

Self-reported Evaluation of Psychosocial Effects of Fluorosis among Inhabitants Living in a Rural Fluorosis Epidemic Area in China: Psychosocial Effects of Dental Fluorosis

Yan Si, Huan-cai Lin, Zuo-min Wang, Bo-xue Zhang, Yu-bo Hou, Xue-jun Gao

Abstract

Objective: The purpose of this study was to investigate the psychosocial effects of fluorosis on the patients in the fluorosis epidemic area.

Methods: In the rural fluorosis epidemic areas in Hebei province of China, 416 inhabitants were randomly selected to be examined using Dean's Index (DI). Surface Index of Fluorosis (TSIF) was used in 178 recruited participants who were also involved in a psychosocial questionnaire investigation. Demographic information and six five-point subscales about "Attitude to Teeth", "Index of Well-Being", "Index of General Affect", "Interaction Anxiousness Scale" (IAS), "Self-Esteem Scale" (SES) and "Impact on Behavior" were included in the questionnaire. SPSS12.0 software was used to analyze the data.

Result: Fluorosis prevalence in the fluorosis epidemic areas of Hebei province was 71.2%, with 1.77 of Community Fluorosis Index. Prevalence of fluorosis according to DI was lower than the results of TSIF. Difference of fluorosis prevalence calculating by DI and TSIF was evident in 35-44 years old group, and the proportion of such questionable cases in 35-44 age group was the highest, which was 40.3%. With the increase of DI score, the average values of subscale "Attitude to Teeth" (2.58-3.51) and "Index of Well-Being" (2.35-2.90) increased. Significant difference of the evaluation on "Attitude to Teeth" could only be found between the "mild group" (DI=1/2) and the "severe group" (DI=3/4), also between the "control group" (DI=0/0.5) and the "severe group". As for the evaluation scores on "Index of Well-Being", there was significantly different between the "control group" and the "severe group". According to the results of multivariate linear stepwise regression analysis, the independent variable entered the regression model was mainly the DI score, while the evaluation of other subscales were not significantly associated with the independent variables in this analysis.

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Key Words: Fluorosis, Social psychology, Self-reported

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Conclusion

The "questionable" fluorosis would make the prevalence results of DI was lower than that of TSIF. The self-reported psychosocial effects of fluorosis were mainly in "Attitude to Teeth" and "Index of Well-Being", and the evaluation was mainly correlated to the DI score.

From 1980s, health model had been transferred from the "Simple Physical Model" to the "Physical-Psychological-Social Model", so the diseases should be analyzed from these three aspects, and the psychosocial factors should also be taken into account firstly when considering the etiology, diagnosis, therapy and prevention of diseases.¹

Most studies about dental fluorosis focused on the epidemiology surveys² and the evaluation of the indices of fluorosis.³ The risk factors of fluorosis⁴ had also been well documented, especially about the relationship between the prevalence of fluorosis and water fluoridation or the fluoride concentration in drinking water.⁵ A few studies had referred to the effects of oral diseases on patients⁶ and some concerned about the satisfaction of the appearance of teeth with fluorosis.⁷ But there were no systematic studies about the psychosocial effects of fluorosis. It is necessary to evaluate the effects of fluorosis on the patients from the aspect of psychology.

As we all know, fluoride had been well proved to be useful to prevent dental caries in 20th century,^{8,9} but overdose of fluoride for long period time during the formation of enamel would cause fluorosis, which could affect the appearance of teeth. The esthetic problem of fluorosis had been discussed in a few literatures.¹⁰⁻¹² Thus we focused on what difference of the psychosocial effects could be found among different degrees of fluorosis? Which degree of fluorosis could cause psychosocial effects and would appear in what aspects of psychosocial status? What correlated factors would be associated with the self-evaluation of the patients with fluorosis? This pilot study aimed to address the above questions and provided preliminary data that would be useful for the preventive strategy of fluoride use to prevent dental caries in future in China.

Materials and Methods

1. Study subjects

Qinghe County and Nangong County (water fluoride concentration: 3.7-4.0ppm) were selected randomly among the fluorosis epidemic areas (water fluoride concentration ≥ 1.5 ppm) in Hebei province. Adults (35-44 years old) were sampled in the villages, while the 12-year-old group and 15-year-old group were recruited in schools. All subjects were all born and living in the county, and hadn't been continuously outside for more than 3 months since born to 6 years old. They were also absence of fixed orthodontic appliances and absence of non-fluoride-related opacities or defects. At length, 416 inhabitants were involved, including 12, 15 and 35-44 years old groups which were 149, 131 and 136, respectively.

