Children's perception of other children with dental fluorosis – A cross-sectional study

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ABSTRACT

Background: Dental appearance may influence how others perceive individuals. This study would help to understand whether young people make judgments about other young people with dental fluorosis.

Aim: We aimed to evaluate the perception of children aged 12–15 years about other children with visible dental fluorosis.

Materials and methods: A self-administered social attribute questionnaire was used to capture dental appearance-related judgments of 455 children aged 12–15 years, from 6 schools. All the children were given either a set of full-face photographs of a boy and a girl, without dental fluorosis or digitally modified anterior teeth to show visible dental fluorosis. The Total Attribute Score (TAS) was measured by totaling the participant's ratings for each characteristic, ranging from 11 (most negative score) and 44 (most positive).

Results: A total of 437 children participated, 53.8% (235) were males with a mean age of 13.99 ± 0.825 . The mean TAS for photographs with fluorosis (25.9 ± 4.73) was significantly lower than without fluorosis (34.8 ± 4.83) ($p < 0.001$). Concerning gender, age, and SES, photos with fluorosis had significantly lower mean TAS than without fluorosis ($p < 0.001$, < 0.001 , < 0.001 and < 0.001), respectively.

Conclusion: Children in our study perceived that fluorosis could have a negative impact on their appearance.

1. Introduction

Physical attractiveness was shown to have an impact on a person's life in various ways. Literature suggests that children who are physically striking, are judged more positively and likely to have behaviors and qualities that are socially desirable and live with content and success than are those of lesser attractiveness.¹ Furthermore, facial appearance is a slightly more powerful predictor of overall attractiveness than the body.² People often conclude and draw attributes and trait inferences from the facial appearance of other people.³

It also has been proven that children with poor dental appearance incited misconceptions and negative responses.⁴ Children with dental anomalies were judged more negatively in terms of behavior, intelligence, and social desirability as a friend.⁵ Unfavorable social and educational judgments were found to be made by school teachers and children.⁶

Tooth color-based social judgments were reported in relation to appearance. Tooth color can be affected in various ways – extrinsic discoloration that occurs on the enamel surface, exposed dentin, or

cementum due to accumulation of deposits, a film, pigment, or calculus and intrinsic discoloration affecting the internal calcified tissues of teeth such as enamel hypo-mineralization, enamel mottling, etc.⁷

A previous study established that lower ratings were given to people with discolored teeth for a set of personality traits such as “intellectual ability,” “social competence,” “satisfaction with relationships,” and “psychological adjustment” when compared with whitened teeth. The color of the teeth did have an impact on how others perceived an individual.⁸

Increased fluoride intake during enamel formation results in the mottling of the enamel.⁹ This mottled enamel is also known as dental fluorosis. It presents with observable changes in enamel (intrinsic tooth discoloration), hence sometimes leading to physical damage of teeth.¹⁰ The impact of the condition varies according to the dosage, extent of duration, and age of the individual during the exposure. The esthetic component of moderate and severe fluorosis is of concern, as teeth are physically damaged.¹¹

Traditionally, dental fluorosis has not been considered as being of public health importance by dental health professionals. But it's been

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one of the most prevalent conditions seen in pediatric dental practice. As it makes an observable difference to the normal dental appearance, it can have a negative effect on the children's perception.¹² To date, to the best of our knowledge, the impact of dental fluorosis on social perceptions was not studied in a young population. This study would help to understand whether children make judgments about other children with dental fluorosis. We aimed to evaluate the perception of children age 12–15 years about other children of the same age group with visible dental fluorosis as well as to assess the role of socio-demographic variables (gender, age, socioeconomic status) on their perception.

2. Materials and methods

We conducted a cross-sectional study to evaluate the perception of children age 12–15 years about other children of the same age group with visible dental fluorosis of Udupi Taluk, Karnataka, India.

2.1. Study area and study population

This study was conducted among children of government and private schools, aged between 12 and 15 years, from January to May 2017. The research was conducted in 3 private schools and 3 government schools in Udupi Taluk. Children who were willing, studying in the selected schools, whose parents were willing to give informed consent and of age 12–15 years old, present on the day of the survey were included. Children who had problems with comprehension (learning disabilities, language barrier, problems with vision, speech and hearing, developmental anomalies, and syndromes) were excluded from our study.

2.2. Sample size calculation

It was calculated that 106 children would be required per school (Government/Private), i.e., 212 participants from each group (with/without fluorosis) would be needed for an 80% power to detect a significant difference in Total Attribute Score (TAS), as per the previous study (Craig et al., 2015). A threshold for significance was set at 5% and a design effect of 2 to ensure randomness in cluster sampling, yielded a sample size of 424. An excess of 10% was recruited to account for non-response. So, a final sample of 470 was required.

