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Readability and reliability of online patient education materials about statins

Summer Ngo [a,1], Roshini Asirvatham [b,1], Grayson L. Baird [c], Ashish Sarraju [d], David J. Maron [a,e], Fatima Rodriguez [a,*]

[a] Division of Cardiovascular Medicine and Cardiovascular Institute, Stanford University School of Medicine, Stanford, CA, USA
[b] University of Minnesota Medical School, Minneapolis, MN, USA
[c] Diagnostic Imaging, Rhode Island Hospital and Alpert Medical School, Brown University, Providence, RI, USA
[d] Department of Cardiovascular Medicine, Heart, Vascular, and Thoracic Institute, Cleveland Clinic, Cleveland, OH, USA
[e] Stanford Prevention Research Center, Department of Medicine, Stanford University, Stanford, CA, USA

* Corresponding author at: Center for Academic Medicine, Department of Medicine/Division of Cardiovascular Medicine, Mail Code 5687, Stanford University School of Medicine, 453 Quarry Road, Palo Alto, CA 94304.
E-mail address: frodrigu@stanford.edu (F. Rodriguez).
[1] These authors contributed equally to this work.

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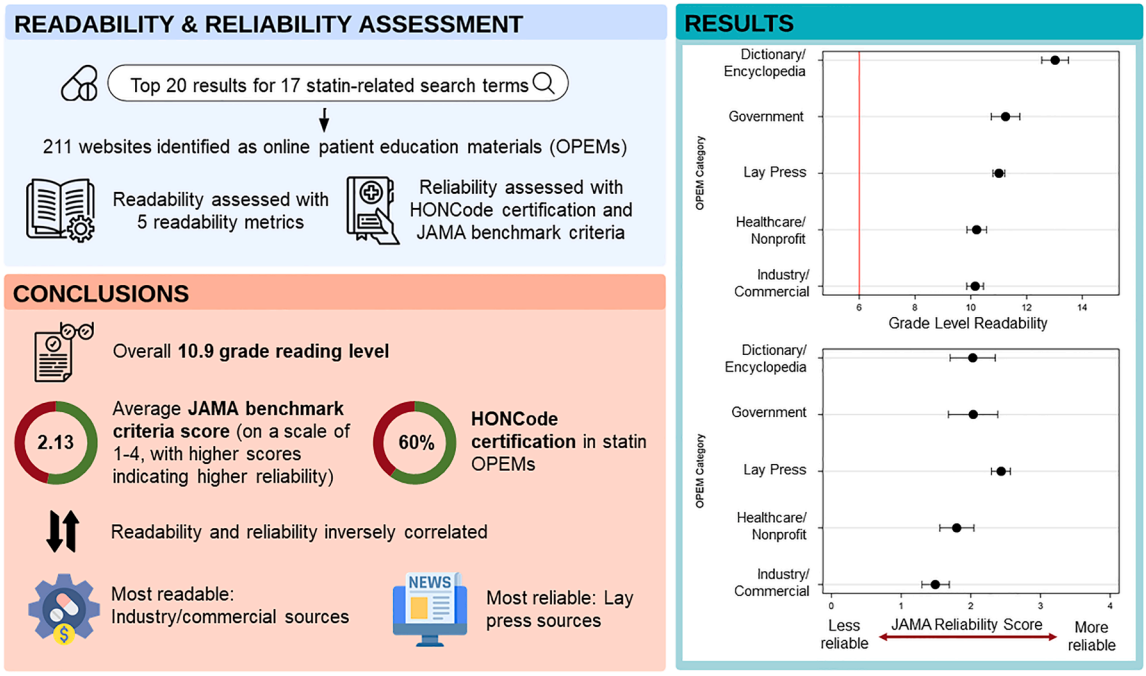
GRAPHICAL ABSTRACT

Central Illustration. Readability and reliability of online patient education materials related to statins. Online patient education materials were grouped to the following categories: dictionary/encyclopedia, government (national, state, or local government agencies), lay press (healthcare-oriented news organizations), healthcare/nonprofit (major health systems and nonprofit organizations with a specific cardiovascular health focus), and industry/commercial (pharmaceutical manufacturers and online pharmacies).



