Patient Education in the Digital Age: Assessing the Readability, Quality, and Actionability of Keloid Information Online

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Abstract

Background: Keloids are chronic fibroproliferative scars that can impair function, cause disfigurement, and affect quality of life. Online patient education materials (PEMs) represent a major source of health information, but their readability, quality, and actionability remain underexplored.

Objective: To evaluate the readability, quality, and actionability of publicly available online PEMs addressing keloid treatment, and to assess differences based on authorship (physician vs non-physician) and source type (academic vs commercial).

Methods: A Google search (January 28, 2025) using the term “keloids” identified the first 30 websites. After applying exclusion criteria, 24 PEMs were analyzed. Readability was assessed using Flesch-Kincaid Grade Level and Flesch Reading Ease. Quality was evaluated using the DISCERN instrument and JAMA benchmarks. Understandability and actionability were measured using the Patient Education Materials Assessment Tool (PEMAT). Interrater reliability was assessed with intraclass correlation coefficients (ICCs). Comparative analyses used independent samples t-tests and Mann–Whitney U tests.

Results: Of 24 PEMs, 11 were authored by physicians, 11 by non-physicians, and 2 with unclear authorship; 13 were academic and 11 commercial. Readability exceeded AMA/NIH recommendations, averaging the 7th–8th grade level. PEMAT scores revealed limited understandability and actionability. DISCERN scores indicated “poor” to “fair” quality, and JAMA benchmarks reflected moderate limitations in transparency. No statistically significant differences were observed between physician- vs non-physician–authored materials or academic vs commercial sources.

Conclusions: Online PEMs about keloids often fall short of recommended readability, quality, and actionability standards, regardless of authorship or source. Improving accessibility and clarity of PEMs is critical to support informed decision-making, enhance health equity, and empower patients.

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Conclusions: Online PEMs about keloids often fall short of recommended readability, quality, and actionability standards, regardless of authorship or source. Improving accessibility and clarity of PEMs is critical to support informed decision-making, enhance health equity, and empower patients.

Keywords: DISCERN; Health LitReracy; Keloid; Patient Education as Topic; Internet; Readability; Educational Measurement

Introduction

Keloids are pathologic scars characterized by excessive fibroproliferative activity, typically developing at sites of cutaneous injury or inflammation.[1] Although benign, they can cause considerable physical discomfort and psychological distress, particularly when located in visible or functionally sensitive areas. The chronic and often refractory nature of keloids requires long-term

treatment strategies, which may include a combination of medical therapies and procedural interventions. High-quality patient education materials (PEMs) are essential for fostering patient understanding, setting realistic expectations, and improving adherence to treatment, which ultimately leads to improved clinical outcomes and patient satisfaction.

In recent years, both the number of individuals seeking health-related information online and the volume of available PEMs have grown substantially.[2] A substantial body of literature has highlighted the influence of online health information on patient behavior and decision-making. For example, online health information can motivate individuals to initiate care or reconsider prior health decisions as they encounter new insights.[2, 3] However, national assessments of adult literacy in the United States reveal a concerning mismatch between the complexity of available health information and the public's capacity to comprehend it. Fewer than 50% of adults read at or above a 10th-grade level, and only 12–15% demonstrate proficiency in interpreting materials written at the 10th to 12th-grade level.[4] Approximately one-third of American adults read between a 6th- and 9th-grade level.

Given this disparity, the critical challenge lies in ensuring that online PEMs are not only medically accurate but also accessible to the average reader. Current guidelines from the American Medical Association (AMA) and the National Institutes of Health (NIH) recommend that health education materials be written at the 6th- and 8th-grade reading levels, respectively.[5] This study evaluates the readability of publicly available online PEMs addressing keloid treatment and assesses their compliance with these national health literacy recommendations. This study evaluates the readability, quality, and actionability of publicly available online patient education materials (PEMs) on keloid treatment, with a focus on their compliance with national health literacy recommendations. It also examines how these characteristics vary based on authorship (physician vs. non-physician) and source type (academic vs. commercial). By exploring the relationship between clinical expertise, institutional affiliation, and the quality of patient-facing materials, this study aims to identify opportunities to improve health communication and promote the development of more accessible, high-quality educational resources.

Methods

On January 28, 2025, we conducted a Google search using the keyword "keloids" to identify publicly available, patient-centered websites related to keloid management. Google was selected as the search engine for this study due to its widespread use among patients. We determined that including additional search engines would be unlikely to yield substantially different insights within the scope of our study design. The first 30 relevant results were reviewed. We chose to review the first 30 search results, as most users rarely navigate beyond the first page of search engine results. This pragmatic sampling strategy prioritizes ecological validity over statistical power. Five websites were excluded because their content was clearly intended for a professional or physician audience. One additional website, Wikipedia, was also excluded. Although patients frequently consult Wikipedia, it was omitted due to the inability to verify authorship and the open-edit nature of its content, which limits reliability. Each included website was evaluated for authorship, content quality, readability, and actionability.

