Observational Study

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Evaluating the readability, quality and reliability of online patient education materials on transcutaneuous electrical nerve stimulation (TENS)

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Abstract

Increasing digitization also raises concerns regarding the reliability and comprehensibility of online health information. In this study, we aimed to examine the readability, reliability, and quality of internet-based patient education materials on "transcutaneous electrical nerve stimulation." On September 15, 2022, we used Google search engine to search the keyword "Transcutaneous Electrical Nerve Stimulation" and obtained information from 200 websites. The readability of the websites was evaluated using the Flesch Reading Ease Score (FRES), Flesch–Kincaid Grade Level, Simple Measure of Gobbledygook, and Gunning Fog. The Journal of American Medical Association score and Health on the Net Foundation code of conduct were used to determine the reliability of the websites, whereas the DISCERN score and Global Quality Score were used to evaluate the quality of the websites. In the readability analysis of 102 websites that met the inclusion criteria of this study, we found that the Flesch Reading Ease Score was 47.91 ± 13.79 (difficult), average Flesch–Kincaid Grade Level and Simple Measure of Gobbledygook were 11.20 ± 2.85 and 10.53 ± 2.11 years, respectively, and average Gunning Fog score was 14.04 ± 2.74 (very difficult). Commercial websites constituted the highest proportion of websites (n = 36, 35.5%). Overall, 16.7% of the websites were found to be of high quality according to the Global Quality Score, 16 (15.7%) websites had Health on the Net Foundation code of conduct certification, and 8.8% of the websites were found to be highly reliable according to the Journal of American Medical Association scores. There was a statistically significant difference between website typologies and quality and reliability scores ($P < .001$). Compared with the sixth-grade level recommended by the American Medical Association and the National Institute of Health, the readability of transcutaneous electrical nerve stimulation-related internet-based patient education materials was considerably high, but they showed low reliability and moderate-to-poor quality. Thus, the quality, reliability, and readability of websites developed by health professionals play a major role in conveying accurate and easily understandable information.

Abbreviations: ARI = Automated Readability Index, CL = Coleman–Liau score, FKGL = Flesch–Kincaid Grade Level, FRES = Flesch Reading Ease Score, GFOG = Gunning Fog, GQS = Global Quality Score, HON = Health on the Net Foundation, JAMA = The Journal of American Medical Association, LW = Linsear Write, PEMs = patient education materials, SMOG = Simple Measure of Gobbledygook, TENS = transcutaneous electrical nerve stimulation.

Keywords: health information, internet, pain, readability, transcutaneous electrical nerve stimulation

1. Introduction

Pain, an important health concern, restricts the activities of daily life and causes loss of work productivity. Pain symptoms are observed in 50% of hospitalized patients and >70% of accident cases who are presented to the emergency department.[1] The prevalence of chronic pain among adults is estimated to be 45% worldwide, and it causes severe disability in 15% of this patient population.[2] In addition, pain leads to financial problems both in terms of treatment and time lost from work.[3] According to a previous study, healthcare and work productivity losses in the United States are estimated to cost an average of 600 billion US dollars annually.[3]

Treatments in pain management are not effective to the desired extent in patients' clinics. In a previous study, 40% of patients with chronic pain believed that the treatments were inadequate and >60% of patients believed that the administered medications were ineffective.[4] Medication or

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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interventional therapies for pain management are tailored to individual needs. In addition to improving the quality of life, these treatments help patients return to normal work productivity. Early diagnosis followed by early treatment also prevents the development of chronic pain. Transcutaneous Electrical Nerve Stimulation (TENS) is a neuromodulation method that is used worldwide for treating acute and chronic pain.[5]

TENS activates nerve fibers by delivering electrical impulses to the skin surface, increases endogenous opioid release, and modifies electrical stimulation to reduce pain.[6] TENS is recommended by healthcare providers for treating inflammatory, neuropathic, and musculoskeletal pain, either alone or in combination with other treatment modalities.[7] TENS is a popular treatment method preferred by patients and healthcare providers as it is inexpensive, available without a prescription, easy and reliable, and has less side effects and complications.[8] Contraindications may include patients with cardiac pacemakers or implanted cardiac defibrillators. Caution should be exercised in patients with active tumors, epilepsy, and deep vein thrombosis as well as pregnant patients.[4] Among several applications of TENS, the most commonly used applications are conventional TENS, which generates strong and painless stimuli, and acupuncture-like TENS, which generates strong and painless pulsed stimuli.[4]

In the digital age, patients search for information about their diseases and treatment options using internet-based patient education materials (PEMs).[9] Although there is a considerable amount of information available on the internet, patients' utilization of this information relies on their health literacy.[10] Health literacy refers to the ability of individuals to perform basic reading and numerical tasks in a healthcare setting.[9] In the US, approximately one-third of adults and two-third of those aged ≥ 65 years only have basic health literacy.[9] To ensure that the information available on the internet is easy to understand for the readers, it must be prepared in a simple language. The US Department of Health and Human Services and the National Institutes of Health have recommended that internet-based PEMs should be written in a language below the sixth-grade level.[11] It can be said that the websites prepared above this value will not be to the benefit of the reader and that the site developers should make an assessment about this issue beforehand. In addition to readability, the reliability and quality of information in the digital environment have been extensively studied in the literature.[12,13]

Patients may receive information about device features and usage method related to TENS on the internet. TENS is frequently recommended by health professionals for treating acute and chronic pain and is available without a prescription. In this study, we aimed to evaluate the readability, quality, and reliability of TENS-related internet-based PEMs. Further, we attempt to identify website typologies that provide highly reliable information about TENS.

2. Methods

For this observational and cross-sectional study, 2 independent authors (V.H. and E.O.) searched the term "Transcutaneous Electrical Nerve Stimulation" on Google (https://www.google.com), the most popular search engine, on September 15, 2022. A neutral term (Transcutaneous Electrical Nerve Stimulation) was used to obtain a larger sample of websites. In cases of possible discrepancies between the authors during the evaluation of the websites, a third independent author (Y.E.) made the final decision. According to the July 2022 data, Google was used in this study because it is the leading search engine with a market share of 83.84%.[14]

2.1. Websites selection criteria

The web browsing history and cookies were deleted during the search so that the results of the research would not be affected. In addition, the study was continued by signing out from all Google accounts and using Google Incognito mode. After the search, the uniform resource locators (URLs) of the first 200 websites were recorded, as per the methodologies described in similar studies.[15,16] The 10 websites listed on the first page of the Google search engine were considered as the most viewed websites.[17] Websites unrelated to TENS, those marked as "Ad," those requesting subscriptions or registrations, those with non-English language content, duplicate websites, and websites without text content but with video or audio content were not included in this study. As PEMs were examined in this study, journal articles were not included. In addition, videos, images, figures and tables in the text, website URLs, punctuation marks, references, telephone, addresses, and author information were not included in the evaluation to avoid false results.[18,19] Of the first 200 websites obtained using the search term, 24 duplicate websites were removed, resulting in 176 websites. Further, after rigorous evaluation according to the exclusion criteria, 74 websites were removed and 102 websites were finally included in this study (Fig. 1).

