Research Letter

The Digital Color Gap in Online Melanoma Education: Cross-Sectional Analysis of Representation and Readability

Aanchal Goel[1], MS; Meriah Frauwirth[2], BS; William Hund[3], DO

[1]Rocky Vista University College of Osteopathic Medicine, Englewood, CO, United States
[2]DeBusk College of Osteopathic Medicine, Lincoln Memorial University, Harrogate, TN, United States
[3]First Coast Mohs Dermatology and Skin Care Specialists, Fernandina Beach, FL, United States

Corresponding Author:

Aanchal Goel, MS
Rocky Vista University College of Osteopathic Medicine
8401 S Chambers Rd
Englewood, CO 80112
United States
Phone: 1 303-373-2008
Email: aanchal.goel@co.rvu.edu

Abstract

This cross-sectional analysis of 20 high-ranking melanoma education websites and 50 Google Images results reveals a significant "digital color gap," characterized by only 25% (5/20) representation of darker skin tones and a persistent visual-textual mismatch for acral melanoma. Readability analysis showed that 80% (16/20) of resources exceeded the recommended sixth-grade reading level, and the first relevant image of melanoma in darker skin appeared at rank 28. These findings suggest that current online resources may hinder early self-recognition in patients with skin of color, necessitating more representative imagery and accessible language to mitigate diagnostic disparities.

JMIR Dermatol 2026;9:e97889; doi: 10.2196/97889

Keywords: melanoma; skin of color; acral lentiginous melanoma; health disparities; digital health; patient education; readability; health literacy

Introduction

Melanoma in patients with skin of color (SOC) is associated with worse outcomes, with 5-year survival rates of 72%-81% in racial and ethnic minorities compared to 90% in White patients [1]. Acral lentiginous melanoma (ALM), which occurs on the palms, soles, and nail units, represents an important melanoma subtype in patients with darker skin tones and may be diagnosed at more advanced stages [2]. Melanoma presentation also varies across racial and ethnic populations, with palmoplantar melanoma particularly prominent in Black and Asian populations, and differences in dermoscopic features reported across skin tones [3]. Digital platforms increasingly influence how patients seek and interpret information about suspicious skin lesions through web searches, image-based resources, and mobile health applications, highlighting the importance of representative online educational resources [4,5]. Prior analyses of internet search behavior demonstrate substantial interest in melanoma diagnosis, including symptom- and image-related queries [6]. Because melanoma recognition is highly visual, patients may compare their own lesions with images encountered online; however, darker skin tones remain underrepresented in patient-facing skin cancer images [4,5,7]. This study evaluated the inclusivity and accessibility of high-ranking online melanoma education by quantifying skin tone representation, assessing visual-textual mismatch for ALM, and analyzing content readability.

Methods

We performed a cross-sectional analysis of the top 20 nonsponsored patient-facing websites identified via a Google search for "melanoma symptoms" conducted on February 12, 2026. Searches were performed in incognito mode with cleared cache and no location filters to reduce personalization bias. Sponsored results, news articles, duplicate links, and non–patient-facing peer-reviewed journal articles were excluded. Fitzpatrick skin phototype classification (types I-VI) was used as a reference framework for describing skin tone [8]. More objective approaches, such as Pantone-based classification, have been described in prior studies; however,

these methods may have limitations when applied to online images [5].

For each website, 2 independent reviewers recorded total number of clinical images (defined as photographic depictions of cutaneous lesions); images approximating Fitzpatrick IV-VI skin tones based on visible pigmentation, consistent with previously published methodologies assessing skin tone representation in dermatologic images; mention of melanoma occurring on acral sites in text; presence of acral clinical images; linguistic inclusivity (acknowledgment that melanoma may appear differently in Fitzpatrick IV-VI skin, including color variation or deviation from ABCDE [asymmetry, border irregularity, color variation, diameter >6 mm, and evolving changes] criteria); and readability assessed using the Flesch-Kincaid Grade Level (FKGL) formula via Readable.com [4,5,9].

A separate Google Images search conducted on February 12, 2026 evaluated the top 50 results for "melanoma symptoms," recording the number of images approximating Fitzpatrick IV-VI skin, number of images depicting acral sites, and the rank position of the first ALM image in darker skin. Interrater agreement was 80% for website selection (κ=0.76) and 100% for categorization of text and images; discrepancies were resolved by consensus. This study analyzed publicly available website and search engine content and did not involve human participants or identifiable private information; therefore, institutional review board approval was not required.

