Readability of Spanish-Language Online Patient Educational Materials for Peripheral Artery Disease Do Not Meet Recommended Standards and Represent a Literacy Barrier to Care

Joel L. Ramirez,[1,2] Karissa Wang,[3] Eric Sung,[4] Stephanie Hernandez,[3] Monica Le,[3] Tucker D. Avra,[3] Stephanie Talutis,[3] James C. Iannuzzi,[1] and Jesus G. Ulloa,[3,5] San Francisco and Los Angeles, California, and Boston, Massachusetts

Background: Online resources are a valuable source of information for patients and have been reported to improve engagement and adherence to medical care. However, readability of online patient educational materials (OPEMs) is crucial for them to serve their intended purpose. The American Medical Association (AMA) recommends that OPEM be written at or below the sixth grade reading level. To avoid disparities in access to comprehensible health information on peripheral artery disease (PAD), it is imperative that the readability of PAD OPEM is appropriate for both English-speaking and Spanish-speaking patients. The aim of this study is to evaluate the readability of PAD OPEM in Spanish and compare to English-language OPEM.

Methods: We conducted a Google search in English and Spanish using "peripheral arterial disease" and "enfermedad arterial periferica", respectively, and the top 25 patient-accessible articles were collected for each. Articles were categorized by source type: hospital, professional society, or other. Readability of English-language OPEM was measured using the Flesch Reading Ease Readability Formula, Automated Readability Index, Coleman-Liau Index, Flesch-Kincaid Grade Level, Gunning Fog, Linsear Write Formula, and the Simple Measure of Gobbledygook Index. Readability of Spanish OPEM was measured using the Fernández-Huerta Index and Índice Flesch-Szigriszt Scale. Readability of the articles was compared to

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[1]*Division of Vascular and Endovascular Surgery, Department of Surgery, University of California, San Francisco, San Francisco, CA.*

[2]*Chan Zuckerberg Biohub, San Francisco, CA.*

[3]*David Geffen School of Medicine, University of California, Los Angeles, CA.*

[4]*Division of Vascular and Endovascular Surgery, Department of Surgery, Boston Medical Center, Boston University Chobanian and Avedisian School of Medicine, Boston, MA.*

[5]*West Los Angeles Veterans Health Administration, Los Angeles, CA.*

Correspondence to: Jesus G. Ulloa, MD, MBA, MSHPM, Department of Surgery, 11301 Wilshire Boulevard, Mail Code 10H2, Los Angeles, CA 90073, USA; E-mail: julloa@mednet.ucla.edu

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the AMA recommendation, between English- and Spanish-language, and across sources using statistical tests appropriate to the data.

Results: OPEM from professional societies represented the fewest number of English- ($n = 7$, 28%) and Spanish-language ($n = 6$, 24%) articles. Most English-speaking ($n = 18$, 72%) and Spanish-language ($n = 20$, 80%) OPEM were considered difficult as measured by the Flesch Reading Ease Readability Formula and Fernández-Huerta Index, respectively, but did not significantly differ between languages ($P = 0.59$). There were no significant differences in the average readability of all readability measurements across sources (hospital, professional society, or other). All the average readability grade levels for English-speaking and Spanish-language OPEM was significantly higher than the sixth grade reading level ($P < 0.01$). Only 3 (6%) OPEM met the AMA recommended reading level and there was no significant difference between English-language and Spanish-language OPEM ($P = 1.0$).

Conclusions: Nearly all Spanish-language and English-language PAD OPEM assessed were written at a reading grade level higher than recommended by the AMA. There was no significant difference in the readability of materials from hospitals or professional societies. To prevent further widening of health disparities related to literacy, health content creators, particularly hospitals and professional societies, should prioritize, develop, and ensure that English-language and Spanish-language patient education materials are written at a level appropriate for the public.

