Cumhuriyet Dental Journal, 26(1): 33-41, 2023
DOI: https://doi.org/10.7126/cumudj.1228295

Cumhuriyet Dental Journal

| cdj.cumhuriyet.edu.tr | Founded: 1998 | Available online, ISSN: 1302-5805 e-ISSN: 2146-2852 | Publisher: Sivas Cumhuriyet Üniversitesi

Influence of Dental Students' Dietary Habits on Tooth Color

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Research Article

History

Received: 02/01/2023
Accepted: 15/01/2023

ABSTRACT

Objectives: To determine the influence of dental students' dietary habits on tooth color.
Materials and Methods: A questionnaire consisting of 18 questions was directed to 202 students included in the study. The following exclusion criteria were used for the selection of participants: gingival problems, the presence of excessive abrasion, dental malocclusion, a history of orthodontic or bleaching treatment, caries, and composite fillings on the facial surfaces of the teeth. The color of the upper central incisors and canines of the participants who completed the questionnaire was measured using a clinical spectrophotometer device(Vita Easyshade V). Tooth color assessment was performed by a calibrated operator. The L*, C*, H*, a*, and b* parameters were recorded. Data were subjected to descriptive statistical analysis, Spearman's rho correlation analysis and multivariate testing.
Results: The sample consisted of 202 dentistry students. 96.5% of the participants were between the ages of 18-25 and more than half were female. L*, C*, H*, a*, and b* mean values in canine and incisor teeth did not differ statistically significantly according to age groups($p>0.05$). The mean values of C* and b* in canine teeth and the mean values of all parameters except L* in incisor teeth showed significant differences according to gender($p<0.05$). Staining beverages in the diet had no effect on L*, C*, H*, a*, and b* parameters of the canine and incisor teeth. A negative correlation was found between the frequency of consuming energy drinks and the L* value in the incisor teeth($r=-0.215$; $p=0.016$).
Conclusions: Females have lighter teeth than males. The increase in the amount of consumption of the evaluated staining beverages is one of the factors that cause the tooth colors to become darker and mat.

Keywords: Beverages, Dental Student, Diet, Tooth Color, Spectrophotometer.

Diş Hekimliği Öğrencilerinin Diyet Alışkanlıklarının Diş Rengine Etkisi

Süreç

Geliş: 02/01/2023
Kabul: 15/01/2023

ÖZ

Amaç: Bu çalışmanın amacı, diş hekimliği öğrencilerinin diyet alışkanlıklarının diş rengine olan etkisini belirlemektir.
Gereç ve Yöntemler: Çalışmaya dahil edilen 202 öğrenciye 18 sorudan oluşan bir anket yönlendirildi. Katılımcıların seçiminde kullanılan dışlama kriterleri şu şekildedir: dişeti problemleri, aşırı aşınma varlığı, diş maloklüzyonu, ortodontik veya beyazlatma tedavisi öyküsü, dişlerin bukkal yüzeylerinde çürük ve kompozit restorasyon olması. Anketi tamamlayan katılımcıların üst santral ve kanin dişlerinin rengi klinik bir spektrofotometre cihazı (Vita Easyshade V) kullanılarak ölçüldü. Diş rengi değerlendirmesi, kalibre edilmiş bir operatör tarafından yapıldı. L*, C*, H*, a* ve b* parametreleri kaydedildi. Veriler tanımlayıcı istatistiksel analize, Spearman's rho korelasyon analizine ve çok değişkenli testlere tabi tutuldu.
Bulgular: Örneklemi 202 diş hekimliği öğrencisi oluşturdu. Katılımcıların %96,5'i 18-25 yaşları arasındaydı ve yarısından fazlası kadındı. Kanin ve santral dişlerde L*, C*, H*, a* ve b* ortalama değerleri yaş gruplarına göre istatistiksel olarak anlamlı farklılık göstermedi ($p>0,05$). Kanin dişlerinde C* ve b* ortalama değerleri ile santral dişlerde L* dışındaki tüm parametrelerin ortalama değerleri cinsiyete göre anlamlı farklılık gösterdi ($p<0,05$). Diyetteki renklendirici içeceklerin kanin ve santral dişlerin L*, C*, H*, a* ve b* parametrelerinin ortalama değerlerine etkisi olmadı. Ancak santral dişte, enerji içeceği içme sıklığı ile L* değeri arasında negatif yönlü zayıf bir ilişki tespit edilmiştir ($r=-0,215$; $p=0,016$).
Sonuçlar: Kadınların diş renkleri erkeklerden daha açıktır. Değerlendirilen boyayıcı içeceklerin tüketim miktarının artması diş renklerinin koyulaşmasına ve matlaşmasına neden olan faktörlerden biridir.

