A Pilot Study of Dental Students' Esthetic Perceptions of Computer-generated Mild Dental Fluorosis Compared to Other Conditions

Carrie B. McKnight, DDS; Steven M. Levy, DDS, MPH; Stephanie E. Cooper, BA, BS, DDS; Jane R. Jakobsen, MA; John J. Warren, DDS, MS

Abstract

Objectives: *Few studies have considered people's opinions about the esthetics of dental fluorosis. Assessments of fluorosis esthetics can be confounded by differences in a number of clinical factors, including tooth shape, color, contour, and gingival status. This pilot study compared esthetic perceptions of mild fluorosis and other conditions using computer-generated images made from a base set of normal appearing teeth.* ***Methods:*** *Entering dental students (n=61) completed questionnaires about four sets of paired photographs. Three sets consisted of fluorotic teeth (very mild to mild) versus other conditions (diastema, isolated enamel opacity, "normal"/control) and the other pair compared two presentations of mild fluorosis (generalized versus limited to incisal one-third). Six questions, both qualitative and quantitative, were asked about each pair of photographs.* ***Results:*** *Mild fluorosis was assessed less favorably than normal/control, midline diastema was less favorable than mild fluorosis, and mild fluorosis was less favorable than isolated opacity.* ***Conclusions:*** *This approach allows fluorosis to be better compared with other oral conditions because the images are standardized. Additional research with this method is warranted, including more variations in conditions, more comparisons, and other study populations. [J Public Health Dent 1999;59(1):18-23]*

Key Words: dental fluorosis, esthetic perceptions, computer-generated, dental students.

Fluoride in the forms of community water fluoridation, fluoridated dentrifices, topical fluorides and dietary fluoride supplements has contributed greatly to the overall decline in caries in many industrialized nations. At the same time, there has been a trend of increasing dental fluorosis prevalence and severity, both in fluoridated and nonfluoridated communities of North America (1-3). The 1986–87 NIDR national children's survey (4,5) showed, using Dean's Fluorosis Index (6), that more than 20 percent of US schoolchildren 7 years of age and older had dental fluorosis, with 76 percent of those cases being mild. Current estimates are that some 50,000 (1.3%) US schoolchildren have moderate to severe fluorosis (3). Dental professionals are aware of the potential for fluorosis to develop as a result of excessive fluoride intake early in life. Researchers may believe that mild fluorosis is not a public health problem, and health professionals probably do not often perceive it to be a public health concern. While even mild cases may cause esthetic concerns, relatively little is known about people's perceptions of the esthetics of dental fluorosis. The accepted indices measure the extent or severity of dental fluorosis, but none determine the esthetic impact of this condition.

Only a few studies (7-15) have attempted to assess people's perceptions of dental fluorosis esthetics, with the majority being conducted outside the United States. They are limited by the possibility of confounding effects of factors other than those of interest, including varying tooth size, color and shape, gingival appearance, and other characteristics. A review of most of these studies has been presented elsewhere (13); however, to summarize, these studies generally reported that respondents could distinguish varying levels of fluorosis, from mild to moderate to severe, with higher levels of fluorosis perceived as more objectionable.

One published paper reported in part on dental students' esthetic perceptions of dental fluorosis (7). Riordan used three groups in his study—students, parents, and dentists. The "student" category was a combined group of 37 nutrition students, 28 first-year preclinical dental students, and 17 nondental administrative staff. Because chi-square analyses showed no statistically significant differences among responses across these subgroups, dental students were not reported separately from those of the other two subgroups in the "student" category. From a conversational distance, observers examined children's teeth and then completed a questionnaire designed to gather opinions on the esthetics of the teeth and the effects the degrees of fluorosis have on children. All groups showed increased concern for appearances as TF fluorosis score (16) increased. For example, 77.3 percent of students agreed or agreed strongly that the appearance of the teeth was pleasing and looked nice at TF=0. However, at TF=3, the percentage of students

