



## Clinical Characterization of Gingival Pigmentation in Indian Adults: A Study on Distribution, Intensity, and Extent – A Cross-Sectional Study

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### KEYWORDS

gingiva, melanin, pigmentation, skin pigmentation

### ABSTRACT:

**Background:** Gingival pigmentation, a physiologic condition primarily attributed to melanin deposition, significantly impacts smile esthetics. It is more frequently observed in individuals with darker skin tones, yet limited data exists on the detailed clinical presentation of this pigmentation in Indian adults.

**Objective:** To evaluate and correlate the distribution, intensity, and extent of gingival melanin pigmentation in Indian adults with darker skin tones using standardized classification systems.

**Materials and Methods:** This cross-sectional study included 80 dark-skinned Indian adults aged 18–60. Standardized intraoral photographs of the maxillary anterior gingiva were assessed by three calibrated examiners. Gingival pigmentation was classified based on de Krom (distribution), DOPI (intensity), and Melanin Index (extent) systems. Statistical analyses including Chi-square, Kruskal–Wallis, and k-means clustering were applied.

**Results:** Category 1 pigmentation (De Krom) was most common (37.5%), followed by Categories 2 (22.5%) and 3 (20%). Heavy pigmentation (DOPI) was seen in 36.3% of participants, while 46.3% showed Degree IV pigmentation (Melanin Index), indicating extensive gingival involvement.

**Conclusion:** Gingival pigmentation is a universal trait among dark-skinned Indian adults. A symmetrical, continuous, darkly pigmented ribbon across the attached gingiva was the predominant pattern. There was considerable overlap among classification systems, supporting the need for a unified, practical clinical index. Age influenced pigmentation extent, while gender did not.

### 1. Introduction

Smile esthetics play a critical role in facial harmony, where gingival appearance—particularly color—greatly influences perceived attractiveness. Although healthy gingiva typically presents a coral pink hue, darker pigmentation due to melanin deposition is common among individuals with darker skin tones. This condition, known as gingival melanin pigmentation (GMP), is physiologic and varies by ethnicity, genetics, and environmental factors such as smoking or drug use [1].

While not pathological, GMP can impact patient confidence and the esthetic outcome of dental

procedures. Some individuals seek depigmentation treatments to achieve a lighter gingival color, while others accept pigmentation as a natural feature. The prevalence of GMP is higher in African, Middle Eastern, and South Asian populations [2–4].

Existing literature provides limited information on the concurrent evaluation of GMP's distribution, intensity, and extent in Indian adults. This study aims to fill that gap by using three established classification systems—de Krom, DOPI, and the Melanin Index—to assess these characteristics in a cross-sectional Indian sample.



## 2. Materials and Methods

### 2.1. Study Design and Population

This cross-sectional study was conducted at a dental institution in India. Ethical approval was obtained, and all participants signed informed consent. Inclusion criteria were:

- Age 18–60 years
- Dark-skinned Indian ethnicity (self-reported and confirmed by four dark-skinned grandparents)
- At least 20 natural teeth, with healthy anterior maxillary gingiva (canine to canine)
- No history of smoking, systemic disease, or drugs known to affect pigmentation

Exclusion criteria included pregnancy, orthodontic treatment, and previous esthetic gingival surgery. A sample size of 80 was selected based on 99% confidence level, 5% margin of error, and a presumed pigmentation prevalence of 98% [3].

### 2.2. Data Collection and Assessment

Standardized intraoral photographs were taken using a DSLR camera with macro lens and ring flash. Photographs were cropped to focus on the maxillary anterior gingiva. Three trained and calibrated examiners independently assessed the images using:

- **De Krom Classification (Distribution):** Categories 1–6 based on symmetry and spread of pigmentation
- **DOPI (Intensity):** 0–3 scale per tooth, averaged for the sextant
- **Melanin Index (Extent):** Degree I–IV based on the area of pigmentation

Three classification systems were utilized in this study to evaluate gingival pigmentation:

- **De Krom Classification (Distribution):**  
This system, designed to categorize the distribution pattern of gingival pigmentation, comprises six distinct categories (16):
- **Category 1:** A wide band of pigmentation encircles the entire dentition, exhibiting a clear apical border. The mucosa beyond the mucogingival junction

remains pink, and the pigmentation is typically symmetrical with consistent color intensity, ranging from light to dark brown.