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How to Cite: Erturk-Avunduk AT, Filiz H, Cengiz-Yanardag E.(2023) Influence of Dental Students' Dietary Habits on Tooth Color, Cumhuriyet Dental Journal, 26(1):33-41.

Introduction

Nowadays, individuals want to have a perfect smile as well as having a good oral-dental health.[1] The appearance of the teeth should be beautiful as well as proportional to each other and arranged in harmony with the gingiva, lips, and face in order to provide smile esthetics in dentistry.[2]

The structure of the tooth consists of tissues like enamel, dentin and pulp. The light scattering and absorption properties of enamel and dentin tissues are effective factors in determining the actual tooth color.[1, 3] Some deposits on tooth surfaces and structural changes arising from tissues can lead to changes in tooth color. The etiology of discoloration is multifactorial and tooth discoloration can be internal or external.[4] Mainly internal discolorations may occur due to amelogenesis and dentinogenesis imperfecta, enamel hypoplasia, tetracycline and fluorosis discolorations, root resorption, and aging.[5] Poor oral hygiene, metal salts, smoking, dietary beverages (tea, coffee, red wine, cola, etc.) are the leading causes of external coloration.[6]

Color is a complex phenomenon and there are many factors (human eye, light conditions, light scattering, opacity and translucency) that affect color perception.[7] For this reason, besides the visual method, instrumental techniques are also used to minimize these factors in the color selection of teeth and dental restorations. Since visual color detection is a subjective method, instrumental techniques eliminate this situation. For this purpose, spectrophotometers, colorimeters and digital image analyzes are widely used in dental practice. Spectrophotometers are the most commonly used instruments among instrumental techniques and measure the amount of light energy reflected back from an object in the visible spectrum range.[8] Compared to conventional methods or evaluations performed with the human eye, spectrophotometers have been reported to have increased accuracy and provide more objective matching.[9]

The CIELAB (Commission International de l'Eclairage) color system is one of the most widely used color measurement systems in dentistry.[10] In the CIELAB system, color is defined with 3 coordinates, L*, a* and b*.[11] L* creates the lightness-darkness coordinates of the color between white (+) - black (-). This parameter is on the vertical axis and is proportional to the tone (value). One of the color components, a*, is between red (+) – green (-) on the horizontal axis; b* represents the chroma coordinates between yellow (+) - blue (-) on the horizontal axis.[12] In the CIEDE2000 color system, L; lightness, C; color intensity (chroma) and H; represents hue (hue).[13] This system is widely used by researchers to evaluate the color changes of different materials.[14] The CIEDE2000 color system was presented as a better alternative to the CIELAB system defined in 2001. The CIEDE2000 color system corrects inconsistencies from the CIELAB system. It also provides a better correlation between the perceived and measured color change amount.[15] Thus, it better reflects the perceptibility and acceptability threshold values for color differences compared to the CIELAB system.[16]

There are many studies in the literature about the oral-dental health levels and dietary habits of dentistry students. However, the number of studies examining the effect of diet habits of dental students on natural tooth color is limited.[17-20] The aim of the present study is to evaluate the effects of demographic characteristics (age and gender) and dietary habits (consumption of tea, coffee, acidic, and staining drinks) on the tooth color of dentistry students. The null hypotheses of the study are as follows: [a] Age and gender would not affect tooth color, [b] Dietary staining and acidic beverages would not affect tooth color.