INTRODUCTION

Online resources are a valuable source of information for patients and have been reported to improve engagement and adherence to medical care.[1] However, readability of online patient educational materials (OPEMs) is crucial for them to serve their intended purpose. Although there is no consensus on how readability should be measured, it is generally defined as the ease with which a reader can understand a written text.[2] To ensure that a broad audience can utilize patient education materials, the American Medical Association (AMA) recommends that materials be written at or below the sixth grade reading level.[3]

Peripheral artery disease (PAD) is a major health concern and has been reported to affect 1 in 5 men and women in the United States by the age of 80.[4] Patients with PAD experience an impaired quality of life due to claudication, decreased mobility, limb loss, increased risk of cardiovascular events, and higher total mortality.[5,6] Despite campaigns aimed at addressing risk factors associated with the development of PAD, the prevalence of PAD is expected to increase.[7] Several ethnic disparities exist in the diagnosis and management of PAD and Hispanic patients generally have worse outcomes.[8] Previous reports have demonstrated that Hispanic patients are more likely to progress to chronic limb threatening ischemia, have higher reintervention rates after surgery, and have an increased risk of major amputation.[9–11] It is also now known that Spanish is the second most common language spoken in the United States and accounts for 13% of the population.[12]

Despite the widespread prevalence of PAD, it continues to be underdiagnosed due to a lack of awareness by both patients and providers.[13–15] To address this, adequate patient education and access to high quality educational materials are critical. It is therefore imperative that the readability of PAD OPEM is appropriate for both English- and Spanish-speaking patients. The aim of this study is to evaluate the readability of PAD OPEM in Spanish and compare to English-language OPEM. We hypothesized that Spanish-language OPEM would not meet the AMA recommended reading level and would be more difficult to read than English-language OPEM.

METHODS

Data Collection

A Google web search was conducted in English and Spanish using ''peripheral arterial disease'' and ''enfermedad arterial periferica'' as the search terms, respectively. Google was utilized as the only search engine as it comprises 89.1% of the market share for searches.[16] The search was conducted in private browsing mode with account, tracking, and location settings disabled. Next, the top 25 patient-accessible articles were collected for each search, in both English and Spanish. Resources were excluded if they displayed only commercial information, were not currently working, password-protected, discussion groups or forums, sponsored search advertisements, subscription-based, or clinician-focused. Articles meeting inclusion criteria were categorized by source type into hospital, professional society, or

Table I. Measures of readability

Test	Qualities assessed	Formula
English		
FRES	Word complexity, sentence length	206.835 − [1.015 (total words/total sentences)] − [84.6 (total syllables/total words)]
Gunning Fog	Word complexity, sentence length	0.4 [(words/sentences) + 100 (words with 3 or more syllables/words)]
Flesch-Kincaid Grade Level	Word complexity, sentence length	[0.39 (total words/total sentences)] + [11.8 (total syllables/total words)] − 15.59
Coleman-Liau Index	Word length, sentence length	[5.89 (characters/words)] − [29.5 (sentences/words)] − 15.8
SMOG	Word complexity, sentence length	1.0430 ($\sqrt{30}$ × words with 3 or more syllables/sentences) + 3.1291
Automated Readability Index	Word length, sentence length	4.71 (letters/words) + 0.50 (words/sentences) − 21.43
Linsear Write Formula	Word complexity, sentence length	[(1 and 2 syllable words) + 3 (3 syllable words)]/total sentences
Spanish		
Fernandez-Huerta Index	Word complexity, sentence length	206.84 − [0.60 (total words/total sentences)] − [1.02 (total syllables/total words)]
INFLESZ Scale	Word complexity, sentence length	206.835 − 62.3 × (syllables/words − words/sentences)

SMOG, Simple Measure of Gobbledygook; INFLES, Índice Flesch-Szigriszt.

other. ''Hospitals'' were defined as institutions that provide medical and surgical care to patients, primarily as inpatients. ''Professional societies'' were defined as organizations focused on the advancement of a particular profession or interest. ''Other'' included information from websites that did not fit in the previous 2 categories, including clinical practices and health information websites. The following components of articles were removed to avoid misleading the readability analysis software: tables, images, titles, headings, embedded punctuation (decimals, colons, semicolons, parenthesis, abbreviations including periods, and dashes within sentences), bullet points not in sentence form, navigation, copyright notice, disclaimers, date stamps, author information, hyperlinks, and source information.[2]