During the evaluation of websites, there may be cases where no evaluation criteria can be found on the home page. According to the 3-click rule used in such cases, the website user can access any information up to 3 mouse clicks. Although there is no official rule, it is believed that if the information cannot be accessed in 3 clicks, the user has not achieved the purpose and will leave the site.[19]

2.2. Ethical considerations

The University of Dokuz Eylul Noninterventional Research Ethics Committee approval was obtained before the study (7443-GOA 2022/29-20).

2.3. Website typology

Websites were classified into six categories according to the ownership and type.[20] In addition, URL extensions (.com, .org, .edu, .gov, and .net) were also assessed during the evaluation. Based on these extensions, it was determined whether they originated from a professional, commercial, or government organization.[21] Typologies include commercial (websites created for making profit, selling products, with URL extensions of.com and.net), government (websites created and managed by an official government agency, with URL extension of .gov), health portals (websites providing useful health-related information, with URL extensions of .com and .net), news (websites created by newspapers and magazines, with URL extensions of .com and .net), nonprofit organizations (charitable/supportive/educational websites created by nonprofit organizations, with URL extensions of .org), and professional (websites created by individuals or organizations with professional medical qualifications, with URL extensions of .edu and .com) websites.[22]

2.4. Reliability of websites

The Journal of American Medical Association (JAMA) Benchmark criteria examines online information and resources based on 4 criteria: authorship, references/sources, indication of date, and ownership. Each criterion is scored between 0 and 1 point. The final score is determined between 0 and 4. A score of 4 indicates the highest reliability of websites.[15] Websites with a JAMA score of ≤2 are considered to have low reliability, whereas those with a JAMA score of ≥3 are considered to have high reliability.[23] (Table 1).

The Health on the Net Foundation (HON) was established to promote the online distribution and efficient use of reliable and useful health information. This organization aims to standardize the reliability of information on the internet. To meet

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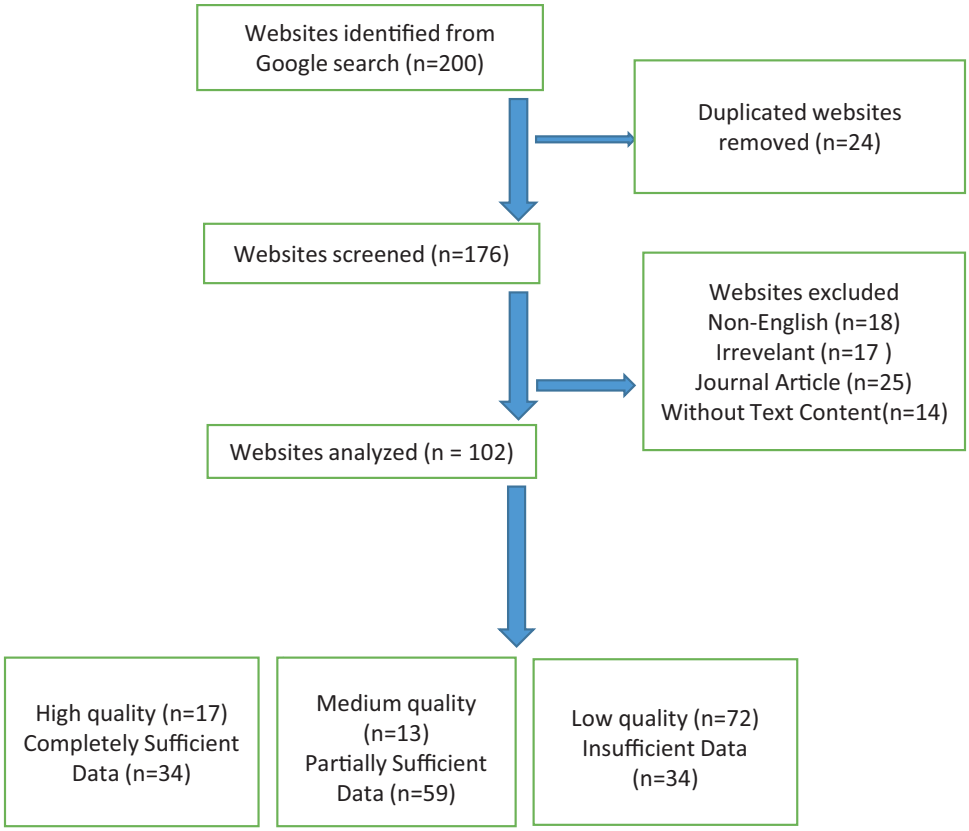


Figure 1. Flowchart revealing the selection of websites.

the HONcode criteria, author credentials should be stated, privacy policy should be disclosed, website financing and advertising policy should be stated, patient–physician relationship should be complemented, and contact information should be disclosed.[24] (Table 1). In this study, we examined whether the website homepage or associated URL had a HONcode stamp.

2.5. Quality of websites

In total, 16 DISCERN criteria with 16 questions were used to assess the website quality. Questions are scored between 1 and 5 points. Two authors independently evaluated the websites according to their DISCERN scores, and the final score was determined based on the average score. The final DISCERN score was 16–80; the scores and quality of websites were as follows: 16–27, very poor; 28–38, poor; 39–50, fair; 51–62, good; and 63–80, excellent.[12] (Table 1).

The Global Quality Score (GQS) is a 5-point scale, which is used to assess the overall quality of websites. These scores are used to determine whether the website is useful for the readers. Accordingly, a score of 5 indicates excellent quality, whereas a score of 1 indicates poor quality.[13] (Table 1). The GQS and quality of websites were as follows: 4–5, high quality; 3, medium quality; and 1–2, low quality.[25]

2.6. Readability

The readability of the websites was determined by evaluating the texts using "https://readabilityformulas.com/free-readability-formula-tests.php." The Flesch Reading Ease Score (FRES), Flesch–Kincaid grade level (FKGL), Simple Measure of Gobbledygook (SMOG), Gunning Fog (GFOG), Coleman–Liau score (CL), automated readability index (ARI), and Linsear Write (LW) were used as readability formulas.[21] (Table 2).

