Readability and reliability of Wikipedia articles in high-risk pregnancy and birth control options

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ABSTRACT

Objective. This study aims to compare the readability and reliability of Wikipedia articles with corresponding Society for Maternal-Fetal Medicine (SMFM) patient education leaflets.

Materials and Methods. We selected Wikipedia articles on high-risk pregnancy and birth control options based on the series of online patient educational leaflets published by the SMFM. Our final analysis included the text content of 13 SMFM. Readability was assessed using six different readability scales, including the Simple Measure of Gobbledygook (SMOG) Index. To evaluate the quality, each of the selected articles was assessed with the modified DISCERN instrument.

Results. Our research establishes a concerning discrepancy between Wikipedia and the average US online page viewer seeking medical information.

Conclusions. In terms of observed lower quality of Wikipedia articles, our findings indicate the obligation for every clinician to use their critical appraisal skills to help patients avoid misleading health information.

INTRODUCTION

Expeditious growth of the Internet has provided patients' access to health-related information undemanding. In order to obtain health-related information, approximately 70% of American adults have used the Internet [1]. Despite rising utilization trend and efforts toward data standardization, there is strong skepticism about medical content quality and accuracy [2]. Furthermore, variations in target literacy levels aggravate overall quality assessment and comprehension [1].

Among the open-access online sources of medical information, Wikipedia has become one of the most popular websites worldwide, covering medical topics written collaboratively by individuals from around the world [3]. Wikipedia is consistently in the top 5 most visited websites in the world, making a common reference for patients seeking health information [2]. In terms of quantity, an estimated

6.5 million US patients directly access Wikipedia as their first online medical solution [4]. Even though many patients obtain health-related information from Wikipedia, concerns over content readability, quality and lack of quality-control mechanisms have been implicated in several studies conducted on other medically related content [4-7]. The Society for Maternal-Fetal Medicine (SMFM) have published their own series of patient education leaflets regarding high-risk pregnancy, birth control options and vaccines in pregnancy, many of which have a corresponding Wikipedia article.

Considering the fact that Wikipedia presents influential health information platform, generating over 500 milion visits per month from different users [3], its content analysis and improvement is mandatory. Similar quality and readability analyses of Wikipedia articles have already been conducted in nephrology, neurosurgery, gastroenterology and hepatology, cardiovascular medicine, pelvic floor disorders and Parkinson's disease [5-10]. However, the obstetric field is prone to lots of dangerous conditions such as pre-term birth [11], uterine rupture, infections, cesarean complications [12-16]. Moreover, different gynecological conditions may hamper fertility outcomes and require appropriate counselling [17].

According to the current evidence on the readability of medical Wikipedia articles, we hypothesized that Wikipedia articles on selected maternal-fetal medicine topics are not readable to the average reader. In terms of reliability assessment, we expect that Wikipedia articles might have compromised overall quality. Moreover, we compare the readability and reliability of these articles with corresponding SMFM patient education leaflets.

MATERIALS AND METHODS

This study was conducted during May 2021 in the Department of Obstetrics and Gynecology, University Hospital Center Zagreb, Croatia. An institutional review board approval was not required because this study used publicly available data.

Article selection

We selected Wikipedia articles on high-risk pregnancy and birth control options based on the series of online patient educational leaflets published by the SMFM. In order to accurately compare the readability and reliability of Wikipedia articles to that of the SMFM, we only selected Wikipedia articles that directly corresponded to the SMFM leaflet. Moreover, we searched only the English version of Wikipedia, in order make the proper correlations without language biases. We identified 20 patient educational leaflets on the official SMFM website, divided in two categories: High-Risk Pregnancy and Birth Control. After initial examination of the SMFM official website, we have searched Wikipedia in order to find corresponding articles, resulting in exclusion of 7 articles due to missing data and/or obvious content discrepancy. Thus, our final analysis included the text content of 13 SMFM patient leaflets and corresponding Wikipedia article.

Four independent evaluators were distributed a pdf document version created for the study without source identification in order to ensure that all evaluators were analyzing the same content and to reduce overall bias.