2.3. Data collection

Two sets of photographs were given along with the questionnaire. All the children were given either a set of full-face pictures of a boy and a girl who is 13 years and 15 years old respectively, who had good oral health without dental fluorosis (Fig. 2a) or digitally modified anterior teeth to show visible dental fluorosis (Fig. 2b). Noticeable dental fluorosis was digitally altered onto the photographic subject's anterior teeth using a graphics editing software program, "Adobe Photoshop CS6" (Adobe Systems Inc, San Jose, CA, USA).

2.3.1. Social attribute questionnaire

The social attribute questionnaire is an 11 item close-ended questionnaire that was developed and validated by Craig et al., in 2015.⁴ This questionnaire was used to evaluate the photographs of the boy and girl, with or without dental fluorosis. The English questionnaire was translated into the Kannada language - local language by a professional, well versed in both Kannada and English languages. A back translation assessed the validity of the Kannada form into English by another expert in both languages. The questionnaire consisted of the following sections:

The first part of the questionnaire assessed socio-demographic details like age, gender, type of school (governmental/private school), family income, parent's occupation, and their educational qualification. Children were classified into different socio-economic strata (upper,

Fig. 1. Flow diagram to show the participation of children in (a) Government schools and (b) Private schools.

middle and lower) by using the modified Kuppaswamy scale, revised in 2017.¹³ The second part of the questionnaire evaluated the value-based judgments about the dental appearance of the photographic images of the boy and the girl with or without dental fluorosis. The participants were asked if the image of the boy and girl looked "naughty," "clever," "rude," "kind," "honest," "he/she does not care about appearance," "careful," "lazy," "confident," "helpful," and "stupid." The responses were categorized on 4 points Likert scale, namely "strongly agree [4]," "agree [3]," "disagree [2]," and "strongly disagree [1]." Children rated the images of the boy and girl for these 11 characteristics separately. The Total Attribute Score (TAS) was measured by totaling the participant's ratings for each component. The negative attributes were reverse coded. Hence, TAS ranged from 11 being the most negative score and 44 being the most positive.

2.3.2. Acquisition of photographs

Selection criteria of the subjects for photographs: a girl and a boy with well-aligned teeth with no gross asymmetry of age range 12–15 years, whose parents were willing to give informed consent to use the photographs for the study were included. Children undergoing orthodontic treatment, visible malocclusion, midline diastema or high smile line, visible enamel defects, trauma or pathologic defects of teeth, developmental anomalies, and syndromes were excluded from our study.

Participants were invited for screening sessions held in different schools other than the schools involved in the study. A series of full-face high-resolution digital color photographs from a standard distance in a frontal view was taken of children who fulfilled the above inclusion criteria. Children were instructed not to wear jewelry, glasses, or make-up and to smile in a way that exposed their anterior maxillary teeth. A tripod-supported Canon EOS-400 digital camera was used without flash in a standardized background and lighting conditions. Girls were asked to tie their hair behind, and boys were asked to clean shave. These original photographs were considered to be the pattern of naturally lit smiles. Using the Adobe Photoshop CS6 software, anterior maxillary teeth were digitally modified to show visible dental fluorosis. Thus, four photographs were obtained, two for each male and female subjects: the natural and digitally altered pictures.

Overall, 120 number of students were screened to fit the criteria, and ten students were finalized for photographs (5 girls and 5 boys).

a: Photographic images without dental fluorosis

b: Photographic images with digitally modified visible dental fluorosis

Fig. 2. a: Photographic images without dental fluorosis b: Photographic images with digitally modified visible dental fluorosis.

These photographs were digitally projected to the evaluators. A group of five evaluators evaluated the appropriateness of the pictures with respect to the study criteria. Once the evaluators finalized the photographs, copies of these photographs (a boy and a girl) were printed on A4 size photographic paper (Fig. 2a and b).

2.4. Pilot study

A pilot study evaluated the feasibility of the photographs. These photographs were distributed in sealed envelopes to children along with the social attribute questionnaire. A total of 54 children were given either a set of pictures of a boy and a girl without dental fluorosis or the same photographs of a boy and a girl with digitally modified anterior teeth to show visible dental fluorosis in school settings. These children were not involved in the main study. With respect to gender, in both the male and female photographs, there was a significant difference in the mean TAS scores between fluorosis and without fluorosis groups ($p < 0.001$, < 0.001 , < 0.001 and < 0.001) respectively.

