Evaluation of Gingival Pigmentation and Related Factors on Former Smokers

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ABSTRACT

Objectives: Gingival pigmentation, the most common etiological factor of which is smoking, is a clinical condition that causes aesthetic complaints. Due to the dose-dependent effect of smoking, gingival pigmentation may present regression following cessation. This cross-sectional study aimed to evaluate gingival pigmentation in former tobacco consumers and compare with current ones.

Material and Methods: A total of 110 people, 70 of whom were current smokers (Group CS) and 40 of whom were former smokers (Group FS), were included in the study. Participants filled out the data collection forms containing questions on demographic features and information related to tobacco consumption. In addition, all individuals were examined with Hedin's melanin index (HMI) to evaluate gingival pigmentation. Statistical significance was set at the $P < 0.05$ level.

Results: The population consisted of 57.3% male, and the mean age of all participants was 39.43 (SD 12.3) years. The mean duration of tobacco consumption did not differ between groups, whereas the mean HMI score of Group FS was significantly lower ($P = 0.001$). The correlation analyses showed that while the HMI score of Group CS was in relation to both daily consumption amount and duration of consumption (for both, $P < 0.01$), the HMI score of Group FS showed a negative association with only time elapsed after cessation ($P = 0.000$).

Conclusions: Considering the limitations of this study, the outcomes revealed a dose- and a time-dependent relation of gingival pigmentation in smokers. However, gingival pigmentation in former tobacco consumers was negatively correlated only with time elapsed after cessation.

Keywords: ex-smokers; pigmentation; smoking cessation; tobacco use.

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INTRODUCTION

Tobacco consumption, especially cigarettes, has well-documented adverse effects on general health as well as on oral and dental health [1]. Smoking modifies the immune response of periodontium against periodontopathogens through both systemic and local effects. Moreover, due to the harmful effects of smoke on the cells known commonly, structural alterations both in gingival epithelium and connective tissue may be occurred. Gingival pigmentation (GP) is a clinical condition that can be observed due to these structural changes. As one of these changes, excessive accumulation of melanin causes the discoloration of gingiva clinically [2]. The fact that smokers show more GP than non-smokers was reported by Hedin [3] in 1977 for first, which was called "smokers' melanosis". This term describes a specific clinical condition that discards genetic factors, ethnicity, or drug-induced discoloration [4,5].

The normal colour of the gingiva is coral pink, whereas skin colour, ethnicity, and other endogenous and exogenous factors can affect this colour. The pigments that cause GP are mainly melanin, haemoglobin, oxyhaemoglobin, and carotene [6]. Melanin, the most important of these pigments, is synthesized by melanocytes of neuroectodermal origin both in the basal and spinous layers of epithelial tissue. After the production, it is stored in melanosomes [7]. Melanin plays a pivotal role in protecting the skin and mucosa against ultraviolet radiation [8]. It has been shown in different studies that tobacco consumption activates melanocytes [9,10]. Since increased nicotine release in the gingival tissue due to tobacco consumption, melanin pigments accumulate in the gingiva much more, and GP ultimately occurs [11]. This clinical condition indicated with a brown or bluish-black discoloration of the attached gingiva is generally seen in the anterior region of the upper jaw and may cause aesthetic concerns.

While the harmful effects of smoking on GP have been extensively studied, there is a limited amount of research on gingival discoloration in individuals who quit smoking. A decrease in GP over time has been reported as an outcome of smoking cessation [12]. Kato et al. [13] reported a relationship between the time elapsed after smoking cessation and the decrease in pigmentation. Since tobacco consumption causes thickening of the epithelium and discoloration of the surface, this effect is thought to be reversible if tobacco use is stopped.

Time of consumption is well-documented factor in gingival pigmentation which has a multifactorial aetiology. Therefore, based on the null hypothesis that current and former smokers have similar smoking duration would not display different pigmentation; this cross-sectional study is aimed to evaluate the gingival pigmentation of former smokers in comparison with current smokers.

MATERIAL AND METHODS

Study design and participants

The protocol of this cross-sectional prospective observational clinical study was approved by the Ethics Committee for Non-Interventional Clinical Research of Istanbul Aydin University (03.01.2022, 2022/11). Written informed consent was obtained from all participants included in this study, which was conducted in accordance with the Declaration of Helsinki.