All websites were sorted and saved. Texts were copied and saved using Microsoft Office Word 2007 (Microsoft Corporation, Redmond, WA). The average readability level for all readability formulas was based on the sixth-grade level recommended by the American Medical Association and the National Institute of Health[12]

The score in the FRES formula decreases with an increase in the average readability scores in SMOG, GFOG, CL, FKGL, ARI, and LW formulas. The accepted readability level in the FRES formula is ≥60.0, whereas it is <7 for the other 6 formulas. Thus, higher FRES scores and lower scores in other formulas indicate better readability.[26]

2.7. Content analysis

We investigated the websites to determine whether they included topics related to TENS (indications, contraindications, procedure, complications, or TENS types) according to their typology.[27]

2.8. Statistical analysis

IBM SPSS Software 25.0 (SPSS Inc., Chicago, IL) was used for performing statistical analysis. Independent variables included website typologies, top 10 websites, and other websites. The dependent variables were the presence of DISCERN, JAMA, GQS, and HONcode. Frequency data are expressed as number (n) and percentage (%). Continuous data are represented as the mean ± standard deviation. For comparison of frequency variables, Chi-square or Fisher's exact tests were used. Kruskal–Wallis or Mann–Whitney *U* tests were used to compare groups with continuous data, such as readability indices and sixth-grade levels. A *P* value of <.05 was considered to indicate statistical significance.

Table 1

Contents of GQS, DISCERN, and JAMA assessment criteria.

GQS	Score
Poor quality, poor flow of the site, most information missing, not at all useful for patients	1
Generally poor quality and poor flow, some information listed but many important topics missing, of very limited use to patients	2
Moderate quality, suboptimal flow, some important information is adequately discussed but others poorly discussed, somewhat useful for patients	3
Good quality and generally good flow, most of the relevant information is listed, but some topics not covered, useful for patients	4
Excellent quality and excellent flow, very useful for patients	5
DISCERN Criteria	**Total Score (16–80 Points)**
1 Are the aims clear?	1–5 point
2 Does it achieve its aims?	1–5 point
3 Is it relevant?	1–5 point
4 Is it clear what sources of information were used	1–5 point
5 Is it clear when the information used or reported in the publication was produced?	1–5 point
6 Is it balanced and unbiased?	1–5 point
7 Does it provide details of additional sources of 1.45 support and information?	1–5 point
8 Does it refer to areas of uncertainty?	1–5 point
9 Does it describe how each treatment works?	1–5 point
10 Does it describe the benefits of each treatment?	1–5 point
11 Does it describe the risks of each treatment?	1–5 point
12 Does it describe what would happen if no treatment is used?	1–5 point
13 Does it describe how the treatment choices affect overall quality of life?	1–5 point
14 Is it clear that there may be more than one possible treatment choice?	1–5 point
15 Does it provide support for shared decision making?	1–5 point
16 Based on the answers to all of the above questions, rate the overall quality of the publication as a source of information about treatment choices.	1–5 point
JAMA Benchmark Criteria	**Total Score (0–4 Points)**
Authorship	1 point (Authors and contributors, their affiliations, and relevant credentials should be provided)
References/sources	1 point (Sources and references for all content should be listed)
Ownership	1 point (Sponsorship, conflicts of interest, funding, advertising, support, and video ownership should be fully disclosed)
Indication of date	1 point (Dates that on which the content was posted and updated should be indicated). JAMA is used to evaluate the accuracy and reliability of information A

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3. Results

3.1. Website typologies

Of the 200 websites ranked using the Google search engine, 102 websites that met the inclusion criteria were compared according to their typology. Commercial websites (n = 36, 35.5%) constituted the highest proportion of websites, followed by professional (n = 17, 16.7%) websites (Fig. 2).

The 10 search results that appeared on the first page of Google were considered the first websites that attract the attention of users. When the top 10 and other search results were evaluated by their typologies, no statistically significant difference was noted ($P = .661$). Among the top 10 websites, professional, nonprofit, health portal, and government organizations were evenly represented (2 each), and news and commercial sites were also equally represented (one each) (Fig. 2).

3.2. Comparison of readability, quality and reliability scores of top 10 and other websites

The readability levels of the top 10 websites were compared with those of the other 92 websites, and no statistically significant difference was observed among the readability levels of websites (FRES, $P = .987$; GFOG, $P = .778$; FKGL, $P = .897$; CL, $P = .315$, and SMOG, $P = .897$). There was no statistically significant association among the DISCERN quality ($P = .586$), GQS quality ($P = .274$), and JAMA credibility ($P = .809$) scores of the top 10 and other websites. In contrast, a statistically significant correlation was noted among the HONcode entities of the top 10 and other websites ($P = .008$) (Table 3).

3.3. Reliability and quality evaluation

Among the 102 websites, the mean JAMA score was 2.00 ± 0.99, mean GQS score was 2.22 ± 1.18, and mean DISCERN score was 39.01 ± 20.42. Based on these results, we determined that the websites included in this study had moderate reliability and moderate-to-poor quality. Significant correlations were noted between the typologies of all websites and JAMA reliability scores ($P < .001$), DISCERN quality scores ($P < .001$), and GQS ($P < .001$). This statistical difference could be explained by the fact that the websites developed by health portals received higher JAMA, DISCERN, and GQS scores. These scores were found to be lower in commercial websites. Overall, 8.8% of the websites received a JAMA score of ≥3, indicating high reliability; moreover, 16.7% of the websites were identified as high quality according to the GQS values. The presence of HONcode was detected in 16 (15.7%) websites. The highest number of HONcodes was detected in health portals (n = 7) (Table 4). A significant correlation was observed among the JAMA, DISCERN, and GQS scores according to website typology ($P < .001$). Accordingly, commercial websites were found to be of low credibility and very poor quality, whereas health portal and nonprofit websites were found

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Table 2

Readability indices.

