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#### Recommended Citation

Docimo S, Jr., Seeras K, Acho R, Pryor A, and Spaniolas K. Academic and community hernia center websites in the United States fail to meet healthcare literacy standards of readability. *Hernia* 2022.

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# Academic and community hernia center websites in the United States fail to meet healthcare literacy standards of readability

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Received: 2 January 2022 / Accepted: 9 February 2022

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## Abstract

**Background** Health literacy is considered the single best predictor of health status. Organizations including the American Medical Association (AMA) and the National Institutes of Health (NIH) have recommended that the readability of patient education materials not exceed the sixth-grade level. Our study focuses on the readability of self-designated hernia centers websites at both academic and community organizations across the United States to determine their ability to dispense patient information at an appropriate reading level.

**Methods** A search was conducted utilizing the Google search engine. The key words “Hernia Center” and “University Hernia Center” were used to identify links to surgical programs within the United States. The following readability tests were conducted via the program: Flesch–Kincaid Grade Level (FKGL), Gunning Fox Index (GFI), Coleman–Liau Index (CLI), Simple Measure of Gobbledygook (SMOG), and Flesch Reading Ease (FRE) score.

**Results** Of 96 websites, zero (0%) had fulfilled the recommended reading level in all four tests. The mean test scores for all non-academic centers ( $n=50$ ) were as follows: FKGL ( $11.14 \pm 2.68$ ), GFI ( $14.39 \pm 3.07$ ), CLI ( $9.29 \pm 2.48$ ) and SMOG ( $13.38 \pm 2.03$ ). The mean test scores [SK1] for all academic programs ( $n=46$ ) were as follows: FKGL ( $11.7 \pm 2.66$ ), GFI ( $15.01 \pm 2.99$ ), CLI ( $9.34 \pm 1.91$ ) and SMOG ( $13.71 \pm 2.02$ ). A one-sample  $t$  test was performed to compare the FKGL, GFI, CLI, and SMOG scores for each hernia center to a value of 6.9 (6.9 or less is considered an acceptable reading level) and a  $p$  value of 0.001 for all four tests were noted demonstrating statistical significance. The Academic and Community readability scores for both groups were compared to each other with a two-sample  $t$  test with a  $p$  value of  $> 0.05$  for all four tests and there were no statistically significant differences.

**Conclusion** Neither Academic nor Community hernia centers met the appropriate reading level of sixth-grade or less. Steps moving forward to improve patient comprehension and/or involving with their care should include appropriate reading level material, identification of a patient with a low literacy level with intervention or additional counseling when appropriate, and the addition of adjunct learning materials such as videos.

**keywords** Health literacy and Community Hernia Centers · Health Literacy and Academic Hernia Centers · Readability and Hernia centers · Health literac and hernia repairs

## Introduction

Abdominal wall hernias are one of the most common surgical diseases faced worldwide. In the United States more than 350,000 hernias are repaired annually making this field of

utmost importance to general surgeons across the globe [1]. With the continued innovation of new techniques combined with newly developed surgical platforms and mesh products; the field of abdominal wall reconstruction is becoming more complex and a clear understanding of the various surgical options by patients is of great importance.

Health literacy is considered the single best predictor of health status [2, 3]. Readability can certainly affect the patient’s ability to comprehend and alter their health literacy. Previous studies estimate poor health literacy contributes to more than \$73 billion dollars of additional burden to the United States Healthcare system [4, 5].

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The Centers for Disease Control and Prevention endorses the definition of health literacy described by Healthy People—2020 as “the degree to which an individual has the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” [6]. Organizations including the American Medical Association (AMA) and the National Institutes of Health (NIH) have recommended that the readability of patient education materials not exceed the sixth-grade level [6].