Results

Among 20 patient-facing websites, only 5 (25%) included images approximating Fitzpatrick IV-VI skin, while 15 (75%) did not (Table 1 and Multimedia Appendix 1). While 18 (90%) of 20 websites mentioned acral melanoma, only 5 (27.8%) of those 18 provided corresponding acral site images. Additionally, only 1 (5%) of 20 websites acknowledged variation in melanoma presentation across skin tones. Out of 20 websites, 16 (80%) exceeded American Medical Association–recommended sixth grade reading level, and the average FKGL across all 20 sites was 7.7 (SD 1.5, range 5.3-10.1) [10].

Table 1. Skin of color representation and readability of online melanoma education materials.

Material type and variable	Value
Websites (N=20), n (%)	
Contains clinical images	10 (50%)
Contains darker skin tone images (approximately Fitzpatrick IV-VI)	5 (25%)
Mentions acral melanoma	18 (90%)
Without corresponding image	13 (72.2%)
With corresponding image	5 (27.8%)
Acknowledges variation in melanoma appearance across skin tones	1 (5%)
Does not acknowledge variation in melanoma appearance across skin tones	19 (95%)
Readability above grade 6	16 (80%)
Readability at grade 6 or below	4 (20%)
Google Images (N=50)	
Darker skin tone images, n (%)	6 (12%)
Acral melanoma images, n (%)	2 (4%)
First acral melanoma image in darker skin tones, rank	28

In Google Images search results, 6 (12%) out of 50 images depicted Fitzpatrick IV-VI skin, while 44 (88%) did not. Relevant images appeared lower in search rankings (Table 1).

Discussion

When highly ranked resources lack representation of Fitzpatrick IV-VI skin or fail to visually demonstrate acral presentations despite describing them in text, users with darker skin may have fewer visual reference points for recognizing potentially suspicious lesions. The low visibility of acral melanoma may further compound this gap, as the first image of acral melanoma in darker skin did not appear until rank 28 in the Google Images search results. Although the present study cannot determine whether these gaps directly influence help-seeking behavior or diagnostic delay, they identify one potential barrier to equitable digital melanoma education. Our readability findings (FKGL mean 7.7, SD 1.5, range 5.3-10.1) were somewhat lower than those reported in earlier assessments of ALM-specific online health information, which reported average grade levels as high as 13.2 [7]. However, the persistent visual-textual mismatch—where acral melanoma is mentioned without accompanying acral-site images—suggests that even when written content is relatively accessible, the lack of representative clinical images remains an important gap in online melanoma education.

Our findings expand upon prior studies showing skin tone underrepresentation in patient-facing materials by specifically quantifying the visual-textual mismatch for acral melanoma and incorporating readability analysis [4,5]. Advancing health equity requires auditing image databases for skin tone

diversity, pairing textual discussions of acral melanoma with representative images, engaging diverse communities in developing digital health resources, and using more accessible language [11].

Limitations include the dynamic and proprietary nature of search algorithms, potential subjectivity in skin tone classification, restriction to English-language results, and heterogeneity in website stakeholders, intended audience, and available resources. Although "melanoma symptoms" has been identified in a prior study as 1 of the top 10 melanoma search terms, results may differ with other search terms or platforms [6]. Incognito mode, cleared cache, and removal of location filters reduced personalization but cannot fully eliminate algorithmic influences on result ranking. We also did not stratify findings by website characteristics or assess audience health or digital literacy, which may influence content, readability, and engagement. Future studies should assess whether these representational differences persist across search strategies and influence lesion recognition or care-seeking behavior.

Improving visual representation alone will not eliminate broader digital health inequities; however, the specific representational gaps identified in this study highlight actionable targets for improving equity in online melanoma education and should be evaluated across additional search platforms.

Generative AI Use

Google Gemini was used for minor language editing. The authors take full responsibility for the content.

Funding

The authors declared no financial support was received for this work.