Assessment of Readability

Readability of English-language OPEM was measured using the Flesch Reading Ease Readability Formula (FRES), Automated Readability Index, Coleman-Liau Index, Flesch-Kincaid Grade Level, Gunning Fog, Linsear Write Formula, and the Simple Measure of Gobbledygook Index. Readability of Spanish OPEM was measured using the Fernández-Huerta Index and Índice Flesch-Szigriszt (INFLESZ) Scale. Factors evaluated and formulas used in calculating each score are outlined in Table I. The FRES, Fernández-Huerta Index, and INFLESZ Scale were scored on a scale from 0 (most difficult) to 100 (easiest) by convention. The remaining scores were calculated as grade level reading difficulty. Scores for each article were recorded.

Statistical Analysis

Summary statistics were reported using mean and standard deviation for continuous variables, along with frequency and percentage for categorical variables. Median readability scores were compared to the AMA recommended reading level using a Student's *t*-test. Fisher's exact tests were used to compare readability between English and Spanish resources by source types and by readability categorized into easy, standard, or difficult by the FRES and Fernández-Huerta Index for English and Spanish, respectively. Mean readability scores for each source type were calculated and compared between English and Spanish resources using an analysis of variance test. A P value < 0.05 was chosen for statistical significance. All statistical analyses were performed using STATA version 17.0 (StataCorp, College Station, Texas).

RESULTS

After implementing inclusion and exclusion criteria, the top 25 English and Spanish language articles

Table II. Distribution of readability scores for English- and Spanish-language sites

Test	Median (Interquartile range)	Comparison to 6th grade or lower reading level[a]
English ($n = 25$)		
FRES[b]	54.3 (49.1–64.6)	$P < 0.01$
Gunning Fog (grade level)	12.8 (11.7–14.0)	$P < 0.01$
Flesch-Kincaid Grade Level (grade level)	9.8 (8.7–11.3)	$P < 0.01$
Coleman-Liau Index (grade level)	11.0 (10.0–12.0)	$P < 0.01$
SMOG (grade level)	9.6 (8.5–10.6)	$P < 0.01$
Automated Readability Index (grade level)	9.7 (8.8–11.1)	$P < 0.01$
Linsear Write Formula (grade level)	10.7 (8.6–12.2)	$P < 0.01$
Spanish ($n = 25$)		
Fernandez-Huerta Index[b]	56.1 (51.3–58.6)	$P < 0.01$
INFLESZ Scale[b]	51.7 (46.4–53.9)	$P < 0.01$

SMOG, Simple Measure of Gobbledygook.
[a]Calculated using a Student's *t*-test with statistical significance set at $P < 0.05$.
[b]Scored from 0 (most difficult) to 100 (easiest).

Table III. Source and readability difficulty in English- and Spanish-language materials

	English-language ($n = 25$)	Spanish-language ($n = 25$)	*P* value[a]
Source			0.54
Hospital	10 (40%)	7 (28%)	
Professional Society	7 (28%)	6 (24%)	
Other	8 (32%)	12 (48%)	
Readability[b]			0.59
Easy	1 (4%)	2 (8%)	
Standard	6 (24%)	3 (12%)	
Difficult	18 (72%)	20 (80%)	

[a]Calculated using a Fisher's exact test.
[b]English-language materials measured using the FRES and Spanish-language materials measured using the Fernandez-Huerta Index.

identified on web search were included in the study (Supplemental Tables 1 and 2). A sensitivity analysis repeating the web searches utilizing ''PAD'' or ''enfermedad vascular periferica'' yielded similar results with minimal variation in articles.

Median readability scores ranged from the ninth grade to the 12th grade for English-language articles and median readability scores were 56 and 51 for Spanish-language articles as measured by the Fernandez-Huerta Index and INFLESZ Scale, respectively, which both correspond to a readability greater than the eighth grade (Table II). All the median readability grade levels and scores for both English-language and Spanish-language articles were significantly higher than the recommended sixth grade reading level (all $P < 0.01$). OPEM from professional societies represented the fewest number of English-language ($n = 7$, 28%) and Spanish-language ($n = 6$, 24%) articles, although this was not statistically significant ($P = 0.54$) (Table III). Most English-language ($n = 18$, 72%) and Spanish-language ($n = 20$, 80%) OPEM were considered difficult as measured by the FRES and Fernández-Huerta Index, respectively, but did not significantly differ between languages ($P = 0.59$).