Based on values from methodologically similar studies [2,13], the power analysis tool G*Power Software, version 3.1.9.7 (Heinrich-HeineUniversität; Düsseldorf, Germany) calculated a total sample size of 93, with an effect size of 0.35, 85% power, and a margin of error of 0.05. A total of 110 participants aged between 19 to 69 applied to Istanbul Aydin University Faculty of Dentistry (Istanbul, Turkey) between 25th of November 2021 and 2nd of September 2022. All participants who were included in this study had to fulfil the criteria listed below:

- Being systemically healthy.
- Not being pregnant and lactating.
- Not consume any prescribed medicines, over-the-counter remedies, and illicit substances.
- Not having undergone depigmentation therapy previously.

People with ethnic and genetic characteristics that may play a role in the aetiology of GP were not included in the study. Also, periodontal status was not considered.

The participants were divided into two distinct groups. Seventy people who consume any of the tobacco products such as cigarettes, tobacco, hookah and etc., regularly in a day included the Group of current smokers (CS). Based on the definition of Centers for Disease Control and Prevention (www.cdc.gov/nchs/nhis/tobacco/tobacco_glossary.htm), 40 people who smoked more than 100 cigarettes in their lifetime or used the other tobacco products in the past at least one year and stopped using them at least one year ago included the Group of former smokers (FS).

Clinical evaluation

Data of the participants were recorded in a form structured as two parts. The first part of the form consisted of questions about medical/dental anamnesis. Additionally, in the first part, questions existed to reveal participants' behaviours about tobacco consumption. Group CS participants were asked about their daily tobacco consumption amount and how long they had used it in this part. On the contrary, Group FS participants were asked how long they had used tobacco in the past and when they had quit.

GP of the participants was evaluated with Hedin's melanin index (HMI) as the second part of the form, which was developed by Hedin [3] in 1977. The score of this index and their clinical interpretations were as follows:

- 0 = no pigmentation.
- 1 = one or two solitary unit(s) of pigmentation in papillary gingiva without the formation of a continuous ribbon between solitary units.
- 2 = more than three units of pigmentation in papillary gingiva without the formation of a continuous ribbon.
- 3 = one or more short continuous ribbons of pigmentation.
- 4 = one continuous ribbon, including the entire area between canines.

All participants were evaluated in terms of GP by the same clinician (C.A.). To achieve examiner self-consistency, C.A. recorded the index above in 2 sessions one week apart from 5 patients with GP who were not included in the study. The agreement of these two records was assessed by Cohen's kappa, and intra-examiner consistency was found to be "almost perfect" with 98.6%.

Statistical analysis

The Number Cruncher Statistical System™ (NCSS) 2007 software (NCSS, LLC; Kaysville, Utah, USA) was used for statistical analysis. Descriptive statistics were shown as percentage, mean and standard deviation (M [SD]), median, minimum and maximum values. The Shapiro-Wilk test was performed to reveal whether the quantitative variables met the criteria of normality distribution. The Kruskal-Wallis test was used for multiple comparisons between groups, while the Mann-Whitney U test was used to compare the mean values of two groups. While quantitative variables were compared with the Mann-Whitney U test, the Chi-square test was used to compare the qualitative ones. The association among variables was revealed with Spearman's correlation analysis. Statistical significance was set at $P < 0.05$ level.

RESULTS

Table 1 displays the variables of all participants and a comparison of variables between Group CS and Group FS. Considering this, the study population consisted of 47 females (42.7%) and 63 males (57.3%), without any difference between groups ($P = 0.971$). In addition, the mean age of all participants was 39.43 (12.3) years (ranging from 19 to 69), and the mean age values were similar between groups ($P = 0.084$).

As shown in Table 1, all participants' mean years of tobacco consumption and the HMI score were recorded as 15.95 (9.55) years and 1.22 (1.18), respectively. Furthermore, the findings revealed that years of tobacco consumption between groups did not differ ($P = 0.41$), whereas the mean HMI score of Group FS was significantly lower than Group CS ($P = 0.001$).

