Correlation Between Skin Color and Tooth Shade in the Pediatric Population

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ABSTRACT

Objective: The dental literature documents the relationship between tooth color and skin tone, with studies focusing primarily on adults. To our knowledge, however, no study has been conducted focusing on the pediatric/adolescent population. Therefore, this study investigated the relationship between tooth and skin color in the pediatric/adolescent population.

Methods: This study was conducted on children and adolescents with fully erupted right maxillary central incisors, undergoing dental treatment at the Queen Fabiola Children's Hospital in Brussels. A spectrophotometer was used to select the shade; after the measurement procedure was initiated, the tooth shade was recorded twice with 'L', 'a', and 'b' values before dental treatment. Skin color was measured according to the Fitzpatrick scale.

Results: Regarding gender, a significant inverse correlation was observed between a* parameter and gender. According to the Fitzpatrick scale, there was a significant inverse correlation ($P<0.0001$) between a* and b* parameters and skin color. There was a linear correlation ($P<0.01$) between the L* parameter and skin color. There was no significant difference between boys and girls.

Conclusion: The existing literature lacks sufficient studies to establish a direct correlation between skin color and tooth color in children and adolescents. Future research is essential to explore this relationship in greater depth. Our research delves into this unexplored area and reveals intriguing findings suggesting a possible association. Especially in certain genetic cases, our study underscores the importance of considering this correlation. The data collected and analyzed in our research also sheds light on the relationship between skin color and tooth color and advocates exploring this alternative perspective. This finding, thus, opens avenues for further investigation into the complex relationship between genetics, skin pigmentation, and dental characteristics, providing valuable insights for practitioners and researchers alike.

INTRODUCTION

Aesthetics is a philosophical concept of beauty that involves the study of beauty, art, and taste, and plays a significant role in shaping our perceptions and experiences. In modern Western society, aesthetics often influences various aspects of our lives, from personal grooming and fashion to the design of our living spaces.[1] The emphasis on looking our best in today's society can be attributed to various factors, including cultural influences, media portrayals, and societal norms. Research in the social sciences has shown that physical appearance can significantly impact an individual's life experience, extending to areas such as social interactions, relationships, and career opportunities.[2] The phenomenon whereby attractive individuals are often associated with positive personality traits is known as the "halo effect. The halo effect suggests that our perception of a person's physical attractiveness influences our overall judgment of their character. This bias can lead to assumptions that attractive individuals possess other desirable traits, such as

intelligence, kindness, and competence, even without direct evidence.[3]

It is important to note that while physical appearance can create first impressions, it does not necessarily reflect a person's true personality or abilities. People are complex, and their inner qualities transcend outward appearances. Nevertheless, the societal emphasis on aesthetics and our interactions and perceptions continue to be shaped by the halo effect. Dentistry has evolved from a primarily health-oriented service to an elective aesthetic service, with patients often seeking dental treatment for aesthetic reasons.[4,5] In addition, the impact of facial and dental appearance on how individuals are perceived and judged by others is underscored by scientific evidence.[4,6,7] The finding that attractiveness is considered more important than intelligence in children's and adolescents' choice of friends indicates the early development of aesthetic preferences that may persist into adulthood.[8] Societal emphasis on attractiveness influences individual choices and preferences. Dentistry recognizes the challenge of achieving accurate and predictable shade matching between natural teeth and restorative materials. This aspect is critical to the success of esthetic dental procedures. The mention of various criteria evaluated for tooth shade, including factors like gender and age, highlights the complexity of achieving optimal esthetic outcomes in dental restorations.[9,10]

Overall, the statement highlights the growing importance of esthetics in dentistry, driven by societal perceptions and individual preferences. It also recognizes the challenges clinicians face in achieving esthetic results, particularly in the context of tooth color matching. More recently, studies[11,12] have explored whether skin color could be an alternative predictor for tooth shade, offering a potentially practical solution in cases where traditional tools are unavailable or inconclusive. However, findings on the correlation between tooth and skin color are inconsistent. Some studies suggest a positive correlation, recommending that skin color be considered a guide for tooth shade selection. According to these findings, individuals with darker skin tend to have lighter teeth, while those with lighter skin may have darker teeth. This approach is based on the hypothesis that matching tooth shade to skin tone could improve the overall aesthetic outcomes of dental restorations.

