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Tooth Shade Relationship with Age, Gender, and Skin Color in a Saudi Population: A Cross-Sectional Study

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Abstract: ***Objectives:*** The aim of this study was to assess the relationship between tooth shade among different groups of patients according to their age, gender, and skin color in a Saudi population. ***Materials and methods:*** Participants were divided based on age into Group 1 (10–20 years), Group 2 (21–30 years), Group 3 (31–40 years), and Group 4 (41+ years), and according to gender. Tooth shade was measured by Vita easyshade, Shade scanner, 3D Master shade system. The skin color was determined according to the Firzpatrick Scale. It consists of six shades, namely: I, II, III, IV, V, and VI. The skin complexion of the participants was divided into six categories: white/very fair, fair, light brown, moderate brown, dark brown, and black. ***Results:*** One hundred and ninety-eight individuals were recruited. Around 70% were males. Females had 25.4% A2 followed by 22% A1, and 22% A3 shade types, while males had B3 shade (18%) followed by A2 and A3 (15.8%). A statistically significant difference was observed between shade and gender ($p < 0.05$). A statistically significant difference was observed between shade and age group ($p < 0.05$), where increased age was correlated with darker teeth shades. Shade A1 was correlated with type I skin color in 57.1% of individuals. Skin color type II had A2 as a dominant shade by 34.1%. A2 and A3 shades were equally observed in skin color III by 20.3%. Overall, statistically significant differences were observed between shade and skin color groups ($p < 0.05$). ***Conclusions:*** In conclusion, the most frequent classical shade noted among male and female participants was shade type A, which represents reddish brownish. Group 2 (21–30 years) had the B3 shade as the most prominent shade type among age groups. Gender, age, and skin types all showed a significant relation with the tooth shade.

Keywords: tooth shade; skin color; shade and age; skin and shade; Saudi

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1. Introduction

Esthetic dentistry has been a concern for patients visiting dental clinics. Patients have more expectations and are looking for higher esthetic results as a consequence of increased awareness and the impact of social media [1]. Usually, patients will assess the dentist's work by function, comfort, speech, and esthetics. The form and alignment of the teeth determine the beauty of the smile; the balance between the color of the teeth and the soft tissues is considered fundamental in determining the satisfaction of the person's dental appearance [2,3]. Systems evolved in defining the shade of teeth depend on three attributes: Hue, Chroma, and Value. The Hue is described as the character of appearance, which is discernible as (red, green, blue, etc.) and depends on the wavelength of each color. Chroma is the saturation of the color as it distinguishes a strong color from a weak one. The value is the color brightness, which compiles the lightness or darkness of the color [4].

One of the obstacles that most dentists are facing is matching a restoration to a natural tooth shade. However, patients described pearly white teeth as preferable [2,5]. Identifying the tooth shade will aid dentists in using fewer amounts of shade tabs and guides required to suit the patients' desires. This will also aid in providing better esthetic results according to the patients' age, gender, and skin color. According to Jahaniri et al., young patients were more likely to have teeth with a high value (lighter teeth) [6,7]. Factors like gender, age, and skin color may contribute to the method of shade selection [8,9]. In Sudan, for instance, shades A3, A2, and A1 were the most common tooth shades, respectively [10]. Karaman et al., in Turkey, reported that shade A2 was most observed in central and lateral incisors for all age groups. For the canines, B3 was most observed for the youngest two groups and A3.5 for the oldest two groups [11]. A study conducted in Jordan comparing tooth shade to skin color revealed that Jordanians have a light tooth value and that people with a dark skin complex have lighter teeth [12]. The skin color of an individual might help the prosthodontist in picking the artificial teeth shade in case of a complete denture [8]. Jahangiri et al. concluded that 50% of persons with low-value teeth had fair skin, whereas 17% had dark skin [6]. However, a study in Nepal [13], and another in India [14], exhibited no difference between all skin colors and tooth shades. Another study conducted in Korea reported that lighter and less chromatic central incisors were characteristics of female subjects in all age groups [15]. Gómez-Polo et al. revealed that age was stronger than gender in all color coordinates. However, females have lighter teeth than males in the plots [9]. Karaman et al. also showed that gender is statistically not related to a color value or Chroma [11]. In Saudi Arabia, a study in the southern region found that the shade gets darker and more yellow with age [16]. However, one ethnic group was examined in this study and could not be generalized to a Saudi Arabia population. Nowadays, high expectations from social media and patient awareness demand a quality level of training and knowledge regarding all aspects of esthetic dentistry. The process of shade selection is challenging because it is a subjective process. Therefore, patient-centered treatments and guidance in shade selection lead to a successful outcome when executed with prior knowledge of how the color is perceived.