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ABSTRACT

Objective: Statins are the cornerstone for the prevention and treatment of cardiovascular disease. Patients often consult online patient education materials (OPEMs) to inform medical decision-making. We therefore aimed to assess the readability and reliability of OPEMs related to statins.

Methods: A total of 17 statin-related terms were queried using an online search engine to identify the top 20 search results for each statin-related term. Each OPEM was then grouped into the following categories based on 2 independent reviewers: government OPEMs (national, state, or local government agencies); healthcare/nonprofit OPEMs (major health systems and nonprofit organizations with a specific cardiovascular health focus); industry/commercial OPEMs (pharmaceutical manufacturers and online pharmacies); lay press OPEMs (healthcare-oriented news organizations); and dictionary/encyclopedia OPEMs. Grade-level readability for each OPEM was calculated using 5 standard readability metrics and compared with AMA-recommended readability recommendations. Reliability of each OPEM was evaluated using the JAMA benchmark criteria for online health information and certification from Health on the Net (HONCode).

Results: A total of 340 websites were identified across the 17 statin search terms. There were 211 statin OPEMs after excluding non-OPEM results; 172 OPEMs had unique content. Statin OPEM readability exceeded the recommended 6th grade AMA reading level (average reading grade level of 10.9). The average JAMA benchmark criteria score was 2.13 (on a scale of 0–4, with higher scores indicating higher reliability), and only 60% of statin OPEMs were HONCode-certified. There was an inverse association between readability and reliability. The most readable results were from industry and commercial sources, while the most reliable sites were from lay press sources.

Conclusions: Statin OPEMs are written at an overall averaging reading grade level of 10.9. There was an inverse association between readability and reliability. Lack of accessible, high-quality online health information may contribute to statin nonadherence.

1. Introduction

Statins are the cornerstone for the prevention and treatment of atherosclerotic cardiovascular disease (ASCVD), the leading cause of death worldwide. Despite numerous studies affirming the safety, efficacy, and cost-effectiveness of statins, these cholesterol-lowering drugs are vastly underused and discontinued in nearly 1 in 2 patients who meet a guideline indication for statin use [1–3]. Patients declining or discontinuing statins often cite concerns of side effects and perceived side effects, which may stem from negative discussions from social media, news, and websites appearing to be health-focused [4].

Misinformation about statins has implications for statin initiation

and adherence. For example, over 1 in 4 patients surveyed in the Patient and Provider Assessment of Lipid Management (PALM) registry believed that statins could cause memory loss, despite little to no evidence of this in clinical trials [4]. Negative news stories about statins are associated with a reduction in statin persistence and adverse outcomes [5]. Patients often rely on online patient education materials (OPEMs) for medication-related information and decisions. OPEMs should be written at a digestible reading level to remain accessible to patients across literacy levels and reliable to avoid spread of misinformation. As such, the American Medical Association (AMA) recommends that OPEMs should be written at or below a sixth grade reading level [6]. We thus aimed to assess the readability and reliability of statin OPEMs.

2. Method

Seventeen search terms related to statin names (brand and generic) were included using the Google search engine: "Altoprev," "atorvastatin," "Crestor," "Ezallor," "FloLipid," "fluvastatin," "Lescol XL," "Lipitor," "Livalo," "lovastatin," "pitavastatin," "pravastatin," "rosuvastatin," "simvastatin," "statins," "Zocor," and "Zypitamag." Location, cookies, and user account information were disabled beforehand to mitigate search bias. Given that the majority of people only view the first page of search results and view counts for a website drop significantly with rank order [7], the first 20 search results for each term were downloaded and saved as PDFs between July 4, 2022 and July 5, 2022. Non-OPEM search results that were excluded included research journal articles, advertised and sponsored results, insurance and regulatory documents, and non-patient-directed sources such as those intended only for health professionals or researchers. Unique OPEMs were identified by removing websites with identical content. Each OPEM was then grouped into the following categories based on 2 independent reviewers: government OPEMs (national, state, or local government agencies); healthcare/nonprofit OPEMs (major health systems and nonprofit organizations with a specific cardiovascular health focus); industry/commercial OPEMs (pharmaceutical manufacturers and online pharmacies); lay press OPEMs (healthcare-oriented news organizations); and dictionary/encyclopedia OPEMs.