Send correspondence and reprint requests to Dr. Levy, Department of Preventive and Community Dentistry, College of Dentistry, University of Iowa, Iowa City, IA 52242. E-mail: steven-levy@uiowa.edu. Drs. McKnight, Warren, and Ms. Jakobsen are all affiliated with the College of Dentistry, University of Iowa. Dr. Cooper is in private practice. Web site: http://vh.radiology.uiowa.edu/beyond/dentistry/prevent.html. Supported in part by US Public Health Service, National Institute of Dental Research grants P30-DE10126 and RO1-DE09551, and the University of Iowa Dental Research Assistantship Program. An earlier version of this paper was presented at the International Association for Dental Research's annual meeting in March 1997. Manuscript received: 9/9/98; returned to authors for revision: 11/5/98; accepted for publication: 2/22/99.

agreeing or agreeing strongly was 22.9 percent. Also, many felt a higher TF score (e.g., TF=3) would be a source of embarrassment for a child. Unlike dentists, more severe fluorosis was seen by lay examiners as a sign of neglect on the families' part.

A published abstract reports on our previous study of entering dental students (14). Seventy of 73 incoming dental students were gathered in a lecture hall during orientation in August 1995 where they viewed pairs of slides and answered questions about esthetic perceptions. Three pairings of clinical photographs that had been used in our previous study of lay people (13) were used: mild fluorosis versus rotation, moderate fluorosis versus tetracycline staining, and severe fluorosis versus isolated opacities. Slides were selected in part based upon similarity of characteristics such as color, shape, and contours of teeth and soft tissues. Where necessary, slides were enlarged and cropped to achieve similar presentation of the six maxillary anterior teeth and associated mandibular teeth. Results with incoming dental students were generally similar to those from our earlier study of lay subjects (13). Respondents not only generally perceived the fluorotic teeth less favorably than the teeth with other conditions (i.e., rotation, isolated opacity, or tetracycline staining), but also could apparently distinguish among degrees of fluorosis as evidenced by respondents perceiving severe fluorosis less favorably than either mild or moderate fluorosis.

Studies generally have not evaluated perceptions of fluorosis when compared with perceptions of other dental conditions, and have been confounded by tooth, gingival appearance, and other factors. The purpose of this pilot study was to assess perceptions of esthetics of mild dental fluorosis versus other conditions among dental students, prior to their beginning dental training, using simulated, computer-generated, standardized images.

Methods

Incoming freshman dental students at the University of Iowa College of Dentistry were recruited as participants during their orientation in August of 1996. Students were gathered in a lecture hall, where a coauthor read through a standardized, rehearsed, written script explaining that she was looking for volunteers to participate in a research project about dental esthetics, and explaining instructions for participation. Informed consent forms approved by the institutional review board were distributed and volunteers read and signed written consent forms. Participation was strictly voluntary, and all students received unique identification numbers unknown to all researchers of this project and collegiate faculty to enable comparison with possible future responses later in dental training. Participation required roughly 25 minutes to view slides and answer questions about them.

The first page of the questionnaire concerned demographics (sex, age, and whether or not the student had any children). Subsequent pages pertained to paired photographs or images that were projected onto two large side-by-side screens at the front of the auditorium. Students were instructed to keep the first four rows vacant to help prevent them from seeing the images too closely. After full instructions were read aloud by the coauthor, three minutes were allowed to answer the six written questions that applied to each pair of projected images.

Images for this study were paired based on what the investigators perceived would elicit somewhat similar esthetic responses; no formal pretesting was done. Four pairs of images were used in this study. However, in contrast to our previous studies (13,14), the images presented were not actual clinical photographs, but rather computer-generated images simulating actual clinical photographs. These images were used in the hope of better controlling for things like differences in tooth size, shape, and color; gingival color, shape, consistency; and arch alignment and occlusion. The images were prepared by scanning an "ideal" clinical photograph into a Macintosh 660 AV computer and altering it using the Adobe Photoshop™ computer program. Various presentations of mild fluorosis and other oral conditions were created on the teeth from the "ideal" set of teeth. The images were reviewed by faculty dentists familiar with dental fluorosis and compared to clinical photos of fluorosis, then modified several more times to make the computer-generated images look more realistic. We considered all our simulated fluorosis cases to be "mild" because they involved only white color changes (opacity), whereas moderate fluorosis typically involves orange/brown staining and severe fluorosis involves pitting (6,16).

The following pairings of photographs were used: control/normal (Photograph A) versus mild fluorosis (Photograph B); mild fluorosis (Photograph C) versus diastema (no fluorosis) (Photograph D); prominent isolated opacity (Photograph E) versus slightly more involved, mild fluorosis (Photograph F); and mild fluorosis limited to the incisal third of the teeth (Photograph G) versus more generalized, mild fluorosis (Photograph H).

