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Research Article

Readability Level of English and Spanish Online Patient Education Materials for Knee Injections

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Conflicts of Interest Statement for Divesh Sachdev

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Dr. Navarro is a proud Fellow of the American Academy of Orthopaedic Surgeons (AAOS) and is a member of the AAOS Leadership Institute Mentoring group, and past work on the AAOS Now Editorial Board as well as past Chair of the AAOS Central Instructional Course Committee. He is a well published author in shoulder and knee surgery and is an Active Member of the prestigious American Shoulder and Elbow Surgeons (ASES) and its exclusive Neer Circle. He is also proudly a member of the American Orthopaedic Association and the Twentieth Century Orthopaedic Association, with board certification and maintenance from the American Board of Orthopaedic Surgery (and is an examiner for the ABOS). He was honored to be appointed Member at Large of the Board of Directors of the AAOS from 2017 to 2019. He was the President of the California Orthopaedic Association (COA serves all Orthopaedic Surgeons in California beyond even KP) for the 2019-2020 year as the Covid-19 pandemic unfolded and helped to plan the response to the pandemic as it related to practices across the state. He has been Deputy Editor for Levels of Evidence with the Journal of Bone and Joint Surgery since April 2022 & separately is a Editorial Board Member for the Journal of Orthopaedic Experience & Innovation. He recently became President of the American Association of Latino Orthopaedic Surgeons. He currently resides in Rolling Hills, California with his wife and daughters.

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Introduction

Health literacy is tied to health outcomes and health disparities, with a significant portion of patients utilizing online patient education materials (OPEM) in medical decision-making. However, orthopedic OPEM are often written above the average eighth-grade reading level of adults in the United States, making them inaccessible to the public. Although there are increasingly more studies examining readability of OPEM, there is a gap in literature on readability of OPEM for knee injections. Also, despite the large Spanish-speaking population, few studies have investigated the readability of Spanish OPEM.

Objective

Our study aimed to determine whether the English and Spanish OPEM for corticosteroid, platelet-rich plasma (PRP), and hyaluronic knee injections exceeded the average eighth-grade reading level of adults in the United States. Our secondary aim was to determine if there is a significant difference in readability of OPEM for English versus Spanish and for corticosteroid versus PRP versus hyaluronic acid.

Methods

Two independent reviewers used search terms in Google to identify the top twenty-five English and Spanish OPEM for corticosteroid, PRP, and hyaluronic acid. The name, URL, and classification (i.e. hospital, healthcare organization, professional society) of each web page was recorded. The English pages were analyzed with an online readability calculator, Readable. Well-validated metrics such as Flesch-Kincaid Grade Level (FKGL), Flesch Reading Ease (FRE), Gunning-Fog Index (GFI), Coleman-Liau Index (CLI), and Simple Measure of Gobbledygook (SMOG) were recorded. For Spanish pages, an online calculator, Spanish Readability, was used to determine Fernández-Huerta Index (FHI), FHI grade level, INFLSZ, INFLESZ grade level, Spaulding index, Spaulding grade level, and Crawford grade level. Independent-samples t-test, one-way ANOVA, Fischer's exact test, and bivariate correlation analysis using Pearson's coefficient were used to evaluate the readability metrics.

Results

The overall mean grade level of English OPEM was significantly higher than that of Spanish OPEM for corticosteroid (12.14 ± 2.32 vs 9.49 ± 1.13, $p < 0.001$). Similarly, the overall mean grade level of search results of English OPEM for PRP was significantly higher than that of its Spanish counterpart (12.24 ± 1.46 vs 9.62 ± 1.10, $p < 0.001$). Additionally, the overall mean grade level of English for hyaluronic acid was significantly higher than its Spanish counterpart (12.32 ± 1.91 vs 9.49 ± 1.13, $p < 0.001$). Zero English or Spanish OPEM pertaining to steroid, PRP, or hyaluronic injections of the knee were written below a seventh-grade reading level. When comparing the mean grade levels of the English steroid, PRP, and hyaluronic acid OPEMs to one another, a one-way ANOVA revealed no significant difference ($p = 0.947$); similarly, a one-way ANOVA revealing no significant difference ($p = 0.891$) was found when comparing the Spanish steroid, PRP, and hyaluronic acid OPEMs to one another.