- **Category 2:** A narrow, unpigmented band of marginal gingiva encircles the teeth, while the attached gingiva resembles the broad pigmented zone described in Category 1. The pigmentation is also uniform and symmetric.
  - **Category 3:** The gingiva appears entirely pink, except for a distinct pigmented line at the mucogingival junction. This band is symmetrical and uniformly colored.
  - **Category 4:** Pigmentation appears irregular and asymmetrical, with patchy distribution and inconsistent color, potentially varying between adjacent teeth.
  - **Category 5:** The mucosa remains mostly pink, but localized dark pigmented spots ("islands") are found between anterior teeth. These patches are symmetrical and sharply demarcated but do not involve the gingiva.
  - **Category 6:** The mucosa is entirely devoid of pigmentation and appears uniformly pink.
  - **Dummett Oral Pigmentation Index (DOPI) – Intensity:** The DOPI scale is used to determine the severity of pigmentation. Each of the six maxillary anterior teeth is scored individually on a 0–3 scale (1):
  - **Score 0:** No visible pigmentation (pink gingiva)
  - **Score 1:** Light brown pigmentation (mild)
  - **Score 2:** Moderate brown or mixed pink-brown pigmentation
  - **Score 3:** Deep brown to blue-black pigmentation (heavy)
- The scores from all six teeth are averaged to yield a mean pigmentation score for the sextant. Based on the average, pigmentation intensity is classified as:
- **0:** No pigmentation
  - **0.1–0.9:** Mild pigmentation



- **1.0–1.9:** Moderate pigmentation
- **2.0–3.0:** Heavy pigmentation
- **Melanin Index (Extent):** This classification evaluates how widespread the pigmentation is within each quadrant (17):
  - **Degree I:** Pigmentation limited to the central portion of one or two isolated interdental papillae
  - **Degree II:** Multiple papillae show isolated pigmentation
  - **Degree III:** Pigmented zones have merged into short continuous segments
  - **Degree IV:** A long, uninterrupted ribbon of pigmentation extends across most of the buccal gingiva of the anterior region, particularly canines and incisor.

### 3. Results

The sample consisted of 80 individuals, with an average age of 28.6 years; 60% were male. In the present study, the distribution of gingival pigmentation was assessed using the De Krom classification system. The most commonly observed pattern was Category 1, seen in 37.5% of the participants, indicating pigmentation localized to the interdental papilla. This was followed by Category 2 (22.5%) and Category 3 (20%), which represent pigmentation extending along the marginal and attached gingiva, respectively. Less frequent patterns included Category 4 (15%) and Category 5 (0.05%), with no cases observed in Category 6. These findings suggest that while localized pigmentation is more common, a subset of the population exhibits more widespread gingival involvement.

The intensity and extent of pigmentation were evaluated using the Dummett Oral Pigmentation Index (DOPI) and the Melanin Index, respectively. Heavy pigmentation was the most prevalent intensity category, noted in 36.3% of individuals, followed by moderate (35%) and mild pigmentation (28.7%). Regarding the extent, nearly half of the study population (46.3%) demonstrated Degree IV pigmentation, indicating coverage of more than three-quarters of the gingiva. Degree III (28.7%), Degree II (15%), and Degree I (10%) followed in decreasing order as shown in Table 1. These results

highlight a notable presence of both intense and extensive gingival pigmentation in the studied population, likely influenced by ethnic, genetic, and environmental factors.

**Table 1:** Distribution (De Krom), intensity (DOPI), and extent (Melanin Index) of GMP in anterior sextant of Indian adults

Classification System	Category / Degree	n (80) (%)
De Krom (Distribution)	Category 1	30 (37.5%)
	Category 2	18 (22.5%)
	Category 3	16 (20%)
	Category 4	12 (15%)
	Category 5	4 (0.05%)
	Category 6	0 (0%)
DOPI (Intensity)	Mild	23 (28.7%)
	Moderate	28 (35%)
	Heavy	29 (36.3%)
Melanin Index (Extent)	Degree I	8 (10%)
	Degree II	12 (15%)
	Degree III	23 (28.7%)
	Degree IV	37 (46.3%)

### 4. Discussion

Melanin pigmentation in the oral cavity can occur across various mucosal regions, though it is most frequently observed in the gingiva. The development and extent of this pigmentation are largely influenced by an individual's genetic background, which explains the variations seen among different ethnic groups. It tends to be more prevalent in individuals of African descent compared to those of Indian or Caucasian origin. In clinically healthy gingiva, pigmentation results from



melanin granules synthesized by melanocytes. Interestingly, the number of melanocytes remains relatively consistent across populations; however, melanocytes in individuals with darker skin are typically more active, producing larger quantities of melanin compared to those in lighter-skinned individuals. The pigment accumulates in the basal and suprabasal layers of the oral epithelium, leading to visible gingival pigmentation. In some cases, this pigmentation may become apparent shortly after birth and tends to become fully developed by the end of adolescence. In our study, the mean age of participants was 28.6 years, with ages ranging from 18 to 51 years.

