Original Paper

Tobacco and Color Parameters of Lateral Incisors in Young Adults

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ABSTRACT: This study aims to identify the disparities in tooth color between young adult consumers and non-consumers of tobacco and/or nicotine products. The study population included healthy young individuals aged 18 to 30 years. Participants were instructed to refrain from smoking for at least 2 hours before to the study session, avoid dental hygiene for a minimum of 2 hours before the session, and abstain from eating and drinking for at least 2 hours preceding the study period. A total 58 young adults participated in this study, consisting of 29 tobacco and/or nicotine users and 29 non-users. The mean lightness±standard deviation for the cervical region of tooth 1.2 was 82.25±2.841145, whereas for tooth 2.2 it was 80.55±3.625857, both derived from non-consumers in the same location. A notable disparity was observed in the a* value for teeth 1.2 in the cervical region when comparing non-consumers to users (p=0.033176). A substantial difference was noted in the central area of tooth 2.2 when comparing non-consumers to smokers (p=0.013802) for the a* values. Understanding the reasons for tooth color changes is important for early detection and accurate assessment of future treatment outcomes.

KEYWORDS: *Tobacco, lateral incisor, color, tooth.*

Introduction

A variety of clinical techniques are used to treat tooth discoloration in order to produce an aesthetically pleasing outcome.

In contrast to endodontically treated teeth, which require either internal or exterior approaches to the tooth, the etiology of the discoloration and any underlying infection must be taken into account [1].

The Whiteness Index for Dentistry (WID) has been validated as an accurate measure for detecting differences in visual tooth whiteness. [2].

The assessment of tooth color is utilized to evaluate clinical outcomes in many dental treatments, including avulsion and replantation [3].

The visual evaluation conducted by one operative may vary from that performed by another operative (the subjective issue).

The visual evaluation may be affected by the lighting or the general setting against which the tooth is observed (the environmental issue).

The shade guide may not be suitable for the work due to the potential non-uniform spacing of the samples (the reference issue) [4].

Nicotine accumulation on dental surfaces may infiltrate enamel pits, resulting in dental discoloration.

Nicotine, although colorless, becomes yellow upon exposure to oxygen [5].

Spectrophotometers are used frequently to assess surface colors [6,7].

Color measurements can be expressed using CIE (Commission Internationale de l'Éclairage) XYZ tristimulus values or the CIELAB color space.

Within CIELAB, the L* variable indicates lightness contrast, ranging from L*=0 (darkest) to L*=100 (lightest). Meanwhile, a* and b* capture chromatic information along two axes: red-to-green and yellow-to-blue [8,9].

Having a lower level of education was linked to a higher likelihood of severe chronic periodontitis, as well as to smoking and greater plaque accumulation [10].

E-cigarette use showed no significant difference from non-smoking in probing depth or plaque index, suggesting it may represent a comparatively safer nicotine source for periodontal health [11].

It has long been recognized that bacterial species in subgingival plaque tend to occur in organized complexes [12].

Smoking affects the interaction between subgingival bacteria and the host, encompassing its influence on host cells, vasculature, and immune-inflammatory responses, along with its impact on the periodontal microbial ecosystem

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and the interactions among periodontal microorganisms [13].

Regular professional dental cleaning is necessary for smokers to eliminate surface stains, external discoloration, and biofilm buildup.

This cleaning can involve a range of mechanical tools, such as ultrasonic and sonic scalers, hand instruments, prophylaxis brushes with polishing paste, and air-polishing systems [14].

Significant site-related variation in tooth stain scores was observed on both buccal and lingual surfaces, though without a clear, consistent trend.

This variability may stem from a combination of smoking habits, oral hygiene routines, and cultural attitudes toward dental appearance.

Since buccal surfaces are more visible and accessible, they tend to be brushed more effectively, whereas lingual surfaces, especially on posterior teeth, are harder to reach and clean thoroughly [15].

Intrinsic tooth color is largely determined by the composition and internal structure of enamel and dentin.

Because enamel is thinner at the cervical region, dentin has a greater influence on color there than in the middle third of the tooth.

