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Aesthetic perceptions and social judgments about different enamel opacities

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Abstract: This study aimed to evaluate adolescents' aesthetic perceptions and their social judgments regarding different enamel opacities. Sample size was calculated and resulted in the inclusion of 100 adolescents (aged 10 to 15 years) from a public school in Jequié, Bahia, Brazil. Images of enamel opacities were manipulated to create aesthetic enamel defects, such as enamel color changes (unilateral and bilateral white opacity, unilateral and bilateral yellowish opacity, and unilateral and bilateral yellowish opacity with loss of structure). The images of the opacities were based on Fédération Dentaire Internationale's Developmental Defects of Enamel (DDE) Index. Aesthetic perception and social judgments were evaluated using a validated questionnaire with 12 questions (six positive and six negative points) on social aspects, considering the six manipulated images and the control. The photographic analyses were projected one-by-one by computer to adolescents individually in a classroom. Participants had one minute to observe each image and answer the questionnaire. The data were analyzed by descriptions, and the Friedman Wilcoxon test ($p < 0.05$). The results indicate that all opacities negatively impacted social judgment ($p < 0.001$). The enamel aesthetic defects most affecting an individual's perception were bilateral yellow opacity with or without loss of structure ($p < 0.001$). Regarding social judgment, all participants showed a negative perception of all the tested opacity types ($p < 0.001$). In conclusion, even opacities presenting only a color change caused aesthetic dissatisfaction to the individuals and changes in their social judgment toward others. Color changes in dental enamel have several aesthetic consequences.

Keywords: Child; Esthetics; Dental Enamel Hypoplasia.

Introduction

Over the years, aesthetic demands have increased mainly in relation to aspects of the smile,[1] and especially to the presence of developmental defects of enamel (DDE).[2,3] These have been defined as qualitative or quantitative defects that occur during the phases of amelogenesis.[3] The most prevalent DDEs are hypomineralization followed by hypoplasia.[3] The prevalence of these conditions varies considerably and ranges from 6.7% to 67.1%.[4,5,6] In relation to etiology, DDEs are associated with prenatal and postnatal aspects (disturbances during pregnancy,

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severe infections and frequent use of antibiotics in childhood)[7,8] and genetic mutations in genes responsible for enamel formation.[9]

One of the main characteristics of DDE is discoloration, which may vary from white/yellowish to brown.[3,10] Another aspect is the loss of tooth structure. This leads to sensitivity and aesthetic problems for the individual, which may affect quality of life.[10,11] Recent studies have shown interest in knowing not only the opinion of the individual about his physical appearance, but also his social judgment of others' appearance.[12,13] The social judgment theory applies to the analysis of interpersonal conflicts caused by cognitive differences between individuals.[14] Sometimes, we are judged by our physical looks, including weight, height and dentofacial esthetics.[2] Physical appearance may influence how people feel about themselves, and may impact how they are judged by others, especially in adolescent groups that are undergoing physiological and physical changes.[15]

Malocclusions, dental traumas and dental enamel disturbances may be judged negatively not just by the individual who has them, but also and even more by others.[16,17] Enamel defects have been widely discussed, mainly in terms of color and loss of structure. These defects may affect an individual's social life and self-esteem.[18] It is important to understand how the impact of dental defects can influence a patient's life, since this information serves to draft public health policies that can prioritize treatment and improve the individual's self-esteem. Thus, the aim of this study was to evaluate adolescents' aesthetic perceptions and their social judgments regarding different enamel opacities.

Methodology

Ethical aspects and sample

This study was approved by the local ethics committee under number 0154.0.454.000-11. All subjects/caregivers read and signed a written informed consent form before participating in the study.

The sample size was calculated using G * Power (Version 3.1.9.2, Germany). The analysis of variance of repeated measures considered the following parameters: effect size f = 0.25 (mean effect size), $\alpha = 0.05$, power = 0.80, and number of measurements = 7 (control, unilateral white opacity, bilateral white opacity, unilateral yellow opacity, bilateral yellow opacity, unilateral yellow opacity with loss of structure, and bilateral yellow opacity with loss of structure). Pearson's correlation coefficient among repeated measures was 0.20, and nonsphericity correction, 0.25. The minimum sample was estimated at 83 individuals. Considering the 15% required for the statistical tests, the minimum sample size was 95 individuals for the present study. Our study used a final sample of 100 individuals, considering possible use of questionnaires, albeit possibly missing some type of information.

