CENTRO INTERNACIONAL DE ESTUDOS
DE DOUTORAMENTO E AVANZADOS
DA USC (CIEDUS)

TESIS DE DOCTORADO

ANALYSIS OF THE QUALITY AND READABILITY OF THE DENTAL INFORMATION FOUND ON WEB PAGES

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ESCUELA DE DOCTORADO INTERNACIONAL EN CIENCIAS DE LA SALUD DE LA USC

PROGRAMA DE DOCTORADO EN CIENCIAS ODONTOLÓGICAS

SANTIAGO DE COMPOSTELA

2020

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En Santiago de Compostela, 14 de febrero de 2020

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D. Juan Manuel Seoane Leston

D. Pablo Ignacio Varela Centelles

Agradecimientos

Tras varios años de trabajo en este proyecto, tengo que agradecer a los doctores Juan Seoane Leston y Pablo Varela Centelles la dedicación y comprensión que han tenido conmigo. La recta final fue compleja, pero nunca desistimos. Es un hecho el decir que sin ellos, esto no sería posible y se hubiera quedado en un intento.

A los colegas de profesión que más admiro, todo un ejemplo en muchos sentidos, mis padres. Viviana Ludi y Luis Ledesma, que lo dieron todo para obsequiarnos a mi hermano y a mí con una vida mejor, una gran educación y amor por esta profesión. A ellos les debo todo y sin ellos no sería quien soy.

A Marcos Ledesma, que nadie te pare, algún día espero devolverte los cuidados en momentos difíciles. Espero estar ahí yo también cuando consigas tus metas. Un amigo y hermano, gracias por tu apoyo y alegría.

Por último, agradecer a la persona que durante casi catorce años ha estado a mi lado, me ha visto crecer y avanzar en la vida y mi profesión, siempre con cariño y apoyo. Gracias por darme alas Adrián.

Aspectos éticos

Esta tesis se basa en información existente, no contiene ningún dato personal. Se basa en información anónima y, por lo tanto, el estudio no necesita ni la evaluación del comité de ética de investigación ni su informe.

La estudiante de doctorado declara que no tiene ningún conflicto de intereses en relación con la tesis doctoral.

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1. Resumen

En 2019, la población mundial superó los 7.7 mil millones de personas, Asia reúne el 55% y representa también más de la mitad de los usuarios de internet, en tanto Europa es la tercera en población (10.7%) y se encuentra en segundo lugar en cuanto a usuarios y Norteamérica es la quinta respecto a la población mundial pero ostenta el mayor porcentaje de usuarios por área geográfica (Internet World Stats, 2019).

El acceso a la información en internet se hace habitualmente a través de un motor de búsqueda. Ocho de cada diez consultas de salud online comienzan con un buscador (Fox & Duggan, 2013). Desde 2009 hasta la actualidad el más usado es Google®, por encima del 90%, seguido por Yahoo!® y Bing®, que apenas superan el 2% cada uno (Statcounter, 2018). Las búsquedas realizadas en Google® ocupan el sexto lugar en cuanto a actividades hechas en un minuto en internet (Clement, 2019).

Los usuarios encuentran información para responder a una pregunta en menos de 6 minutos, pero no visitan secciones referentes a la calidad y origen de los contenidos de las webs (Eysenbach & Köhler, 2002) y la mayoría accede sólo a las tres primeras webs ofrecidas por el buscador (Wang et al, 2012).

Dentro del ámbito oncológico, en pacientes con cáncer de tiroides, el 87% usaron internet para buscar información y más del 50% de las decisiones de tratamiento fueron afectadas por los resultados obtenidos (Chang et al, 2019). La incidencia de cáncer oral tiende a aumentar (Alsoghier et al, 2018), y el 54% de pacientes con cáncer de cabeza y cuello confían en internet para encontrar información sobre su tratamiento, efectos secundarios y sobre cómo mantener su salud (Rogers et al, 2012).

En cuanto a salud en general, una revisión sistemática demostró una baja calidad de información sanitaria online (Daraz et al, 2019). En el campo odontológico se encuentran resultados muy variados en ortodoncia (McMorrow & Millett, 2016; Olkun et al, 2019); en cuanto a implantes hay un cierto consenso en la dificultad de la legibilidad de la información (Jayaratne et al, 2014) y su baja calidad (Ali et al, 2014) en páginas web. En endodoncia la legibilidad es variable (Woodmansey, 2010) y sobre cáncer oral, la legibilidad en español se encuentra por debajo del inglés (Irwin et al, 2011).

Teniendo presente lo descrito en la literatura dental hasta la fecha, resultan llamativas la variabilidad en los resultados y las limitaciones metodológicas que dificultan la obtención de una imagen de conjunto sobre la situación de la información odontológica dirigida a pacientes que se ofrece en páginas de internet: en el caso del cáncer oral los estudios emplean un número limitado de índices de legibilidad (lo que podría introducir un sesgo en los resultados), en el campo de la endodoncia la información disponible procede de un único estudio sobre una muestra reducida, al igual que ocurre con la calidad de la información implantológica. Está además por aclarar una hipotética influencia de los motores de búsqueda en las características de la información que ofrecen a través de la preselección y prelación de los resultados que presentan al lector. Esta situación hace necesario progresar en la investigación sobre la comprensión y la calidad de la información que se ofrece a los pacientes, vista la influencia que las fuentes online tienen en la formación de opiniones de salud y su peso en la toma de decisiones.

Además, en las últimas dos décadas se han validado escalas que permiten evaluar la calidad de la información sanitaria en internet. Así, se creó DISCERN, un conjunto estandarizado de criterios para juzgar la calidad de la información de salud escrita para el público general (Charnock et al, 1999). Es un cuestionario de 16 preguntas que se puntúan del 1 al 5 (de baja a alta calidad), con un bloque sobre fiabilidad, otro sobre alternativas de tratamiento y un ítem final para la puntuación global de la web (Charnock & Shepperd, 2004).

Otra herramienta disponible es el instrumento LIDA, que analiza tres dimensiones: la accesibilidad, la utilidad y la fiabilidad de la

información. La primera se mide de manera automática en la web www.minervation.com/validation, la utilidad y fiabilidad respondiendo un cuestionario (puntuaciones de 0 al 3) (Minervation, 2012; Kucukdurmaz et al, 2015).

También existen sellos de acreditación sanitaria que buscan verificar la calidad y reputación de la información que se ofrece, como el Health on the Net Foundation (HONcode seal) que informa sobre la intención de una web de publicar información transparente cumpliendo un código ético (Health On the Net Foundation, 2018).

Respecto al análisis de la legibilidad, se han desarrollado diferentes fórmulas que permite evaluar la dificultad de lectura empleando distintas herramientas que deben adaptarse a las peculiaridades gramaticales y semánticas de cada idioma (Slyh & Hansen, 2010). Para el inglés contamos con seis fórmulas: Flesch Reading Ease Score (FRES), Flesch-Kincaid Reading Grade Level (FKRGL), Gunning Fog Index (GFI), Coleman-Liau Index (CLI), Automated Readability Index (ARI) y Simple Measure of Gobbledygook Index (SMOG). Sin embargo, para el español tan solo han sido validados dos índices: Fernández-Huerta e INFLESZ. Todos ellos basados en cuantificar oraciones, palabras, sílabas o caracteres. Sus resultados se traducen en el nivel de estudios que debe tener el lector para la compresión del texto. Para el público en general estima que el nivel apropiado es de octavo curso. Los cálculos pueden llevarse a cabo de forma manual o automatizada mediante aplicaciones específicas.

El mayor interés a lo largo del tiempo de la población lega, en términos de volumen de búsquedas en internet, sobre implantes dentales, cáncer oral y tratamiento de conductos, condicionó y priorizó nuestros objetivos de investigación. Además se han utilizado las mismas herramientas e índices para el análisis de la legibilidad en todos nuestros estudios, lo que proporciona coherencia a nuestra tesis doctoral.

Así pues, los objetivos de esta tesis fueron:

1. Evaluar la calidad de las webs relacionadas con implantes dentales dirigidas a pacientes en términos de fiabilidad, accesibilidad, utilidad y legibilidad, así como analizar las

diferencias en la información proporcionada por los buscadores de internet más utilizados (Google® y Yahoo!®).
2. Evaluar la legibilidad de la información online sobre cáncer oral.
3. Evaluar la legibilidad de la información en internet dirigida a pacientes sobre endodoncia en inglés y español.

1.1 METODOLOGÍA

Para la consecución de los objetivos previamente formulados se analizaron dos motores de búsqueda (Google® y Yahoo!®), utilizando los descriptores de interés, previamente confirmados como los más populares para la búsqueda por la población general en internet: implantes dentales, cáncer oral, y tratamiento de conductos radiculares. En nuestro último estudio se analizó de forma comparativa el idioma inglés respecto al español, y para utilizar los descriptores adecuados en español se llevó a cabo un estudio piloto mediante un cuestionario a 162 pacientes que asistieron a la unidad de endodoncia de la Facultad de Medicina y Odontología (Universidad de Santiago de Compostela) para identificar el tema más buscado en internet, el cual resultó ser "¿Qué es una endodoncia?". Para verificar la consulta se usó Google Trends el cual detecta las búsquedas realizadas en Google® en un momento y lugar determinados (Nuti et al, 2014). Se registró un alto uso de estos términos en países de habla hispana, por ello fueron utilizados para realizar la búsqueda en español.

Se confeccionaron listados de las 100 primeras webs obtenidas en cada motor de búsqueda. Se excluyeron las webs irrelevantes, únicamente comerciales, duplicadas, foros y grupos de discusión, webs no operativas y las protegidas por contraseña. Las que cumplieron los criterios de inclusión se categorizaron por especialización y filiación. También se consideraron indicios de reputabilidad (HONseal).

Como índices de legibilidad para el inglés se utilizaron: FRES, FKRGL, GFI, CLI, ARI y SMOG. Cuando se analizaron las webs escritas en español, se utilizaron como herramientas los índices

Fernández Huerta e INFLESZ. Cuando se analizó la calidad de las webs se usaron las escalas DISCERN y el instrumento LIDA.

El cálculo de los índices se hizo de forma automatizada y fue chequeado de forma ocasional mediante procedimientos manuales.

1.2 RESULTADOS

En base a que esta tesis doctoral ha sido concebida desde el principio, como una tesis por compendio de artículos, a continuación se presenta un resumen de los resultados obtenidos.

