Scientific Research Report

Self-Perception of Teeth Alignment and Colour in Adolescents: A Cross-sectional Study

Larissa Viana de Oliveira [1], *Paulo Roberto Grafitti Colussi* [2], *Carla Cioato Piardi* [3], *Cassiano Kuchenbecker Rösing* [3], *Francisco Wilker Mustafa Gomes Muniz* [1*]

[1] *Federal University of Pelotas, Pelotas, Rio Grande do Sul, Brazil*
[2] *University of Passo Fundo, Passo Fundo, Rio Grande do Sul, Brazil*
[3] *Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil*

ARTICLE INFO

Article history:
Received 18 January 2021
Received in revised form
23 March 2021
Accepted 4 April 2021
Available online 25 May 2021

Key words:
Adolescents
Dental aesthetic
Life quality
Tooth discolouration
smoking

ABSTRACT

Objective: This study aimed to evaluate the prevalence and factors associated with self-perception of teeth alignment and colour in adolescents.

Methods: This cross-sectional study was carried out in public and private schools in Passo Fundo, Brazil. A representative sample of students aged 15 to 19 years were included. The outcome of this study was self-perception of teeth alignment and colour according to selected items from a structured and validated questionnaire (the Child's and Parent's Questionnaire about Teeth Appearance). Bivariate and multivariable analysis, using Poisson regression with robust variance, were used. A *P* value <.05 was established for statistical significance.

Results: The study included 736 adolescents. The worst self-perception of teeth alignment and colour was observed in 46.5% (n = 342) of the adolescents. Nonsmokers presented a prevalence ratio (PR) 29% lower (95% CI, 0.57-0.89) for the worst self-perception of teeth alignment and colour when compared to smokers/former smokers. Adolescents with highly educated mothers presented a lower prevalence of negative self-perception than those with mothers with a low level of education (PR: 0.66; 95% CI, 0.51-0.86). Presence of orthodontic treatment with (PR: 0.76; 95% CI, 0.62-0.94) or without (PR: 0.61; 95% CI, 0.46-0.76) tooth whitening were associated with better self-perception of teeth alignment and colour.

Conclusions: Exposure to smoking and lower maternal level of education were associated with worse self-perception of teeth alignment and colour in adolescents. A history of orthodontic treatment with or without tooth whitening was associated with a lower concern with aesthetics.

Introduction

The face has important aesthetic significance, and dental appearance is considered a significant component. In this sense, self-perception of aesthetics is related to the way that individuals see themselves and are seen by others.[1] The perception of a smile may change after orthodontic treatment, as the literature has reported that adolescents may experience improvement in quality of life[2] and reduced concern with oral health[3] after undergoing this type of treatment. In addition, a greater concern with smile aesthetics is related to worse oral health–related quality of life[2] and a greater need for dental treatment.[4] In addition, the literature shows that teeth alignment and colour are important characteristics in a smile, especially when considering confidence in smiling[5] and smile attractiveness.[6] A study conducted amongst adolescents also showed that 18% of them reported dissatisfaction with the colour of their teeth.[7]

It has also been reported that level of education, lifestyle, and family economic situation can directly affect the oral health conditions of individuals.[8] More specifically, a lower prevalence of tooth loss has been detected amongst these individuals, but tooth loss levels approximately double with increasing age.[9] The latter issue is mainly due to caries,

* *Corresponding author*. Rua Gonçalves Chaves, 457, Pelotas, Rio Grande do Sul, Brazil.
E-mail address: wilkermustafa@gmail.com (F.W.M.G. Muniz).

https://doi.org/10.1016/j.identj.2021.04.001

followed by trauma and extractions scheduled for orthodontic purposes.[9,10] In contrast, periodontitis has a low prevalence amongst adolescents.[9] Additionally, a considerable part of the Brazilian population has difficulty in accessing dental care services, and adolescents constitute a significant portion of this population.[11]

Adolescence is a period of life marked by constant changes and represents one of the most important stages of human development. This is a critical phase that often involves extreme behaviours, ranging from periods of extreme excitement to apathy, extending to areas such as negligence with health care.[12] During this period of transition between childhood and adulthood, adolescents experience an increase in social interaction, the desire for popularity, and physical changes. This time may bring a person's first significant relationships outside the family structure. Therefore, it is natural for adolescents to build their aesthetic ideals based on cultural stereotypes and their own expectations, which result from their social experiences.[13]

Despite this knowledge of smile characteristics, the literature is scarce in demonstrating what variables are associated with non-aesthetic dental improvements amongst adolescents. Therefore, the present study aimed to assess the association between self-perception of teeth alignment and colour with demographic, behavioural, medical, and dental history factors in high school adolescents in a city in South Brazil. The hypothesis of this study is that history of orthodontic treatment and tooth whitening are associated with better self-perception of teeth alignment and colour amongst adolescents.