Materials and Methods

The present cross-sectional study was conducted from November to December 2022 using a questionnaire. The study protocol was approved by the Mersin University ethics committee (number 2022/708). It was conducted in accordance with the latest guidelines of the Declaration of Helsinki. The study was conducted following the STROBE guidelines.[21]

Participants

The sample size was calculated by using the G*Power (V. 3. 1. 9. 6) package program. With 95% confidence (1-α), 95% test power (1-β), f=0.40 effect size, the minimum number of cases to be included in the study was determined as 131 (125/0.955). Individuals in the current epidemiological study were selected among dentistry students who accepted to participate in the study and were studying at Mersin University Faculty of Dentistry. Intraoral examinations of the participants were performed in Mersin University Faculty of Dentistry, Department of Restorative Dentistry. Volunteers who agreed to participate in the study were given a questionnaire prepared by the researchers and asked to fill in. Individuals who did not agree to fill out the questionnaire were not included in the study. Reminder announcements were made to the students in order to increase the participant rate and to minimize the risk of bias.

The teeth of the volunteers to be included in the study were screened according to the following inclusion criteria: Being over 18 years old and having right or left maxillary central and canine teeth (chosen because of easy to see)in the mouth. Exclusion criteria were as follows: Presence of fixed orthodontic appliances, pregnancy, previous professional dental prophylaxis performed in less than 6 months, upper central/canine teeth with restoration, endodontic treatment or presence of caries.

Questionnaire

The questions used in the present work were modified from previous questionnaires validated by Nalbant *et al.*[18] and Calzada *et al.*[22] and directed to the students. A pilot test on 20 dentistry students was conducted and subject to minor adjustments on the questionnaire. As a result of the

research, it was planned to see the effect of the age, gender and dietary habits of the person on the color of the teeth.

Color measurement

In the present study, the measurement of color values in teeth was made with a clinical spectrophotometer device (VITA EasyShade V, Vita Zahnfabrik, Germany). The device has a 1.5 x 2 inch touch screen on its own. With the help of the automatic calibration plate, the device was calibrated before each measuring. VITA EasyShade V can be used in any lighting conditions, unaffected by halogen light or ambient light. It measures with both CIELAB and CIEDE2000 color systems and the device has the feature of archiving the measurements.

Tooth color assessment was performed by a calibrated operator (H. F.). Measurements were performed between 10.00 and 14.00, which is the time zone when daylight is most active. During color measurements, the participants were asked to hold their heads steady, lean on the unit headrest and open their mouths slightly. In order to eliminate tissue reflection due to transparency in the incisal (cutting edge) areas of the teeth, since the resting tongue on the upper jaw anterior palate area may cause erroneous measurements; the tongue was kept in the resting position. The reflector (unit light) was kept off during the measurements. The measuring tip of the spectrophoto meter was placed as perpendicular to the facial surface of the tooth as possible (Figure 1). Color measurements started from the central teeth and continued with the canine teeth. To ensure standardization, measurements were taken from the middle third of the teeth facing the lip. The data obtained after the measurements were transferred to the computer for analysis.

Figure 1. Color measurement of teeth

Statistical analysis

Statistical analyzes were performed using the Statistical Package for the Social Sciences (Version 25.0, SPSS Inc., Chicago, IL, USA). Analysis of demographic data was done by descriptive statistical analysis. Multivariate analysis was used to compare the L*, C*, H*, a* and b* values obtained from the upper central (incisors) and canine teeth, and Spearman's rho correlation analysis was used to determine the relationship between them. Analysis results were presented as mean and standard deviation. Statistical significance level was taken as $p<0.05$.

Results

The questionnaire was directed to 250 students, of whom 202 completed the questionnaire and met the inclusion criteria (81% participation rate). The demographic distributions (n, %) of data are summarized in Table 1. 96.5% of the participants were between the ages of 18-25 and more than half were women. The proportion of those who consumed tea and coffee twice a day or more in their diet was close to each other (38.6% and 37.3%, respectively). The rate of those who never used acidic beverages was 10%. 76.7% of the participants rarely used staining beverages (juice, wine, etc.) in their diet.

Table 2 shows the comparisons between color parameters by age groups for each tooth measured (upper central and canine teeth). L*, C*, H*, a* and b* mean values in canine and central teeth did not differ statistically significantly according to age groups ($p>0.05$). However, it was observed that the lightness (L*) of the color parameters of the teeth increased with advancing age.