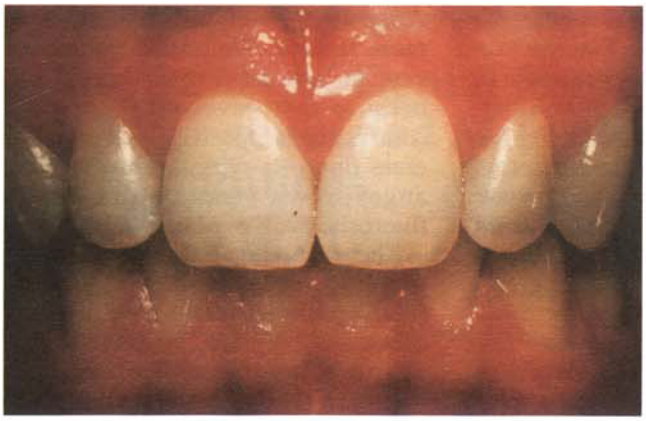
Raters were asked to respond to six different statements relating to dental esthetics, all used in our previous study (13). One question was based on the concept of the Social Acceptability Scale of Occlusal Conditions (17) and its earlier adaptation for use in another fluoride esthetics study by Clark (8). For both substudies, a 69 mm visual analog scale was used with pairs of semantically chosen opposite words in an attempt to discern possible subtle differences in meaning and interpretation for each of the images (13).

The questionnaire data were reviewed, entered, and verified. Frequency distributions, means, and standard deviations were determined for the questionnaire responses. Statistical analyses using paired *T*-tests were performed with SAS (18) to compare results within pairs for the interval level variables (questions 3 and 6). Statistical tests were not performed on the categorical variables due to limited cell sizes. Significance levels of $P<.05$ were considered statistically significant.

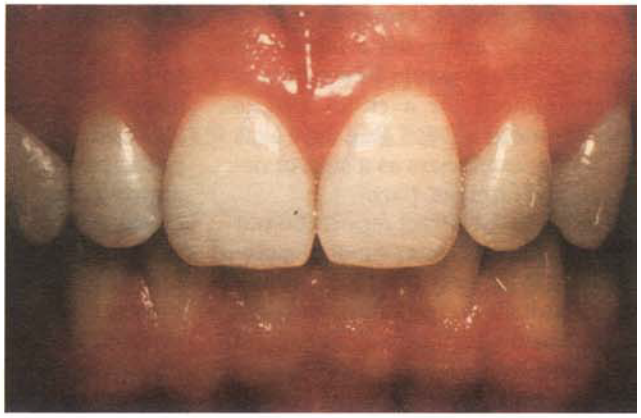
Results

All students attending the portion of the orientation during which the study was conducted, or 61 of 75 first-year students, agreed to participate. The majority of respondents were male (62%) and were 20–24 years of age (73% vs 27% aged 25+). Seventeen percent reported having children.

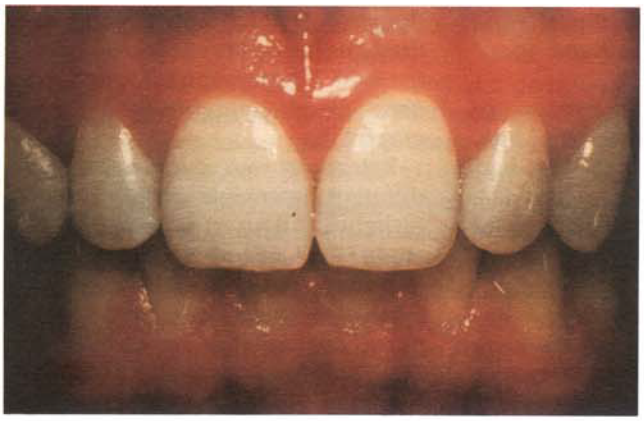
Question #1 asked, "Which of these looks better?" Responses were: pair 1, A (normal/control)=54 percent, B (mild fluorosis)=46 percent; pair 2, C