El análisis de la información sobre implantes dentales ha permitido evidenciar que las webs de Yahoo!® han mostrado información más relevante, mejor descripción de los beneficios del tratamiento y puntuaciones de utilidad significativamente más altos que Google®. Sin embargo muy pocas, sólo tres de ellas, estaban acreditadas con HONseal. Los resultados de legibilidad se encontraron dentro del rango de difícil lectura (FRES = 51,72 [38,70–55,27]; FKRGL = 12,76 [10,07–14,87]). Respecto a la calidad, la puntuación media para la calificación general del cuestionario DISCERN fue 3 (rango: 2-3) lo que supone una deficiencia grave de la calidad. En esta línea, el instrumento LIDA reveló porcentajes modestos de accesibilidad (79,36 [74,60–85,31]) e intermedios tanto de utilidad (59,20 [50,46–68,51]) como de fiabilidad (55,55 [45,37–66,66]).

Cuando analizamos la legibilidad de los sitios web con información sobre cáncer oral hemos obtenido una puntuación promedio dentro del rango de difícil lectura, la cual requiere altos niveles de comprensión y de health literacy. Se accedió a través de Google®, Yahoo!® y HONsearch para pacientes utilizando los términos “oral cancer” con interfaz inglesa, sin localización predeterminada ni filtros. Se excluyeron 47 webs de Google®, 57 de Yahoo!® y 89 de HONsearch. Finalmente se estudiaron un total de 119 páginas. Los índices de legibilidad tuvieron una puntuación media dentro del rango de “difícil lectura” (FRES = 36,04 (14,87)) la cual requiere altos niveles de comprensión (FKRGL = 11,44 (3,27)). Estos resultados muestran una mayor dificultad de lectura para la información focalizada en cáncer oral respecto a la disponible para implantes dentales.

De otra parte, cuando comparamos la legibilidad de la información online proporcionada por webs escritas en inglés con contenidos sobre tratamientos endodónticos (root canal treatment), la legibilidad se ha encontrado dentro de la categoría de "normal", fácil de entender para estudiantes de 13 a 15 años (IQR) [53,9-66,2]; GFI, 10,4, IQR [8,8-12]; CLI, 12,5, IQR [11,6-13,3]; ARI, 8,6, IQR [6,7-9,8]) Incluso el SMOG mostró valores compatibles para alumnos de 7 años (SMOG, 7,6, IQR [6,5-8,8]). Las webs en español obtuvieron índices de legibilidad normal para un adulto, equivalente a séptimo u octavo grado (Fernandez-Huerta, 62,3, IQR [59,7-66,6]; INFLESZ, 57,5, IQR [55,1-62,1]). Estos resultados no mostraron diferencias significativas entre la legibilidad de las webs en español o inglés. Aún así, al comparar diferentes grados de dificultad de lectura, en inglés el 36,6% tienen cierto grado de dificultad en la legibilidad, mientras que en español este porcentaje es del 23%. Particularmente, en inglés las webs clasificadas como difíciles o muy difíciles fueron del 15,3%, mientras que en español fue solo del 1.5%, esta diferencia, alcanzó valores estadísticamente significativos.

Considerados de forma agrupada, las webs con información sobre cáncer oral han mostrado unos preocupantes índices de dificultad para la comprensión lectora por encima de los obtenidos para los implantes dentales y los tratamientos endodónticos.

1.3 DISCUSIÓN

A pesar de obtener resultados semejantes a otras investigaciones, existen algunas limitaciones: los estudios se centraron en el idioma inglés preferentemente y uno también en español. Aunque existe contenido en otros muchos idiomas en la red, con estos dos se cubre una amplia proporción de la población ya que el inglés es el idioma más hablado en el mundo (Ethnologue, 2019).

Los motores de búsqueda no actúan de forma neutra, introduciendo un posible sesgo de selección, ya que el orden de los resultados no es idéntico para todos los casos y si se añade el hecho de que la población en general solo accede a los tres primeros resultados (Wang et al, 2012) el problema se agrava. Para minimizar este sesgo e intentar recoger las páginas que un usuario no profesional obtendría,

se recolectó una amplia muestra de 100 webs por búsqueda, muy superior a lo que un usuario medio utilizaría.

Hay un gran número de motores de búsqueda, sin embargo a través del uso de Google®, que ostenta el 90% de cuota entre todos los buscadores, y Yahoo!®, que ocupa el segundo o tercer lugar (Statcounter, 2018), quedan cubiertas la mayoría de las búsquedas que pueda hacer un usuario lego (Fox & Duggan, 2013), proporcionando una mayor validez externa al estudio.

La lingüística cuantitativa reduce un idioma al recuento de oraciones, palabras, sílabas y caracteres, lo que podría no reflejar la realidad de una lengua (Notorc, 2006). No sólo la extensión de las palabras condiciona su complejidad, la frecuencia con que se utiliza afecta también a su legibilidad (cuanto más se use una palabra, más fácil de entender será) (Seely, 2013). También se debe tener en cuenta las variaciones de un mismo idioma en diferentes regiones, e incluso entre diferentes culturas.

Todas las fórmulas de legibilidad utilizadas tanto para inglés como para español plantean un posible problema en cuanto a su interpretación. Todas ellas se entienden como el nivel escolar que debe tener el lector para comprender el texto según el sistema educativo de Estados Unidos (Readable, 2011). El problema está en encontrar la equivalencia para otros idiomas o países, no solo en la nomenclatura del nivel escolar (por ejemplo, octavo curso de Estados Unidos sería segundo de la ESO en España) sino también en las posibles discrepancias de qué nivel de lectura se pueda considerar como el idóneo para el público general según el lugar del mundo en que nos encontremos y los conocimientos básicos de salud de su población.

Son limitados los artículos centrados en la calidad y/o legibilidad de las páginas webs con información odontológica identificada en los motores de búsqueda. En lo que respecta a los implantes dentales solo existía información sobre la calidad de las webs procedentes del Reino Unido, suponiendo una limitación geográfica (Ali et al, 2014). Aun así coinciden con nuestros resultados, encontrando información de baja calidad. El segundo artículo estudia solo la legibilidad, obteniendo puntajes superiores al nivel recomendado, siendo la mayoría

catalogados como difíciles de leer (Jayaratne et al, 2014), lo que también coincide con nuestros resultados. En términos de calidad, y sobre la información online en la toma de decisiones sobre realizar endodoncia o extraer el diente y colocar un implante dental (Rossi-Fedele et al, 2016), la calidad resultó ser de moderada a baja. En cuanto a la enfermedad perimplantaria (periimplantitis), también cuenta con información deficiente en términos de calidad y legibilidad (Leira et al, 2019).

La calidad de la información online es muy variable en cuanto a exactitud y fiabilidad (Ni Riordain & McCreary, 2009), o muy deficiente (Lopez-Jornet & Camacho-Alonso, 2009). La información sobre lesiones precancerosas orales tiene importantes problemas tanto en calidad como legibilidad (Wiriyakijja et al, 2016; Alsoghier et al, 2018). En estudios que analizaron las webs sobre cáncer oral en español e inglés se encontró una baja calidad, siendo los peores resultados para las páginas en español (Irwin et al, 2007; Irwin et al, 2011). Estos hallazgos son concordantes con nuestros hallazgos.

Sólo existe un estudio previo centrado en evaluar la legibilidad de la información online de la endodoncia (Woomansey, 2010) con resultados que informan sobre textos con un rango entre moderado y difícil para la comprensión lectora, pero mezclan el análisis de material analógico y digital lo cual se ha demostrado que no es correcto (Oxman et al, 1993). Aún bajo estas condiciones los resultados obtenidos son consistentes con los que dimanan de nuestro estudio.

Futuras investigaciones deberían focalizarse en incrementar los conocimientos básicos en el ámbito de salud (“health literacy”) de la población general, particularmente en los temas de interés y sobre los que hemos identificado textos con alta dificultad para su legibilidad. Además deberían incrementarse los esfuerzos en aras de mejorar los niveles de alfabetización en salud oral para la población general (National Institute of Dental and Craniofacial Research, National Institute of Health, U.S. Public Health Service, Department of Health and Human Services, 2005), utilizando menos palabras por oración o sílabas por palabra (Pothier & Pothier, 2009). Es importante generar webs con información fiable, accesible, útil, de calidad y con una

legibilidad acorde a la audiencia a la que se dirige. Es necesario realizar escrutinios periódicos de la información sanitaria disponible para el público general, estudiar la información "online" en salud en más idiomas, instruir a pacientes y profesionales en la búsqueda de información de calidad y legible, estudiar cómo poder mejorar los métodos de análisis de la legibilidad y aplicarlos en todas las áreas posibles.

Sería también recomendable extender nuestro abordaje de análisis bilingüe, e incentivar estudios multilingües, que puedan identificar lagunas y falta de congruencia entre legibilidad y cultura sanitaria en los diferentes idiomas y diferentes sociedades. Por ejemplo, el chino o hindi, segunda y tercera lengua más hablada en el mundo (Ethnologue, 2019), de asiento preferente en Asia, que además agrupa más de la mitad de los usuarios de internet (Internet World Stats, 2019). También serían focos de interés el identificar barreras en la accesibilidad a la información "online" y determinar la influencia de los diferentes motores de búsqueda sobre la información comprendida por el usuario medio (público general). Otra de las potenciales dianas de intervención sería mejorar los índices de legibilidad mediante la participación de grupos multidisciplinares, de modo que se utilizasen lenguajes llanos y se tuviesen en cuenta diferencias interculturales, y la contribución de gráficos o imágenes a la compresión de la información sanitaria en los diferentes sitios web.

De otra parte, debería tenerse en cuenta que una de las actividades más populares en internet, independientemente de las búsquedas en Google®, es la visualización de videos de YouTube®. Existen artículos que estudian la información sanitaria en esta plataforma audiovisual (Nason et al, 2016) y aunque carecen de una metodología aceptada y validada que pueda analizar la calidad, podría constituirse como una importante herramienta de diseminación de la información sanitaria. Parece recomendable ampliar nuestra investigación más allá de la información escrita y estudiar la información audiovisual ofrecida por los motores de búsqueda, puesto que en la actualidad se encuentran disponibles, no sólo páginas con información escrita, sino también podemos encontrar videos, tutoriales, píldoras de conocimiento y otros formatos con amplia aceptación por parte del público y de los

pacientes potenciales. En este sentido, se ha demostrado previamente que las redes sociales se han convertido en parte de la educación sanitaria, con una promoción más amplia de la salud (Balatsoukas et al, 2015), siendo capaces de generar un cambio de comportamiento en cuanto a los hábitos saludables (Latkin & Knowlton, 2015). Todo ello refuerza la idea de extender el análisis de la comprensión de sus contenidos y de compatibilizarlos y personalizarlos al público general, usuarios de internet, etc.