Table 3 summarizes the comparisons between color parameters by sex for each tooth (central and canine teeth). C* and b* mean values of canine teeth were found to differ significantly by gender ($p<0.001$). The mean values of all parameters of central teeth except L* differed significantly according to gender ($p<0.05$).

The mean and standard deviation values of the color parameters according to the dietary habits of the central and canine teeth are shown in Table 4 and Table 5, respectively. It was observed that dietary staining beverages (tea, coffee, acidic and colored drinks) had no effect on the mean values of L*, C*, H*, a* and b* parameters of canine and central teeth ($p>0.05$).

There was no statistically significant correlation between age and color parameters in canine and central teeth ($p>0.05$). The results of the correlation analysis between the color parameters according to the frequency of consumption of dietary beverages are summarized in Table 6. A weak negative correlation was found between the frequency of consuming energy drinks and the L* value only in the central tooth ($r=-0.215$; $p=0.016$). Other relationships were not statistically significant ($p>0.05$).

Discussion

Color changes can be observed in teeth that are exposed to foods and beverages taken intermittently with the diet, and to chemical agents that are constantly absorbed from adherent debris or released as a result of bacterial decomposition of the debris.[19] In this context, demographic characteristics of dentistry students such as age and gender, and the effect of dietary staining agents on tooth color were investigated in the current study.

Dentistry students represent the sample of the current study. Because they can improve and change their attitudes/behaviors toward their oral health and dietary habits through dental education. On the other hand, follow-up is more convenient and the administration and application of the questionnaire are easy. The

questionnaire used in the present study was primarily conducted as a pilot test and following reminder announcements were made to increase participation in order to limit bias.[23] An optimum response rate of 70% to 80% is preferred to minimize the risk of bias.[24] In studies conducted on dental students, this rate varies from 68%[25] to 89%[26]. The participation rate in the present study is 81% and this rate can be considered as high.

Visual and instrumental techniques can be used to evaluate color changes in teeth and dental materials.[27] It has been stated that visual color assessment is unreliable due to interobserver inconsistencies in color perceptions.[28] Therefore, instrumental techniques are widely preferred to provide an objective interpretation in the determination of color changes. At the same time, instrumental techniques are considered advantageous over visual methods in terms of analyzing the physical properties of color, reproducibility of measurements, and giving quantifiable results.[16] Choi *et al.*[29] concluded that digital analysis of tooth color is more accurate and reproducible than a visual assessment. The CIEDE2000 color system also includes some color parameters based on the CIELAB system. These include the lightness darkness (L—lightness), saturation (C—chroma) and hue (H—hue) of the color and their weighting functions, an interactive parameter (ΔR) between saturation and hue difference for blue colors. It also includes the a* parameter to improve the performance of gray colors. Researchers reported that the variable factors in the CIELAB color system were not evaluated equally, and the CIEDE2000 color system was more compatible in determining acceptability and perceptibility closest to the range of values that the eye could perceive.[30] The VITA Easyshade V used in the current study is a clinical spectrophotometer used for tooth color matching.

Some studies have reported that light conditions can affect the assessment of tooth color, which can be controlled if a standard environment has already been established.[1,31] Therefore, in the present study, measurements were made in a standard time zone. In our study, color measurements were performed from the middle thirds of the upper central and canine teeth to ensure standardization. A previous study has described the middle third of the tooth as the region that best represents color.[1] It has been stated that the incisal region is usually translucent and affects the background of the tooth, while the color of the cervical area is changed by the light scattered from the gingiva.[27]

Since our sample consisted of students studying in the faculties of dentistry, 96.5% of the participants were between the ages of 18-25 and it was seen that there was no statistically significant difference between color parameters according to age groups. This finding contradicts with the results of Demirel & Tunçdemir.[32] Researchers reported significant differences in all L*, a*, and b* parameters for age subgroups (≤35, 35–55, and ≥55). The fact that the participants in the current study were very young may have caused the lack of difference in the present study. On the other hand, a statistically insignificant increase in the lightness parameter was observed in participants with older age of canine teeth.

