



ORIGINAL ARTICLE

Assessment of the influence of gender and skin color on the preference of tooth shade in Saudi population



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KEYWORDS

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Abstract *Aim:* The aim of the study was to evaluate the influence of gender and skin color on the preference of different teeth shades in general population.

Materials and methods: Two standardized frontal smile photographs of male and female subjects were manipulated using photoshop to represent 4 skin colors [(type II, III, IV, and V) (Fitzpatrick scale)]. The teeth shades under each skin color were digitally manipulated to represent one of 6 teeth shades (BL1, BL2, BL3, BL4, B1 and A1). A questionnaire assessed demographic characteristics (age, nationality, gender, education level, occupation, and income) along with the satisfaction of their smiles. Male and female set of pictures with combination of skin colors and teeth shades were presented and participants were asked to select the most esthetically pleasing teeth shade with regard to gender and skin color. Cross-tabulations and chi-squared tests were used to perform the statistical analyses ($\alpha = 0.05$).

Results: Three hundred and thirty-six (60.4% male; 39.6% female) individuals participated in the study. The difference in the preferred teeth shades was significant among the male and female photographs across all skin colors ($p < 0.05$). Lighter teeth shades were preferred among female subjects compared to male subjects with the same skin color. In addition, lighter teeth shades were preferred among subjects with a lighter skin color and vice versa ($p < 0.05$).

Conclusion: Gender and skin color influences the perception of teeth shades among general population. Therefore, lighter tooth shades (BL1, BL2) for lighter skin color and comparatively darker

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tooth shades (BL4, B1, A1) for darker skin individuals should be prescribed as these are perceived as natural among Saudi population.

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1. Introduction

The creation of an attractive but natural dental appearance has become a critical treatment success criterion in all fields of dentistry, in particular, in prosthetic and restorative dentistry (Carlsson et al., 2008). Smile (teeth and perioral tissues) is considered an expression of utmost importance in reflecting an individual's personality (Niaz et al., 2015). It is reported that patients show a particular desire for pearly white teeth (Qualtrough and Burke, 1994; Alkhatib et al., 2004) as they are associated with high ratings of social competence, intellectual ability, psychological adjustment and relationship status (Kershaw et al., 2008). Although, shape and alignment of teeth influence the smile attractiveness; the harmony between tooth color and soft tissues is considered precarious in determining individuals' satisfaction with dental appearance (Qualtrough and Burke, 1994; Tam and Lee 2012).

The process of shade selection is a continuous challenge for dental professionals as they attempt to satisfy the esthetic requirements of patients. The perception of tooth color is subjective and influenced by many factors, including the type of light, reflection and absorption of light by the tooth, adaptation state of the observer and the context in which the tooth is viewed (Sabherwal et al., 2009). In terms of the viewing context, perceived brightness and hue of the tooth can change depending upon the brightness and color of the background respectively (Dunn et al., 1996). Sabherwal et al., studied the effect of variations in skin color on the perceptions of smile attractiveness for a given tooth shade value. They reported, that variations in skin color for most tooth shade values influenced dentists' perceived smile attractiveness (Sabherwal et al., 2009). In addition, subjects with darker skin were rated the lowest in comparison with subjects with other skin colors (Sabherwal et al., 2009). Furthermore, perceived tooth whiteness and attractiveness are influenced by the color of surrounding lips and gingiva (Reno et al., 2000). In a study by Reno et al., it was concluded that a magenta hue appeared to enhance the perceived whiteness of tooth color, whereas yellow and darker hues failed to show such impact (Reno et al., 2000). Moreover, gender is also reported to influence shade matching, and females are significantly better at shade-matching than males (Haddad et al., 2009). However the evidence related to the influence of facial outline and features among males and females and its impact on shade perception is not available. It is noteworthy that these studies (Reno et al., 2000; Sabherwal et al., 2009) were performed among dental professionals and an opinion of the general population might differ from them on the basis of dental exposure and social experiences (Nakhaei et al., 2016; Pohlen et al., 2016).

Increased participation of patients is encouraged in decision making with regards to oral health treatment including shade selection and smile design. The selection of an artificial tooth or restoration with a proper shade has shown to influence

the patient's esthetic perception positively and improve prosthesis acceptance (Bauer et al., 2012). It is hypothesized that skin color and gender of patient have no effect on the selected teeth shade in general population. Therefore, the aim of the study was to evaluate the influence of gender and skin color on the preference of different teeth shades in general population.