1.4 CONCLUSIONES

1. La información, disponible en páginas de internet, sobre implantes dentales ha sido evaluada como de difícil lectura para el público general y con importantes limitaciones en su calidad, que va desde deficiencias graves a potencialmente importantes. Sin embargo, estas web han alcanzado estándares aceptables en términos de utilidad y fiabilidad. Además, los diferentes motores de búsqueda parecen condicionar ligeramente la calidad de la información. Búsquedas con Yahoo!® proporcionan una información más relevante y con mayor utilidad que las encontradas con el motor Google®.
2. La legibilidad de la información sobre cáncer oral alojada en sitios web se encuentra en el rango de difícil a muy difícil, y requiere por parte del público general altos niveles de comprensión, lo que afecta a la población con bajos niveles de alfabetización, en una temática particularmente sensible.
3. La información web relativa a la endodoncia presenta una legibilidad similar tanto en español como en inglés. Sin embargo, existe una mayor proporción de las web en inglés que muestran alguna dificultad de lectura respecto a las web escritas en español. A pesar de ello, la información sobre tratamientos endodónticos almacenada en las páginas escritas en inglés se encuentran en el rango de la normalidad para la lectura y son de fácil comprensión. En cualquier caso, el material sanitario

orientado al consumidor sobre tratamiento de conductos radiculares permite un menor nivel educativo para la comprensión lectora, que la que exige la información relativa al cáncer oral y a los implantes dentales.

2. Summary

In 2019, the world population exceeded 7.7 billion people, Asia gathering 55% and also representing more than half of Internet users, while Europe is the third most populated (10.7%) and ranks in second place in terms of Internet users. North America is the fifth geographic región with respect to the world population, however it has the highest percentage of users by area (Internet World Stats, 2019).

Access to information on the Internet is usually done by a search engine. Eight out of ten online health consultations begin in a search engine (Fox & Duggan, 2013). The most used search engine has been Google® since 2009, above 90%, followed by Yahoo!® and Bing®, which barely exceed 2 % each (Statcounter, 2018). The searches carried out in Google® rank in sixth place in terms of activities done on the Internet in a minute (Clement, 2019).

Users find information to answer a question in less than 6 minutes, but do not visit sections referring to both the quality and origin of the contents of the webs pages (Eysenbach & Köhler, 2002); moreover the majority of users access only to the first three websites listed by the search engine (Wang et al., 2012).

Within the cancer field of content, 87% of patients with thyroid cancer used the Internet to search for information and more than 50% of the treatment decisions were conditioned by the results achieved (Chang et al, 2019). Oral cancer incidence tends to increase (Alsoghier et al, 2018), and 54% of patients with head and neck cancer rely on the Internet to find information about their treatment, collateral effects of it and how to keep their health standards (Rogers et al, 2012).

Regarding health in general, a recent systematic review showed a low quality of online health information (Daraz et al, 2019). On the dental field there are very inconsistent results in orthodontics

(McMorrow & Millett, 2016; Olkun et al, 2019); readability difficulties in websites about dental implants (Jayaratne et al, 2014) and low quality contents (Ali et al, 2014). On endodontics, readability is variable (Woodmansey, 2010) and readability of oral cancer websites was found to be poorer in Spanish than in English (Irwin et al, 2011).

Bearing in mind what has been described in dental literature to date, the wide variability in the results reported and the methodological limitations are striking, making it difficult to obtain an overall picture of the status of dental information addressed to patients available on websites. Regarding oral cancer, studies use a limited number of readability indexes (which could lead to biased results); the information available about endodontics comes from a single study with a limited sample, as occurs with the quality of implantological information. On the other hand, the hypothetical influence search engines exercise over the standards of the information presented to the user through their pre-selected, prioritized rankings of results is unknown. This circumstance suggests the need for a progressive research on the comprehension and quality of information provided to patients, given the influence online sources have in building awareness in health issues and their weight in decision-making processes.

In addition, tools have been developed and scales validated to assess the quality of health information on the Internet in the last two decades. Thus, DISCERN was developed as a standardized set of criteria to assess the quality of written health information to the general public (Charnock et al, 1999). It is a questionnaire of 16 items that are scored from 1 to 5 (from low to high quality), with a block on reliability; another one on treatment alternatives and a final item for the overall web score (Charnock & Shepperd, 2004).

Another tool available is the LIDA instrument, which analyzes three dimensions: accessibility, usability and reliability. The first one is measured automatically on the web www.minervation.com/validation, whereas both the utility and reliability are checked by answering a quiz (with scores from 0 to 3) (Minervation, 2012; Kucukdurmaz et al, 2015).

There are also health audit resources that seek to verify the quality and reputation of the information offered, such as the Health on the Net Foundation (HONcode seal) that informs about the ability of a website to publish transparent information complying with an ethical code (Health On the Net Foundation, 2018).

Regarding the readability analysis, different formulas have been developed that allow the reading difficulty to be tested using different tools that must be adapted to the grammatical and semantic standards of each language (Slyh & Hansen, 2010). For English we have six formulas: Flesch Reading Ease Score (FRES), Flesch-Kincaid Reading Grade Level (FKRGL), Gunning Fog Index (GFI), Coleman-Liau Index (CLI), Automated Readability Index (ARI) and Simple Measure of Gobbledygook Index (SMOG). However, for Spanish only two indexes have been validated: Fernández-Huerta and INFLESZ. All of them are based on quantifying sentences, words, syllables or characters. Their results are extrapolated at the level of studies that the user should have for text comprehension. For the general public it is estimated that the appropriate level is eight grade. The calculations can be entered either manually or automatically through specific applications.

The dental topics of most interest to average Internet users, measured in terms of volume of internet searches, have been dental implants, oral cancer and the root canal treatments (endodontic treatments). These findings conditioned and prioritized our research objectives. We have also used the same tools and indexes for readability analysis in all of our studies, which provides coherence to our PhD dissertation.

Thus, the objectives of this thesis were:

1. To assess the quality of the websites related to dental implants aimed at patients in terms of reliability, usability, accessibility and readability, and to analyze the differences in the information provided by Internet search engines most commonly used (Google® and Yahoo! ®).
2. To evaluate the readability of online information about oral cancer.

3. To test the readability of information on the Internet aimed at endodontics patients in both English and Spanish.

2.1 METHODOLOGY

Two search engines (Google® and Yahoo!®) were analyzed using interest descriptors previously checked as being the most popular searched ones by the mainstream population on the internet: dental implants, oral cancer and root canal treatment.

In our last study, searches in English were compared to those made in Spanish; and in order to identify the appropriate descriptors in Spanish, a pilot study was carried out using a quiz to 162 patients who attended the endodontics unit of the Faculty of Medicine and Dentistry (University of Santiago de Compostela): the most searched topic on the internet turned out to be *'¿Qué es una endodoncia?´* (What is a root canal treatment?). To verify the query, Google Trends was used, which checks the searches made in Google® at a specific time and place (Nuti et al, 2014). There was a high use of these terms in Spanish-speaking countries and we used them to perform the search in Spanish.

Lists of the first 100 websites obtained in each search engine to carry out the studies. Irrelevant sites, those with commercial purposes only, duplicates, forums and discussion groups, non-operational pages and password-protected websites were excluded from the lists. Those that met the inclusion criteria were categorized by specialization and affiliation. Reputability evidence (HONseal) was also considered.

Readability indexes for English were FRES, FKRGL, GFI, CLI, ARI and SMOG. When websites in Spanish were analyzed, Fernández-Huerta and INFLESZ indexes were used as tools. To analyze the quality of the websites DISCERN questionnaire and the LIDA instrument were used.

The calculation of the indexes was done automatically and checked occasionally by manual procedures.

2.2 RESULTS

A summary of the results is presented in the next paragraphs as this PhD thesis has been conceived as compendium of articles.

The analysis of information on dental implants has allowed us to show that Yahoo!® has more relevant information, a better description of the treatment benefits and usability ratings significantly higher than Google®. However, only three of them were certified by HONseal. The readability results were within the range of 'difficult Reading' (FRES = 51.72 [38.70–55.27]; FKRGL = 12.76 [10.07–14.87]). Regarding quality, the average score for DISCERN questionnaire general qualification was 3 (range: 2-3), which implies a serious quality deficiency. On this end, LIDA tool revealed modest percentages of accessibility (79.36 [74.60–85.31]) and intermediate values in both usability (59.20 [50.46–68.51]) and reliability (55.55 [45.37–66.66]).

When we analyzed the readability of websites on oral cancer, we obtained an average score of 'difficult reading', which requires high levels of understanding and health literacy. Websites were visited through Google®, Yahoo!® and HONsearch for patients using the terms 'oral cancer' with English interface, without either predetermined location or filters. Forty-seven websites from Google®, 57 from Yahoo!® and 89 from HONsearch were excluded from this analysis with a total of 119 pages were analyzed. The readability indexes had an average score within the range of 'difficult reading' (FRES = 36.04 (14.87)), which requires high levels of health understanding (FKRGL = 11.44 (3.27)). These results showed a greater reading difficulty for information focused on oral cancer compared to that available on dental implants.

On the other hand, when we compare the readability of the online information provided by websites written in English with content on root canal treatment, readability has been ranged as 'normal', easy to understand for students from 13 to 15 years old (IQR)[53.9-66.2]; GFI, 10.4, IQR [8.8-12]; CLI, 12.5, IQR [11.6-13.3]; ARI, 8.6, IQR [6.7-9.8]). Even SMOG showed compatible values for 7-year-old students (SMOG, 7.6, IQR [6.5-8.8]). Websites in Spanish had normal readability indexes to an adult, equivalent to seventh or eighth grade (Fernández-Huerta, 62.3, IQR [59.7-66.6]; INFLESZ, 57.5, IQR [55.1-62.1]). These results showed no significant differences between the readability of the websites in either Spanish or English. Even so,

when comparing different degrees of reading difficulty, 36.6% have some degree of readability difficulty in English; while this percentage is 23% in Spanish. English websites classified as 'difficult' or 'very difficult' were 15.3%, whereas it was only 1.5% in Spanish. This difference yielded statistically significant values.