The inclusion criteria were adolescents, boys and girls, ranging in age from 10 to 15 years, regularly enrolled in the public school selected for the study. Individuals who did not have a written informed consent to participate in the study were excluded. The final sample comprised 100 adolescents between 10 and 15 years old, of both sexes, and from a public school of Jequié City, Bahia, Brazil. The participants were invited to answer a questionnaire about their perceptions and judgments regarding different enamel opacities.

Image selection

A total of 12 images, six from each individual (boy and girl) were manipulated based on healthy enamel to create the effect of enamel color change (ECC). The adolescents (boys and girls) were selected according their age. A boy and a girl at 12.5 ± 1.2 years (mean age of the individuals included in the present study – 10 to 15 years old) and the image modification were selected according to DDEs, based on the Fédération Dentaire Internationale's recommended index.[3] Demarcated opacity without any loss of structure was considered mild, whereas opacities with loss of structure were considered severe cases.

In addition, an image without any enamel alteration was used as a control for all the images. The photographs of the boy and the girl were manipulated to eliminate any malocclusion, and simulate satisfactory aesthetic occlusion. After this step, localized color changes were made to simulate different opacities.[3] All image alterations were made

using a software program (Photoshop, CS3, Adobe Systems, San Jose, CA), and the color changes were made only on a central incisor tooth. The modified photographic analyses were designed individually for the adolescents. The images selected were those of unilateral white opacity (Figures 1A, 2A), bilateral white opacity (Figures 1B, 2B) unilateral yellowish opacity (Figures 1C, 2C), bilateral yellowish opacity (Figures 1D, 2D), unilateral yellowish opacity with loss of structure (Figures 1E, 2E), and bilateral yellow opacity with loss of structure (Figures 1F, 2F). Lifesize images were shown, as if the person was there, in a 42", high-resolution monitor. The images were analyzed at an average distance of 50 cm, simulating a casual conversation. The adolescents were given one minute to observe each image and to answer the questions. During their analyses, the adolescents could not use a magnifying glass or any other tool that could modify the design.[16] The adolescents were also not allowed to return to previous images to make comparisons or alter their initial responses.[16]

Questionnaire

A perception survey was carried out using a questionnaire for individuals between 10 and 15 years old.[16] This instrument was composed of 12 questions (Table 1) that identified the perceptions of different dental consequences and their influence on social judgments (positive or negative).[16]

The responses were presented in the form of multiple-choice options, each question having four optional answers: the positive characteristics (questions 1 to 6) were coded as "certainly yes" = 3 points, "maybe yes" = 2 points, "maybe not" = 1 point, and "certainly not" = 0 points; the negative characteristics (questions 7 to 12) had inverted negative scores for "certainly yes" = -3 points, "maybe yes" = -2 points, "maybe not" = -1 point, and "certainly not" = 0 points.[16] The scale gradations ranged from the worst condition (0) to the best possible condition (18) for positive characteristics, and in inverse order for negative characteristics, -18 was the worst, and 0 was the best[16]. The total score could range from 0 to

Figure 1. Opacity in the boy: A) Unilateral white opacity; B) Bilateral white opacity; C) Unilateral yellowish opacity; D) Bilateral yellowish opacity; E) Unilateral yellowish opacity + Enamel with loss of structure; F) Bilateral yellowish opacity + Enamel with loss of structure.