Methods

Study design and location

This study was a representative cross-sectional study carried out in both private and public schools in Passo Fundo, Brazil. Passo Fundo is a city located in the state of Rio Grande do Sul, 300 km from Porto Alegre, the state capital. The city has a population of 184,826 inhabitants, according to the last census.[14] The Municipal Human Development Index in 2010 was 0.776.[14] Across all 23 schools in the city, 7558 students were enrolled in 2012. Of these schools, 16 were public (82.78%) and 7 were private (17.22%). A representative sample of adolescents regularly enrolled in high school and aged between 15 and 19 years was included in the present study.

Ethical considerations

This study was reviewed and approved by the local ethics committee under protocol #016/2014. In addition, formal consent from the Seventh Education Department in the city of Passo Fundo was obtained prior to conducting the study in all of the schools. The study was also authorized by the dean of each school. All students received an informed consent form that needed to be signed by their parents or guardians. If they were absent on the first day of data collection, a second contact was made before the adolescent was excluded. In addition, each adolescent signed an informed consent form to participate in the study.

Sample

All of the schools in the city, public and private, were required to participate in the study. Of these student populations, 30% of the students from each school who agreed to be part of the study were invited to participate. The sample was randomly chosen, using a list of all adolescents from the participating schools. Further details of the sampling strategy can be found elsewhere.[15] In order to be included in the study, adolescents should be between 15 to 19 years and regularly enrolled in a high school. No exclusion criteria were adopted.

The sample size calculation of the present study was based on the prevalence of adolescents' satisfaction with the aesthetics of their teeth (17.79%) as reported in a previous study.[16] Assuming a precision of 5%, a CI of 99%, and an attrition rate of 15%, a total number of 729 adolescents was deemed necessary.

Clinical examinations and interviews

A structured questionnaire was used, which included demographic data and socioeconomic and behavioural status. In addition, a set of questions from the Primary Care Assessment Tool Brasil (PCATool-SB), an instrument validated for adults in Brazil, was used.[17] Other variables were added to this questionnaire, such as history of orthodontic treatment and oral hygiene habits.

Between April and June 2012, selected adolescents were examined and interviewed by trained researchers. Regarding the oral examination, all teeth present, except third molars, were counted. Wooden spatulas were used during oral examinations under natural light. Teeth that could be restored were considered present. Roots and teeth indicated for extraction were considered absent.

Training for data collection was conducted with theoretical lectures on the theme and explanations about each item of the questionnaire. The time interval between theoretical and practical calibration was 14 days. Training for the dental exam was conducted by dental students in adolescents not included in the final sample of the present study. This examination was verified by the study coordinator. Seventy-three adolescents were randomly selected to participate in the calibration, and adolescents were examined twice with 7 days between examinations. An agreement of 98% (inter-examiner κ index = 0.96) was observed, which was considered to have adequate reproducibility for the number of teeth present.

Independent variables

The following independent variables were considered: sex, type of school, age, adolescent occupation, skin colour, mother's level of education, money to pay for medical expenses, smoking exposure, toothbrushing frequency, history of tooth whitening, history of orthodontic treatment, and number of missing teeth. The Direct Acyclic Graph (Figure) graphically expresses the theoretical construct of the present study, since the included variables could be predictors of satisfaction/dissatisfaction with teeth alignment and colour. Table S1 shows the applied question along with response options.

