https://doi.org/10.54589/aol.35/2/98

Tooth color in dental students from Buenos Aires University, Dental School, Argentina

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ABSTRACT

The aim of this study was to evaluate tooth color in dental students at the University of Buenos Aires, Argentina. The participants were 184 students (157 women and 27 men) aged 21 to 33 years, mean age 24.45 (SD 2.79) years, who were in the fourth year of their dental degree. They agreed to participate through an informed consent. Exclusion criteria were: having undergone a bleaching treatment within the previous six months, presence of total or partial peripheral restoration, pigmentations, fracture, carious and non-carious lesions or absence of the right upper central incisor (1.1). A dental prophylaxis procedure was performed on the buccal surface of each 1.1 tooth with a prophylaxis brush (TDV) mounted on a low-speed rotary instrument Kavo 2068 CHC (Germany) micromotor and a Kavo LUX K201(Germany) contra-angle. Shade was measured in the middle third of each 1.1 tooth, by the same observer, using a VITA Easyshade V spectrophotometer (Zahnfabrikn Bad Säckingen, Germany), which was calibrated before each determination according to manufacturer's instructions, in the same dental unit (Sino S2316), with natural illumination, in the same time slot, without using the dental unit lamp. The results were recorded in an ad-hoc form and rates and confidence interval were obtained. Shade prevalence percentages (95% CI) were: A1: 46.2 (38.83 - 53.68); followed by A2 and B2, both with 17.39 (12.21 - 23.66); A3: 6.52 (3.41-11.11); B1: 4.35 (1.9-8.39); D2: 2.72 (0.89 - 6.23); B3: 2.17 (0.60-5.47) and C2: 1.09 (0.13-3.87); D3, C3, A3.5 and A4: 0.54 (0.01-2.99). Shades D1 and C1 were not determined in any subject.

Within the conditions of this study, A1 was the most prevalent shade in central incisors, followed by A2 and B2.

Keywords: *tooth - color - spectrophotometry.*

Color dentario en estudiantes de la Facultad de Odontología de la Universidad de Buenos Aires, Argentina

RESUMEN

El objetivo de este estudio fue evaluar la prevalencia de color dental en estudiantes de odontología de la Universidad de Buenos Aires (UBA). Los participantes fueron 184 estudiantes de cuarto año de la carrera de Odontología (157 mujeres y 27 hombres) de entre veintiuno y treinta tres años, con un promedio de edad de 24,45 (DE 2,79) años que aceptaron participar mediante consentimiento informado. Criterios de exclusión: quienes hayan recibido blanqueamiento en los últimos seis meses, tenían una restauración periférica total o parcial, pigmentaciones, fractura, lesiones cariosas y/o no cariosas en el incisivo central superior derecho (1.1) o éste estaba ausente. Se realizó profilaxis dental en la superficie bucal de cada 1.1 con un cepillo ad-hoc (TDV) montado en un micromotor de baja velocidad Kavo 2068 CHC (Alemania) y un contra-ángulo Kavo LUX K201 (Alemania). La medición del color se llevó a cabo en el tercio medio de cada 1.1, por el mismo observador, en la misma clínica dental, con iluminación natural en la misma franja horaria y sin utilizar la lámpara del equipo dental. Se utilizó un espectrofotómetro VITA Easyshade V (Zahnfabrikn Bad Säckingen, Alemania) que se calibró antes de cada determinación de acuerdo con las instrucciones del fabricante. Los resultados se registraron en una planilla ad-hoc y se obtuvieron tasas e intervalos de confianza. Prevalencia de colores % (IC 95%): A1: 46,2 (38,83 - 53,68), seguido de A2 y B2 ambos con 17,39 (12,21 - 23,66), A3: 6,52 (3,41-11,11), B1: 4,35 (1,9- 8,39), D2: 2,72 (0,89 - 6,23), B3: 2,17 (0,60-5,47) y C2: 1,09 (0,13-3,87); D3, C3, A3.5 y A4: 0.54 (0.01-2.99) D1 y C1 no se determinaron en ningún sujeto.

Dentro de las condiciones de este estudio A1 fue el color más prevalente en los incisivos centrales de estudiantes de odontología, seguido de A2 y B2.

