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Determination of the extent of the polychromatic nature of teeth using a Nigerian adult population

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Abstract

Background/Objective: Teeth are composed of a number of colours and individual tooth colour also varies from the gingival margin to the incisal edge. This study sought to determine the extent of the polychromatic nature of teeth using a Nigerian adult population

Materials and method: This was a cross-sectional study of patients receiving fixed prosthesis in UBTH. Visual assessment using vita shade guide was used to determine the shade of the teeth to receive the fixed prosthesis. The shade of the incisal/occlusal half and the cervical half were assessed and recorded along with the age, gender and tooth. Data collated was subjected to statistical analysis using the SPSS 21.0. The statistical tools employed were descriptive statistics, independent sample t-test, non-parametric test (Kruskal-Wallis test) where appropriate.

Results: A total of 115 participants were recruited for the study with age ranging from 19 to 79 years and a mean age of 42.87±14.5 years. The most prevalent shade recorded for the incisal/occlusal half was A2 (39.1%) while the most prevalent shade recorded for the cervical half was A3 (38.3%). Four hues were recorded for both incisal/occlusal and cervical halves with the most represented hue being A in both incisal/occlusal (73.9%) and cervical (69.6%) halves. The shade difference between the incisal/occlusal and cervical half of the teeth ranged from -7 to 11 with a mean of 3.59±2.65. The mean shade difference between the incisal/occlusal and cervical half of the teeth was higher in females (3.83±2.38) compared to males (3.27±2.97), however this was not statistically significant (p=0.26).

Conclusion: Teeth are polychromatic in nature with the cervical shade darker than the incisal/occlusal. However, this difference is not significant and is not influenced by gender, age or tooth type with the predominant hue being A.

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Introduction

Teeth are composed of a number of colours and individual tooth colour also varies from the gingival margin to the incisal edge [1]. Dentin confers the basic colour to the dental element, or the hue, this colour is not entirely perceived by the observer, as the enamel modulates the chroma and the value of the hue according to its greater or smaller thickness. Regions where the thickness of the enamel is smaller, such as the cervical third, tend to be darker when compared to the middle and incisal thirds, as the colour conferred by the dentin is less subject to enamel modulation, and thus it is more easily perceived [2]. With the increase in enamel thickness towards the middle third, there is a progressive decrease of the intensity or the colour chrome. The hue remains the same, although the greater thickness of the enamel interferes in its perception, giving it a less saturated aspect [3-5].

A better understanding of the optical behaviour of dental tissues has allowed a more artistic approach for accomplishment of aesthetic restorations [3]. It is a complex restorative challenge to achieve true harmonisation of the primary parameters in aesthetics [2,6]. In order to achieve a naturally appearing restoration clinicians are expected to have a comprehensive knowledge of the optical properties of the teeth as well as the dimensions of colour [7].

The colour of teeth is of considerable importance to the general population with the social and psychological impact of tooth discoloration becoming increasingly less tolerated [8]. There is need for proper interpretation of shade variations while trying to achieve aesthetic restorations [3].

The natural tooth has been demonstrated to be polychromatic in nature [2,9-11] having a great variety of colours and nuances that can be perceived and interpreted by the human brain [10,11]. It has been reported that tooth colour varies among the gingival, incisal and cervical areas according to the thickness, reflection of different colours and translucency of enamel and dentine [5]. However, the extent of the differences in colour is yet to be determined hence this study which seeks to determine the extent of the polychromatic nature of teeth using a Nigerian adult population.

Methodology

This was a cross-sectional study of patients receiving fixed prosthesis in the University of Benin Teaching Hospital over a 2-year period (January 2016 to December 2018). Colour selection was done on clean teeth and with the natural humidity of the oral cavity because water plays a fundamental role in the final colour outcome. Enamel dehydration reduces its translucency by 82%, misleading the clinician to select a lighter and more opaque shade than the natural tooth colour [2]. The vita shade guide was used to determine the shade of the teeth to receive the fixed prosthesis.

Colour is a three-dimensional system and can be described according to the Munsell colour space in terms of hue, value and chroma [11-13]. Hue is a descriptive term which enables one distinguish between different families of colour and refers to the main name of the colour or colour family such as red, blue, yellow, orange as perceived by the observer. This is represented by the letters A, B, C, D in a Vita shade guide. Value refers to the dynamic dimension of the bodies and corresponds to the luminosity of the colour [3,10]. It is the relative lightness or darkness of a colour on a scale from black to white. Chroma is the quality used to describe the degree of colour saturation or intensity and strength of a colour as it changes, for example pink to crimson [1,3,10]. This is represented by Arabic numerals in the Vita shade guide.