Websites on oral cancer as a whole have shown worrying indexes of difficulty in reading comprehension above those obtained for their dental implants and endodontic treatments counterparts.

2.3 DISCUSSION

Despite our results are comparable to other reports, there are some potential constraints that must be taken into account: the existence of a large number of languages spoken in the world, while our studies focused on the English language alone and just one research did it in Spanish. Although there are contents available in many other languages in the Internet, the former two cover a large share of the population since English is the most spoken language worldwide (Ethnologue, 2019).

Search engines do not act neutrally as they introduce a likely selection bias, since the order of the results is not identical for all cases and mainstream Internet users only access the first three results (Wang et al, 2012). To offset this bias and to consider the pages that a non-professional user would obtain, a large sample of 100 websites per search was analyzed, a number far greater than an average user would use.

There are a huge number of search engines, however by using Google®, which accounts for 90% of the searches made, and Yahoo!®, which ranks the second or third place (Statcounter, 2018), most of the searches that an inexperienced user could do are covered (Fox & Duggan, 2013), adding greater external validity to the study.

Quantitative linguistics limits the study of a language to the count of sentences, words, syllables or characters, which may not reflect the reality of a language (Notorc, 2006). Not only the length of the word affects its complexity, but its use frequency has an impact on its readability (the more a word is used, the easier will be to understand it) (Seely, 2013). Variations in the use of a same language in different

regions should be also take it into account, and even among different cultures.

All readability formulas used in both English and Spanish pose a possible problem with respect to their interpretation. All of them are standardized to the United States' school level comprehension the average user must have to understand the text (Readable, 2011). The problem appears when finding a suitable equivalence to other languages or countries, not only in the nomenclature of the school level (for example, the United States' 8th year corresponds Spain's ESO's 2nd year) but also in the possible discrepancies of what level of reading can be considered as the ideal for the mainstream audience according to the country we are in and the health literacy of its population.

Articles focusing on the quality and/or readability of web pages on dental information are limited. With regard to dental implants, there was only information on the quality of websites in the United Kingdom, assuming a significant geographical limit (Ali et al, 2014). Even so, we have obtained coincident results in finding low quality information. The second article focuses only on readability, obtaining scores higher than the recommended level and the majority of websites being classified as 'difficult to read' (Jayaratne et al, 2014), which also matches our results. In terms of online information quality in the decision-making process about endodontic treatments, tooth extraction or dental implant placement (Rossi- Fedele et al, 2016), the quality turned out to be 'moderate' to 'low'. Regarding perimplantitis disease, it also yields poor information in terms of both quality and readability (Leira et al, 2019).

The quality of online information is very variable in terms of accuracy and reliability (Ni Riordain & McCreary, 2009), becoming 'very poor' (Lopez- Jornet & Camacho-Alonso, 2009). In the same terms, information on oral precancerous lesions experience significant problems, both in quality and readability (Wiriyakijja et al, 2016; Alsoghier et al, 2018). In studies analyzing oral cancer websites in Spanish and English, a low quality information was found, with the worst results for Spanish sites (Irwin et al, 2007; Irwin et al, 2011). These findings are also consistent with our results.

There is only a previous study focused on assessing the readability of online endodontic information (Woomansey, 2010) with contents ranging between 'moderate' to 'difficult' in reading comprehension. However, the study included a mixed analysis of both analogical and digital material, a methodology which has been shown to be incorrect (Oxman et al, 1993). Even under these conditions, the results obtained are consistent with those resulting from our study.

Future research should focus on increasing the health literacy of general population, particularly on issues of interest on which we have identified contents very difficult to read. In addition to this, efforts should be increased in order to improve literacy levels on oral health for the general population (National Institute of Dental and Craniofacial Research, National Institute of Health, US Public Health Service, Department of Health and Human Services, 2005), using fewer words per sentence or syllables per word (Pothier & Pothier, 2009). It is important to create websites with reliable, accessible, and useful high-quality information which is readable by the audience to whom it is addressed. It is necessary to carry out periodic surveys on the health information available to the general public; to assess online health contents in more languages; to train patients and professionals in the search for quality and readable information; and to study how to improve the methods of readability analysis of health-related information and to apply them to all possible areas.

It would also be advisable to extend our bilingual analysis approach and encourage multilingual studies that can identify gaps and lack of congruence between legibility and health culture in different languages and societies. For example, Chinese or Hindi, the second and third most spoken language in the world (Ethnologue, 2019), located in a geographical area which also accounts for more than half of Internet users (Internet World Stats, 2019). It would also be of interest to identify barriers to accessibility to online information and determine the influence of different search engines on the information comprehended by the average user (general public). Another field of potential interest would be to improve readability rates by studying multidisciplinary groups where intercultural differences and language uses could be taken into account, and the

contribution of graphics or images to the compression of health information on different websites.

Furthermore, it should be noted that one of the most popular activities on the Internet, regardless of searching on Google®, is viewing videos on YouTube®. There are articles that study health information in this audiovisual platform (Nason et al, 2016) and although they lack an accepted and validated methodology that can analyze their quality, it could be an important tool for the dissemination of health information. It seems advisable to expand our research beyond written information and study the audiovisual information offered by search engines, since they are currently retrieving not only websites with written contents, but also videos, tutorials, knowledge pills and other visual formats with wide acceptance by the public and potential patients. In this sense, it has been previously shown that social networks have become part of health education, with a broader promotion of health (Balatsoukas et al, 2015), being able to generate a change in behaviour in terms of healthier habits (Latkin & Knowlton, 2015). All of this strengthen the idea of extending the analysis of the understanding of their contents and making them compatible and customized to the general public, Internet users, etc.

2.4 CONCLUSIONS

1. The information available on websites about dental implants has been evaluated as ‘difficult’ to read for the general public and with significant constraints in quality, ranging from ‘serious’ to ‘potentially important’ deficiencies. However, these websites have reached acceptable standards in terms of usability and reliability. In addition, different search engines seem to slightly bias the quality of information. Searching on Yahoo!® provide more relevant and useful information than those websites found by Google®.
2. The readability of oral cancer information hosted on websites is in the range of ‘difficult’ to ‘very difficult’ and requires a high level of comprehension by the general

public, which affects the less educated population on a particularly sensitive subject.

3. Online information related to endodontics has similar readability in both Spanish and English; however there is a greater proportion of websites in English which shows some difficulty in reading compared to websites written in Spanish. On the contrary, information about endodontics treatment hosted on English websites are in the range of 'normal' reading and easy to understand. In any case, the user-friendly health material on root canal treatment permits a lower educational level in terms of reading comprehension than it is required for information on oral cancer and dental implants.

3. Introduction

By mid 2019, world population exceeded 7.7 billion people (Internet World Stats, 2019; United Nations: Population Division, 2019). The availability of massive communication, information and knowledge exchange channels that global population need and generates is made possible thanks to the existence of the Internet: a network of worldwide networks that has experienced exponential growth since its creation in the 60s of the last century (Internet World Stats, 2019).

According to the number of internet users, the world population can be divided into seven major regions: Asia, Europe, Africa, Latin America/Caribbean, North America, Middle East and Oceania/Australia (Internet World Stats, 2019).

Asia represents 55% of the world's population and more than half of internet users. Africa, despite being the second most populated region (17.1%), is the third area in number of web users since just 39.6% of its inhabitants have access to the Internet. Europe ranks third in population (10.7%) goes in second place in terms of web users because 87.7% of Europeans have access to the Internet. North America is the fifth populated area in the world (4.7%) and the fifth also in Internet users (7.2%), despite having the highest percentage of users by geographical area (89.4%) (Internet World Stats, 2019).

The dramatic increase in the number of internet users (1,157%) in the last 19 years (Internet World Stats, 2019) seems to be closely related to the boom in network access through mobile devices (from 11.44% to 51.7% in 6 years) (Statcounter, 2018).

Access to information is usually done through a search engine: a system that operates by indexing files and data on the web to facilitate the location of the same terms and concepts relevant to the user by

simply entering one or more keywords. After typing the keyword, the application returns a list of web addresses in which that said word is either included or mentioned. Eight out of ten online health queries start by a search engine (Fox & Duggan, 2013), so it is important to know how they work and which ones are the most frequently used.

Search engines browse the websites collecting information from their contents, look into their databases and give results sorted by their relevance. Other aspects come also into play, such as the difference between searching for a specific term or a topic. If we deal with a term (the word/s as they are written), we will obtain a sample of all the terms of the query in the language in which it was made. On the other hand, when we search for a topic, we will be given the result of a group of terms that share the same concept in any language (Google Trends, 2018).

Each search engine has different domains through which you can access. In the particular case of Google® (Mountain View, CA, USA) its domains include 165 countries and 21 dependencies. These are mostly of top-level country code domains, which are Internet domains used and reserved for a country or dependent territory. For example, in Spain we have www.google.es, in Argentina www.google.com.ar, in Australia www.google.com.au, etc. Thus, we deduct that there is no single URL to access the same search engine and use its algorithm.

There are several search engines, but from January 2009 the main search engine is Google®, which has a constant 90% of use ever since, followed by Yahoo!® (Sunnyvale, CA, USA) and Bing® (Microsoft corporation, Redmond, WA, USA), which barely represent 2% each. The fourth place goes to the search engine Baidu® (Baidu Campus, Beijing, China) with 0.81%, followed by Yandex® (Moscow, Russia) with 0.6% (Statcounter, 2018). The place in this classification also depends on the access device: for PC's, Bing® ranks second place (3.84%) but it drops to the fourth in mobile phones, just behind Baidu® (Statcounter, 2018). This global classification has regional variants: in China, Baidu® reaches a 65.05% share, followed by Shenma® (Beijing, China), and Google® falls to the fifth place (Statcounter, 2018).

The role of search engines as intermediaries in accessing information is not neutral. There are several reasons that could explain this phenomenon: either by favouring certain servers or languages, or by commercial strategies as it is the case in Google® that supports placing long-term 'cookies' on users' devices to learn from their preferences, location, language, etc. and thus optimizing the searches (Google Privacy and Terms, 2019). As a conclusion, it can be assumed that not every user necessarily obtains the same results when searching on the Internet for the same subject or term.

The searches made in Google® occupy the sixth place in the number of activities done in a minute on the Internet with 3.8 million searches/min, just behind other actions such as sending an email, texting on the mobile phone or watching videos on YouTube® (San Bruno, CA, USA) (Clement, 2019).

