

Readability assessment of oral cancer

Dipanshi Sharma*, Ritu Gupta, Bhuvandeep Gupta, Saumya Vats, Kartiki Mehrotra

Department of Periodontology and Oral Implantology, Swaastik Dental and Cosmetology Clinic, Delhi, India

Abstract

Background: Online health information is being used more ubiquitously by the general population. However, this information typically favours only a small percentage of readers, which can result in suboptimal medical outcomes for patients. **Objective:** The readability of online patient education materials regarding the topic of oral cancer was assessed through seven readability assessment tools. **Methods:** The search phrase “Oral Cancer” was employed into the search engine Google, Yahoo and Microsoft edge. Out of the first 100 websites, only 90 were included attending to compliance with selection and exclusion criteria. These were then assessed through seven readability assessment tools. **Results:** Of the 100 websites identified, only 90 met the study inclusion criteria and were analysed for readability. The readability scores of online health information about oral cancer ranged from 10 to 80 using the FKGR tool, with a mean of 54.3, 3.4 to 10 using the New Dale Chall readability with a mean score of 6.2. Readability scores using the SMOG Index ranged from 7.7 to 12 with a mean of 11.5. Values generated using these tools can be interpreted as, to understand most of the material, one needs the reading ability of at least an 8th grader. Efforts need to be made to better tailor online patient education materials to the general population.

Keywords: Health literacy, Oral cancer, Readability.

Introduction

An individual's health literacy is considered the single best predictor of their health status [1]. Health literacy is defined as the “capacity to obtain, interpret, and understand basic health information and services and the competence to use such information and services to enhance health”. It is the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions [2].

Health literacy is of concern to everyone involved in health promotion and protection, disease prevention and early screening, health care and maintenance and policy making [3].

A clear understanding of health literacy can guide the health system of public health practitioners, care providers, insurers and community agencies toward adopting definitions and policies that resolve incompatibilities between the needs of individuals and the demands of health systems [4].

The environment in which patients consume medical and health information has changed. Internet sphere has placed an unprecedented amount of health information within reach of general consumers [5]. The principal dilemma of the internet is that, while its anarchic nature is desirable for fostering open

debate without censorship, this raises questions about the quality of information available, which could inhibit its usefulness [6]. It is important that the health information which is provided to the consumers is accessible and easily understandable which do not mislead and mis-guard the patients. The readability of a document is the ease with which text can be read and understood. It is an indirect measure of the quality of written communication. High readability makes it easy to understand the meaning of the text and induces further reading [7].

Patients typically have reading skills that are about five grades lower than the highest attained educational grade [8]. Consequently, a major portion of the population may have difficulty comprehending some of the available patient education materials [9]. Older adults are the most likely to experience chronic health conditions, which are the leading causes of morbidity and mortality. This population has also been shown to have lower levels of health literacy relative to the general population [10].

Readability indices have been developed to study the ease of reading a text. They are based on the syllables, sentence length and the number of hard words. Although there are various readability tests, the commonly used ones are the Flesch

*Correspondence to: Dipanshi Sharma, Department of Periodontology and Oral Implantology, Swaastik Dental and Cosmetology Clinic, Delhi, India; E-mail: dipanshisharma771@gmail.com

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readability score and Flesch grade [11]. Many recently published articles show that medical websites are not pitched to the appropriate communication levels of the general public [12]. The Joint Commission on Accreditation of Healthcare Organization (JCAHO) mandates the availability of easily understandable patient information materials as part of the accreditation process for healthcare facilities. Healthcare organizations such as the national work group on cancer and health, American Medical Association, and national institutes of health recommend the readability of patient information material should be no higher than sixth grade level, while the Centres for Disease Control and Prevention (CDC) recommends the readability to be lower than eighth grade level [13].

Oral cancer is a major problem in the Indian subcontinent where it ranks among the top three types of cancer in the country. Age adjusted rates of oral cancer in India are high that is, 20 per 100,000 population and accounts for over 30% of all cancers in the country. It is diagnosed at later stages which result in low treatment outcomes and considerable costs to the patients whom typically cannot afford this type of treatment [14]. Rural areas with middle and low-incomes also have inadequate access to trained providers and limited health services. As a result, delay has also been largely associated with advanced stages of oral cancer which increases the burden of oral cancer in our country [15].