Readability assessment and quality evaluation

Our assessment of the readability of the SMFM patient education leaflets and Wikipedia articles is based on six different readability scale measures generated by an online Readability Test Tool by WebpageFX (WebpageFX Inc., Harrisburg, PA, USA). Titles, subtitles and references were excluded from the analysis, with only body text and bullet point text included. The six readability scales were the Flesch Reading Ease (FRE), Flesch–Kinkaid Grade Level (FKGL), Gunning Fog Score (GFS), Simple Measure of Gobbledygook Index (SMOG), Coleman Liau Index (CLI), and Automated Readability Index (AR). All of the six mentioned readability scales have a close association with an educational level required for text comprehension. For instance, FRE score is calculated according to a total number of syllables, words and sentences included in article. The total score ranges from 0 to 100 with higher scores corresponding to a lower US grade level required for comprehension of the passage [18]. Likewise, SMOG Index calculate the readability based on the total number of sentences and average word length where the total score directly correlates with US grade level [19].

To evaluate the quality, we assessed each of the selected articles using the modified DISCERN in-

strument [20]. It represents short, valid and reliable standardized set of criteria created to assess the quality of health information written for the public, originally developed and validated by public health experts at the University of Oxford [19, 20]. An adjustment of the original version was made in order to allow the presence and quality of visual aids and to properly assess the gaps in knowledge and scientific authenticity [4, 20]. The modified DISCERN instrument presents 10-item questionnaire, with score range between 10 and 50 points, where score of less than 30 indicates poor quality, a score of 30-39 moderate quality, and a score of 40 or more good quality content [20]. The instrument was tested before being used in this study. The aim of testing the instrument was to attempt to standardize the evaluations between four independent assessors (one subspecialist in maternal-fetal medicine and three OB/GYN residents). A total of 10 articles from the field of maternal-fetal medicine and human reproduction (other than those included in the study) were randomly selected and used for this purpose. Each item of the modified DISCERN instrument was a mandatory field.

Statistical analysis

Normality of the distribution was tested via the Shapiro–Wilk test. Data assuming normal distribution were evaluated using Student's t test. Mann-Whitney U test was used for non-normal data distribution. The readability score across the six different readability scales and quality scores were presented as mean ± standard deviation (SD). The interrater reliability was calculated using intraclass correlation coefficient (ICC). Significance level was set as $p < 0.05$. Data analysis was perfomed using SPSS 23.0 (IBM Corp., Armonk, NY).

RESULTS

Readability scores

The mean result of all readability scales measure of SMFM and corresponding Wikipedia articles are presented in **Table 1**. The mean SMOG score for analysed Wikipedia articles was 12.65 ± 1.04 ($p < 0.001$). This indicates that a college-level education is required for article comprehension. The mean SMOG score for SMFM patient educational leaflets is 9.30 ± 1.75 ($p < 0.001$), which corresponds to a ninth-grade level. The described tendency persisted across the mean values of all readability scales measure.

The analysis of an individual SMFM and corresponding Wikipedia articles is shown in **Table 2** and **Table 3**. These results consistently confirm that a grade level above US-secondary education and, in some instances, even a college graduate-level is required to understand the Wikipedia articles. Conversely, many of the SMFM articles are easily understood by 13- to 15-year-old students.

Quality evaluation

The mean modified DISCERN score for the analysed SMFM articles was 43.83 ± 2.08 which indicates good quality content, while the mean modified DISCERN score for corresponding Wikipedia articles was 38.29 ± 4.10, indicating moderate content quality. Complete analysis, including individual grades for each article is shown in **Table 4** and **Table 5**, respectively. All of the SMFM articles met the criteria for "good" quality article which was the case for 38.5% of analysed corresponding Wikipedia articles. Furthermore, Wikipedia article about Periviable Premature Rupture of Membranes (PPROM) received "poor" quality score. Interrater reliability was assessed using the intraclass correlation coefficient (ICC) – reliability for the SMFM

Table 1. *Results of all readability scales measure of SMFM and corresponding Wikipedia articles.*

Readability scale	SMFM		Wikipedia		P-value
	Mean	SD	Mean	SD	
FRE	54.746	11.2034	34.085	5.2019	< 0.001
FKGL	9.777	2.1657	13.946	1.1738	< 0.001
GFS	12.662	2.4747	16.769	1.4778	< 0.001
SMOG	9.300	1.7459	12.654	1.0421	< 0.001
CLI	12.162	1.1095	14.331	.8864	< 0.001
AR	9.262	2.2374	13.623	1.6187	< 0.001

FRE: Flesch Reading Ease; FKGL: Flesch–Kinkaid Grade Level; GFS: Gunning Fog Score; SMOG: Simple Measure of Gobbledygook Index; CLI: Coleman Liau Index; AR: Automated Readability Index.