Therefore, this research aims to assess teeth shades and their relationship with age, gender, and skin color in a Saudi population.

2. Materials and Methods

The approval of the Institutional Review Board was granted to conduct a cross-sectional study on diverse age groups. The sample size was calculated using a G power software to be 196 Saudi participants (n = 139 males, n = 59 females) visiting the Dental University Hospital (DUH) at King Saud University in Riyadh, Saudi Arabia. Included participants were only Saudi to limit the heterogenicity of the skin color and to homogenize the skin color in relation to the age. The inclusion criteria were healthy participants, above the age of 15 years, with fully erupted maxillary anterior teeth. Participants with no history of periodontal disease, bleaching, or active orthodontic treatment were included. The exclusion criteria were participants with anterior teeth having intrinsic and extrinsic stains, smoking, tobacco chewing, or developmental defects. Furthermore, teeth that are endodontically treated, restored, or carious were excluded. Any participant who reported tanned skin, dermatological disease, or undergoing any dermatological treatment was also excluded. Participants were divided based on gender (male and female) as well as age (Group 1: 15–20 years, Group 2: 21–30 years, Group 3: 31–40 years, and Group 4: 41 years and more).

Tooth shade was obtained by VITA Easy shade Advance 4.0® spectrophotometer (VITA Zahnfabrik, Bad Sackingen, Germany), which was calibrated following the manufacturer's instructions. The recorded shade was the closest to the classical shade guide. Prophylaxis was not carried out before shade selection because dehydration affects the tooth shade and requires hours to regain the original shade [17,18]. Instead, they were asked to brush for 3 min prior. Then, the teeth were wiped with a sterile gauze [15]. The tip of the spectrophotometer was held at a 90° angle against the middle aspect of the labial surface of tooth #11.

The skin phototypes of all participants were selected utilizing the Fitzpatrick skin phototypes criteria, skin phototype I: pale white skin, skin phototype II: fair skin, skin phototype III: darker white skin, skin phototype IV: light brown skin, skin phototype V: brown skin, and phototype VI: dark brown or black skin [19]. The skin color evaluation method was determined following Treesirichod's protocol: a room with fluorescent lighting, with no interfering outdoor sunlight, and at 20–30 min after enrollment [20]. The sample size was calculated using the G power software considering a power of 0.95, the effect size of 0.23, and the alpha set at 0.05 to be 196 participants. Data were analyzed by statistical software (SPSS 22.0, SPSS) using descriptive statistics, Pearson product-moment correlation, and chi-square tests. The statistical significance level was set at $p < 0.05$.

3. Result

One hundred and ninety-eight individuals were recruited from December 2020 until February 2021. Around 70% were males (n = 139) and the rest were females (n = 59). Participants were divided into five groups based on age where the majority (n = 78) of individuals were from Group 2 (21–30 years), followed by 45 individuals from Group 3 (31–40 years), 36 individuals from Group 1 (15–20 years), 25 individuals from Group 4 (41–50 years), and 14 individuals from Group 5 (51 years and more).

In the current study, the most frequent shade noted among male and female participants (n = 120) was shade type A, which represents reddish brownish. The second most frequent shade was type B (n = 49), followed by 20 participants with shade type C, and nine with shade D (Table 1). Most female participants had an A2 shade representing 25.4%, followed by A2 with 22%, and A3 with another 22% individually, while males had a B3 shade (18%) followed by A2 and A3 (15.8%) (Figure 1). Overall, the results showed a significant relationship between tooth shade and participant's gender, with a p-value of less than 0.05 (Table 2).