2. Materials and methods

2.1. Preparation of photographs

The study protocol was approved by the College of dentistry research center (CDRC). Two adult subjects [male (35 age) and female (33 age)] with an esthetic smile showing most of the maxillary and mandibular anterior teeth were recruited (with consent) for the study. One standardized frontal view smile photograph of the teeth and perioral area was made for each of the two subjects (male and female) in ambient light using digital camera (Nikon d7100, Japan, shutter speed of 1/80 s and aperture of 8.0). The camera was placed at the level of the occlusal plane, and both subjects were asked to display a normal smile.

Six different teeth shades (BL1, BL2, BL3, BL4, A1, and B1) from a commercially available shade guide [A-D shade guide © 2016 Ivoclar Vivadent Inc., USA] (Fig. 1) were utilized in the study. Shade tabs were photographed using a digital camera (Nikon d7100, Japan, shutter speed of 1/80 s and aperture of 8.0, macro USM lens) and two external flashes in a photography tent (Neewer® 60 × 60 cm/24" × 24"). Each shade tab was photographed separately before being merged using Photoshop software (Adobe Lightroom, Adobe Systems Software Ireland Ltd.). The obtained photographs of the subjects were manipulated using Photoshop (Adobe Photoshop CC 2014). For each subject's photograph, the skin was modified into one of 4 skin colors [fair type II, medium III, olive IV and brown V (Fitzpatrick scale)] (Fig. 2). For each skin color in both male and female subject pictures, the original teeth shade was modified into one of six different shades using the obtained images from the shade tabs (BL1, BL2, BL3, BL4, B1, and A1) using Photoshop software. Six to eight copies of each shade tab were made, depending upon the visible teeth in the subjects' smile. Furthermore, they were arranged according to the subjects' teeth size (central, lateral and canine). Later, the shade was adapted using the software color-matching tool. In total, there were 48 modified images for both the male and the female subjects (Figs. 3–10). Performing a pilot test validated the shades. A sample of dentists were shown random skin tones along with random teeth shades and were asked to select the correct shade shown on a tablet computer. The total number of dentists who participated in the pilot test was 15.



Fig. 1 A-D shade guide ©.

The Fitzpatrick Scale



Fig. 2 The Fitzpatrick scale.