Conclusions

To the best of our knowledge, our study is the first to compare the readability of English versus Spanish OPEM for corticosteroid, PRP, and hyaluronic knee injections. We found that the readability for all injections in both English and Spanish were written significantly higher than the average eighth-grade reading level in the US.

INTRODUCTION

In today's technological age, patients have greater access than ever to online education materials to become more actively involved in their health. 52 million US adults or 55% of those with Internet access use the web to search health-related information within the past year and of those who use the Internet, 70% say the information influences their medical decision-making (Fox 2000). Studies have shown that health literacy has a significant impact on health with lower literacy levels shown to be correlated with increased hospitalization, poor adherence, decreased utilization of resources, worse clinical outcomes, lower health-related quality of life, and poorer treatment satisfaction (Berkman, Sheridan, Donahue, et al. 2011; Hälleberg Nyman, Nilsson, Dahlberg, et al. 2018; Roh, Lee, Park, et al. 2016; Wright,

Edwards, Goggins, et al. 2018). In addition to impact on clinical outcomes and services, patient health literacy and utilization of online education materials can influence the patient-physician relationship. Patients are often exposed to poor quality, inaccurate, and highly complex medical information on the Internet, which can cause spread of misinformation, self-diagnosis, or mistrust towards medical professionals. However, most (71%) of patients who take online information to their physician want the physician's opinion; thereby increasing accessibility of online patient education materials (OPEM) can be an opportunity for physicians to provide education and build trust through meaningful conversations (Murray, Lo, Pollack, et al. 2003).

Although OPEM allows for increased accessibility of healthcare information and have potential to combat health disparities, they often are not written at the target audience's literacy level. Readability is defined as the reading comprehension skills needed to understand a written text. According to the National Adult Literacy Survey, the average reading proficiency in the US is at the eighth-grade level, and over one-fifth of adults in the US are functionally illiterate (W 2003). To reach the target audience, the American Medical Association (AMA) recommends writing OPEM at the fifth or sixth-grade level (W 2003). However, current literary evidence suggests that OPEM in multiple different fields of medicine and from various authors and sources are written above the eighth-grade level (Stossel, Segar, Gliatto, et al. 2012). These findings suggest that although there may be a surplus of OPEM in today's technological era, patients are still limited in access by readability.

Although there are studies examining readability of English OPEM, there are relatively few studies examining the readability of Spanish OPEM, with even fewer comparing readability for English vs Spanish (Patetta, Pond, Tennant, et al. 2021). According to the US Census Bureau, Spanish is the most common non-English language spoken at home (62% in 2019) with 39% of those speaking Spanish at home reporting English proficiency "less than well". Therefore, there is a significant portion of the US population that are turning to Spanish OPEM for healthcare information and decision-making (Dietrich 2022).

Previous literature findings suggest that the readability of orthopedics OPEM are written significantly above the eighth-grade level (Patetta, Pond, Tennant, et al. 2021; Para, Thelmo, Rynecki, et al. 2021; Stelzer, Wellington, Trudeau, et al. 2022; Guzman, Dela Rueda, Williams, et al. 2023; Michel, Dijanic, Abdelmalek, et al. 2023; Ryu and Yi 2016; Mohan, Yi, and Morshed 2017; Karimi, Shah, Hecht, et al. 2023; Hartnett, Philips, Daniels, et al. 2022; Luciani, Foster, Hayes, et al. 2022). Although there are increasingly more studies examining readability of OPEM, there is a gap in literature on readability of OPEM for knee injections. Since biologics like Platelet-Rich Plasma (PRP) are relatively recent treatments for knee osteoarthritis, patients are likely to conduct their own research to draw comparisons with other treatments like corticosteroid and hyaluronic acid injections. Although there are some studies on knee injections and biologic therapies, studies comparing the readability between different types of injections are incomplete and to our knowledge, there are no studies examining the readability of Spanish OPEM for knee injections or comparing English versus Spanish (Carlson, Sparks, Savla, et al. 2023; Sullivan, Abed, Joiner, et al. 2022; Ghodasra, Wang, Jayakar, et al. 2018; Nwachukwu, Rauck, Kahlenberg, et al. 2018).