When referring to the most used search engine, we know that 'health' as a topic aroused 100% interest in February 2004. That is, since Google® makes worldwide searches, that month was when more health-related terms were introduced in all languages. In November 2018 the interest was 78% (Google Trends, 2018). Every December it experiences peaks in world interest, although it remains at an average of 70-80%. Australia turned out to be the most concerned country in health issues with Italy as the least worried out of a group of 67 countries. Spain is ranked 28 (Google Trends, 2018).

Although health content's search techniques are often not optimal, Internet users successfully found health information to answer questions in an average of 5 minutes 42 seconds (median 4 minutes 18 seconds) per question (Eysenbach & Köhler, 2002). They mainly value formal aspects of the web, language and ease of use and do not visit sections referring to the quality and origin of the web contents (Eysenbach & Köhler, 2002).

When searching for information through a search engine, Google® shows all possible website results by listing ten results per page by default (it can be configured to provide more results per page). When users in general look for health information in a search engine, it has been noticed that most non-professional Internet users only access the first three websites listed by the search engine, and

they only occasionally see the first page of complete results (Wang et al, 2012). The results obtained through search engines may vary depending on the location, cookies placed by the search engine, etc. This practice makes reproducibility of online information studies challenging and introduces a difficult bias to cope with.

A survey of people over 14 who visit Spanish websites (Association for Media Research, 2018) saw that searches on health information are in the ninth place of activities carried out on the Internet. In addition to this, one out of three North American adults has connected to the Internet seeking information about their health status or that of another person (Fox & Duggan, 2013).

Users looking for online health information mostly do it for cardiovascular and cancer issues (Couper et al, 2010) and to check about their symptoms and treatment (Walsh & Volsko, 2008). In the case of patients with thyroid cancer, a study revealed that 87% of them had used the Internet to search for information (94% through Google®) about treatment and management of symptoms, and more than half of treatment decisions were affected by the results obtained on the network (Chang et al, 2019).

This phenomenon also applies for oral oncology information, reaching 83% in March 2018. The prevalence of oral cancer tends to increase (Alsoghier et al, 2018), being oral and pharyngeal neoplasms responsible for more than 7,600 deaths/year in the US alone in 2011 (Irwin et al, 2011). Approximately 54% of patients with head and neck cancer rely on the Internet to find information about their treatment, collateral effects and how to keep their health standards in the future (Rogers et al, 2012).

Oral implantology is another issue of global interest (100% interest in October 2018) (Google Trends, 2018), only surpassed by dental amalgam and aesthetic treatments in the dental area (Chestnutt & Reynolds, 2006; Fox & Duggan, 2013), with the addition that patient knowledge and expectations has an impact on the success of implant therapy (Rustemeyer & Bremerich, 2007). Also in the dental field, endodontics has been experiencing a striking growth since 2004 to reach 100% interest in October 2018 (Google Trends, 2018).

Concerns about the quality of health content on websites have led to a proliferation of tools and guidelines to produce and evaluate information online (Kim et al, 1999; Gagliardi & Jadad, 2002). It should be kept in mind that the Internet represents a new means of information that requires new quality standards with new problems to evaluate. (Lindberg & Humphreys, 1998). The tools designed to assess conventional media (Oxman et al, 1993) would no longer be relevant in the case of digital format. For this reason, DISCERN was created, a standardized set of criteria to judge the quality of written health information for the general public (Charnock et al, 1999). This instrument consists of 16 questions that must be answered according to a Likert scale from 1 (low quality) to 5 (high quality). It is divided into two blocks: the first one (items 1 to 8) deals with the reliability of the web as a source of information; the second one (from 9 to 15) refers to whether it provides treatment alternatives, thus obtaining a final score for the whole web page (Charnock & Shepperd, 2004).

Another tool for assessing the quality of health information is the LIDA instrument, which analyzes three aspects: accessibility, usability (18 questions) and reliability (9 questions) of information. The first one is measured automatically by entering the web www.minervation.com/validation, having a maximum score of 63: its online tool analyzes each HTML looking for errors that can affect user access. Usability and reliability should be scored by answering a survey which assigns a score from 0 to 3 (0 = never, 1 = rarely, 2 = often, 3 = always) with a maximum score of 54 for usability and 27 for reliability. Usability was defined as the clarity of the information and the consistency and functionality of the web design. Reliability is based on the frequency of the site updates, potential conflict of interest, content production methodology and accuracy. The software processes the results obtaining a percentile associated with high, medium or low quality. The final result is an average score and indicates the overall value of the design and content of the website (Minervation, 2012; Kucukdurmaz et al, 2015; Verhoef et al, 2015).

There are seals of validation of health reputation that seek to verify the quality of the information offered, HONcode seal may be the most notable example for its age and dissemination (Health On the

Net Foundation, 2018). It was created to encourage the dissemination of quality health information for patients, professionals and the general public and to facilitate access to the most recent and relevant medical data through the Internet. It verifies the purpose of a website to publish transparent information. To obtain the seal, the page must comply with an ethical code (HONcode) that establishes a minimum set of mechanisms to provide transparent, objective and quality medical information. It is based on eight foundations: authorship (author qualifications), complementary information (giving support), confidentiality, attribution (citing sources and dates), justification, transparency (valid contacts), financial disclosure (financing details) and advertising (differentiating it from editorial content) (Health On the Net Foundation, 2018). One of the great disadvantages of these initiatives is that the accuracy of medical information cannot be guaranteed at any given time, and therefore it only demonstrates the intention to contribute to providing quality medical information.

It is useless to meet high standards of quality, accessibility, reliability, etc., if the average user does not understand the presented text. On this end, readability analysis assesses this handicap using different tools, adapted to the grammatical and semantic characteristics of each language (Slyh & Hansen, 2010).

For English, the most spoken language (Ethnologue, 2019), there are six different tools for this purpose (Table 1), each with its own standards:

1. Flesch Reading Ease Score (FRES): Based on the count of syllables, words and sentences. It shows the educational level in the US Educational system the reader must have in order to understand the text. High scores indicate ease of reading; and low scores refer to growing difficulty. The score ranges from 0 to 100 and it can categorize texts that a 5th grade student (100 - 90) can understand, those requiring a university degree (30 - 0), as well as intermediate requirements: a score between 70-80 is equivalent to an 8th grade level, which means that the text is suitable to an average literate adult (Readable, 2011).

2. Flesch-Kincaid Reading Grade Level (FKRGL): It also counts syllables, words and sentences. This formula is easier to use because we need a conversion table to understand the results of FRES. The result is also a figure that corresponds directly to the educational level in the US system. For example, if it gives us a result of 8, it means that the minimum educational level to understand the text corresponds to 8th grade or school ages of 13 to 14 years old. On the other hand, due to the mathematical formula used, it has no upper limit and can offer results that are hundreds of times greater than the completion of the US high school. The lowest score that can be obtained is -3.40 but there are few real texts where these results are given. As mentioned above, a text intended to the general public should have a score around 8 (Readable, 2011).
3. Gunning Fog Index (GFI): This formula provides a score that ranges from 0 to 20. It also reports the educational level required for the reader to understand the text based on the US education system. As in the FKRGL, a score of 8 refers to 8th grade. Scores above 17 correspond to a college's graduate level. The main difference with the previous equations is that it is a simpler formula since it was created to perform the calculations manually. It also counts words and sentences but introduces the concept of 'complex words' by defining them as those of 3 syllables or more. The need to move from a human algorithm to a computerized one made it necessary to adapt the equation, which entailed some difficulties (Armstrong, 1982; Audisio et al, 2009).
4. Coleman-Liau Index (CLI): it counts words and sentences, but advocates that the syllable count is inaccurate, so the character count is performed. Like the FKRGL and the GFI, a score of 8 is equivalent to 8th grade in the United States.
5. Automated Readability Index (ARI): As the CLI takes into account characters, words and sentences. When your result

is a non-integer number, it is rounded to the top figure, for example, a 6.1 or a 6.8 will also become 7. It provides a range of scores from 1 to 14. Like FKRGL, GFI or CLI, the result it is interpreted as the level of studies that the reader must have to understand the text in the US school system (2 = 2nd year, 3 = 3rd year, etc.) (Readable, 2011). Studies in the 60s and 70s praised the virtues of this formula over the others, due to the reliability of automation for being simpler and faster (Smith & Senter, 1967; Kincaid el al, 1975).

6. Simple Measure of Gobbledygook Index (SMOG index): For texts of 30 sentences at least, it counts the number of polysyllabic words and sentences, known for their great simplicity. The result is again equivalent to the level of studies according to the US education system. It is widely used in health texts (Hedman, 2008) and preferred when assessing readability for the health area (Fitzsimmons et al, 2010; Wang et al, 2013).

Information on the different formulas for the calculation of readability in English are found in Table 1.

Table 1. Readability formulas. English language

Index	Formula
Flesch Reading Ease Score	206.839 – (1.015 (total words/total sentences)) – (84.6 (total syllables/total words))
Flesch-Kincaid Reading Grade Level	(0.39 (total words/total sentences)) + (11.8 (total syllables/total words)) – 15.59
Gunning Fog Index	0.4 ((words/sentences) + 100 (complex words*/words))
Coleman-Liau Index	(5.89 (characters/words)) – (29.5 (sentences/words)) – 15.8
Automated Readability Index	4.71 (letters/words) + 0.5 (words/sentences) – 21.43
Simple Measure of Gobbledygook Index (SMOG)	1.0430($\sqrt{}$30 x polysyllables*/ sentences) + 3.1291
*Words of 3 or more syllables	

Spanish language has other readability indexes adapted to its characteristics, such as the more frequent use of longer words and sentences (Blanco Pérez & Gutiérrez Couto, 2002).

There are two readability indexes that have been previously validated: index Fernández-Huerta and INFLESZ:

1. Fernández-Huerta Index: This is an adaptation of the FRES formula to Spanish. It counts syllables, words and sentences. The results are interpreted as those from FRES on a scale of 0-100, being 0-30 university level and 90-100 level of 4th-5th grade (Muñoz Fernández, 2016).
2. INFLESZ scale: it counts syllables, words and sentences. It is an adaptation of the Szigriszt-Pazos Perspicuity Index, which it is itself another Spanish adaptation of the Flesch formula (Barrio-Cantalejo et al, 2008). It is scored from 0 to 100. Below 40 it is considered a very difficult text for university students or scientists, between 55 and 65 it is ranked as a normal text that should coincide with those written in mainstream newspapers; and above 80 points they are very easy texts of comic comprehension level (Barrio-Cantalejo et al, 2008).