Table 1. Comparison of variables between groups

		All (n = 110)	Group CS (n = 70)	Group FS (n = 40)	P
Sex	Female (n)	47	30	17	0.971
	Male (n)	63	40	23	
Age (year)	Mean (SD)	39.43 (12.3)	37.93 (12.26)	42.03 (12.08)	0.084
	Median (min; max)	40 (19; 69)	37 (19; 69)	41.5 (19; 63)	
Time of consumption (year)	Mean (SD)	15.95 (9.55)	15.42 (9.69)	16.88 (9.35)	0.41
	Median (min; max)	15 (1; 38)	15 (1; 38)	16.25 (4; 35)	
HMI score	Mean (SD)	1.22 (1.18)	1.81 (1.07)	0.18 (0.39)	0.001[a]
	Median (min; max)	1 (0; 4)	2 (0; 4)	0 (0; 1)	

[a]Statistically significant at level $P < 0.05$ (Mann-Whitney U test).
n = number; HMI = Hedin's melanin index; SD = standard deviation; CS = current smokers; FS = former smokers.

As shown in Figure 1, cigarettes were the most opted product for tobacco consumption both in all participants (90.9%) (Figure 1A) and in each of the study groups (for Group CS and Group FS with 90% and 92%, respectively) (Figure 1B and C). However, in Group FS, no participants regularly consumed cigars and pipes in the past (Figure 1C).

Considering the tobacco product type consumed by the group participants, the mean age of the cigarette consumers in Group CS and Group FS were 39.34 (12.1) years and 42.78 (11) years, respectively (Table 2). The mean age of the cigarette consumers in Group CS had a significant difference from the hookah and the cigar and pipe consumers (for both, P = 0.017).

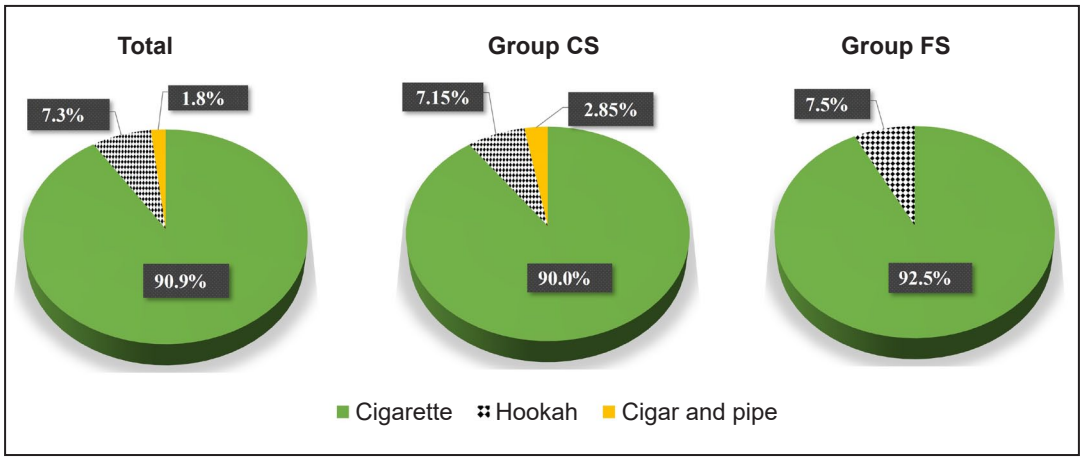

Figure 1. Distribution of tobacco products in study groups.

Table 2. Comparison of variables according to consumed tobacco product in groups

	Group CS				Group FS			
		Mean (SD)	Median (min; max)	P[a]		Mean (SD)	Median (min; max)	P[b]
Age	Cigarettes (n = 63)	39.34 (12.1)[c]	40 (21; 69)[c]	0.017*	Cigarettes (n = 37)	42.78 (11.93)	42 (25; 63)	0.19
	Hookah (n = 5)	24.4 (3.13)	25 (19; 27)		Hookah (n = 3)	32.67 (11.85)	39 (19; 40)	
	Cigar and pipe (n = 2)	28 (4.24)	28 (25; 31)		Cigar and pipe (n = 0)	N/A	N/A	
Time of consumption	Cigarettes (n = 63)	16.32 (9.79)	15.5 (1; 38)	0.06	Cigarettes (n = 37)	17.14 (9.48)	15.5 (4.5; 35)	0.589
	Hookah (n = 5)	6.4 (1.82)	7 (4; 8)		Hookah (n = 3)	13.67 (8.39)	18 (4; 19)	
	Cigar and pipe (n = 2)	10 (0)	10 (10; 10)		Cigar and pipe (n = 0)	N/A	N/A	
Daily consumption	Cigarettes (n = 63)	14.71 (9.79)	12.5 (0.25; 50)	0.141	Cigarettes (n = 37)	5.19 (5.26)	4 (1; 27)	0.185
	Hookah (n = 5)	6.26 (9.02)	0.1 (0.1; 20)		Hookah (n = 3)	2.33 (1.53)	2 (1; 4)	
	Cigar and pipe (n = 2)	11.3 (15.84)	11.3 (0.1; 22.5)		Cigar and pipe (n = 0)	N/A	N/A	
HMI score	Cigarettes (n = 63)	1.89 (1.08)	2 (0; 4)	0.179	Cigarettes (n = 37)	0.19 (0.4)	0 (0; 1)	0.413
	Hookah (n = 5)	1.2 (0.45)	1 (1; 2)		Hookah (n = 3)	0 (0)	0 (0; 1)	
	Cigar and pipe (n = 2)	1 (1.41)	1 (0; 2)		Cigar and pipe (n = 0)	N/A	N/A	