Palabras clave: *diente - color - espectrofotometría.*

To cite:
Trigo-Humaran MM, Agüero-Romero AB, Lespade M, García-Cuerva JM, Iglesias ME. Tooth color in dental students from Buenos Aires University, Dental School, Argentina. Acta Odontol Latinoam. 2022 Sep 30;35(2):98-104. https://doi.org/10.54589/aol.35/2/98

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Received: May 2022.
Accepted: July 2022.

INTRODUCTION

Characterization and reproduction of tooth color is one of the main objectives of cosmetic and restorative dentistry. The increase in patients' aesthetic demands has resulted in the development of high-performance restorative materials such as ceramics and composites[1].

Color identification and communication has been a challenge in virtually every application area. Traditionally, the color of teeth has been described in terms of the parameters of the Munsell system, and its dimensions, hue, value and chroma. However, in order to facilitate the quantification of color differences, the CIE L*a*b* (CIELAB) chromatic model is currently employed, which enables description of all the colors perceived by the human eye, and is based on the standardization of sources of light and observers[2,3]. It was developed specifically for this purpose by the *Commission Internationale de L'eclairage* (International Commission on Illumination) in 1931[4] and was re-published in 1971[5]. The asterisks (*) that follow each letter are part of the name (L*, a* and b*), since they determine the chromatic coordinates L, a, and b. The three parameters in the model represent: the luminosity (value) of color (L*; L* = 0 indicates black and L* = 100 white), and while a* designates its position between red and green (negative values indicate green while, positive values indicate red), b* indicates its position between yellow and blue (negative values indicate blue and positive values indicate yellow)[2,4]. The CIELab color model is three-dimensional because color can only be adequately represented in a space[5]. Over the years, simplified, agile, more or less reliable and reproducible color measurement methods have been developed through the optimization of traditional dental color guides, and the recent introduction of digital instruments[6,7].

The most popular method for color determination is visual, which is based on elements called visual color guides (VCG) that employs standardized colors. One of the most frequently used VCG in dental practice and by laboratory technicians is the VITA Classical guide (VITA Zahnfabrik, Bad Säckingen, Germany)[1,8]. The visual color guides only achieve an approximation to tooth color, and their shades are the product of average values obtained in population studies[9]. Since the first VCG in 1956 (Vita's Lumin Vacuum), different representations associated with different brands of ceramic and composite materials have been marketed with their respective tables of equivalences, such as Vitapan Classical and Vita 3D Master (VITA), Chromascop (Ivoclar-Vivadent), Shofu Vintage Halo (Shofu) and Dentsply EsthetX (Dentsply)[10-15]. Ahn and Lee reported that one of the main drawbacks of VCGs is that the optical properties of the materials with which they are constructed are different from those of dental tissues; and some commercial guides are even manufactured with materials different from the restorative material whose color they are intended to reproduce[16]: These conditions are associated with significant error margins. Another limitation, described by Tung et al., is that evidence has been found from studies using spectrography that teeth present nearly 300 different possible shades (located in a cluster in the spatial distribution of color according to three-dimensional systems such as Munsell and CIELAB), while visual shade guides only have sixteen (Vitapan Classical) to twenty eight (Shofu Vintage Halo) shades[17].

The visual identification of color depends on many factors, some subjective, such as the perception of the observer; some related to the environment, such as lighting conditions, and some related to other properties of the teeth, such as translucency, surface smoothness, brightness, fluorescence and opalescence[18].

Color measurement devices have the potential to improve selection accuracy and reliability by removing the observer factor from equation, and in some cases even the effect of the lightning conditions[19]. Devices used for clinical tooth color determination include spectrophotometers, colorimeters, and digital camera systems[20,21].