The internet is easily accessible in the United States and is now one of the most common platforms utilized to acquire health information throughout the country. A previous study estimated eight million Americans will utilize the internet to seek health information on a typical day [7]. The internet is a great tool for eager patients to be involved in their care as information can be quickly obtained while maintaining privacy [8]. Our study focuses on the readability of self-designated hernia centers websites at both academic and community organizations across the United States to determine their ability to dispense patient information at an appropriate reading level.

## Methods

A search was conducted utilizing the Google search engine. The key words “Hernia Center” and “University Hernia Center” were used to identify links to surgical programs within the United States. All programs were categorized into two groups: non-academic hernia centers and academic affiliated hernia programs. A community hernia center was identified as a program which identifies as a “hernia center” on their website with no identifiable university or academic affiliation. Academic hernia centers were defined as consisting of surgeons who claim an academic affiliation and carry a university logo or affiliation on its website.

The aim of the study is to evaluate a hernia center’s website for readability in regards to patient health care literacy. Therefore, to standardize the content obtained from each website, the website’s general description of a hernia was copied and evaluated using readability tests. The readability test utilized consisted of the Flesch–Kincaid Grade Level (FKGL), Gunning Fox Index (GFI), Coleman–Liau Index (CLI), Simple Measure of Gobbledygook (SMOG), and Flesch Reading Ease (FRE) score.

FKGL is a formula that uses the sentence length and number of syllables to compute the US grade level required to read the text. For example, a score of 6–6.9 should be readable by the average sixth-grade student. The scores were categorized into three difficulty levels: easy (< 6), average (6–10) and difficult (> 10). The FKGL formula is  $FKG = [0.39 \times (W/S)] + [11.8 \times (Sy/W)] - 15.5$  (50). FKGL scores are

categorized as follows: 0–3 (Learning to read books), 3.1–6 (The Gruffalo), 6.1–9 (Harry Potter), 9.1–12 (Jurassic Park), 12.1–15 (Brief History of Time), 15.1–18 (Academic Paper) [9]. The FKGL has been utilized in the readability of medical information in previous publications [10, 11].

The GFI, is a formula that generates the grade level needed to comprehend the material. It is based on the average sentence length and the percentage of hard words (words with more than three syllables). Table 1 demonstrates the GFI and associated reading levels. The GFI is calculated using the formula  $GF = 0.4 \times [(W/S) + (CW/W) \times 100]$  [12]. The GFI score has been utilized in the readability of medical information in previous publications [13, 14].

The CLI is readability test that computes the US grade level of education. Its variables include the number of letters in a word and the number of words in a sentence. The CLI is calculated using the formula  $CLI = (0.0588 \times L) - (0.296 \times S) - 15.8$  where  $L$  = average number of letters per 100 words and  $S$  = average number of sentences per 100 words [12]. The CLI has been utilized in the readability evaluated of medical information in previous publications [15, 15]. The CLI output approximates the US grade level believed necessary to comprehend the text analyzed, similar to the GFI.

The SMOG uses the number of multi-syllable words contained in 30 sentences of a text to generate a US grade level of education. The SMOG grade yields a 0.985 correlation with a standard error of 1.5159 grades with the grades of readers who had 100% comprehension of test materials [16]. SMOG is calculated as  $Grade\ Level = 1.0430 \times \text{Square root}(\text{number of polysyllabic} \times ((30)/\text{number of sentences}))$  [12]. SMOG has been utilized to evaluate medical information in previous publications [17–19].

