Metatarsal Stress Fractures: An Analysis of Readability and Quality of Online Health Materials

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Research Article

Keywords: Metatarsal Stress Fracture, Patient Education, Health Literacy, Reading Level, Sports Injury, Orthopaedic Surgery

Posted Date: October 31st, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2172279/v1

Abstract

Background

Patients are increasingly accessing health information via the internet. Our aim was to assess the quality and readability of online patient education materials regarding metatarsal stress fractures. We hypothesised that this information would be too difficult for the average patient to read and of a lesser quality than desired.

Method

A search of the top 50 results on 3 search engines (Google, Bing, Baidu) was completed (MeSH “metatarsal stress fracture”, “metatarsal stress fractures”). Readability of these websites was calculated using www.readable.com, producing 3 scores: Gunning-Fog (GF), Flesch Reading Ease (FRE) and Flesch-Kincaid Grade (FKG). Quality of the retrieved webpages was analyzed using Journal of American Medical Association (JAMA) benchmark criteria and the Health On the Net (HON) code toolbar extension.

Results

77 unique websites were identified. The mean scores were: FRE 56.34+/- 16.1, FKG 8.36 +/- 2.8 and GF 9.35 +/-3.4. This corresponds with most webpages being pitched to a grade 8–12 reading level. Most webpages per the FRE score (n = 47, 61%) were pitched at a grade 10 reading level and above. The GF index identified 20 webpages (26%) aimed towards readers of a grade 7 level or below. 10 websites (13%) displayed a current HONcode certificate. Most websites (n = 35, 45.5%) didn’t meet any of the JAMA criteria.

Conclusion

This study uncovers the high difficulty and poor quality of online health materials relating to MSFs, potentially contributing to negative health outcomes. Given the relationship of health literacy and patient outcomes, it is vital that we address these deficiencies swiftly.

Background

Metatarsal stress fractures (MSF) are the most common fractures of the foot in the general population and frequently befall athletes (1). MSF’s arise following prolonged exposure to submaximal stress (2). Awareness of these fractures is crucial as missed diagnoses delay appropriate treatment and increase the risk of malunion (2). MSFs are initially treated with modification of activity intensity, training techniques and footwear (1). Further management (if appropriate) includes ice and analgesics, immobilization, and operative measures (3).

Due to markedly increased access to health information via the internet, it is in both the patient and providers best interest to ensure that the available information is of high quality and easily understood (4). Reliable health information concerning MSF’s allows patients to reference their symptoms and mechanism of injury against a valid database (1). Additionally, it increases their health literacy, that is, the ability to obtain and apply health knowledge in self-management and in exchanges with health providers (5). Studies demonstrate that patients with augmented orthopedic health literacy are more likely to be satisfied with their injury management and have more accurate outcome expectations (6, 7). Furthermore, a developed health literacy enables patients to exercise informed decision making (7).

It is widely recognized that health education information should be addressed to a USA 6th grade reading level, corresponding with a sixth-class student in the Republic of Ireland and year 7 student in the United Kingdom (UK) (8). However, several studies show that general online orthopedic health information is of poor quality and pitched several reading grades higher than favoured (8–10).

There are currently no studies examining the readability or quality of health data regarding metatarsal stress fractures available on the internet. Given the increased difficulty associated with accessing online orthopedic health information in general, we hypothesized that the information regarding MSFs would be too advanced for the typical patient.

This study was devised to evaluate the quality and readability of online information relating to metatarsal stress fractures using standardized, reputable tools.

Materials & Methods

A search of the Google, Bing and Baidu search engines was conducted on the 11th of April 2022 at 8:51pm. At the time, these 3 search engines accounted for 96.16% of the market share in Ireland (Google 91.56%, Bing 3.1%, Baidu 1.5%) (11). The search terms “metatarsal stress fracture” and “metatarsal stress fractures” were used on each platform to ensure that no relevant websites were neglected. The top 50 results for each search term from each search engine were amassed for a total of 300 initial results. Following the removal of duplicates (n = 108), articles with irrelevant content (n = 81), inaccessible websites and files (n = 29) and webpages containing videos only (n = 5), 77 unique websites remained. All websites were reviewed by two independent authors within 24 hours of the original search. A complete list of all 77 unique websites can be found in Appendix A (Additional File 1).