Our primary aim was to determine whether the English and Spanish OPEM for corticosteroid, PRP, and hyaluronic knee injections exceeded the average eighth-grade reading level of adults in the US. Our secondary aim was to determine if there is a significant difference in readability of OPEM for English versus Spanish and for corticosteroid versus PRP versus hyaluronic acid.

METHODS

Using methodology outlined in previous studies investigating readability of OPEM, we used Google to identify top accessed education materials for knee injections (Heap, Dezfuli, Bennett, et al. 2015). We used Google for our search engine since it comprises roughly 90% of the online search market (Bianchi 2024). The following search terms were used: "knee steroid injection", "inyección de esteroides en la rodilla", "knee PRP injection", "inyección de PRP en la rodilla", "knee hyaluronic acid injection", and "inyección de ácido hialurónico en la rodilla" to identify English and Spanish OPEM for corticosteroid, PRP, and hyaluronic acid knee injections. Google searches were performed on March 11th, 2024 and independently verified by two reviewers (V.X. and J.G.). Most Internet users do not make it past the first 10 links with two-thirds of users ending their investigation after the first 5 clicks (Meyer 2014). Thus, we determined that recording the top twenty-five searches would adequately capture most or if not all the OPEM patients would access. Pages that included patient education material were included, and those that contained video or pictures only, were behind a paywall, published in a peer-reviewed journal, contained reference material for medical professionals, or had insufficient text for analysis were excluded.

The name, URL, and classification (i.e. hospital, healthcare organization, professional society) of each web page was recorded. The English pages were analyzed with an online readability calculator, Readable. Well-validated metrics such as Flesch-Kincaid Grade Level (FKGL), Flesch Reading Ease (FRE), Gunning-Fog Index (GFI), Coleman-Liau Index (CLI), and Simple Measure of Gobbledygook (SMOG) were recorded (Stelzer, Wellington, Trudeau, et al. 2022; Guzman, Dela Rueda, Williams, et al. 2023; Michel, Dijanic, Abdelmalek, et al. 2023; Ryu and Yi 2016; Mohan, Yi, and Morshed 2017; Hartnett, Philips, Daniels, et al. 2022; Luciani, Foster, Hayes, et al. 2022; McLaughlin 1969). For Spanish pages, an online calculator, SpanishReadability, was used to determine Fernández-Huerta Index (FHI), FHI grade level, INFLESZ, INFLESZ grade level, Spaulding index, Spaulding grade level, and Crawford grade level (Patetta, Pond, Tennant, et al. 2021).

STATISTICAL ANALYSIS

All statistical analysis for this investigation was performed using IBM SPSS Statistics for Macintosh, Version 28.0.1.1 (Corp, n.d.). To compare the mean overall reading levels of English OPEM to Spanish OPEM, an independent-samples t-test was performed. To compare the mean overall reading levels of English steroid, PRP, and hyaluronic acid OPEM to one another, a one-way ANOVA was performed. A one-way ANOVA was also performed to compare the mean overall reading levels of Spanish steroid, PRP, and hyaluronic acid OPEM to one another. Fisher's exact test was used to compare the number of English versus Spanish OPEM written below a sixth-grade level; this analysis was also conduction to compare the number of OPEM written below a ninth-grade level. Bivariate correlation analysis using Pearson's coefficient was used to evaluate whether the readability metrics for the same language were significantly correlated to one another.

RESULTS

Descriptive statistical analysis was completed for each English and Spanish query (TABLE A, TABLE B, and TABLE C). The OPEM yielded by the English search phrase "knee steroid injection" and its Spanish counterpart "inyección de esteroides en la rodilla'' were written at an overall mean grade level of 12.14 ± 2.32 and 9.49 ± 1.13, respectively, which demonstrates a statistically significant difference ($p < 0.001$) (TABLE D). Bivariate correlation analysis revealed that all English readability metrics for "knee steroid injection" were significantly correlated to one another, and that all Spanish readability metrics for "inyección de esteroides en la rodilla" were also significantly correlated to each other (TABLE F). Zero English or Spanish OPEM pertaining to steroid injections of the knee were written below a seventh-grade reading level. However, ten Spanish OPEM (40%) were written below a ninth-grade reading level, which was seen to be significantly higher than the zero English OPEM written below a ninth grade reading level ($p < 0.001$) (TABLE E).

