfaces of maxillary and mandibular incisors and canines, because of their role in facial esthetic, were selected to be scored.

Dental fluorosis diagnostic criterion was bilateral teeth enamel defects.

Each student was examined using disposable dental mirror and explorer and headlight. The most severe bilateral fluorotic teeth based on Dean's classification in each student were diagnosed after drying teeth with sterilized gauze. Scoring the severity of fluorosis according to modified Dean's index scoring is as follows:
- 0 – Normal: Glossy, smooth, even enamel surface, and white or pale creamy white in color
- 1 – Questionable: Altered glossiness with few white spots on enamel surface
- 2 – Very mild: Irregular white opaque flecks on <25% of enamel surface
- 3 – Mild: White opaque flecks on <50% but >25% of enamel surface
- 4 – Moderate: Distinctive enamel attrition like wear with brown stain
- 5– Severe: Enamel hypoplasia due to severe fluorosis, pitted and corroded-like enamel, and brown stain on all over the enamel.[13]

A questionnaire, designed in previous studies,[11,14] based on dental appearance was used in this study to assess the effect of fluorosis on the QOL. Factors indicating the quility af life were assessed through following domains:Physical, social, psychological and perception of tooth color change.

To evaluate the content and form validities, the original English version of questionnaire was translated to Farsi language by two qualified translators followed by translating back the best one to English language by a third translator. A three-member team consisting of pediatric dentistry and community dentistry specialists compared the translations and made final corrections.

The validity and reliability of the final Farsi version of the questionnaire were assessed in a pilot study on 20 students (20% of sample size) of Dodangeh village's high school. The results were analyzed using SPSS version 16 (SPSS Inc; Chicago, IL, USA) and Cronbach's α was calculated (α = 0.8) for measuring internal consistency. This pilot study was repeated in 1 month on the same students (test–retest). The results of two pilot studies were compared, and the agreement coefficient was acceptable (Cohen's kappa = 0.8).

The Farsi version of condition-specific OIDP (CS-OIDP) questionnaire was recruited to assess oral situation-related QOL. If the answer of interviewee was positive to the question about tooth color change in the oral complication part, the reported changes would be considered in fluorosis part of CS-OIDP questionnaire.[13,14] This index consists of eight functions categorized in psychological, physical, and social domains.[7]

The students answered the questions regarding the effect of oral condition on the following eight functions: eating, talking clearly, teeth cleaning, smiling and let their teeth be shown without embarrassing, sleeping and relaxing, enjoying talking to others, job activities, and emotional conditions such as being upset.

The questionnaires were completed by the interviewer in face-to-face interviews.

COMPUTING THE QUESTIONNAIRES

The scores 1, 2, and 3 were assigned to low, average, and high frequencies and also to mild, moderate, and severe intensities, respectively, in the CS-OIDP questionnaire.

To determine the outcome of CS-OIDP index, hundred times of the sum of grades of functions (multiplication of the scores of frequency and intensity) divided by the possible maximum grade (72). This formula was applied to consider the difficulties of a student in some functions in the outcome.

TOOLS FOR ANALYZING THE RESULTS

Finally, the results and data from Dean's index, CS-OIDP questionnaire grade, and the average of the tooth appearance-related QOL scores were analyzed using Pearson's and Spearman's correlation coefficient statistical analyses in SPSS version 20 software. Spearman's correlation coefficient was used to assess the averages of CS-OIDP and Dean's indices and correlation between the average of tooth appearance-related QOL questionnaires' scores and Dean's index. The Pearson's correlation statistical analysis was used for evaluating the correlation between the averages of CS-OIDP and tooth appearance QOL questionnaires' scores (α = 0.05).

RESULTS

Minimum, maximum, and average values of fluoride content in samples were 1.2, 1.4, and 1.3 ppm, respectively.

The average age of students was 16.5 years. The average score of tooth appearance-related QOL was 61.5 ± 20.8 out of 100 higher score in this index indicates higher QOL.

Table 1 shows the frequency distribution of fluorosis intensity in the students. One hundred students participated in this study. The frequencies of fluorosis intensity were as follows: questionable 13 cases, very mild 17 cases, mild 21 cases, and moderate 49 cases. No severe fluorosis cases were observed. As it is seen, the most frequent intensity belonged to moderate fluorosis.

Table 2 shows the average scores and standard deviations of CS-OIDP index and the eight domains. The average score of CS-OIDP was 23.5 out of 100. The maximum and minimum problems were seen in the 3rd (tooth cleaning) and 7th (school activities) domains, respectively.