Total 178 patients with different degrees of fluorosis were filtered from all the above subjects. The filter criteria included no missing teeth, no decayed teeth, neither of the evident malocclusion. Among the filtered subjects, there were 60(34.5%) 12-year-old students with 23 boys and 37 girls, 55(31.6%) 15-year-old students with 27 boys and 28 girls, and 59(33.9%) 35-44 years old with 20 male and 39 female, respectively. The average age was 38.7 years old.

2. Clinical examination

Dean's Index (DI) was firstly developed by Dean in 1934¹³ and was modified in 1942. Two severest teeth with fluorosis were selected, and the score of the second severest teeth was recorded as the score of the subject. The fluorosis of 416

inhabitants was recorded by DI, and the 178 filtered samples were re-examined using Tooth Surface Index of Fluorosis (TSIF). TSIF was established by Horowitz from the National Institute of Dental Research in 1984,¹⁴ which included eight levels (0-7) and excluded the level of "questionable". A separate score was given to each facial and lingual surface of the anterior teeth, and for the posterior teeth, the scores were recorded by the buccal, occlusal and lingual surfaces.

Two examiners (s/c) were trained by an experienced epidemiologist (w) before the investigation. The theoretical training was performed firstly, and the weighted Kappa coefficients were 0.89(w/s:DI), 0.86(w/c:DI), 0.96(w/s:TSIF), 0.89(w/c:TSIF) according to the maxillary right central incisors of the 20 fluorosis photos, and the prevalence of agreement were 84.21%, 84.21%, 94.73% and 84.21% respectively with the strength of agreement was "very good". Then the clinical training was carried out, and 15 patients were examined by the reference examiner and the two examiners. Examiner of DI (c) was entirely accordance with the standard examiner and the Kappa coefficient was "1", while the weighted Kappa coefficients of the examiner of TSIF (s) compared with the reference examiner were 0.81 when calculated the scores of the labial surface of anterior teeth. The prevalence of agreement was 91.67% and the strength of agreement was "very good".

3. Evaluation of psychosocial status

Literature review and a series of pretests were performed before the study. The self-reported psychosocial questionnaire involved demographic data and six subscales, "Attitude to Teeth", "Index of Well-Being", "Index of General Affect", "Interaction Anxiousness Scale" (IAS), "Self-Esteem Scale" (SES), "Impact on Behavior",¹⁵ which included 12, 8, 4, 15, 10 and 9 items in the subscales respectively. All the psychosocial items were five-point questions, that is level "1" to level "5" represented five levels from "very good" to "very bad" (positive questions) or from "very bad" to "very good" (negative questions).

The validity of psychosocial questionnaire was evaluated by the "internal consistency reliability" using Cronbach's α Coefficient. The larger Cronbach's α Coefficient means more validity of the questionnaire.¹⁶ Except for the 0.57 Cronbach's α Coefficient of the subscale of "Self-Esteem Scale", the Coefficients of other subscales ranged from 0.66 to 0.84, which indicated that the validity of the psychosocial questionnaire used in this study was acceptable.

4. Statistical analysis

SPSS12.0 software was adopted to analyze the data. Basic descriptive statistics such as the prevalence and proportion of fluorosis and the Community Fluorosis Index (CFI) was calculated first. Before the questionnaires data analyzed, the evaluation scores of the negative questions were unified according to the positive questions. Therefore, we got the uniform evaluation scores, ranging from 1 to 5, in which higher scores represented severer psychosocial effect of fluorosis.

Difference of the evaluation scores among different severity of fluorosis were analyzed using "One-Way ANOVA". Subjects were divided into "control group" (DI=0/0.5), "moderate group" (DI=1/2) and "severe group" (DI=3/4) according to DI scores for further analysis. "Independent-Samples *t* Test" was used to compare evaluation scores between the three groups on the six subscales.

Multivariate linear stepwise regression analysis was performed to determine the correlated factors of the evaluation of the patients with fluorosis, with enter level was 0.05 and removal level was 0.10, in which the evaluation scores on the six subscales were regarded as "dependent variables", and the "independent variables" included DI score and the demographic data of the evaluators, including age, gender, occupation and the marriage status.

Results

1. Epidemiological data of fluorosis

Fluorosis prevalence in fluorosis epidemic areas of Xingtai City in Hebei province was 71.2% (DI \geq 1, n=416), and the prevalence of the three age groups were 94.6%, 87.0% and 66.2%. Significant difference existed among three age groups (Chi-square test, $P < 0.001$). On account of TSIF scores recorded for each teeth surface, three methods were suggested to compute the prevalence of fluorosis.¹⁴ The subject with one of the following criteria was computed as a fluorosis case: 1) The maximum TSIF score of the labial surfaces of the maxillary anterior teeth was one or above; 2) The maximum TSIF score of the labial surfaces of the anterior teeth was one or above; 3) The maximum TSIF score of all the surfaces of a subject was one or above.