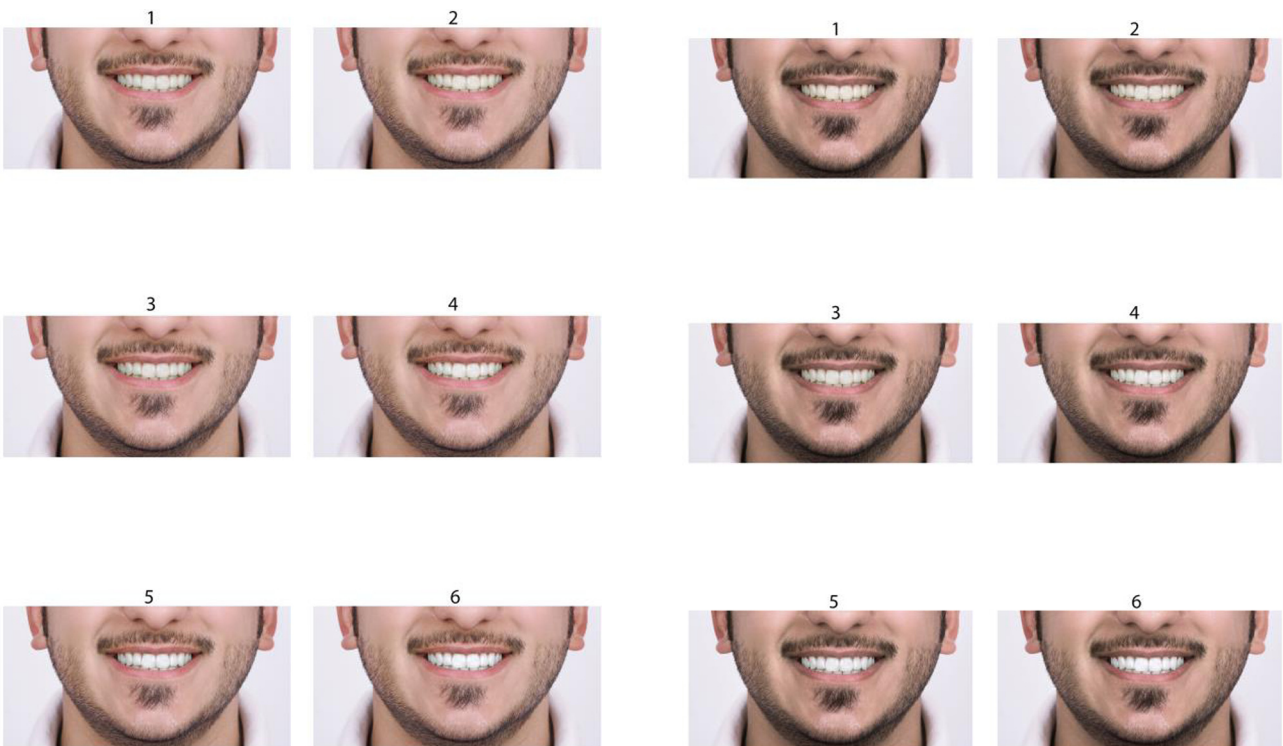


Fig. 3 Type II skin color.

Fig. 4 Type III skin color.

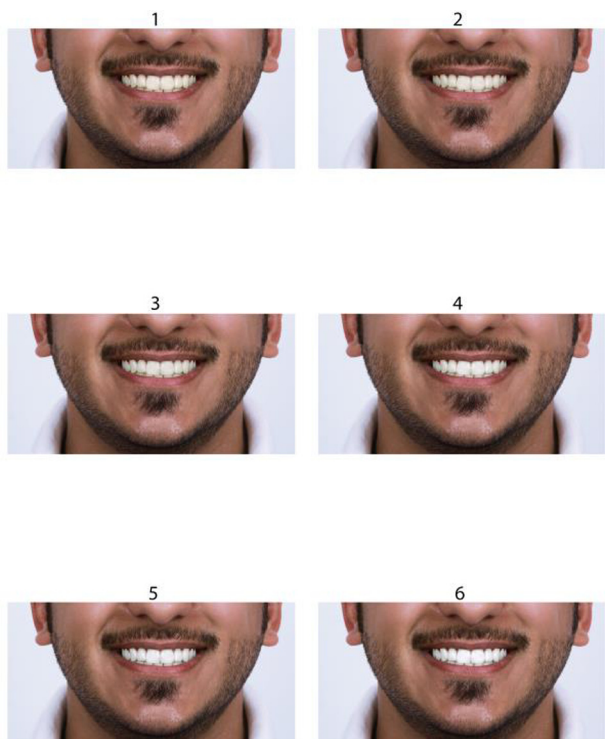


Fig. 5 Type IV skin color.

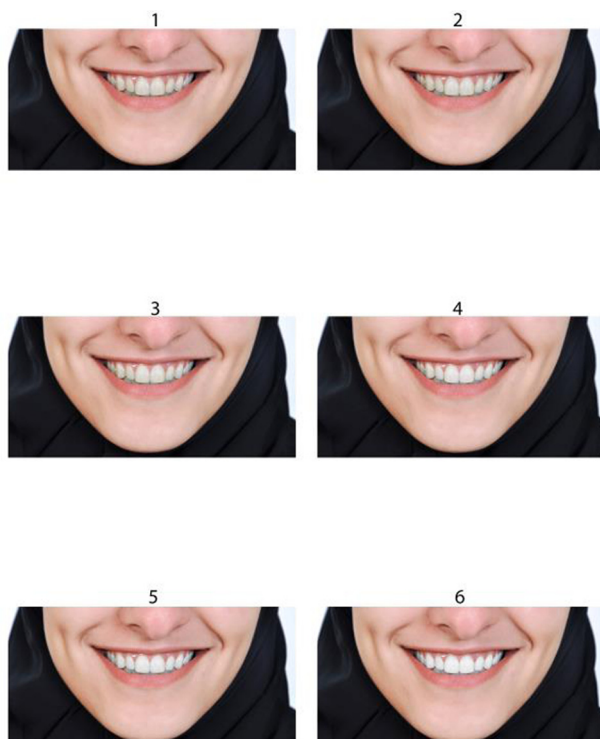


Fig. 7 Type II skin color (Female).