Data Availability

The dataset is included in Multimedia Appendix 1.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Raw data and analysis of 20 patient-facing websites and 50 Google Images results, including Fitzpatrick skin phototype classifications, acral-specific images and text, and Flesch-Kincaid Grade Level scores for all websites included by reviewer consensus.
[XLSX File (Microsoft Excel File), 14 KB-Multimedia Appendix 1]

References

1. Joshi UM, Kashani-Sabet M, Kirkwood JM. Cutaneous melanoma: a review. JAMA. Dec 16, 2025;334(23):2113-2125. [doi: 10.1001/jama.2025.13074] [Medline: 40853557]
2. Brunsgaard EK, Wu YP, Grossman D. Melanoma in skin of color: part I. Epidemiology and clinical presentation. J Am Acad Dermatol. Sep 2023;89(3):445-456. [doi: 10.1016/j.jaad.2022.04.056] [Medline: 35533771]
3. Karampinis E, Lallas A, Lazaridou E, Errichetti E, Apalla Z. Race-specific and skin of color dermatoscopic characteristics of skin cancer: a literature review. Dermatol Pract Concept. Oct 1, 2023;13(4 S1):e2023311S. [doi: 10.5826/dpc.1304S1a311S] [Medline: 37874992]
4. Konisky H, Ortega K, Fayiga FF, Balazic E, Kobets K, Kindred C. Underrepresentation of skin of color in Google Images search of common skin, hair, and nail conditions. J Drugs Dermatol. Jul 1, 2024;23(7):e161-e163. [Medline: 38954616]
5. Sadur A, Nasseri M, McCormick ET, Friedman A. Skin tone representation on patient-facing skin cancer education websites. J Drugs Dermatol. May 1, 2024;23(5):e137-e138. [doi: 10.36849/JDD.7905] [Medline: 38709691]
6. Nanda JK, Hay JL, Marchetti MA. Analysis of keywords used in internet searches for melanoma information: observational study. JMIR Dermatol. Jan 2021;4(1):e25720. [doi: 10.2196/25720] [Medline: 36936812]
7. Yu Z, Dee EC, Nambudiri VE, Ogbechie-Godec OA, Jakus J, Siegel DM. Quality and readability of online health information for acral lentiginous melanoma. Dermatol Surg. May 1, 2021;47(5):697-698. [doi: 10.1097/DSS.0000000000002457] [Medline: 32483094]
8. Fitzpatrick TB. The validity and practicality of sun-reactive skin types I through VI. Arch Dermatol. Jun 1, 1988;124(6):869. [doi: 10.1001/archderm.1988.01670060015008] [Medline: 3377516]
9. Child D. Flesch Reading Ease and the Flesch Kincaid Grade Level. Readable. URL: https://readable.com/readability/flesch-reading-ease-flesch-kincaid-grade-level/ [Accessed 2026-09-30]
10. Weiss BD. Health Literacy and Patient Safety: Help Patients Understand Manual for Clinicians. 2nd ed. American Medical Association; 2007. URL: https://psnet.ahrq.gov/issue/health-literacy-and-patient-safety-help-patients-understand-manual-clinicians-2nd-ed [Accessed 2026-02-04]

11. Wilson S, Tolley C, Mc Ardle R, et al. Recommendations to advance digital health equity: a systematic review of qualitative studies. NPJ Digit Med. Jun 29, 2024;7(1):173. [doi: 10.1038/s41746-024-01177-7] [Medline: 38951666]

Abbreviations

ABCDE: asymmetry, border irregularity, color variation, diameter >6 mm, and evolving changes
ALM: acral lentiginous melanoma
FKGL: Flesch-Kincaid Grade Level
SOC: skin of color

Edited by Michael Kirchberger; peer-reviewed by Deborah Verran, Emmanouil Karampinis; submitted 16.Apr.2026; initial comments to author 02.Jul.2026; final revised version received 28.Jul.2026; accepted 12.Aug.2026; published 26.Nov.2026

Please cite as:
Goel A, Frauwirth M, Hund W
The Digital Color Gap in Online Melanoma Education: Cross-Sectional Analysis of Representation and Readability
JMIR Dermatol 2026;9:e97889
URL: https://derma.jmir.org/2026/1/e97889
doi: 10.2196/97889

© Aanchal Goel, Meriah Frauwirth, William Hund. Originally published in JMIR Dermatology (http://derma.jmir.org), 26.Nov.2026. This is an open-access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in JMIR Dermatology, is properly cited. The complete bibliographic information, a link to the original publication on http://derma.jmir.org, as well as this copyright and license information must be included.