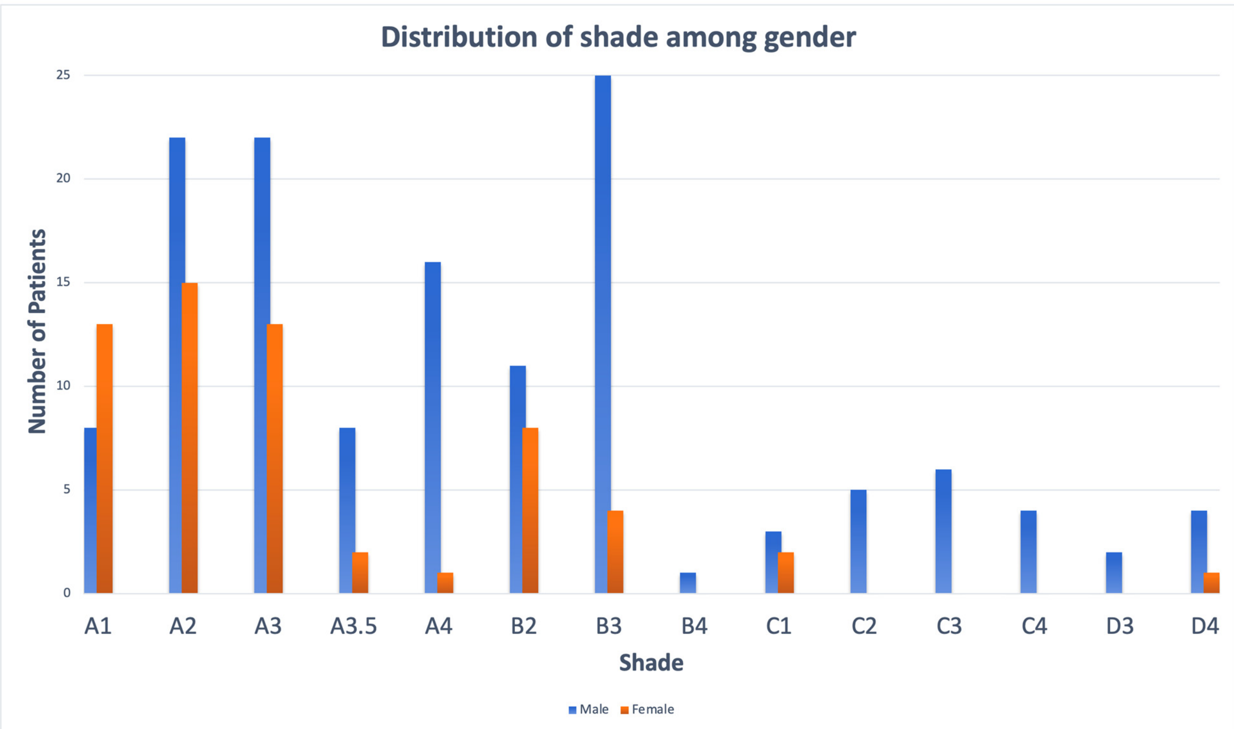

Figure 1. Relationship between teeth shade and among male and female participants.

Table 1. Relationship between teeth shade and gender. Most participants had an A2 shade.

Relationship between Shade and Gender *				
Shade		Gender		Total
		Male	Female	
A1	No. Participants	8	13	21
	% within Shade	38.1%	61.9%	100.0%
	% within Gender	5.8%	22.0%	10.6%
A2	No. Participants	22	15	37
	% within Shade	59.5%	40.5%	100.0%
	% within Gender	15.8%	25.4%	18.7%
A3	No. Participants	22	13	35
	% within Shade	62.9%	37.1%	100.0%
	% within Gender	15.8%	22.0%	17.7%
A3.5	No. Participants	8	2	10
	% within Shade	80.0%	20.0%	100.0%
	% within Gender	5.8%	3.4%	5.1%
A4	No. Participants	16	1	17
	% within Shade	94.1%	5.9%	100.0%
	% within Gender	11.5%	1.7%	8.6%
B2	No. Participants	11	8	19
	% within Shade	57.9%	42.1%	100.0%
	% within Gender	7.9%	13.6%	9.6%
B3	No. Participants	25	4	29
	% within Shade	86.2%	13.8%	100.0%
	% within Gender	18.0%	6.8%	14.6%
B4	No. Participants	1	0	1
	% within Shade	100.0%	0.0%	100.0%
	% within Gender	0.7%	0.0%	0.5%
C1	No. Participants	3	2	5
	% within Shade	60.0%	40.0%	100.0%
	% within Gender	2.2%	3.4%	2.5%
C2	No. Participants	5	0	5
	% within Shade	100.0%	0.0%	100.0%
	% within Gender	3.6%	0.0%	2.5%
C3	No. Participants	6	0	6
	% within Shade	100.0%	0.0%	100.0%
	% within Gender	4.3%	0.0%	3.0%
C4	No. Participants	4	0	4
	% within Shade	100.0%	0.0%	100.0%
	% within Gender	2.9%	0.0%	2.0%
D3	No. Participants	2	0	2
	% within Shade	100.0%	0.0%	100.0%
	% within Gender	1.4%	0.0%	1.0%
D4	No. Participants	4	1	5
	% within Shade	80.0%	20.0%	100.0%
	% within Gender	2.9%	1.7%	2.5%
Total	No. Participants	139	59	198
	% within Shade	70.2%	29.8%	100.0%
	% within Gender	100.0%	100.0%	100.0%