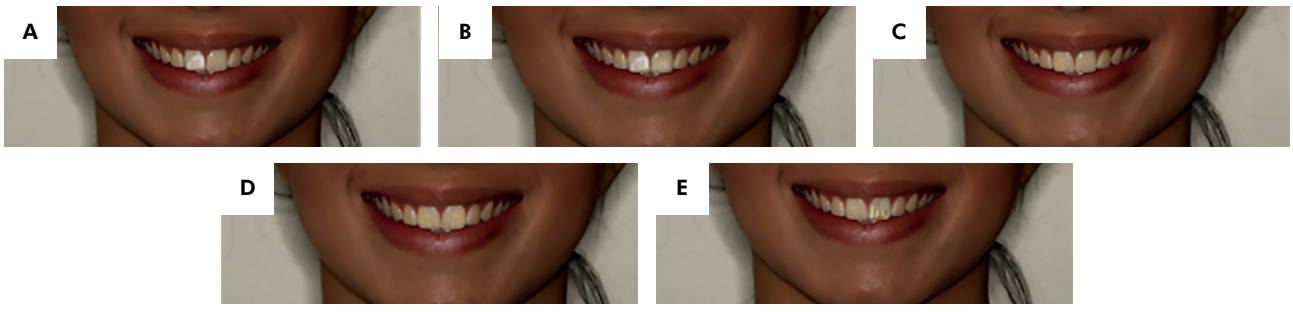

Figure 2. Opacity in the boy: A) Unilateral white opacity; B) Bilateral white opacity; C) Unilateral yellowish opacity; D) Bilateral yellowish opacity; E) Unilateral yellowish opacity + Enamel with loss of structure; F) Bilateral yellowish opacity + Enamel with loss of structure.

Table 1. Analysis of floor and ceiling effects of social judgment scale.

Factor	Floor (%)	Ceiling (%)
Positive social characteristics		
Control	0.0	20.0
Unilateral white opacity	0.0	0.0
Bilateral white opacity	0.0	0.0
Unilateral yellowish opacity	0.0	0.0
Bilateral yellowish opacity	0.0	0.0
Unilateral yellowish opacity + *LS	0.0	0.0
Bilateral yellowish opacity +*LS	0.0	0.0
Negative social characteristics		
Control	0.0	0.0
Unilateral white opacity	0.0	0.0
Bilateral white opacity	0.0	0.0
Unilateral yellowish opacity	0.0	0.0
Bilateral yellowish opacity	0.0	0.0
Unilateral yellowish opacity +*LS	0.0	0.0
Bilateral yellowish opacity + *LS	0.0	0.0
Social judgment score		
Control	0.0	0.0
Unilateral white opacity	0.0	0.0
Bilateral white opacity	0.0	0.0
Unilateral yellowish opacity	0.0	0.0
Bilateral yellowish opacity	0.0	0.0
Unilateral yellowish opacity +*LS	0.0	0.0
Bilateral yellowish opacity +*LS	0.0	0.0

18 points for positive characteristics, and from 0 to -18 for negative characteristics.[16]

Validation of the questionnaire

Before the questionnaire was applied, it was validated, based on a previous study.[16] The validation process was carried out at two different times, with an interval of 20 days between the two applications. A total of 15 children and adolescents between 10 and 15 years of age participated in this stage. These groups were not included in the final sample.

Statistical analysis

Acceptability of the instrument was investigated by applying floor and ceiling effects and by analyzing the frequency of responses to each item. The floor effect occurs when more than 15% of the answers are concentrated on the minimum value, and the ceiling effect occurs at the maximum value of the scales. The construct validity was based on the discriminant validity determined by comparing the control image with the images of the different types of dental enamel opacities using the Friedman test, with comparisons between the pairs tested.[19]

Regarding reliability assessment, the diversity scale considered Cronbach's alpha values ≥ 0.7, with tolerance for values slightly below this cut-off point. Regarding temporal stability, ICC values > 0.70 indicated acceptable reproducibility.[20]

The data were analyzed using BioEstat statistical software version 5.0 (Belém, PA, Brazil). Descriptive statistics were performed to express the results as means, medians, standard deviations, interquartile amplitudes, and minimum and maximum values. The effect of dental opacity on perception and social judgment (positive/negative) was evaluated using the Friedman test (with comparisons between pairs made by the Wilcoxon test) at a significance level of 5% ($\alpha = 0.05$).

Results

Questionnaire validation process

Floor and ceiling effects

All of the 12 questions in the questionnaire showed a 100% response rate in both the test and the retest, thus indicating high acceptability of the instrument. Although the floor effect was not applied, the ceiling effect was observed for the control image only when positive characteristics were evaluated (Table 1).

Discriminant construct validity

Discriminant construct validity showed that there was a significant difference ($p < 0.05$) between the control image and all the types of dental enamel opacities (Table 2).

Test-retest

Satisfactory indexes of agreement were found between the test and the retest results, as evidenced by the intraclass correlation coefficients (Table 3).

Main study results

A total of 100 adolescents between 10 and 15 years old, of both sexes (50 boys and 50 girls) were included in the study, for an average age of 12.5 ± 1.2.

Table 2. Analysis of the Discriminant Construct Validity of the social judgment scale.

