

Original Article



Prevalence and pattern of physiologic oral pigmentation in a Pakistani population

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Abstract

Background: Excessive melanin deposition in the oral cavity without any systemic disease or other known cause is known as hyperpigmentation or physiologic pigmentation. The site and intensity of pigmentation of the oral mucosa varies in different populations, and it is especially common in individuals with darker skin tones. This study aimed to determine the prevalence of physiologic oral pigmentation in a Pakistani population and its association with age, sex, and skin tone.

Methods: This was a cross-sectional observational study of 386 consenting individuals aged between 18 and 75 years attending a dental college over two months. Individuals with pathologic pigmentation were excluded based on their history and clinical examination. All participants underwent a comprehensive oral examination to document the sites and intensity of pigmentation, and skin tone was classified according to the Fitzpatrick phototype classifications III, IV, and V. The chi-squared test or Fisher's exact test was used in the analysis.

Results: Nearly sixty percent of the population had some pigmentation within the oral cavity. The most common site of pigmentation was the attached gingiva. Oral pigmentation was significantly associated with darker skin tone and older age but not sex.

Conclusion: Oral pigmentation is present in about sixty percent of the Pakistani population and is associated with darker skin tones.

Keywords: Gingiva, Hyperpigmentation, Skin pigmentation, Pigmentation, Melanin

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Introduction

Several genetic, metabolic, endocrine, infective, inflammatory, and neoplastic processes and chemical exposure contribute to the development of oral pigmentation.¹ The excessive deposition of melanin in the oral cavity without systemic disease is described as hyperpigmentation, or physiologic pigmentation.²⁻⁴ It is recognized as the localized or diffuse darkening of the oral mucosa, predominately in dark-skinned people.^{1,5} While physiologic pigmentation most commonly occurs in the gingiva, it can affect other oral sites like the tongue, buccal mucosa, labial mucosa, and palate.^{5,6} The intensity, color (deep purple, brown, or black), and pattern (irregularly shaped striae or strands) of the pigmentation vary.^{3,5,7} Physiologic pigmentation is a normal variant and not a disease. Still, it can be an aesthetic problem for people with gummy smiles.² Interestingly, although individuals of different ethnicities have the same number of melanocytes, differences in melanin expression determine the color of mucosae.^{8,9} As such, differences in the size and

distribution of melanosomes, types of melanin, and the masking effect of the overlying epithelium all contribute to variable pigmentation.⁵

Physiologic pigmentation is, however, invariably associated with increased deposition of melanin.^{5,9} Melanosomes accumulate melanin and transport it to the dendritic-like projections of melanocytes and then to adjacent keratinocytes in the keratinocyte-melanin unit, thus producing pigmentation.^{10,11} At least 11 different genes affecting melanin deposition have been implicated in physiologic pigmentation, including those of the encoding adrenocorticotrophic hormone and alpha-melanocyte-stimulating hormone, which stimulate the activity of tyrosinase and enhance melanogenesis.⁹

Physiologic oral pigmentation is common in some geographic regions and may be related to skin color. A study of 1275 patients attending dental clinics in Jordan reported physiologic oral pigmentation in nearly forty percent of patients,¹¹ and an Indian study reported a significant correlation between the severity of gingival



pigmentation and skin color.² Since physiologic pigmentation appears to be more pronounced in Asian and Black populations^{2,12} and there is little baseline data on physiologic pigmentation in Pakistani populations, the purpose of this investigation was to determine the prevalence and pattern of physiologic pigmentation in a Pakistani population and explore associations between physiologic pigmentation and age, sex, and skin tone. This is important to fill in the knowledge gap caused by the limited data and provide valuable insight into the Pakistani population. This study aimed to establish a foundation for understanding normal pigmentation.

Methods

The Riphah International University Ethics Review Board approved the study protocol (IIDC/IRC/2020/001/021). This cross-sectional study was carried out at the Riphah International University, Islamic International Dental Hospital, Islamabad, Pakistan, during June and July 2021. For a confidence level of 95% and margin of error of 5%, the sample size was calculated for an unlimited population using the WHO formula $n = \frac{Z^2 X p (1-p)}{e^2}$ with $z=1.96$, $e=0.05$, and $p=0.5$. It was calculated as 386. As such, 416 consenting individuals aged between 18 and 75 years were recruited by convenience sampling.