The 16 tabs of the shade guide arranged from highest (B1) to lowest (C4) value. Although this scale is not linear in the truest sense, the changes are treated as representing a continuous and approximately linear ranking for the purpose of analysis [14].

Vita shade guide	B1	A1	B2	D2	A2	C1	C2	D4	A3	D3	B3	A3.5	B4	C3	A4	C4
Scores	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Data collated was subjected to statistical analysis using the SPSS 21.0. The statistical tools employed were descriptive statistics (frequencies, percent, mean and standard deviation), independent sample t-test, non-parametric test (Kruskal-Wallis test), cross tabulations, Chi Square test and where cells had counts less than 5 Fischer's exact was used.

Result

A total of 115 participants were recruited for the study with age ranging from 19 to 79 years and a mean age of 42.87±14.5 years. There was a higher proportion of females (57.4%) with a male female ratio of 1: 1.35. Those within the ages of 31 to 50 years made up 47.8% of the study population (Table 1).

Table 1: Age and gender distribution of the participants

	Frequency	Percent
Age group (years) ≤ 30	29	25.2
31-50	55	47.8
>50	31	27.0
Gender Male	49	42.6
Female	66	57.4
Total	115	100.0

With regards to the characteristics of the teeth evaluated as depicted in Table 2, more than half (55.7%) of the teeth evaluated were central incisors while canines were the least (7.0%). Majority (94.8%) of the teeth evaluated were located in the maxillary arch. Most (76.5%) of the teeth evaluated had same shade at the incisal and cervical half.

Table 2: Characteristics of teeth evaluated among the participants

Characteristics	Frequency	Percent
Teeth Central incisor	64	55.7
Lateral incisor	17	14.8
Canine	8	7.0
First premolar	16	13.9
Second premolar	10	8.7
Arch Maxillary	109	94.8
Mandibular	6	5.2
Value of incisal and cervical shade Same	88	76.5
Different	27	23.5
Total	115	100.0

Ten shades were recorded for the incisal/occlusal half while 15 shades were recorded for the cervical half (Figure 1). The most prevalent shade recorded for the incisal/occlusal half was A2 (39.1%) while the least recorded was C3 (0.9%). The most prevalent shade recorded for the cervical half was A3 (38.3%) while the least shade recorded was A1, B4, C2, C4 each 0.9% (Figure 2).

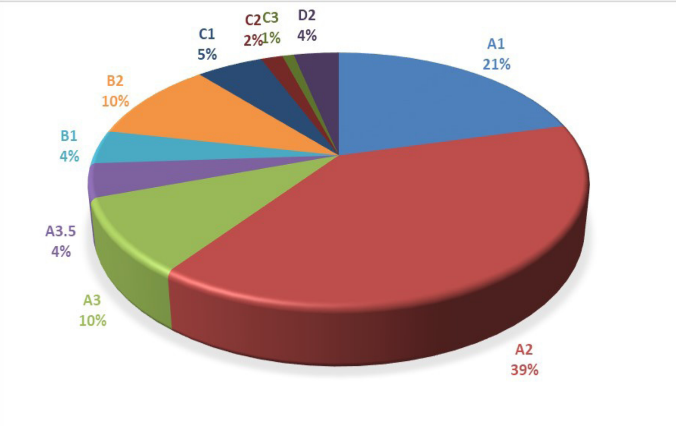

Figure 1: Distribution of incisal/occlusal shade

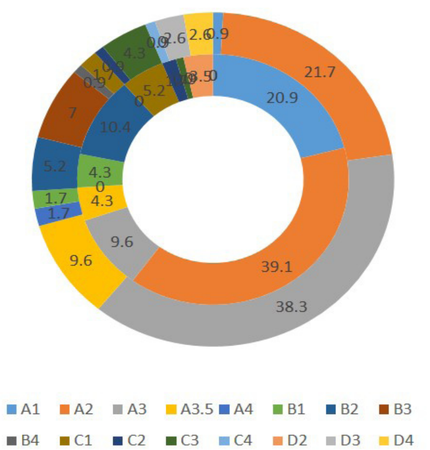

Figure 2: Shade distribution of incisal/occlusal and cervical shade

Four hues (A, B, C & D) were recorded for both incisal/occlusal and cervical halves with the most represented hue being A in both incisal/occlusal (73. 9%) and cervical (69.6%) halves. The least represented hue was D in both incisal/occlusal (3.5%) and cervical (5.2%) halves (Figure 3). There was statistically significant association between the incisal/occlusal half hue and cervical half hue with a higher proportion of the incisal/occlusal half hue corresponding to the cervical half hue (p<0.0001) (Table 3).