At the incisal edge and proximal areas, where enamel is essentially the only remaining structure and highly translucent, the color of whatever lies behind the tooth plays a larger role.

It is widely accepted that teeth tend to darken and become more chromatic with age.

Advances in color measurement, analysis, and interpretation tools within dentistry have made it increasingly feasible to define a standardized color space for natural teeth [16].

This study's purpose is to determine whether smoking is associated with measurable differences in tooth lightness, and chromatic shifts along the red-green and yellow-blue axes.

Materials and Methods

Approval was secured from the bioethics commission of Ovidius University in Constanta (15089/9.12.2025).

Confidentiality was guaranteed for all participants, who were informed of their right to withdraw at any time without facing any consequences.

Participation was optional.

The participants provided informed consent and authorized the use of the collected data.

The research has been conducted in accordance with the ethical principles set forth in the Declaration of Helsinki.

This study was performed at the Ilarie Voronca Clinic of the Faculty of Dentistry, Ovidius University of Constanța, during the period from December 2025 to February 2026.

The study includes two groups: consumers and non-consumers of tobacco and/or nicotine.

The inclusion criteria for the study population are healthy young individuals aged 18 to 30 years, with the possession of whole anterior teeth in either the maxillary or mandibular arch.

Exclusion criteria encompass conditions that may affect dental color assessments, including the daily use of mouthwashes containing chlorhexidine for a minimum of 7 days before screening; anterior teeth with any composite restorations, prosthetics, crowns, or veneers; recent whitening treatments; lack of professional cleaning within the last 24 weeks prior to screening; presence of tooth jewelry or orthodontic appliances on the vestibular teeth.

Participants were directed to stop from smoking for a minimum of 2 hours before to the study session, avoid cleaning their teeth for at least 2 hours before the session, and abstain from eating and drinking (with the exception of water) for a minimum of 2 hours prior to the study session.

Prior to the dental color assessment, participants were instructed to rinse their mouths with water, followed by gentle flushing and drying to guarantee a clean surface, eliminating any food particles.

All measures were conducted consistently in the same examination room, under uniform ambient illumination circumstances, and done by the same operator.

The OptraGate (Ivoclar Vivadent, Liechtenstein) was the tool used for the retraction of the lips and cheeks.

The Vita Easyshade V (VITA Zahnfabrik H. Rauter GmbH & Co. KG, Germany) digital spectrophotometer was calibrated and employed in accordance with the manufacturer's specifications.

The determination of tooth shade was selected to assess the color from the cervical, central, and incisal regions.

Participants were instructed to momentarily hold their breath throughout the measurement to avoid fogging of the measuring tip, which could jeopardize the accuracy of color readings.

The responses were analyzed using Microsoft Excel (Microsoft Corporation, Washington, USA), the data were summarized as mean (average)±standard deviation and a T-test was employed to ascertain relationships between different groups and derive a p-value.

The significance level was established at $p \leq 0.05$.

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Results

58 individuals took part in the study in total, split evenly into two groups: 29 participants who used tobacco and/or nicotine products, and 29 participants who did not.

Out of the non-consumers, a total number of 40 maxillary lateral incisors and 56 mandibular lateral incisors were recorded and analyzed and out of the consumers, 48 maxillary and 58 mandibular lateral incisors were documented.

The L*a*b* mean (average)±standard deviation has been determined for each region of the tooth.

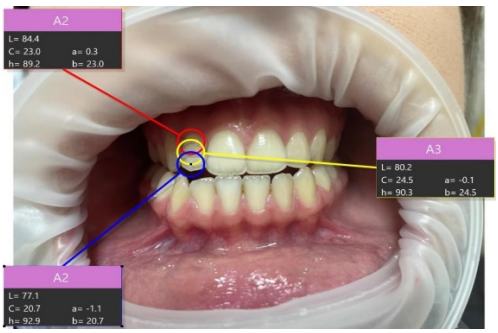

Figure 1. Photograph of a study participant's tooth 1.2 showing CIE Lab* measurements.