Type of enamel opacity	Positive social characteristics	Negative Social characteristics	Social judgment score
Control	15.0 ± 4.0	-4.0 ± 3.0	11.0 ± 4.0
Unilateral white opacity	11.5 ± 2.5***	-9.0 ± 2.5***	2.0 ± 3.0***
Bilateral White opacity	7.0 ± 6.0***	-14.0 ± 6.0***	-5.0 ± 7.0***
Unilateral yellowish opacity	12.5 ± 5.2***	-12.0 ± 2.0***	-0.5 ± 4.8***
Bilateral yellowish opacity	7.0 ± 6.0***	-15.0 ± 3.0***	-5.0 ± 6.0***
Unilateral yellowish opacity + *LS	10.0 ± 3.0***	-11.0 ± 1.5***	-0.5 ± 4.5***
Bilateral Yellowish opacity + *LS	7.0 ± 6.0***	-14.0 ± 0.0***	-7.0 ± 6.0***
**p-valor	< 0.001	< 0.001	< 0.001

*LS Loss of structure; **Friedman's test; ***indicates significant difference in relation to the control image (Wilcoxon test).

Table 3. Internal consistency measures of the social judgment scale in adolescents.

Factor	Number of items	Cronbach's alpha*
Positive social characteristics		
Control		0.9
Unilateral white opacity		0.9
Bilateral white opacity		0.9
Unilateral yellowish opacity	6	0.9
Bilateral yellowish opacity		0.9
Unilateral yellowish opacity +LS*		0.9
Bilateral yellowish opacity + LS*		0.8
Negative social characteristics		
Control		0.9
Unilateral white opacity		0.9
Bilateral white opacity		0.9
Unilateral yellowish opacity	6	0.6
Bilateral yellowish opacity		0.8
Unilateral yellowish opacity +LS*		0.7
Bilateral yellowish opacity + LS*		0.7
Social judgment score		
Control		0.9
Unilateral white opacity		0.9
Bilateral white opacity		0.6
Unilateral yellowish opacity	12	0.6
Bilateral yellowish opacity		0.7
Unilateral yellowish opacity +LS*		0.5
Bilateral yellowish opacity+ LS*		0.5

LS* Loss of structure

Table 4 shows the mean positive social judgment scores according to the individual's perception of the different enamel opacities. Observe that the enamel opacity factor had an effect on all positive characteristics evaluated ($p < 0.001$). These results indicate that all the opacities negatively influenced the judgment of the positive characteristics evaluated, compared to the control ($p < 0.001$). In general, when the unilateral white opacity was at issue, the total scores for the positive characteristic had the lowest reduction ($p < 0.001$), whereas the yellow opacity with loss of tooth structure had the highest reduction in the general score ($p < 0.001$).

Table 5 shows the mean scores of the negative social judgments for the enamel opacities. Observe that the enamel opacity factor had an effect on all the negative characteristics evaluated ($p < 0.001$). The results indicate that all the opacities worsened the judgment of the negative characteristics. Bilateral yellowish opacity with or without loss of structure had the greatest impact on this score.

Figure 3 shows the social judgments for the different types of opacities. The results indicate that all the opacities had a negative influence on the participants' perceptions ($p < 0.001$). Unilateral white opacity had the least negative impact on perception, whereas unilateral yellowish opacity and bilateral yellowish opacity with or without loss of structure had the most negative impact.

Figure 4 shows the beauty score ($p < 0.001$). The opacity that negatively affected aesthetic perception the most was bilateral yellowish opacity with or without loss of structure.

Discussion

The literature has shown an increase in the number of individuals with DDE in the last 10 years, together with major consequences to aesthetic perception.

Table 4. Scores (mean ± standard deviation and median ± interquartile range) for positive social judgment according to the individual's perception of enamel opacities.