Public awareness is poor, and most of the patients present with late stage disease, contributing to high mortality. Oral cancer is often preceded by a clinical premalignant phase accessible to visual inspection, and thus there are opportunities for earlier detection and to reduce morbidity and mortality [16].

According to Google trends search data, the term oral cancer was one of the most searched having a score of 100 in August 2023 worldwide as well as in India. This illustrates that public interest in learning about oral cancer is high, and that there must be authentic, unambiguous, and legible data and resources for the people which can also be utilised in assisting healthcare professionals to detect and intervene early in the progression of the disease [17].

In this cross-sectional study, online patient education materials on the particular topic of oral cancer were assessed by the authors. Early intervention and treatment can improve quality and length of life for most patients. Thus, it is crucial that online information pertinent to oral cancer be tangible to the general public in order to understand, manage, and track their condition in the appropriate manner. This study focused on assessing the readability levels and reading ease of online oral cancer articles available to the general public via Google, Yahoo and Microsoft edge.

Materials and Methods

Study setting

The study is a cross-sectional study using commonly used search engines.

Search engine

The Google, Yahoo and Microsoft edge search engines were used because the majority of patients that use the Internet for health-related information reported using these search engines. The search terms such as “Oral Cancer”, “Mouth Cancer”, and “Oral Cavity Cancer” were entered into these browsers and the search was performed on Aug 20, 2023.

Inclusion criteria

The first 100 search results were analysed to determine if they would be eligible for inclusion. Websites were eligible for inclusion if they:

- Were in English,
- Were free to access
- Provided information on oral cancer.

Exclusion criteria

Websites were excluded if they were:

- Advertisements for medical products or news articles or pertained only to animal-based diseases.
- Closed access websites.
- The websites which were paid.

Readability assessment

The readability of each website was assessed using seven readability formulas. Text was copied into Microsoft Word and all figures, captions, links, advertisements, references and disclaimers were removed. Text was then pasted into an online readability tool, wordcalc which is available online [18]. Seven validated tests were identified for the analysis;

Flesch-Kincaid grade level and Flesch reading ease: In the Flesch reading-ease test, higher scores indicate material that is easier to read; lower numbers mark passages that are more difficult to read. It is calculated using the average sentence length (*i.e.*, the number of words divided by the number of sentences) and the average syllables per word (*i.e.*, the number of syllables divided by the number of words) using different formulas. Flesch-Kincaid reading ease is based on a ranking scale of 0-100. FRE score uses a scale from 0 to 100, where a lower score indicates a more difficult readability level (0-30 is very difficult, 30-50 is difficult, 50-60 is fairly difficult, 60-70 is standard, 70-80 is fairly easy, 80-90 is easy and 90-100 is very easy) [19].

Flesch-Kincaid reading ease formula: $206.835 - 1.015 \times (\text{words/sentences}) - 84.6 \times (\text{syllables/words})$.

Flesch-Kincaid grade level formula: $0.39 \times (\text{words/sentences}) + 11.8 \times (\text{syllables/words}) - 15.59$.

New Dale Chall readability: The New Dale-Chall readability score measures a text against a number of words considered familiar to fourth-graders. The more unfamiliar words used, the higher the reading level. The lower the score, the more readable the text for a fourth-grader [20].

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Spache readability score: The Spache readability formula is a readability test for writing in English, designed by George Spache. It works best on texts that are for children up to fourth grade. The method compares words in a text to a set list of everyday words. The number of words per sentence and the percentage of unfamiliar words determine the reading age. The formula used to calculate this index is:

$$\text{Grade level} = (0.121 \times \text{Average sentence length}) + (0.082 \times \text{Percentage of unique unfamiliar words}) + 0.659$$

Gunning Fog index: The Gunning Fog formula generates a grade level between 0 and 20. It estimates the education level required to understand the text. A gunning fog score of 6 is easily readable for sixth graders. Text above a 17 has a graduate level. The formula used to calculate this score is:

$$0.4 \left[\left(\frac{\text{words}}{\text{sentences}} \right) + 100 \left(\frac{\text{complex words}}{\text{words}} \right) \right]$$

Coleman-Liau index: This formula uses sentences and letters as variables. The Coleman-Liau index is calculated with the following formula:

$$\text{CLI} = 5.89 \times (\text{characters/words} - 0.3 \times (\text{sentences/words})) - 15.8$$