The readability score of these websites was computed by www.readable.com. This webpage measures the likelihood that written information will be understood by the intended reader (12). It uses validated formulae to produce numerical scores indicating the level of education received by the United States of America (USA) education system required to read the text with ease (12). Selected USA grade levels and corresponding grade levels in other English speaking education systems are depicted in Table 1 (13–17).

Table 1
English Speaking Education Systems

USA **Canada** **South Africa**	**Kindergarten** **Reception**	**Grade 1**	**Grade 6**	**Grade 7**	**Grade 8**	**Grade 9**	**Grade 12**
England Wales New Zealand	Year 1	Year 2	Year 7	Year 8	Year 9	Year 10	Year 13
Scotland	P1	P2	P7	P8	P9	P10	P13
Republic of Ireland	Senior Infants	1st Class	6th Class	1st Year	2nd Year	3rd Year	6th Year
Australia	Kindergarten	Year 1	Year 6	Year 7	Year 8	Year 9	Year 12

URLs were inputted and data extracted by www.readable.com to produce scores and associated reading grade levels for all 77 unique websites. Using multiple scales allows for an analysis of the complexity of a webpage using length of

words, syllables per word, length of sentences and uncommon words. Thus, an average readability level of a website is determined using multiple scores. These scores include the Flesch-Kincaid Reading Ease (FRE), the Flesch-Kincaid Grade Level (FKG) and the Gunning Fog Index (GF) (Table 2).

Table 2
Readability Formulae

Flesch-Kincaid Reading Grade Level	**Grade Level**	**Designed for technical documents and suited to a broad array of disciplines from marketing to government.**	**FKG = [0.39 x (W/S)} + [11.8 x (Sy/W)] – 15.5**
Flesch-Kincaid Reading Ease	Index Score (0-100)	Developed to assess the readability of newspapers. Currently used to assess school textbooks and technical manuals. Scores range 0-100, with higher scores indicating easier readability.	FRE = 206.835 – [84.6 x (Sy/W)] – [1.015 x (W/S)]
Gunning Fog	Grade Level	Developed to assist American businesses improve the clarity, of their writing. Applicable to numerous disciplines.	GF = 0.4 [(W/S) + (CW/W) x 100]
[W, Words; S, Sentences; CW, Complex Words (3 or more syllables excluding proper nouns, familiar jargon, compound words and common suffixes); Sy, Syllables; GF, Gunning FOG; FKG, Flesch Kincaid Grade; FRE, Flesch Reading Ease.]			

The quality of information provided by the webpages was also scored by the validated Health on the Net Foundation (HON) Code of Conduct seal and the Journal of the American Medical Association (JAMA) benchmark criteria.

The HON seal originated from Switzerland in 1995 and is awarded to websites containing high quality health information (18). Its goal it to ensure professionals are receiving extremely reliable information, uploaded to the internet by ethical and reliable sources (18). The HON status of each website in our study was assessed using a HONcode toolbar Google Chrome extension. This toolbar automatically confirmed the presence of the HON seal when a URL was inputted into Google Chrome.

The JAMA benchmark criterion evaluates 4 domains – authorship, attribution, disclosure, and currency (Table 3) (19).

Table 3
JAMA benchmark criteria

Domain	**Description**
Authorship	The name(s) of the author(s), their affiliation(s) and their credentials stated on the website.
Attribution	The website accurately references all material presented and relevant copyright information noted.
Disclosure	Ownership of the relevant website, advertising, sponsorship, or any potential conflicts of interest should clearly appear on the website.
Currency	The website must display the upload date of the material and any review dates.

Results

Reading level

As per the FRE score, 12 webpages (15.6%) were pitched at the grade 7 level and below with only 1 at a grade 5 level. 18 websites (23.4%) were determined to be suitable for 13-15-year-olds, while most webpages (n = 47 61%) were suitable for grade 10 readers and above. Most of the material fell between “fairly difficult to read” to “extremely difficult to read”. The FRE scores along with their corresponding grade level and interpretation can found in Table 4.