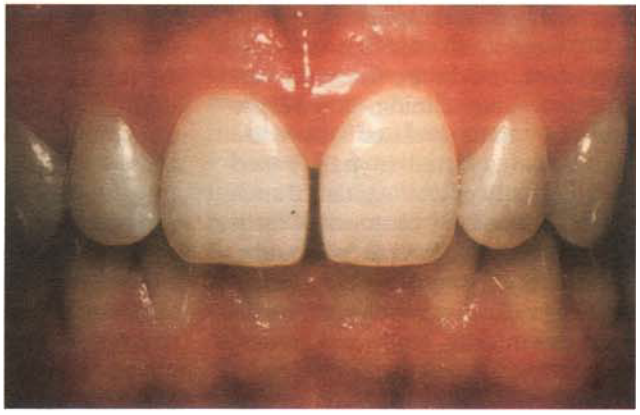
PAIR 1, Photograph A: normal=control



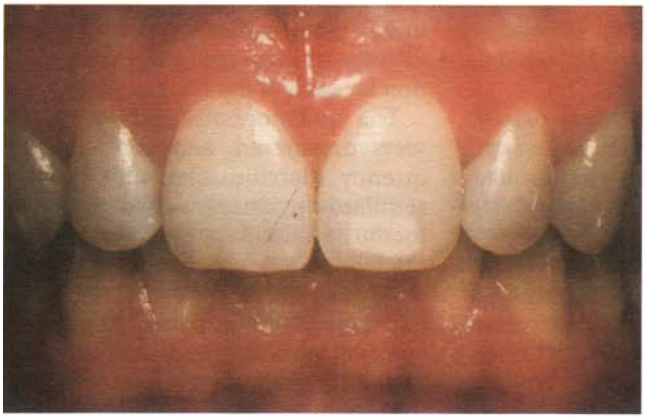
Photograph B: mild dental fluorosis



PAIR 2, Photograph C: mild dental fluorosis



Photograph D: diastema (no fluorosis)



PAIR 3, Photograph E: isolated opacity

Photograph F: more involved, mild dental fluorosis

PAIR 4, Photograph G: incisal third only, mild dental fluorosis

Photograph H: more generalized, mild dental fluorosis

(mild fluorosis)=80 percent, D (diastema, no fluorosis)=20 percent; pair 3, E (isolated opacity)=64 percent, F (more involved, mild fluorosis)=36 percent; pair 4, G (incisal third only, mild fluorosis)=36 percent, H (more generalized, mild fluorosis)=64 percent.

Table 1 shows results for "If either of these people were advertising or selling toothpaste, how likely would you be to purchase it?" Responses did not tend to consistently favor fluorotic or nonfluorotic teeth.

Table 2 shows how pleased or embarrassed respondents reported they would be with the appearance of the teeth if the teeth were their own. Answers were based on a scale from 1 to 10, with 1 being very pleased and 10 being very embarrassed at the appearance of the teeth. In pairs 1 and 3, the fluorotic teeth scored less favorably, in pair 4 the mild, generalized fluorosis scored less favorably, and in pair 2 the diastema scored less favorably than the mild fluorosis. Differences were statistically significant for 3 of the 4 pairs.

Table 3 refers to the question, "If these teeth were your own, how often would you smile with your teeth showing?" In pairs 2, 3, and 4, for photographs C, E, and G, respondents were more likely to smile.

Question #5 asked, "If these teeth were your own, would you get professional dental treatment to change their appearance?" Responses of "Yes" were: pair 1, A=25 percent, B=46 percent; pair 2, C=39 percent, D=82 percent; pair 3, E=82 percent, F=89 percent; pair 4, G=85 percent, H=82 percent. The only images where a majority would not choose to seek professional care to change the appearance were the normal and the two mildest presentations of fluorosis.

Table 4 summarizes results of question #6, asking respondents to assess the color of the teeth by marking a point along a line from good to bad and a line from satisfactory to unsatisfactory (visual analog scales). Responses were measured in millimeters, based on a 69 mm visual analog scale (low score is positive). Responses with both scales were similar. The fluorotic teeth generally scored less favorably than their nonfluorotic counterparts, except in pair 2, where the diastema scored less favorably. In pair 4, the mild, generalized fluorosis scored less favorably than the mild, incisal third only fluorosis.

Statistically significant differences were found in Tables 2 and 4, with results generally showing similar trends in Tables 1 and 3. However, chi-square statistical analyses were not conducted (with Tables 1 and 3) due to the relatively small sample sizes for the 16 cells that would be part of each such analysis.