SMOG index score: SMOG stands for 'simple measure of Gobbledygook'. The SMOG index estimates the years of education a person needs to comprehend a piece of writing. The SMOG Formula is considered appropriate for secondary age (4th grade to college level) readers. The Formula used to calculate this index is as follows:

SMOG index

$$\text{grade} = 1.0430 \sqrt{\text{total polysyllables} \left(\frac{30}{\text{total sentences}} \right)} + 3.1291$$

The automated readability index: The Automated Readability Index (ARI) is a readability test for English texts, designed to gauge the understand ability of a text. The formula of this index is as follows:

$$4.71 \left(\frac{\text{characters}}{\text{words}} \right) + 0.5 \left(\frac{\text{words}}{\text{sentences}} \right) - 21.43$$

The seven readability tests chosen have been widely used in a variety of previous studies. Each test assesses readability according to word difficulty and sentence length using different weighting factors. Different readability tests were used in order to compare the readability of each website based upon different factors.

Statically analysis

The collected data was entered to MS excel version 2010 and analysed, using SPSS version 21.0 for windows. Analysis was done using descriptive statistics and expressed in form of frequency and tables. Results were considered statistically significant at a p value of 0.05 or less.

Results

Of the 100 websites identified, only 90 met the study inclusion criteria and were analysed for readability. The websites were excluded because they did not describe oral cancer, pertained to animal-based diseases, were advertisements, required payment or were news articles.

The readability scores of online health information about oral cancer ranged from 10 to 80 using the FKGR tool, with a mean of 54.3, 3.4 to 10 using the New Dale Chall readability with a mean score of 6.2. Readability scores using the SMOG index ranged from 7.7 to 12 with a mean of 11.5. Values generated using these tools can be interpreted as, to understand most of the material, one needs the reading ability of at least an 8th grader.

Only 7 of the 90 websites had a readability score less than the eighth-grade level according to FKRE, 11 and 4 of the 90 websites according to New Dale Chall score and Spache readability score had an eighth-grade readability level respectively whereas only six websites, according to the Coleman-Liau index, were easily readable for people with reading levels below eighth grade.

List of websites providing health information on oral cancer with website type along with the search engine are presented in Table 1.

Table 1. List of oral cancer websites with their website and search engine type.

Website link	Website type	Search engine
https://www.nidcr.nih.gov/health-info/oral-cancer	General	Google
https://www.mayoclinic.org/diseases-conditions/mouth-cancer/symptoms	General	Google
https://www.webmd.com/oral-health/guide/oral-cancer	General	Google
https://my.clevelandclinic.org/health/diseases/11184-oral-cancer	General	Google
https://www.healthline.com/health/oral-cancer	General	Google

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https://en.wikipedia.org/wiki/Oral_cancer	General	Google
https://oralcancerfoundation.org/	Specific	Google
https://oralcancerfoundation.org/facts/	Specific	Google
https://www.cancer.org	Specific	Google
https://medlineplus.gov/ency/article/	General	Google
https://www.medicalnewstoday.com/articles/	General	Google
https://www.urmc.rochester.edu/encyclopedia/content	General	Google
https://www.nhsinform.scot	General	Google
https://www.cancercenter.com/cancer-types/oral-cancer/types	Specific	Google
https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/mouth-cancer	General	Google
https://www.mskcc.org/cancer-care/types/mouth	General	Google
https://www.hopkinsmedicine.org/health/conditions-and-diseases/oral-cancer	General	Google
https://www.cancerresearchuk.org	Specific	Google
https://www.cancer.gov/types/head-and-neck/patient/adult/	Specific	Google
https://www.cancer.org.au/cancer-information/types-of-cancer/mouth-cancer	Specific	Google
https://www.mdanderson.org/cancer-types/oral-cancer.html	General	Google
https://www.cancer.net/cancer-types/oral-and-oropharyngeal-cancer/statistics	Specific	Google
https://www.mouthhealthy.org	Specific	Google
https://www.pennmedicine.org/cancer/types-of-cancer/mouth-cancer	Specific	Google
https://www.cdc.gov/cancer/headneck/index.htm	General	Google
https://www.rush.edu/news/preventing-oral-cancer	General	Google
https://www.sciencedirect.com/topics/medicine-and-dentistry/oral-cancer	General	Google
https://cancer.ca/en/cancer-information/cancer-types/oral/what-is-oral-cancer	Specific	Google
https://www.everydayhealth.com/oral-cancer	Specific	Google
https://www.wordcalc.com/readability/	General	Google
https://www.rgirc.org/mouth-cancer-treatment/	General	Google
https://www.dukehealth.org/treatments/cancer/oral-cancer	General	Google
https://nyulangone.org/conditions/oral-cancer/diagnosis	Specific	Google
https://www.healthdirect.gov.au/mouth-cancer	General	Google
https://cytecare.com/blog/head-and-neck	Specific	Google
https://www.cedars-sinai.org	Specific	Google
https://moffitt.org/cancers/	Specific	Google

