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Original research article

Fluoride and the internet: an assessment of online information available to the public

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Abstract

Objective: Obtaining information online in health-related issues is becoming increasingly important among patients and parents. Parents are concerned about their children's fluoride use and tend to search on the internet. In this regard, the aim of this study is to assess the reliability, quality, accessibility, and readability of websites giving information on fluoride treatment.

Materials and Method: Two search terms, "fluoride treatment for kids" and "is fluoride varnish safe?", were entered into the search engines of both Google and Yahoo, and the first 50 websites were saved. After excluding duplicate sites, promotional product sites, blogs/forums, news and articles, the remaining websites were evaluated. The DISCERN and LIDA tools were used to assess reliability, quality, and usability of websites. The accessibility of websites was assessed with AChecker tool while the readability was assessed with FRES instrument.

Results: Of the 200 websites saved, 94 were suitable for inclusion. The mean total DISCERN score was 53±11.2 of a possible total of 80 (66%). With the LIDA instrument, the average score for reliability was 11.8±3.9 of a possible total of 27 (43%) while the average score for usability was 31.2±7 of a possible total of 54 (58%). The mean total AChecker score was 21.8±37 and the mean FRES score was 57.7± 11.6 (of a possible total of 100) indicating a level of fairly difficult to read.

Conclusion: Information about fluoride on the internet is easily accessible although the reliability and quality were highly variable. The readability of websites should be improved to be more understandable.

Keywords: Fluorides; internet; pediatric dentistry; topical

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Introduction

The Internet has recently been a popular source of information on health-related issues.[1] In 2007, 71% of internet users searched for health-related information and/or health-related products on the internet in Europe.[2] Similarly, in the United States, 74% of internet users searched online about medical issues in 2011.[3] A similar tendency has also been observed for oral health information. Patients using the internet for health-related searches utilize the internet for various purposes, such as to find information about a condition, treatment, or symptoms and advice about treatment or symptoms.[4,5]

Internet users and/or patients can access health information through online sources such as discussion groups, personal or advertising/marketing websites, and open-access journal articles.[5] However, thousands of websites can be found by patients, and it is difficult to determine which information is reliable and valid. Unfortunately, there is no regulation of the content of health information on the internet. The information can be written by any individual, company, or organization and without peer review. Thus, the quality and accuracy of the information on the internet is not always known.[6,7] There are several specialized tools and methods under development to help users evaluate and rate the quality of websites. Some of the most commonly used tools are LIDA (Minervation Ltd, Oxford, UK; www.minervation.com/lida-tool) and DISCERN (University of Oxford, UK; www.discern.org.uk/discern_instrument.php).

Several studies have assessed the quality of information on specific topics related to dentistry available on the internet, such as orthognathic surgery,[8] orthodontic extractions,[9] adult orthodontics,[10] pain during orthodontic treatment,[1] and orthodontic retainers.[11] Trends in health-related research on the internet also affect pediatric dentistry. Parents and/or caregivers are using the internet to learn about dental treatments for their children. Fluoride application is one of the treatments that parents have doubts about due to wrong and inadequate information.[12]

In many countries, fluoride is used regularly to reduce the prevalence and severity of dental caries. Fluoride is safe and effective in preventing and controlling dental caries when used appropriately.[13] The American Academy of Pediatric Dentistry (AAPD) recommends a professional fluoride application at least every 6 months for children at risk of caries. The type and frequency of preventive fluoride application should be modified if the risk categories change over time.[14] A significant number of parents and caregivers may refuse preventive treatment due to concerns about their child receiving fluoride. Topical fluoride refusal and resistance may result from many reasons, such as cases of accidental hyper-fluoridation of community water and concerns about fluoride safety or dental fluorosis.[15] Parents tend to research the benefits and risks of fluoride on the internet before fluoride application.

The quality of the health information that parents' access on the internet pertaining to fluoride treatment is unclear and has not been investigated previously. The aim of the present study id to evaluate the reliability, quality, accessibility, and readability of information on the Internet about fluoride treatment that is accessed by parents. The null hypothesis tested is that the reliability, quality, accessibility, and readability of information available on the Internet on fluoride treatment are of a high quality.

Materials and Method

The present study was conducted by accessing online information about fluoride on the internet; therefore, ethical approval was not required.