Table 4
FRE results

Flesch-Reading Ease (FRE) Score	United States of America (USA) School Level	Notes	Number of Webpages
90–100	Grade 5	Very Easy to Read	1
80–90	Grade 6	Easy to Read	4
70–80	Grade 7	Fairly Easy to Read	7
60–70	Grade 8-Grade 9	Understood by 13–15-year-olds.	18
50–60	Grade 10-Grade 12	Fairly Difficult to Read	29
30–50	College	Difficult to Read	14
10–30	College Graduate	Very Difficult to Read	2
< 10	Professional	Extremely Difficult to Read	2

The FKG scores revealed that 31 websites (40.3%) were directed at individuals at a grade 7 level or below. A further 29 webpages (37.7%) were suitable for grades 8 and 9, while the remaining 17 pages (22%) found themselves in the 10th grade reading level and above. Therefore, most of the information is “very easy to read” to “fairly easy to read”, however the raw mean FKG score indicates that the material is “understood by 13-15-year-olds”. Table 5 outlines the FKG scores and their corresponding grade level.

Table 5
FKG results

Flesch-Kincaid Grade (FKG)	United States of America (USA) School Level	Number of Webpages
< 5	< Grade 5	4
5	Grade 5	8
6	Grade 6	9
7	Grade 7	10
8	Grade 8	14
9	Grade 9	15
10	Grade 10	9
11	Grade 11	5
12	Grade 12	0
13+	College	3

The GF index identified 20 websites (26%) targeted towards readers below a grade 7 level. 19 webpages (24.7%) were suitable for grade 8 or 9. Most webpages (n = 38, 49.3%) again found themselves in the 10th grade reading level and above. Therefore, most of the material is “fairly difficult to read” to “extremely difficult to read”. The GF scores along with their analogous grade level are found in Table 6.

Table 6
GF results

Gunning Fog Index (GF)	United States of America (USA) School Level	Number of Webpages
< 6	< Grade 6	7
6	Grade 6	10
7	Grade 7	3
8	Grade 8	6
9	Grade 9	13
10	Grade 10	16
11	Grade 11	9
12	Grade 12	6
13	College Year 1	5
14+	College Year 2+	2

The raw mean scores are as follows; FRE 56.34 +/-16.1, FKG 8.36 +/- 2.8 and GF 9.35 +/-3.4. This corresponds with most webpages being pitched to a grade 8–12 reading level.

Health on the net

The HONcode toolbar identified 14/77 (18.2%) of websites as having the HONcode seal of approval when their URL was entered. However, upon verifying each website's certification of compliance by clicking on the HONcode toolbar, it was found that 10/14 (71.4%) websites held current certificates and the other websites' certificates had expired.

JAMA benchmark criteria

Only 1 website (1.3%) satisfied all 4 JAMA criteria, 5 websites (6.5%) had 3 of the criteria, 9 websites (11.7%) achieved 2 of the criteria and 27 websites (35%) met only one of the criteria. Most websites (n = 35, 45.5%) did not meet any JAMA criteria.

28 websites (36.4%) identified the authors, credentials, and affiliations, 17 websites (22.1%) correctly attributed the information with appropriate referencing, 14 websites (18.2%) clearly displayed the upload and review date of their health information, and 5 websites (6.5%) made relevant commercial disclosures.

Discussion

The results from our study are in line with previous research indicating that online orthopaedic health materials are of low quality and pitched at a higher readability level than is appropriate for the average patient (8–10, 20). The mean FRE corresponds to a 10th -12th reading grade level, which is far above the recommended level of difficulty, with only 5 webpages at or below a 6th grade reading level. In 2008, the American Medical Association (AMA) recommended that patient education materials be written at a 6th grade reading level, although the average American reads at a 7th grade level (21, 22). The mean FKG is a grade 8 reading level with 21 webpages at or below a 6th grade reading level. The mean GF corresponds with a grade 9 reading level, with 17 webpages at or below a 6th grade reading level. The FKG and GF are both indicators of the average number of words per sentence and syllables per word, indicating that the information of

some webpages is on target in terms of complexity (23). However, all readability scores demonstrate a consistent trend of online material regarding MSFs being pitched above the recommended level of difficulty.

The HONcode tool and JAMA framework were both used to assess the quality of webpages. 13% of webpages held current HONcode certificates, indicating that most of the information pertaining to MSFs is not upheld to a standardized publishing conduct. Only one webpage met all 4 JAMA criteria, and while 41 (54.5%) webpages met at least one of the four JAMA criteria, only 28 were able to indicate authorship and 14 currency. These are arguably the two most important factors in determining the quality of a webpage, as authorship indicates credibility and currency relevance (4). Therefore, the overall quality of webpages was low.