These photographs were used for the main study.

2.5. Main study

Before the commencement of the study, ethical approval was sought from the Institutional Ethics Committee of Kasturba Hospital, Manipal (IEC number: 923/2016). Overall there were 63 high schools in Udupi Taluk. A total of six schools (3 government and 3 private schools) were randomly selected for the study. Permission to use the photographs for the study was obtained from the photographic subjects and their parents. Informed consent was sought from parents/guardians, and the written assent was obtained from all the participating children.

Eligible and consented children were included in the study. The study was conducted in school settings. A total of 479 children aged 12–15 years of age were willing to participate in the study. Due to the language barrier and not being able to comprehend the local language, eighteen children were excluded, and overall, 455 children took part in the study. They were given instructions before the administration of the

questionnaire and queries were solved by the investigators.

All the children were given a set of facial photographs, either of a boy and a girl without dental fluorosis or those with digitally modified anterior teeth to show visible dental fluorosis. On the day of collection of data, a teacher was chosen to hand out packs of questionnaires randomly to class teachers prior to the implementation of the study. Each pack included pictures, either of subjects with dental fluorosis or without dental fluorosis.

2.6. Statistical analysis

Statistical analysis was performed using SPSS version 18 (Chicago, Ill, USA). The level of statistical significance was set at $P < 0.05$. The mean TAS obtained from the responses of the questionnaire was compared with the socio-demographic variables (age, gender, socioeconomic status). Independent sample *t*-test was used to compare the mean TAS for the photographic subjects with and without dental fluorosis, with respect to age, gender and socioeconomic status. Multiple linear regression analysis was done to evaluate the association of dental fluorosis on the photographs with TAS after adjusting for socio-demographic variables (gender of the rater, SES, type of school and age) separately for the ratings of male and female photographs.

3. Results

Questionnaires containing more than 30% of responses missing were excluded ($n = 18$). A total of 437 children completed all the stages of this survey, out of which 53.8% (235) were males, with a mean age of 13.99 ± 0.83 . A total of 217 children participated from the government schools and 220 children participated from private schools with a response rate of 91.1 and 82.3%, respectively (Fig. 1a and b).

Among 12–13 and 14–15 year school children, the mean TAS was significantly higher in photographs (boy and girl) without dental fluorosis than with fluorosis ($P < 0.001$ and < 0.001 ; $P < 0.001$ and < 0.001) respectively (Table 1). The mean TAS was significantly lower for photographs (boy and girl) with dental fluorosis by the male raters compared to those without dental fluorosis ($P < 0.001$ and < 0.001), respectively. A similar result was found with respect to female raters ($P < 0.001$ and < 0.001), respectively (Table 2).

In government school children, both the photographs (boy and girl) without dental fluorosis had higher mean TAS than the pictures with dental fluorosis ($P < 0.001$ and < 0.001), respectively. Similar findings were seen with respect to private school children ($P < 0.001$ and < 0.001) respectively (Table 3). The children belonging to the upper and middle strata showed significantly lower mean TAS with respect to the photographs (boy and girl) with fluorosis than without dental fluorosis ($P < 0.001$ and < 0.001 ; $P < 0.001$ and < 0.001) respectively (Table 4).

Overall, the mean TAS for the photographs with dental fluorosis was 25.9 ± 4.73 , and the mean TAS for the pictures without dental fluorosis was 34.8 ± 4.83 . Therefore, the mean TAS in the

Table 2

Comparison of mean TAS for the photographs (boy and girl), with and without dental fluorosis with respect to children's gender.

Children rating photographs	Fluorosis				P-value
	Present		Absent		
	N	Mean TAS $\pm$ SD	N	Mean TAS $\pm$ SD	
Male child rating boy photographs	108	23.94 $\pm$ 4.29	127	34.48 $\pm$ 4.61	< 0.001
Female child rating boy photographs	108	26.83 $\pm$ 4.23	127	36.20 $\pm$ 4.52	< 0.001
Male child rating girl photographs	103	25.03 $\pm$ 5.04	99	32.80 $\pm$ 5.37	< 0.001
Female child rating girl photographs	103	27.84 $\pm$ 4.39	99	35.41 $\pm$ 4.23	< 0.001

photographs (boy and girl) with fluorosis showed a significantly lower score than that without fluorosis ($P < 0.001$). The presence of dental fluorosis showed a significant positive association with TAS in male ($\beta = 9.25$; CI: 8.33–10.17; $P < 0.001$) and female ($\beta = 8.56$; CI: 7.73–9.38; $P < 0.001$) photographs respectively, after adjusting for gender of the rater, SES, type of school and age (Table 5).