* $p < 0.05$.

Table 2. Pearson Chi-Square test shows the significant level between shade and gender.

Chi-Square Tests			
	Value	**df**	**Asymptotic Significance (2-Sided)**
Pearson Chi-Square	32.294 [a]	15	0.006
Likelihood Ratio	38.688	15	0.001
Linear-by-Linear Association	16.805	1	0.000
N of Valid Cases	198		

[a] 19 cells (59.4%) have expected count less than 5. The minimum expected count is 0.30.

According to the age, 33.3% of Group 1 (10–20 years) had shade A2 while Group 2 (21–30 years) and 3 (31–40 years) had 17.9% and 22.2% of shade B3, respectively. Shade A3 accounted for 20% of individuals in Group 4 and 28.6% of Group 5 individuals (Table 3) (Figure 2). A statistically significant difference was observed between shade and age groups ($p < 0.05$) (Table 4). Skin color type IV appeared to be the most dominant type with a total of 67 individuals, followed by skin color type III with a total of 64 individuals. Forty-one individuals had type II skin color, 17 individuals had type V skin color, then skin type I and VI with 7 and 2 individuals, respectively (Table 5).

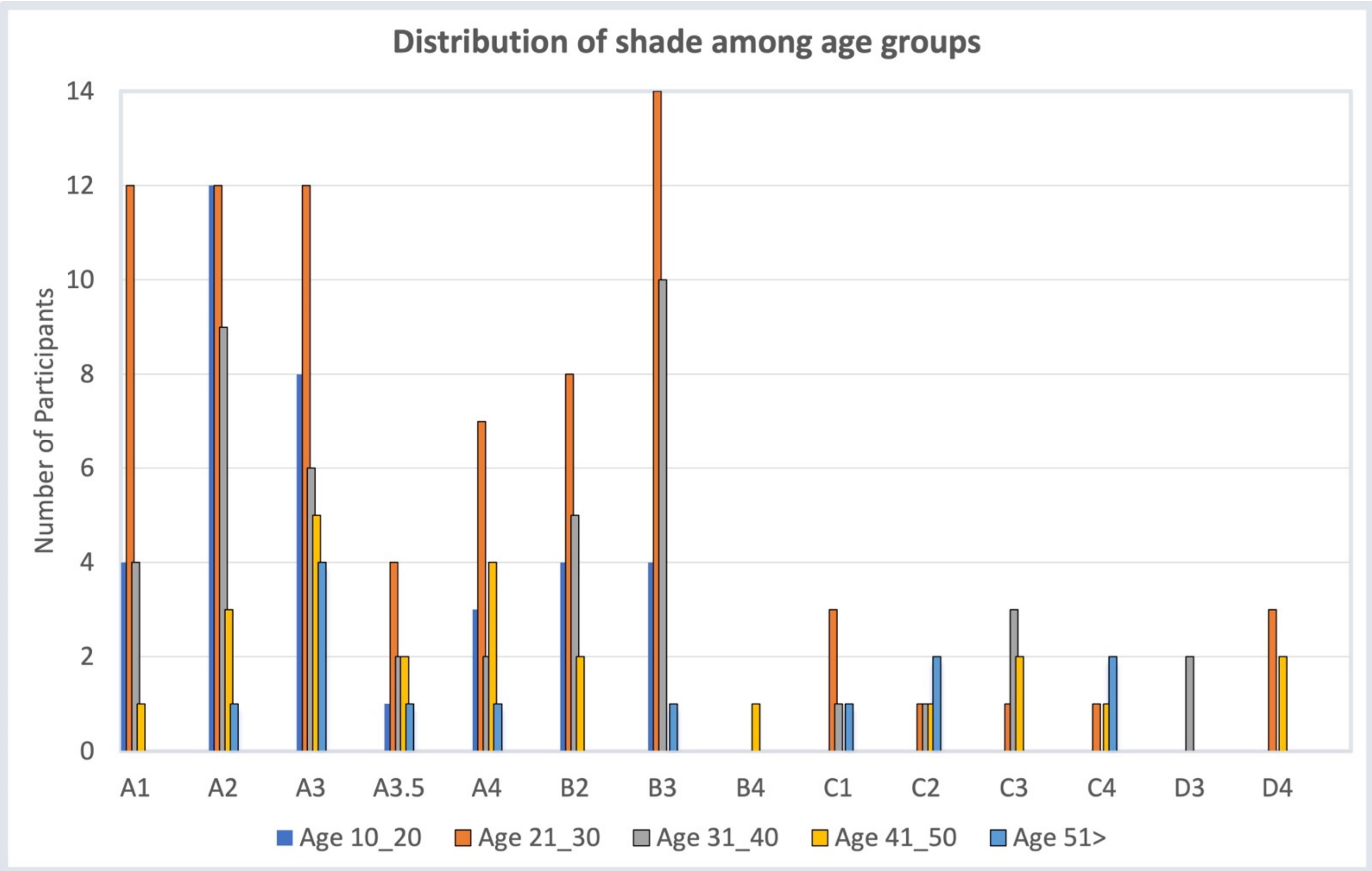

Figure 2. Relationship between teeth shade and age groups. A2 was the most frequent shade in all age groups.

Table 3. Relationship between teeth shade and age groups showed a statistical significance.

Relationship between Shade and Age *							
Shade		Age					Total
		10–20	21–30	31–40	41–50	51>	
A1	No. Participants	4	12	4	1	0	21
	% within Shade	19.0%	57.1%	19.0%	4.8%	0.0%	100.0%
	% within Age	11.1%	15.4%	8.9%	4.0%	0.0%	10.6%
A2	No. Participants	12	12	9	3	1	37
	% within Shade	32.4%	32.4%	24.3%	8.1%	2.7%	100.0%
	% within Age	33.3%	15.4%	20.0%	12.0%	7.1%	18.7%
A3	No. Participants	8	12	6	5	4	35