Table 2 provides information on the formula to test readability rates in Spanish.

Table 2. Readability formulas. Spanish language

Index	Formula
Fernández-Huerta Index	206.84 - (0.60 (total words/total sentences)) - (1.02 (total syllables/total words))
INFLESZ	206.835 - 62.3 x (syllables/words - words/sentences)

These calculations can also be done in an automated way through internet portals by entering a text or directly a URL, which facilitates the analysis. Examples of these resources are https://legible.es/ or https://www.webfx.com/tools/read-able/.

We cannot ignore the limits of reducing the complexity of a language only to the extent of its words and sentences (Notorc, 2006). A short word can be difficult if the majority of the audience to which

it is addressed does not use it frequently and a long one can be easy to understand. The frequency in which a word is used also affects the readability of the text (Seely, 2013), alongside with variations of the same language in different geographical areas.

The overview of the most recent health contents on the Internet focuses on the analysis of both readability and quality. Moreover, the results in previous researches seem not to have had the desired effect on the information available online through Internet pages. Thus, in terms of quality, DISCERN finds inconsistent results in medical fields such as osteoporosis (Fuzzell et al, 2019) or total reverse shoulder arthroplasty (Houck et al, 2019) to mention a few examples in recent studies. In oncology on ductal carcinoma in situ, a low percentage of websites with low or high quality information has been disclosed, with most of them scoring in the 'moderate' range (Blackwood et al, 2019). In general terms, a recent systematic review of the literature found 153 studies that evaluated 11,785 websites using 14 different tools to test their quality, demonstrating a sub-optimal quality in health information available online, rated as unreliable (Daraz et al, 2019).

Regarding readability, there seems to be a generalized deficit in the medical information available on websites: almost 93% of websites have an unacceptable legibility on topics of great interest such as bariatric surgery or influenza (Meleo-Erwin et al, 2019; Basch et al, 2019).

Yet on the dental field, readability data are very heterogeneous. In some controversial topics such as fluoridation of drinking water, anti-fluor information found in Google® turned out to be more readable than the pro-fluor content, although anti-fluoride websites accounted for only 29% of total publications (Basch et al, 2019).

On the contrary, the studies that combine quality and readability assessments also reveal a very variable picture. On one hand there are encouraging data, as in a study on ankylosing spondylitis; on the other hand, it also revealed that 46% of the websites had a high quality depending on the type of web, with the best quality in scientific journals and news sites; commercial or other websites showed the worst results (Kocyigit et al, 2019). In common paediatric emergencies the proportion decreases, with 26% of high quality but

the rest with inadequate precision, quality, reliability and readability (Rothrock et al, 2019). A negative example would be diabetic retinopathy, with low quality material difficult to understand (Kloosterboer et al, 2019).

In orthognathic surgery, almost all websites (98%) mentioned the benefits of surgery; however, very few discussed the surgical procedure (24%), the postoperative care (20%) and risks or complications (12%). The average DISCERN score was 25.5 out of 80 and only 2 websites achieved DISCERN outcomes of acceptable quality. The degree of readability was 13.4 (range from 7.8 to 17.3), which implies a marked difficulty reading (Lee et al, 2019). We also find inconsistent results in orthodontics: the quality is moderate, and the average readability is good in adult orthodontics (McMorrow & Millett, 2016). Another significant aspect in orthodontics, such as dental extractions to gain space have shown good averages in readability but the reliability turned out to be low (Patel & Cobourne, 2011). The worst results were found on websites about lingual orthodontics, with poor scores for the DISCERN ranks (36.3) and low quality in general (Olkun et al, 2019).

As for implants, most websites were ‘difficult’ in their readability (Jayaratne et al, 2014); Online information about implant treatment is generally of poor quality and many aspects are overlooked, such as long-term outcomes and complications (Ali et al, 2014). Some particular aspects associated with implantological treatment such as perimplant disease (perimplantitis) have shown a generalized low quality standard, in addition to difficult readability scores (Leira et al, 2019), but in root canal treatment, FRES and FKRGL scores were between 4.5 and 10.6 (Woodmansey, 2010). These data inform about the wide variability of the results that range between a moderate degree and a high reading difficulty.

As for information available on oral cancer, the first studies carried out in 2007 and 2011 by Irwin and collaborators have shown a worse quality for online information published in Spanish than in English, this circumstance could provide a disadvantage for the Spanish speaking population (Irwin et al, 2007; Irwin et al, 2011).

The literature reviewed shows a growing use of the Internet for the search of information by the general population, with great interest in health issues, in which dentistry is no exception. Generally speaking, this information contributes to the build up of opinions about pathologies and influences communication with health professionals, frequently generating unrealistic treatment expectations that could favour litigation while conditioning decision-making in such transcendent aspects such as oral cancer. This scenario creates the need to evaluate both the quality of the available information and the extent to which it is understandable by the general population.

The reviews published to date on dental information available on Internet pages show variable results, with important limits in terms of quality and requirements for proper interpretation. Thus, in the case of oral cancer, the use of a limited number of readability indexes could introduce a bias in the results, as on the field of endodontics, where available information is limited to a single study with a limited sample. Regarding information about oral implantology available for patients, there are two articles published in the same year as the one that is part of this dissertation: the first one, and published in the same journal, is reduced to readability analysis (obviating the quality of the information contained), while the second one analyzes the quality of a limited number of UK web pages, thus making necessary a broader perspective for an adequate picture of reality in the English language, which has the greatest impact on the Internet.

3.1 REASONED JUSTIFICATION OF THE THEMATIC UNITY AND METHODOLOGICAL COHERENCE OF THIS PHD THESIS.

Patients check the Internet during and after the diagnostic process, when they choose a therapeutic option, just before treatment, and during periodic check-ups after therapy. All this is done by looking for information on different treatment options, side effects, and how to maintain health standards after treatment (Ziebland et al, 2004).

The literature review shows an increasing use of the Internet for the search of information by the general population, with great interest in health issues, in which dentistry is no exception. In general, this information contributes to the build up of opinions on pathologies, it

influences communication with health professionals, generating different expectations of treatment, while conditioning decision-making in such transcendent aspects as oral cancer. This scenario creates the need to assess the readability (reading comprehension difficulty) to the general population of the web pages that report on dental health aspects and also to analyze qualitative aspects of this information.

Within the broad spectrum of dental issues that could potentially be subjected to research, we have used the criterion of ‘volume of Internet searches’ and ‘public interest over time of Internet searches’, to select the topics of greater interest and study them in the current PhD Thesis work. We analyzed that the volume of search in Google® goes worldwide in the past 5 years for ‘conservative dentistry‘, ‘dental fillings‘, ‘root canal treatment‘, ‘orthodontic treatment‘, ‘dental implants‘, ‘dental prosthesis‘, and ‘oral cancer‘ according to Google Trends (https://www.trends.google.com/trends/). It is a previously validated tool to determine the public interest which monitors internet search activity for a specific topic by time, geographic location and category. The periodgram provided by Google Trends has shown the higher standards of popularity for descriptors ‘dental implants‘, ‘oral cancer’ and ‘root canal treatment‘ (Fig 1 and 2.).

Fig. 1. Interest over time of the topics 'oral cancer ', 'dental implant', 'root canal treatment', 'orthodontic treatment' and 'dental fillings'

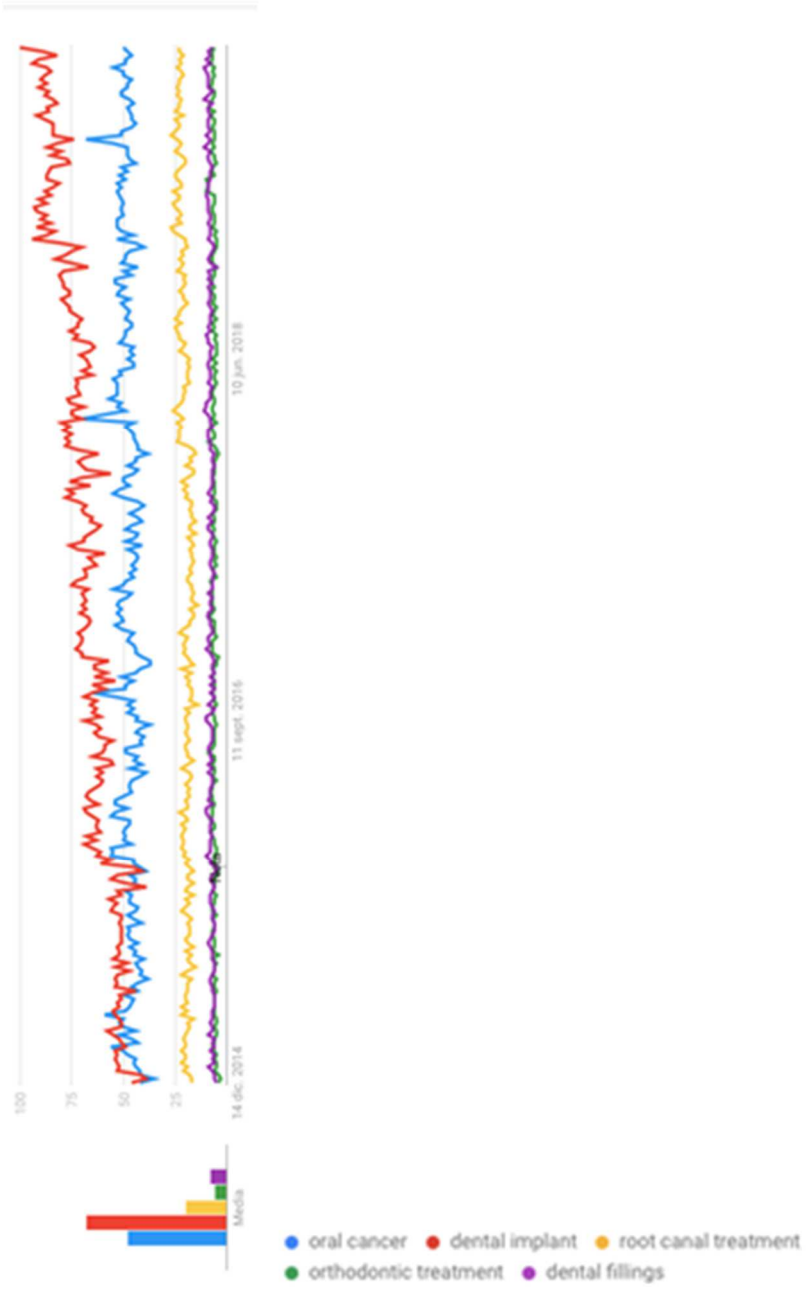
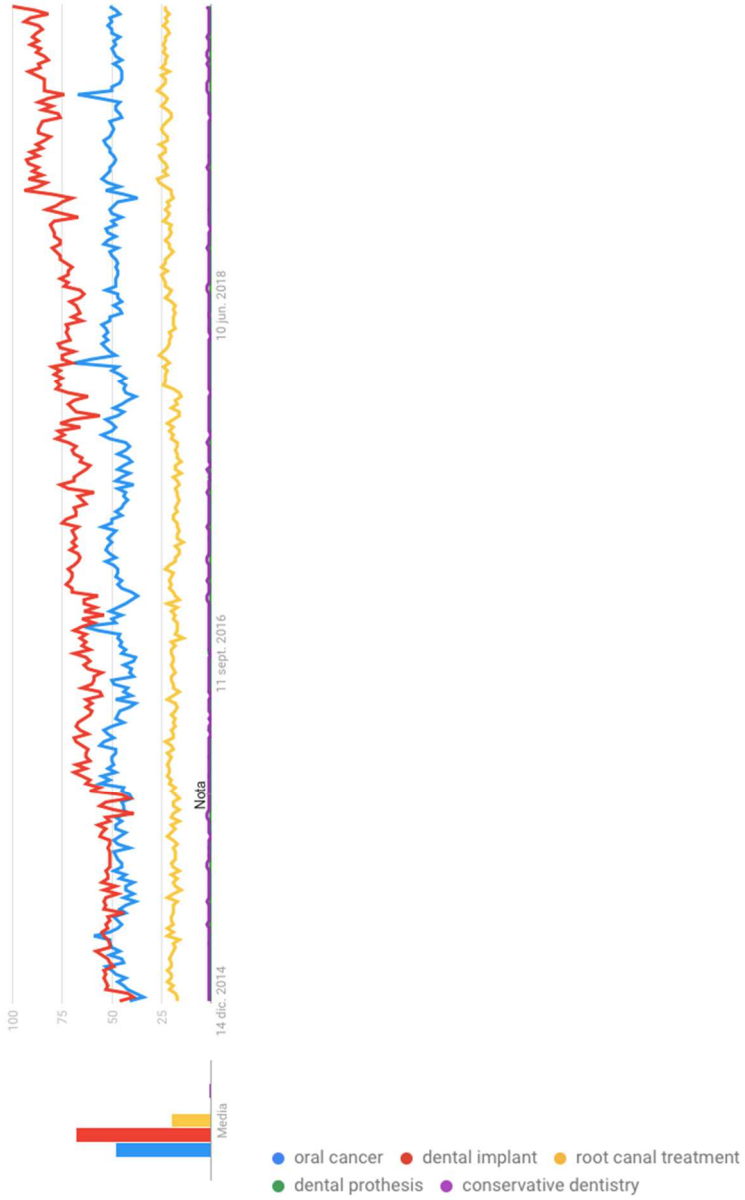