Table 2. *Readability analysis of selected SMFM articles.*

Topic - SMFM	FRE	FKGL	GFS	SMOG	CLI	AR	CW
Cesarean Scar Pregnancy	51.7	9.8	14.0	10.1	12.9	9.0	20.07
Cytomegalovirus	55.9	9.4	12.7	9.4	11.5	8.3	16.50
Delayed Cord Clamping	58.8	9.2	10.7	7.9	12.2	9.3	10.84
Fetal Anemia	33.5	13.3	16.1	11.8	13.9	11.8	21.73
Fetal Growth Restriction	60.6	9.4	12.5	9.1	11.4	9.5	13.31
Intrahepatic Cholestasis of Pregnancy	66.6	7.3	9.4	7.0	11.3	6.9	10.48
Periviable Premature Rupture of Membranes	36.7	13.1	16.1	11.9	13.9	12.3	21.23
Preeclampsia	51.1	11.6	13.8	10.0	13.2	12.8	13.47
Prenatal Screening Using Cell-Free DNA	49.6	11.2	14.6	10.6	11.7	10.3	17.04
Vasa Previa	47.1	11.0	15.0	10.9	12.9	10.2	20.32
Intrauterne Device (IUD)	66.5	7.2	10.1	7.5	10.4	5.9	12.74
The Implant	67.2	6.9	9.6	7.2	11.0	6.0	12.37
Combined Birth Control Pills	66.4	7.7	10.0	7.5	11.8	8.1	11.00
Mean (total)	54.7	9.8	12.7	9.3	12.2	9.3	15.5

FRE: Flesch Reading Ease; FKGL: Flesch–Kinkaid Grade Level; GFS: Gunning Fog Score; SMOG: Simple Measure of Gobbledygook Index; CLI: Coleman Liau Index; AR: Automated Readability Index.

Table 3. *Readability analysis of corresponding Wikipedia articles.*

Topic - WIKIPEDIA	FRE	FKGL	GFS	SMOG	CLI	AR	CW
Cesarean Scar Pregnancy	28.8	15.5	19.6	14.5	14.2	15.2	25.11
Cytomegalovirus	32.4	14.6	17.2	12.9	15	15	21.07
Delayed Cord Clamping	40.5	13.3	15.7	11.7	13.4	13.4	17.81
Fetal Anemia	32.4	14.6	17.2	12.9	15	15	21.07
Fetal Growth Restriction	30.5	13.8	16.1	12.6	15.5	13.2	24.66
Intrahepatic Cholestasis of Pregnancy	38.1	14.1	17.1	12.7	13.5	14.4	19.42
Periviable Premature Rupture of Membranes	36.9	13.9	16.4	12.4	13.4	13.5	19.83
Preeclampsia	24.8	15.5	19.1	14.2	15.5	15	26.84
Prenatal Screening Using Cell-Free DNA	33.6	12.9	16.2	12.1	14.8	11.8	25.23
Vasa Previa	35.3	12.7	15.9	11.6	14.7	11.7	23.16
Intrauterne Device (IUD)	45	11.3	13.7	10.6	12.6	9.9	19.36
The Implant	32.8	14.5	17	13.2	14.3	14.5	22.14
Combined Birth Control Pills	32	14.6	16.8	13.1	14.4	14.5	21.85
Mean (total)	34.1	13.9	16.8	12.6	14.3	13.6	22.11

FRE: Flesch Reading Ease; FKGL: Flesch–Kinkaid Grade Level; GFS: Gunning Fog Score; SMOG: Simple Measure of Gobbledygook Index; CLI: Coleman Liau Index; AR: Automated Readability Index.

articles was fair (ICC = 0.49) and for the Wikipedia articles very good (ICC = 0.77).

Comment

Principal findings
To the best of our knowledge, this is the first study to evaluate SMFM patient education leaflets available online and compared with corresponding Wikipedia articles in terms of readability and reliability. Our research suggests significant difference between readability of the SMFM and corresponding Wikipedia articles – many of the SMFM articles are easily understood while Wikipedia articles require at least 12th-grade level for adequate comprehension. Among the other published readability assessment studies [4-9], this is the first study evaluating maternal-fetal medicine topics regarding high-risk pregnancy as well as birth control options. Patient leaflets for *Vaccines in Pregnancy* were not evaluated because systematization of Wikipedia articles was completely different compared to the SMFM articles, thus, adequate readability and quality comparison will be inadequate.