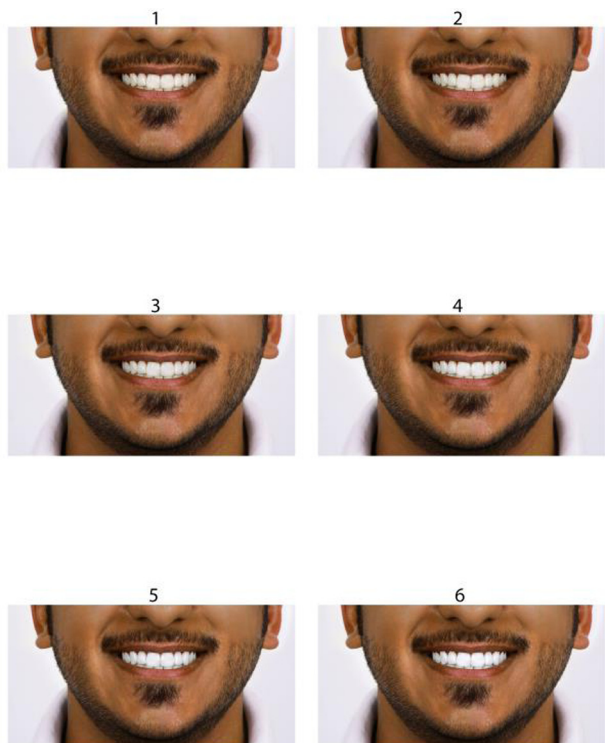


Fig. 6 Type V skin color.

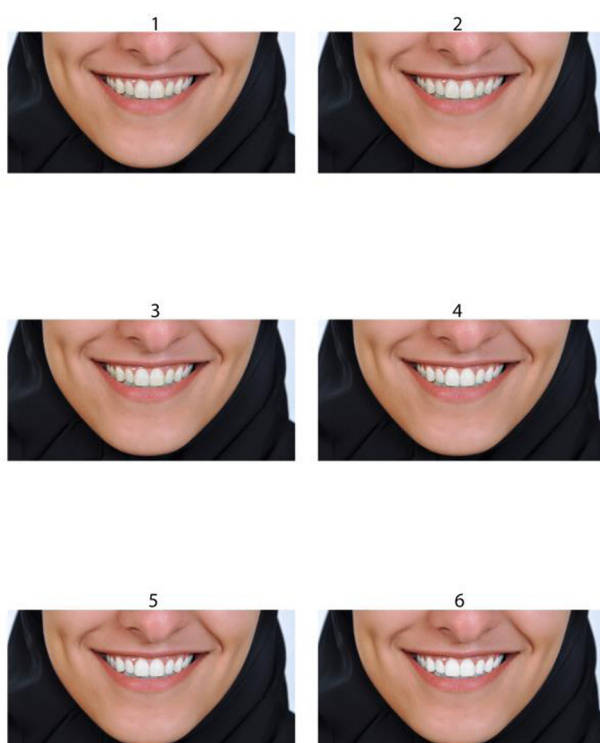


Fig. 8 Type III skin color (Female).

2.2. Questionnaire distribution and data collection

A consent was obtained from each participant prior to their being enrolled in this survey. The participants were randomly

selected from subjects who visited 3 different shopping malls (RG, GM and AMM) in Riyadh city. Exclusion criteria included dentists and individuals with color blindness. Partic-

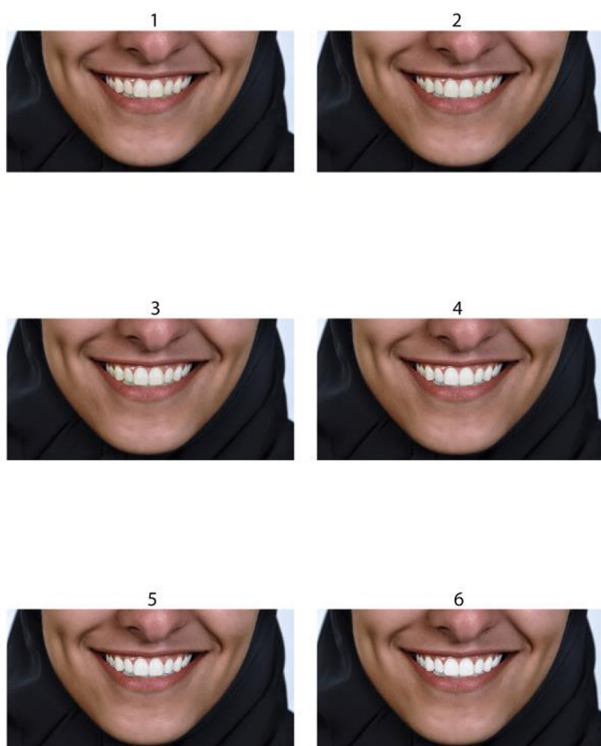


Fig. 9 Type IV skin color (Female).