Spectrophotometers (SP) are among the most accurate and useful instruments for color determination in dentistry[22], measuring the amount of light energy reflected by an object throughout the visible spectrum[6,23]. An SP contains a source of optical radiation (a set of ultraviolet (UV), infrared (IR) and visible light (VIS) radiation that are not ionizing but do cause thermal or photochemical effects, a means to scatter light, an optical measuring system, a detector and a mechanism to convert the received light into a signal that can be analyzed. The measurements obtained are often translated into dental shade guides or expressed in the CIE[24,25] system and converted into tabs of equivalent colors with a coincidence in 93.3% of the cases[5]. An example of a spectrophotometer used in dentistry is the VITA Easyshade (Vita Zahnfabrik, Bad Säckingen, Germany) with different measurement modes such as single tooth mode, tooth area mode (cervical, middle and incisal shades), restoration shade check (includes clarity, chroma and hue comparison) and color tab mode[26].

Colorimeters are tools that determine the hue for a more objective measurement of color from the CIE system[24,27]. To do this, they quantify the tristimulus values, filter the light in red, green and blue areas of the visible spectrum, do not register spectral reflectance and can therefore be less accurate than spectrophotometers[4]. On the other hand, digital cameras use an additive model in which the red, green, and blue lights are added together in various ways to reproduce a wide range of colors. Digital cameras are perhaps the most basic approach to instrumental tooth color acquisition, and still require a certain degree of subjective human shade selection[28].

Studies in which the visual evaluation of color was compared to the colorimetric evaluation detected wide variations in the results[29]. On the other hand, there is evidence that the spectrophotometric evaluation of tooth color is more accurate than the visual evaluation[5,30-35].

Several authors have reported on the different factors that affect the color of teeth, such as age and sex[36,37]. Gonzalo-Diaz et al.[31] reported elderly subjects with darker and yellower teeth[31,38], and women with lighter teeth than men[31,39]. Karaman et al. found that the value was higher for central incisors than for lateral incisors and canines, in both men and women[38]. When males and females were compared with the CIE L*, a* and b* dimensions, significant differences were only detected in the a* dimension. In the general distribution (without considering age and sex), A2 (29.7%) and A1 (12.9%) were more frequently found in the central incisors, while B1, C4 and D2 (0.5%) were the least frequent. The most outstanding points in the L* a* b* distribution were: a) the lowest value of a* was found in the upper central incisor; b) the highest value of L* was found in the upper central incisor and, c) the highest value of b* was found in the central and lateral incisors[40].

To date, no publication has been found on the prevalence of tooth colors in population groups in Argentina.

The aim of this study was to evaluate tooth color in dental students from the University of Buenos Aires, Argentina.

MATERIALS AND METHODS

The participants were 184 students (157 women and 27 men), with ages ranging from 21 to 33 years, mean age 24.45 (SD 2.79) years (Fig. 1). They were all in the fourth year of a dentistry degree at the University of Buenos Aires and agreed to participate through informed consent approved by resolution number 030/2019 of the Ethics Committee of the Dental School of the above mentioned University. The exclusion criteria were: a) the presence of total or partial peripheral restorations in maxillary central incisors; carious and non-carious lesions, pigmentations caused by fluorosis, tetracyclines and hypoplasia; b) the absence of 1.1 and c) having received a teeth whitening treatment within the previous 6 months.