Search methods

The Internet search was conducted in September 2018 using the Google (www.google.com) and Yahoo (www.yahoo.com) search engines. In order to simulate the methods that a parent may use when searching the Internet, two keyword terms "fluoride treatment for kids" and "is fluoride varnish safe?" were used. The top 50 websites from each engine were saved and collected to unify repetitions. The URL (unique resource locator), ownership, and country of the 200 websites were recorded. The exclusion criteria were as follows: duplicate sites, promotional product sites, blogs/forums or discussion groups, video feeds, news articles, and links to scientific articles (Figure 1, flowchart).

Quality evaluation

The included websites were then assessed by one operator using the DISCERN and LIDA tools. Intra-operator agreements were determined for all parts of DISCERN and for the usability and reliability parts of LIDA, which were re-evaluated 1 month after the initial assessment. The accessibility (AChecker) and readability (FRES) were calculated with online software without any agreements.

The DISCERN, developed in 1999, is a valid instrument to assess the quality and reliability of consumer health information. The instrument consists of three sections with 16 questions. Each question can be scored from 1 (low/poor) to 5 (high/excellent), resulting in a total score ranging from 16 to 80. Section 1 assesses the reliability with 8 questions (score ranging from 8 to 40), section 2 focuses on treatment options with 7 questions (score ranging from 7 to 35), and section 3 provides an overall rating of the quality of the websites based on 1 question (score ranging from 1 to 5).[16]

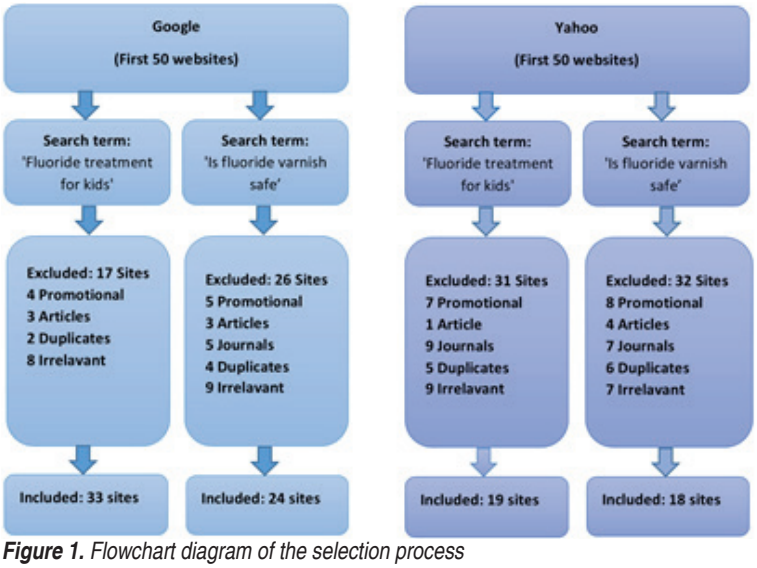

Figure 1. *Flowchart diagram of the selection process*

Table 1. Websites evaluation parameters, measurement tools and achievable scores

Measurement Tools	Parameters	Scoring (minimum and maximum scores)
DISCERN	Quality	7-35
	Reliability	8-40
LIDA	Reliability	0-27
	Usability	0-54
AChecker	Accessibility	Not applicable
FRES	Readability	0-100

The LIDA, developed in 2002, is a valid instrument to assess the content of health care websites comprehensively in three different areas: usability, reliability, and accessibility. The instrument consists of 43 questions, and each question is scored on a scale of 0 (never) to 3 (always). The usability score is computed by evaluating the clarity, consistency, functionality, and intelligibility of the websites. The reliability score is based on three main areas regarding the content of websites: currency, conflicts of interest, and content production. The accessibility score is calculated automatically by entering the URL of websites at http://www.minervation.com/lida-tool.[17] However, the accessibility part of LIDA did not work, and the provider suggested using the AChecker tool for the assessment.