Conversely, other studies[13,14] report an inverse relationship between skin and tooth color, suggesting that individuals with darker skin may have darker teeth and those with lighter skin may have lighter teeth. These conflicting observations may be due to variations in study populations, methodologies, and sample sizes. Furthermore, previous research primarily focused on adult populations (18 years and older), leaving a gap in understanding regarding pediatric and adolescent populations. This study investigated whether skin tone can predict tooth color in children and adolescents, addressing the possibility of using skin color as an alternative criterion in tooth shade selection. Unlike traditional approaches, this study examines whether, in the absence of other tools or evidence, skin tone could serve as a reliable guide for selecting tooth shades, mainly when replacing missing teeth or enhancing dental aesthetics. The null hypothesis posits that skin color does not provide valuable information for predicting tooth shade.

MATERIALS & METHODS

Population selection

This study was conducted on children and adolescents under dental treatment at Queen Fabiola Children's Hospital, Free University of Brussels, Belgium, between September 2020 and February 2021. Approval from the Ethics committee of the Children's Hospital of Queen Fabiola, Free University of Brussels, and the informed consent of all volunteers and their parents were obtained for the study.

individuals were included in the study if their maxillary right central incisors fully erupted to allow for accurate shade assessment, regardless of whether root apex closure was complete. The exclusion criteria were specified as follows:

- Unable to provide informed consent
- Teeth that required or had received

endodontic therapy
- Teeth with decay or/and restoration
- Patients who had orthodontic appliances
- Xerostomia
- Abnormalities in tooth development
- Teeth received a bleaching procedure
- Teeth with tetracycline, MIH, or hypomineralization staining
- Smoking
- Patients undergoing radio/chemotherapy
- Teeth with black stain

Assessment of tooth shade

The **Vita Easyshade™ V spectrophotometer** (VITA Zahnfabrik GmbH, Bad Säckingen, Germany) was used to determine tooth color. This device utilizes the **CIE color model** (Commission Internationale de l'Éclairage), which measures three key parameters:

- **L*** (lightness), where 0 represents black and 100 represents white.
- **a*** (the red-green axis), where positive values indicate redness and negative values indicate greenness.
- **b*** (the yellow-blue axis), where positive values represent yellowness and negative values represent blueness.

The procedure was initiated to assess tooth color, and the color was measured twice for each tooth. The average of these two measurements was then calculated to determine the patient's tooth color. All measurements were performed on clean, dry tooth surfaces under standardized lighting conditions. The spectrophotometer was calibrated according to the manufacturer's instructions before use to ensure accurate readings.

Assessment of skin color

Skin color measurements were made using the Fitzpatrick scale:

- Type I: Very fair skin, always burns, never tans. Example: Individuals with pale white skin, often with freckles, red or blond hair, and light-colored eyes (blue or green).
- Type II: Fair skin, usually burns, tans minimally. Example: People with fair skin, blond or light brown hair, and blue, green, or hazel eyes.
- Type III: Medium skin, sometimes burns, tans gradually to light brown. Example: Individuals with fair to medium skin tones, often with darker hair and brown or hazel eyes.
- Type IV: Olive or moderate brown skin, rarely burns, tans easily. Example: People with naturally darker Caucasian or Mediterranean skin tones, often with dark hair and brown eyes.
- Type V: Dark brown skin rarely burns and tans very quickly. Example: Individuals with deep brown skin, commonly of Middle Eastern, Latin American, or Indian descent.
- Type VI: Very dark or black skin, never burns, always tans deeply. Example: People with very dark brown to black skin tones, typically African or Afro-Caribbean descent.

Based on the Fitzpatrick Skin Type, we categorized the patients into two categories: the fair skin category with Fitzpatrick skin types I, II, and III, and the dark skin category with Fitzpatrick skin types IV, V, and VI (Figure 1).

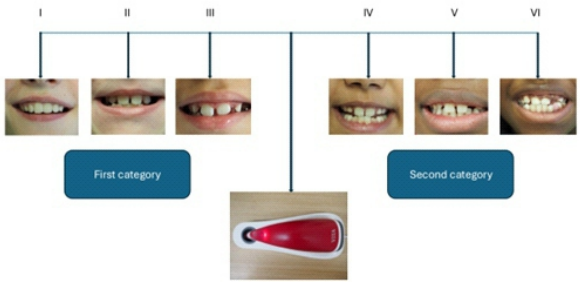

Figure 1: Skin complexion classification adapted from the Fitzpatrick scale for this study: Category 1 (Types I-III) and Category 2 (Types IV-VI).

The collected data were analyzed statistically using one-way ANOVA to compare group means and Spearman correlation coefficients to assess monotonic relationships between variables. The normality of the data for each variable was assessed using the Shapiro-Wilk

and Kolmogorov-Smirnov tests, which indicated that none of the variables followed a normal distribution. Consequently, non-parametric tests were applied where appropriate. Post-hoc comparisons were performed using Tukey's test to identify specific group differences. Statistical significance was established at $p < 0.05$ for all analyses. All analyses were done with GraphPad Prism, version 9.0 (GraphPad Software Inc., La Jolla, CA, USA).