A thorough history was taken from all participants to determine possible factors contributing to a known cause of oral pigmentation (e.g., smoker's melanosis, drug-induced hyperpigmentation, heavy-metal-related pigmentation, hemochromatosis, Addison's disease, café au lait spots, tattoo, melanoacanthoma, melanoma, post-inflammatory melanosis, Peutz-Jeghers syndrome, neurofibromatosis and other syndromes with associated pigmentations), which excluded thirty participants. The included individuals then underwent a comprehensive examination. This was done in the dental clinic on the dental chair with proper lighting conditions, where two trained examiners recorded the presence and intensity of oral pigmentation in each participant according to the following criteria: 0, pink tissue (no clinical pigmentation); 1, mild, light brown tissue (mild clinical pigmentation); 2, medium brown or mixed pink or brown tissue (moderate clinical pigmentation); and 3, deep brown or blue/black tissue (heavy clinical pigmentation). Following Rakhewar et al,² skin tone was classified into three categories according to the Fitzpatrick phototype classification, where the prevalent types in the Asian population are types III, IV, and V.¹³ At least two researchers examined each participant, and the results were reviewed to reach a consensus in case of disagreement. A third examiner was asked to make the final decision on disagreements that were not resolved.

Data were analyzed using IBM SPSS (v25.0, IBM Statistics, Armonk, NY). Differences in the presence or absence of oral pigmentation concerning age, gender,

and skin tone were analyzed with the chi-square test or Fisher's exact test as appropriate. A P value <0.05 was considered significant.

Results

Of 386 consenting individuals aged between 18 and 75 years (mean 40.25, standard deviation 16.06) that met the inclusion criteria, 178 (46.1%) were males and 208 (53.9%) were females. Oral pigmentation was present in 229 (59.3%) participants, and it was commonly mild or light brown. The gingiva was the most common site of pigmentation, seen in 131 (49.5%) of patients exhibiting pigmentation, but pigmentation was also seen in the labial mucosa (57, 14.8%), buccal mucosa (56, 14.5%), hard palate (76, 19.7%), soft palate (9, 2.3%), floor of the mouth (14, 3.6%), and tongue (56, 14.50%) (Table 1).

The prevalence of oral pigmentation concerning age, gender, and skin tone is shown in Table 2.

There was a statistically significant difference in oral pigmentation concerning age ($P=0.024$) and skin tone ($P=0.001$) but not sex ($P=0.262$). Oral pigmentation was more prevalent in patients with darker skin tones and was present in 100% of individuals with type V skin tone.

Discussion

The prevalence of physiologic oral hyperpigmentation in a population of patients attending a dental clinic in Pakistan was examined. It was noted that there was some physiologic pigmentation in at least 59% of our sample, much higher than the 20.8% global prevalence of oral pigmentation reported in a recent systematic review¹⁴ although this review did not exclude other causes of pathological pigmentation such as cigarette smoking and other forms of tobacco use, medications, and diseases that can result in pigmentation. Other studies from Asia, where the populations are similar to that presented here, have estimated the prevalence of physiologic pigmentation at 60.6% in Chinese women, 62.7% in the general Yemeni population, 40% in Jordan, and 60% in multiethnic Singapore.^{11,15-17} While these results are similar to ours, a previous study from Pakistan estimated physiologic oral pigmentation in only 12% of their sample, possibly because they were documenting all abnormal oral processes and were not investigating specific and subtle color differences in the mucosa.¹⁸ The observation that the gingivae were the most common site of involvement is consistent with previous studies in South African and Indian populations.^{2,19,20}

The data on the association between oral pigmentation and age are conflicting. A statistically significant difference in oral pigmentation concerning age was found, with the highest proportion observed in the 21–39-year-old age group. These data are consistent with previous data from India, concluding that the intensity of pigmentation increased with age^{20,21} but not with other studies from

Table 1. Distribution of oral pigmentation in different regions of the oral mucosa.

Site	Pink tissue	Mild/ light brown tissue	Medium brown/mixed pink and brown tissue	Deep brown and blue-black tissue	Total
Labial mucosa	329 (85%)	39 (10%)	16 (4%)	2 (0.5%)	57 (14.8%)
Buccal mucosa	330 (85%)	45 (11.7%)	11 (2.8%)	0 (0%)	56 (14.5%)
Gingivae	195 (50.5%)	96 (25%)	79 (20.5%)	16 (4.1%)	131 (49.5%)
Hard palate	310 (80%)	54 (14%)	19 (5%)	3 (1%)	76 (19.7%)
Soft palate	377 (97.7%)	8 (2.1)	1 (0.2%)	0 (0%)	7 (2.3%)
Floor of mouth	372 (96.4%)	12 (3.1%)	2 (0.5%)	0 (0%)	14 (3.6%)
Tongue	320 (85.5%)	42 (10.9%)	14 (3.6%)	0 (0%)	56 (14.5%)