Both male and female participants were considered. For type of school, adolescents were divided into public or private

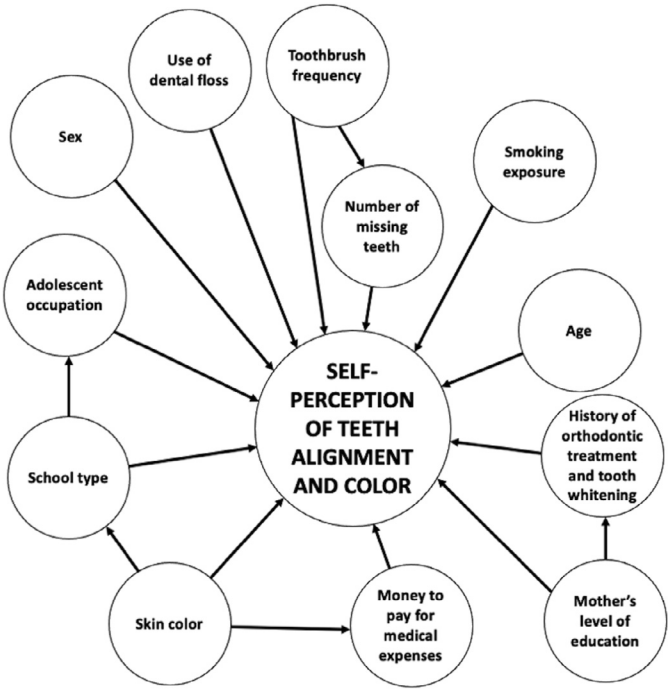

Figure – Direct Acyclic Graph of all independent variables (sociodemographic, habits, and medical history) and the possible association with the outcome.

schools. Age was considered as a continuous variable. Occupations of students were divided into two groups: those who only study and those who study and work at least one shift. Skin colour was classified as white, black, yellow, brown, and indigenous. The mothers' levels of education were divided into three groups: a group with complete or incomplete higher education (high level of education), another with complete or incomplete high school (middle level of education), and a third with completed elementary school or with lower schooling (low level of education).

Having money for medical expenses was dichotomized as yes or no. Smoking exposure was divided into two categories: those who had never been smokers and those who were former or current smokers. Self-reported daily toothbrushing frequency was classified into three groups: those who brushed more than 3 times, those who brushed 3 times, and those who brushed fewer than 3 times. Use of dental floss was dichotomized as yes or no. Number of teeth present was reported in a continuous fashion.

Adolescents who were undergoing orthodontic treatment at the time of the examination and those who reported having previously received such treatment were categorized as having a history of orthodontic treatment. Regarding tooth whitening, previous or current whitening were considered to constitute a history of tooth whitening. Both treatments performed in-office and at home were considered. Using these data, the following combinations of variables were listed: (1) those without a history of tooth whitening and without orthodontic treatment, (2) those with a history of tooth whitening and orthodontic treatment, (3) those with a history of only tooth whitening, and (4) those with a history of only orthodontic treatment.

Outcome definition

For the present study, the main outcome was self-perception of teeth alignment and colour, using two questions from a previously validated questionnaire (the Child's and Parent's Questionnaire about Teeth Appearance).[18] The following questions were used: "Are my teeth very aligned, slightly aligned, neither aligned nor crooked, slightly crooked, or very crooked?" and "Are my teeth very white, slightly white, neither white nor stained, slightly stained, or very stained?" These questions were used because the literature has shown great significance for teeth alignment and colour when considering smile characteristics, especially confidence to smile[5] and smile attractiveness.[6] The questions were the only ones that assessed these smile characteristics.

For the first question, those who answered "very aligned," "slightly aligned," or "neither aligned nor crooked" were categorized as having self-perception of aligned teeth. Adolescents who answered "slightly crooked" or "very crooked" were included in the group who considered their teeth not aligned. Regarding the second question, adolescents who answered "very white," "slightly white," and "neither white nor stained" were classified as having white teeth. In contrast, a self-report of stained teeth was attributed to those who responded that their teeth were "slightly stained" or "very stained." The sample was dichotomized into two groups according to a combination of these responses: a group who considered their teeth aligned and white and another group formed by those individuals who reported unaligned and/or stained teeth.

When considering both the collected variables and the defined outcome, the overall Cronbach's alpha was 0.640. When the variable tooth colour was excluded, the Cronbach's

alpha detected was 0.687. In addition, when the variable of teeth alignment was removed, the Cronbach's alpha was 0.609.

Statistical analysis

The dependent variable of the study was self-perception of an aesthetic smile. The SPSS statistical package (version 21.0, SPSS Inc.) was used for data analysis. Chi-square and Fisher's exact tests evaluated the association between the dependent and independent variables. Multivariable analyses were performed using Poisson regression with robust variance to confirm the association between dependent and independent variables. To be included in the initial multivariable model, the independent variable had to have a value of $P < .20$ in the bivariate analysis. History of tooth whitening and orthodontic treatment were included in the final multivariable model, regardless of the *P* value detected in the bivariate analysis. To build the final multivariable model, a backward elimination strategy was performed, excluding one independent variable at each time. The independent variable with the highest *P* value was excluded until the lowest Bayesian information criterion was achieved. The Wald test ascertained the overall fit of the predictors. Therefore, the final multivariable model was formed by a combination of $P < .05$ and changes in goodness of fit. Both significant and nonsignificant independent variables could be included in the final multivariable model. In addition, multicollinearity analyses were performed using the following cutoffs: inflation factor <5 and tolerance >0.2.

