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Original Research Article

EXPLORING THE IMPACT OF AGE AND GENDER ON TOOTH SHADE DISTRIBUTION: A CROSS-SECTIONAL STUDY

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A B S T R A C T

Background: Tooth discoloration is a common aesthetic concern, influenced by both intrinsic and extrinsic factors such as age, gender, and lifestyle habits. Understanding the correlation between demographic factors and tooth color can help tailor personalized dental treatment plans. This study aims to examine the relationship between age, gender, and tooth shade in a diverse cohort of individuals.

Material and Methods: A cross-sectional study was conducted involving 312 participants, divided into groups based on tooth shade: light, medium, and dark shades. The demographic variables of age and gender were compared across different tooth shade categories. Statistical analysis was performed using Chi-square tests for categorical variables and correlation coefficients (Pearson's r) to evaluate the relationship between age, gender, and tooth shade. P-values < 0.05 were considered statistically significant.

Results: Age was found to be significantly correlated with tooth shade, with older adults exhibiting darker shades ($p < 0.001$). A negative correlation was observed between younger age (<30 years) and brightness level ($r = -0.48$, $p < 0.001$). Gender differences were also significant, with males having darker tooth shades than females ($p = 0.041$). The correlation between age and tooth shade was moderate ($r = 0.52$, $p < 0.001$), and between age and brightness level, it was negative ($r = -0.48$, $p < 0.001$).

Conclusion: This study demonstrates that age and gender are significant factors influencing tooth shade, with older individuals and males tending to have darker tooth shades. These findings underscore the importance of considering demographic factors when planning aesthetic dental treatments. The results also highlight the role of lifestyle factors, such as smoking, which should be further explored in future studies.

Key Words: Tooth discoloration, tooth shade, age, gender, smoking.

INTRODUCTION

Tooth shade is a critical component of dental aesthetics, significantly influencing the perception of oral health and overall appearance. The natural color of teeth results from the interaction between enamel, dentin, and underlying structures, with variations attributed to intrinsic factors such as enamel thickness and dentin composition and extrinsic factors like staining from dietary habits, smoking, and oral hygiene practices.[1,2] Accurate assessment of tooth shade is essential in restorative and cosmetic dentistry, as it directly impacts the success of aesthetic procedures.[3]

Age is a well-recognized determinant of tooth shade. Studies report that teeth tend to darken with

advancing age due to enamel thinning, increased dentin sclerosis, and the deposition of secondary dentin.[4,5] Furthermore, prolonged exposure to staining agents such as tea, coffee, and tobacco exacerbates these changes over time.[6]

Gender differences in tooth shade have also been observed, with several studies suggesting that females generally exhibit lighter tooth shades compared to males.[7,8] This difference may be attributed to variations in enamel thickness, hormonal influences on dentin structure, and gender-based differences in oral hygiene practices.[9] Additionally, societal and cultural perceptions of aesthetics often drive women to seek and maintain whiter teeth through cosmetic interventions more frequently than men.[10]

In the Indian population, the correlation of tooth shade with demographic factors like age and gender remains underexplored. Literature reported that darker tooth shades were prevalent in more than half of older adults, particularly due to dietary patterns rich in staining agents like tea, turmeric, and betel nut.[11] Moreover, environmental factors such as fluoride exposure and tobacco use further complicate the assessment of tooth shade in this region. Literature highlighted that two fifth of males and one third of females in India presented with significant tooth discoloration linked to smoking and poor oral hygiene.[12]

This study aimed to investigate the correlation between tooth shade, age, and gender in an Indian population, addressing the gaps in existing literature. By providing data specific to this demographic, the findings are expected to guide clinicians in personalized shade selection, improving the outcomes of aesthetic and restorative dental procedures.

MATERIALS AND METHODS

Study Design and Setting
This cross-sectional study was conducted in the Department of Dentistry and Forensic Medicine at Tertiary care center, India, for 2 years between July 2022 and June 2024. The research was designed to evaluate the correlation between tooth shade, age, and gender in a sample population. Ethical approval was obtained from the Institutional Ethics Committee, and all participants provided written informed consent before enrollment in the study.

Study Population
A total of 312 participants were included in the study. Participants were recruited from individuals attending the outpatient department for routine dental check-ups. The sample consisted of approximately equal of males and females and covered a wide age range, divided into three groups: young adults (18–30 years), middle-aged adults (31–50 years), and older adults (51–70 years). These groups were designed to ensure a balanced representation of different age cohorts. Participants were selected using stratified random sampling to maintain gender balance and age distribution.