	% within Shade	22.9%	34.3%	17.1%	14.3%	11.4%	100.0%
	% within Age	22.2%	15.4%	13.3%	20.0%	28.6%	17.7%
A3.5	No. Participants	1	4	2	2	1	10
	% within Shade	10.0%	40.0%	20.0%	20.0%	10.0%	100.0%
	% within Age	2.8%	5.1%	4.4%	8.0%	7.1%	5.1%
A4	No. Participants	3	7	2	4	1	17
	% within Shade	17.6%	41.2%	11.8%	23.5%	5.9%	100.0%
	% within Age	8.3%	9.0%	4.4%	16.0%	7.1%	8.6%
B2	No. Participants	4	8	5	2	0	19
	% within Shade	21.1%	42.1%	26.3%	10.5%	0.0%	100.0%
	% within Age	11.1%	10.3%	11.1%	8.0%	0.0%	9.6%
B3	No. Participants	4	14	10	0	1	29
	% within Shade	13.8%	48.3%	34.5%	0.0%	3.4%	100.0%
	% within Age	11.1%	17.9%	22.2%	0.0%	7.1%	14.6%
B4	No. Participants	0	0	0	1	0	1
	% within Shade	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
	% within Age	0.0%	0.0%	0.0%	4.0%	0.0%	0.5%
C1	No. Participants	0	3	1	0	1	5
	% within Shade	0.0%	60.0%	20.0%	0.0%	20.0%	100.0%
	% within Age	0.0%	3.8%	2.2%	0.0%	7.1%	2.5%
C2	No. Participants	0	1	1	1	2	5
	% within Shade	0.0%	20.0%	20.0%	20.0%	40.0%	100.0%
	% within Age	0.0%	1.3%	2.2%	4.0%	14.3%	2.5%
C3	No. Participants	0	1	3	2	0	6
	% within Shade	0.0%	16.7%	50.0%	33.3%	0.0%	100.0%
	% within Age	0.0%	1.3%	6.7%	8.0%	0.0%	3.0%
C4	No. Participants	0	1	0	1	2	4
	% within Shade	0.0%	25.0%	0.0%	25.0%	50.0%	100.0%
	% within Age	0.0%	1.3%	0.0%	4.0%	14.3%	2.0%
D3	No. Participants	0	0	2	0	0	2
	% within Shade	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
	% within Age	0.0%	0.0%	4.4%	0.0%	0.0%	1.0%
D4	No. Participants	0	3	0	2	0	5
	% within Shade	0.0%	60.0%	0.0%	40.0%	0.0%	100.0%
	% within Age	0.0%	3.8%	0.0%	8.0%	0.0%	2.5%
Total	No. Participants	36	78	45	25	14	198
	% within Shade	18.2%	39.4%	22.7%	12.6%	7.1%	100.0%
	% within Age	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* $p < 0.05$.