Results

A sample of 736 adolescents was included in this study. In total, 620 (84.2%) of these adolescents studied at public schools, and 511 (69.4%) of them reported being white. Mean age (± SD) was 16.14 (±1.03) years. Regarding the outcome of the present study, it was observed that 53.5% (n = 394) of the individuals reported having aligned and white teeth. In contrast, 175 (23.8%) reported having their teeth not aligned and white, 81 (11.0%) reported having teeth not aligned and stained, and 86 (11.7%) of them reported teeth aligned and stained. There was no missing data.

Regarding history of orthodontic treatment, 424 (57.6%), 241 (32.7%) were undergoing such treatment at the time of data collection. Teeth whitening was reported by 41.2% (n = 303). However, only 138 (45.5%) had received this treatment under professional supervision. All other adolescents used only specialized toothpaste for teeth whitening.

Table 1 demonstrates that 165 (41.9%) of males reported having aligned and white teeth. Amongst females, 229 (58.1%) reported having the best self-perception of alignment and colour. When comparing males and females, no statistically

Table 1 – Demographic and dental characteristics according to self-perception of teeth alignment and colour in school adolescents.

Variable	n (%) or mean ± SD	Aligned and white (n = 394; 53.5%)	Not aligned and/or stained (n = 342; 46.5%)	*P* value
Sex	Male	165 (41.9)	158 (46.2)	.239*
	Female	229 (58.1)	184 (53.8)	
School type	Public	312 (79.2)	308 (90.1)	<.001*
	Private	82 (20.8)	34 (9.9)	
Age	In years	16.09 ± 0.956	16.20 ± 1.10	.256#
Adolescent occupation	Study and work	125 (31.7)	127 (37.1)	.123*
	Only study	269 (68.3)	215 (62.9)	
Skin colour	White	297 (75.4)	214 (62.6)	<.001*
	Black	17 (4.3)	29 (8.5)	
	Yellow	2 (0.5)	16 (4.7)	
	Brown	75 (19.0)	76 (22.2)	
	Indigenous	3 (0.8)	7 (2.0)	
Mother's level of education	Low	142 (36.0)	165 (48.2)	<.001*
	Medium	138 (35.0)	127 (37.1)	
	High	114 (28.9)	50 (14.6)	
Money to pay for medical expenses	No	321 (81.5)	260 (76.0)	.071*
	Yes	73 (18.5)	82 (24.0)	
Smoking exposure	Smokers/former smokers	12 (3.0)	31 (9.1)	.001*
	Never smoker	382 (97.0)	311 (90.9)	
Toothbrushing frequency	<3 times a day	106 (26.9)	80 (23.4)	.006*
	3 times a day	242 (61.4)	193 (56.4)	
	>3 times a day	46 (11.7)	69 (20.2)	
Use of dental floss	No	168 (42.6)	178 (52.0)	.011*
	Yes	226 (57.4)	164 (48.0)	
Number of missing teeth		27.58 ± 1.00	27.58 ± 0.94	.567#
History of orthodontic treatment and tooth whitening	No whitening and no orthodontic treatment	76 (19.3)	117 (34.2)	<.001*
	Both treatments	108 (27.4)	76 (22.2)	
	Teeth whitening only	51 (12.9)	68 (19.9)	
	Orthodontic treatment only	159 (40.4)	81 (23.7)	

* Chi-square test;
\# Mann-Whitney test.

significant association was detected for self-perception of teeth alignment and colour ($P = .239$). Similarly, the following variables were not significantly associated with self-perception of teeth alignment and colour: age, adolescent occupation, tooth whitening, and number of missing teeth ($P > .05$). In contrast, type of school ($P < .001$), skin colour ($P < .001$), mother's level of education ($P < .001$), smoking exposure ($P = .001$), toothbrushing frequency ($P = .006$), and history of orthodontic treatment and teeth whitening ($P < .001$) were significantly associated with self-perception of teeth alignment and colour.