Readability index	Description	Formula
Flesch Reading Ease Score (FRES)	It was developed to evaluate the readability of newspapers. It is best suited for evaluating school textbooks and technical manuals. The standardized test used by many US government agencies. Scores range from 0 to 100, with higher scores indicating easier readability	I = (206.835 – (84.6 X (B/W)) – (1.015 X (W/S)))
Gunning FOG (GFOG)	It was developed to help American businesses improve the readability of their writing. Applicable to many disciplines	G = 0.4 X (W/S+((C*/W) X 100))
Simple Measure of Gobbledygook (SMOG)	It is generally suitable for middle-aged (4th grade to college level) readers. While testing 100% comprehension, most formulas test about 50%–75% comprehension. Most accurate when applied to documents ≥ 30 sentences long	G = 1.0430 X √ C + 3.1291
Flesch–Kincaid grade level (FKGL)	Part of the Kincaid Navy Personnel test collection. Designed for technical documentation and suitable for a wide range of disciplines	G = (11.8 X (B/W)) + (0.39 X (W/S)) –15.59
Automated readability index (ARI)	ARI has been used by the military in writing technical manuals, and its calculation returns a grade level necessary for understanding	ARI = 4.71 X I + 0.5*ASL – 21.43
Coleman–Liau (CL) score	It is designed for middle-aged (4th grade to college level) readers. The formula is based on text in the grade level range of 0.4 to 16.3. It applies to many industries.	G = (–27.4004 X (E/100)) + 23.06395
Linsear Write (LW)	It is developed for the United States Air Force to help them calculate the readability of their technical manuals	LW = (*R* + 3C)/S Result • If >20, divide by 2 • If ≤20, subtract 2, and then divide by 2

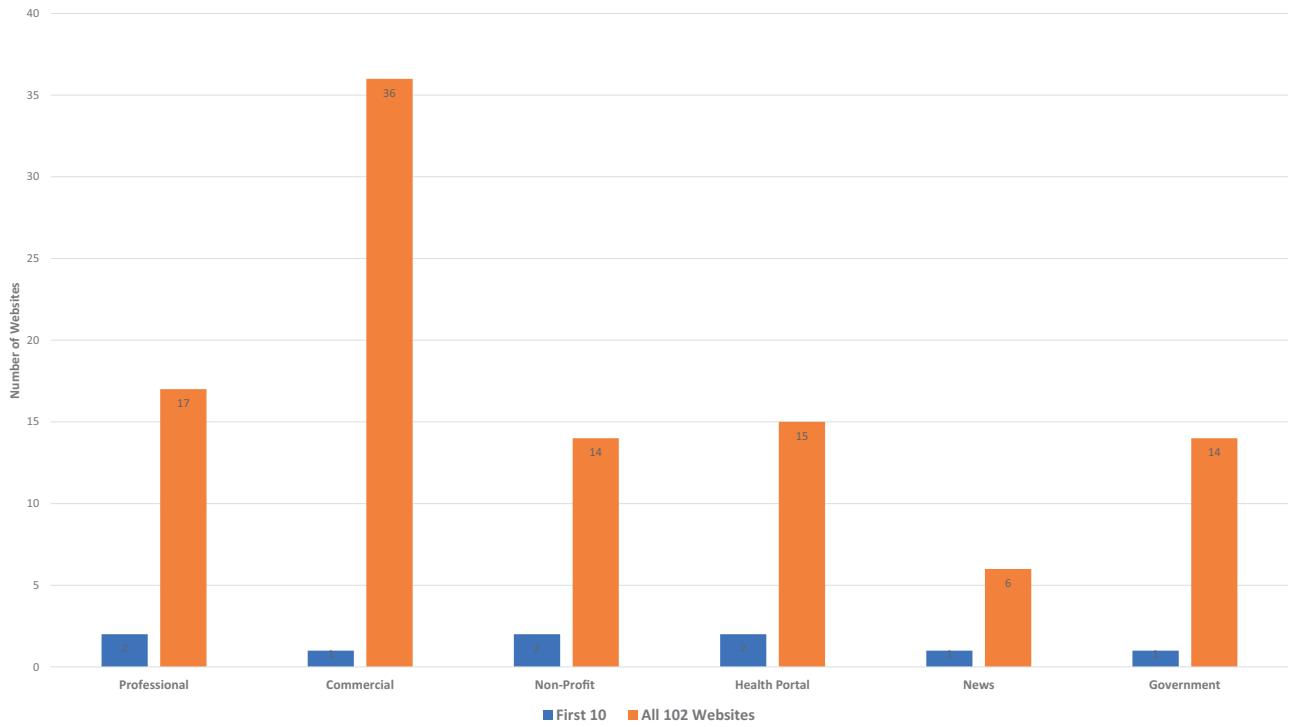


Figure 2. Typologies of websites.

to be dominated by high quality content. When JAMA scores were evaluated according to website typology, the reliability of websites was ranked from high to low in the following order: health portal > nonprofit organization > professional > news > government > commercial. When the GQS results were evaluated according to website typology, the quality scale of websites was ranked from high to low in the following order: health portal > nonprofit organization > professional > government > news > commercial (Fig. 3).

3.4. Readability evaluation

In the text readability analysis of 102 websites, the mean FRES was 47.91 ± 13.79 (difficult) and mean GFOG was 14.04 ± 2.74

Table 3

All group of websites' mean results and statistical comparison of text content to 6th grade reading level.

Readability indexes	Mean ± SD			Comparison of the first 10 websites and remaining 92 websites according to parameters (p)	Comparison of the 102 websites' according to 6th grade reading level (p)
	Top 10 (n = 10)	Others (n = 92)	Total (n = 102)		
FRES	47.97 ± 15.94	47.91 ± 13.64	47.91 ± 13.79	0.987	**<0.001**
GFOG	14.99 ± 4.56	13.93 ± 2.48	14.04 ± 2.74	0.778	**<0.001**
FKGL	11.63 ± 4.42	11.15 ± 2.66	11.20 ± 2.85	0.897	**<0.001**
The CL Index	11.20 ± 1.22	11.80 ± 2.00	11.74 ± 1.94	0.315	**<0.001**
The SMOG Index	10.82 ± 2.99	10.50 ± 2.01	10.53 ± 2.11	0.897	**<0.001**
ARI	11.91 ± 5.18	11.48 ± 3.02	11.52 ± 3.26	0.831	**<0.001**
LW formula	13.46 ± 7.10	12.38 ± 3.54	12.48 ± 3.98	0.996	**<0.001**
Grade level	11.70 ± 4.16	11.44 ± 2.50	11.47 ± 2.68	0.824	**<0.001**
JAMA, mean ± SD	2.10 ± 1.28	2.00 ± 0.96	2.00 ± 0.99	0.809	
DISCERN, mean ± SD	43.00 ± 23.72	38.58 ± 20.13	39.01 ± 20.42	0.586	
GQS, mean ± SD	2.70 ± 1.49	2.17 ± 1.14	2.22 ± 1.18	0.274	
JAMA, n (%)					
Insufficient data	3 (30)	31 (33.7)	34 (33.3)	0.422	
Partially sufficient data	5 (50)	54 (58.7)	59 (57.8)		
Completely sufficient data	2 (20)	7 (7.6)	9 (8.8)		
DISCERN, n (%)					
Very poor	2 (20)	29 (31.5)	31 (30.4)	0.408	
Poor	4 (40)	23 (25)	27 (26.5)		
Fair	1 (10)	17 (18.5)	18 (17.6)		
Good	1 (10)	17 (18.5)	18 (17.6)		
Excellent	2 (20)	6 (6.5)	8 (7.8)		
HONcode, n (%)					
+	5 (50)	81 (88)	86 (84.3)	**0.008**	
–	5 (50)	11 (12)	16 (15.7)		
GQS, n (%)					
Low quality	6 (60)	66 (71.7)	72 (70.6)	0.491	
Medium quality	1 (10)	12 (13)	13 (12.7)		
High quality	3 (30)	14 (15.2)	17 (16.7)		
Typology, n (%)					
Professional	2 (20)	15 (16.3)	17 (16.7)	0.661	
Commercial	1 (10)	35 (38)	36 (35.3)		
Nonprofit	2 (20)	12 (13)	14 (13.7)		
Health portal	2 (20)	13 (14.1)	15 (14.7)		
News	1 (10)	5 (5.4)	6 (5.9)		
Government	2 (20)	12 (13)	14 (13.7)		