Gender is another factor that is significantly associated with tooth color. In a certain age group, the teeth color values of males in the population were found to be darker than females.[33] In the present study, it was observed that the mean values of C* and b* values of canine teeth and mean values of all parameters except L* of central teeth showed significant differences according to gender. This was similar to a previous study that reported no significant difference in the L* parameter for the sex subgroup.[32] However, in the present study, although there was no statistically significant difference, canine teeth were found to be brighter in males. It was also evident that the white tone of the males' teeth was similar to that of the females, but appeared darker because the yellow and red tones were stronger. Hasegawa *et al.*[34] reported that with advancing age, the lightness of the teeth tended to decrease and the yellowness increased, but the difference between male and female could not be distinguished. Considering these findings, our first null hypothesis, which was stated as "age and gender will not affect tooth color", was partially rejected.

Understanding the etiology of tooth discoloration, which is caused by various factors, facilitates the correct diagnosis and affects the treatment options that the dentist will apply to patients.[35] Tooth discoloration occurs due to external factors (tea, coffee, red wine, cigarettes, cola, metal salts, and poor oral hygiene) and internal factors (due to the change in the structural composition or thickness of dental hard tissues). It has been reported that commonly consumed beverages such as tea, coffee, red wine, fruit juice and cola cause significant discoloration in teeth as well as in tooth-colored restorative materials.[36] In the present study, it was observed that the staining beverages did not cause a significant difference in the color parameters of the central and canine teeth. Therefore, the second hypothesis of the study was accepted. The reason for this finding can be concluded that the study sample consisted of dentistry students and they had sufficient knowledge about oral-dental health and caries prophylaxis. On the other hand, it was observed that the increase in the consumption of staining beverages evaluated in the study was one of the factors that caused the darkening and dulling of tooth colors. It was determined that the L* parameter of the central and canine teeth increased in the participants who consumed colored beverages (fruit juice, wine, etc.) 2 or more times a day, that is, the teeth were darker. There are studies evaluating the effect of colored beverages in the diet on tooth color according to the frequency of consumption of individuals.[19, 37] A previous study investigating the effect of food and beverages consumed on primary and permanent tooth color reported that tooth enamel color changed.[19] In accordance with the present study, the researchers observed that the tooth color was darker in individuals with a higher frequency of consumption of staining beverages.

When the correlation analysis findings of our study were examined, it was seen that there was no significant relationship between age and color parameters, but there was a weak negative correlation between the frequency of consumption of energy drinks taken with diet and the L* parameter. As stated before, the age range of the population constituting our study sample is very close to each other and 96.5% of the participants are between the ages of 18-25, which may have caused this result. A previous study in Japanese population investigated the relationship between the age and the color of central teeth over a wide age range (13-84 years). Researchers have reported that there is a negative correlation between age and the L* parameter, and a positive correlation with the b* and a* parameters.[34] There are studies that show differences in the external appearance of teeth with increasing age.[38, 39] Aged dentin (sclerotic dentin) is dark and mineralized. Its density is high and its lightness is decreased. In advanced age, the color of dentin undergoes a change and exhibits a transition from red-yellow to yellow. However, because of wear, the glossy enamel thickness to cover the dentinal redness is reduced, and the color of old teeth appears redder than that of young ones. [34]

The present study has several limitations. First, the measurements were made only with the spectrophotometer device. Using and comparing different color measurement methods (calorimeter, digital camera, etc.) may produce different results. In addition, increasing the number of samples and including older age groups will increase the accuracy of the study and will give more meaningful results for these statistical analyses. In the future, it may be appropriate to include students from different faculties in the sampling or to conduct more research on different populations.

