Difficult to read: An analysis of urology publications using readability tools

Peter Gariscsak[1], Charlotte Coleman[2], Michael Leveridge[3]
[1]School of Medicine, Queen's University, Kingston, ON, Canada; [2]Department of Obstetrics and Gynecology, University of Ottawa, Ottawa, ON, Canada; [3]Department of Urology, Queen's University, Kingston, ON, Canada

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Corresponding author: Dr. Michael Leveridge, Department of Urology, Queen's University, Kingston, ON, Canada; Michael.Leveridge@kingstonhsc.ca

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INTRODUCTION

Publication is the mark of novelty and relevance of medical research. Despite this, readability scales rank medical articles to be difficult to read, which may impact understanding and knowledge translation.[1] The readability of scientific literature has been steadily worsening, while scientific terminology use increases.[2] Clinicians and researchers benefit from more clear prose, and are not the sole consumers of medical research.[3] Patients, advocates, policy experts and media also need readable prose. While the readability of urologic patient materials is well studied, the readability of urology research articles has not been studied.[4,5]

KEY MESSAGES

- Despite its academic nature and complex topics, readabilty of medical literature is important in knowledge translation and learning.
- The urologic literature is difficult to read, with most papers exceeding that threshold using established measures of reading difficulty.
- Authors and editors should attend to readability as a quality indicator in their submitted and published work.

METHODS

We analyzed original articles from *BJU International*, *European Urology*, *Urology*, and *Journal of Urology* published from October 2019 to March 2020, chosen to mitigate the potential bias from the COVID-19 crisis on published research. Articles were assessed using established readability metrics - Flesch Reading Ease (FRE) score and a United States school grade level. Higher FRE scores reflect easier reading and range between 0 to 100. United States school grade level is an average of four readability scores (Coleman-Liau, Flesch-Kincaid, Automated Readability Index, Simple Measure of Gobbledygook Index) and estimates the number of educational years needed to understand a text. Reviews, meta-analyses, and opinion pieces were

excluded to reduce variability and potential bias from variable article types across journals. Region of study origin was considered the corresponding author's institution. We extracted both abstracts and full-texts manually due to previously reported strong, positive relationships,[2] and removed headings, tables, figures, and references from analyses. Unpaired t-tests and analysis of variances with post-hoc Tukey test, and Bonferroni-adjustment for multiple comparisons, assessed the impact of specified and previously explored study characteristics on readability scores.[2] Pearson's coefficient was used for correlation. Statistical significance was set at $p \leq 0.05$.

RESULTS

A strong relationship was found between FRE and United States school grade level, r^2=-0.842, p<0.001 (Figure 1). To mitigate the risk of false-positives through multiple comparisons, FRE was used as the primary outcome as it is the most widely utilized within readability literature. We identified 396 articles from 27 countries: 149 (37.6%) from *Urology*, 107 (27.0%) from *Journal of Urology*, 87 (22.0%) from *BJU International*, and 53 (13.4%) from *European Urology*. 226 articles (57.1%) were oncology topics and 170 (42.9%) were non-oncology.

The median grade level for understanding was 12.75 (range 8.12-16.98, IQR 11.60-13.72). The median FRE was 34.82 (range 11.39-57.16, IQR 29.13-40.71), categorized as "difficult to read" (Figure 2). 113 (28.5%) articles were "very difficult to read" and 268 (67.7%) were "difficult to read". Only 15 (3.8%) of articles were "fairly difficult to read".

Weak positive correlations between author count and FRE score (r^2=0.028, p=.003) and between word count and FRE score (r^2=0.024, p=0.006) were identified. There was no significant relationship between reference count and FRE score (p=0.255).

There were significant differences in FRE scores between journals (p=0.011). Specifically, compared to *Urology*, both *Journal of Urology* (difference: 3.05, 95% CI 0.36-5.75, p=0.019) and *BJU International* (difference: 2.88, 95% CI 0.01 to 5.76, p=0.049) had significantly higher FRE scores, or easier reading (Figure 3). Additionally, different study types had significant differences in FRE scores (p=0.004). Both randomized controlled trials (difference: 6.085, 95% CI 1.34-10.83, p=0.006) and prospective cohort studies (difference: 4.56, 95% CI 0.67-8.44, p=0.014) had higher FRE scores compared to the other category (non-human subject-based articles). Oncology studies had significantly higher FRE scores than non-oncology studies (difference: 3.434, 95% CI 1.80-5.07, p<0.001). Although region of origin had significant differences on FRE scores (p=0.008), no post-hoc comparisons survived.