The AChecker, developed in 2009, is a valid instrument to assess the accessibility of websites and contains recommendations for making content accessible to a wider range of people with visual, cognitive, motor, auditive, or speech disabilities. AChecker defines three levels of problems: "known," "likely," and "potential." Known problems are identified as certain accessibility barriers and should be resolved by website owners. Likely problems are probable barriers that require a person to identify. Potential problems cannot be detected by the AChecker and require human judgment. In this study, known problems were reported.[18]

Readability evaluation

The Flesch Reading Ease Score (FRES), developed in 1948, was used to assess the readability of websites. FRES automatically calculates the level of readability by rating the average length of sentence and the number of syllables per word. Calculated score ranges from 0 to 100, with higher scores relating easier reading of text. Scores between 90 and 100 are considered easily understood by a 10- to 11-year-old, whereas scores between 60 and 70 are easily comprehended by 13- to 15-year-old, and scores between 0 and 30 considered that is best understood by a university graduate. For the health information, a score of 90 to 100 is recommended. To assess the level of readability, an abstract from each included website consisting of 200 to 500 words was entered into an online FRES calculator.[19]

Statistical analysis

Descriptive statistics were performed to present the results. Intra-operator agreement for the DISCERN and LIDA scores were determined using intra-class correlation coefficients

Results

Search results

Two thousand websites were selected by Google and Yahoo search engines, and 106 of them were not included in the evaluation. These consisted of promotional product sites, irrelevant and duplicate sites, articles, and scientific article or journal links. Of the remaining 94 websites were scored (Figure 1). The majority of included websites were from the United States (n=70; 75%), followed by United Kingdom (n=16; 18%), and Canada (n=8; 7%).

Forty-nine (54%) websites were owned by private practices. The ownership of 16 websites (18%) were categorized as public institutions, which are state-owned entities. There were 14 websites (15%) owned by private institutions. These websites consisted of non-governmental and non-profit research organizations. Only 12 websites (13%) were owned by private individuals including public discussion groups and formal blogs.

Quality evaluation

Intra-class correlation coefficient for DISCERN was 0.935. The mean total DISCERN score was 53±11.2 of a possible total of 80 (66%). The average score for the reliability section of DISCERN was 26.7±6.5 of a possible total of 40 (67%). The average score for the quality of information section of DISCERN was 23±4.7 (57%). The maximum DISCERN score was 78 of 80 and the lowest score was 29 of 80. The majority of websites fell below the maximum score according to DISCERN of the remaining 94 websites that were scored. The highest score of 78 (97%) was attained by the health care and patient safety service part of a governmental website. Interestingly, the lowest score of 29 (36%) was also attained by a governmental website (Figure 2).

Intra-class correlation coefficient for LIDA was 0.875. The mean total LIDA score could not be calculated because the accessibility part was broken. The average score for reliability section of LIDA was 11.8±3.9 of a possible total of 27 (43%). The results for reliability fell substantially below the expected standard. The highest score of 23 (85%) was achieved by a private practice website developed by pediatric dentists. The lowest score of 2 (9%) were obtained from two websites especially aimed at explaining the pediatric dental treatments. The average score for usability section of LIDA was 31.2±7 of a possible total of 54 (58%). The most usable website was produced by American Dental Association, achieving a score of 47 (85%), whereas the least usable was a private practice

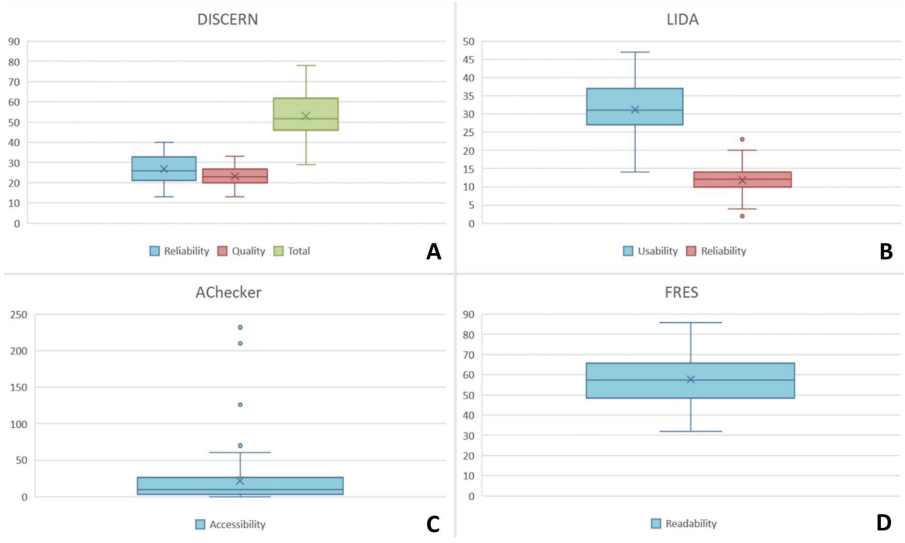

Figure 2. *Box-and-whisker diagrams illustrating the mean DISCERN, LIDA, AChecker and FRES scores; (A) the mean DISCERN scores: reliability, quality and total, (B) the mean LIDA scores: reliability and usability, (C) the mean AChecker score: accessibility, (D) the mean FRES score: readability*