[a]Kruskal-Wallis test; [b]Mann-Whitney U test; [c]Mann-Whitney U test with Bonferroni correction.
*Statistically significant at level P < 0.05.
n = number; HMI = Hedin's melanin index; SD = standard deviation; CS = current smokers; FS = former smokers.

However, any of the remaining variables did not differ among these sub-groups (P > 0.05). When the participants in Group FS were sub-grouped similarly, no significant difference was found between the mean values of the sub-groups in terms of the variables listed as time after cessation, time of consumption and HMI score (P > 0.05) (Table 2).

The association between variables in Group CS is shown in Table 3. Strong positive relationships between the HMI score and both the time of consumption (r = 0.427, P = 0.000), and daily consumption was observed (r = 0.396, P = 0.001) (Table 3). Table 4 displays the relationship between variables in Group FS. According to this, the negatively directed relationship between the time elapsed after cessation and the HMI score was remarkable (r = -0.533, P = 0.000).

DISCUSSION

GP, which is one of the reasons for patients to apply for treatment with aesthetic concerns, occurs due to melanin accumulation in the gingiva. The rising popularity of GP-related studies in recent years could be attributed to the increased aesthetic demands of individuals [14-17]. Previous studies on GP, in which smoking is at the forefront of its aetiology, have mostly focused on the effect of consumption. In contrast, studies on the impact of cessation on regression have been limited [9,18]. This cross-sectional prospective observational clinical study evaluated the GP and related factors in FS and compared it with CS.

Smoking, as a well-defined etiological factor, is related to increased periodontal disease activity due to harmful substances in tobacco smoke and systemic effects. Besides the aforementioned harmful effects, such as periodontal disease activity and predisposing oral lesions to carcinogenesis on individuals [19], the environmental negative impact of the chemicals released into the air during the burning of tobacco will also impact a person's wellness and well-being [20].

Table 3. Correlation analysis in Group CS

		Age	Daily consumption	Time of consumption	HMI score
Age	r	1	0.129	0.897	0.323
	P	-	0.289	0.000[a,b]	0.007[a,b]
Daily consumption	r	0.129	1	0.166	0.396
	P	0.289	-	0.174	0.001[a,b]
Time of consumption	r	0.897	0.166	1	0.427
	P	0.000	0.174	-	0.000[a,b]
HMI score	r	0.323	0.396	0.427	1
	P	0.007[a,b]	0.001[a,b]	0.000[a,b]	-

[a]Statistically significant at level P < 0.05 (Spearmen's correlation test).
[b]Statistically significant at level P < 0.01 (Spearmen's correlation test).
HMI = Hedin's melanin index; CS = current smokers.

Table 4. Correlation analysis in Group FS

		Age	Time after cessation	Time of consumption	HMI score
Age	r	1	0.583	0.75	-0.177
	P	-	0.000[a,b]	0.000[a,b]	0.275
Time after cessation	r	0.583	1	0.144	-0.533
	P	0.000[a,b]	-	0.377	0.000[a,b]
Time of consumption	r	0.75	0.144	1	0.12
	P	0.000[a,b]	0.377	-	0.461
HMI score	r	-0.177	-0.533	0.12	1
	P	0.275	0.000[a,b]	0.461	-

[a]Statistically significant at level P < 0.05 (Spearmen's correlation test).
[b]Statistically significant at level P < 0.01 (Spearmen's correlation test).
HMI = Hedin's melanin index; FS = former smokers.