Characteristics	Enamel Opacities							p-valor*
	Control	Unilateral white opacity	Bilateral white opacity	Unilateral yellowish opacity	Bilateral yellowish opacity	Unilateral yellowish opacity +ELS**	Bilateral yellowish opacity + ELS**	
Do you find this boy/girl funny?	2.52 ± 0.54^{a}	2.05 ± 0.59^{b}	1.80 ± 0.73^{cd}	1.95 ± 0.59^{bc}	1.65 ± 0.70^{d}	1.85 ± 0.53^{bcd}	1.55 ± 0.70^{d}	< 0.001
Do you find this boy/girl happy?	2.45 ± 0.54^{a}	1.95 ± 0.58^{b}	1.72 ± 0.70^{bc}	1.87 ± 0.57^{bc}	1.64 ± 0.64^{c}	1.77 ± 0.60^{bc}	1.55 ± 0.61^{c}	< 0.001
Do you find that this boy/or girl has many friends?	2.50 ± 0.54^{a}	2.03 ± 0.58^{b}	1.78 ± 0.71^{bcd}	1.91 ± 0.64^{bc}	1.67 ± 0.67^{cd}	1.82 ± 0.65^{bcd}	1.56 ± 0.61^{d}	< 0.001
Would you like this boy/girl to be your friend?	2.54 ± 0.54^{a}	2.07 ± 0.59^{b}	1.83 ± 0.71^{bc}	1.96 ± 0.58^{bc}	1.71 ± 0.72^{c}	1.86 ± 0.62^{bc}	1.62 ± 0.69^{c}	< 0.001
Do you think this boy/girl is intelligent?	2.48 ± 0.54^{a}	2.01 ± 0.57^{b}	1.76 ± 0.70^{bcd}	1.90 ± 0.60^{bc}	1.65 ± 0.66^{cd}	1.79 ± 0.61^{bcd}	1.55 ± 0.76^{d}	< 0.001
Do you think this boy/girl is handsome?	2.48 ± 0.54^{a}	2.01 ± 0.59^{b}	1.76 ± 0.68^{bcd}	1.91 ± 0.61^{bc}	1.61 ± 0.65^{cd}	1.80 ± 0.66^{bcd}	1.48 ± 0.72^{d}	< 0.001
Total GSC	14.97 ± 3.00^{a}	12.11 ± 3.28^{b}	10.65 ± 4.06^{ce}	11.49 ± 2.99^{c}	9.93 ± 3.35^{d}	10.88 ± 2.82^{e}	9.31 ± 3.02^{f}	< 0.001

GSC: good social characteristics; *Friedman test (different a, b, c, d, e, f letters in rows indicate statistical difference in opacity change according to the Wilcoxon test); **ELS: Enamel with loss of structure.

Table 5. Scores (mean ± standard deviation and median ± interquartile range) for negative social judgment according to the individual's perception of enamel opacities.

Characteristics	Enamel Opacities							p-valor*
	Control	Unilateral white opacity	Bilateral white opacity	Unilateral yellowish opacity	Bilateral Yellowish opacity	Unilateral yellowish opacity +ELS**	Bilateral yellowish opacity + ELS**	
Do you think this boy/girl is ashamed?	-0.83 ± 0.60^{a}	-1.40 ± 0.64^{b}	-2.00 ± 0.62^{c}	-1.73 ± 0.68^{b}	-2.15 ± 0.63^{c}	-1.75 ± 0.71^{b}	-2.24 ± 0.57^{c}	< 0.001
Do you think this boy/girl likes to be alone?	-0.77 ± 0.57^{a}	-1.27 ± 0.49^{b}	-1.85 ± 0.67^{c}	-1.38 ± 0.49^{bd}	-1.72 ± 0.75^{cd}	-1.27 ± 0.49^{b}	-1.85 ± 0.67^{c}	< 0.001
Do you think this boy/girl could start fights?	-0.80 ± 0.57^{a}	-1.68 ± 0.64^{b}	-1.96 ± 0.68^{bc}	-1.98 ± 0.65^{bc}	-2.15 ± 0.85^{c}	-2.06 ± 0.76^{bc}	-2.22 ± 0.76^{c}	< 0.001
Do you think that classmates of this boy/girl put nicknames on him/her?	-0.82 ± 0.56^{a}	-1.72 ± 0.68^{b}	-2.02 ± 0.70^{bc}	-2.12 ± 0.67^{c}	-2.25 ± 0.83^{c}	-2.20 ± 0.71^{c}	-2.31 ± 0.75^{c}	< 0.001
Do you think this boy/girl should be ashamed to smile?	-0.79 ± 0.56^{a}	-2.08 ± 0.52^{b}	-2.49 ± 0.67^{cd}	-2.48 ± 0.63^{cd}	-2.61 ± 0.70^{cd}	-2.37 ± 0.66^{bd}	-2.72 ± 0.59^{c}	< 0.001
Do you think this boy/girl needs to look for a dentist?	-0.51 ± 0.52^{a}	-2.47 ± 0.42^{b}	-2.62 ± 0.57^{bcd}	-2.62 ± 0.58^{bc}	-2.81 ± 0.49^{cd}	-2.77 ± 0.45^{cd}	-2.91 ± 0.35^{d}	< 0.001
Total ***BSC	-4.52 ± 2.83^{a}	-10.60 ± 2.74^{b}	-12.94 ± 2.97^{c}	-12.30 ± 2.31^{ce}	-13.69 ± 2.90^{df}	-12.40 ± 2.24^{e}	-14.25 ± 2.28^{f}	< 0.001