The results of the prevalence computed according to TSIF scores were all higher than those of DI scores, especially in the 35-44 years old group, in which the difference of the two indices was almost 40% (Figure 1). The percentage of the fluorosis patients according to DI scores in the three age groups were showed in Figure 2, from which one could found that the percentage of the "questionable" level was higher in the middle-age group than in the other two age groups.

According to the DI scores, CFI could be calculated as follow:¹⁷ $(0.5 \times \text{number of "questionable"} + 1 \times \text{number of "very mild"} + 2 \times \text{number of "mild"} + 3 \times \text{number of "moderate"} + 4 \times \text{number of "severe"}) / \text{number of all the subjects}$. The CFI scores and the public health significance of the three age groups were listed in table 2. CFI in fluorosis epidemic areas of Xingtai City in Hebei province was 1.77, indicating the degree of fluorosis prevalence in the community was moderate.

2. Evaluation of the psychosocial status of the patients with fluorosis

The average evaluation scores and Standard Deviations of six subscales for various degrees of fluorosis had been calculated (Table 2). With the increase of DI score, the average value of subscale "Attitude to Teeth" rose, ranging from 2.58 to 3.51,

and the value of "Index of Well-Being" was also increasing, ranging from 2.35 to 2.90. The results of analysis of variance showed that statistical differences of subscale average values only existed in "Attitude to Teeth" ($P < 0.001$) and "Index of Well-Being" ($P = 0.030$), and no significant difference could be found among different degree of fluorosis in other subscales.

Three groups of different degrees of fluorosis were reassigned according to DI scores for further analysis. The results of "Independent-Samples *T* Test" showed that the evaluation on "Attitude to Teeth" was significantly different between the "mild group" (DI=1/2) and the "severe group" (DI=3/4) ($T = -4.55$, $P = 0.000$), and between the "control group" (DI=0/0.5) and the "severe group" ($T = -4.51$, $P = 0.000$), while the difference between the "control group" and the "mild group" had no statistical significance. As for the evaluation scores on "Index of Well-Being", significant difference could only be found between the "control group" and the "severe group" ($T = -3.18$, $P = 0.002$) (Table 4). While no statistical significance was existed between the three groups when analyze the evaluation scores on the other subscales.

3. Correlated factors of the evaluation of the patients with fluorosis

The results of the multivariate linear stepwise regression analysis (Table 5) indicated that only the evaluation scores on "Attitude to Teeth" and "Index of Well-Being" could establish the regression models, and the independent variable entered the regression model was mainly the DI score, which meant that degree of fluorosis was significantly associated with the evaluation scores, while the evaluation of other subscales were not significantly associated with the independent variables involved in this analysis.

The multivariate linear stepwise regression model of the evaluation on "Attitude of Teeth" was as follows: $Y_1 = 2.19 + 0.27X_1(\text{DI}) + 0.01X_2(\text{age})$, which had been proved to have statistical significance ($F = 16.94$, $P < 0.001$). And the model of the evaluation on "Index of Well-Being" was: $Y_2 = 2.35 + 0.12X_1(\text{DI 记分})$, which also had been validated ($F = 8.76$, $P = 0.004$).

Discussion

In the present survey, the prevalence of fluorosis recorded as DI was lower than the results by TSIF, especially in the 35-44 years old group, with the difference was almost 40%. Dean's Index has been used in many epidemiological surveys for half a century since it was developed, which was also the recommended index for survey of fluorosis by the World Health Organization.¹⁸ But Dean suggested that "one person, one disease", and DI score was based on a person or a community, not on a tooth or a tooth surface.^{14,17} Kingman pointed out that prevalence for the TSIF at surface level could be defined by requiring that TSIF \geq 1, but DI required fluorosis to be present on at least two teeth if the case could be regard as a patient.¹⁹ In the adult group of this study, the severest teeth were almost consistent with the second

severest teeth, while the proportion of “questionable” in the 35-44 years old group was the highest (40.3%). The difference of the prevalence between the two indices was attributed to the imprecise diagnosis of the level “questionable” (DI=0.5), which could be diagnosed as fluorosis in the criteria of TSIF (TSIF=1) or TFI (TFI=1).²⁰ Other literatures had also reported that the diagnosis of “questionable” could affect the result of fluorosis prevalence.²¹