2.1. Readability assessment

Websites meeting OPEM criteria were converted to plain text in separate Microsoft Word documents. Following the design of other readability studies, advertisements, images, figures, captions, videos, citations, hyperlinks, disclaimers, acknowledgments, and copyright notices were removed [8]. Periods were used to mark the end of each sentence and all other punctuation were removed according to Centers for Medicare and Medicaid Services guidelines [9]. Five readability metrics were then calculated with Readable.com: Flesch-Kincaid Grade Level, Gunning Fog Index, Coleman-Liau Index, Simple Measure of Gobbledygook (SMOG) Index, and Automated Readability Index. Each of these indices calculates an estimate of grade level readability using an equation based on word and sentence length in a given text.

The *Journal of the American Medical Association's* (JAMA) benchmark criteria [10] for online health information and HONCode (Health on the Net) Certification [11] status were used as metrics of OPEM reliability, which encompasses transparency of sourcing and quality of presented information. To evaluate the JAMA reliability criteria, each OPEM website was assessed by 2 independents readers for 4 parameters: authorship, attribution, disclosure, and currency. JAMA reliability scores range from 0 to 4, with higher scores suggesting higher reliability. HONCode Certification is granted by the Health on the Net Foundation based on 8 criteria of health information reliability [11]. Active certification in July 2022 was verified using the HONCode search engine. No human patients were recruited for the study. All of the data were collected from websites that are publicly accessible, and thus do not require institutional review board review.

2.2. Statistical analysis

All analyses were conducted using SAS Software 9.4 (SAS Software, Cary, NC). Readability was estimated using generalized linear mixed modeling (GLMM) where the five readability metrics were nested within each observation using the GLIMMIX procedure. JAMA reliability scores and HONCode were also modeled using GLMM where observations were nested within each reader. Readability, JAMA reliability scores, and HONCode were examined by OPEM category (Lay Press, Industry/Commercial, Healthcare/Nonprofit, Government, Dictionary/Encyclopedia). Because some content was presented multiple times (e.g., different website name but same text content), duplicated content was nested using GLMM. Agreement between readers was assessed using Kappa with the FREQ procedure. All interval estimates were calculated for 95% confidence.

3. Results

In total, 340 websites were collected across the 17 statin search terms. There were 211 statin OPEMs after excluding non-OPEM results. Of these 211 statin OPEMs, 172 OPEMs had unique content. Mean grade level readability across all sites was 10.9 (95 % CI 10.6–11.1). Mean JAMA benchmark criteria score across all sites was 2.13 (95 % CI 2.02–2.24) and 60.4 % of all OPEMs evaluated were certified by the Health on the Net Foundation. The largest OPEM category was the lay press category (44 %), followed by industry/commercial (22 %), healthcare/nonprofit (17 %), dictionary/encyclopedia (9 %), and government (8 %) categories.

Fig. 1A summarizes the mean reading grade level of statin OPEMs. Industry/commercial and healthcare/nonprofit sites were the most readable with a mean grade level of 10.2 (95 % CI 9.6–10.7) and 10.2 (95 % CI 9.6–10.9), respectively. Dictionary/encyclopedia statin OPEMs were the least readable with a mean grade level of 13.0 (95 % CI 12.1–13.9).

Fig. 1B summarizes reliability across statin OPEM categories by mean JAMA benchmark criteria score. The lay press statin OPEM category scored highest for reliability with a mean score of 2.7 (95 % CI 2.4–3.0). Sites from the industry/commercial sector had the lowest reliability with a mean score of 1.3 (95 % CI 1.2–1.5)

The number of statin OPEMs that met each of the JAMA benchmark criteria were as follows: 55, 32.0 % (authorship); 41, 23.8 % (attribution); 101, 58.7 % (currency); and 143, 83.1 % (disclosure). Agreement between independent reviewers for JAMA reliability scoring, measured by Cohen's Kappa, was 0.82 overall. Mean Kappa for each JAMA reliability criterion was 0.95 (authorship), 0.83 (attribution), 0.53 (disclosure), and 0.97 (currency).

Lay press sources also had the highest percentage of sites certified by HONCode (94 %). This was followed by government (80 %), healthcare/nonprofit (69 %), and industry/commercial (2 %). None of the dictionary/encyclopedia statin OPEMs were HONCode certified.