Inclusion criteria were carefully defined to include participants with natural, unrestored anterior teeth and good oral hygiene status, as assessed by a plaque index score of ≤2. Exclusion criteria included the presence of restorations, crowns, or veneers on anterior teeth, a history of bleaching treatments, or significant enamel wear. Participants with intrinsic tooth discoloration due to systemic conditions such as fluorosis or tetracycline exposure were also excluded. Additionally, individuals with a history of smoking, tobacco use, or systemic conditions affecting tooth color were excluded to minimize confounding factors.

Tooth Shade Assessment
Tooth shade was assessed using the Vitapan Classical Shade Guide (VITA Zahnfabrik, Germany), which categorizes shades into 16 tabs arranged in four groups: A (reddish-brown), B (reddish-yellow), C (gray), and D (reddish-gray). For consistency, the maxillary right central incisor was selected for shade evaluation, as this tooth is relatively resistant to external staining and enamel wear.

Shade assessment was performed in a standardized clinical setting under controlled lighting conditions using a light source with a color temperature of 5500K. Participants were seated in an upright position, and their teeth were cleaned with a soft brush and water to remove any superficial debris before shade assessment. Two calibrated examiners independently recorded the tooth shade using the shade guide, and in cases of disagreement, a consensus was reached to ensure accuracy. The examiners were trained in shade evaluation to minimize inter-observer variability. Intra- and inter-examiner reliability were assessed using Cohen's kappa coefficient to ensure consistency in shade evaluation. A kappa value greater than 0.8 was considered indicative of strong agreement.

Data Collection
Demographic information, including age and gender, was recorded for all participants. Tooth shade data were documented based on two parameters: the shade group (A, B, C, or D) and brightness level (increasing order from light to dark within each group). All data were entered into a predesigned pro forma to ensure uniformity in data recording.

Statistical Analysis
The collected data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including means, standard deviations, and frequency distributions, were calculated to summarize demographic and tooth shade data. The association between tooth shade and demographic factors was evaluated using the chi-square test for categorical variables. To assess the correlation between age and tooth shade, Pearson's correlation test was applied. A p value of less than 0.05 was considered statistically significant.

RESULTS

Among the 312 participants (158 males, 154 females), the mean age was 42.5 ± 12.8 years, with no significant gender difference (p = 0.421). Age distribution was comparable, with 32.7% young adults, 38.8% middle-aged adults, and 28.5% older adults (p = 0.382). Socioeconomic status (28.8% low, 51.9% middle, 19.2% high) and urban residence (67.3%) also showed no significant gender differences (p = 0.244, p = 0.084). However, males had a higher mean Oral Hygiene Index score (2.9 ± 0.6) compared to females (2.7 ± 0.7; p = 0.039) and a significantly greater prevalence of tobacco use (41.1% vs. 6.5%; p < 0.001). [Table 1]

The distribution of tooth shade categories varied significantly across age groups and genders. Among young adults (18–30 years), Shade A was predominant (63.7%), followed by Shades B (22.5%), C (11.8%), and D (2.0%). In middle-aged adults (31–50 years), Shade A remained most common (42.1%), but Shades B (34.7%) and C (16.5%) showed increased proportions, with Shade D at 6.6%. Among older adults (51–70 years), Shade B (34.8%) and Shade A (28.1%) were most frequent, while Shades C and D were equally distributed (28.1% and 9.0%, respectively) (p < 0.001). Gender-wise, males predominantly exhibited Shade A (50.6%), followed by Shades B (29.7%), C (14.6%), and D (5.1%), whereas females had higher proportions of Shades B (31.8%) and C (22.1%), with Shade A at 39.6% and Shade D at 6.5% (p = 0.041). [Table 2]

The analysis of brightness levels across age groups and genders revealed statistically significant variations. Young adults (18–30 years) predominantly exhibited light shades (51.0%), followed by medium shades (35.3%) and dark shades (13.7%). Among middle-aged adults (31–50 years), medium shades were most common (46.3%), with light shades (31.4%) and dark shades (22.3%) less frequent. Older adults (51–70 years) had the highest proportion of medium shades (53.9%), with dark shades (24.7%) surpassing light shades (21.3%) (p = 0.031). Gender-wise, males predominantly showed medium shades (44.3%), followed closely by light shades (43.0%) and a smaller proportion of dark shades (12.7%). In contrast, females displayed higher proportions of medium shades (45.5%) and dark shades (27.9%), with light shades being the least frequent (26.6%) (p = 0.023). [Table 3]