Table 2 shows the bivariate analysis for the association between self-perception of teeth alignment and colour and the independent variables. Regarding skin colour, black, yellow and indigenous adolescents presented, respectively, a 51%, 112%, and 67% higher prevalence ratio (PR) for having the worst self-perception of teeth alignment and colour compared to white adolescents. Students from private schools had a 41% lower PR than public school students (95% CI, 0.44-0.79) regarding a poor self-perception of teeth alignment and colour. In relation to the mothers' levels of education, the lowest level of education had a significantly higher PR than adolescents with mothers with high levels of education (PR: 1.76; 95% CI, 1.37-2.27). Additionally, significant associations were found with smoking exposure, toothbrushing frequency, use of dental floss, history of orthodontic treatment, and tooth whitening. All of these variables were included in the initial multivariable model. Age, adolescent occupation, and money to pay for medical expenses were included in the model as well.

Results of the multivariable analysis of the association between self-perception of teeth alignment and colour and independent variables are provided in Table 3. Nonsmokers had a PR of 0.71 (95% CI, 0.57-0.89) in comparison with current smokers/former smokers to report the worst self-perception of teeth alignment and colour ($P = .002$). Adolescents with mothers with high levels of education were 34% less likely to present worse aesthetic self-perception when compared with adolescents who had mothers with low levels of education. In addition, no associations were found for toothbrushing frequency. A history of orthodontic treatment with (PR: 0.76; 95% CI, 0.62-0.94) or without (PR: 0.61; 95% CI, 0.46-0.76) teeth whitening was associated with lower self-perception of teeth alignment and colour. Those who reported a history of only tooth whitening did not show a significant association with the outcome in comparison to those without both treatments ($P = .676$).

Discussion

The present study observed that certain independent variables had significant associations with self-perception of teeth alignment and colour in adolescents. These variables were as follows: exposure to smoking, maternal lower level of education, and history of orthodontic treatment and tooth

Table 2 – Bivariate analysis of the association between the worst self-perception of teeth alignment and colour and sociodemographic variables and medical and dental history in school adolescents.

Variable		Prevalence ratio (95% CI)	*P* value
Sex	Male	Ref.	.237
	Female	0.91 (0.78-1.06)	
School type	Public	Ref.	<.001
	Private	0.59 (0.44-0.79)	
Age		1.06 (0.99-1.10)	.122
Adolescent occupation	Study and work	Ref.	.117
	Only study	0.88 (0.75-1.03)	
Skin colour	White	Ref.	
	Black	1.50 (1.18-1.92)	.001
	Yellow	2.12 (1.75-2.57)	<.001
	Brown	1.20 (0.99-1.45)	.056
	Indigenous	1.67 (1.10-2.54)	.016
Mother's level of education	Low	Ref.	
	Medium	0.89 (0.76-1.05)	.168
	High	0.57 (0.44-0.73)	<.001
Money to pay for medical expenses	No	Ref.	.059
	Yes	0.85 (0.71-1.01)	
Smoking exposure	Smokers/former smokers	Ref.	<.001
	Never smoker	0.62 (0.51-0.76)	
Toothbrushing frequency	<3 times a day	Ref.	
	>3 times a day	0.74 (0.62-0.89)	.001
	3 times a day	0.72 (0.57-0.90)	.003
Use of dental floss	No	Ref.	.011
	Yes	0.82 (0.70-0.96)	
Number of teeth present		1.00 (0.92-1.08)	.993
History of orthodontic treatment and tooth whitening	No whitening and no orthodontic treatment	Ref.	
	Both treatments	0.68 (0.55-0.83)	<.001
	Teeth whitening only	0.94 (0.78-1.14)	.548
	Orthodontic treatment only	0.56 (0.45-0.69)	<.001

Poisson regression with robust variance was used for all analyses.

Table 3 – Final model for the multivariable analysis of the association between worst self-perception of teeth alignment and colour and sociodemographic variables and medical and dental history in school adolescents.