For the purpose of this study, sources that were not clearly written for a patient audience were excluded. This included content that was highly technical, designed for continuing medical education, or hosted on platforms that required institutional logins. While necessary for maintaining consistency across resources, this exclusion criterion is important to recognize as many patients may access such content unintentionally. Evaluating these resources for clarity may be worthwhile.

Content quality was assessed using the DISCERN instrument and the Journal of the American Medical Association (JAMA) benchmarks. The DISCERN instrument is a validated 16-item questionnaire designed to evaluate the reliability and quality of written consumer health information, particularly with regard to treatment options. The JAMA benchmarks assess four core elements of website credibility: authorship, attribution, currency, and disclosure. To ensure interrater

reliability, four independent reviewers assigned DISCERN scores and JAMA benchmarks, and the mean score for each site was calculated.

Readability was measured using the Flesch-Kincaid Grade Level, which estimates the U.S. school grade level required to understand the text, and the Flesch Reading Ease Score, which evaluates how easy the text is to read on a scale from 0 to 100, with higher scores indicating greater readability. Additionally, the Patient Education Materials Assessment Tool (PEMAT) was used to evaluate both understandability and actionability. The PEMAT is a standardized tool developed by the Agency for Healthcare Research and Quality (AHRQ) that assesses whether educational materials are easy to understand and whether they clearly explain actions that users can take based on the information presented.

To assess the consistency of scores across reviewers, we calculated intraclass correlation coefficients (ICCs) for each evaluation metric. ICCs are widely used to quantify interrater reliability and ensure that scoring reflects true differences in website quality rather than variability among raters. All ICCs demonstrated strong agreement, indicating a high level of scoring consistency.

Using these evaluation scales, we assessed the sources and compared them based on authorship (physician vs. non-physician) and source type (academic vs. commercial). Sources with unclear or unavailable author information were excluded from the comparative analysis.

To compare scores across authorship (physician vs. non-physician) and source type (academic vs. commercial), we performed both independent samples *t*-tests and Mann–Whitney *U* tests. Given the relatively small sample size and violations of normality assumptions in several variables, non-parametric testing was deemed necessary to ensure robustness. Although *t*-tests are commonly used for comparing group means, the Mann–Whitney *U* test was also applied across all measures to account for potential deviations from parametric assumptions. Results were interpreted in parallel, with both tests yielding consistent conclusions across all comparisons.

Results

Our search yielded 24 publicly accessible articles that met inclusion criteria. Of these, 11 were authored by physicians, 11 by non-physicians, and 2 had unclear authorship. Thirteen materials were categorized as academic in origin or intent, while the remaining 11 were commercially affiliated. The intraclass correlation coefficients (ICCs), which assess interrater reliability for scoring using a standardized system, were 0.9079 (95% CI: 0.8338–0.953) for Flesch-Kincaid Grade Level, 0.8812 (95% CI: 0.801–0.931) for Flesch Reading Ease, 0.8102 (95% CI: 0.759–0.851) for PEMAT scores, and 0.9101 (95% CI: 0.835–0.966) for DISCERN scores. JAMA benchmark is an objective score and only a single rater was required..

Flesch-Kincaid Grade Level analysis revealed no significant difference in readability between physician-authored (mean = 7.85) and non-physician-authored (mean = 7.06) materials (t-test: p = 0.320; Mann-Whitney U: p = 0.278). Similarly, no significant difference was observed between academic (mean = 7.53) and commercial (mean = 7.06) materials (t-test: p = 0.551; Mann-Whitney U: p = 0.644).

Flesch Reading Ease scores were also comparable, with physician-authored materials averaging 57.19 and non-physician-authored materials averaging 63.60 (t-test: p = 0.159; Mann-Whitney U: p = 0.071). Academic sources (mean = 60.89) and commercial sources (mean = 56.34) did not differ significantly (t-test: p = 0.286; Mann-Whitney U: p = 0.460).

PEMAT scores indicated higher mean understandability for non-physician-authored materials; however, the difference was not statistically significant when compared to physician-authored materials (68.45% vs. 62.57%; t-test: p = 0.301; Mann-Whitney U: p = 0.552) or between commercial and academic sources (69.52% vs. 62.44%; t-test: p = 0.265; Mann-Whitney U: p = 0.352). Similarly, PEMAT Actionability scores did not differ significantly between physician-authored (29.87%) and non-physician-authored materials (32.47%; t-test: p = 0.484; Mann-Whitney U: p = 0.634), nor between academic (34.07%) and commercial sources (28.57%; t-test: p = 0.291;

Mann-Whitney U: p = 0.076).