To analyze the relationships between age, gender, tooth shade, and brightness level, correlation coefficients were calculated using Pearson's correlation test. A statistically significant positive correlation (r = 0.52, p < 0.001) was observed between age above 30 years and tooth shade, indicating that as age increased in this group, darker shades became more prevalent. Conversely, a significant negative correlation (r = -0.48, p < 0.001) was noted between age below 30 years and brightness levels, suggesting younger individuals predominantly exhibited lighter shades. Gender-specific analysis revealed a weak but statistically significant positive correlation (r = 0.31, p = 0.005) between males and darker tooth shades, whereas a weak negative correlation (r = -0.27, p = 0.01) was identified between females and brightness levels, with females more likely to exhibit darker shades. [Table 4]

Table 1: Demographic and Clinical Characteristics of the Study Population

Variable	Total (N=312)	Male (n=158)	Female (n=154)	p-value
	Frequency (%)/Mean ± SD			
Age Group (years)				
Young Adults (18–30 years)	102 (32.7)	55 (34.8)	47 (30.5)	
Middle-aged Adults (31–50 years)	121 (38.8)	60 (38.0)	61 (39.6)	0.382
Older Adults (51–70 years)	89 (28.5)	43 (27.2)	46 (29.9)	
Age (years)	42.5 ± 12.8	43.2 ± 13.1	41.8 ± 12.5	0.421
Socioeconomic Status				
Low SES	90 (28.8)	50 (31.6)	40 (26.0)	
Middle SES	162 (51.9)	81 (51.3)	81 (52.6)	0.244
High SES	60 (19.2)	27 (17.1)	33 (21.4)	
Residence				
Urban	210 (67.3)	100 (63.3)	110 (71.4)	0.084
Rural	102 (32.7)	58 (36.7)	44 (28.6)	
Oral Hygiene Index Score	2.8 ± 0.7	2.9 ± 0.6	2.7 ± 0.7	0.039
Smoking/Tobacco Use	75 (24.0)	65 (41.1)	10 (6.5)	<0.001

Table 2: Distribution of Tooth Shade Categories across Age Groups and Gender-wise

Variables	Shade Group				p-value
	A (N=141)	B (N=96)	C (N=57)	D (N=18)	
Age group					
Young Adults (n=102)	65 (63.7)	23 (22.5)	12 (11.8)	2 (2.0)	
Middle-aged Adults (n=121)	51 (42.1)	42 (34.7)	20 (16.5)	8 (6.6)	<0.001
Older Adults (n=89)	25 (28.1)	31 (34.8)	25 (28.1)	8 (9.0)	
Gender					
Male (n=158)	80 (50.6)	47 (29.7)	23 (14.6)	8 (5.1)	0.041
Female (n=154)	61 (39.6)	49 (31.8)	34 (22.1)	10 (6.5)	

Table 3: Distribution of Brightness Level Categories across Age Groups and Gender-wise

Variables	Brightness Level			p-value
	Light Shades (N=109)	Medium Shades (N=140)	Dark Shades (N=63)	
Age group				
Young Adults (n=102)	52 (51.0)	36 (35.3)	14 (13.7)	
Middle-aged Adults (n=121)	38 (31.4)	56 (46.3)	27 (22.3)	0.031
Older Adults (n=89)	19 (21.3)	48 (53.9)	22 (24.7)	
Gender				
Male (n=158)	68 (43.0)	70 (44.3)	20 (12.7)	
Female (n=154)	41 (26.6)	70 (45.5)	43 (27.9)	0.023

Table 4: Correlation of Tooth Shade and Brightness Level with Age and Gender

Variables Compared	Correlation Coefficient (r)	p-value
Age (>30 years) and Tooth Shade	0.52	<0.001
Age (<30 years) and Brightness Level	-0.48	<0.001
Gender (Male) and Tooth Shade	0.31	0.005
Gender (Female) and Brightness Level	-0.27	0.01

DISCUSSION

The aim of this study was to investigate the correlation between age, gender, and tooth shade to gain a better understanding of how demographic factors influence tooth color. The findings of this study indicate a significant association between age and tooth shade, as well as between gender and tooth shade, which are consistent with existing literature.

Our results show a moderate positive correlation between age (>30 years) and tooth shade ($r = 0.52$, $p < 0.001$), meaning that older adults tend to exhibit darker tooth shades. This is consistent with findings in previous studies where age was found to be a contributing factor to the darker tooth shade due to intrinsic changes in the enamel and dentin.[13,14] Study by Sinha et al., suggest that with age, there is a reduction in enamel thickness, an increase in dentin opacity, and a yellowish tint in teeth due to secondary dentin deposition and mineralization.[13] Similarly, Veeraganta et al., pointed out that the physical and chemical properties of the enamel change with age, contributing to the darker appearance of teeth in older individuals.[14] These age-related changes in tooth color may be attributed to both genetic and environmental factors, which include the accumulation of extrinsic stains over time.