DISCUSSION

The urologic literature is difficult to read. Surely lay and academic literature are not expected to be similar prose, but increasing difficulty may decrease knowledge translation even for experts.[3] Two-thirds of articles are "difficult to read" as per the FRE scale and almost 30% are "very difficult to read". Author count, word count, and reference count were weakly correlated with readability scores; authors' country of origin did not.

Readers of medical literature are typically highly educated experts, but even here, increases in the non-germane work of reading may impact learning. Prior work on revising text for readability improved experts' comprehension[3]. Moderating readability makes research more accessible.

Our results and previous reports indicate variability in readability across urological subspecialties. We identified higher readability in oncology papers. Contrastingly, urologic oncology patient education materials have demonstrated poor readability.[5] Replacing medical with lay terminology lowered reading levels, suggesting utility in considering the audience when writing research papers. Further, readability has a clinical impact. Following prostatectomy, patients given a more readable hospital discharge summary were less likely to contact their provider or visit the emergency department within 30 days of admission.[4]

We offer the following recommendations to increase urological literature readability. First, to revise drafts to target Flesch Reading Ease Scores above 30 when writing manuscripts. Second, for editorial boards to consider readability in the editorial process. Inclusion of navigational aids using colour, font size, and graphics to simplify complex messages are design choices that may further improve reading. Attention to non-expert readers from patient, advocacy or commercial areas is increasingly important. For example, *European Urology* requires a succinct summary of the clinical message, in lay terms, to be provided with each submission. To date, no investigation has evaluated the effect of these interventions on patient engagement with scientific literature.

Our study indicates difficult readability across the urological literature; however, our data are limited to the journals and issues analyzed. Further studies on the breadth of urological publications will be informative. Additionally, no investigation has surveyed which resources urology patients use to learn about their own care. This offers a future direction for investigation to optimize patient-targeted care resources. Finally, readability's impact on citation counts, social media footprints, or journalism uptake has yet to be investigated. Additionally, it is not clear at which point precision is sacrificed in the quest for maximally improving readability scores.

Readability affects information extraction no matter the level of education. More readable papers afford medical research the usefulness the work intends, and should be a goal for authors and journals.

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FIGURES AND TABLES

Figure 1. Correlations of Flesch Reading Score and (A) United States school grade level; (B) author count; (C) word count; and (D) reference count.