Table 4. Pearson Chi-Square test shows the significant level between shade and age groups.

Chi-Square Tests			
	Value	**df**	**Asymptotic Significance (2-Sided)**
Pearson Chi-Square	96.008 [a]	60	0.002
Likelihood Ratio	82.950	60	0.027
Linear-by-Linear Association	16.142	1	0.000
N of Valid Cases	198		

[a] 68 cells (85.0%) have expected count less than 5. The minimum expected count is 0.07.

Table 5. Relationship between shade and skin types. Skin color type IV appeared to be the most dominant type.

Relationship between Shade and Skin Color *								
Shade		**Skin Color**						**Total**
		I	**II**	**III**	**IV**	**V**	**VI**	
A1	No. Participants	4	5	8	1	3	0	21
	% within Shade	19.0%	23.8%	38.1%	4.8%	14.3%	0.0%	100.0%
	% within Skin color	57.1%	12.2%	12.5%	1.5%	17.6%	0.0%	10.6%
A2	No. Participants	1	14	13	5	3	1	37
	% within Shade	2.7%	37.8%	35.1%	13.5%	8.1%	2.7%	100.0%
	% within Skin color	14.3%	34.1%	20.3%	7.5%	17.6%	50.0%	18.7%
A3	No. Participants	1	2	13	18	1	0	35
	% within Shade	2.9%	5.7%	37.1%	51.4%	2.9%	0.0%	100.0%
	% within Skin color	14.3%	4.9%	20.3%	26.9%	5.9%	0.0%	17.7%
A3.5	No. Participants	0	2	0	6	2	0	10
	% within Shade	0.0%	20.0%	0.0%	60.0%	20.0%	0.0%	100.0%
	% within Skin color	0.0%	4.9%	0.0%	9.0%	11.8%	0.0%	5.1%
A4	No. Participants	1	3	5	6	2	0	17
	% within Shade	5.9%	17.6%	29.4%	35.3%	11.8%	0.0%	100.0%
	% within Skin color	14.3%	7.3%	7.8%	9.0%	11.8%	0.0%	8.6%
B2	No. Participants	0	6	10	2	0	1	19
	% within Shade	0.0%	31.6%	52.6%	10.5%	0.0%	5.3%	100.0%
	% within Skin color	0.0%	14.6%	15.6%	3.0%	0.0%	50.0%	9.6%
B3	No. Participants	0	4	6	17	2	0	29
	% within Shade	0.0%	13.8%	20.7%	58.6%	6.9%	0.0%	100.0%
	% within Skin color	0.0%	9.8%	9.4%	25.4%	11.8%	0.0%	14.6%
B4	No. Participants	0	0	0	1	0	0	1
	% within Shade	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
	% within Skin color	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.5%
C1	No. Participants	0	1	1	3	0	0	5
	% within Shade	0.0%	20.0%	20.0%	60.0%	0.0%	0.0%	100.0%
	% within Skin color	0.0%	2.4%	1.6%	4.5%	0.0%	0.0%	2.5%
C2	No. Participants	0	2	2	1	0	0	5
	% within Shade	0.0%	40.0%	40.0%	20.0%	0.0%	0.0%	100.0%
	% within Skin color	0.0%	4.9%	3.1%	1.5%	0.0%	0.0%	2.5%
C3	No. Participants	0	0	3	2	1	0	6
	% within Shade	0.0%	0.0%	50.0%	33.3%	16.7%	0.0%	100.0%
	% within Skin color	0.0%	0.0%	4.7%	3.0%	5.9%	0.0%	3.0%
C4	No. Participants	0	0	2	2	0	0	4
	% within Shade	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	100.0%
	% within Skin color	0.0%	0.0%	3.1%	3.0%	0.0%	0.0%	2.0%
D3	No. Participants	0	1	0	0	1	0	2
	% within Shade	0.0%	50.0%	0.0%	0.0%	50.0%	0.0%	100.0%
	% within Skin color	0.0%	2.4%	0.0%	0.0%	5.9%	0.0%	1.0%
D4	No. Participants	0	1	1	1	2	0	5
	% within Shade	0.0%	20.0%	20.0%	20.0%	40.0%	0.0%	100.0%
	% within Skin color	0.0%	2.4%	1.6%	1.5%	11.8%	0.0%	2.5%
Total	No. Participants	7	41	64	67	17	2	198
	% within Shade	3.5%	20.7%	32.3%	33.8%	8.6%	1.0%	100.0%
	% within Skin color	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* $p < 0.05$.