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https://www.preventcancer.org/preventable-cancer/oral-cancer/	Specific	Google
https://www.colgate.com	General	Google
https://www.ucsfhealth.org/conditions/oral-cancer	General	Google
https://sahyadrihospital.com/videos/understanding-mouth-cancer/	General	Google
https://www.stanfordchildrens.org/en/topic/default?id=oral-cancer	General	Google
https://www.cigna.com/knowledge-center/early-signs-oral-cancer	General	Google
https://www.msmanuals.com	General	Google
https://www.wcrf.org/cancer-trends/mouth-and-oral-cancer-statistics/	General	Google
https://www.headandneckcancer.org	Specific	Google
https://www.canada.ca/en/public-health	General	Google
https://www.yalemedicine.org/conditions/oral-cancer	General	Google
https://www.macmillan.org.uk/=	General	Google
https://www.uchicagomedicine.org/cancer/	General	Yahoo
https://www.dentalhealth.org/mouth-cancerc	General	Yahoo
https://timesofindia.indiatimes.com	General	Yahoo
https://www.osmosis.org/learn/Oral_cancer	General	Yahoo
https://www.verywellhealth.com	General	Yahoo
https://www.wikihow.com/Tell-if-You-Have-Mouth-Cancer	General	Yahoo
https://www.verywellhealth.com/oral-cancer-diagnosis-1059442	General	Yahoo
http://www.ocf.org.in	General	Yahoo
https://www.medindia.net	General	Yahoo
https://link.springer.com	General	Yahoo
https://www.nature.com/articles/s41571-021-00511-2	General	Yahoo
https://www.sciencedirect.com	General	Yahoo
https://cancer.ca/en/cancer-information	Specific	Yahoo
https://www.medicalnewstoday.com/articles/322575	General	Yahoo
https://www.cancer.org	Specific	Yahoo
https://www.ncbi.nlm.nih.gov/books	Specific	Yahoo
https://www.apolloclinic.com	General	Yahoo
https://www.frontiersin.org/articles	General	Yahoo
https://journals.plos.org	General	Yahoo
https://link.springer.com	General	Yahoo
https://cancer.ca/en/cancer-information/cancer-types/oral/staging	Specific	Yahoo
Mouth cancer (oral cancer): Signs, symptoms, treatment patient	Specific	Yahoo

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Symptoms of mouth cancer - NHS (www.nhs.uk)	Specific	Yahoo
Mouth cancer action month: How to spot mouth cancer (dentalhealth.org)	Specific	Yahoo
Mouth (Oral) cancer Memorial Sloan Kettering Cancer Centre (mskcc.org)	Specific	Yahoo
10 symptoms of mouth cancer - fact health	Specific	Yahoo
Early signs of mouth cancer Colgate®	General	Microsoft Edge
Mouth ulcers: Types, causes, symptoms, and treatment	Specific	Microsoft Edge
Oral cancer: Causes and risk factors (verywellhealth.com)	Specific	Microsoft Edge
Oral cancer National Institute of Dental and Craniofacial Research (nih.gov)	Specific	Microsoft Edge
Oral cavity cancer Johns Hopkins Medicine	Specific	Microsoft Edge
Mouth cancer causes, symptoms and treatments cancer Council	Specific	Microsoft Edge
The 'big three' causes of mouth cancer—oral cancer news	Specific	Microsoft Edge
Oral cancer-India against cancer (cancerindia.org.in)	General	Microsoft Edge
Mouth cancer—who's at risk, symptoms and treatments health direct	General	Microsoft Edge
Different types of oral/mouth cancers (candrol.com)	General	Microsoft Edge
Mouth cancer (oral cancer): signs, symptoms, treatment patient	General	Microsoft Edge
Oral cancer-facts, diagnosis and treatment md Anderson cancer centre	General	Microsoft Edge
Oral cancer: Epidemiology	General	Microsoft Edge
Mouth cancer Macmillan Cancer Support	Specific	Microsoft Edge
Oral cancer information	Specific	Microsoft Edge
Best oral cancer treatment in India	Specific	Microsoft Edge
Oral Cancer: A Historical review - PubMed (nih.gov)	Specific	Microsoft Edge
Mouth (oral) cancer treatment	Specific	Microsoft Edge
Mouth /Oral cancer - Rajiv Gandhi Cancer Institute	Specific	Microsoft Edge
Oral cancer: A historical review - PubMed (nih.gov)	Specific	Microsoft Edge
Different types of oral/mouth cancers (candrol.com)	General	Microsoft Edge