Flesch Reading Ease (FRE) score, the earliest of the commonly used tools to assess readability, gives a score on a scale ranging from 0 to 100, with 0 being unreadable and 100 being most readable [20]. The FRE score is calculated

**Table 1** Gunning fog index reading levels

GFI	Reading level by grade
6	Sixth grade
7	Seventh grade
8	Eighth grade
9	High School Freshman
10	High School Sophomore
11	High School Junior
12	High School Senior
13	College Freshman
14	College Sophomore
15	College Junior
16	College Senior
17 or Higher	College Graduate

**Table 2** Flesch reading ease scores and corresponding United States reading grade levels

FRE score	Grade level (US)	Description
100.00–90.00	5th grade	Very easy to read. Comprehended by an average 11-year old
90.0–80.0	6th grade	Easy to read
80.0–70.0	7th grade	Fairly easy to read
70.0–60.0	8th and 9th grade	Comprehended by 13- to 15-year-old students
60.0–50.0	10th–12th grade	Fairly difficult to read
50.0–30.0	College	Difficult to read
30.0–10.0	College graduate	Very difficult to read. Comprehended by university graduates
10.0–0.0	Professional	Extremely difficult to read. Comprehended by university graduates

using the formula  $FRE = 206.835 - 1.015 \text{ (total words/total sentences)} - 84.6 \text{ (total syllables/total words)}$ . The FRE has been utilized to evaluate medical information in the United States and other parts of the world [21, 22]. Table 2 demonstrates the conversion of FRE scores to United States grade levels [9].

### Readability analysis

After the google search was performed, the first 50 hernia centers that fit the description of an academic and a community hernia center were chosen for a total of 100 hernia centers. This methodology provided randomness to how the hernia centers were chosen to minimize bias. After each hernia website was identified (Tables 3 and 4), the website content that described or provided a definition of a hernia was copied and pasted into the readability formulas.

### Statistical analysis

The five readability tests were compared to the recommended readability level (grade level  $\leq 6.9$ ) utilizing a one-sample *t* test. A grade level of 6.9 was utilized considering the evidence suggesting medical content should not be presented at a reading level greater than the sixth-grade. Academic and non-academic program readability scores were compared utilizing a two-sample *t* test. A *p* value of  $< 0.05$  was used to determine statistical significance. Of note, the FRE scores are presented in Tables 3 and 4 and not analyzed against the standard 6.9 score considering the raw FRE scores do not correlate to a US grade level [6]. Table 2 provides a FRE conversion between the FRE scores and a US grade level.

### Results

A total of 50 academic and 50 non-academic websites were identified. Four academic websites were removed due to the inability to link operating physicians to an academic medical center or lack of an obvious hernia definition on the website.

Of 96 websites, zero (0%) had fulfilled the recommended reading level in all four tests. The mean test scores for all non-academic centers ( $n = 50$ ) were as follows: FKGL ( $11.14 \pm 2.68$ ), GFI ( $14.39 \pm 3.07$ ), CLI ( $9.29 \pm 2.48$ ) and SMOG ( $13.38 \pm 2.03$ ). The mean test scores [SK1] for all academic programs ( $n = 46$ ) were as follows: FKGL ( $11.7 \pm 2.66$ ), GFI ( $15.01 \pm 2.99$ ), CLI ( $9.34 \pm 1.91$ ) and SMOG ( $13.71 \pm 2.02$ ). A one-sample *t* test was performed to compare the FKGL, GFI, CLI, and SMOG scores for each hernia center to a value of 6.9 (6.9 or less is considered an acceptable reading level) and a *p* value of 0.001 for all four tests were noted demonstrating statistical significance.

The Academic and Community readability scores for both groups were compared to each other with a two-sample *t* test with a *p* value of  $> 0.05$  for all four tests and there were no statistically significant differences. The average FRE score for Academic hernia centers was 49.5 (College Reading Level) and 51.6 (10–12th Grade Reading Level) for Community hernia centers.

### Discussion

The increased utilization of the internet to obtain health care information increased dramatically in recent years. In a recent survey of American adults in 2019 revealed that approximately 3 in 4 individuals have accessed the internet in the past 12 months to research a specific medical condition [23]. However, not all patients have the adequate health literacy, which is defined as, “the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions” [24]. Readability is paramount to achieving health care literacy and ensuring health information is readable by patients. Readability, defined as the “ease with which a person can read and understand written materials” [25], has been identified as a key component of effective health communication by the Health Communication section of Healthy People 2010 [26].