The overall mean grade level of search results yielded from "knee PRP injection" was significantly higher than that of its Spanish counterpart "inyección de PRP en la rodilla" (12.24 ± 1.46 vs 9.62 ± 1.10, $p < 0.001$) (TABLE D). Bivariate correlation analysis found that all English metrics were significantly correlated to one another; the same was true for Spanish readability metrics (TABLE G). Zero English or Spanish OPEM pertaining to PRP injections of the knee were written below a seventh-grade level. Zero English PRP OPEM and five Spanish PRP OPEM (20%) were written below a ninth-grade reading level, but this difference was not statistically significant ($p = 0.050$) (TABLE E).

When comparing the overall mean grade level of OPEM yielded from "knee hyaluronic acid injection" and "inyección de ácido hialurónico en la rodilla" it was found that the English OPEM were written at a significantly higher grade level than Spanish OPEM (12.32 ± 1.91 vs 9.49 ± 1.13, $p < 0.001$) (TABLE D). All English hyaluronic acid OPEM were significantly correlated to one another and all Spanish hyaluronic acid OPEM were significantly correlated to one another when examined using bivariate correlation analysis (TABLE H). Zero English or Spanish hyaluronic acid OPEM were written below a seventh-grade reading level. Furthermore, zero English OPEM were written below a ninth-grade level, which was significantly lower than the nine Spanish OPEM (36%) written below a ninth-grade reading level ($p = 0.002$) (TABLE E). When comparing the mean grade levels of the English steroid, PRP, and hyaluronic acid OPEM to one another, a one-way ANOVA revealed no significant difference ($p = 0.947$); similarly, a one-way ANOVA revealing no significant difference ($p = 0.891$) was found when comparing the Spanish steroid, PRP, and hyaluronic acid OPEM to one another (TABLE I).

DISCUSSION

We analyzed top Google search results for English and Spanish OPEM patients are most likely to encounter for various knee injections. We found that readability level was poor across the board with both English and Spanish OPEM for corticosteroid, PRP, and hyaluronic acid scored above the eighth-grade reading level. We also found that English OPEM were written at a higher grade level than Spanish OPEM (12 vs 9). This is likely because English OPEM were written by more academic institutions, whereas Spanish OPEM were written by more non-academic institutions such as private practice hospitals (TABLE J). Our findings were consistent with previous studies that showed readability for OPEM is consistently written above the average eighth-grade reading level (Patetta, Pond, Tennant, et al. 2021; Para, Thelmo, Rynecki, et al. 2021; Stelzer, Wellington, Trudeau, et al. 2022; Guzman, Dela Rueda, Williams, et al. 2023; Michel, Dijanic, Abdelmalek, et al. 2023; Ryu and Yi 2016; Mohan, Yi, and Morshed 2017; Karimi, Shah, Hecht, et al. 2023; Hartnett, Philips, Daniels, et al. 2022; Luciani, Foster, Hayes, et al. 2022). Additionally, readability has not significantly changed in the last two decades, so despite increasing awareness and data on the topic, there is little action and change (Luciani, Foster, Hayes, et al. 2022). Our findings suggest that especially as new technology and advancements in medicine present patients with more options for treatment, it is more important than ever that patients have access to accurate and comprehensible educational resources. Our findings suggests that there is an abundance of inaccessible OPEM, so there needs to be increased awareness of the issue of readability of OPEM and more resources and training to help medical professionals write OPEM that will reach their target audience.