Mean scores along with the standard deviation for each readability formula is presented in Table 2.

Table 2. Mean scores for each readability formula.

Readability formula	Mean score	Minimum score	Maximum score	Standard deviation
Flesch-Kincaid grade level	54.3	10	80	17.2
New Dale Chall readability	6.21	3.4	10	1.3
Spache readability score	4.9	4.3	5	0.075

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Flesch-Kincaid grade level	9.4	4.1	12	2.08
Gunning Fog index	13.2	6.1	19	11.5
Coleman-Liau index	11.057	7.6	12	1.1
SMOG index score	10.9	7.7	12	1.1
Automated readability index	8.94	3.5	12	2.41

Category breakdown of readability scores of health information websites is given in Table 3. List of websites providing health information on oral cancer with website type along with the search engine are presented in Table 3.

Table 3. Category breakdown of readability scores of health information websites.

Readability scores	Number of websites (n=90)
FKRE scores	
Easy (80-100)	7
Average (60-79)	39
Difficult (0-59)	44
New Dale Chall score	
4 th grade and below (<4.9)	2
5.0-5.9 (5 th -6 th grade)	9
6.0-6.9 (7 th -8 th grade)	26
7.0-7.9 (9 th -10 th grade)	27
8.0-8.9 (11 th -12 th grade)	26
9.0-9.9 (Graduate)	0
10 and above (Post-graduate)	0
Spache readability score	
4 th grade and below (<4.9)	2
5.0-5.9 (5 th -6 th grade)	2
6.0-6.9 (7 th -8 th grade)	79
7.0-7.9 (9 th -10 th grade)	7
8.0-8.9 (11 th -12 th grade)	0
9.0-9.9 (Graduate)	0
10 and above (Post-graduate)	0
Flesch Kincaid grade level	
0-1 (1 st grade)	0
1-5 (1 st grade-5 th grade)	8
5-11 (5 th grade-11 th grade)	55
11-18 (11 th grade-18 th grade)	27
Gunning-fog Index	
5.0 (Very easy)	0
5.1-6.0 (Easy)	2
7.0-8.0 (Fairly easy)	2

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8.0-9.0 (Standard English)	7
10.0-12.0 (Fairly difficult)	31
13.0 -16.0 (Difficult)	25
More than 16 (Very difficult)	23
Coleman-Liau index	
5 and below (5 th grade)	1
6 (6 th grade)	2
7 (7 th grade)	3
10 (8 th grade-10 th grade)	21
11-12 (11 th and 12 th grade)	20
13-16 (College)	43
17+ (Professional)	0
SMOG index score	
4.9 or lower (Elementary school)	0
5-8.9 (Middle school)	7
9-12.9 (High school)	83
13-16.9 (Undergraduate)	0
17 or higher (graduate)	0
Automated readability index	
0-1(1 st grade)	0
1-5 (1 st grade-5 th grade)	5
5-8 (5 th grade-8 th grade)	35
8-11 (8 th grade-11 th grade)	38
11 and above (11 th grade-college)	12

Discussion

Internet access has increased the number of resources available for use as educational materials, however the writing style and language of the majority of publications related to medicine favour only a narrow segment of the wider population. It's crucial that patients have access to accurate and pertinent medical information in all healthcare settings to avoid misinformation, confusion, and unnecessary stress. However, content that is offered online in a manner that is outside the scope of the broader public prevents it from being used efficiently. According to the standards established by the AMA the information must be written at a sixth-grade reading level or lower in order to be accessible to the general public. The American Medical Association (AMA) and National Institutes of Health (NIH) recommend health information to be written at a 6th grade or lower reading level.