Adequate health literacy is a patient asset and protective against poor patient outcomes and all-cause mortality (24). There is a clear, proportional link between reading skills and health literacy (24). The Programme for International Assessment of Adult Competencies (PIAAC) found that Irish adults of a low socioeconomic class or of foreign birth to have decreased literacy levels compared to the Irish mean (25). This provides a clear target for the increased dissemination of quality health information, using simple, non-medical wording to achieve the best results (24). Additionally, this relationship emphasizes the importance of accessible health information written at an appropriate level of difficulty.

MSFs can be managed non-operatively for a significant period and are considered low risk orthopaedic ailments (1). Due to their prevalence in non-athletes and athletes alike, online health information is particularly important to guide conservative at-home clinical management. This is of particular concern as patient reliance on online health-related information has increased during the Coronavirus-19 (COVID19) pandemic (4). Additionally, due to the nature of the injury, patients should have access to readable, quality information that delineates the symptomatic difference between an MSF requiring non-operative management and one requiring operative management. There is an increased reliance on virtual sources by foot and ankle surgeons due to the COVID19 pandemic (20). As this is the first study examining the readability of online MSFs information, there is great room for improvement that should be prioritized in both the readability and the quality of the existing materials.

Online health materials regarding sports medicine injuries are inappropriately difficult to read for the average Irish citizen (26–29). The American Academy of Orthopaedic Surgeons consistently provides online information regarding sports injuries written at 2.5 grade levels higher than the recommended grade 7 (27). Furthermore, a study examining the readability level of online health pages relating to Achilles tendon rupture found that the average webpage is written at a grade 11 level (29). This study is consistent with the findings of sports injury related materials being pitched to 2 + grade levels above the recommended readability level (27, 29).

As MSFs are found in high density among runners, it is important to identify if online health information regarding MSFs is being pitched primarily to this demographic, thus inappropriately skewing the difficulty of available information (1). There is no evidence in the literature that runners, or any other type of athlete, have a higher health literacy than the average population.

There are some potential limitations to this study. First, the websites were accumulated on one day, limiting the sources to that specific day. Some of these links were no longer functional when the analysis began, and as such were deemed “inaccessible”. Secondly, the exclusion of webpages containing only videos and the inability of readability algorithms to compute figures and tables excludes the value they may bring to a patient’s capacity to comprehend medical information. Finally, the readability formulas used are not recognized as health care literature assessment tools. However, in the absence of other specialized tools, they provide reliable insight into the approachability of online health care information.

This study provides insight into the readability status of online health materials regarding MSFs through reliable, quantitative methods. The findings of this study are consistent with results of other orthopaedic readability studies and reinforces the need for revision of the writing of online health materials to an Irish year 7/ US grade 6 level.

Conclusion

This study uncovers the deviation of online patient education materials regarding MSFs relative to the expected standard as directed by the AMA. The readability level of these materials is too high for the average Irish patient, potentially contributing to negative health outcomes and fracture complications including malunion, non-union and refracture (26). Our study also highlights the poor quality of available online materials. Given the relationship of health literacy and patient outcomes, it is vital that we address these deficiencies swiftly. As there is increased dependence on the internet to provide patient health information and a high prevalence of MSFs in the general population and athletes, it would be advantageous for both patients and health care providers for the readability and quality of online information relating to MSFs improve markedly.

Abbreviations

AMA – American Medical Association

COVID19 – Coronavirus-19

FKG – Flesch Kincaid Grade

FRE – Flesch Reading Ease

GF – Gunning Fog

HON – Health on the Net

JAMA – Journal of the American Medical Association

MSF – Metatarsal Stress Fracture

PIAAC – Programme for International Assessment of Adult Competencies

UK – United Kingdom

USA – United States of America

Declarations

Ethical approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The dataset(s) supporting the conclusions of this article is(are) included within the article (and its additional file(s)). (Additional File 2).

Competing interests

The authors declare that they have no competing interests.

Funding

No funding was received for this project.

Authors' contributions

YH incepted the idea of this study. OH and IK collected the data regarding quality and readability of online health information regarding metatarsal stress fractures. OH analyzed the data and wrote the initial manuscript, with significant edits made by BM. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

Declaration of Interest

None.

Sources of Financial Support

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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