Our readability findings for PRP, corticosteroid, and hyaluronic acid were also comparable to the readability numbers in previous studies (Carlson, Sparks, Savla, et al. 2023; Sullivan, Abed, Joiner, et al. 2022; Ghodasra, Wang, Jayakar, et al. 2018; Nwachukwu, Rauck, Kahlenberg, et al. 2018). Additionally, when comparing between different types of injections (corticosteroid vs PRP vs hyaluronic acid), we found that there were no differences in readability among English and Spanish OPEM. This finding suggests

Table A. Readability of English and Spanish OPEM for Steroids

English Steroid OPEM	Mean	SD	Median	Q1	Q3
FRE	47.89	12.44	51.90	45.60	55.40
FKGL	10.27	2.60	9.60	8.60	11.00
GFI	13.03	2.81	12.70	11.10	14.60
CLI	12.38	2.02	12.00	11.00	12.90
SMOG	12.86	2.07	12.60	11.40	13.90
Overall	12.14	2.32	11.88	10.58	12.90
Spanish Steroid OPEM	Mean	SD	Median	Q1	Q3
FHI	49.24	11.21	51.00	43.00	58.00
FHI Grade Level	10.26	1.52	9.50	9.50	11.50
INFLESZ	44.50	11.36	46.54	37.96	53.06
INFLESZ Grade Level	9.82	1.22	9.50	9.50	11.50
Spaulding Index	86.04	14.16	82.00	77.00	91.00
Spaulding Grade Level	9.30	1.44	9.50	8.00	9.50
Crawford Grade Level	8.56	0.75	8.00	8.00	9.00
Overall	9.49	1.13	9.13	8.75	10.38

Table B. Readability of English and Spanish OPEM for PRP

English PRP OPEM	Mean	SD	Median	Q1	Q3
FRE	47.92	10.04	49.90	46.80	52.10
FKGL	10.32	1.82	9.90	9.70	10.80
GFI	12.94	1.91	13.00	12.30	13.90
CLI	12.56	1.66	12.30	11.80	12.90
SMOG	13.11	1.43	13.20	12.50	13.50
Overall	12.24	1.46	12.08	11.83	12.65
Spanish PRP OPEM	Mean	SD	Median	Q1	Q3
FHI	49.56	8.44	49.00	43.00	56.00
FHI Grade Level	10.22	1.48	11.50	9.50	11.50
INFLESZ	45.13	8.37	44.41	39.05	51.26
INFLESZ Grade Level	9.72	1.34	9.50	9.50	11.50
Spaulding Index	91.88	22.01	95.00	84.00	105.00
Spaulding Grade Level	9.98	1.41	9.50	9.50	11.50
Crawford Grade Level	8.56	0.50	9.00	8.00	9.00
Overall	9.62	1.10	9.88	9.13	10.88

that there are no differences in access to online materials for newer modalities of knee injections like PRP. Since readability is poor for all types of injections, any interventions should be targeted broadly to encompass all domains of health.

Since health literacy has a significant impact on clinical outcomes and overall health, it is more important than ever that we prioritize this issue (Berkman, Sheridan, Donahue, et al. 2011; Hälleberg Nyman, Nilsson, Dahlberg, et al. 2018; Roh, Lee, Park, et al. 2016; Wright, Edwards, Goggins, et al. 2018). Additionally, studies have shown that health literacy contributes to health disparities in health outcomes, race/ethnicity, and social disadvantages (Bennett, Chen, Soroui, et al. 2009; Schillinger 2021). Since marginalized communities have inequitable access to healthcare resources and information, it is important to understand literacy as a driver among social determinants of health. In addition to increasing the health literacy of the public, increasing the accessibility of OPEM could help mitigate health disparities and inequities.

Although our study provided new insights into the readability of OPEM, our study did have some limitations. While reading scores are helpful, they do not account for jargon, so even if a text is written at the appropriate reading com-

Table C. Readability of English and Spanish OPEM for Hyaluronic Acid

English HA OPEM	Mean	SD	Median	Q1	Q3
FRE	43.17	10.16	43.30	38.30	50.80
FKGL	10.86	2.20	10.60	9.10	11.90
GFI	12.66	2.42	12.20	11.50	13.60
CLI	12.85	1.59	13.00	11.40	13.50
SMOG	12.90	1.68	12.60	11.90	13.50
Overall	12.32	1.91	12.03	11.08	13.18
Spanish HA OPEM	Mean	SD	Median	Q1	Q3
FHI	46.64	7.56	47.00	43.00	52.00
FHI Grade Level	10.70	1.13	11.50	9.50	11.50
INFLESZ	41.95	7.60	42.41	38.27	47.53
INFLESZ Grade Level	10.06	1.06	9.50	9.50	11.50
Spaulding Index	90.48	11.05	91.00	81.00	96.00
Spaulding Grade Level	9.58	1.00	9.50	9.50	9.50
Crawford Grade Level	8.80	0.69	9.00	8.00	9.00
Overall	9.49	1.13	9.13	8.75	10.38