Poor health care literacy has been shown to have a detrimental effect on outcomes and costs. The healthcare cost of Medicaid patients with limited literacy alone is four times

**Table 3** Readability scores for each academic hernia center

Academic hernia centers						
Institution identifier	FKGL	GFI	CLI	SMOG	FRE	Words analyzed
1	8.4	11.3	9.7	11.2	61.9	15
2	14.4	17.9	12.6	15.9	34.4	24
3	11.8	15.5	7.8	13.8	54.2	49
4	14.4	18.6	9.5	15.9	44.4	88
5	13.5	18	10.5	15.9	42.7	25
6	7.9	11	9	11.2	58	54
7	9.3	12.7	7.3	12.2	53.6	28
8	15.5	16.7	13.4	15.9	32.2	27
9	9.3	13.9	8.1	13	56.6	48
10	10.5	11.5	10.5	13	50.2	17
11	8.4	11.6	6	11.2	65.8	35
12	12.4	14.4	10.5	13	47.4	23
13	13.3	15.2	11.4	13	47.8	27
14	12.3	16.1	8.2	14.6	46.1	22
15	11.3	12.7	6.9	11.2	54.8	23
16	12.6	16.9	7.1	14.6	54.5	28
17	12.1	14.8	9.1	13	52.9	25
18	9.8	11.6	10.3	11.2	57	18
19	11.1	16	8	14.6	52.6	21
20	9.9	14	7.4	13	59.6	40
21	10.5	14.6	7.7	13	62.6	24
22	10.5	16	8	14.6	55.4	20
23	18.8	22.3	9	17.1	33.2	41
24	10.1	12.7	10.4	13	53.7	35
25	10.1	15	7.7	13.8	55.4	37
26	12.5	14.6	7.8	13	54.3	55
27	17.8	21.4	13.2	18.2	22.5	31
28	12.9	18	10.4	15.9	38.5	20
29	8	11.3	9.6	11.2	62.7	28
30	12.3	16.6	8.6	14.6	53.5	26
31	10.7	13.1	9	12.5	50	53
32	6.4	9.4	6.6	9.7	73.3	41
33	15.1	19.8	13	17.1	24.4	21
34	13.4	17.9	10.7	15.9	40	46
35	15.1	18.3	10.9	15.9	36.4	28
36	8.9	11.6	9.7	11.2	51.7	23
37	13.4	17.9	10	15.9	40	23
38	13.9	17.9	12.1	15.9	38	24
39	10.2	14.3	5.3	13	61.5	22
40	10.6	13.9	9.8	13.8	46.5	31
41	8.4	9.9	8.1	10.1	60.8	29
42	10.8	12.7	10.5	12.2	43.3	29
43	8.4	12.7	6.9	12.2	65.8	35
44	15.4	18.7	10.7	15.9	38.2	30
45	13.4	14.6	10.9	14.6	41.5	24
46	12.6	14.8	9.8	13	49.5	25
Mean	11.70435	15.0087	9.341304	13.71087	49.55217	31.26087

*FKGL* Flesch–Kincaid Grade Level, *GFI* Gunning Fox Index, *CLI* Coleman–Liau Index, *SMOG* Simple Measure of Gobbledygook, *FRE* Flesch Reading Ease