In the present study, Google, Yahoo, and Microsoft Edge were used to evaluate the readability of websites related to oral cancer. Google is the top most website which is used in India. 90 of the top 100 search results met the criteria for inclusion in

this study, and as a result, they were analysed using seven readability assessment tools. Only seven websites, as shown in Table 3, met FKRE's required levels, eleven websites met the criteria of new Dale Chall index, only four websites met the inclusion criteria of Spache readability index and gunning fog index while only seven websites met the criteria for SMOG index and Coleman Lieu index. None of them were able to satisfy all seven evaluation criteria, demonstrating that online medical content is often not written at a level that is suitable for the average person. This study, which we believe is one of the few to use these seven readability assessment tools to evaluate the readability of online patient education content specifically related to oral cancer, demonstrates that finding websites with information on the disease is simple, but many of them were difficult to understand. Information often missing in the oral cancer websites included complication and risk of treatments and quality of life information which was in accordance to a similar study done on colorectal cancer by P Grewal et al., using different readability formulas. In a previous study done by Kher A et al., it was determined that the average readability of Wikipedia.org, MayoClinic.org, WebMD.com, Medicine.net, and NIH.gov on the disease-

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specific issue of congestive heart failure was higher than the suggested sixth-grade reading level. This was in line with the outcomes of our study when the average of the readability assessment scores from all seven methods was considered.

Our results were consistent with a study done by Bhatia S et al., to assess the patient material resources on the internet for oral cancer and revealed that a majority of the websites were fairly difficult to comprehend and readable only by college-level graduates which shows that there is a definite need to monitor the quality of the websites on oral cancer. Another study done by Varella P, et al., on oral cancer websites revealed that the mean scores for readability were within the range of “difficult to read” (FRES=46.04 (14.87)) with high educational requirements (FKRGL=11.44 (3.27)) which was similar to the results of our study in which the mean FRES were found to be 54.3 and FKRGL to be 9.4.

Conclusion

In our study, 44 websites (according to FKRE) and 79 websites (according to the gunning fog index) out of the total websites that were analysed indicated that the text was difficult to read whereas according to the Gunning-Fog index, only 4 websites of the total websites were very easy and easy to read while 31 websites were comprehended as fairly difficult and 48 websites were found to be very difficult. According to the Spache readability index only 4 websites were found to be below 6th grade level while 86 websites were above 6th grade level. According to New Dale Chall index, only 2 websites met the easily readable criteria while according to the Coleman-Liau index only 3 websites were easily readable and 87 websites were above 7th grade reading level. According to the automated readability index 5 websites were within 1st grade to 5th grade level and 85 were above the 5th grade level in which 12 websites were at 11th grade and college grade reading level. According to WHO recommendations, oral health practitioners should be involved in the early detection and diagnosis of oral cancer. Even though improving oral cancer screening knowledge and abilities is generally regarded as the primary educational goal associated with secondary prevention, there are still knowledge gaps in this area among the general public and health care professionals, which may limit the efficacy of oral cancer screening. In this regard, web-based resources for oral cancer may help to improve the current circumstances, especially by establishing global cooperation networks and electronic websites that contain global training material.

Limitations

The assessment of health information's readability using readability formulas has an inherent flaw. The equations, which depend only on the quantity of words and syllables in a sentence, may not adequately reflect reading level.

All the websites which were analysed were only in English language.

Recommendations

The text on patient education websites should be kept at a sixth-grade reading level or lower to maximise the number of patients who can access the information.

The NIH states that this is crucial for the first few lines of text in especially since if the reader has trouble grasping the content at the outset, they may give up reading entirely. Improvements are required to provide patients with reliable information to make well informed decisions and choices on medical treatments. Health experts should suggest and assist in creating websites that are simple to read and have excellent medical information. The website needs to offer sufficient details on the available treatments, particularly how each will impact the patient's quality of life.

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