ARI = automated readability index, CL = Coleman-Liau score, FKGL = Flesch-Kincaid grade level, FRES = Flesch reading ease score, GFOG = Gunning FOG, GQS = Global Quality Score, HONcode = The Health on the Net Foundation Code of Conduct (HONcode), JAMA = Journal of American Medical Association Benchmark Criteria, ve LW = Linsear Write, SMOG = Simple Measure of Gobbledygook.
Bold character; statistically different ($P < .05$).

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(very difficult). Further, the mean FKGL and SMOG were 11.20 ± 2.85 and 10.53 ± 2.11 years of education, respectively. The CL index was 11.74 ± 1.94 years of education, whereas the ARI index was 11.52 ± 3.26 years of education. When the typologies of the sites were compared with the readability indices, no statistically significant association was noted except for the CL index ($P = .025$) (FRES, $P = .050$; GFOG, $P = .205$; FKGL, $P = .156$; SMOG, $P = .177$; ARI, $P = .190$; and LW, $P = .438$) (Fig. 4). According to the CL index, government websites were more readable than others. However, it was still found to be significantly difficult to read when compared to the 6th grade reading level. When the mean readability indices of all websites were compared with the sixth-grade reading level, a statistically significant difference was observed among them ($P < .001$) (Table 3). According to this result, the mean readability indices of all websites were significantly higher than the 6th grade level.

3.5. Correlation analysis

Correlation analysis revealed a weak positive correlation between the JAMA scores and DISCERN scores ($R = 0.935$, $P < .001$), GQS ($R = 0.927$ $P < .001$) and the presence of HONcode ($R = 0.351$, $P < .001$). A correlation was also observed between DISCERN scores and GQS ($R = 0.940$, $P < .001$) and the presence of HONcode ($R = 0.405$, $P < .001$) (Table 5).

3.6. Content analysis

Content analysis revealed the number websites associated with the content of each topic related to TENS as follows: indications, 89 (87%); contraindications, 30 (29.4%); procedures, 76 (74.5%); complications, 68 (66.7%); and TENS types, 20 (19.6%). Comparison of the content between the top 10 and other websites revealed a statistically significant difference in the contents of contraindications ($P = .035$) and complications ($P = .002$). This significant difference may be because 60% of the top 10 websites indicated contraindications and 80% indicated complications. When website typologies and content were compared, a statistically significant difference was observed in the content of complications ($P = .001$) and TENS types ($P = .003$). Complication was not mentioned in 90% of commercial websites, and TENS types were mentioned more in professional and health portal websites (Table 6).

4. Discussion

In this study, we aimed to investigate the readability, quality, and reliability of internet-based PEM on TENS. We also attempted to determine the types of websites that are easily readable and highly reliable. We investigated the association of readability of sites with their reliability and quality. We compared the top 10

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Table 4

Comparison of JAMA, DISCERN scores, HONcode presences, and reading levels according to the typologies of the websites.

	Professional	Commercial	Non-profit	Health portal	News	Government	*P*
N (%)	17 (16.7)	36 (35.5)	14 (13.7)	15 (14.7)	6 (5.9)	14 (13.7)	
JAMA (mean ± SD)	2.23 ± 0.43	1.27 ± 0.74	2.64 ± 1.01	2.73 ± 1.09	2.16 ± 0.40	2.14 ± 0.94	**<.001**
Insufficient data n:34	0 (0%)	25 (69.4%)	3 (21.4%)	2 (13.3%)	0 (0%)	4 (28.6%)	
Partially sufficient data n:59	17 (100%)	10 (27.8%)	9 (64.3%)	8 (53.3%)	6 (100%)	9 (64.3%)	
Completely sufficient data n:9	0 (0%)	1 (2.8%)	2 (14.3%)	5 (33.3%)	0 (0%)	1 (7.1%)	
DISCERN (mean ± SD)	45.64 ± 11.79	23.11 ± 12.93	51.71 ± 21.66	53.86 ± 22.23	34.66 ± 6.53	45.14 ± 19.14	**<.001**
Very poor n:31	0 (0%)	24 (66.7%)	3 (21.4%)	2 (13.3%)	0 (0%)	2 (14.3%)	
Poor n:27	6 (35.3%)	10 (27.8%)	0 (0%)	2 (13.3%)	5 (83.3%)	4 (28.6%)	
Fair n:18	7 (41.2%)	1 (2.8%)	3 (21.4%)	3 (20%)	1 (16.7%)	3 (21.4%)	
Good n:18	4 (23.5%)	0 (0%)	6 (42.9%)	4 (26.7%)	0 (0%)	4 (28.6%)	
Excellent n:8	0 (0%)	1 (2.8%)	2 (14.3%)	4 (26.7%)	0 (0%)	1 (7.1%)	
GQS (mean ± SD)	2.41 ± 0.61	1.41 ± 0.76	2.92 ± 1.38	3.13 ± 1.50	2.00 ± 0.00	2.50 ± 1.01	**<.001**
Low quality n:72	11 (64.7%)	35 (97.2%)	5 (35.7%)	7 (46.7%)	6 (100%)	8 (57.1%)	
Medium quality n:13	5 (29.4%)	0 (0%)	4 (28.6%)	1 (6.7%)	0 (0%)	3 (21.4%)	
High quality n:17	1 (5.9%)	1 (2.8%)	5 (35.7%)	7 (46.7%)	0 (0%)	3 (21.4%)	
HONcode							**0.002**
+ n:16	4 (23.5%)	0 (0%)	3 (21.4%)	7 (46.7%)	1 (16.7%)	1 (7.1%)	
– n:86	13 (76.5%)	36 (100%)	11 (78.6%)	8 (53.3%)	5 (83.3%)	13 (92.9%)	
Reading level, n (%)							**0.010**
Easy to read	1 (5.9)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Fairly easy to read	0 (0)	0 (0)	1 (7.1)	0 (0)	0 (0)	1 (7.1)	
Standard/average	2 (11.8)	1 (2.8)	1 (7.1)	4 (26.7)	1 (16.7)	8 (57.1)	
Fairly difficult to read	5 (29.4)	18 (50)	7 (50)	5 (33.3)	0 (0)	1 (7.1)	
Difficult to read	7 (41.2)	13 (36.1)	4 (28.6)	3 (20)	3 (50)	3 (21.4)	
Very difficult to read	2 (11.8)	4 (11.1)	1 (7.1)	3 (20)	2 (33.3)	1 (7.1)	
Readers age, n (%)							.517
10–11 Years old (Fifth and Sixth graders)	1 (5.9)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
11–13 Years old (Sixth and Seventh Graders)	1 (5.9)	0 (0)	1 (7.1)	0 (0)	0 (0)	1 (7.1)	
12–14 Years old (Seventh and Eighth Graders)	1 (5.9)	1 (2.8)	0 (0)	2 (13.3)	0 (0)	3 (21.4)	
13–15 Years old (Eighth and Ninth Graders)	2 (11.8)	2 (5.6)	1 (7.1)	4 (26.7)	1 (16.7)	4 (28.6)	
14–15 Years old (Ninth to Tenth Graders)	1 (5.9)	6 (16.7)	3 (21.4)	2 (13.3)	0 (0)	1 (7.1)	
15–17 Years old (Tenth to Eleventh Graders)	3 (17.6)	13 (36.1)	6 (42.9)	1 (6.7)	1 (16.7)	2 (14.3)	
17–18 Years old (Twelfth Graders)	1 (5.9)	3 (8.3)	1 (7.1)	2 (13.3)	1 (16.7)	1 (7.1)	
18–19 Years old (College Level Entry)	2 (11.8)	2 (5.6)	0 (0)	0 (0)	0 (0)	0 (0)	
21–22 Years Old(college level)	1 (5.9)	2 (5.6)	0 (0)	0 (0)	1 (16.7)	1 (7.1)	
College Graduate	4 (23.5)	7 (19.4)	2 (14.3)	4 (26.7)	2 (33.3)	1 (7.1)	