**Table 4** Readability scores for community hernia centers

Community hernia centers						
Institution identifier	FKGL	GFI	CLI	SMOG	FRE	Words analyzed
1	14.6	18.2	10.5	15.9	38.4	27
2	7.7	9.1	8.2	11.2	69.8	50
3	11.5	15.9	10.1	13.8	36.1	79
4	10.8	14.4	8.4	13	58.4	46
5	11.3	16.1	7.8	14.6	54.3	45
6	7.2	10.2	7	10.1	71.6	32
7	11	14.6	7.7	13	59.1	24
8	8	11.4	7.9	11.2	67	33
9	17.3	21.3	10.9	17.1	36.7	37
10	12.9	14	13.3	13	38.5	20
11	10.5	13.9	8.6	13	54	19
12	11.1	14	8.9	13.8	50.4	39
13	12.6	14	13	13.8	40.6	40
14	13.6	15	12	15.9	43.8	26
15	9.7	14.9	10.2	13.6	52.5	45
16	10.1	12.7	9.4	13	47.6	28
17	10.7	14.3	7.2	13	57.6	22
18	8	9.7	4.3	8.8	71.8	19
19	12.9	12.9	10.2	11.2	45	24
20	8.5	12.8	6	12.2	66.9	37
21	9.6	12.4	6.6	11.2	65.3	22
22	10.4	17.5	9.5	14.6	44	13
23	13	14.8	11.7	13	46	25
24	13.6	16.5	10.8	14.6	43.3	51
25	5.8	11.4	6.6	11.2	76	38
26	8.1	11.3	7.4	11.2	61.7	42
27	12.4	9.4	13.9	11.2	38.2	18
28	12.9	17.9	9.5	15.9	43.7	23
29	12.6	14.8	8.7	13	49.5	25
30	12.3	14.1	10	13	44.5	21
31	8.8	9.9	9.6	11.2	56.7	28
32	11.3	15.3	8.4	13.8	54.8	46
33	14.5	18	9.8	15.9	35.9	25
34	11.2	13.9	10.8	13	45.3	17
35	10.5	16	8	14.6	55.4	20
36	14.3	19	14.9	17.1	27.9	40
37	12.6	15.7	8.4	13.8	49.9	51
38	14.1	16.6	10.7	14.6	40.5	26
39	6.8	14.8	2.8	13	67.8	12
40	9.9	14	8.4	13	59.6	40
41	9.6	14	15.6	17.1	44.4	20
42	9.4	8.3	10.9	11.2	50.5	13
43	6.7	11.4	6.3	11.2	70	13
44	11.7	14.1	8.3	13	48.5	21
45	12.6	16.9	8.1	14.6	54.5	28
46	18.3	23	9.8	18.2	35.1	40
47	6.8	9.8	8.2	10.1	67.8	24
48	13.4	17.3	6.3	14.6	52.3	30
49	9.8	13.9	9.2	13	53.1	16
50	14	18	12.4	16	38.7	49
Mean	11.14	14.388	9.264	13.382	51.62	30.58

*FKGL* Flesch–Kincaid Grade Level, *GFI* Gunning Fox Index, *CLI* Coleman–Liau Index, *SMOG* Simple Measure of Gobbledygook, *FRE* Flesch Reading Ease

that of those individual who have adequate health literacy [27]. Those with lower health literacy often seek emergency care, have more frequent hospital admissions with longer length of stays, more often miss medical appointments, have poor compliance, and also greater disease progression [24, 27–30]. Poor communication between physician and patients also increases the risk of malpractice litigation and improved communication lowers patient anxiety, and improves patient compliance and clinical outcomes [27].

In the United States, about one in five (21%) adults reads at or below the fifth-grade level [31]. Furthermore, nearly 50% of the Hispanic and African American population is functionally illiterate, defined as having a zero- to fifth-grade reading level [32, 33], which further adds to the healthcare disparity noted in emergent hernia repairs [34]. Organizations including the American Medical Association (AMA) and the National Institutes of Health (NIH) have recommended that the readability of patient education materials not exceed the sixth-grade level. There have been numerous studies across multiple sub-specialties that have demonstrated a much more complex reading level than the above recommendation, thus this topic warrants further investigation [16, 35–39].