TABLE 1
Question 2: If Either of These People Were Advertising or Selling Toothpaste, How Likely Would You Be to Purchase It? (not at all likely=1, somewhat likely=2, very likely=3, definitely would=4)

		How Likely (%)			
Pair	Photograph	1	2	3	4
1	A (normal=control)	23	61	13	3
	B (mild fluorosis)	38	41	18	3
2	C (mild fluorosis)	20	59	21	0
	D (diastema/no fluorosis)	36	48	15	2
3	E (isolated opacity)	57	33	8	2
	F (more involved, mild fluorosis)	67	30	3	0
4	G (incisal third only, mild fluorosis)	64	34	2	0
	H (more generalized, mild fluorosis)	62	38	0	0

TABLE 2
Question 3: Rate Each Picture on a Scale of 1 to 10, with 1 Being Very Pleased with Appearance of Teeth and 10 Being Very Embarrassed by their Appearance

		Rating (%)					
Pair	Photograph	1–2	3–4	5–6	7–8	9–10	Mean (SD)
1*	A (normal=control)	8.2	59.0	24.6	4.9	3.3	4.30 (1.72)
	B (mild fluorosis)	9.8	37.7	31.2	16.4	4.9	4.85 (2.02)
2*	C (mild fluorosis)	11.5	39.3	37.7	9.9	1.6	4.57 (1.71)
	D (diastema/no fluorosis)	1.6	14.8	37.7	37.7	8.2	6.20 (2.16)
3*	E (isolated opacity)	4.9	9.9	29.5	36.0	19.7	6.52 (2.16)
	F (more involved, mild fluorosis)	0	4.9	32.8	39.3	23.0	7.11 (1.87)
4	G (incisal third only, mild fluorosis)	0	4.9	32.8	39.3	23.0	6.64 (1.84)
	H (more generalized, mild fluorosis)	0	11.5	34.4	37.7	16.4	6.72 (1.81)

*$P<.05$, paired T-test.

Discussion

With the exception of the diastema and mild fluorosis comparison, results revealed that respondents generally found the fluorotic teeth less esthetic. A majority would seek professional dental treatment to change the appearance of the teeth; however, no costs of treatment were considered with this decision, and if faced with time, economics, and costs of treatment, respondents may have deferred treatment. This response also may reflect overall positive attitudes toward dentistry and esthetic demands of incoming dental students.

Just as in our earlier study of dental students (14), respondents had es-

thetic concerns about many of the photographs and fluorosis generally was viewed less favorably. No other studies are available with which comparisons can be made among such a range of patterns of results for mild fluorosis versus the other selected conditions. Results, however, are in agreement with the one other study that assessed perceptions of fluorosis and isolated opacities, showing that both may be concerns (11).

The respondents for this pilot study consisted of entering freshman dental students at a single dental school prior to dental training and subsequent sensitization to faculty biases. Although a

TABLE 3
Question 4: If These Teeth Were Your Own, How Often Would You Smile With Your Teeth Showing? (never=1, very little=2, sometimes=3, often=4)

		How Often (%)			
Pair	Photograph	Never	Little	Some	Often
1	A (normal=control)	0	7	22	61
	B (mild fluorosis)	2	13	31	44
2	C (mild fluorosis)	0	12	46	43
	D (diastema/no fluorosis)	7	31	36	26
3	E (isolated opacity)	8	51	25	16
	F (more involved, mild fluorosis)	16	46	25	13
4	G (incisal third only, mild fluorosis)	7	41	36	16
	H (more generalized,mild fluorosis)	8	46	31	15

TABLE 4A
Question 6: For Each Picture, Assess Appearance of Teeth Using the Visual Analog Scale from Good to Bad (%) (0–69 mm)

		Visual Analog Scale Score*							
Pair	Photograph	0–9	10–19	20–29	30–39	40–49	50–59	60–69	Mean (SD)
1†	A (normal=control)	24	42	20	9	3	0	2	17.56 (11.67)
	B (mild fluorosis)	19	31	17	16	9	5	3	23.81 (15.86)
2†	C (mild fluorosis)	20	31	20	19	9	0	2	22.00 (13.38)
	D (diastema/no fluorosis)	5	21	21	22	24	5	2	30.43 (14.78)
3†	E (isolated opacity)	5	20	13	17	17	17	12	36.30 (17.37)
	F (more involved, mild fluorosis)	0	7	17	17	28	12	20	42.82 (15.70)
4	G (incisal third only, mild fluorosis)	2	15	17	23	15	17	12	37.05 (16.50)
	H (more generalized, mild fluorosis)	2	12	22	20	17	13	15	38.22 (16.60)

*Low=good, high=bad.
†$P<.05$, paired T-test.