Table 1. The distribution of the demographic data

	n	%
Age		
18-25	195	96.5
25-30	7	3.5
Gender		
Female	102	50.5
Male	100	49.5
The frequency of smoking		
I never consume	114	56.4
Rarely	40	19.8
Once in a day	46	22.8
Twice or more in a day	2	1.0
The frequency of consuming tea		
I never consume	11	5.4
Rarely	39	19.3
Once in a day	74	36.6
Twice or more in a day	78	38.6
The frequency of consuming coffee		
I never consume	4	2.0
Rarely	45	22.4
Once in a day	77	38.3
Twice or more in a day	75	37.3
The frequency of consuming acidic beverages		
I never consume	20	10.0
Rarely	123	61.2
Once in a day	43	21.4
Twice or more in a day	15	7.5
The frequency of consuming colored beverages (wine, juice etc.)		
I never consume	20	9.9
Rarely	155	76.7
Once in a day	26	12.9
Twice or more in a day	1	0.5
The frequency of consuming energy drinks		
I never consume	54	26.7
Rarely	117	57.9
Once in a day	25	12.4
Twice or more in a day	6	3.0

Table 2. Comparisons by age groups for each tooth

	Central Incisor			Canine		
	18-25	**25-30**	**p**	**18-25**	**25-30**	**p**
L*	77.3 ± 3.8	77.8 ± 3.7	0.712	71 ± 3.4	72.4 ± 2.3	0.261
C*	18.3 ± 4.2	17.7 ± 2.5	0.743	24.6 ± 3.2	25.5 ± 3.6	0.447
H*	93.4 ± 5.9	93.1 ± 2.6	0.894	87.4 ± 10.7	86.3 ± 0.8	0.788
a*	-0.7 ± 1.1	-0.9 ± 0.7	0.711	1.5 ± 0.5	1.6 ± 0.4	0.674
b*	17.9 ± 3.3	17.7 ± 2.5	0.855	24.4 ± 2.9	25.5 ± 3.6	0.369

**p<0.05 is significant. p values are based on a Multivariate analysis test.*

Table 3. Comparisons by gender for each tooth

	Central Incisor			Canine		
	Female	**Male**	**p**	**Female**	**Male**	**p**
L*	77.8 ± 3.4	76.8 ± 4	0.052	70.8 ± 3.4	71.2 ± 3.4	0.455
C*	17.2 ± 3.3	19.3 ± 4.7	<0.001*	23.8 ± 2.8	25.5 ± 3.4	<0.001*
H*	94.3 ± 4.1	92.4 ± 7.0	0.017*	88.4 ± 14.7	86.3 ± 1.2	0.169
a*	-1.0 ± 1.0	-0.4 ± 1.1	<0.001*	1.5 ± 0.5	1.6 ± 0.5	0.083
b*	17 ± 2.8	18.9 ± 3.6	<0.001*	23.8 ± 2.8	25.2 ± 2.9	<0.001*

*p<0.05 is significant. p values are based on a Multivariate analysis test.

Table 4: Means± standard deviations of color parameters of central incisor teeth according to dietary habit