Table 3: Characteristics of teeth evaluated among the participants

Incisal/ occlusal half hue	Cervical hue				Total
	A	B	C	D	
A	72 (84.7)	10 (11.8)	3 (3.5)	0 (0.0)	85 (100.0)
B	7 (38.9)	9 (50.0)	2 (11.1)	0 (0.0)	18 (100.0)
C	1 (12.5)	1 (12.5)	4 (50.0)	2 (25.0)	8 (100.0)
D	0 (0.0)	0 (0.0)	0 (0.0)	4 (100.0)	4 (100.0)
Total	80 (69.6)	20 (17.4)	9 (7.8)	6 (5.2)	115 (100.0)

Fisher's exact <0.0001

Majority (94.8%) had their cervical shade darker than their incisal/occlusal shade. The shade difference between the incisal/occlusal and cervical half of the teeth evaluated in this study ranged from -7 to 11 with a mean of 3.59±2.65. The mean shade difference between the incisal/occlusal and cervical half of the teeth was higher in females (3.83±2.38) compared to males (3.27±2.97), however this was not statistically significant (p=0.26). In like manner there was no statistically significant association in shade difference between the incisal/occlusal and cervical half of the teeth across categories of age groups (p=0.726) as well as across categories of teeth (p=0.396).

There was no statistically significant association between gender, arch and type of teeth evaluated and the incisal/occlusal and cervical shades recorded. However, there was statistically significant association between the value of the incisal/occlusal half and the cervical half with almost all (93.1%) of the participants less than 30years of age having same shade value at the incisal/occlusal half and the cervical half (p=0.029) (Table 4).

Table 4: Association between age group and shade at incisal/occlusal and cervical half

Age group (years)	Shade at incisal/occlusal and cervical half		Total
	Same	Different	
<30	27 (93.1)	2 (6.9)	29 (100.0)
30 -50	37 (67.3)	18 (32.7)	55 (100.0)
>50	24 (77.8)	7 (22.6)	31 (100.0)
Total	88 (76.5)	27 (23.5)	115 (100.0)

P=0.029

There was no statistically significant association between the age group and the cervical half shade (p=0.233). However, Table 5 depicts a statistically significant association between the age group of the participants and the incisal/occlusal half shades recorded (p=0.031).

Table 5: Association between age group and incisal/occlusal shade

Age group (years)	Incisal/occlusal shade										
	A1	A2	A3	A3.5	B1	B2	C1	C2	C3	D2	Total
< 30	10 (34.5)	12(41.4)	3 (10.3)	0 (0.0)	2 (6.9)	0 (0.0)	1 (3.4)	0 (0.0)	0 (0.0)	1 (3.4)	29 (100.0)
30-50	9 (16.4)	24 (43.6)	5 (9.1)	0 (0.0)	3 (5.5)	8 (14.5)	2 (3.6)	2 (3.6)	1 (1.8)	1 (1.8)	55 (100.0)
>50	5 (16.1)	9 (29.0)	3 (9.7)	5 (16.1)	0 (0.0)	4 (12.9)	3 (9.7)	0 (0.0)	0 (0.0)	2 (6.5)	31 (100.0)
Total	24 (20.9)	45 (39.1)	11 (9.6)	5 (4.3)	5 (4.3)	12 (10.4)	6 (5.2)	2 (1.7)	1 (0.9)	4 (3.5)	115 (100.0)

Fisher's Exact = 0.031

Discussion

The colour and appearance of teeth are a phenomenon, created by a lot of factors such as lighting conditions, translucency, opacity, light scattering, gloss, and human perception [15]. Tooth tissues (pulp, dentin, and enamel) have different optical properties, and their natural appearance depends on their thickness, calcification, composition, and translucency, which are ultimately responsible for the polychromatic characteristics of the crown [16].