There were no significant differences in the average readability of all readability measurements across sources (hospital, professional society, or other) (Table IV). Only 3 total articles (1/25, 4% in English; 2/25, 8% in Spanish) met the AMA recommended reading level. This was not significantly different between languages ($P = 1.0$) (Fig. 1).

DISCUSSION

In this study we evaluate and compare the readability of publicly available OPEM on PAD in both English and Spanish. This analysis revealed both English and Spanish PAD OPEM were written on average at a high-school literacy level. The average reading level of adults in the United States is at the eighth grade level and only 12% of adults have the literacy skills needed to manage their own

Table IV. Readability by source in English-language and Spanish-language materials

Test	Hospital	Professional society	Other	*P* value[a]
English ($n = 25$)				
FRES[b]	50.7 (6.2)	56.5 (3.9)	54.5 (17.0)	0.53
Gunning Fog (grade level)	13.6 (1.7)	12.4 (0.9)	12.7 (3.2)	0.50
Flesch-Kincaid Grade Level (grade level)	10.4 (1.4)	9.5 (0.9)	9.8 (2.9)	0.65
Coleman-Liau Index (grade level)	11.5 (1.1)	10.4 (0.5)	10.9 (2.2)	0.32
SMOG (grade level)	10.0 (1.2)	9.2 (0.8)	9.5 (2.5)	0.63
Automated Readability Index (grade level)	10.5 (1.7)	9.4 (1.0)	9.8 (3.1)	0.57
Linsear Write Formula (grade level)	11.1 (2.4)	10.4 (1.9)	10.6 (3.2)	0.83
Spanish ($n = 25$)				
Fernandez-Huerta[b]	56.9 (4.5)	60.9 (11.8)	53.6 (8.1)	0.24
INFLESZ Scale[b]	52.5 (4.4)	56.5 (12.0)	49.0 (8.2)	0.22

Reported as mean (standard deviation).
SMOG = Simple Measure of Gobbledygook.
[a]Calculated using an analysis of variance (ANOVA) test.
[b]Scored from 0 (most difficult) to 100 (easiest).

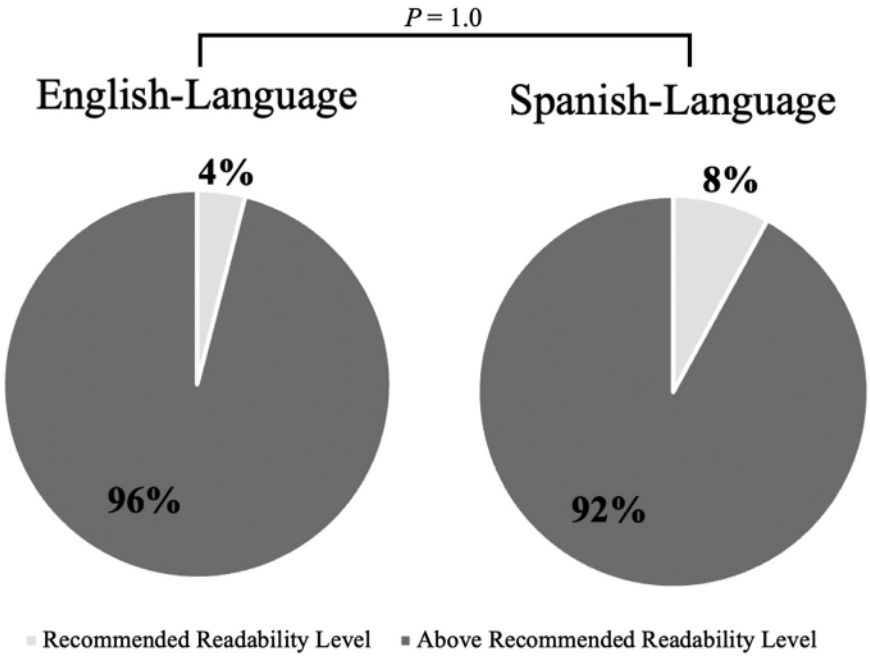

Fig. 1. Few materials met the American Medical Association recommendation of a 6th grade reading level or lower.