Table 1. Teeth 1.2 and 2.2 CIE L*a*b* mean±standard deviation for non-consumers.

	1.2 cervical	1.2 central	1.2 incisal	2.2 cervical	2.2 central	2.2 incisal
L*	82.25± 2.841145	79.805± 2.58609134	72.235± 2.683336	80.55± 3.625857	79.215± 3.675563	70.375± 5.842483
a*	-0.005± 0.702233	-1.135± 0.728571	-1.8± 0.523148	0.075± 0.838467	-1.23± 0.70345	-1.63± 0.557343
b*	23.31± 2.851943	20.17± 2.835694	15.595± 2.991827	22.84± 2.900708	19.58± 2.757497	15.24± 2.31753

For the cervical area of teeth 1.2 the lightness mean±standard deviation calculation was 82.25±2.841145 and for 2.2 it was 80.55±3.625857 from the same area in non-consumers (Table 1).

For the central area for teeth 1.2 in consumers the analysis was 79.1666667±3.54335467 for the mean±standard deviation and for 2.2 the calculation was 77.79583±3.839438 for the identical region (Table 2).

Table 2. Teeth 1.2 and 2.2 CIE L*a*b* mean±standard deviation for consumers.

	1.2 cervical	1.2 central	1.2 incisal	2.2 cervical	2.2 central	2.2 incisal
L*	81.08333± 2.812343	79.1666667± 3.54335467	71.6625± 6.481734	79.25833± 4.91554	77.79583± 3.839438	70.84167± 5.837951
a*	0.470833± 0.967507	-1.05833± 0.764948	-1.78333± 0.765374	0.35± 1.152691	-0.70833± 0.812359	-1.4375± 1.019724
b*	24.11667± 3.26745	20.475± 3.064559	15.62083± 3.512955	23.17917± 2.75586	20.725± 3.023567	16.04167± 3.248132

For the incisal region for teeth 3.2 the results for a* parameters were -1.03929±1.064351 and for 4.2 they were -1.27857±0.987461 for the same area in non-consumers (Table 3).

Table 3. Teeth 3.2 and 4.2 CIE L*a*b* mean±standard deviation for non-consumers.

	3.2 cervical	3.2 central	3.2 incisal	4.2 cervical	4.2 central	4.2 incisal
L*	76.13571± 5.634958	81.41071± 2.957143	77.14286± 14.75783	76.94643± 13.77742	82.325± 2.465409	80.53929± 2.896785
a*	4.407143± 4.020312	0.389286± 1.305356	-1.03929± 1.064351	2.507143± 1.916774	-0.09643± 0.97695	-1.27857± 0.987461
b*	26.25357± 3.812988	22.11429± 3.280325	18.78214± 3.59393	27.14286± 3.497028	22.46786± 3.089295	18.77143± 3.356901

For teeth 3.2 in the cervical area the b* parameters results were 24.94828±3.526797 when calculating the mean±standard deviation for consumers and for 4.2 it was 26.44138±3.957318 for the identical region (Table 4).

Table 4. Teeth 3.2 and 4.2 CIE L*a*b* mean±standard deviation for consumers.

	3.2 cervical	3.2 central	3.2 incisal	4.2 cervical	4.2 central	4.2 incisal
L*	75.88966± 4.146198	81.33793± 2.832391	79.28276± 3.188155	78.84138± 4.663193	81.62069± 2.798773	79.06897± 3.893594
a*	3.772414± 2.627179	-0.12069± 0.899754	-1.33793± 0.716347	2.372414± 2.176153	0.062069± 1.071852	-1.11034± 0.898151
b*	24.94828± 3.526797	21.45862± 2.993268	18.32759± 3.611084	26.44138± 3.957318	22.58276± 4.067122	18.87931± 4.06829

There was a significant difference between a* value for teeth 1.2 in the cervical area by comparing non-consumers with users (p=0.033176). Another notable disparity was also observed for the central area of teeth 2.2 when evaluating non-consumers with consumers (p=0.013802) for the a* parameters (Table 5).