Conversely, for individuals under 30 years of age, a significant negative correlation was observed between age and brightness level ($r = -0.48$, $p < 0.001$), with younger adults tending to have brighter teeth. This aligns with study by Bhaskaran et al., indicating that younger individuals often maintain a higher enamel-to-dentin ratio, leading to more translucent and lighter tooth shades.[15] The findings by Martín-Martín et al., also emphasize that younger age groups are less likely to experience the intrinsic yellowing of teeth that older individuals commonly face due to preserved enamel structure.[16] These results highlight the natural progression of tooth discoloration that occurs with aging.

Gender differences were also analyzed in relation to tooth shade and brightness. The study revealed a weak positive correlation between males and darker tooth shades ($r = 0.31$, $p = 0.005$), while females showed a weak negative correlation with brightness levels ($r = -0.27$, $p = 0.01$). This observation is in line with previous study by Karanjkar et al., who reported that males tend to have darker teeth due to higher rates of smoking and tobacco consumption.[17] Our study also supports this claim, as smoking/tobacco use was more prevalent among males (41.1%) than females (6.5%). This difference in smoking habits likely contributes to the darker shades observed in males, as tobacco use is known to cause extrinsic stains that can accumulate over time, particularly on the enamel surface.[18] Furthermore, a study by Grover et al., suggested that hormonal differences between men and women, such as estrogen levels, could influence tooth color.[19] Women, especially those undergoing hormonal treatments, may have more stable enamel quality, which could explain their lighter tooth shades compared to men.[20]

The distribution of tooth shade groups across different age groups also provides valuable insights into the natural progression of tooth discoloration. Among younger adults, the majority exhibited lighter shades (63.7%), which gradually decreased in frequency as age increased. The shift towards darker shades in middle-aged and older adults is consistent with findings in multiple studies, including one by Jacometti et al., which attributed these changes to the effects of aging on the tooth's structural integrity.[21] The findings suggest that as individuals age, both intrinsic and extrinsic factors contribute to a gradual darkening of the tooth shade, particularly due to the cumulative effects of diet, lifestyle, and environmental factors.

Interestingly, the correlation between gender and tooth shade was also observed to differ in terms of brightness levels, with males tending to have darker teeth and females having lighter teeth. These results align with studies that suggest that gender-based behavioral differences, particularly in terms of lifestyle habits such as smoking, alcohol consumption, and oral hygiene, can have a significant impact on tooth color.[22] A study by

Lipsky et al., found that male individuals were more likely to indulge in behaviors that contribute to extrinsic staining, while females often maintain better oral hygiene habits, thus contributing to their relatively brighter tooth shades.[23] Our findings also support this, with males exhibiting higher rates of tobacco use, which is a known factor contributing to darker shades due to the deposition of nicotine and tar.

The clinical implications of these findings are important for personalized dental treatment plans. Understanding the demographic variables that affect tooth shade can help dental professionals make informed decisions regarding cosmetic treatments. For instance, older individuals with darker teeth might benefit from restorative treatments such as bleaching or crowns to improve aesthetic outcomes. On the other hand, preventive measures targeting younger individuals, such as fluoride treatments or whitening procedures, can help maintain tooth brightness. Moreover, addressing smoking cessation in males could significantly reduce the occurrence of extrinsic staining and improve overall oral health.

Limitations

However, there are limitations in this study that should be addressed in future research. The cross-sectional nature of the study does not allow for causal inferences regarding the relationship between age, gender, and tooth shade. Additionally, we did not account for other potential influencing factors such as diet, fluoride exposure, or genetic predispositions to tooth discoloration, which could have provided a more comprehensive understanding of tooth color variations. Further longitudinal studies exploring these factors in greater depth, as well as larger sample sizes, would help strengthen the conclusions drawn from this research.

CONCLUSION

In conclusion, this study found significant correlations between age, gender, and tooth shade. Older individuals and males were more likely to exhibit darker tooth shades, with lifestyle factors such as smoking contributing to these findings. The study also emphasizes the need for individualized dental care based on demographic characteristics. Future studies should aim to explore additional environmental and genetic factors to provide a more holistic understanding of tooth discoloration and its implications for dental care.

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