website owned by general dentists with a score of 14 (26%) (Figure 2).

The mean total AChecker score was 21.8±37. The maximum AChecker score achieved by one of the websites was 232, and the lowest score achieved by twelve websites were 0 (Figure 2). The most frequent accessibility error types reported by AChecker were "scripts must have functional text", "text equivalents", and "accessible forms".

Readability evaluation

The mean FRES score was 57.7±11.6 indicating a level of fairly difficult to read. A website giving information for children health developed by physicians, nurses and dentists got the highest score of 85.6. The lowest score of 32 was obtained from a private practice website developed by general dentists (Figure 2). The null hypothesis was rejected according to these results.

Discussion

Access to information online is becoming more and more important for healthcare providers. However, parents may have difficulty using this resource to access accurate and reliable information regarding their children. Indeed, this study has found that the quality of online information about fluoride treatments is variable.

To the best our knowledge, this study was the first to investigate the quality of information about fluoride treatments on the internet. However, it was not without a precedent; in dentistry, similar studies have been conducted on the quality of online information about orthodontics. For the present study, both Google and Yahoo searches were used to find almost a million sources on fluoride treatments. Although many of these results were accessible, search engine users tended to search no further than the first few pages. Thus, only the first 50 websites from each search engine were investigated, similar to other studies.[9,10]

It was determined that the majority of the search results originated in the United States of America. This trend could be explained by the fact that the USA had the second greatest number of internet users worldwide, after China. Subsequently, the quality of information about fluoride on the internet was assessed using four methods: DISCERN, LIDA, AChecker and FRES. DISCERN and LIDA are commonly used tools to extensively evaluate sources, so the majority of extant research on the quality of health related websites had been conducted using these tools.[8-11] AChecker was used as well because the accessibility part of LIDA was broken, and AChecker was a quick method for evaluating the parameter. LIDA's developer recommended AChecker for this purpose as the tool was free of charge and easy to use, and it subjectively and automatically reported accessibility errors for three domains (known, likely, and potential problems). Finally, FRES was used as it was designed specifically for measuring the readability of websites (i.e., how easy it was to read passages of text).

This parameter was important for evaluating websites that included health information. Overall, the study's DISCERN findings were similar to those of other studies.[10,11] However, the mean total DISCERN score was lower than the mean total DISCERN scores reported by Aldairy *et al.*[8] with regards to orthognathic surgery. The difference may have been due to the fact that the websites about fluoride treatments used fewer sources and had less current information than the websites on orthognathic surgery. Additionally, the majority of the websites on fluoride treatments did not contain additional sources of information, and this reduced each website's quality.

It was also found that the mean LIDA score for website reliability (43%) was lower than the mean LIDA score for usability (58%). These results were similar to those of previous studies, in which reliability was the lowest scoring domain.[1,9,10] Indeed, reliability scores of 16%-67% were noted for websites on orthodontic pain,[9] orthodontic retainers,[1] orthodontic practices,[20] and oral hygiene instructions.[21] These low scores could be attributed to irregular updates, missing references, and missing descriptions of ownership.

In contrast, although some studies used AChecker to evaluate the accessibility scores of general health websites, only one study assessed orthodontic websites.[22-24] The researchers, Aghasiyev and Şen Yılmaz,[24] reported fewer accessibility errors than those found in the present study. However, the present study's accessibility scores were in agreement with those found in general health studies. The difference may have been caused by increased awareness about the importance of website accessibility among website designers.

Finally, the FRES scores for the websites on fluoride treatments indicated that the websites were difficult to read. These scores were lower than FRES scores for orthodontic websites that were examined in previous studies.[1,9,10] To improve these scores, healthcare-based website designers should be encouraged to ensure website readability by communicating a broad range of messages to a wide variety of readers. Additionally, designers should consider the use of short words and sentences and avoid using medical language.