Spearman's correlation coefficient was used to find the correlation between CS-OIDP index and the domains and fluorosis intensity. As it is shown in Table 3, the Spearman's correlation coefficient revealed direct correlations between the fluorosis intensity and CS-OIDP total score and also its eight domains. These correlations

Table 1: The frequency distribution of dental fluorosis in 100 students

Fluorosis intensity (Dean's index)	Frequency (%)
Questionable	13 (13)
Very mild	17 (17)
Mild	21 (21)
Moderate	49 (49)
Severe	0
Total	100 (100)

were not significant between fluorosis intensity and the domains 3ʳᵈ and 4ᵗʰ.

Spearman's correlation coefficient was used to evaluate the correlation between fluorosis and the tooth appearance-related QOL questionnaire score [Table 4]. The average score of CS-OIDP was 23.5 out of 100. The maximum and minimum problems were seen in the 3ʳᵈ (tooth cleaning) and 7ᵗʰ (school activities) domains, respectively.

Pearson's correlation coefficient in Table 5 reveals a negative correlation between tooth appearance-related QOL and CS-OIDP index. As the tooth-related QOL score according to the questionnaire was higher, the difficulties in daily activities according to the CS-OIDP index would be lower.

Discussion

The hypothesis of the present study regarding lowered QOL in individuals with dental fluorosis was approved. The sample population in this study was selected from the female students of Teshan and Dodangeh of districts of Behbahan, located in the south east of Khuzestan Province. The findings of this study show that the average score of CS-OIDP was 23.5 out of 100. The maximum and minimum problems were seen in the 3ʳᵈ (tooth cleaning) and 7ᵗʰ (school activities) domains, respectively, and also, the average score of CS-OIDP was 23.5 out of 100. The maximum and minimum problems were seen in the 3ʳᵈ (tooth cleaning) and 7ᵗʰ (school activities) domains, respectively.

The mean value of fluoride concentration in drinking water in these two places was 1.3 ppm, which is higher than the allowed value by the WHO.[15]

Oral health problems have a significant effect on physical and social activities and also mental health of the population.[18]

This is the first study that evaluates the correlation between dental fluorosis and QOL in the residents of the endemic dental fluorosis area in Iran.

Prabu and Saravanan[16] and Honarmand *et al*.[1] based on the Dean's index and Roman[8] based on Thylstrup–Fejerskov index reported very mild and severe dental fluorosis, respectively, as the highest prevalence of dental fluorosis. Their findings disagree with ours that could be due to differences in region, nutrition, drinking water fluoride concentrations, age groups, and indices.

The most hampered activities in the reports of Kavand *et al*.[17] that applied Child-OIDP index and also Amaral SL *et al*.[5] tooth cleaning and eating. These results are, respectively, consistent and inconsistent with ours. The

Table 2: Average scores of condition-specific oral impact on daily performance and domains in the students

	Mean±SD
CS-OIDP index (total score)	23.5±2.30
1. Eating	1.8±0.23
2. Talking clearly	2.3±0.31
3. Teeth cleaning	3.1±0.33
4. Relaxing	1.9±0.27
5. Emotional control	1.7±0.26
6. Smiling and let your teeth be shown without embarrassing	2.7±0.26
7. School activities	1.3±0.21
8. Socializing	2.3±0.29

SD=Standard deviation, OIDP=Oral impact on daily performance

Table 3: Spearman's correlation coefficients between fluorosis intensity and condition-specific oral impact on daily performance index and also domains

CS-OIDP and domains	Dental fluorosis intensity	
	r	*P*
CS-OIDP index (total score)	0.342	0.001
1. Eating	0.219	0.03
2. Talking clearly	0.267	0.007
3. Teeth cleaning	0.09	0.39
4. Relaxing	0.126	0.22
5. Emotional control	0.201	0.04
6. Smiling and let your teeth being shown without embarrassing	0.416	<0.001
7. School activities	0.332	0.001
8. Socializing	0.357	<0.001

CS-OIDP=Condition-specific oral impact on daily performance

Table 4: Spearman's correlation coefficient between tooth-related quality of life and dental fluorosis intensity

Variable	Tooth appearance-related QOL score	
	R	*P*
Fluorosis intensity	−0.496	<0.001
CS-OIDP	−0.655	<0.001

QOL=Quality of life, CS-OIDP=Condition-specific oral impact on daily performance

Table 5: Pearson's correlation coefficient between tooth appearance-related quality of life and condition-specific oral impact on daily performance scores

Variable	Tooth-related QOL score	
	R	*P*
CS-OIDP	−0.647	<0.001

QOL=Quality of life, CS-OIDP=Condition-specific oral impact on daily performance

specialized Child-OIDP questionnaire might be the reason of this inconsistency. In this study, only those individuals who answered positive to color change in the CS-OIDP questionnaire were included while other items in the Child-OIDP such as toothache and gingival

problems which cause pain on chewing and impact the eating field of the questionnaire were considered. In the other word, the majority of the individuals in this study owned colored teeth because of fluorosis, while in other studies, the severity of caries impacted the results. In the Roman's study,[8] the impacted daily activities were assessed by OIDP index. These activities were smiling, emotional stability, connecting with others, and tooth cleaning. Speech, eating, and relaxing were the least impacted activities. Low prevalence of impairment in workplace or of school activities in Roman's study was consistent with our study.