*Friedman test (different a, b, c, d, e, f letters in rows indicate statistical difference in opacity change according to the Wilcoxon test); **ELS: Enamel with loss of structure. ***BSC: Bad social characteristics

This perception toward dental enamel may have a significant impact on the physical, social, and psychological well-being of individuals, and may also affect their families.[21,22]

A white smile is highly valued in society, especially in the age group of adolescents and young adults. In the present study, all the enamel opacities were found to have a negative impact on the perception of

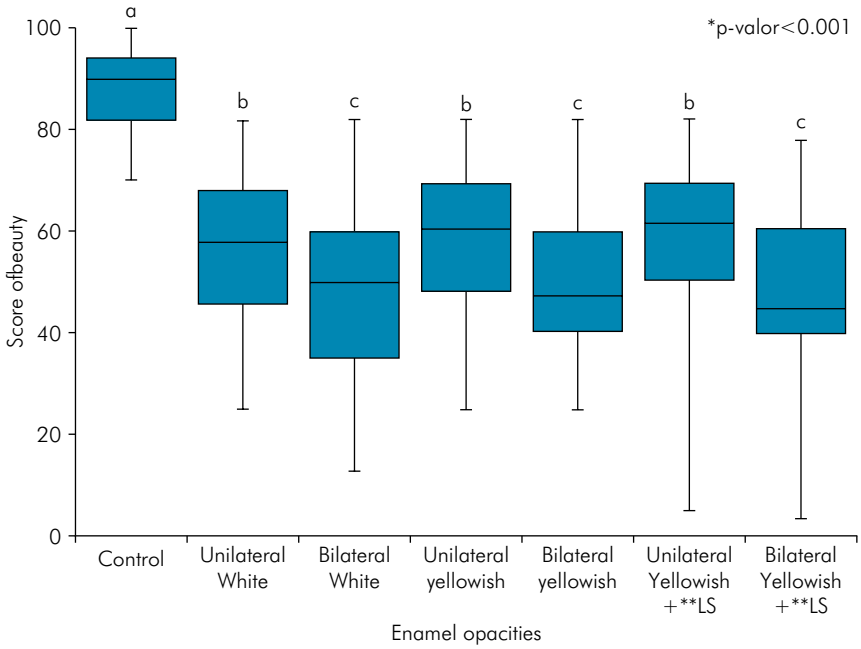

Figure 3. Social judgment score according to the enamel opacities. Rectangle height represents quartiles 1 and 3; line cutting the rectangle represents the median; the semi-quarters connect quartiles 1 and 3 to the minimum and maximum values. *Friedman test (different a, b, c, d, e, f letters in rows indicate the statistical difference in opacity change according to the Wilcoxon test); **Opacities with loss of structure