Table 5. Statistical significance (p-values) of measurement comparing non-users and users for maxillary teeth.

	1.2			2.2		
	cervical	**middle**	**incisal**	**cervical**	**middle**	**incisal**
L*	0.090286	0.24723556	0.348078	0.161249	0.109244	0.396592
a*	**0.033176**	0.367887	0.466184	0.182994	**0.013802**	0.216302
b*	0.193505	0.366881	0.489555	0.347465	0.098279	0.173168

Another significant difference (Table 6) for a* parameters in teeth 3.2 in the central region was noticed when the two categories were compared (p=0.046725).

Table 6. Statistical significance (p-values) of measurements comparing non-users and users for mandibular teeth.

	3.2			4.2		
	cervical	**middle**	**incisal**	**cervical**	**middle**	**incisal**
L*	0.426116	0.462394	0.229441	0.247328	0.158701	0.055522
a*	0.242795	**0.046725**	0.110849	0.402432	0.280867	0.252175
b*	0.092831	0.217221	0.31789	0.240434	0.452327	0.456663

Discussions

In this study there were no statistical differences between L* values when compared the consumers with non-users of tobacco and/or nicotine products for the cervical area for teeth 1.2 (p=0.090286) and there were no statistical discrepancies with b* parameters (p=0.193505) for the same teeth.

Comparing non-users with users, tooth 1.2 showed a significant difference in a* values at the cervical region (p=0.033176).

A similar significant difference in a* values appeared for tooth 2.2 at the central region when comparing non-consumers with consumers (p=0.013802).

For the incisal lightness area for teeth 2.2 in consumers the analysis was 70.84167±5.837951 for the mean±standard deviation and for 1.2 was 71.6625±6.481734 for the same region.

The incisal lightness area for teeth 2.2 in non-consumers had the following the analysis: 70.375±5.842483 for the mean±standard deviation and for 1.2 was 72.235±2.683336 for the same region.

In a study conducted by Conte G. et. al. the cross-group comparisons revealed no significant differences in L* values (p> 0.05), indicating that tooth lightness does not appear to be influenced by smoking status [2].

In contrast, significant differences emerged between groups for both a* (p=0.016) and b* (p<0.001), suggesting that cigarette smoking can shift tooth color toward greater redness and yellowness, contributing to visible discoloration.

The corresponding WID was also markedly lower in current smokers (13.42±4.9) than in never smokers (20.38±5.3), a difference that exceeded the clinically perceptible threshold [2].

In this research there were no statistical discrepancies between the users and non-consumers of tobacco and/or nicotine products for the L* value of the central area of the teeth 3.2 (p=0.462394).

Al Ankily et al. compared the effects of conventional cigarette smoke and heated tobacco aerosol on extracted human enamel and cementum and reported that both products produced significant colorimetric change (ΔE), although conventional cigarette smoke produced a greater effect, attributable to the higher tar content and its adhesive, pigmented residue [17].

The findings in a systematic review and meta-analysis by Karanjkar et al. indicated that cigarette smoke stains a range of dental structures and materials, including enamel, dentin, resin composite, ceramics, and acrylic, with resin composite showing greater susceptibility to discoloration than enamel [18].

E-cigarette use was also associated with staining of enamel, dentin, resin composite, and ceramics, though the effect was milder than that of cigarettes and more evenly distributed across enamel, dentin, and resin composite [18].

In a study done by Kowalski J et al. it shows that age and smoking history were both

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significantly linked to detrimental WID scores [15].

Among the countries studied, Italian participants had the whitest teeth by WID measurement, whereas Indonesian participants showed the least gingival inflammation and the least plaque buildup.

Meanwhile, smoking history (measured in pack-years) was significantly and positively associated with Modified Gingival Index across the whole sample [15].

Gupta et al. compared dental color parameters by digital spectrophotometry across five groups-current smokers, former smokers, never smokers, and exclusive users of electronic cigarettes and exclusive users of heated tobacco products -and found that current smokers had the lowest WID values (13.38 units) compared with never smokers (19.96) and former smokers (16.79), while exclusive e-cigarette and heated tobacco product users showed greater WID values (16.72 and 17.82, respectively) that were visually distinguishable from those of current smokers [9].