Fig. 2. Interest over time of the topics 'oral cancer ', 'dental implant', 'root canal treatment', 'dental prothesis ' and 'conservative dentistry'.



The greatest interest for general population on these 3 dental issues influenced our research objectives and provided coherence to it. In addition, knowledge about the information with the highest social demand for searches in dental health information on the web could be used to increase the effectiveness of communication with the patient, since there is evidence to suggest that online searches on health issues are associated to the behaviours and habits in health-related searches.

4. Objectives

1. To assess the quality of patient-addressed, dental implants-related websites in terms of reliability, accessibility, usability and readability. To disclose hypothetical differences in the information harvested by the most frequently used Internet search engines (Google® and Yahoo®).
2. To assess the readability of online information on oral cancer.
3. To assess the readability of web-based, patient addressed information about endodontic treatments, in both the English and Spanish languages.

5. Research Development

5.1 OBJECTIVE 1.

LEIRA-FEIJOO, Y., LEDESMA-LUDI, Y., SEOANE-ROMERO, J.M., BLANCO-CARRION, J., SEOANE, J. and VARELA-CENTELLES, P., 2015. Available web-based dental implants information for patients. How good is it? Clinical oral implants research, 26(11), pp. 1276-1280. (Annex 2).

The community of Internet users gathers about 2500 million people, mostly from Asia, Europe and North America (Internet World Stats, 2013), who frequently surf the net seeking information on health-related issues (Fox & Duggan, 2013). These individuals use the Internet for searching information and/or advice about a specific condition, mostly cardiovascular and oncologic diseases (Diaz et al, 2002; Couper et al, 2010), their symptoms and treatment (Walsh & Volsko, 2008). Conversely, physicians tend to use web-based resources to ease clinical decision making (Couper et al, 2010), mostly related to diagnostic work-up and therapy (Davies & Harrison, 2007). Regarding oral health, implant-related information ranks on the third place, only behind aesthetic treatments and dental amalgam issues (Chestnutt & Reynolds, 2006; Fox & Duggan, 2013).

Despite patients' knowledge and expectations conditions success of implant therapy (Rustemeyer & Bremerich, 2007), public awareness of dental implants as an option for replacing missing teeth is very variable around the world, while about 30% of people in India had heard about dental implants (Chowdhary et al, 2010; Suprakash et al, 2013), only 9.7% of healthcare workers in Nigeria know about them (Mgbeokwere et al, 2011). Conversely, public awareness and

acceptance of oral implants is well above 70% in developed countries (Zimmer et al, 1992; Berge, 2000; Pommer et al, 2011), where dentists and physicians seem to play a minor role as a source of information (Zimmer et al, 1992). This phenomenon also appears to be common in emerging economies, as up to 45% of the Chinese population is reported to search information online before receiving dental care (Hu et al, 2009).

Massive use of the Internet as a source of health information has raised concerns about the quality of the information obtained about consumers' ability to tell "good" information from "bad" information (Bates et al, 2006), particularly when sound web-based information seem to ease shared decision making based upon realistic expectations and a better doctor-patient communication (Eysenbach, 2003). Moreover, the quality of the available medical information has proved to be highly variable, incomplete and generally poor (Wong et al, 2013; Fahy et al, 2014; Jaffe et al, 2014; Wasserman et al, 2014).

Regardless of these facts, and to the best of our knowledge, no investigation has focused on the quality of websites offering information on dental implants. Thus, the aim of this study was to assess the quality of patient-addressed, dental implants-related websites in terms of reliability, accessibility, usability and readability and also to disclose hypothetical differences in the information harvested by the most frequently used Internet search engines (Google® and Yahoo!®).

5.1.1 Methods and materials

5.1.1.1 Searching strategy

The search engines Google® (www.google.com) and Yahoo!® (www.yahoo.com) were used in this study, undertaken in September 2013, employing the terms "dental implants" without limits about location or filters, and using English language for the interface and operative system. The websites were listed (10 sites per page), displayed, accessed and saved in a DVD for further analysis.

The first 100 sites, as listed by each engine, were considered for the study. The webs were excluded because of irrelevant contents,

commercial-only information, duplicated websites, forums and discussion groups, non-working webs and password-protected pages.

5.1.1.2 Evaluation procedures

Each particular site was categorised by specialisation (totally or partially related to dental implants) and affiliation (non-profit organisation, commercial, university/medical centre, government) (Ni Riordain & McCreary, 2009). The presence of the HON seal (Health On the Net Foundation, 2018) was also recorded: this seal recognises websites with reliable health information based upon a code of conduct. This code ensures authoritative information, complementarity, privacy, attribution, justifiability and transparency of the contents as well as financial disclosure and a clear advertising policy (Ni Riordain & McCreary, 2009). The information retrieved by the HON search engine (section for medical professionals) was also used to assess the legibility of the professional-addressed contents about dental implants.

5.1.1.3 Quality assessment

The DISCERN questionnaire was chosen for rating quality of the websites. This instrument is made of 16 questions to be answered by means of a Likert scale in a 1 (low quality) to 5 (high quality) basis. The first set of items deals with trust in the site as a source or information. A second group of questions (9–15) deals with information on treatment alternatives, with a final item on the overall rating of the publication (Charnock et al, 2004). It is worth mentioning that the DISCERN tool is not designed for investigating the reliability of a website, as it is not concerned with the accuracy of the published information (www.discern.org.uk/background).

The LIDA instrument (v1.2; Minervation Ltd., Oxford, UK) was also used, as it is reported to provide a validated method for assessing contents of healthcare websites (Minervation, 2012). This tool investigates three dimensions: accessibility (16 questions); usability – can users find the information they need? – (18 questions); and reliability – does the site keep up to date and reflects current knowledge? – (9 questions). Scores for accessibility (0–100%) can be

electronically calculated by means of the LIDA tool using each website's URL, whereas usability and reliability have to be determined using a questionnaire where the researcher allocates scores according to a three-degree scale: 0: never; 1: seldom; 2: often; and 3: always. The results are processed by the software to obtain a percentile associated to high, medium or low quality. The final LIDA result is an average of its dimensions and indicates the overall value of both design and content of the website. These results were recorded in a summary sheet for each URL. The review process was performed by an expert observer (YL).

5.1.1.4 Readability assessment

The Flesch-Kinkaid Reading Grade Level (FKRGL) and the Flesh Reading Ease Score (FRES) were used to assess legibility of the identified websites (Badarudeen & Sabharwal, 2010; Livas et al, 2013; Jayaratne et al, 2014). These systems are well-validated for English written information (Pothier & Pothier, 2009). To assess readability, a free, easy-to-use online computer program was employed (http://www.online-utility.org): the URL of each website was copied and pasted into this program, which automatically calculated these indices for each selected website.

The accuracy of the online method was checked using the following readability formulas: FRES = 206.835 – (1.015 x average number of words per sentence) – (84.6 x average number of syllables per word); FKRGL = (0.39 x average number of words per sentence) + (11.8 x average number of syllables per word) – 15.59).

The FRES score was categorised as very difficult-college graduates (scores 0–30); difficult (30–50); fairly difficult (60); normal-easily understood by 13- to 15- year-old students (60–70); fairly easy (70–80); easy (80–90); and very easy (90–100). Websites were also graded according to the FKRGL scale as easy ($\leq 6^{th}$ grade level) or difficult ($\geq 10^{th}$ grade level) to read (Jayaratne et al, 2014).