Bold character indicates statistically different ($P < .05$).

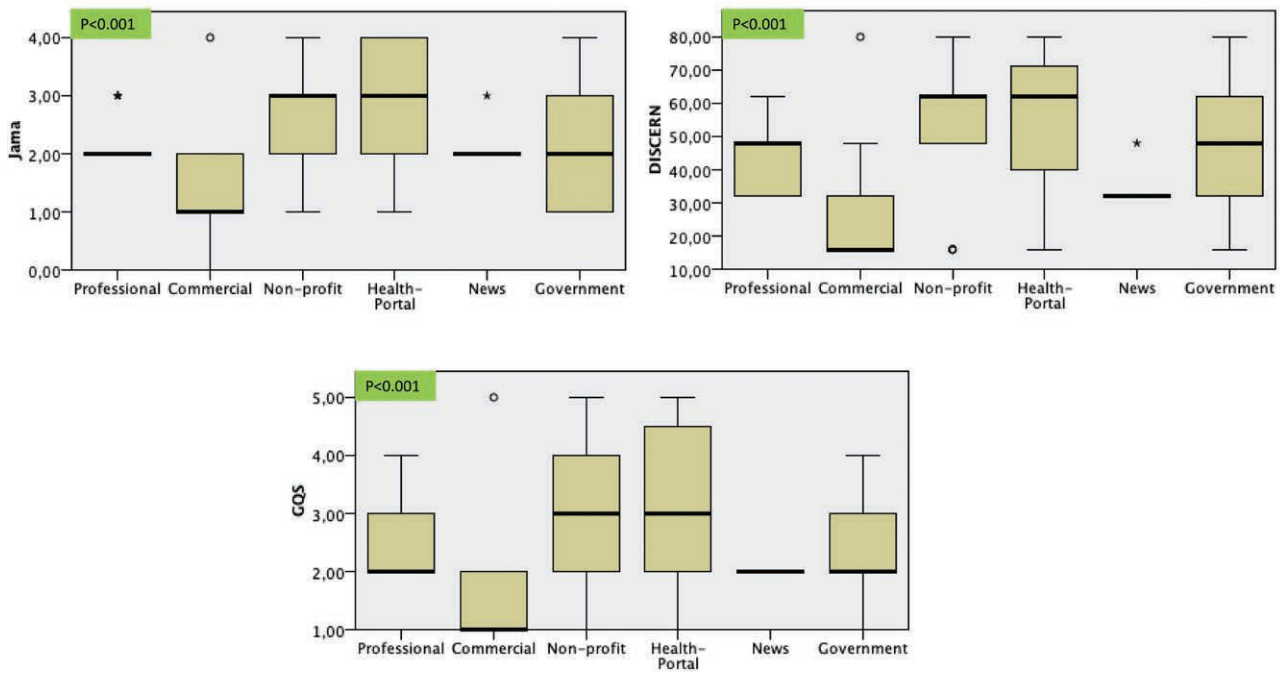


Figure 3. Evaluation of JAMA, DISCERN, and GQS scores of websites according to their typologies ($P < .05$, statistical significance). GQS = Global Quality Score, JAMA = The Journal of American Medical Association.

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websites on the first page with other websites in terms of quality, readability, and reliability.

TENS, the neuromodulation of central nociceptive stimulation, is known to be superior to other stand-alone treatments for acute pain and more effective than placebo for osteoarthritis and musculoskeletal pain.[4] According to the report by the French National Authority for Health, TENS would be useful and beneficial only in those cases of chronic pain where pharmacological treatment failed.[28] The advantages of TENS include excellent safety profile when recommended by a healthcare provider, prepurchase trial phase of the device, and reasonable price compared with other treatments.[28] As TENS is available without a prescription, it is easily accessible and allows patients to use it without the guidance of a health professional.[29] However, patients lack sufficient knowledge regarding the use of health products and use internet as a source to obtain information.[30] Information obtained from internet also has several disadvantages in terms of reliability and quality, and the text usually written in a language that is difficult to understand by the readers.[12]

Internet has become an important source of health-related information. According to a 2018 study, 9 out of 10 Americans use internet and 72% of them search for health-related content.[12] Well-informed patients are known to have increased satisfaction and overall better health outcomes, emphasizing the importance of quality patient education.[11] Patients have access to reliable quality information on any health topic, which is written in a language they can understand, and can immediately evaluate the prevention, diagnosis, and treatment of diseases.