Persons with attractive appearance are always assumed to possess more socially desirable personalities, and are happier and more successful than other who are less attractive^[22]. Oral cavity is an important area for the appearance of a person,^{4,22} so the dental diseases could not only affect the physical health of patients, but also influence the psychological health, which could impact their day-to-day living or life quality in turn.⁶ The results of this study showed that the psychosocial effects of fluorosis in the rural epidemic areas were mainly appeared in the aspects of “Attitude to Teeth” and “Index of Well-Being”. A study of Tanzania also concluded that dental fluorosis impacted negatively on the functional, social and psychological well-being of the secondary school children who were 12-20 years old.²³ Mwaniki in Kenya reported that 60%-84% of mothers with children aged 3-6 years old regarded fluorosis could affect the individual’s personality and had observed affected people cover their mouths with the hand when laughing, and dental fluorosis was viewed as an embarrassing condition by 77.5%.²⁴

There were no significant difference among the self-reported evaluation scores with different degree of fluorosis in the aspects of the other subscales, i.e. “Index of General Affect”, “Interaction Anxiousness Scale” (IAS), “Self-Esteem Scale” (SES) and “Impact on Behavior”. Because all the subjects were the inhabitants of the epidemic fluorosis areas, and many of the surrounding people of the subjects were also the patients with fluorosis, so the psychosocial status of these aspects was not so obvious. The psychosocial status could also be affected by the economic and cultural environment. The subjects in this study were almost peasants coming from rural areas, and may not care about these aspects of psychosocial status. Further studies in more areas were needed to be carried out to evaluate the influence of fluorosis on the psychosocial status of patients.

With the increase of DI score, the average value of subscale “Attitude to Teeth” and “Index of Well-Being” was raising, which implied that the influence of fluorosis was more apparent in the severer patients. Many studies had also come to the conclusion.^{4,10} Alkhatib reported that the proportion of respondents who were dissatisfied with their own tooth color ascended with the increasing severity of discoloration.¹¹ The study of Riordan also showed that fluorosis with TFI \geq 2 could easily noticed, and the observers would felt that the appearance would increase the embarrassment of children as the TF score rising.¹⁰

The evaluation of “Attitude to Teeth” was significantly different between the “mild group” (DI=1/2) and the “severe group” (DI=3/4), and between the “control group” (DI=0/0.5) and the “severe group”, and the difference of scores on “Index of Well-Being” was significant between the “control group” and the “severe group”, while the difference between the “control group” and the “mild group” had no statistical significance. Woodward also found that the parents of the children with TSIF \geq 2 was half as likely to be satisfied with the appearance of the children’s teeth than the parents of the children with no or mild fluorosis.⁷ So some investigators pointed out the psychosocial effects of fluorosis were mainly appeared in the moderate and severe fluorosis, not in the patients with mild fluorosis,^{4,12,25} and this study also had a similar result.

The evaluation scores on “Attitude of Teeth” and “Index of Well-Being” were significant associated with the DI score, while the demographic data of evaluators didn’t enter the regression models. But a previous self-evaluated study presented that the gender, age, income and smoking of evaluators had statistically significant effects on the prevalence of perceived discoloration.¹¹ The possible reason maybe the demographic data of the subjects in this study were similar, and the difference could not be found. The further study was suggested in the field of the surrounding people of the patients with the fluorosis and the public, so that we could explore the psychosocial effects of the esthetic problem of fluorosis from variable aspects.

The first conclusion could be drawn that the most probably reason for the results of DI was lower than that of TSIF was that a person with “questionable” fluorosis wouldn’t be calculated as a fluorosis patient. The second conclusion was the self-reported psychosocial status of the patients with fluorosis in epidemic areas was mainly appeared in the aspects of “Attitude to Teeth” and “Index of Well-Being”, especially in the severe group, and the evaluation was mainly correlated to the DI score.