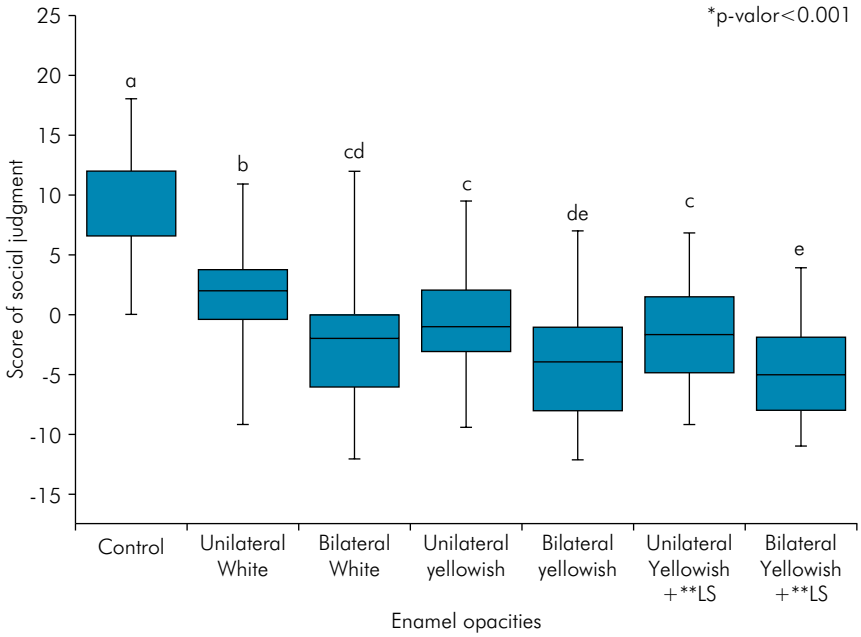

Figure 4. Beauty score according to enamel opacities. Rectangle height represents quartiles 1 and 3; the line that cuts the rectangle represents the median; the semi-quarters connect quartiles 1 and 3 to the minimum and maximum values. *Friedman test (different a, b, c, d, e, f letters in rows indicate the statistical difference in opacity change according to the Wilcoxon test); **Opacities with loss of structure.

the adolescents, and influenced their negative social judgments. This result corroborates those of other studies using similar methodologies. It shows that adolescents have a harsh perception of appearance and

may make value judgments about other people, based on aesthetic imperfections related to stained teeth.[2,20,23]

Adolescence is a transitional stage of physical, psychological and social interaction and human development. The perceptions of others can influence the way a person acts, and can even result in long-term developmental changes.[20] The number of individuals who fall victim to bullying or prejudgment regarding their appearance has been rising.[24] Children and adolescents affected by bullying or any type of prejudgment due to physical traits may become adults with low self-esteem, have relationship problems, and/or have a high chance of exhibiting aggressive behavior.[24]

Tooth color plays a crucial role in social development. Furthermore, it is perceived as critical in regard to satisfaction with one's smile appearance. The noticeable discoloration of teeth can have a detrimental impact on a person's physical attractiveness, self-image, and self-confidence. Studies of individuals with DDE are important to understand how much this affects people's perceptions.[13,25,26] Most studies corroborate that DDE causes loss of tooth structure, resulting not only in aesthetic but also functional problems (sensitivity and dental caries)[18] for the individual, to the point of affecting quality of life. It is very important that professionals understand how very dissatisfied patients are with enamel defects, in addition to how these individuals are seen by other people.

In addition, it is important that DDE be diagnosed correctly to guide dentists toward developing the most appropriate treatment, considering that one of the great difficulties encountered is the treatment choice for teeth affected by DDE. The following factors should be borne in mind before indicating the treatment: the stage of eruption, the affected tooth, the severity of the DDE and the patient's age.[23] Most treatments have functional complications,[23] and aesthetic restorations have posed a great challenge to dentists trying to repair enamel defects in the anterior teeth. This is because it is difficult to choose the best restorative treatment for areas with opacity. In the present study, the authors showed readers that there was a negative perception of an opacity, even if it was white. This means that dentists should hear out a patient, even though there may be no indication of a functional restorative treatment that will ensure aesthetic satisfaction.

Among the limitations facing the authors of this study was the use of images to portray social judgment, a practice that can be seen as artificial. In real life, people make judgments about other aspects, such as hair color, height, facial expressions and even voice. However, the images used eliminated any oral condition (dental caries, malocclusion), and focused solely on opacities, thus excluding any bias at the time of perception. Another limitation is that the applied questionnaire did not include sociodemographic characteristics, given that the children's response to these factors would not be reliable. Previous studies reported that aspects related to the skin color and face of individuals influenced social judgment and attractiveness.[27,28,29] The lack of these aspects could be considered a limitation of the present study, since facial characteristics were not related, and standard clear skin was pictured. The authors of the present study encourage future studies to assess these aspects, and the influence of sociodemographic differences on different dental changes.

This study demonstrates that adolescents know that enamel defects and even opacities without loss of structure negatively affect the perception of individuals. The authors suggest that other studies be undertaken to determine the aesthetic perceptions of patients with DDE at different ages and with different socioeconomic conditions. Future studies should also address the actual need for aesthetic treatment in patients with DDE affecting incisors without a loss of structure. Studies on aesthetic appearance are important to evaluate the real need for treatment, especially in young patients whose aesthetic demands are high.

Conclusion

Summary defects in tooth enamel may negatively affect an individual's social life. In this study, even opacities without any structural loss were found to negatively affect an individual's perception. Yellowish opacities with loss of tooth structure had a very negative influence on an individual's perception and social judgment.

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