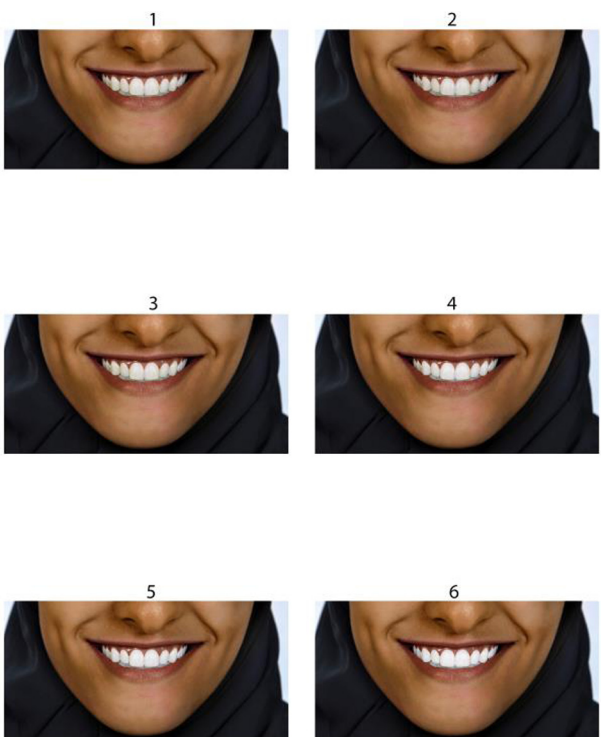


Fig. 10 Type V skin color (Female).

Participants were tested for color blindness using the Ishihara test (Fig. 11). The questionnaire was electronically displayed to the participants on a tablet device (Apple iPad Pro tablet, Apple Inc.). The questionnaire included items to assess demo-

graphic characteristics such as age, nationality, gender, education level, occupation, and income. The participants were asked to report level of satisfaction of their smiles on a scale from 0 to 10 (0, not satisfied and 10, very satisfied). Participants were also asked to indicate the importance of a smile using the same scale (0, not important and 10, very important). They were required to report their own skin color by selecting one of the 6 displayed skin tones [type I to VI-Fitzpatrick scale]. Sets of male and female pictures were displayed to the participants. Each set represented one skin color of each subject with 6 modified teeth shades. The participants were asked to select the most esthetically pleasing teeth shade with regard to gender and skin color. Therefore, each participant was asked to select a total of 8 shades from the 8 different sets of images. To ensure the standardization and optimal viewing conditions of the manipulated photographs, the tablet device (Apple iPad Pro tablet, Apple Inc.) was set to a brightness of 50% and contrast of 100%.

2.3. Statistical analysis

Data were analyzed using SPSS statistical software (version 16, SPSS Inc., Chicago, IL, USA). The frequencies and percentages of the socio-demographic data were calculated. Additionally, the frequencies and percentages of the most commonly selected shade among each of the male and female subject images were assessed. Cross-tabulations and chi-squared tests were used to analyze the significance of the participant choices and the influence of socio-demographic variables on the selected teeth shades. A p -value of ≤ 0.05 was considered significant.

3. Results

The total number of participants was 336. Males and females comprised 60.4% and 39.6% of the sample, respectively. Among the participants, 70.8% were below 30 years and 29.2% were more than 30 years (Table 1). Frequency of participants skin color ranged from 3% having type VI to nearly 34% with type III (Fitzpatrick scale) (Table 2).

3.1. Frequencies of the selected teeth shades under each skin color

The distribution and the percentage of the preferred teeth shades by the participants for the four skin colors in male and female subjects are shown in Table 3. Among the male subject images of types II, III, IV, and V skin colors, the most frequently selected shades were BL2, BL2, BL3, and A1, respectively. Among the images of females with type II, III, IV and V skin colors, BL1, BL2, BL3, and B1 were the most commonly selected shades, respectively. The differences in the selected teeth shades were found to be statistically significant among the male and female images of all skin colors ($p \leq 0.05$).