In this study, when the websites were compared according to their typologies, no statistically significant difference was observed between the top 10 and other websites. Commercial websites constituted the highest proportion of all websites. The 10 search results on the first page of Google were relatively evenly distributed across typologies. There was a statistically significant difference between website typologies and

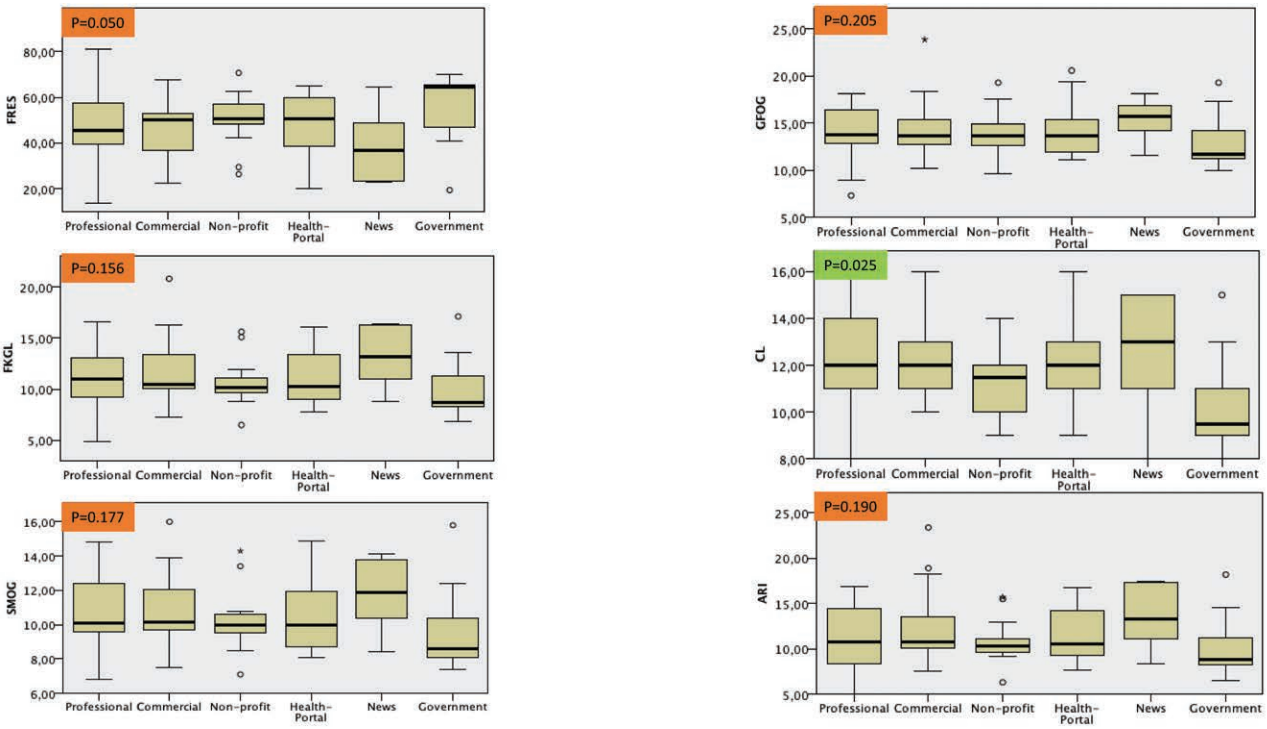


Figure 4. Evaluation of readability scores of websites according to their typologies ($P < .05$, statistical significance).

Table 5

Correlation relationships between readability formulas and JAMA, DISCERN, GQS scores, HONcode precenses.

	JAMA		DISCERN		GQS		HONcode	
	r	*P*	*r*	*P*	*r*	*P*	*r*	*P*
Mean FRES	–0.011	.911	–0.019	.846	–0.051	.607	0.064	.524
Mean GFOG	–0.045	.656	0.023	.819	0.057	.568	–0.052	.605
Mean FKGL	–0.046	.649	–0.009	.930	0.018	.859	–0.124	.215
Mean CL Index	0.032	.749	0.015	.881	0.051	.612	0.029	.773
Mean SMOG index	–0.012	.905	0.031	.757	0.063	.527	–0.092	.358
Mean ARI	–0.082	.415	–0.031	.756	0.007	–.943	–0.123	.219
Mean LW Formula	–0.081	.416	–0.014	.889	0.003	.977	–0.169	.090
Grade Level	–0.072	.469	–0.030	.761	–0.006	.955	–0.116	.245
JAMA	–	–	0.935	**.001>**	0.927	**.001>**	0.351	**.001>**
DISCERN	0.935	**.001>**	–	–	0.940	**.001>**	0.405	**.001>**
GQS	0.927	**.001>**	0.940	**.001>**	–	–	0.398	**.001>**
HONcode	0.351	**.001>**	0.405	**.001>**	0.398	**.001>**	–	–

Bold character indicates statistically different ($P < .05$).

Table 6

Content analysis by typology.

		Professional	Commercial	Non-profit	Health portal	News	Government	Total	*P*
Indications	+	14 (82.4%)	31 (86.1%)	13 (92.9%)	14 (93.3%)	3 (50%)	14 (100%)	89 (87%)	.055
	–	3 (17.6%)	5 (13.9%)	1 (7.1%)	1 (6.7%)	3 (50%)	0 (0%)	13 (12.7%)	
Contraindications	+	6 (35.3%)	8 (22.2%)	4 (28.6%)	6 (40%)	2 (33.3%)	4 (28.6%)	30 (29.4%)	.843
	–	11 (64.7%)	28 (77.8%)	10 (71.4%)	9 (60%)	4 (66.7%)	10 (71.4%)	72 (70.6%)	
Procedure	+	13 (76.5%)	25 (69.4%)	13 (92.9%)	11 (73.3%)	3 (50%)	11 (78.6%)	76 (74.5%)	.412
	–	4 (23.5%)	11 (30.6%)	1 (7.1%)	4 (26.7%)	3 (50%)	3 (21.4%)	26 (25.5%)	
Complications	+	7 (41.2%)	4 (11.1%)	5 (35.7%)	8 (53.3%)	2 (33.3%)	8 (57.1%)	68 (66.7%)	**.011**
	–	10 (58.8%)	32 (88.9%)	9 (64.3%)	7 (46.7%)	4 (66.7%)	6 (42.9%)	34 (33.3%)	
Tens types	+	5 (29.4%)	1 (2.8%)	3 (21.4%)	5 (33.3%)	4 (66.7%)	2 (14.3%)	20 (19.6%)	**.003**
	–	12 (70.6%)	35 (97.2%)	11 (78.6%)	10 (66.7%)	2 (33.3%)	12 (85.7%)	82 (80.4%)	

Bold character indicates statistically different ($P < .05$).