disease, leaving certain populations at a disadvantage for understanding the risk factors and consequences of PAD.[17,18]

The rates of PAD have been on the rise in recent decades and are projected to increase at an even faster rate with the expansion of our aging population.[4] The average Medicare beneficiary has a fifth-grade literacy level further highlighting the need for readable PAD OPEM.[19] Studies investigating the readability of various medical education materials in English and Spanish have found similar results as our study and further highlight the lack of accessible medical education for patients.[17,20,21] The mismatch of increasing PAD burden and poor medical education materials may lead to difficulties in managing PAD and compounding the severity of health disparities.

Demographic trends in the United States emphasize the need for readable PAD OPEM that can be easily understood by patients. Lower health literacy

is associated with poorer health-related outcomes including increased inpatient hospitalizations, length of stay, and readmission.[22–24] Health literacy has a profound impact on health outcomes and empowers patients to take control of their own health. The shift away from a paternalistic model of medicine where physicians were the sole adjudicator of medical decision-making allows patients to play a role in their own healthcare. Proper health literacy and education is fundamental in a shared decision-making model and increases awareness of risk reduction and proper management of patients' PAD. Additionally, OPEM serve as the bridge between healthcare visits and at-home health resources where people may learn more about their PAD and treatments options. With the ease and ubiquity of internet access in the United States, comprehensive education of patients through publicly available materials online serves to bridge healthcare with home care.

This study highlights the lack of adequate PAD OPEM not only in English, but in Spanish as well. The Hispanic population is the largest ethnic minority in the United States and is projected to comprise 28.6% of the population by 2060.[25] It is necessary for medical professions to recognize this increase in Spanish-speaking Americans and curate language appropriate education materials for patients to adequately understand their PAD diagnosis. This concept goes further. The demographic make-up of the United States is diverse, with large groups of individuals without English competency. More than 20% of Americans speak a language other than English at home, highlighting the need for language appropriate education materials for all patients.[26] Inadequate health literacy furthers medical disparities and ill-prepares patients to manage their PAD outside of the healthcare setting.

Literacy competency of the intended audience should be taken into consideration when patient education materials are being developing. However, feasibility of understanding must be balanced with accurate and comprehensive medical information that provides accessible counseling for patients with PAD. Professional societies are often the gold-standard for physicians as well as patients seeking to understand a disease as well as evidence-guided treatment algorithms. However, in the current study, OPEM originating from professional societies were not written at an appropriate readability level in English or Spanish. Professional societies play a vital role in educating not only providers, but patients as well and should have patient educational material accessible to their intended audience. One possible solution to facilitating the creation of educational materials with appropriate readability is to leverage artificial intelligence solutions, including large language models, such as ChatGPT. While relatively new in its application in healthcare, research has shown that ChatGPT can answer many patient-generated questions and may be leveraged to convert existing patient education articles into versions with audience-specific readability levels.[27,28]

Limitations

There are limitations to this study. Only the top 25 articles were evaluated, although there is previously reported evidence demonstrating that only 3% of the population ever goes beyond 10 articles, which suggests that these are the highest yield articles.[29] Furthermore, articles and posts coming directly from social media platforms were not evaluated in this analysis. The assessments utilized measure the readability of the articles but do not specifically assess quality of content or integrate cultural variations. Additionally, these assessments do not evaluate tables, images, videos, or diagrams in the articles.

CONCLUSION

Nearly all Spanish-language and English-language PAD OPEM assessed were written at a reading grade level higher than recommended by the AMA. There was no significant difference in the readability of materials from hospitals or professional societies. To prevent further widening of health disparities related to literacy, health content creators, particularly hospitals and professional societies, should prioritize, develop, and ensure that English-language and Spanish-language patient education materials are written at a level appropriate for the public.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.avsg.2023.10.029.

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