Table D. Overall Mean Reading Grade Level for English vs Spanish OPEM

Overall Mean Grade Level	English OPEM	Spanish OPEM	p-value
Steroid	12.14 ± 2.32	9.49 ± 1.13	**p < 0.001**
PRP	12.24 ± 1.46	9.62 ± 1.10	**p < 0.001**
Hyaluronic Acid	12.32 ± 1.91	9.49 ± 1.13	**p < 0.001**

Table E. Reading Level Below vs Above 9th Grade Level

Steroid	Below 9th Grade Level	9th Grade Level and Above	**p < 0.001**
English	0 (0%)	25 (100%)	
Spanish	10 (40%)	15 (60%)	
PRP	Below 9th Grade Level	9th Grade Level and Above	p = 0.050
English	0 (0%)	25 (100%)	
Spanish	5 (20%)	20 (80%)	
Hyaluronic Acid	Below 9th Grade Level	9th Grade Level and Above	**p = 0.002**
English	0 (0%)	25 (100%)	
Spanish	9 (36%)	16 (64%)	

prehension level, the use of medical jargon could still present a considerable barrier to access of OPEM. Thus, interventions should aim to address both reading comprehension level of the text as well as limited use of medical jargon. Additionally, the Flesch-Kincaid score is based on the physical characteristics of the text, so longer word length and sentence length will impact the score (W 2003). Readability calculators also cannot analyze images or videos, so our analysis cannot be extrapolated beyond written text. Also, the quality of online patient materials is often poor, especially for newer treatments like knee biologic treatments (Nwachukwu, Rauck, Kahlenberg, et al. 2018). This means patients are faced with a combination of the dangers of poor-quality, incorrect, and misleading information when searching for general information but also encounter inaccessible material written too complexly when trying to access reputable sources. Although we acknowledge that there is variability in quality and accuracy of OPEM, improving the readability of all education materials can make it easier for patients to identify misinformation or bring OPEM to their physician for further discussion. Although our study provided new findings on

Table F. English vs Spanish Readability Metrics for Steroid

Steroid - English Metrics		FRE	FKGL	GFI	CLI	SMOG		
Flesch Reading Ease Index	Pearson Correlation	1	-0.945	-0.92	-0.975	-0.913		
	p - value		<.001	<.001	<.001	<.001		
Flesch-Kincaid Grade Level	Pearson Correlation	-0.945	1	0.978	0.904	0.987		
	p - value	<.001		<.001	<.001	<.001		
Gunning-Fox Grade Level	Pearson Correlation	-0.92	0.978	1	0.879	0.98		
	p - value	<.001	<.001		<.001	<.001		
Coleman-Liau Grade Level	Pearson Correlation	-0.975	0.904	0.879	1	0.869		
	p - value	<.001	<.001	<.001		<.001		
SMOG Grade Level	Pearson Correlation	-0.913	0.987	0.98	0.869	1		
	p - value	<.001	<.001	<.001	<.001			
Steroid - Spanish Metrics		FHI	FHI GL	INFLESZ	INFLESZGL	Spaulding	SpauldingGL	Crawford
Fernandez-Huerta Index	Pearson Correlation	1	-0.905	1	-0.886	-0.92	-0.879	-0.921
	p - value		<.001	<.001	<.001	<.001	<.001	<.001
Fernandez-Huerta Index Grade Level	Pearson Correlation	-0.905	1	-0.906	0.856	0.767	0.706	0.884
	p - value	<.001		<.001	<.001	<.001	<.001	<.001
INFLESZ	Pearson Correlation	1	-0.906	1	-0.884	-0.917	-0.874	-0.921
	p - value	<.001	<.001		<.001	<.001	<.001	<.001
INFLESZ Grade Level	Pearson Correlation	-0.886	0.856	-0.884	1	0.816	0.761	0.761
	p - value	<.001	<.001	<.001		<.001	<.001	<.001
Spaulding Index	Pearson Correlation	-0.92	0.767	-0.917	0.816	1	0.951	0.805
	p - value	<.001	<.001	<.001	<.001		<.001	<.001
Spaulding Index Grade Level	Pearson Correlation	-0.879	0.706	-0.874	0.761	0.951	1	0.748
	p - value	<.001	<.001	<.001	<.001	<.001		<.001
Crawford Grade Level	Pearson Correlation	-0.921	0.884	-0.921	0.761	0.805	0.748	1
	p - value	<.001	<.001	<.001	<.001	<.001	<.001	