3.2. The effect of different socio-demographic variables on the preferred teeth shade

For male images, chi-squared tests revealed a significant association between the age of the participants and the preferred shade for type II and IV skin colors ($p \leq 0.05$). Participants ≤ 30 yrs and > 30 yrs of age preferred whiter shades (BL2 and BL1, respectively) for a lighter skin color (Type II). For male image with darker skin color (type IV), both > 30 yrs and ≤ 30 yrs old participants preferred a natural tooth shade (BL3) (Table 4). However, overall the differences in tooth

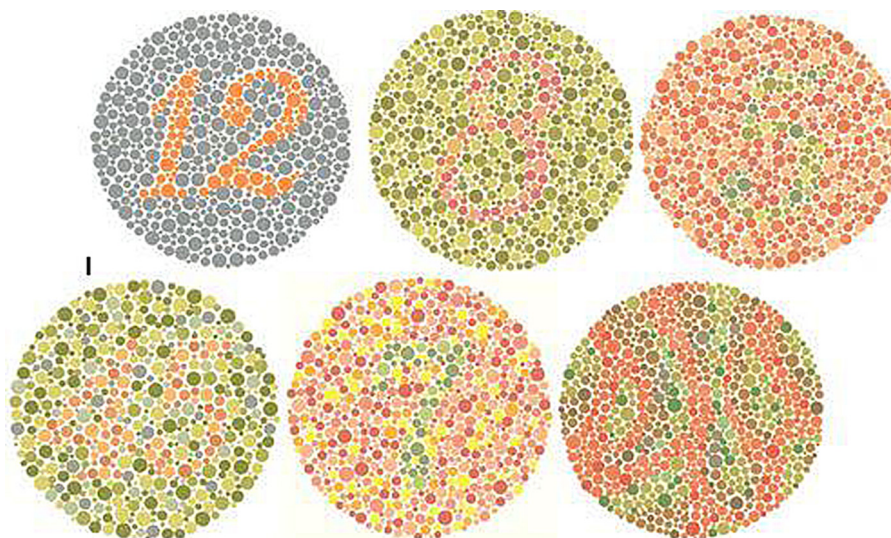


Fig. 11 Ishihara test.

Table 1 Distribution of socio-demographic characteristics of participants (*n* = 336).

Characteristics	No. (%)
<i>Age groups</i>	
≤30 years	238(70.8)
> 30 years	98(29.2)
<i>Gender</i>	
Male	203(60.4)
Female	133(39.6)
<i>Educational level</i>	
School level	127(37.8)
Bachelor and higher level	209(62.2)
<i>Occupation</i>	
Unemployed	126(37.5)
Governmental employee	127(37.8)
Private employee	83(24.7)
<i>Monthly income</i>	
≤7000 SR	182(54.2)
> 7000 SR	154(45.8)

Table 2 Distribution of skin tone of participants.

Study variables	No. (%)
<i>Skin color</i>	
Type I	38(11.3)
Type II	46(13.7)
Type III	114(33.9)
Type IV	65(19.3)
Type V	62(18.5)
Type VI	11(3.3)

shade preference by participants for male type IV images were significant (*p* = 0.034).

Chi-squared test also revealed a statistically significant association between the gender of the participants and the preferred shade among the male and female images (Table 5). Significant differences in shade preference among male and female participants were found in Male type II, type III, type IV and female type IV images. Overall, female participants preferred lighter shades (BL1, BL2, and BL3) as compared to the male participants. However, for male Type II images, females preferred BL2 in comparison with males who preferred BL1 (Table 5). A significant association between the education level of the participants and commonly selected dental shade was found only in the female subject's images with type IV skin color. The participants with a bachelor's degree or higher level of education preferred the BL3 shade (Table 6). In addition, a significant association between the monthly income of the participants and selected dental shade was found only in the female subject images with type III skin color. The

participants with a higher incomes (monthly >7000), preferred BL2 (31.2%) and BL1 (29.2%) shades (Table 7). However participants with low incomes (monthly < 7000), preferred BL2 (29.7%) and BL3 (26.4%) shades. No statistically significant association was found between participants' occupation and the selected dental shades for any of the male and female subject images.