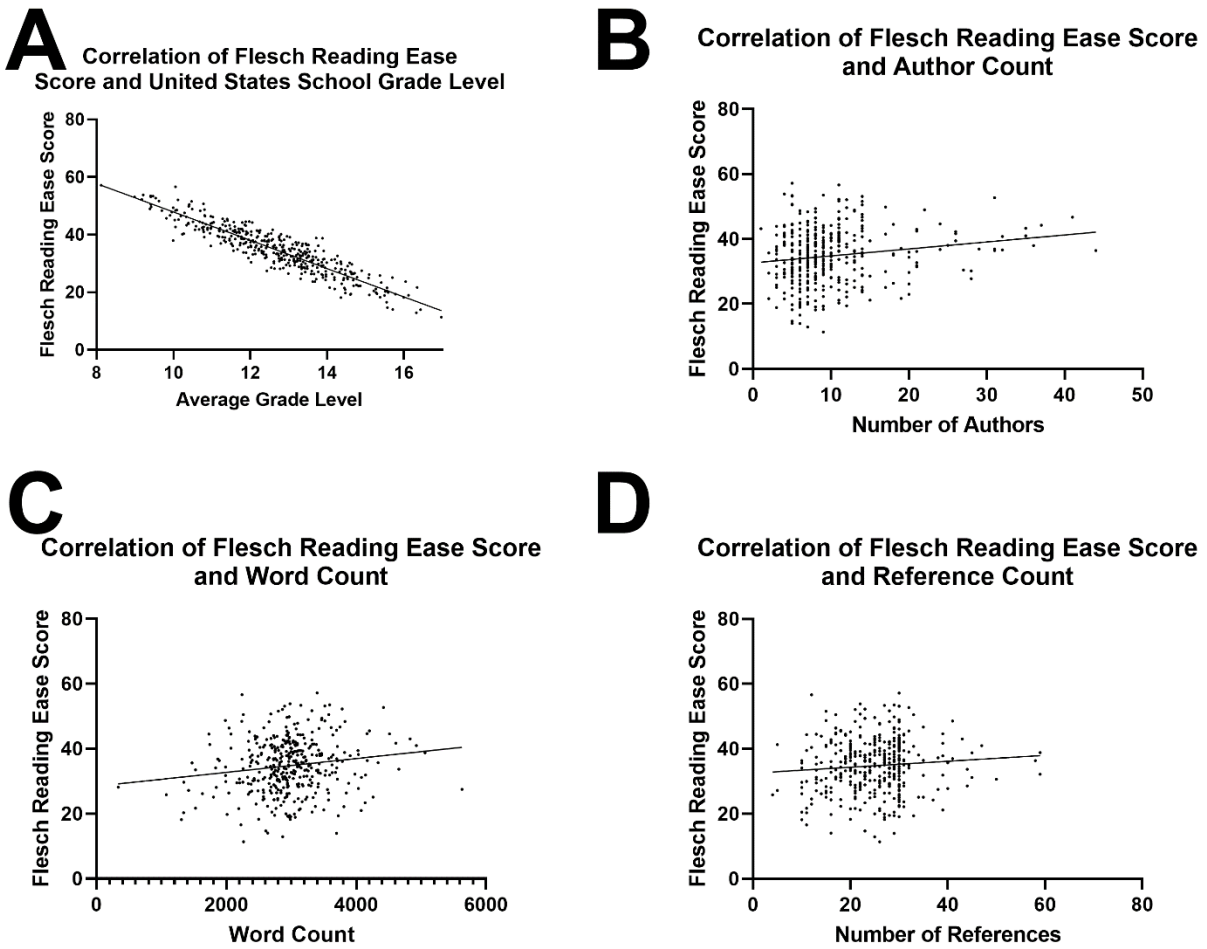

Figure 2. Frequency of Flesch Reading Ease (FRE) score and United States school grade level of urological literature. Left of the solid line indicates "very difficult to read" FRE (≤30), and left of the dotted line indicates "difficult to read" FRE (≤50). No utilized delineation exists of United States school grade level scores outside of intended grade level of the reader.

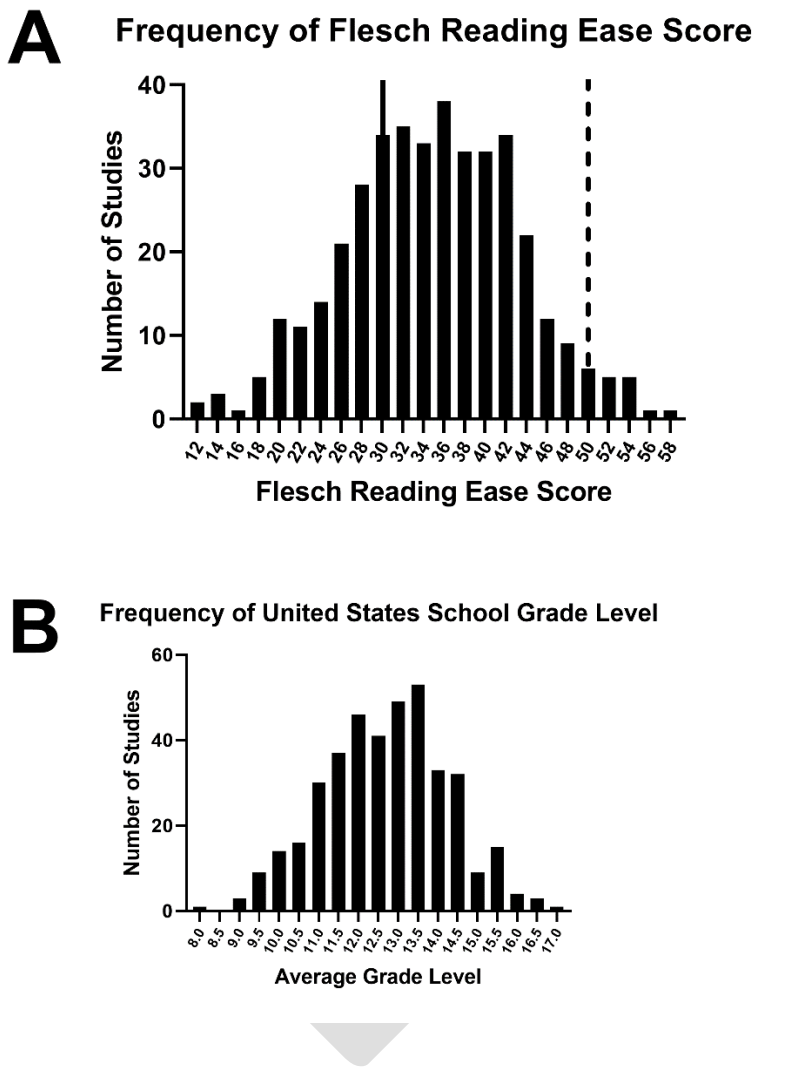

Figure 3. One-way analysis of variances of Flesch Reading Ease (FRE) score and (A) journal; (B) type of study; (C) oncology vs. non-oncology study; (D) and geographic region. Below the solid line indicates "very difficult to read" FRE (≤30), and below the dotted line indicates "difficult to read" FRE (≤50).