		Tea		Coffee		Acidic beverages		Colored beverages		Energy drink	
		Mean± sd	**p**	**Mean± sd**	**p**	**Mean± sd**	**p**	**Mean± sd**	**P**	**Mean± sd**	**P**
L*	I never consume	78.5±2.7	0.726	75.3 ± 4.3	0.732	77.8 ± 4.4	0.615	77.1 ± 4	0.490	76.7 ± 3.4	0.072
	Rarely	77.2±4.9		77.5 ± 3.5		77.4 ± 3.6		77.3 ± 3.8		77.9 ± 3.8	
	Once in a day	77.1±3.4		77.3 ± 3.7		77.4 ± 3.8		77.2 ± 3.4		76.1 ± 3.9	
	Twice or more in a day	77.4±3.5		77.3 ± 3.9		76.2 ± 3.4		83.1 ± 0		76.8 ± 3.8	
C*	I never consume	17.9±2.6	0.506	22.1 ± 7.5	0.173	17.3 ± 2.6	0.638	17.7 ± 2.8	0.614	17.7 ± 3.1	0.371
	Rarely	19.1±6.3		17.6 ± 2.8		18.5 ± 4.7		18.4 ± 4.4		18.6 ± 4.6	
	Once in a day	17.9±3.9		18.6 ± 3.9		17.9 ± 3.4		17.8 ± 3.5		18.4 ± 4.3	
	Twice or more in a day	18.2±3.2		18.2 ± 4.9		18.4 ± 3.5		22.5 ± 0		16.1 ± 2.7	
H*	I never consume	93.2±3.7	0.448	91.1 ± 5.5	0.873	93.3 ± 4.6	0.901	92.7 ± 2.9	0.824	93 ± 3.7	0.635
	Rarely	94.7±10.1		93.6 ± 3.8		93.6 ± 6.6		93.5 ± 6.2		93.6 ± 6.7	
	Once in a day	93.2±4.4		93.3 ± 7.8		93 ± 3.9		93.3 ± 4.6		92.4 ± 4.3	
	Twice or more in a day	92.9± 3.8		93.3 ± 4.2		92.7 ± 4.7		88.9 ± 0		95.2 ± 6	
a*	I never consume	-0.7 ± 0.8	0.999	-0.2 ± 1.6	0.250	-0.7 ± 1.1	0.969	-0.7 ± 0.9	0.771	-0.7 ± 1	0.649
	Rarely	-0.7 ± 1.3		-0.9 ± 1		-0.7 ± 1.1		-0.7 ± 1.1		-0.7 ± 1.1	
	Once in a day	-0.7 ± 1.1		-0.5 ± 1.1		-0.7 ± 1.1		-0.8 ± 1.2		-0.6 ± 1.3	
	Twice or more in a day	-0.7 ± 1.1		-0.8 ± 1.2		-0.6 ± 1.2		0.4 ± 0		-1.2 ± 1.3	
b*	I never consume	18 ± 2.5	0.708	22 ± 7.6	0.051	17.3 ± 2.7	0.743	17.6 ± 2.8	0.503	17.7 ± 3.2	0.377
	Rarely	18.2 ± 3.7		17.5 ± 2.9		18 ± 3.4		18 ± 3.4		18.2 ± 3.6	
	Once in a day	17.6 ± 3.3		18.3 ± 3.3		17.8 ± 3.3		17.6 ± 3.4		17.7 ± 2.3	
	Twice or more in a day	18.1 ± 3.3		17.7 ± 3.1		18.3 ± 3.6		22.5 ± 0		16 ± 2.8	

p<0.05 stands for statistically significance. p values are based on a Multivariate analysis test.

Table 5: Means± standard deviations of color parameters of canine teeth according to dietary habits

		Tea		Coffee		Acidic beverages		Colored beverages		Energy drinks	
		Mean± sd	P	Mean± sd	P	Mean± sd	p	Mean± sd	P	Mean± sd	P
L*	I never consume	71 ± 2.7	0.701	69 ± 4	0.234	71.4 ± 2.3	0.813	71.6 ± 3.6	0.677	71.3 ± 3.4	0.059
	Rarely	71.5 ± 3.8		71.4 ± 3.3		70.9 ± 3.6		71 ± 3.3		71.2 ± 3.1	
	Once in a day	71 ± 3		71.4 ± 3.1		71.3 ± 3		70.8 ± 3.7		69.3 ± 4.2	
	Twice or more in a day	70.8 ± 3.5		70.6 ± 3.5		70.5 ± 3.8		74.1 ± 0		71.1 ± 2.7	
C*	I never consume	25.1 ± 3.5	0.566	26.6 ± 3.8	0.651	24.4 ± 2.5	0.729	24.9 ± 3.1	0.885	25.1 ± 4.2	0.411
	Rarely	25.1 ± 4.2		24.6 ± 3.8		24.5 ± 3.1		24.5 ± 3		24.6 ± 2.8	
	Once in a day	24.3 ± 3		24.7 ± 3		24.8 ± 3.8		24.9 ± 4.4		24.1 ± 2.8	
	Twice or more in a day	24.7 ± 2.8		24.5 ± 3		25.5 ± 3.1		25.9 ± 0		23.5 ± 1.9	
H*	I never consume	86.8 ± 0.6	0.932	85.4 ± 1.3	0.843	86.3 ± 0.8	0.738	86.3 ± 1.4	0.877	87.6 ± 9.2	0.888
	Rarely	86.6 ± 1.5		86.5 ± 1.7		88 ± 13.4		87.7 ± 12		87.6 ± 12.3	
	Once in a day	87.2 ± 7.8		87.2 ± 7.7		86.4 ± 1.3		86.2 ± 1.5		86.1 ± 1.3	
	Twice or more in a day	87.9 ± 15.1		88.1± 15.4		86 ± 1.5		87.3 ± 0		85.6 ± 1.1	
a*	I never consume	1.4 ± 0.4	0.289	2 ± 0.5	0.281	1.6 ± 0.3	0.872	1.6 ± 0.5	0.914	1.6 ± 0.6	0.461
	Rarely	1.4 ± 0.6		1.5 ± 0.6		1.5 ± 0.5		1.5 ± 0.5		1.5 ± 0.5	
	Once in a day	1.5 ± 0.5		1.5 ± 0.4		1.5 ± 0.5		1.5 ± 0.5		1.7 ± 0.5	
	Twice or more in a day	1.6 ± 0.5		1.6 ± 0.5		1.6 ± 0.5		1.2 ± 0		1.6 ± 0.4	
b*	I never consume	25.1 ± 3.5	0.747	26.6 ± 3.8	0.401	24.3 ± 2.5	0.658	24.8 ± 3.1	0.879	24.7 ± 3.5	0.602
	Rarely	24.6 ± 3.3		24.2 ± 2.8		24.5 ± 3.1		24.5 ± 2.9		24.5 ± 2.7	
	Once in a day	24.2 ± 2.8		24.7 ± 2.8		24.4 ± 2.5		24.2 ± 3		24 ± 2.8	
	Twice or more in a day	24.6 ± 2.8		24.5 ± 3		25.4 ± 3.1		25.9 ± 0		23.4 ± 1.9	