Nicotine and benzopyrene, prominent chemicals in tobacco smoke, may increase melanin secretion in gingival tissue [11,21]. Regarding this, it should be kept in mind that smoking is an important risk factor for morphological changes in gingival tissue and its effect on periodontal disease activity.

GP was first defined and classified by Hedin [3] in 1977, and subsequently, HMI, as an objective tool to measure GP with inspection, was introduced by the same researcher. In this presented study, HMI was opted to assess GP in participants and to avoid a bias, all clinical records were performed by a single, experienced, and calibrated clinician. The "gingival melanosis recording", an alternative to the HMI recorded by direct vision, measures smoking-induced melanosis with intraoral photographic images [13]. Although the findings of this study showed that this method was as reliable as HMI, it was not preferred for this study due to its disadvantages, such as being time-consuming and raising ethical concerns about personal data.

The effects of tobacco consumption on gingival discoloration in smokers were investigated by various researchers [2,22]. Araki et al. [11] found that individuals who smoked ten or more cigarettes daily had higher gingival melanosis scores. In addition, children whose parents were smoker were reported to show increased pigmentation tendency than children with non-smoker parents [23]. The result of the study conducted by Ponnaiyan et al. [24] in which passive smokers exposed to environmental tobacco smoke showed more GPs figured out that environmental health effects should not be underestimated. Consistent with previous studies, GP scores were higher in tobacco consumers than in former consumers. Similar to the outcomes of Araki et al. [11] the findings of this study revealed that pigmentation of CS positively associates both daily consumption amount with a dose-dependent manner and consuming period in years with a time-dependent one.

The findings show that the daily consumption amount and duration (years) are similar in Group CS. In addition, the HMI scores of these three subgroups were similar too. Therefore, it can be assumed that the amount and duration of consumption affect pigmentation rather than the quality of tobacco product type. Since combustion reactions activate the tobacco products examined in this study, they end with similar effects on the gingiva. Although the popularity of heated tobacco products (e.g. IQOS® Tobacco Heating System by Philip Morris Products S.A.) has been increasing recently, none of the participants were using these products surprisingly. Since this fact, no outcomes were revealed regarding the effects of these products here.

One of the studies evaluating smoking cessation and GP, which is relatively few compared to the studies examining the relationship between smoking and GP, was conducted by Hedin et al. [12]. The outcomes of the study noticed that smoking cessation resulted in a decrease in GP, evenly disappeared at the end of 6 months. The observed negative relationship between GP and the time elapsed after cessation in Group FS supports the outcomes presented by Hedin et al. [12]. However, GP scores in Group FS were not associated with the duration of consumption in years. Correlation tables show that age and HMI scores are correlated in the CS group but not in the FS group. This outcome may be interpreted as age-related changes not affecting the regression of GP. Therefore, it would be assumed that time elapsed after cessation was the main factor determining GP scores in former consumers rather than duration of consumption.

Besides strengths of the study as well as some limitations were considered in interpreting outcomes. Although the sample size is sufficient to reveal the true difference between the groups, it is recommended to plan longitudinal studies by increasing the number of participants. Thus, it is foreseen that more generalizable outcomes may be obtained. Participants' cigarette exposure was not considered, as it would have been difficult to determine whether they were aware of their passive smoking. In addition to these limitations, the possible effect of factors such as the individual not having enough knowledge and awareness to understand the topic and the questions, not being capable of remembering the consumption history (year, amount, etc.), concern that he/she will be discriminated against due to his/her answers etc., on the results should be taken into consideration. Another limitation of the study is that it was not possible to standardize the amount of nicotine in the tobacco products consumed by the participants. It should also be considered as another limitation that thanks the nature of the cross-sectional design of this study does not allow to determine the causality.

CONCLUSIONS

Within the limitations of this study, the outcomes show that gingival pigmentation has a negative relation with time elapsed after cessation in former smokers. Moreover, the revealed findings support the well-described knowledge about the dose- and the time-dependent associations between gingival pigmentation and tobacco consumption in current

smokers. The results of the study are consistent with previous studies; however, controlled designed studies with many participants are needed to obtain findings that will elucidate the relationship between gingival pigmentation and tobacco consumption.

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The authors report no conflicts of interest related to this study.

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