4. Discussion

Dental Fluorosis has been one of the most prevalent conditions seen in pediatric dental practice.¹² As it makes a visible difference to the normal dental appearance, it may have a negative impact on the children's perception. This was an anticipated outcome, provided that several previous studies were done in the literature using similar methodologies, stating that the difference in dental appearance from expected and ordinary norms tends to generate negative social judgments.^{14–16} The broader appearance literature proves the negativity in views expressed by the public regarding individuals with facial differences.¹⁷

The method of using photographs to make social judgments, as in the current study, is questionable as it could be considered as an artificial approach. People judge other individuals based on differences in facial appearances, dynamic facial expressions and voice as well in real life. However, the usage of static 2D pictures has been validated previously. A comparison of a static facial photograph with dynamic video clips to rate on men's attractiveness¹⁸ showed no significant differences. It concluded that it was a valid method for social science research. Tigue et al. compared 2D and 3D rotating facial images of women to see for the differences in the ratings for attractiveness by male participants¹⁹ and concluded that the judgments made for 2D images were valid and similar to the decisions made on the 3D models.

The current study found that children, both male and female raters, were significantly more negative in their social judgments of the photographs with dental fluorosis than those without dental fluorosis. Gender was not shown to influence judging the pictures. Previous studies had female teenagers rating more positively than male teenagers

Table 1

Comparison of mean TAS according to age group.

Age	Photograph Gender	Fluorosis				P-value
		Present		Absent		
		N	Mean TAS ± SD	N	Mean TAS ± SD	
12–13	Boy	55	24.47 ± 4.82	73	33.91 ± 5.82	< 0.001
	Girl	55	27.38 ± 4.17	73	35.59 ± 4.80	< 0.001
14–15	Boy	156	24.47 ± 4.66	153	33.66 ± 4.60	< 0.001
	Girl	156	27.30 ± 4.39	153	35.98 ± 4.21	< 0.001

Table 3

Comparison of mean TAS according to the type of schools (Government/Private).

School	Photograph Gender	Fluorosis				P-value
		Present		Absent		
		N	Mean TAS ± SD	N	Mean TAS ± SD	
Government	Boy	101	24.86 ± 5.19	116	33.44 ± 5.57	< 0.001
	Girl	101	27.60 ± 4.25	116	35.30 ± 4.51	< 0.001
Private	Boy	110	24.11 ± 4.18	110	34.06 ± 4.36	< 0.001
	Girl	110	27.06 ± 4.39	110	36.44 ± 4.22	< 0.001

with respect to children with visible enamel defects⁴ or orthodontic appliances.²⁰ However, Shaw concluded that dental appearance influences the perception of males and females.⁶

Age didn't show any influence on the rater's judgment of the photographs in our study. Both the age groups showed significantly more negative judgments for the pictures with dental fluorosis. This could be because children in that age group overall generally are conscious about their identity, as having visible dental fluorosis is a variation to normal dental appearance during adolescence. Similar results were found by Rodd et al. in which 11- to 12-year-old children attributed negatively for personality characteristics to other children with visible incisor trauma. However, in the same study, the converse was true for 14 to 15-year olds. Older children tend to make a conscious and deliberate decision not to make negative judgments about subjects with traumatized incisors. Instead, they tried to overcompensate by rating them more positively than children with usual incisor esthetics.¹⁶

Socioeconomic status did not affect making negative psychosocial judgments based on enamel appearance.⁴ The present study results showed a similar pattern as the children belonging to both the upper and middle strata showed significantly lower mean TAS concerning the photographs with fluorosis than without dental fluorosis. Contradicting the widespread belief that children of lower socioeconomic status would rather judge other children with a poorer dental appearance more positively as they have poorer dental health and lower expectations for treatment.

Overall, we found that the presence of visible dental fluorosis could have a negative impact on their appearance and young people might make negative judgments about other children with noticeable dental fluorosis. Similar findings were reported in the case of children with discolored teeth,⁸ prominent incisors, missing upper lateral incisor, severely crowded incisors, and unilateral cleft lip.⁶ This evidence proves that the photographs of children with normal dental appearance would be judged more positively. Hence, enhancing the need for treatment.