p<0.05 stands for statistically significance. P values are based on a Multivariate analysis test.

Table 6. The findings of correlation analysis.

Tooth			L*	C*	H*	a*	b*
Canine	The frequency of consuming tea	r	-0.060	-0.012	-0.131	0.107	-0.008
		p	0.397	0.869	0.064	0.128	0.914
	The frequency of consuming coffee	r	-0.073	-0.024	-0.032	0.037	-0.009
		p	0.304	0.733	0.649	0.603	0.903
	The frequency of consuming acidic beverages	r	-0.010	0.061	0.000	-0.009	0.043
		p	0.891	0.387	0.996	0.904	0.548
	The frequency of consuming colored beverages (wine,juice etc)	r	-0.027	-0.004	-0.009	-0.033	-0.014
		p	0.698	0.953	0.894	0.637	0.843
	The frequency of consuming energy drink	r	-0.083	0.024	0.029	-0.009	0.011
		p	0.360	0.788	0.748	0.924	0.905
Central Incisor	The frequency of consuming tea	r	-0.071	0.005	-0.073	0.033	0.017
		p	0.318	0.945	0.302	0.636	0.807
	The frequency of consuming coffee	r	-0.019	-0.018	0.022	-0.028	-0.024
		p	0.785	0.797	0.757	0.695	0.737
	The frequency of consuming acidic beverages	r	-0.070	0.018	-0.033	0.017	0.024
		p	0.322	0.800	0.643	0.809	0.734
	The frequency of consuming colored beverages (wine,juice etc)	r	0.020	0.017	-0.002	-0.006	0.011
		p	0.773	0.816	0.980	0.930	0.874
	The frequency of consuming energy drink	r	-.215*	0.066	-0.066	0.117	0.083
		p	0.016	0.463	0.462	0.194	0.356

r: Spearman's rho correlation coefficient. p<0.05 stands for statistical significance.

Conclusions

Within the limitations of the present study, the results can be summarized as follows: Since the ages of the participants included in the study were very close to each other, the age parameter had no effect on tooth color. The central incisors in females and canines in males were more lightness color. The increase in the consumption amount of the evaluated staining beverages is one of the factors that cause the darkening and dulling of the tooth colors. When staining beverages (juice, wine, etc.) were consumed two times or more a day, the measured teeth became darker.

Acknowledgements

The authors thank Naci Murat for his kind support during the statistical analysis.

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Declaration of Interests

The authors declare that they have no conflict of interest.

This study was presented as a poster presentation at the Society of Restorative Dentistry (RDD) Winter Symposium (17-18 December 2022, Adana, Türkiye).

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