4. Discussion

4.1. Principal results

Across 211 statin OPEMs, the overall 10.9 grade reading level significantly exceeded AMA readability recommendations that OPEM be written at or below a 6th grade reading level. The most readable statin OPEMs were from industry/commercial and healthcare/nonprofit sources, while the most reliable sites were from lay press sources. There was an inverse association between readability and reliability, with the most readable OPEMs having the lowest reliability.

Misinformation and disinformation about statins can lead to confusion and mistrust over medical conditions and treatment decisions. For example, widespread false claims on the internet about the adverse effects of statins may trigger the nocebo effect. A study found a strong

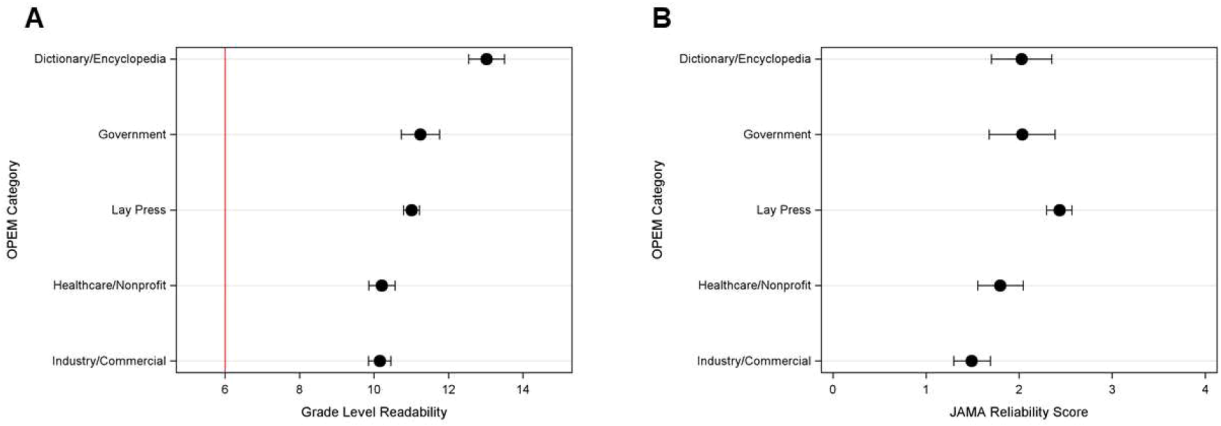

Fig. 1. Average grade level readability and reliability of online patient education materials (OPEMs) for statins by website category. 95 % CIs are included for each statin OPEM category. (**A**) Average grade level readability for each statin OPEM category is listed in descending order from top to bottom. All OPEMs surpassed the 6th grade reading level recommended by the American Medical Association (AMA) for online health information (depicted by a vertical red line). (**B**) Reliability, assessed by average JAMA benchmark criteria score, is displayed for each statin OPEM category. JAMA reliability criteria scores range from 0 to 4 (1 point each for authorship, attribution, disclosure, and currency). Higher scores indicate higher reliability.

positive correlation between the prevalence of online information about statin side effects and statin intolerance [12]. Additionally, patients who discontinued statins in the Understanding Statin use in America and Gaps in Education (USAGE) survey were more likely to use the internet to research statins or report internet medical resources such as WebMD as their most used information source [13]. The lack of accessible, high-quality online patient educational materials has direct impact on statin adherence, and low statin adherence is strongly associated with increased mortality [1].

OPEMs on statins need to be written at an appropriate reading level for the general public to ensure that patients adequately understand the safety and effectiveness of statins. There has been a growth in disinformation through anti-statin websites, blogs, social media, and articles from a small and vocal minority claiming to promote health and wellness. Readable and reliable statin OPEMs have the potential to reverse the spread of misinformation and facilitate patient-clinician conversations about the risks and benefits of statins.

The inverse relationship between readability and reliability in statin OPEMs is noteworthy and has implications for patients with lower health literacy. Vulnerable patient populations including historically marginalized groups, older adults, and those with lower educational attainment may be at higher risk of consuming less reliable information online, as these sources tend to be more readable and therefore more accessible. Industry/commercial OPEMs scored the lowest in reliability, which aligns with findings from other studies assessing reliability of OPEMs in other subject areas [14,15]. The low reliability score of industry/commercial statin OPEMs was largely due to failure to fulfill the attribution, currency, and authorship JAMA criteria parameters. Individual authors tend not to be named on drug company sites, and references are cited more frequently in websites targeting medical professionals [16].