A positive relationship was found between facultative melanin levels and both the extent of tobacco use, as well as nicotine dependence, among African American smokers in a study by King et al. [19].

The appearance of tooth color is a multifaceted phenomenon that cannot be entirely represented by CIELAB values alone in a study by Hein et al. [20].

In clinical practice, the acceptance or rejection of a restoration frequently hinges on environmental elements that cannot be entirely elucidated by visual thresholds alone [20].

Coffee drinking was linked to more yellowing and stronger chromaticity in teeth, whereas tea showed no meaningful effect in a study by Ghinea et. al. [21].

Brushing teeth often was associated with lighter tooth color, and whitening treatments had a substantial effect, highlighting how much cosmetic procedures can shift tooth shade.

Smoking's effect was small by comparison-light smokers showed only slightly more discoloration than nonsmokers [21].

Thermal stress from smoking can increase enamel porosity, making teeth more prone to staining in a study by Alayadi [22].

Although nicotine patches are generally viewed as a lower-risk alternative to smoking, they may still have some indirect impact on enamel-particularly through reduced salivary flow, which creates a more acidic oral environment and raises the risk of demineralization and caries.

On a more positive note, individuals who quit smoking often become more conscious of their oral health and more motivated to improve their hygiene habits [22].

In addition to conventional teaching methods, there is a necessity for creative tools tailored to modern lifestyles to assist patients in maintaining a long-term ideal oral care regimen [23].

This study is not without limitations.

The relatively small sample size (n=58) may limit the statistical analysis and the generalizability of the findings; future studies involving a larger and more diverse cohort would allow for more robust subgroup comparisons and increase confidence in the observed associations.

Conclusions

Precise identification of tooth color in tobacco and/or nicotine users is important as these chemicals are linked to quantifiable color changes that may not be consistently recognized through subjective visual evaluation alone.

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None to declare.

Author Contributions

Conceptualization, M.M. and A.C.; methodology, C.B.-N.; software, S.-G.B.; validation, C.G.P. and E.-C.S.; formal analysis, G.R. and M.M.; investigation, C.G.P. and M.M.; resources, A.C.; data curation, S.-G.B.; writing-original draft preparation, M.M.; writing-review and editing, G.R.; visualization, E.-C.S. and S.-G.B.; supervision, A.C. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

None to declare.

Institutional Review Board

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Ovidius University, Constanta, Romania Nr. 15089/9.12.2025.

Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to institutional and ethical restrictions.