Shade A1 was related to type I skin color in 57.1% of individuals. Skin color type II had A2 as a dominant shade by 34.1%. A2 and A3 shades were equally observed in skin color type III by 20.3%. A3 shade was observed in 26.9% with skin color IV, while A1 and A2 shared the most observed shade in skin color V by 17.6% (Table 5). The relationship between tooth shade and skin color is exhibited in (Figure 3). The results showed statistically significant differences between shade and skin color groups ($p < 0.05$) (Table 6).

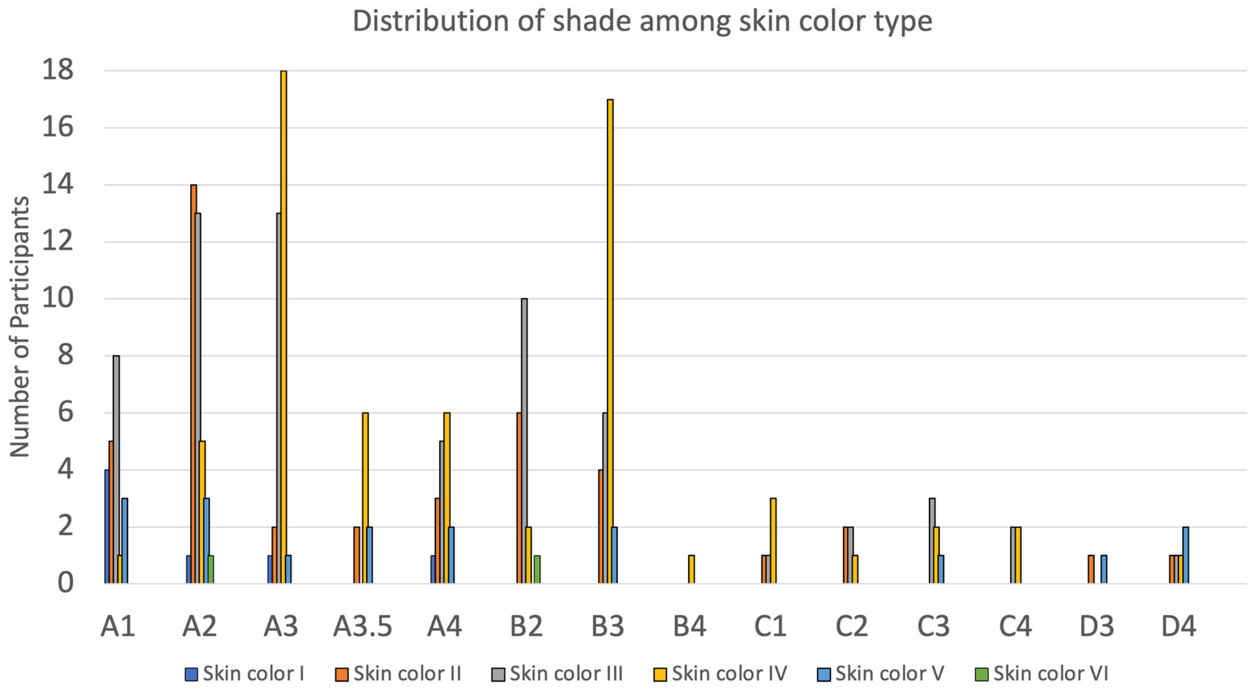

Figure 3. Relationship between teeth shade and skin color. Skin color type II had A2 as a dominant shade type.

Table 6. Pearson Chi-Square test shows the significant level between shade and skin type.

Chi-Square Tests			
	Value	**df**	**Asymptotic Significance (2-Sided)**
Pearson Chi-Square	96.689 [a]	75	0.047
Likelihood Ratio	100.032	75	0.028
Linear-by-Linear Association	7.172	1	0.007
N of Valid Cases	198		

[a] 81 cells (84.4%) have expected count less than 5. The minimum expected count is 0.01.

4. Discussion

Selecting a proper tooth shade is considered a complex process during prosthetic rehabilitation, which requires fundamental knowledge of color and esthetic. The dentist's skills in determining the right shade play a role in the success of treatment and patient satisfaction. Multiple factors such as light and background affect tooth color [21]. Some studies prefer using conventional shade tabs, while others consider digital devices for more accuracy and precision [22,23]. Digital devices can detect more data about tooth shade, such as lightness, Chroma, and Hue, which can aid in mimicking the color of adjacent natural teeth.

According to the present study, there was a relation between shade, gender, and skin type. The participants of this cross-sectional study belong to a specific ethnic group (Middle eastern) in a specific country (Saudi Arabia). Considering the regional limitation of the data collection and sample size, the most dominant tooth shade observed was shape A2. Labban et al. studied the Saudi population's perception of their preference for the desired tooth shade. In the above-mentioned study, the researchers provided the participants with a questionnaire consisting of images that had been modified digitally