There was no statistically significant difference in average DISCERN scores between physician-authored materials (mean = 37.28) and non-physician-authored materials (mean = 41.35; t-test: p = 0.428; Mann-Whitney U: p = 0.533). Similarly, academic sources (mean = 41.98) did not differ significantly from commercial sources (mean = 35.80; t-test: p = 0.228; Mann-Whitney U: p = 0.230). Overall, DISCERN scores across these categories fall within the “poor” to “fair” quality range.

JAMA Benchmark scores also did not differ significantly between physician-authored materials (mean = 2.27) and non-physician-authored materials (mean = 2.64; t-test: p = 0.536; Mann-Whitney U: p = 0.556). Similarly, no significant difference was observed between academic sources (mean = 2.38) and commercial sources (mean = 2.36; t-test: p = 0.927; Mann-Whitney U: p = 0.871). Scores in this range suggest moderate limitations in transparency and reliability.

Table 1. Comparison of Readability, Actionability and Quality Scores by Author Type (Physician vs Non-physician)

Scoring Scale	Mean (Physician)	Mean (Non-Physician)	p-value (T-test)	P-value (Mann-Whitney U)	ICC (95% CI)
Flesch-Kincaid Grade Level	7.85	7.06	0.320	0.278	0.9079 (0.8338–0.953)
Flesch Reading Ease	57.19	63.60	0.159	0.071	0.8812 (0.801–0.931)
PEMAT Understandability	62.57%	68.45%	0.301	0.552	0.8102 (0.759–0.851)
PEMAT Actionability	29.87%	32.47%	0.484	0.634	0.8102 (0.759–0.851)
DISCERN	37.28	41.35	0.428	0.533	0.9101 (0.835–0.966)
JAMA Benchmark	2.27	2.64	0.536	0.556	N/A

Table 2. Comparison of Readability and Quality Scores by Source Type (Academic vs Commercial)

Scoring Scale	Mean (Academic)	Mean (Commercial)	P-value (t-test)	p-value (Mann-Whitney U)	ICC (95% CI)
Flesch-Kincaid Grade Level	7.53	7.06	0.551	0.644	0.9079 (0.8338–0.953)
Flesch Reading Ease	60.89	56.34	0.286	0.460	0.8812 (0.801–0.931)
PEMAT Understandability	62.44%	69.52%	0.265	0.352	0.8102 (0.759–0.851)
PEMAT Actionability	34.07%	28.57%	0.291	0.076	0.8102 (0.759–0.851)
DISCERN	41.98	35.80	0.228	0.230	0.9101 (0.835–0.966)
JAMA Benchmark	2.38	2.36	0.927	0.871	N/A

Discussion

The results of this study highlight a persistent gap between the readability and quality of online patient education materials (PEMs) on keloid treatment and the recommended standards for health literacy in the United States.[5] Despite the critical role PEMs play in supporting patient understanding and adherence, particularly in the context of chronic or recurrent conditions like keloids, the results show that many of the materials fell short of being truly accessible and actionable.

Keloids disproportionately affect minority populations, with Black and Asian patients more frequently presenting with multiple, larger, and more severe lesions..[6] Understanding the burden of disease across demographics further emphasizes the importance of quality educational materials. In one study, 35.7% of respondents with keloids had a high school education or less, underscoring the need for PEMS that are not only high quality, but tailored to a range of literacy levels to promote health equity and effective patient self-management.[6]

Author Type

The readability of PEMs related to keloid treatment remains a significant barrier to accessibility. Based on both Flesch-Kincaid metrics, the majority of materials achieved the recommended 6th to 8th grade reading level for patient-facing content.[5] While physicians and non-physicians generally produce materials that may be readable for the average adult (Table 1), this still falls short of established health literacy standards designed to promote accessibility for broader and more vulnerable populations, particularly those with limited literacy. Achieving baseline readability is not sufficient. Physicians should place greater emphasis on improving the clarity of their materials to ensure that health information is accessible and understandable to all patients, particularly those from lower socioeconomic backgrounds. Prioritizing plain language and clear structure can help address these gaps and promote equity.

Findings from the PEMAT reveal that both physicians and non-physicians have room for improvement in two critical areas: understandability and actionability (Table 1). Many materials are not written or organized in a way that enables patients to easily grasp key messages, and they often lack clear, specific guidance to support health-related decision-making. To address these shortcomings, physicians should adopt plain language, logical information flow, and visual aids or summaries to enhance clarity. Additionally, embedding concise, actionable instructions can empower patients to engage more confidently in their care and make informed decisions.

While readability affects whether content is understandable, quality measures reflect how trustworthy, balanced and complete the information is. Unlike previous reports citing quality differences based on physician versus non-physician authorship, this study showed no significant difference in DISCERN scores.[7] There were also no statistically significant differences in JAMA scores based on authorship type. Consequently, while patients may empirically consider certain sources to be superior, based on authorship or publication location, each individual source warrants evaluation before being trusted (Table 2).