Table G. English vs Spanish Readability Metrics for PRP

PRP- English Metrics		FRE	FKGL	GFI	CLI	SMOG		
Flesch Reading Ease Index	Pearson Correlation	1	-0.855	-0.419	-0.95	-0.536		
	p - value		<.001	0.037	<.001	0.006		
Flesch-Kincaid Grade Level	Pearson Correlation	-0.855	1	0.787	0.711	0.871		
	p - value	<.001		<.001	<.001	<.001		
Gunning-Fox Grade Level	Pearson Correlation	-0.419	0.787	1	0.203	0.971		
	p - value	0.037	<.001		0.329	<.001		
Coleman-Liau Grade Level	Pearson Correlation	-0.95	0.711	0.203	1	0.345		
	p - value	<.001	<.001	0.329		0.091		
SMOG Grade Level	Pearson Correlation	-0.536	0.871	0.971	0.345	1		
	p - value	0.006	<.001	<.001	0.091			
PRP - Spanish Metrics		FHI	FHI GL	INFLESZ	INFLESZGL	Spaulding	SpauldingGL	Crawford
Fernandez-Huerta Index	Pearson Correlation	1	-0.901	0.999	-0.883	-0.784	-0.864	-0.848
	p - value		<.001	<.001	<.001	<.001	<.001	<.001
Fernandez-Huerta Index Grade Level	Pearson Correlation	-0.901	1	-0.903	0.824	0.774	0.81	0.865
	p - value	<.001		<.001	<.001	<.001	<.001	<.001
INFLESZ	Pearson Correlation	0.999	-0.903	1	-0.884	-0.787	-0.868	-0.85
	p - value	<.001	<.001		<.001	<.001	<.001	<.001
INFLESZ Grade Level	Pearson Correlation	-0.883	0.824	-0.884	1	0.789	0.869	0.656
	p - value	<.001	<.001	<.001		<.001	<.001	<.001
Spaulding Index	Pearson Correlation	-0.784	0.774	-0.787	0.789	1	0.786	0.636
	p - value	<.001	<.001	<.001	<.001		<.001	<.001
Spaulding Index Grade Level	Pearson Correlation	-0.864	0.81	-0.868	0.869	0.786	1	0.73
	p - value	<.001	<.001	<.001	<.001	<.001		<.001
Crawford Grade Level	Pearson Correlation	-0.848	0.865	-0.85	0.656	0.636	0.73	1
	p - value	<.001	<.001	<.001	<.001	<.001	<.001	