An acknowledged limitation of the present study is that other influential factors such as an individual's values, beliefs, previous dental experience, and personal dental attractiveness also could have contributed to appearance-related judgments made by participants about their peers. Preferably, it would've been better to have communicated

Table 5

Association of dental fluorosis on the photographs with TAS after adjusting for sociodemographic variables (gender of the rater, SES, type of school and age) separately for the ratings of male and female photographs.

Photograph Gender	Variable	β	SE	P-value	95% CI
Male	Fluorosis	9.25	0.47	< 0.001	8.33–10.17
	Gender of the rater	−0.34	0.47	0.478	−1.26–0.59
	SES	0.13	0.58	0.823	−1.01–1.27
	Type of school	0.06	0.59	0.916	−1.09–1.22
	Age	−0.14	0.53	0.794	−1.18–0.90
Female	Fluorosis	8.56	0.42	< 0.001	7.73–9.38
	Gender of the rater	0.03	0.42	0.94	−0.80–0.86
	SES	0.63	0.52	0.229	−0.40–1.65
	Type of school	0.06	0.53	0.905	−0.97–1.10
	Age	0.09	0.47	0.847	−0.84–1.02

Multiple linear regression; Dependent Variable: TAS.

to a few of the participants to find out why they chose to give the scores that they did, to get a better description of their thought process when a social judgment is made.

It is imperative to highlight the broader psychosocial impacts for youngsters with visible dental fluorosis. Negatively perceived children with poor dental appearance may severely have an impact in the way they act, even affecting future development in the long run, and life opportunities.^{21–23} Indeed, earlier studies have proven that the focus group discussions, regarding the photographs of individuals with visible enamel opacities, prompted misconceptions that “these people did not care about their teeth or their appearance.”⁴

It is essential to be much aware of the clinical and emotional requirements of children with dental fluorosis as a dental professional and representatives of dental services. It is recommended that the child should wait till they're older to correct any cosmetic concern, therefore having to overcome some challenging teenage years with poor dental aesthetics. There are many simple and non-invasive procedures available to improve the appearance of dental fluorosis. Tooth whitening and removal of surface stains have been encouraged. It's been shown

Table 4

Comparison of mean TAS according to socio-economic status.

SES	Photograph Gender	Fluorosis				P-value
		Present		Absent		
		N	Mean TAS ± SD	N	Mean TAS ± SD	
Upper	Boy	104	24.45 ± 4.26	104	33.81 ± 5.30	< 0.001
	Girl	104	27.38 ± 4.18	104	36.42 ± 4.71	< 0.001
Middle	Boy	107	24.49 ± 5.10	122	33.69 ± 4.79	< 0.001
	Girl	107	27.26 ± 4.48	122	35.37 ± 4.07	< 0.001

that bleaching of teeth may momentarily worsen the appearance of dental fluorosis. Coating of the tooth with a hard resin, a procedure known as bonding is often suggested to treat visible dental fluorosis as it bonds to the enamel, crowns and veneers. MI Paste is a calcium phosphate product that is frequently used in combination with procedures such as micro-abrasion to treat tooth discoloration.²⁴

Apart from the common dental diseases like caries, and malocclusions, a clinician should consider oral health in a holistic view and figure out ways to improve the quality of life. It was reported that higher severity of dental fluorosis was associated with lower quality of life in children.²⁵ Further research involving qualitative approaches, such as focus groups or interviews, would allow for a deeper understanding of children's experiences of the management of visible dental fluorosis in both general dental practice and specialist settings. It is becoming increasingly important that treatments are justified in terms of patient benefit. Thus clinicians should be more proactive in seeking feedback from children to safeguard and develop services.

5. Conclusion

Children in our study perceived that fluorosis could have a negative impact on their appearance and children make negative judgments about other children with dental fluorosis. Further studies are needed to have an insight into the relationship between oral health and a child's understanding of general and complete well-being. Future research on the influence of individual values, beliefs, previous dental experience, and personal dental attractiveness is required for shaping further child-oriented dental facilities.

Informed consent

Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

Ethical approval

All procedures performed in studies involving human participants were following the ethical standards of the institutional and/or national research committee (Institutional Ethics Committee of Kasturba Hospital, Manipal - IEC number: 923/2016) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Statement of Author's contributions

All authors have made substantive contribution to this study and/or manuscript, and all have reviewed the study prior to its submission.

- Siddiq H conceived the idea, conducted the study, literature search and wrote the initial draft of the manuscript.
- Pentapati K mentored this study and making of study design, performed data analysis and helped in the preparation of final draft of the manuscript.
- Acharya S co-mentored and co-orientated the conduction of the work and final review of the manuscript.

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Declaration of competing interest

The authors declare that they have no conflict of interest.

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