RESULTS

Gender: A total of 159 patients, 79 boys and 80 girls, participated in the study. No significant correlation was found between gender regarding teeth and skin for the **L*** and **b*** parameters. In contrast, a significant inverse correlation was observed between **a*** parameter and gender (p=0,0242).

Age: The ages of the patients ranged from 7 to 16 years, with a mean age of 10.44 (±SD 2.73). The mean age for boys and girls was 10.12 (±SD 0,71) and 10.86 (±SD 1,47), respectively. There was no significant difference between boys and girls of different ages (Table 1)

Table 1: Distribution of Patients by Gender and Age

Gender	Number of patients	Age Range (years)	Mean Age (±SD)
Boys	79	7-16	10.12 (±0.71)
Girls	80	7-16	10.86 (±1.47)
Total	159	7-16	10.44 (±2.73)

Fair and dark skin color: The distribution of patients according to two categories of skin color is presented in Table 2.

Table 2: Distribution of patients according to two categories of skin color is

Skin complexion	N total	N girls	N boys
Fair skin	53	26	27
Dark skin	106	54	52

Table 3 compares tooth color parameters (L*, a*, b*) between patients with fair skin (n=53) and dark skin (n=106). Notable differences were observed, with higher b* values in the fair-skinned group indicating greater yellowness and slight variations in L* and a* between the two groups.

There was no significant difference in the L* parameter between individuals with fair and dark skin tones ($p = 0.1021$). Similarly, no significant difference was observed in the a* parameter between fair and dark skin tones ($p = 0.9797$). In contrast, a significant difference was found in the b* parameter, with fair and dark skin tones showing distinct values ($p < 0.0001$).

Table 3: Comparison of Tooth Color Parameters Between Fair and Dark Skin Groups

Parameters	Fair Skin (n=53)	Dark skin (n=106)	Mean difference	p-value Comparison between Fair Skin and Dark skin	Significant
L* (±SD)	83.81 (±3.1)	84.97 (±3.84))	-1.29	0.1021	No
L* (IQR)	4.3	4.52			
a* (±SD)	0.27 (±0.81)	-0.070 (±0.89)	0.36	0.9797	No
a* (IQR)	0.4	-0.12			
B* (±SD)	25.72 (±3.08)	21.63 (±3.39)	3.95	<0.0001	Yes
B* (IQR)	2.6	4.37			

There was a significant inverse correlation (respectively P<0.0001and P<0.001) between a* and b* parameters and skin color skin. There was a linear correlation (P<0.001) between the L* parameter and the skin color. In contrast, there was no significant difference between boys and girls (Table 4).

Table 4: Correlation Between Tooth Color Parameters, Skin Tone, and Age

Correlation	r_s	p-value	Interpretation
L*/skin	0.02	<0.001	Significant linear correlation
a*/skin	-0.07	<0.0001	Significant inverse correlation
b*/skin	-0.02	<0.001	Significant inverse correlation
b*/age	9.728×10^{6}	<0.45	Not significant

DISCUSSION

The aim of this study was to determine the relationship between skin complexion and tooth shade in children and adolescents. This relationship could be useful when selecting the tooth shade in order to achieve an esthetic restoration and to enhance the natural appearance. The correlation between tooth color and skin tone has been extensively explored and documented in dental literature, with a predominant emphasis on adult populations. The existing body of research predominantly delves into the nuances of tooth coloration and its aesthetic implications for adults. However, as the fabrication of dental prosthetics is more commonly associated with

the adult demographic, there is a noticeable gap in literature concerning the relationship between tooth color and skin tone in children.

First, some genetic conditions, such as ectodermal dysplasia syndrome, Allgrove syndrome and Papillon-Lefevre syndrome, may cause oligodontia or anodontia. The absence of teeth in children and adolescents could lead to functional and psychological problems. Thus, early treatment is important to improve masticatory function, appearance, and reduce the psychosocial impact.[15] Congenital tooth agenesis requires a multidisciplinary treatment approach which include participation of orthodontists, pediatric dentists, and prosthodontists. Clinicians are confronted with the problem of not knowing the patient's natural tooth color. It would, therefore, be interesting to use other facial features, gender and skin complexion to select tooth shade, nevertheless, the problem is even more complicated in young patients due to the presence of mixed dentition.