4. Discussion

Shade matching is a complex phenomenon, which encompasses both subjective and objective characteristics (Sharma et al., 2010). Accurate identification of shade is a critical aspect in the execution of a successful dental treatment. The selection of teeth with a proper shade has shown to influence patient's esthetic perception positively and improve treatment prognosis (Bauer et al., 2012). Among other vital factors, facial complexion and skin color have the potential to influence the accuracy of shade matching. However, there is limited evidence to implicate skin color, as a factor influencing shade perception. Failure to associate these factors limits the ability of a dental clinician to select the proper artificial teeth shade to complement the facial complexion of the patient (Vadavadagi et al., 2016). According to the findings of this study, the hypothesis that skin color has no affect on the selected teeth shade in a Saudi general population was rejected.

Table 3 Distribution and comparison of preference of the 6 dental shades in each of the 4 skin color groups among male and female participants No (%).

Groups	Code of dental shade						Total	χ^2 -value	P-value
	A1	B1	BL4	BL3	BL2	BL1			
Male type II	12(3.6)	9(2.7)	34(10.1)	81(24.1)	102(30.4)	98(29.2)	336	163.11	<0.001
Male type III	7(2.1)	18(5.4)	52(15.5)	97(28.9)	101(30.1)	61(18.2)	336	135.57	<0.001
Male type IV	25(7.4)	50(14.9)	74(22.0)	100(29.8)	51(15.2)	36(10.7)	336	65.75	<0.001
Male type V	91(27.1)	81(24.1)	67(19.9)	44(13.1)	31(13.1)	22(6.5)	336	69.57	<0.001
Female type II	8(2.4)	7(2.1)	8(2.4)	71(21.1)	77(22.9)	165(49.1)	336	349.21	<0.001
Female type III	14(4.2)	30(8.9)	29(8.6)	82(24.4)	102(30.4)	79(23.5)	336	115.89	<0.001
Female type IV	29(8.6)	45(13.4)	51(15.2)	103(30.7)	63(18.8)	45(13.4)	336	58.11	<0.001
Female type V	57(17.0)	89(26.5)	76(22.6)	56(16.7)	31(9.2)	27(8.0)	336	52.11	<0.001

Table 4 Association between age of participants and their preferences of dental shades of different male and female groups No (%).

Groups	Age groups (in years)		χ^2 -value	p-value
	≤30	>30		
<i>Male type II</i>				
A1	4(1.7)	8(8.2)	13.35	0.020
B1	6(2.5)	3(3.1)		
BL4	21(8.8)	13(13.3)		
BL3	58(24.4)	23(23.5)		
BL2	81(34.0)	21(21.4)		
BL1	68(28.6)	30(30.6)		
<i>Male type IV</i>				
A1	19(8)	6(6.1)	12.03	0.034
B1	30(12.6)	20(20.4)		
BL4	58(24.4)	16(16.3)		
BL3	78(32.8)	22(22.4)		
BL2	32(13.4)	19(19.4)		
BL1	21(8.8)	15(15.3)		

Dental shades of BL1 to BL4, A1, and B1 were selected in the study, as they were relevant to the current popular tooth whitening market. Whiter teeth have been positively correlated with high ratings of social competence and intellectual ability. Therefore, it was logical to examine the effect of different skin colors on the perception of white teeth shades that are commonly used in everyday dentistry.

In the present study, it was observed that lighter teeth shades were preferred (BL1, BL2, and BL3) and were considered to be more esthetically appealing with fair skin color. However, when the skin color became darker, the participants preferred darker teeth shades (BL4, B1, and A1). A possible explanation for this may be derived from the fact that the perception of teeth shade is influenced by a number of factors relating to the context in which the tooth is viewed (Joiner et al., 2008). The perceived brightness of the tooth can change, depending upon the brightness of the background (Stephen, 2003). Sabherwal et al. (2009) conducted a study to determine whether variations in skin color would influence perceptions of smile attractiveness for a given tooth shade value. They concluded that variation in skin color for most teeth shade values influenced the perceived smile attractiveness. In a similar study, Jahangiri et al., assessed the relationship between skin color and teeth shade in a multiracial population. However, they found an inverse relationship between skin color and

teeth shade (Jahangiri et al., 2002). In addition, Hassel et al., conducted a study in a Caucasian cohort evaluating teeth shade with the Vita Lumin shade guide and correlated with different skin colors (Hassel et al., 2008). They found no relationship between teeth shade and skin color. Hassel et al. (2008). It is noteworthy that none of these studies (Jahangiri et al., 2002; Hassel et al., 2008; Sabherwal et al., 2009) took into consideration the opinion of the general public regarding which teeth shade is considered to be esthetically appealing in relation to different skin colors. Therefore in light of findings in the present study, it is suggested to advise darker-skinned patients with relatively darker teeth shade (BL4, B1, and A1), as whiter teeth shades (BL1, BL2) can be perceived as being unnatural in their appearance.