Table H. English vs Spanish Readability Metrics for Hyaluronic Acid

HA - English Metrics		FRE	FKGL	GFI	CLI	SMOG		
Flesch Reading Ease Index	Pearson Correlation	1	-0.924	-0.794	-0.905	-0.872		
	p - value		<.001	<.001	<.001	<.001		
Flesch-Kincaid Grade Level	Pearson Correlation	-0.924	1	0.954	0.875	0.987		
	p - value	<.001		<.001	<.001	<.001		
Gunning-Fox Grade Level	Pearson Correlation	-0.794	0.954	1	0.814	0.981		
	p - value	<.001	<.001		<.001	<.001		
Coleman-Liau Grade Level	Pearson Correlation	-0.905	0.875	0.814	1	0.851		
	p - value	<.001	<.001	<.001		<.001		
SMOG Grade Level	Pearson Correlation	-0.872	0.987	0.981	0.851	1		
	p - value	<.001	<.001	<.001	<.001			
HA - Spanish Metrics		FHI	FHI GL	INFLESZ	INFLESZGL	Spaulding	SpauldingGL	Crawford
Fernandez-Huerta Index	Pearson Correlation	1	-0.801	0.999	-0.863	-0.745	-0.686	-0.908
	p - value		<.001	<.001	<.001	<.001	<.001	<.001
Fernandez-Huerta Index Grade Level	Pearson Correlation	-0.801	1	-0.801	0.64	0.632	0.589	0.816
	p - value	<.001		<.001	<.001	<.001	0.002	<.001
INFLESZ	Pearson Correlation	0.999	-0.801	1	-0.865	-0.734	-0.677	-0.913
	p - value	<.001	<.001		<.001	<.001	<.001	<.001
INFLESZ Grade Level	Pearson Correlation	-0.863	0.64	-0.865	1	0.762	0.676	0.696
	p - value	<.001	<.001	<.001		<.001	<.001	<.001
Spaulding Index	Pearson Correlation	-0.745	0.632	-0.734	0.762	1	0.883	0.551
	p - value	<.001	<.001	<.001	<.001		<.001	0.004
Spaulding Index Grade Level	Pearson Correlation	-0.686	0.589	-0.677	0.676	0.883	1	0.487
	p - value	<.001	0.002	<.001	<.001	<.001		0.014
Crawford Grade Level	Pearson Correlation	-0.908	0.816	-0.913	0.696	0.551	0.487	1
	p - value	<.001	<.001	<.001	<.001	0.004	0.014	

Table I. Steroid vs PRP vs HA Readability Level

	Steroid (Mean Grade Level)	PRP (Mean Grade Level)	HA (Mean Grade Level)	ANOVA p - value
English	12.14 ± 2.32	12.24 ± 1.46	12.32 ± 1.91	0.947
Spanish	9.49 ± 1.13	9.62 ± 1.10	9.49 ± 1.13	0.891

Table J. Breakdown of Type of OPEM

	Steroid (English)	Steroid (Spanish)	PRP (English)	PRP (Spanish)	HA (English)	HA (Spanish)
Academic Institution	10	6	8	2	4	3
Non-academic Institution	4	11	11	18	10	20
Professional Association	4	2	1	2	3	1
Other Information Network	7	6	5	3	8	1

differences between English vs Spanish OPEM readability, our analysis is limited by potential confounding factors. Our findings could be influenced by socioeconomic disparities affecting reading levels in predominantly Spanish-speaking populations, which could impact the baseline reading comprehension level of primary English-speaking vs primary Spanish-speaking populations, causing a skew in findings. The FHI and INFLESZ scales were also developed using text originating from Spain, so the readability calculator does not account for cultural and dialect variations in languages from different Spanish-speaking countries and within Spain (Barrio-Cantalejo, Simón-Lorda, Melguizo, et al. 2008; J. 1959).

Given that the readability of OPEM have not changed significantly in the past two decades, we may need to turn to more novel solution. The rising use of artificial intelligence (AI) and ChatGPT in medicine could be the key to the problem we face. Studies have shown that ChatGPT is able to convert medical text to below the AMA recommended sixth-grade level through a simple copy and paste (Rouhi, Ghanem, Yolchieva, et al. 2024). More studies need to be done to determine the accuracy and reliability of using ChatGPT to rewrite OPEM, but there is growing evidence for this resource as a possible solution (Golan, Ripps, Reddy, et al. 2023).

CONCLUSION

To the best of our knowledge, our study is the first to compare the readability of English versus Spanish OPEM for corticosteroid, PRP, and hyaluronic knee injections. We found that the readability for all injections in both English and Spanish were written significantly higher than AMA's recommended sixth-grade reading level and the average eighth-grade reading level in the US. Health literacy has been tied to health outcomes and health disparities, so increasing the readability of patient education materials may improve patient outcomes. Although more research is needed on the effectiveness of OPEM, the need to improve readability is more important than ever to combat health inequities.

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