Source Type

This study found no statistically significant differences between academic and commercial sources across any of the evaluated metrics, including readability, understandability, actionability and content quality (Table 2). These findings call into question the assumption that academic sources inherently produce higher-quality patient education materials solely based on their institutional credibility or presumed rigor in content evaluation.[8]

Although academic institutions may possess greater access to evidence-based guidelines and clinical expertise, this advantage does not translate to more actionable or accessible patient facing content. In fact, commercially affiliated sources, which are sometimes critiqued for potential conflicts of interest or biases, demonstrated comparable performance across all domains assessed.[8]

While no significant differences were observed between academic and commercial sources,

materials from both categories frequently fell short of established national standards, rendering them difficult to understand for a large proportion of the general population. The lack of differentiation may suggest a systemic shortfall in the application of health literacy principles and patient-centered communication strategies across both sectors.

Limitations

This study is limited by its reliance on Google search results and English-language materials, which may constrain the generalizability of the findings to broader populations. The decision to analyze only the first few pages of Google search results was intentional, as it mirrors typical user behavior; however, the relatively small sample size limits the ability to draw definitive conclusions or capture the full breadth of available patient education materials. While readability and quality assessment tools offer valuable insights, they do not fully capture patient comprehension, engagement, or cultural relevance. Future research should evaluate real-world patient outcomes, incorporate direct patient feedback, and explore the development of culturally tailored materials. Investigating the potential of artificial intelligence to personalize PEMs for diverse populations also represents a promising direction for improving accessibility and impact.

Conclusions

As patients increasingly rely on the internet for medical information, the quality, readability, and actionability of online PEMs must be prioritized. This study demonstrates that, regardless of authorship or source, many PEMs on keloid treatment fall short of national health literacy standards, limiting their effectiveness for a broad and diverse patient population. Addressing this gap will require interdisciplinary collaboration among healthcare professionals, content creators, and policymakers to ensure that online health information is both accessible and trustworthy. Physicians, in particular, play a critical role in shaping the quality of PEMs. As they contribute more actively to public-facing educational content, they must be equipped with best practices in health communication, emphasizing plain language, clear structure, and actionable guidance, without compromising accuracy or credibility. Including references to supporting evidence can further enhance transparency and foster patient trust. Ultimately, improving the accessibility and quality of PEMs can support shared decision-making, promote health equity, and empower patients to engage more confidently in their care.

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References

1. Walsh LA, Wu E, Pontes D, et al. Keloid treatments: an evidence-based systematic review of recent advances. *Syst Rev*. 2023;12(1):42. doi:10.1186/s13643-023-02192-7
2. Bujnowska-Fedak MM, Węgierek P. The Impact of Online Health Information on Patient Health Behaviours and Making Decisions Concerning Health. *Int J Environ Res Public Health*. 2020;17(3):880. doi:10.3390/ijerph17030880
3. Chen YY, Li CM, Liang JC, Tsai CC. Health Information Obtained From the Internet and Changes in Medical Decision Making: Questionnaire Development and Cross-Sectional Survey. *Journal of Medical Internet Research*. 2018;20(2):e9370. doi:10.2196/jmir.9370
4. NLC. Literacy and Numeracy Skills of U.S. Adults. National Coalition for Literacy. August 12, 2014. Accessed May 18, 2025. https://nationalcoalitionforliteracy.org/about-adult-literacy/piaac/
5. Rooney MK, Santiago G, Perni S, et al. Readability of Patient Education Materials From High-Impact Medical Journals: A 20-Year Analysis. *J Patient Exp*. 2021;8:2374373521998847. doi:10.1177/2374373521998847

6. Swenson, A., Paulus, J. K., Jung, Y., Weiss, S., Berman, B., Peeva, E., Yamaguchi, Y., George, P., & Jagun, O. (2023). Natural History of Keloids: A Sociodemographic Analysis Using Structured and Unstructured Data. Dermatology and Therapy, 14(1), 131–149. https://doi.org/10.1007/s13555-023-01070-3
7. Nigro, A. , Osman, A. , Nanda, S. & Collins, L. (2024). Quality and Readability of Online Educational Mohs Micrographic Surgery Resources. *Dermatologic Surgery*, *50* (10), 904-907. doi: 10.1097/DSS.0000000000004269.
8. Kington, R. S., Arnesen, S., Chou, W.-Y. S., Curry, S. J., Lazer, D., & Villarruel, A. M. (n.d.). Identifying Credible Sources of Health Information in Social Media: Principles and Attributes. NAM Perspectives, 2021, 10.31478/202107a. https://doi.org/10.31478/202107a