The higher proportion of females supports the evidence that females are more conscious about their appearance because they feel their appearance is central to how they are evaluated by others [17,18].

Age has been found to be an important sociodemographic factor that impacts on an individual's perception of dental aesthetic [17], and this has been found to be more common among the younger age group [18,19]. This could be the probable reason why participants in this study belonged to the fourth to sixth decade of life.

The central incisors formed the bulk of teeth evaluated in this study. This may be due to their prominence in the maxillary jaw making them very key in evaluation of aesthetics. Hence, they tend to be restored or replaced when flawed. They are also very significant in the assessment of a person's smile. The canines are about the strongest teeth in the dentition and tend to be rarely restored hence their low prevalence in this study.

It was observed in this study that the majority of the teeth evaluated were in the maxillary arch. In the ideal occlusion, the maxillary arch is ahead of the mandibular arch and tends to be more proclined. This proclination of the maxilla makes the teeth subject to fracture during trauma. This may have contributed to the increased involvement of maxillary teeth in this study.

Although, the thickness of enamel is greater at the occlusal/incisal edge of the tooth and thinner at the cervical third making the teeth to be darker on the cervical one third than at the middle or incisal one third [5], it was observed in this study that majority of the teeth evaluated had no shade difference between the incisal and cervical half of the teeth. This may be due to age changes in the enamel with the structure and level of ionic processes changing with age [20].

Ten shades were recorded for the incisal/occlusal half while 15 shades were recorded for the cervical half in this study. This lends credence to previous observation that differences do exist in colour among different people, different teeth in one person and even within a tooth [21]. This further depicts the polychromatic nature of teeth which could be as a result of the different optical properties of teeth and their natural appearance that depends on their thickness, calcification, composition and translucency [16].

Paravina et al. [22] divided tooth shades into four categories based on their value, they include the highest value group (shades A1, B1, A2, B2), high value group (shades C1, D2, A3, D4), medium value group (shades B3, B4, C2, C4) and low value group (shades A3.5, C3, A4, C4). Shade A2 which belongs to the highest value group was found to be most prevalent in the incisal/cervical half of the crowns recorded while shades A1, B4, C2 and C4 were the least shades recorded, these fall within the high and medium value groups. The findings of this study differ from that of Rana et al. [23], which reported only highest and high value groups.

The normal colour of permanent teeth is grayish yellow, grayish white or yellowish white. With age, the colour of the teeth changes to more yellow or grayish yellow due to increase in dentin thickness and decrease in enamel thickness [5]. The hue of the teeth is the colour of the teeth and it is represented by the alphabet A, B, C and D. Of the hues recorded hue A was the most represented both in incisal/occlusal half and cervical half. A finding similar to previous reports [23,24].

Cervical shades were darker than the corresponding incisal/occlusal shade with a shade difference ranging from -7 to 11 and a mean of 3.59±2.65. This may be because regions where the thickness of the enamel is smaller, such as the cervical third, tend to be darker when compared to the middle and incisal thirds, as the colour conferred by the dentin is less subject to enamel modulation, and thus it is more easily perceived [2].

It's been reported that age and gender affect tooth colour [25]. However, in this study it was observed that there was no association between gender, arch and type of teeth a finding similar to previous studies [26-28]. But in contrast to other studies which observed significant differences in tooth colour by gender [19,25,29]. The reason for this slight difference in tooth colour by gender is probably because the human eye is not able to pick all the nuances in tooth shade [25] as some of these studies utilized spectrophotometer in their assessment of tooth shade. Furthermore, it is not always very easy to artificially reproduce all the intrinsic characteristics with the need for the dentist to have an artistic sense in order to identify details and define the different nuances of each tooth [30].

This study revealed that almost all of the participants less than 30years of age had same shade value at the incisal/occlusal half and the cervical half of their teeth. It has been reported that as age increases the colour of the teeth darkens as a result of secondary dentin deposition that increases with age and thinning of enamel due to tooth wear [28,31]. Also, it has been suggested that the value of teeth should correspond to the lightness or darkness of the skin colour [32].

Conclusion

Teeth are polychromatic in nature with the cervical shade darker than the incisal/occlusal. However, this difference is not significant and is not influenced by gender, age or tooth type with the predominant hue being A.

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