to illustrate different skin and tooth shade combinations. It was found that people with lighter skin preferred to have lighter teeth shade [9]. On the contrary, data on the participants' skin type and tooth shade were obtained directly without involving participants' subjectivity in the data acquisition. Skin color might be valuable when selecting teeth shade for edentulous patients. In this study, an observation of shade relation to skin color groups was statistically significant. People with type I skin tones possess lighter tooth shade (A1 type). Furthermore, darker skin tones such as type IV and V possess darker tooth shade (A3, A3.5 types). This finding contradicts the previous work of Jahangiri et al. and Al-Nsour et al., who reported that individuals with dark skin color have lighter teeth in comparison to individuals with light skin color [6,12]. This might contribute to different ethnic populations and regional limitations.

The hypothesis that males tend to have darker shades than females was reported in previous studies. Gómez-Polo et al. study showed that 25.4% of females had A2 shade while 18% of males had B3 Shade [9]. Kim et al. reported that females' teeth are lighter and less chromatic than males' teeth [15]. In the current study, females tend to have a lighter shade and less Chroma than males, which was in agreement with previous studies.

Based on our study, aging affects tooth color. Older participants tend to have darker teeth than younger individuals. Haralur observed that teeth become darker with age due to multiple factors such as enamel thickness reduction due to wear and secondary dentin deposition [16]. Furthermore, Karaman et al. reported that a statistically significant difference between age groups was valid for central and lateral incisors [24].

5. Conclusions

Within the limitations of this study, it can be assumed that females tend to have a lighter teeth shade than males. Younger individuals have lighter teeth shades than older people in the Saudi population. The process of shade selection should reflect on the relation between skin color and teeth shade. In terms of skin type, type IV was the most common among the Saudi population. Moreover, people with type I skin tones possess lighter teeth.

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