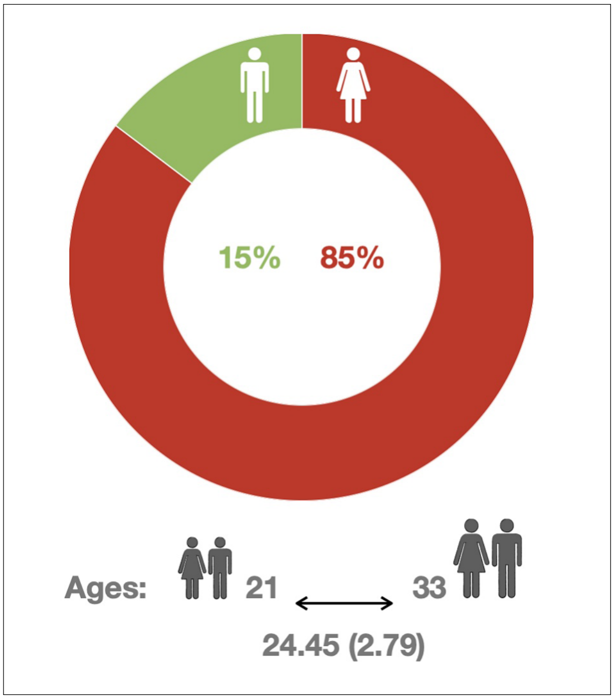

Fig. 1: Participants' gender and age distribution

Shade was measured in each subject in the middle third of the upper right central incisor (1.1), by the same observer, in the same dental chair (Sinol S2316), and time slot, with natural light and without using the dental chair light. Prior to determining color, the buccal aspect of the tooth to be examined was cleaned with a prophylaxis brush (TDV, Brazil) with low-speed rotary instruments Kavo 2068

CHC micromotor (Germany) and Kavo LUX K201 contra-angle (Germany). The VITA Easyshade V (VITA ES) spectrophotometer (Zahnfabrikn Bad Säckingen, Germany) was used, as proposed by Chu et al.[1] and according to the manufacturer's instructions, it was calibrated with the ad-hoc white tiles provided before taking each color sample. Probe protectors were used for each participant to avoid contamination and maintain biosafety standards. Color was determined by a single observer who examined each participant separately, without spandex, with the subject sitting on the dental chair in the most upright position, with the fiber-optic of the VITA ES positioned at 90º to the tooth surface. Two measurements were recorded in "single tooth" mode, and they were coincident with each other in all cases (Fig. 2). Rates in percentage and 95% confidence intervals were obtained for each VITA shade.

Fig. 2: Site and environmental conditions for color registration

Table 1. Frequency of shades in central incisors

Shades		Rate %	CI (95%)
A	A1	46.20	38.83 - 53.68
	A2	17.39	12.21 - 23.66
	A3	6.52	3.41 - 11.11
	A3.5	0.54	0.01 - 2.99
	A4	0.54	0.01 - 2.99
B	B1	4.35	1.90 - 8.39
	B2	17.39	12.21 - 23.66
	B3	2.17	0.60 - 5.47
C	C1	-	-
	C2	1.09	0.13 - 3.87
	C3	0.54	0.01 - 2.99
D	D1	-	-
	D2	2.72	0.89 - 6.23
	D3	0.54	0.01 - 2.99

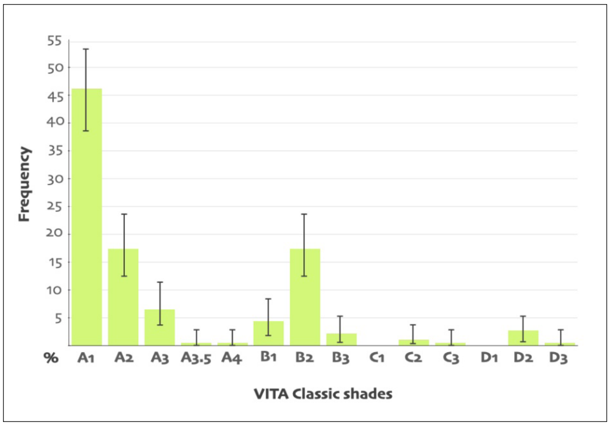

Fig.3: Frequency and Ci 95% of tooth color assessed with a spectrophotometer in fourth-year dental students from the University of Buenos Aires

RESULTS

The most frequently found color in central incisors of dental students from the University of Buenos Aires was A1 (46.2% CI 95%: 38.83 – 53.68). A2 and B2, each identified in 17.39% (CI 95%: 12.21 – 23.66) of the participants, shared the second place. Shades D1 and C1 were not found in any of the participants. Shade A3: 6.52% (CI 95%: 3.41-11.11) was more frequent than C2 1.09% (CI 95%: 0.13-3.87), D3, C3, A3.5 and A4: 0.54 (CI 95%:0.01-2.99), but shared the third place with B1: 4.35% (CI 95%:1.9-8.39), D2: 2.72% (CI 95%: 0.89 – 6.23) and B3: 2.17% (CI 95%: 0.60-5.47). See Table 1 and Fig. 3.