The effects of different socio-demographic variables on shade preference were also examined in the present study. With regards to the influence of gender on the outcome of shade preference, the results demonstrated that female participants preferred lighter shades than male participants. In a similar study by Sabherwal et al., it was reported that males assigned lower ratings to images than females (Sabherwal et al., 2009). It was also reported that males are more critical of physical attractiveness than females and that females tend to give higher ratings of attractiveness than males (Cochrane et al., 1998). In addition, Vallittu et al., found that as the age of par-

Table 5 Association between gender of participants and preferences of dental shades of different male and female groups No (%).

Groups	Gender		χ^2 -value	P-value
	Male	Female		
<i>Male type II</i>				
A1	10(4.9)	2(1.5)	17.99	0.003
B1	6(3.0)	3(2.3)		
BL4	26(12.8)	8(6.0)		
BL3	47(23.2)	34(25.6)		
BL2	47(23.2)	55(41.4)		
BL1	67(33.0)	31(23.3)		
<i>Male type III</i>				
A1	7(3.4)	0(0)	20.75	0.001
B1	15(7.4)	3(2.3)		
BL4	39(19.2)	13(9.8)		
BL3	52(25.6)	45(33.8)		
BL2	50(24.6)	51(38.3)		
BL1	40(19.7)	21(61)		
<i>Male type IV</i>				
A1	22(10.8)	3(2.3)	21.51	0.001
B1	31(15.3)	19(14.3)		
BL4	48(23.6)	26(19.5)		
BL3	44(21.7)	56(42.1)		
BL2	35(17.2)	16(12.0)		
BL1	23(11.3)	13(9.8)		
<i>Female type IV</i>				
A1	23(11.3)	6(4.5)	15.52	0.008
B1	21(10.3)	24(18.0)		
BL4	31(15.3)	20(15.0)		
BL3	53(26.1)	50(37.6)		
BL2	42(20.7)	21(15.8)		
BL1	33(16.3)	12(9.0)		

Table 6 Association between educational level of participants and preferences of dental shades of male and female No (%).

Groups	Educational level		χ^2 -value	p-value
	School level	Bachelor and Higher education level		
<i>Female type IV</i>				
A1	16(12.6)	13(6.2)	11.95	0.036
B1	18(14.2)	27(12.9)		
BL4	15(11.8)	36(17.2)		
BL3	33(26.0)	70(33.5)		
BL2	21(16.5)	42(20.1)		
BL1	24(18.9)	21(10.0)		

Table 7 Association between Income of participants and preferences of dental shades of different male and female No (%).

Groups	Monthly Income (in SR)		χ^2 -value	p-value
	≤7000	> 7000		
<i>Female type III</i>				
A1	7(3.8)	7(4.5)	15.42	0.009
B1	25(13.7)	5(3.2)		
BL4	14(7.7)	15(9.7)		
BL3	48(26.4)	34(22.1)		
BL2	54(29.7)	48(31.2)		
BL1	34(18.7)	45(29.2)		

ticipants increased, the perception that whiter teeth are more attractive decreased (Vallittu et al., 1996). They also found that younger participants expressed a greater preference for white teeth than older participants (Vallittu et al., 1996). However, in the present study the correlations between age and teeth shade preference were not found to be significant.

One possible compromise in the study is that although both the male and the female subjects were photographed under the exact same conditions, no attempt was made to compare their images. Due to social factors, the female subject had a darker background (black) than the male subject. This background variation could have influenced the preferences of the participants. However as the outcomes of this study mostly address the local population and their preference for teeth shades in Saudi Arabia, the results are valid for the included population. Therefore, further studies to assess the influence of skin color and gender of subject on the preferred tooth shades in different population cohorts are recommended.

5. Conclusion

It is concluded that variations in skin color influence the perceptions of teeth shade in general population. In addition, lighter teeth shades were preferred for lighter skin colors and vice versa. Therefore it is proposed that lighter tooth shades (BL1, BL2) for lighter skin color and comparatively darker tooth shades (BL4, B1, A1) for darker skin individuals should be prescribed as these are perceived as natural among Saudi population.

Conflict of interest

The authors of the manuscript do not have conflict of interest to declare.

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