Secondly, the shade of teeth in children and adolescents is not as significantly affected by extrinsic factors such as tobacco, coffee, or wine, mainly due to differences in consumption compared to adults, which is found to be generally lower. The dietary and lifestyle habits of young individuals often differ from those of adults, which can contribute to maintaining a more natural tooth color. It is well-established that the consumption of certain substances, such as tobacco, coffee, and wine, can lead to discoloration of teeth in adults. However, this phenomenon is not as pronounced in children and adolescents. Understanding these distinctions is, therefore, essential for oral health professionals, as it highlights the need for age-specific selecting the tooth shade to achieve an esthetic restoration and to enhance the natural appearance. Currently, scientific research on the correlation between tooth shade and skin color is limited, and findings often must be more consistent. This variability may stem from factors such as the demographics of the populations studied, along with the methods used for measuring and categorizing tooth color. Shade assessment techniques typically rely on standards designed to mimic natural tooth appearance.[9]

Our study analyzed the relationship between tooth color parameters (L*, a*, b*) and key skin tone and age variables. A significant linear correlation between L* and skin tone suggests that brighter teeth (L*) are associated with lighter skin tones. However, the weak correlation indicates that other factors, such as genetics, and environmental influences, are likely to play a more significant role in determining tooth brightness than skin tone alone. Similarly, the inverse correlation between a* and skin tone indicates that teeth tend to appear less red as skin tone darkens. The weak correlation suggests that factors such as enamel thickness or pigmentation may be more influential in determining tooth redness. The correlation between b* and skin tone also showed an inverse relationship, indicating that teeth are less yellow in individuals with darker skin tones.

The parameter **b*** was chosen to evaluate the relationship with age because it represents the yellow-blue component of tooth color, which is particularly relevant to understanding age-related changes. Tooth yellowness, as indicated by **b***, tends to increase with age due to biological factors such as dentin thickening and enamel thinning, which alter the perceived color more significantly than changes in brightness (**L***) or redness/greenness (**a***). While **L*** reflects lightness and **a*** captures the red-green axis, these parameters are less directly influenced by age, especially within the 7–16-year age range where enamel wear and translucency changes are minimal. Despite the statistical significance of some correlations, their weak nature points to the complex and multifactorial nature of tooth color.

Presently various tooth shade guides and devices are available. In our study, we assessed tooth color using a spectrophotometer. Several studies reported that color matching by spectrophotometer was more reliable than visual method.[16-18] While this method provides an interesting perspective on the relationship between skin tone and tooth color, it has limitations. It should be considered a complementary tool rather than a stand-alone solution. Its use is particularly relevant in cases

of dental agenesis or other situations where traditional methods of tooth shade measurement cannot be performed. In such scenarios, using skin tone as a guide for shade selection can be a practical alternative. Thus, in light of the current knowledge gap, future research endeavors could explore the specific mechanisms underlying the observed correlations. Investigating the physiological and psychological factors contributing to the perceived tooth color in relation to different skin tones could enhance our understanding.

Additionally, longitudinal studies could be conducted to track changes in children's perceptions of teeth shade as they grow, considering the dynamic nature of both skin color and dental development. This longitudinal approach could shed light on the evolving influence of skin color on teeth shade preferences over time. Furthermore, exploring the potential cultural and societal factors that contribute to the relationship between skin color and teeth shade selection would enrich the context of the research. Understanding how cultural perceptions shape aesthetic preferences in pediatric dentistry could inform more culturally sensitive and patient-centered approaches. The outcomes of this research could also have profound implications for pediatric dental practice. Dentists and orthodontists may incorporate this knowledge into treatment planning, considering the impact of skin color on teeth shade preferences to enhance patient satisfaction and psychological well-being.

Moreover, the findings could be utilized in the development of educational materials for both dental professionals and parents, promoting awareness of the intricate relationship between skin color and teeth shade. This, in turn, could lead to more informed decision-making regarding dental treatments and aesthetic considerations in pediatric dentistry. From the findings of this study, the hypothesis that skin color has no effect on the selected teeth shade in our sample population was rejected.

CONCLUSION

The findings of this study contribute valuable insights into the intricate relationship between skin shade and tooth color among children and adolescents. Through a meticulous examination of diverse participants, it becomes evident that a discernible connection exists, shedding light on the intricate interplay of genetics, environmental factors, and individual variations. Ultimately, this study serves as a stepping stone in the ongoing exploration of the intricate nexus between skin shade and tooth color, urging researchers, clinicians, and educators alike to consider these aspects in the pursuit of comprehensive oral health strategies for the diverse pediatric and adolescent populations.

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