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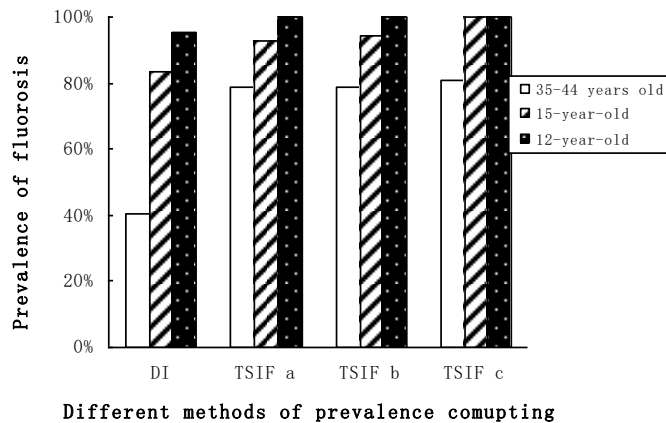


Figure 1. Comparison of Fluorosis prevalence by DI/TSIF.
a : the maximum TSIF score of the labial surfaces of the maxillary anterior teeth ≥ 1 ;
b : the maximum TSIF score of the labial surfaces of the anterior teeth ≥ 1 ;
c : the maximum TSIF score of all the surfaces of a subject ≥ 1 .

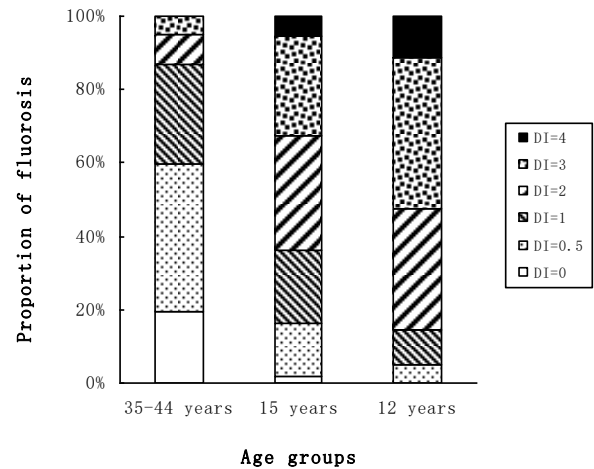


Figure 2. The proportion of fluorosis in three age groups.

Age groups	CFI	Public health significance
35-44 years old	0.59	Borderline
15-year-old	2.22	Marked
12-year-old	2.46	Marked
Total	1.77	Moderate

Table 1. Community Fluorosis Index (CFI) in Xingtai City of Hebei Province.

DI	Attitude to Teeth		Index of Well-Being		Index of General Affect		Interaction Anxiousness Scale		Self-Esteem Scale		Impact on Behavior	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
0	2.58	0.94	2.39	0.52	2.33	1.00	2.67	0.66	2.69	0.42	2.00	0.51
0.5	2.78	0.63	2.35	0.70	2.28	0.63	2.84	0.57	2.57	0.57	2.13	0.53
1	2.88	0.49	2.58	0.62	2.29	0.68	2.84	0.61	2.79	0.60	2.16	0.75
2	2.84	0.55	2.52	0.60	2.32	0.79	2.90	0.51	2.64	0.48	2.40	0.73
3	3.23	0.49	2.70	0.53	2.38	0.89	2.90	0.50	2.78	0.60	2.15	0.65
4	3.51	0.51	2.90	0.67	2.53	0.74	3.01	0.29	2.85	0.24	2.41	0.48
Total	2.95 ***	0.62	2.55 *	0.62	1.17	0.38	2.87	0.54	2.70	0.54	2.21	0.66

Table 2. Evaluation scores on six subscales of patients with fluorosis . $P < 0.001$; * : $P < 0.05$.

	Mean(S.D.)	Mild (DI=1,2)		Severe (DI=3,4)	
		Difference of value	P	Difference of value	P
Control (DI=0/0.5)	2.73(0.72)	0.13	0.240 ^a	0.55	0.000 ^b
Mild (DI=1,2)	2.86(0.52)	---		0.42	0.000 ^c
Severe (DI=3,4)	3.28(0.72)	---		---	

^a : no significance difference between "Control group" and "Mild group" ($P > 0.05$)

^b : significant difference between "Control group" and "Severe group" ($P < 0.001$)

^c : significant difference between "Mild group" and "Severe group" ($P < 0.001$)

Table 3. Comparison of the evaluation on "Attitude to Teeth" between groups.

	Mean(S.D.)	Mild (DI=1,2)		Severe (DI=3,4)	
		Difference of value	P	Difference of value	P
Control (DI=0/0.5)	2.36(0.65)	0.19	0.100	0.38	0.002 ^b
Mild (DI=1,2)	2.55(0.61)	---		0.19	0.073 ^c
Severe (DI=3,4)	2.74(0.56)	---		---	

^a : no significance difference between "Control group" and "Mild group" ($P > 0.05$)

^b : significant difference between "Control group" and "Severe group" ($P < 0.001$)

^c : no significance difference between "Mild group" and "Severe group" ($P > 0.05$)

Table 4. Comparison of the evaluation on "Index of Well-Being" between groups.