References

1. Kahler B. Present status and future directions-Managing discoloured teeth. Int Endod J, 2022, 55(Suppl. 4):922-950.
2. Conte G, Pacino SA, Urso S, Emma R, Pedullà E, Cibella F, Stefanini M. Zucchelli G, Polosa R. Repeatability of dental shade by digital spectrophotometry in current, former, and never smokers. Odontology, 2022, 110(3):605-618.
3. Day PF, Duggal MS, High AS, Robertson A, Gregg TA. Ashley PF, Welbury RR, Cole BO. Westland S. Discoloration of teeth after avulsion and replantation: results from a multicenter randomized controlled trial. Journal of endodontics, 2011, 37(8):1052-1057.
4. Pan Q, Westland S. Tooth color and whitening-digital technologies. Journal of dentistry, 2018, 74:S42-S46.
5. De Geus JL, Beltrame FL, Wang M, Avula B, Khan IA, Loguercio AD, Kossatz S, Reis A. Determination of nicotine content in teeth submitted to prophylaxis and in-office bleaching by gas chromatography-mass spectrometry (GC-MS). Clinical oral investigations, 2018, 22(9):3043-3051.
6. Suganya SP, Manimaran P, Saisadan D, Kumar CD, Abirami D, Monnica V. Spectrophotometric evaluation of shade selection with digital and visual methods. Journal of Pharmacy and BioAllied Sciences, 2020, 12(Suppl 1):S319-S323.
7. Alnusayri MO, Sghaireen MG, Mathew M, Alzarea B, Bandela V. Shade selection in esthetic dentistry: a review. Cureus, 2022, 14(3):e23331.
8. Carter EC, Ohno Y, Pointer YMR, Robertson AR, Seve R, Schanda JD, Witt K. International Commission on Illumination (CIE), Recommendations concerning uniform colour spacing and colour differences. Ed Commission Internationale de L'Eclairage**,** 2004, ISBN 3 901 906 33 9, 1-72.
9. Gupta S, Sahni V, Emma R, Gospodaru S, Bordeniuc G, Fala V, Amaliya A, La Rosa GRM, Pacino SA, Urso S, Yilmaz HG, Zucchelli G, Polosa R. E-cigarettes and heated tobacco products impact on dental color parameters. Heliyon, 2024, 10(3):1-10.
10. Zini A, Sgan-Cohen HD, Marcenes W. Socio-economic position, smoking, and plaque: a pathway to severe chronic periodontitis. Journal of clinical periodontology, 2011, 38(3):229-235.
11. Robbins J, Kamran A. How do periodontal indices compare among non-smokers, tobacco and e-cigarette smokers?. Evidence-Based Dentistry, 2022, 23(3):116-117.
12. Socransky SS, Haffajee AD, Cugini MA, Smith C, Kent Jr RL. Microbial complexes in subgingival plaque. Journal of clinical periodontology, 1998, 25(2):134-144.
13. Zhang J, Yu J, Dou J, Hu P, Guo Q. The impact of smoking on subgingival plaque and the development of periodontitis: a literature review. Front Oral Health, 2021, 2:751099.
14. Sigwart L, Wiesmüller V, Kapferer-Seebacher I. Colour Changes and Surface Roughness After Air-Polishing for Tobacco Stain Removal. International Dental Journal, 2025, 75(2):1409-1419.
15. Kowalski J, La Rosa GRM, Cibella F, Urso S, Polosa R, SMILE study working group. The SMILE study cohort: baseline comparison of oral health and dental aesthetics among smokers in Italy, Poland, Moldova, and Indonesia. J Dent, 2025, 106229.
16. Gasparik C, Pérez MM, Ruiz-López J, Ghinea RI, Dudea D. The color of natural teeth: a scoping review of in-vivo studies. J Dent, 2025, 158:105725.
17. Al Ankily M, Makkeyah F, Bakr MM, Shamel M. Evaluating the effects of cigarette smoking and heated tobacco products on hard dental tissues: a comparative histological and colorimetric analysis. Clin Exp Dent Res, 2024, 10(4):e941.
18. Karanjkar RR, Preshaw PM, Ellis JS, Holliday R. Effect of tobacco and nicotine in causing staining of dental hard tissues and dental materials: a systematic review and meta-analysis. Clin Exp Dent Res, 2023, 9(1):150-164.
19. King G, Yerger VB, Whembolua GL, Bendel RB, Kittles R, Moolchan ET. Link between facultative melanin and tobacco use among African Americans. Pharmacology Biochemistry and Behavior, 2009, 92(4):589-596.
20. Hein S, Morovič J, Morovič P, Saleh O, Lüchtenborg J, Westland S. How many tooth colors are there?. Dental Materials, 2025, 41(1):51-57.
21. Ghinea R, Herrera LJ, Ruiz-López J, Sly MM, Paravina RD. Color ranges and distribution of human teeth: a prospective clinical study. J Esthet Restor Dent, 2025, 37(1):106-116.
22. Alayadi H. The impact of nicotine patches on gingival and oral health: a narrative review. Cureus, 2024, 16(9):e70571.
23. Morariu VM, Soancă A, Roman A, Albu S, Gâta A, Vesa Ș, Șurlin P, Tăut D, Negucioiu M, Cândea A. Digital Support for Daily Oral Hygiene: A Mobile Application to Improve Patients' Adherence and Management of Periodontitis-Initial Implementation and User Feedback. Dentistry Journal, 2025, 13(11):520.

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