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reliability and quality scores. This significant difference was associated with the presence of HONcode as well as high JAMA, DISCERN, and GQS values on the websites of health portal and nonprofit organizations. These scores were lower for commercial websites. There were no statistically significant differences between the top 10 and other websites in terms of reliability, quality, and readability. When the readability indices of all websites were evaluated by their typologies, no statistically significant difference was found except for the CL index. Based on the CL indices, videos from government sources were found to be more readable than the other typologies. There was no statistically significant difference in readability scores between the top 10 and other websites.

In this study, websites developed by commercial sources accounted for the highest proportion, which is similar to the result reported by several studies investigating online information on different topics.[15,31] We found that commercial websites had lower JAMA, DISCERN, and GQS values. These data indicate that commercial websites do not provide sufficient reliable and quality information on TENS. In this study, only 1 of the top 10 websites had commercial content. Bağcıer et al[32] found 2 commercial websites in the top 10 websites evaluated in their study on myofascial pain syndrome. In contrast to the results of our study, Koçyiğit et al[25] found no commercial content in the first 10 websites obtained in their study on ankylosing spondylitis. In general, internet users act based on the top 10 websites that appear on the first page of Google. According to the results of previous studies and the current study, there are no or few websites with commercial content in the top 10 websites. It may be possible that Google restricts these low-quality and low-reliability commercial sites to prevent users from being misinformed.

In our study, the presence of HONcode, a quality indicator, was detected in 16 (15.6%) websites. Kocyigit et al[25] found HONcode in 17.9% of the websites and Ahmadi et al[33] found it in 12.9% of the websites analyzed in their respective studies. The results of the current study are similar to those reported in the literature. Correlation analysis revealed a weak positive correlation between the presence of HONcode and DISCERN, JAMA, and GQS values. Most patients consider that the first and most trusted source of information is health professionals.[33] Therefore, health professionals have a duty of providing quality and reliable information. Further, patients should be aware that they can find more reliable and quality information during their search on websites with HONcode.

The median DISCERN score (39.01 ± 20.42) in our study indicated fair quality. Wrigley et al[34] and Killip et al[35] reported median DISCERN scores with fair quality (43 and 43.8, respectively), similar to our results. The median JAMA score in our study was 2.00 ± 0.99. Similar to our results, Goldenberg et al[36] and Halboub et al[37] reported median JAMA scores of 2.34 ± 1.11 and 2.08 ± 1.05, respectively. In our study, 8.8% of the websites were found to be highly reliable according to the JAMA scores. Arif et al[38] found 37% of the sites to be highly reliable, whereas Basavakumar et al[15] detected high reliable JAMA scores in 43% of websites. The reason for the higher number of reliable websites in both studies compared with that in our study is that they included websites containing scientific journals in their studies. Further, as we focused on TENS in the current study, there were a large number of commercial sites selling devices, resulting in lower reliability rates. Although academic sites have highly reliable content, readers have low interest in websites that contain complex medical terminology. For this reason, we excluded academic websites in our study to match the general interest of users.

When all website typologies were compared with their readability, no statistically significant difference was noted except for the CL index. According to this index, it was concluded that government-oriented websites are easier to read than other websites. When we evaluated the readability results of our study according to the sixth-grade level recommended by the American Medical Association and the National Institute of Health, we found that the results were higher than the recommended level. Risoldi Cochrane et al[39] and Kecojevic et al[40] indicated that government websites are easier to read than commercial websites. Although Kecojevic et al[40] did not use academic websites in their study, they found that the readability levels were higher than the sixth-grade level, similar to the results of our study. It is important to understand that information with a high level of readability can be presented to a wider audience and more people can benefit from it.

In this study, content analysis revealed that indication (87%) and procedure (74.5%) were the most common topics. When the content was analyzed according to the sources, we found that a low number of commercial sites reported content related to complications. Complications related to devices or procedures are rarely mentioned on commercial- or product sales-oriented websites, indicating the financial goals of the website. Considering that users order TENS devices online without a prescription, it may be advisable for them to be more careful and obtain information from trusted sources, possibly from healthcare providers, to avoid any adverse effect.

The results of our study are influenced by some factors. The increase in digitalization and the ease of access to information quickly results in people trying to reach health-related

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information without contacting a health care provider. However, it is very difficult for users to reach accurate and quality information in the internet ocean. It is obvious that users are misled in a platform where all kinds of right or wrong information can be written without any control mechanism, financial interests are at the forefront and advertising is at every corner. Checking this information by the authorities and taking penal actions will help the public to reach the right information.[37] We have obtained similar results by analyzing the influence of the gaps caused by the uncontrolledness of all this platform in our study.

In this study, it has been determined that the reliability and quality of patient education materials related to TENS on the internet are low and their readability is difficult. Governments should take initiatives and take measures to ensure the dissemination of accurate and reliable information on the Internet, in cooperation with international and national health institutions/organizations. It is recommended that users continue their research on websites that are safe, high quality and suitable for public readability, away from financial interests.

4.1. Limitations of this study

The limitations of the study include the fact that only 1 search term (Transcutaneous Electrical Nerve Stimulation) was used during the study. Further, we only searched English language websites using a single search engine, that is, Google. In addition, as there is no consensus on which readability index provides the most accurate results, the indices commonly used in the literature were considered. The reliability, readability, and quality of the websites were assessed using a set of scales and criteria, and the results showed 97% similarity between the authors. This 3% difference indicates a bias between the authors, which can be stated as another limitation of the study.

4.2. Strengths of this study

We determined the reliability, quality, and readability of online information on TENS, which can be obtained by patients for common pain symptoms through online sources without a prescription. With the increase in digitalization, we revealed the challenges associated with TENS as patients prefer to obtain information from digital media instead of healthcare institutions. For this purpose, we excluded academic sites and searched for websites that would be of interest to the average educated population.

5. Conclusion

We found that internet-based PEM on TENS had low reliability and moderate-to-poor quality content. Websites were found to have significantly higher readability scores than Grade 6 recommended by the National Institute of Health. In the analysis of quality and reliability, commercial websites showed lower scores, whereas health portals and nonprofit organizations showed higher scores. The low amount of content related to complications on commercial websites was attributed to the financial goals of these websites. In the digital age, quality, reliable, and readable websites developed by health professionals can significantly contribute to providing accurate and understandable information to wider population.

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