Our investigation revealed that websites related to both academic and community hernia centers and specialists are written well above the recommended reading level as advised by the NIH and AMA. Strikingly, none of the websites met the criteria of having a sixth-grade reading level or lower as recommending by the AMA and NIH. Such a finding demonstrates the importance of educating the medical and surgical community of the importance of readability and healthcare literacy in the design of hernia center websites. As Badarudeen et al. note, raising awareness among health

care workers regarding the importance of readability and healthcare literacy can provide substantial gains in improving patient-centered communication [40].

Considering the increasing complexity of hernia repairs as well as the noted health care disparity in the field of hernia repair [41], the need to improve the physician–patient line of communication is paramount. The ability to ensure readability to a reading level comprehensible to the majority of the population has been demonstrated to improve health outcomes [24, 35, 42].

## Limitations

First, we only evaluated a fraction of the content provided by the website and may have excluded descriptions that may be at an acceptable reading level. Second, we did not account for multimedia (pictures, videos, audio descriptions) content which may impact the readers overall comprehension. People across the country will comprehend and retain information differently, thus adjusting only the reading level may not produce as satisfactory a result as hoped for. A criticism of readability formulas is that they calculate a score based on the length and structure of a sentence and ignore other means of comprehension such as illustrations, layout, and motivation or interest of the reader [29, 43, 44]. Additionally, considering this study was performed using readability testing parameters developed in the United States, the extrapolation to various countries that utilize different grade and reading level designations will require conversion of US grade/reading levels to a specific country's grade/reading level. Table 5 provides a select number of United States grade levels across various countries and continents.

**Table 5** United States grade level equivalents across various countries and continents [45–47]

Age (years)	US Grade level	British	French	Netherlands	Italy	Canada, Australia, India, Korea
5	Kindergarten	Year 1	Grande	Group 2	Asilo	Kindergarten
6	Grade 1	Year 2	CP	Group 3	1a Elem	Grade 1
7	Grade 2	Year 3	CE1	Group 4	2a Elem	Grade 2
8	Grade 3	Year 4	CE2	Group 5	3a Elem	Grade 3
9	Grade 4	Year 5	CM1	Group 6	4a Elem	Grade 4
10	Grade 5	Year 6	CM2	Group 7	5a Elem	Grade 5
11	Grade 6	Year 7	6 ème	Group 8	1a Media	Grade 6
12	Grade 7	Year 8	5 ème	Brugklas	2a Media	Grade 7
13	Grade 8	Year 9	4 ème	2e Jaar	3a Media	Grade 8
14	Grade 9	Year 10	3 ème	3e Jaar	1 Liceo	Grade 9
15	Grade 10	Year 11	2 ème	4e Jaar	2 Liceo	Grade 10
16	Grade 11	Year 12	1 ème	5e Jaar	3 Liceo	Grade 11
17	Grade 12	Year 13	Terminale	6e Jaar	4 Liceo	Grade 12
18	College level				5 Liceo	



## Conclusions

Our study demonstrates both academic and community hernia centers in the United States fail to meet the recommended readability of a sixth-grade level or less. This health care literacy deficiency, supported by five individually validated readability scores, demonstrates the need for both academic and community centers to re-evaluate how they communicate with patients using text on their hernia center websites. Steps aimed at improving health care literacy and the readability of hernia center websites include evaluating text for appropriate reading levels, the addition of adjunct learning materials such as videos and also identifying a patient with a low literacy level with intervention or additional counseling when appropriate, and the addition of adjunct learning materials such as videos.

## Declarations

**Conflict of interest** Dr.'s Seeras, and Acho have no conflicts of Interest. Dr. Pryor receives consulting fees from Ethicon, Medtronic, Stryker, and Gore as well as honoraria from Baranova and Obalon. Dr. Spaniolas receives honorarium from Gore. Dr. Docimo receives consulting fees from Boston Scientific and Medtronic.

**Human and animal rights** No humans or animal rights were violated during this study.

**Informed consent** IRB exemption was indicated considering it is a review article of websites and no patient information was obtained to complete this study.

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