TABLE 4B
Question 6: For Each Picture, Assess Appearance of Teeth Using the Visual Analog Scale from Satisfactory to Unsatisfactory (%) (0–69 mm)

		Visual Analog Scale Score*							
Pair	Photograph	0–9	10–19	20–29	30–39	40–49	50–59	60–69	Mean (SD)
1	A (normal=control)	25	48	14	7	3	2	2	16.86 (12.43)
	B (mild fluorosis)	20	19	29	17	5	7	3	24.64 (16.15)
2	C (mild fluorosis)	21	28	26	14	7	4	2	22.43 (13.78)
	D (diastema/no fluorosis)	5	15	20	25	22	9	3	32.22 (15.17)
3	E (isolated opacity)	7	12	10	23	18	15	15	38.17 (18.04)
	F (more involved, mild fluorosis)	0	7	8	27	25	13	20	43.87 (15.19)
4	G (incisal third only, mild fluorosis)	2	8	27	22	15	15	12	37.62 (15.96)
	H (more generalized, mild fluorosis)	2	8	18	22	22	15	13	39.90 (16.12)

*Low=satisfactory, high=unsatisfactory.
†$P<.05$, paired T-test.

few studies have shown that lay and professional raters score esthetics in generally similar ways (7), responses of dental students may not fully represent those of other dental schools' students, the general lay public, or of other groups.

Several limitations should be considered in interpreting study results. Although from our previous study (14) we knew the time generally necessary for completing the questionnaire, and all the dental students successfully answered the questions during the allotted time, there is always the possibility that fatigue or "learning" after a certain point during the questionnaire administration influenced respondents' views. Also, the order effect of the pairings could have influenced observer perceptions. In addition, respondents' possible "experience" with the conditions was not assessed. Respondents who have had the conditions themselves or have children with the conditions may have responded differently than someone who had never before seen the condition(s). No data were collected on respondents' socioeconomic status, caries experience, dental fluorosis, or other esthetic problems.

Computer-generated images were used to reduce confounding from extraneous factors such as varying tooth size, shape, and color; gingival color, texture, and contour; and midline discrepancies and rotations. These images helped the respondents to focus only on the appearance of the teeth, thus giving greater validity of responses than in previous studies. The images appeared fairly natural to lay viewers; however, because they were artificially created, deviation from the natural appearance of photographs was unavoidable. Experienced dentists, dental hygienists, and fluorosis researchers may have known the images were artificial, but the entering dental students reported them to look realistic. Specifically, the projected images presented more regular white striations (opacities) than typically are seen clinically with fluorosis. This appearance was due to the technical and time limitations inherent in preparing the images in time to conduct the study during student orientation. Also, only after the study was completed did we notice that the contrast between normal and "fluorosed" portions of the canine region was greater than planned. This occurred because the level of whiteness of the opacity was held constant from incisor to canine, while the canine is darker than the incisors both naturally and on the photographs. It is difficult to predict the effects of these patterns. However, they were somewhat less noticeable as projected slide images due to unavoidable distortion on projection and magnification compared to their appearance in the actual photographs in this article.

The results of this study are generally consistent with those from the other less controlled studies in finding that fluorosis esthetics can be a concern. Thus, esthetic perceptions should continue to be studied to allow the public's preferences to be better considered in development of oral health care policies.

Future research could assess a larger, more representative population or study other groups, such as other lay, dental, and health professional groups. The use of balanced or controlled pairing using larger, factorial designs should be considered. Also, additional images could be created to include such conditions as off-midline diastemas, peg laterals, and malocclusions, as well as moderate and severe dental fluorosis. Computer-generated images would appear to provide a means for improved validity of such comparisons.

Such research would allow improved study of perceptions of children, adults, dentists, and other health professionals (13). Results would allow decisions about recommended fluoride levels to be based not solely on dental health leaders' perceptions and assumptions (13), but also on data concerning the broader population groups' esthetic perceptions.

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