Variable		Prevalence ratio (95% CI)	*P* value
Smoking exposure	Smokers/former smokers	Ref.	.002
	Never smoker	0.71 (0.57-0.89)	
Mother's level of education	Low	Ref.	
	Medium	0.97 (0.83-1.15)	.751
	High	0.66 (0.51-0.86)	.002
Toothbrushing frequency	<3 times a day	Ref.	
	3 times a day	1.00 (0.83-1.22)	.968
	>3 times a day	1.24 (0.99-1.56)	.061
History of orthodontic treatment and tooth whitening	No whitening and no orthodontic treatment	Ref.	
	Both treatments	0.76 (0.62-0.94)	.010
	Teeth whitening only	0.96 (0.79-1.17)	.676
	Orthodontic treatment only	0.61 (0.59-0.76)	<.001

Poisson regression with robust variance was used for all analyses.

whitening. On a related note, dental alignment and not tooth colour has been related to confidence in one's smile amongst adults.[5] However, individuals with yellow teeth are considered less attractive when compared with those who have white teeth.[6] This at least partially explains concerns with aesthetics in both adolescents and the population as a whole, justifying the need for studies on self-perception of teeth alignment and colour. For this purpose, the outcome of the present study was assessed using a questionnaire translated and validated for a Brazilian sample.[18]

When one is speaking, attention is usually directed to speaker's mouth and eyes. Therefore, one's smile can be considered an important part of the face, not only during social interaction but also in light of its correlation with self-acceptance and self-confidence.[19] In the present study, 46.5% of the adolescents reported that their teeth were not aligned and/or were stained. Because tooth colouring affects people's appearance, those with discoloured teeth may experience dissatisfaction, concern, shame in smiling, more negative self-perceptions, and potential negative impacts on quality of life. In this sense, the study of self-perception of teeth alignment and colour is of importance, as it has already been demonstrated that the aesthetics of one's smile can change the perception of that person's character. Furthermore, such aesthetics can affect the judgments made by future employers when evaluating a candidate for a position.[20] In addition, this study reported that appearance of the mouth and teeth are essential elements in aesthetic assessment, both professionally and societally, and that teeth appearance is one of the first factors noticed by others. Therefore, it is speculated that less attractive aesthetic traits could lead to social exclusion, bullying, or lack of self-acceptance when an individual does not meet the requirements imposed by society.

Smoking is a risk factor for several health outcomes. Regarding oral health, it is associated with mucosal lesions, oral cancer, and periodontitis. However, for aesthetic purposes, the most striking aspect is tooth staining.[21] The literature has reported that the prevalence of tooth pigmentation is doubled in smokers when compared with nonsmokers.[21] The present study demonstrated that those who have never been smokers have a 29% lower PR of having worse self-perception of teeth alignment and colour than do smokers or former smokers. When examining these findings, it was concluded that staining, caused by smoking exposure, is linked to the greatest aesthetic concern of adolescents. Additionally, it has been suggested that colour has a strong relationship with dental appearance, and this was supported here by the high level of dissatisfaction with slightly stained teeth.[20]. It may be hypothesized that there is an aesthetic ideal of an exaggeratedly white and aligned smile. In the pursuit of this ideal, there has been a significant increase in demand for aesthetic dental services.[19]

The present study demonstrated that adolescents of mothers with high levels of education presented a lower PR of having the self-perception of misaligned and/or stained teeth when compared with those who had mothers with a low level of education. It has been shown that higher rates of history of orthodontic treatment have also been detected in adolescents with highly educated mothers.[3] This may be linked to the higher level of education of these mothers but also to the expenses associated with orthodontic treatment. In Brazil, the public health system does not provide this treatment on a large scale, so this demand is met by the private oral care system. For this reason, less wealthy social classes have reduced access to this type of treatment. It is known that a mother's level of education may act as a proxy for family income.[22] In this sense, it is well established that the population lgroup with the lowest socioeconomic status occupies a disadvantaged position, with poor oral health compared with higher classes.[23]

One of the aims of orthodontic treatment is to achieve correct occlusion and, as much as possible, more aligned teeth, along with an aesthetically pleasing smile.[24] Despite these results being a secondary objective of orthodontic treatment, relevant literature has reported that the main motivation for this type of treatment is to improve the appearance of teeth and that improving oral function is not necessarily the priority.[25] Moreover, adolescents who showed concern for oral health had a lower PR for history of orthodontic treatment.[3] The present study demonstrated that orthodontic treatment, with or without teeth whitening, was associated with higher self-perception of teeth alignment and colour. Orthodontic treatment was also related to an improvement in aesthetic

perception, which was associated with a higher quality of life.[2]