According to the Ministry of Health and Medical Education of Iran, more than 68% of drinking water is supplied from surface sources. Dental fluorosis which is temperature dependent is seen abundantly in Khuzestan Province. It is observed that in some places in Booshehr province, located in the south of Iran, at Persian Gulf coast, dental fluorosis is probably endemic.[19] It seems that Persian Gulf coast due to environmental situation and high temperature is located on dental fluorosis belt.

The incidence of dental fluorosis, because of excluding individuals with no dental fluorosis, was not evaluated in this study. The highest frequency, however, belonged to moderate dental fluorosis which is expected regarding the fluoride concentration in local water and warm climate of that area. CS-OIDP was the index to assess the QOL in this study. The mean values of CS-OIDP and its eight domains were analyzed. The results showed that the most frequency of problems was in the domain of teeth cleaning followed by smiling, talking, and communication while the least belonged to school activities. A significant correlation ($P < 0.001$) was also detected between the scores of the questionnaires of tooth appearance-related QOL as well as CS-OIDP and the severity of dental fluorosis. It showed that with increasing the severity of dental fluorosis, the OHRQOL decreases.

Ismail and Messer[2] reported anterior teeth fluorosis in children who used high fluoride concentrated well water in the 1st year of their lives. Honarmand *et al.*[1] observed the highest incidence of dental fluorosis in anterior teeth. Increased water consumption due to warm and dry climate beside the high fluoride content of drinking water seems to have an important role in increasing dental fluorosis. The findings of Ismail and Honarmand regarding the effects of climate and source of drinking water on dental fluorosis are consistent with ours.

In this study, 15–18-year-old girls were selected because of the importance of appearance in individuals in this age range, and also, they had been exposed adequately to fluoride.[8]

Relative frequencies of fluorosis severity based on Dean's index in this study were 13%, 17%, 21%, 49%, and 0% for questionable, very mild, mild, moderate, and severe fluorosis, respectively. As it is shown, the highest frequency belonged to the moderate fluorosis.

The severity of fluorosis had no significant relationship with tooth cleaning and also relaxing but had a direct one with the average of other fields of CS-OIDP.

Amaral SL *et al.*[5] did not find any relationship between fluorosis and eight OIDP fields. Their results were consistent with ours only in tooth cleaning and relaxing fields. Since questionable cases in this study had the highest frequency, dental fluorosis seemed had no effect on the QOL in the elementary school students.

By analyzing the relationship between fluorosis severity and QOL, it was concluded that higher severity of dental fluorosis was associated with lower QOL in students, and also, there was a significant relationship between fluorosis severity and the scores of both CS-OIDP and OHRQOL questionnaires. These results are similar to Roman,[8] Prabu and Saravanan,[16] Bhagyajyothi and Pushpanjali,[4] Martínez-Mier *et al.*,[14] and Alkhatib.[10]

The present study is also consistent with Williams *et al.*,[18] Tellez *et al.*,[11] and Aguilar-Díaz *et al.*[12] in the negative effect of dental fluorosis on QOL, appearance, embarrassment, anxiety, and avoid smiling.

Williams *et al.*[18] reported no significant unpleasant effect of dental fluorosis on appearance and emotional status. These results are inconsistent with ours that could be due to very low severity of dental fluorosis in their study.

Abuhaloob and Abed[19] reported that 96.6% of Palestinian children with fluorosis had the feeling of having good appearance. These children did not hide their smiles. Dental fluorosis is high and is an ordinary subject.

One limitation of this study was in-cooperation of the security of the school district that made us inevitable to limit the study to girl's schools. Small sample size and excluding individuals with no dental fluorosis were other limitations that made us, consequently, unable to measure the prevalence of dental fluorosis.

The results of this study can help for national health decisions as there are some fluoride therapy programs conducting nationally in this country and there are severe needs for research introducing the high fluoridated area and their problems.

Since the fluorosis is an irreversible condition and the patients cannot afford esthetic restorative treatments, financial aids for these families are necessary. Public

education regarding dental fluorosis and prevention is also needed.

Treatment of fluorosis depends on the severity of fluorosis and includes bleaching, large and micro grit abrasing, and veneer composite.

Conclusions

Dental fluorosis impacts the OHRQOL and has a negative effect on daily activities in psychosocial domains. Dental fluorosis can also impact self-satisfaction, confidence, and image; social activities; establishing relationships; and enjoying the life. Embarrassment, worry about smiling and talking, was associated with dental fluorosis.

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Conflicts of interest

There are no conflicts of interest.

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