Gingival melanin pigmentation (GMP) is often a cosmetic concern for many individuals, prompting the use of various depigmentation methods to improve esthetics. When pigmentation appears localized and is of high intensity, a differential diagnosis should be considered to rule out other pigmented oral lesions. Additionally, some evidence suggests that melanin may have a protective role, potentially mitigating the progression of gingival inflammation (18-20).

This study demonstrates a high prevalence of physiological gingival pigmentation in dark-skinned Indian adults. The predominant presentation was a symmetrical, continuous ribbon of pigmented attached gingiva with pink free gingiva (de Krom Category 2 and Melanin Index Degree IV) [5,6]. These findings align with similar studies in African and Middle Eastern populations [2,7].

Interestingly, while the intensity of pigmentation remained consistent across age groups, the extent and distribution were significantly greater in younger participants. This may relate to melanocytic activity being more pronounced in younger tissues [8].

## 5. Conclusion

In this sample of dark-skinned Indian adults, gingival pigmentation was a universal finding. The most common pattern was heavy, symmetric pigmentation across the attached gingiva with preserved pink marginal gingiva. There were no gender differences, but younger individuals showed more extensive pigmentation. The overlap among classification systems supports the development of a consolidated clinical index for GMP assessment.

## References

- [1] Dummett CO, Gupta OP. Estimating the epidemiology of oral pigmentation. *J Natl Med Assoc.* 1964;56(5):419–420.
- [2] Masilana A, Khammissa RAG, Lemmer J, Feller L. Physiological oral melanin pigmentation in a South African sample: a clinical study. *J Investig Clin Dent.* 2017;8(4):e12258.
- [3] Ponnaiyan D, Jegadeesan V, Perumal G, Anusha A. Correlating skin color with gingival pigmentation in South Indians. *Oral Health Dent Manag.* 2014; 13(1):132–136.
- [4] Alhajj WA, Alhajj MN. Prevalence of melanin pigmentation in a Yemeni population and its relation to some risk factors. *Braz Dent Sci.* 2020; 23(2):1–9.
- [5] de Krom CJ, et al. The oral pigmentation chart. *Int J Prosthodont.* 2005;18(1):66–70.
- [6] Bolden TE. The oral pigmentation index (DOPI). *N Y State Dent J.* 1966;32(5):203–206.
- [7] Gorsky M, et al. Physiologic pigmentation of the gingiva in Israeli Jews. *Oral Surg Oral Med Oral Pathol.* 1984;58(4):506–509.
- [8] Yaar M, Gilchrist BA. Ageing and photoageing of keratinocytes and melanocytes. *Clin Exp Dermatol.* 2001;26(7):583–591.
- [9] Janiani P, et al. Evaluation of the intensity of gingival melanin pigmentation at different age groups. *J Indian Soc Pedod Prev Dent.* 2018; 36(4): 329–333.
- [10] Peeran SW, et al. Gingival pigmentation index: review of indices. *Eur J Dent.* 2014;8(2):287–290.
- [11] Hedin CA. Smokers' melanosis. *Arch Dermatol.* 1977;113(11):1533–1538.
- [12] Moneim RAA, et al. Gingival pigmentation: cause, treatment, and histology. *Future Dent J.* 2017;3(1): 1–7.
- [13] Sridharan S, et al. Environmental tobacco smoke and gingival pigmentation. *J Periodontol.* 2011;82 (7):956–962.
- [14] Eid HA, et al. The role of gingival melanin pigmentation in inflammation. *J Int Oral Health.* 2013;5(4):1–7.
- [15] Longo BC, et al. Gingival pigmentation: concurrent assessment in a black population. *J Esthet Restor Dent.* 2022;34(6):897–906.



- [16]de Krom CJ, van Waas MA, Oosterveld P, Koopmans AS, Garrett NR. The oral pigmentation chart: a clinical adjunct for oral pigmentation in removable prostheses. *Int J Prosthodont.* 2005;18(1):66-70.
- [17]Haresaku S, Hanioka T, Tsutsui A, Watanabe T. Association of lip pigmentation with smoking and gingival melanin pigmentation. *Oral Dis.*2007;13(1):71-76.
- [18]Subasree S. Comparative assessment of gingival depigmentation using scalpel versus microneedling with ascorbic acid: a randomized controlled trial. *Cureus.* 2024 Apr 15;16(4).
- [19]Srinivasan P, Sundar S, Yadalam PK, Ramadoss R, Mosaddad SA, Heboyan A. Classification and prediction of smoker melanosis in gingiva using SqueezeNet algorithms. *Oral Surgery.* 2024 Nov; 17(4):327-35.
- [20]Raj P, Nagesh S, Boyapati R. Impact of gingival pigmentation on laypersons 'perception of smile aesthetics: an observational study. *Exploration of Medicine.* 2025 Jan 14;6:1001274.