The smile plays an important role in showing emotions, such as sympathy and enjoyment. Colour, position, tooth shape, and size are all important factors in producing an attractive smile, along with lip size and shape and the amount of visible gum. However, it has been reported that only smile height and dental position have significant associations with confidence when smiling.[5] These findings may partially explain why a history of orthodontic treatment, with or without teeth whitening, was associated with better aesthetic self-perception of one's smile. Notably, the majority of adolescents included in the present study had performed teeth whitening procedures without the supervision of a dentist. According to the literature, when comparing in-office and home-based teeth whitening, home-based treatments display higher cost-effectiveness.[26] Furthermore, this dental procedure has a positive effect on quality of life, increasing one's likelihood of smiling and laughing without feeling ashamed.[27]

Other dental variables, such as frequency of toothbrushing and tooth loss, were not associated with self-perception of teeth alignment and colour in adolescents. Prevalence of dental caries in adolescents has been shown to be as high as 88.9%, and this can be considered one of the major causes of tooth loss, leading to 0.6% to 14.4% of permanent tooth loss.[9] In addition, the socioeconomic condition of an individual can affect tooth loss, as noted in developed countries.[9] Another factor to be considered is extractions scheduled for orthodontic reasons. Overall, tooth loss is more strongly associated with these factors than with aesthetics itself, so no significant association between these variables was found in this study. The first molar is the most frequently lost tooth, since it is the first permanent tooth to erupt.[10] It has been demonstrated that 65.1% of adolescents brush their teeth 2 or more times each day.[28] Thus, one may hypothesize that the frequency of toothbrushing is not directly related to the quality of one's oral hygiene.[29]

The present study involved trained and calibrated examiners, and the outcomes were assessed using a validated questionnaire. However, only teeth alignment and colour were used to define the outcomes, which did not represent the entire component of aesthetic characteristics of a smile. Other limitations should be noted: this is a cross-sectional study, so it was not possible to assign temporality between the dependent and independent variables. Therefore, the findings presented herein do not support causality. Associations are important in establishing health care policies that require further testing. Limited external validity may be expected for locales with different economic conditions and habits and for adolescents not regularly enrolled in school. Despite this, the present study involved a representative sample of adolescents in the city. In addition, it must be highlighted that dental caries, periodontal diseases, malocclusion, and other oral health problems were not assessed. Low numbers of black, yellow, and indigenous adolescents were included (in accordance with the ethnic distribution in the city). The absence of a pilot study must also be acknowledged. All of these characteristics may be considered limitations of the present study.

Further studies could be conducted assessing other oral health problems and their associations with teeth alignment and colour. In addition, longitudinal studies are necessary in order to provide causality between both outcome and independent variables. In conclusion, this study demonstrated that concerns about smile characteristics were reported by almost half of the adolescents. Worse self-perception of teeth alignment and colour was associated with smoking exposure and lower levels of maternal education. Finally, a history of orthodontic treatment with or without tooth whitening was associated with less concern with aesthetic factors.

Conflict of interest

The authors report no conflict of interest related to this study.

Acknowledgements

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001. All other funding was provided by the authors. The authors report no conflict of interest related to this study.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.identj.2021.04.001.

REFERENCES

1. Klages U, Erbe C, Sandru SD, Brüllman D, Wehrbein H. Psychosocial impact of dental aesthetics in adolescence: validity and reliability of a questionnaire across age-groups. Qual Life Res 2015;24:379–90.
2. Goulart MA, Condessa AM, Hilgert JB, Hugo FN, RK Celeste. Concerns about dental aesthetics are associated with oral health related quality of life in Southern Brazilian adults. Cien Saude Colet 2018;23:3957–64.
3. Merlo GH, Piardi CC, Gabrielli E, Muniz FW, Rösing CK, Colussi PR. Association between history of orthodontic treatment and sociodemographic factors in adolescents. Acta Odontol Latinoam 2018;31:3–10.
4. Rebouças AG, Cavalli AM, Zanin L, Ambrosano GMB, Flório FM. Factors associated with Brazilian adolescents' satisfaction with oral health. Community Dent Health 2018;;35:95–101.
5. Muniz FWMG, Cavalcante DJ, Moreira MMSM, et al. Association between confidence in smiling and esthetic characteristics. J Esthet Restor Dent 2017;29:E56–66.
6. Di Murro B, Gallusi G, Nardi R, Libonati A, Angotti V, Campanella V. The relationship of tooth shade and skin tone and its influence on the smile attractiveness. J Esthet Restor Dent 2020;;32:57–63.
7. Kavand G, Broffitt B, Levy SM, Warren JJ. Comparison of dental esthetic perceptions of young adolescents and their parents. J Public Health Dent 2012;72:164–71.
8. Sawyer SM, Afifi RA, Bearinger LH, et al. Adolescence: a foundation for future health. Lancet 2012;379:1630–40.