Table 4. *Quality evaluation of an individual SMFM articles, including interrater reliability evaluation.*

DISCERN - SMFM	Evaluator 1	Evaluator 2	Evaluator 3	Evaluator 4	Mean score (SD)	ICC (CI)
Cesarean Scar Pregnancy	46	48	45	46	46.25 (1.08)	0.49 (- 0.11 – 0.82)
Cytomegalovirus	45	44	44	44	44.25 (0.43)	
Delayed Cord Clamping	42	43	43	47	43.75 (1.92)	
Fetal Anemia	42	45	39	40	41.5 (2.29)	
Fetal Growth Restriction	44	40	44	37	41.25 (2.95)	
Intrahepatic Cholestasis of Pregnancy	46	45	46	49	46.5 (1.5)	
Periviable Premature Rupture of Membranes	43	44	43	45	43.75 (0.83)	
Preeclampsia	44	40	42	43	42.25 (1.48)	
Prenatal Screening Using Cell-Free DNA	45	45	37	37	41 (4)	
Vasa Previa	45	46	41	46	44.5 (2.06)	
Intrauterne Device (IUD)	45	48	46	40	44.75 (2.95)	
The Implant	43	49	43	46	45.25 (2.49)	
Combined Birth Control Pills	47	48	44	40	44.75 (3.11)	

ICC: Intraclass correlation coefficient.

Table 5. *Quality evaluation of corresponding Wikipedia articles, including interrater reliability evaluation.*

DISCERN - WIKIPEDIA	Evaluator 1	Evaluator 2	Evaluator 3	Evaluator 4	Mean score (SD)	ICC (CI)
Cesarean Scar Pregnancy	30	36	29	32	31.75 (3.09)	0.772 (0.44 – 0.92)
Cytomegalovirus	36	41	36	41	38.50 (2.89)	
Delayed Cord Clamping	37	40	35	32	36.00 (3.37)	
Fetal Anemia	38	42	42	40	40.50 (1.91)	
Fetal Growth Restriction	37	42	42	37	39.50 (2.89)	
Intrahepatic Cholestasis of Pregnancy	40	47	45	37	42.25 (4.57)	
Periviable Premature Rupture of Membranes	30	30	23	32	28.75 (3.95)	
Preeclampsia	38	47	45	44	43.50 (3.87)	
Prenatal Screening Using Cell-Free DNA	34	42	33	35	36.00 (4.08)	
Vasa Previa	39	45	45	44	43.25 (2.87)	
Intrauterne Device (IUD)	30	47	45	35	39.25 (8.09)	
The Implant	33	49	41	43	41.50 (6.61)	
Combined Birth Control Pills	35	44	32	37	37.00 (5.09)	

ICC: Intraclass correlation coefficient.

The quality of each SMFM and Wikipedia article was assessed using the modified DISCERN [4-9]. According to the four independent evaluators, the vast majority of the Wikipedia articles were "moderate" quality articles, while all of the 13 analysed SMFM articles demonstrated "good" quality content. However, it is concerning that the Wikipedia article about PPROM shown "poor" quality content, as well as compromised readability.

RESULTS

The vast majority of readability scales were meticulously designed in order to correlate with educational level required for comprehension of leaflets. Considering previously publicated research on the readability of the healthcare handouts, SMOG index appeared superior to other readability scale measure for evaluating health-related information [4, 9, 19]. The main advantage of SMOG index is

its extraordinary consistency of results which was confirmed in readability assessment of online Parkinson's disease information [9]. Although the most commonly used for evaluating the readability of health-related information, the FRE score significantly underestimate reading difficulty [19]. In terms of the SMOG index and FRE score, our results revealed significant difference between Wikipedia and SMFM leaflets in US-grade level required for adequate comprehension. Our results are in line with multiple studies which have shown that online health-related information have compromised overall readability [4-7].