To counter misinformation and disinformation, search engines may consider prioritizing search results from more reliable websites. The large majority of online searches end after the first page of results; listing OPEMs from trustworthy sources (e.g., the American College of Cardiology, American Medical Association, American Heart Association, and Centers for Disease Control and Prevention) first can help direct people to more high quality, credible health information.

The implications of our work also translate to clinical practice settings, as clinicians often provide patients with information about prescribed medications. Increasing the readability of patient-centered information about statins may improve adherence. For example, a trial found that patients participating in a patient counseling and education program were more likely to fill new statin prescriptions and to continue taking statins 120 days later. The intervention included a brief in-office counseling on cardiovascular risk followed by patient education mailings. Physicians participating in the program noted that using a 1-minute cardiovascular risk manager tool for patient counseling and a pocket cholesterol management guideline were most helpful for facilitating patient engagement [17]. Simple, easy-to-use tools such as these can help streamline and clarify risk communication without significant additions to cost or labor.

The cardiovascular care team can also increase statin adherence by providing patient education resources from known, reliable organizations such as the National Lipid Association [18], CardioSmart [19], and the American Heart Association [20]. In addition, clinicians can empower patients to discern reliable websites by teaching website evaluation skills (e.g., checking for credible authorship, information sources, and date of publication), offering a list of reputable websites with up-to-date information about statins, discussing professional medical organizations, and encouraging open communication. A focus group study exploring patients' perspectives on barriers and solutions to statin therapy nonadherence reinforced the importance of having easily accessible and understandable information about statins. Patients suggested that it would be helpful to have more written information about statins describing risks, side effects, and medication administration to help them understand and remember what was discussed with their clinician [21].

4.2. Limitations

This study should be interpreted in the context of several limitations. First, we did not account for statin OPEM results from other search engines besides Google. However, over 84 % of global internet users use Google as their most frequent search engine [22]. Second, the readability metrics used do not consider the inherent complexity of some medical terminology, a common limitation of other OPEM readability studies. Third, the quality of OPEM is multidimensional and there is no "gold standard" for evaluating the readability, reliability, and accuracy of online health information. We did not systematically evaluate the most reliable sources of OPEMs, such as medical or professional educational materials. Given that there are no universally accepted criteria for assessing the quality of online health information, reliability was scored using both the JAMA benchmark criteria and HONCode certification, as done in prior studies [23–26]. Although JAMA benchmark criteria are not comprehensive (mainly focusing on the

transparency and trustworthiness of a source) and do not account for the medical validity of OPEM content, JAMA scores have been commonly used in other health information quality assessment studies and coincide with other nationally-used reliability scoring tools such as DISCERN [27] and Ensuring Quality of Information for Patients (EQIP) [28]. One limitation of the JAMA score is its reliance on subjective interpretation of reliability parameters. The authors attempted to standardize the scoring process as much as possible, and concordance was high across most categories between the two independent reviewers. Disclosure of site ownership had the lowest mean Kappa score (0.53); this could have been improved with mutual agreement between reviewers on how disclosure would be objectively defined prior to scoring websites. HONCode certification requires voluntary submission of websites to the Health on the Net Foundation, so sites whose owners elect not to apply for certification are automatically excluded. Fourth, it is possible that patients search information about statins using non-statin search terms (e.g., "cholesterol drugs") that were not included in our analyses.

4.3. Conclusions

Online patient education materials related to statins are significantly less readable than the guidelines recommended by the American Medical Association. The most readable results come from industry and commercial sources, while the most reliable sites come from lay press sources. An inverse relationship between readability and reliability may present challenges for patients who use online information as a factor in their decision to take and adhere to statins.

Author contributions

All authors were involved in the conception and design of the study, had access to the data, and participated in the writing of the manuscript.

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Role of the funding source

The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Fatima Rodriguez reports consulting fees from Novartis, Novo-Nordisk (CEC), Esperion, and HealthPals. Outside the submitted work. The remaining authors report no relevant disclosures or competing interests.

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