DISCUSSION

The aesthetic success of a restoration depends mainly on the reproduction of the natural shape of the tooth and its optical properties, such as color. This is more important when it involves an anterior tooth[15,35]. Different authors have assessed the prevalence of tooth colors in different populations (Fig. 4) and, in some cases, the effect of factors such as age and gender[34,35]. A2 and A1 were the most prevalent colors in studies on younger populations. In Turkey, Karaman et al. assessed tooth color of 202 subjects (89 men and 113 women) who attended the Elazig Oral Health Service, and whose ages ranged from 15 to 24 years, among whom the most frequent color was A2 (35.2%), followed by A1 (16.9%), while

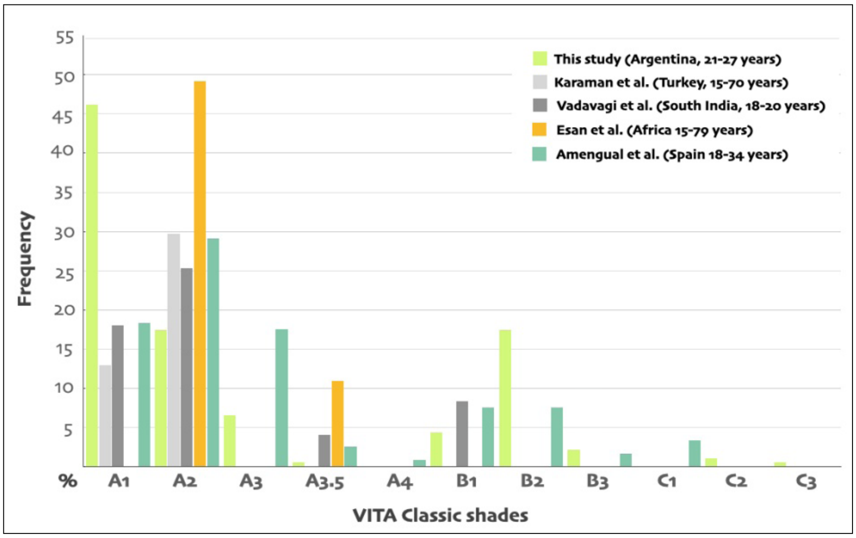

Fig. 4: Comparison of the frequencies of VITA Classic shades found in studies from different regions

B1, C4 and D2 (0.5%) were the least common[39]. In the Valencia community, in Spain, Amengual et al. evaluated, among other groups, residents aged 18 to 34 years and found that A2 (29.1%) was the most common color in both men and women, followed by A1 (18.3%) and A3 (17.5%), while C3, B3, B4 and D4 were not found in any subject[35].

In the present study, the most prevalent color was A1 (46.2%), followed by A2 and B2 (17.39%). The higher prevalence of lighter shades than in other studies may be due to three reasons: a) the high rate of women in the study population, b) the 21 to 33 year age range of the participants, and c) the fact that all participants were students of dentistry that may be a source of bias in terms of self-care or higher levels of buccal health information. This might be the case because both Vadavagi et al., in southern India[32], and Alrifai et al. in Lubli, Poland[33] worked on dental student populations, with ages between 18 and 20 years, and 19 and 32 years, respectively. In the first case, A2 was present in 34 % of subjects, A1 in 27.3 %, B1:15.3 %, B2: 8.7 %, C1: 8 % and A3.5: 6.7 %, and the authors observed that there were significant differences in prevalence of tooth color between sexes. Shade A1 was found in 27.3 % of females, while A2 was more often detected in males (42 %). In subjects with fair skin, the most prevalent color was A1 (52.3%), followed by A2 (29.7%)[32]. The study by Alrifai et al. reported that the most prevalent shade in central incisors was A2, followed by D3, C1 and A1. When participants were grouped by nationality, they found that the Polish population had lighter teeth shades than the Saudis and the Taiwanese, and when they were grouped according to gender, males seemed to have darker shades than females[33].

CONCLUSION

Within the limitations of this study, A1 was the most prevalent shade in central incisors of the dental students in evaluated Argentina, followed by A2 and B2, which shows a lighter color predominance compared to studies from other regions.

DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

FUNDING

This study was supported by a Grant from University of Buenos Aires, UBACYT Program 20720190200016BA

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