In addition to the readability, our intention was to determine and compare quality of content using modified DISCERN instrument. Another quality assessment strategies include frequency of updating articles estimation and assessing the references [20]. The original DISCERN instrument neglects the questions about the quality and inclusion of figures, images, and tables to support information provided [21, 22]. These differences warranted the need to modify the DISCERN instrument. Although not formally validated, it was successfully tested and used in online article examination [4-7]. The very recent study by Handler *et al.* demonstrated mainly poor and moderate quality of Wikipedia articles regarding pelvic floor disorders [4]. Similar quality concern is underlined in our research, regarding high risk pregnancy and birth control options described on Wikipedia. Another potential low-quality sources were detected among websites from health care institutions. For instance, a systematic review of online information regarding preoperative fasting, including health care institution websites, found that more than 50% included at least one recommendation that contradicted evidence-based guidelines [1]. Moreover, we have also assessed interrater reliability using ICC. In terms of Wikipedia articles, calculated ICC implies very good interrater reliability (ICC = 0.77) while the SMFM articles evaluation resulted with poor interrater reliability (ICC = 0.49). This discrepancy indicates that there is an easier agreement achieved on the lesser quality of the Wikipedia articles than in terms of superior quality of the SMFM leaflets.

Clinical implications

There is general consensus that optimal information should be understandable to patients, accu-

rate, evidence-based according to the latest guidelines and without bias. Contextual barriers, such as highly-medical language used in patient leaflets, can be immense and confusing for patients. Although provided studies have shown widespread lack of quality of Internet health-related content, there is growing evidence that readability occurs as a substantial issue resulting with complex content for most of the Internet users [1, 3, 10].

The college readability level of the Wikipedia articles we objectively measured is way above the 8th-grade mean reading level of US adults [23]. This fact establishes a concerning discrepancy between Wikipedia and the average US online page viewer seeking medical information. In terms of observed lower quality of Wikipedia articles, our findings indicate the obligation for Wikipedia text managers, contributors and clinicians making patient educational leaflets to constantly update content to reflect standard guidelines. In fact, some authors addressed importance of strong ethical obligation for every clinician to use their critical appraisal skills to help patients avoid misleading health information [24].

Research implications

The analysis in this study is primarily exploratory and meant to generate hypothesis for further investigation in larger studies regarding maternal-fetal medicine and other relevant medical society recommendations. Proposals for future research include finding the most adequate algorithm for creating the most suitable patient education leaflets in order to enhance patient retention of physician counselling. Another research proposal includes comparison of broader maternal-fetal medicine topics, including not only medical societies and corresponding Wikipedia articles, but websites from health-care institutions which are detected as *weakest links* in terms of accuracy, quality and readability.

Strengths and limitations

In terms of authenticity, this is the very first study evaluating both readability and reliability of Wikipedia articles regarding high-risk pregnancy and birth control options and comparing them with the patient educational leaflet series published by the SMFM. Furthermore, our readability analysis is based on the most relevant readability metric for health-related information incorporat-

ing six different objectively calculated readability scores. Regarding quality evaluation of selected articles, blind and independent quality assessors who have maternal-fetal medicine background add to the value of our research results. One of the advantages of this study is also in its methodology; before applying the modified DISCERN instrument to the selected articles, pilot study was performed.

However, the study is not free from limitations. Although piloted, modified DISCERN instrument was not formally validated prior to the research. Owing to the use of a single quality assessment tool, all potential quality indicators may be excluded from final analysis. Other limitations include analysis of only English-speaking articles which results with lack of generalization to other medical articles on Wikipedia. Due to low observed intraclass correlation coefficient in quality evaluation of the SMFM articles, adding more evaluators in future research will certainly improve interrater reliability. Moreover, often wikipedia articles are written by non-academic experts on an issue. This condition strongly decreases the article's quality and make it prone to lots of biases. However, Wikipedia tries to determine the scientific appropriateness of an article, especially when related to medicine, with disclosure statements.

CONCLUSIONS

In conclusion, the findings from the present study demonstrate good quality and sufficient readability of the SMFM articles. On the other hand, Wikipedia articles exhibit moderate quality but inadequate readability for average US internet user.

Considering Wikipedia's importance in creating overall public knowledge and that many patients use it as a primary medical reference, it is pivotal that it is constantly improved and updated. Our results emphasize importance of content simplification and proper readability adaptation because pregnant women will certainly seek medical information via internet in order to learn more about high-risk pregnancies and birth control strategies. Moreover, our research adds suggestion that maternal-fetal medicine experts should take care to direct patients toward appropriate medical resources.

COMPLIANCE WITH ETHICAL STANDARDS

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