Further, the use of unreliable and poor quality information on websites about fluoride treatments may cause unfavorable outcomes as parents may use this information to determine whether to pursue fluoride treatments for their children. For example, hesitancy and refusal to use fluoride has been noted among caregivers as fluoride safety is a significant concern among this demographic;[15,25] and this phenomenon is similar to the opposition of some caregivers to vaccinations. A consequence is that many children do not benefit from the preventive effects of fluoride even though fluoride is safe. Indeed, topical fluoride applications are safe and effective procedures for preventing dental caries.[14] Thus, caregivers need improved access to accurate and reliable information on the internet. National health services and specialized pediatric dentistry societies should work on developing definitive internet sources on commonly searched and controversial topics in the dental field.

The present study has several strengths in terms of methodology. One of the strengths of our study is to conduct the research using two separate keywords related to fluoride. Many previous studies have been conducted by searching for only one related keyword. In addition, not only the reliability and quality of the websites, but also their accessibility and readability were evaluated using different measurement tools in our study. However, it should be noted that the present study had some limitations. First, the search was limited to the English language and conducted by only one operator. However, this method was similar to the methods used for extant research in the dental field in regards to assessing information on the internet.[10,11] Second, the results of this study reflected only fluoride-related websites active in September 2018; however, websites are frequently updated and can change over time due to the dynamic nature of the internet. Thus, future studies may obtain different results while conducting the same research.

Conclusion

Information about fluoride treatment on the internet is easily accessible although the reliability and quality were highly variable. The readability of websites should be improved to be more understandable. Accurate and reliable internet sources are required for fluoride treatment.

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Florür ve internet: halkın kullanımına sunulan çevrimiçi bilgilerin değerlendirmesi

Özet

Amaç: Sağlık ile ilgili alanlarda çevrimiçi olarak bilgi edinme, hastalar ve ebeveynler arasında giderek daha önemli hale gelmektedir. Ebeveynler, çocuklarına florür uygulanmasından endişe duymakta ve internette arama yapma eğilimindedirler. Bu bağlamda, bu çalışmanın amacı, florür tedavisi ile ilgili bilgi veren internet sitelerinin güvenilirlik, kalite, erişilebilirlik ve okunabilirlik açısından değerlendirilmesidir.

Gereç ve Yöntem: 'Çocuklar için florür tedavisi' ve 'florür vernik güvenli mi?' anahtar cümleleri Google ve Yahoo arama motorlarına yazılarak aratılmış ve çıkan ilk 50 internet sitesi kaydedilmiştir. Yinelenen siteler, promosyon ürün siteleri, bloglar/forumlar, haberler ve makaleler çıkarıldıktan sonra kalan internet siteleri çalışmaya dahil edilmiştir. DISCERN ve LIDA araçları, internet sitelerinin güvenilirliğini, kalitesini ve kullanılabilirliğini değerlendirmek için kullanılmıştır. İnternet sitelerinin erişilebilirliği AChecker aracı ile, okunabilirliği ise FRES aracı ile değerlendirilmiştir.

Bulgular: Kaydedilen 200 internet sitesinden, 94'ü değerlendirme için uygun bulunmuştur. Ortalama DISCERN skoru, olası toplam 80 puan üzerinden 53±11.2'dir (%66). LIDA aracı ile, güvenilirlik için ortalama skor, olası toplam 27 puan üzerinden 11.8±3.9 (%43) iken, kullanılabilirlik için ortalama skor, olası toplam 54 puan üzerinden 31.2±7'dir (%58). Ortalama toplam AChecker skoru 21.8±37 ve FRES skoru okunması oldukça zor bir seviyeyi işaret eden 57.7±11.6'dır (olası toplam 100 puan üzerinden).

Sonuç: İnternetteki florür hakkındaki çevrimiçi bilgiler, güvenilirlik ve kalite açısından oldukça değişken olmasına rağmen, kolayca erişilebilir olarak saptanmıştır. İnternet sitelerinin okunabilirliği daha anlaşılır olacak şekilde geliştirilmelidir.

Anahtar Kelimeler: Çocuk diş hekimliği; florürler; internet; topikal