Table 2. Prevalence of oral pigmentation concerning age, gender, and skin tone

Characteristic		Total n (%)	Physiological pigmentation present n (%)	Difference between groups (physiologic pigmentation vs. no physiologic pigmentation), <i>P</i> value
Sex	Male	178 (46.1%)	111 (62.3%)	0.262
	Female	208 (53.9%)	118 (56.7%)	
Age	<20	34 (8.8%)	19 (55.9%)	0.024
	21–39	167 (43.2%)	101 (60.5%)	
	40–59	126 (32.6%)	71 (56.3%)	
	≥60	59 (15.2%)	38 (64.4%)	
Skin tone	Type III	132 (34.1%)	24 (18.2%)	<0.01
	Type IV	193 (50%)	144 (74.6%)	
	Type V	61 (15.8%)	61 (100%)	

South Africa and India in the pediatric population.^{22,23} The age association can be attributed to continuous exposure of the human skin to intrinsic and extrinsic factors and the aging effect on cells, including melanocytes, responsible for pigmentation.²⁴ This can be due to hyperactivation of melanocytes and altered distribution and turnover of pigment.²⁴ While there were no significant differences in oral pigmentation according to sex, consistent with other studies,^{19,22,23} a South African study did detect more frequent pigmentation in males while a Saudi study detected more association in females.^{25,26}

The data on oral pigmentation and skin tone are more consistent. Ethnicity, which is related to skin tone, is an important determinant of physiologic oral pigmentation.²⁷ Skin tone is primarily determined by genetics, which influences the production and distribution of melanin pigment.²⁸ Melanin pigment is variable in different ethnic groups.²⁹ While the number of melanocytes generally remains constant, variations in melanin production and melanosome (the melanin-containing organelle) quantity dictate the presence and intensity of pigmentation in both the skin and oral cavity.^{28,29}

A study from Singapore showed the highest percentage of gingival pigmentation in people of Malay ethnicity compared with those of Indian and Chinese ethnicity.¹⁷ Consistent with a prior study from India, it was also concluded that physiologic hyperpigmentation was

more common in patients with darker skin tones.¹⁹ A study from South Africa detected higher rates of oral pigmentation in Black and Asian patients than in White patients,³⁰ and other studies have similarly found that individuals with darker skin tones have higher rates of oral pigmentation.^{2,20,30} One study from Northwest Australia did not detect a difference in oral pigmentation and forehead skin tone in a presumably predominantly White population, suggesting that the phenomenon is primarily related to skin tones associated with Black and Asian ethnicity.³¹

A study conducted in Saudi Arabia on more than 800 patients who were originally from multiple geographic areas and ethnic origins showed a significant association between oral pigmentation intensity and country of origin. Pakistan and its neighboring countries (Afghanistan and India) were included in the study. They showed a medium pattern in the Indian population and a light pattern in the Afghani population,²⁶ which is comparable to the results of this study, which show that the majority have light or mild pigmentation. It also showed that most of the medium skin tone group was associated with medium gingival pigmentation, and the light skin group with light gingival pigmentation.²⁶ A study done on Israeli patients from different ethnic origins showed the presence of gingival pigmentation in 58% of the Eastern group, 49% in the Sephardic group, and 21% in the Ashkenazi group, which is also consistent with skin tone, which gets lighter from the Eastern Jews to the Sephardi Jews and the Sephardic Jews to the Ashkenazi Jews.³²

Strengths and Limitations

This study has several limitations, including an unbalanced sample population concerning age and sex distribution, subjective observation of skin tone and oral pigmentation, and recruiting a sample population at dental clinics only, which may not accurately reflect the general Pakistani population. Although confounding factors, such as passive smoking, were excluded as much as possible in this study, a possible cause of oral pigmentation could not be excluded.³³ In addition, this study only took an adult population into consideration, and prior studies have shown that children also exhibit oral pigmentation,³⁴ so

the latter population requires separate consideration.

Conclusion

Almost 59.3% of the Pakistani population demonstrated pigmentation within their oral cavity, most commonly located at the attached gingiva. Oral pigmentation was significantly associated with skin tone and age but not sex.

Authors' Contribution

Conceptualization: Amna Arooj, Amber Kiyani, Sobia Hassan.

Data curation: Amna Arooj, Soulaifa Almazrooa.

Investigation: Amna Arooj, Amber Kiyani, Sobia Hassan.

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Methodology: Amna Arooj, Amber Kiyani, Sobia Hassan.

Project administration: Amna Arooj, Soulaifa Almazrooa.

Supervision: Amber Kiyani, Sobia Hassan.

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Resource: Amber Kiyani, Soulaifa Almazrooa.

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Visualization: Amber Kiyani, Sobia Hassan, Soulaifa Almazrooa.

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Writing-review & editing: Soulaifa Almazrooa.

Competing Interests

The authors declare that no conflict of interest exists.

Data Availability Statement

The data set is available upon request.

Ethical Approval

The Riphah International University Ethics Review Board approved the study protocol (IIDC/IRC/2020/001/021).

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