9. Barbato PR, Peres MA. Tooth loss and associated factors in adolescents: a Brazilian population-based oral health survey. Rev Saude Publica 2009;;43:13–25.
10. Colussi P, Neves F, Muniz F, Rösing C. Tooth loss and associated factors in adolescents – impact of extractions for orthodontic reason. Braz J Oral Sci 2018;17:e18149.
11. Massoni ACLT, Porto É, Ferreira LRBO, et al. Access to oral healthcare services of adolescents of a large-size municipality in northeastern Brazil. Braz Oral Res 2020;34:e029.
12. Yurgelun-Todd D. Emotional and cognitive changes during adolescence. Curr Opin Neurobiol 2007;17:251–7.
13. Nazir MA. Predictors of routine dental check-up among male adolescents in Saudi Arabia. Acta Stomatol Croat 2019;53:255–63.
14. Instituto Brasileiro de Geografia e Estatística (IBGE). Índice de Desenvolvimento Humano. Available from https://cidades.ibge.gov.br/brasil/rs/passo-fundo/panorama. Accessed 18 May 2021.
15. Colussi PR, Hugo FN, Muniz FW, Rösing CK. Oral health-related quality of life and associated factors in Brazilian adolescents. Braz Dent J 2017;28:113–20.
16. Ericsson JS, Östberg AL, Wennström JL, Abrahamsson KH. Oral health-related perceptions, attitudes, and behavior in relation to oral hygiene conditions in an adolescent population. Eur J Oral Sci 2012;120:335–41.
17. Brazil. Ministério da Saúde. Manual do Instrumento de Avaliação da Atenção Primária à Saúde: PCATool-Brasil. No.. 2010.
18. Furtado GE, Sousa ML, Barbosa TS, Wada RS, Martínez-Mier EA, Almeida ME. Perceptions of dental fluorosis and evaluation of agreement between parents and children: validation of a questionnaire. Cad Saude Publica 2012;28:1493–505.
[19]. Prasad KN, Sabrish S, Mathew S, Shivamurthy PG, Pattabiraman V, Sagarkar R. Comparison of the influence of dental and facial aesthetics in determining overall attractiveness. Int Orthod 2018;16:684–97.
20. Almedlej R, Aldosary R, Barakah R, et al. Dental esthetic and the likelihood of finding a job in Saudi Arabia. A cross-sectional study. J Family Med Prim Care 2020;9:276–81.
21. Alkhatib MN, Holt RD, Bedi R. Smoking and tooth discolouration: findings from a national cross-sectional study. BMC Public Health 2005;5:27.
22. Hernandes ES, Lebrão ML, Duarte YA, Santos JL. Health insurance coverage of the elderly and socioepidemiological characteristics associated. Rev Saude Publica 2012;46:1030–8.
23. Steele J, Shen J, Tsakos G, et al. The interplay between socioeconomic inequalities and clinical oral health. J Dent Res 2015;94:19–26.
24. Choi SH, Kim JS, Cha JY, Hwang CJ. Effect of malocclusion severity on oral health-related quality of life and food intake ability in a Korean population. Am J Orthod Dentofacial Orthop 2016;149:384–90.
25. Tuominen ML, Tuominen RJ. Factors associated with subjective need for orthodontic treatment among Finnish university applicants. Acta Odontol Scand 1994;52:106–10.
26. Mounika A, Mandava J, Roopesh B, Karri G. Clinical evaluation of color change and tooth sensitivity with in-office and home bleaching treatments. Indian J Dent Res 2018;29:423–7.
27. Kothari S, Gray AR, Lyons K, Tan XW, Brunton PA. Vital bleaching and oral-health-related quality of life in adults: a systematic review and meta-analysis. J Dent 2019;84:22–9.
28. Montero J, Costa J, Bica I, Barrios R. Caries and quality of life in portuguese adolescents: impact of diet and behavioural risk factors. J Clin Exp Dent 2018;10:e218–23.
29. Muniz FWMG, Costa RDSA, Cavagni J, et al. Body fat rather than body mass index is associated with gingivitis - a southern Brazilian cross-sectional study. J Periodontol 2018;89:388–96.