5.1.1.5 Statistical analysis

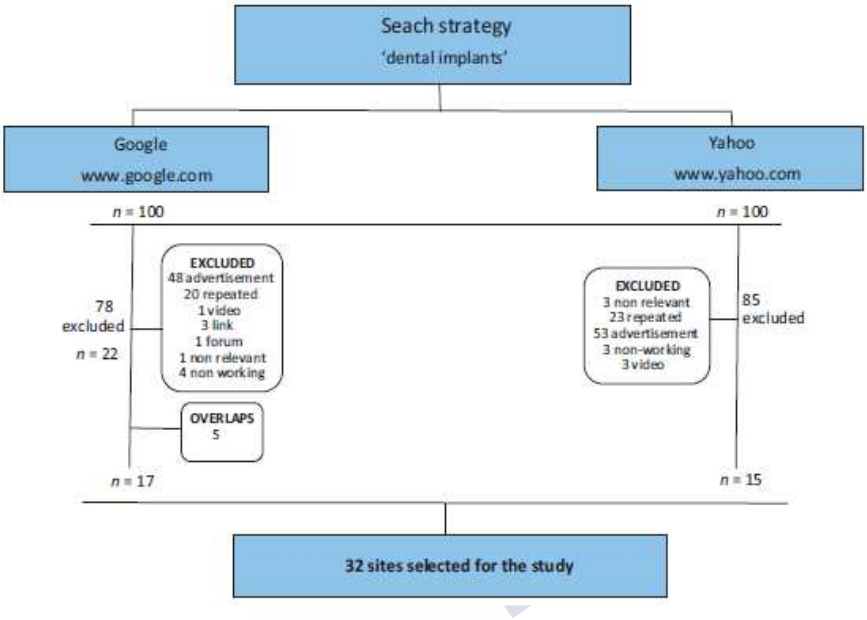
Data were coded and entered into a statistical package (SPSS; SPSS Inc, Chicago, IL, USA) for analysis. The variables were

described using the median as central trend measure and the interquartile range for spread. Comparisons between variables were undertaken using the Mann–Whitney test. The chosen significance level was 5%.

5.1.2 Results

Of the first 100 consecutive sites listed by each search engine, 78 sites identified by Google® and 85 harvested by Yahoo!® did not meet the inclusion criteria for the study, and another five sites were recognised by both search engines. Thus, 32 single websites were considered for this investigation (Fig. 3).

Fig. 3. Flow-chart of websites about dental implants.



These webpages were generally affiliated to non-profit organisations (n = 24; 75%) or to universities or medical centres (n = 4; 12.5%). The degree of specialisation of their contents resulted to be intermediate and mostly exclusively related to dental implants (17; 53.1%).

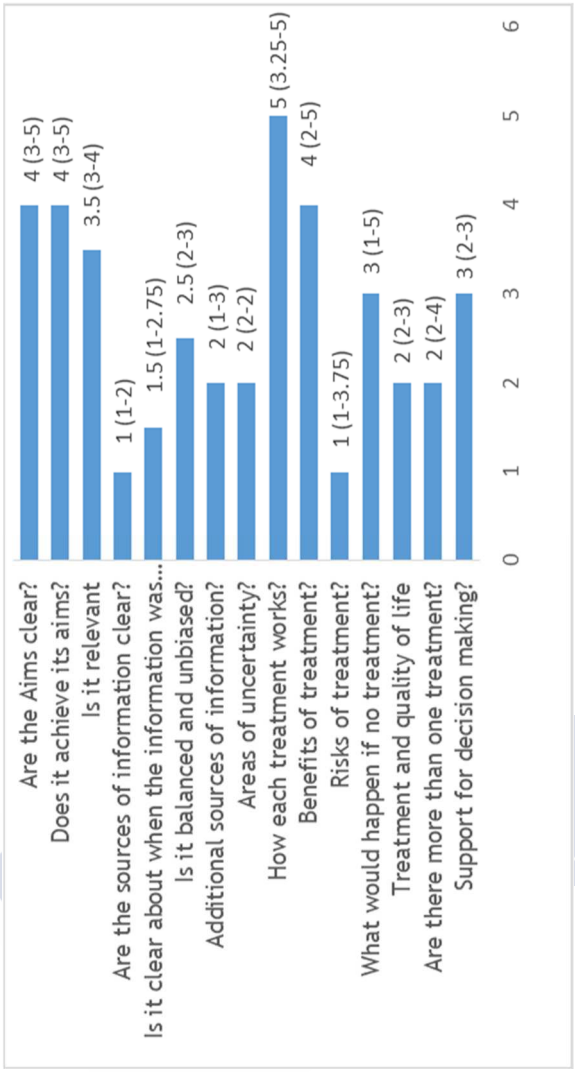
Both searches yielded similar results in terms of quality and legibility of the information (Table 3), but Yahoo!®-retrieved websites showed significantly better rating in achieving their aims (P = 0.01) and more relevant information (P = 0.002) with better description of the benefits from each treatment (P = 0.05). Usability scores were also significantly higher for the websites identified by Yahoo!®.

Table 3. Quality and readability of the selected websites

	Google (N=22)	Yahoo (N=15)	Mann-Whitney
Variable	Median (interquartile range)	Median (interquartile range)	P-value
DISCERN overall rating	3 (2-3)	3 (3-3)	0.11
Accessibility (total)	79.36 (74.20-84.12)	79.36 (73.01-85.71)	0.80
Usability (total)	53.70 (46.29-60.64)	68.51 (61.11-77.77)	0.0001◊
Reliability	55.55 (443.51-67.59)	48.14 (40.74-72.77)	0.96
FRES Score	49.74 (34.74-53.49)	52.79 (34.95-56.08)	0.48
FKRGL Score	9.83 (8.39-11.10)	10.07 (8.47-11.40)	0.92
◊Statistically significant			

When all 32 selected sites were considered, only 3 (9.4%) had been awarded with the HON seal. The median score for the overall rating produced by the DISCERN instrument was 3 (range: 2–3), so serious or potentially important shortcoming in the quality of the information obtained can be assumed. These serious weaknesses were particularly relevant in terms of details on what sources of information the sites use (1 [1–2]) and when this information was produced (3 [2–3]) (Fig. 4).

Fig. 4. Median quality ratings across the 32 included sites using the DISCERN instrument.



Webpage analysis by means of the LIDA instrument revealed modest percentages for accessibility (79.36 [74.60–85.31]) and intermediate for usability (59.20 [50.46–68.51]) and reliability (55.55 [45.37–66.66]).

Legibility indices of patient-addressed sites (Yahoo!® and Google®) reached scores within the range of difficult to read (FRES = 51.72 [38.70–55.27]; FKRGL = 12.76 [10.07–14.87]), whereas the information obtained from the first 100 sites identified by HONsearch for professionals elicited even poorer legibility scores (FRES = 27.69 [19.41–35.48]; FKRGL = 13.87 [12.26–16.05]) that reached statistical signification (P = 0.0001).

5.1.3 Discussion

There are also some shortcomings of our investigation that have to be addressed: our research was constrained to English-language websites, thus generalisation of our results is limited. The use of two single search engines (Google® and Yahoo!®) may also bias our investigation, although the fact that most patients seeking e-health information begin their searches through any of these engines (Fox & Duggan, 2013) minimises this possibility. The variations in the order by which search engines list sites over time may hamper reproducibility of the study, so to avoid this inconvenience and to reduce the risk for a potential selection bias, we screened up to 200 potential websites, which may be much more than an average patient would browse in a search (Zimmer et al, 1992).

Some patients – "online diagnosers" – check their symptoms at computer applications (Apps) in order to be able to obtain a diagnosis (Fox & Duggan, 2013; Khatoon et al, 2013), but most users (up to 59% of USA adults) can be better described as "online health seekers", as their intention is to gather information on health-related topics (Fox & Duggan, 2013).

However, many studies have proved that Internet users are not particularly worried about the quality of the information they get when seeking health information online (Meric et al, 2002), probably because patients do not identify distrust information as a barrier for Internet use (Rogers et al, 2012). This circumstance is frequently exploited by webs with marked commercial interests and unscrupulous sites (Pothier & Pothier, 2009) and usually produces misinformed patients.

DISCERN and LIDA tools are the most frequently used tools for assessing quality and reliability of medical websites, particularly in the areas of anaesthesia (Jaffe et al, 2014), urology (Wong et al, 2013), and oncology (Wasserman et al, 2014).

In the field of maxillofacial pathology, previous reports highlight the poor quality of the patient-addressed information about several oral lesions (Lopez-Jornet & Camacho-Alonso, 2009; Ni Riordain & McCreary, 2009; Lopez-Jornet & Camacho-Alonso, 2010). The quality of the contents related to orthodontic treatments is very variable (Livas et al, 2013), reaching intermediate scores for the particular topic of orthodontic extraction (Patel & Cobourne, 2011). Our results show a poor overall quality score for websites as a source of information about dental implant treatment, with potentially important shortcomings, as happens to websites dealing with head and neck carcinomas (Ni Riordain & McCreary, 2009).

Users' accessibility to dental implants websites was slightly better than that reported for other dental-related websites, although usability resulted to be somewhat lower (Patel & Cobourne, 2011; Livas et al, 2013). We could identify significant differences in terms of usability (clarity, consistency, functionality and engagability; Minervation) between search engines: "online health seekers" using Yahoo!® would find the information they need about dental implants better than those using Google®.

Dental implants websites also reached intermediate values in reliability (keeping up to date with latest research and reflecting best current knowledge).

Readability (reading skills and individual must possess to understand a written text) analysis show implant-related contents are "difficult to read", with FRES scores away from what is considered to be acceptable for patients (≥60) (Bernstam et al, 2005), probably due to the technical nature of the information displayed. This comprehension difficulty is lower than those described for websites about stroke, pulmonary and heart disease, diabetes or cancer (Walsh & Volsko, 2008), but higher than that found for other dental related websites (Patel & Cobourne, 2011; Livas et al, 2013). This circumstance is particularly worrying due to the high number of

people with low levels of health literacy (ability to access, understand, evaluate and communicate health information) (Canadian Council on Learning, 2008).

This inconvenience may be solved using few syllables per word and few words per phrase (Pothier & Pothier, 2009), which may also help to improve readability and to reduce the potential for cultural bias in understanding (Pothier & Pothier, 2009). Another additional strategy would be to involve potential users, associations of patients, etc. in the development of health-related websites (Bjerkan et al, 2015) and to improve their health literacy skills.

It is concluded that e-health information on dental implants in English language is difficult to read and poor in terms of quality, which may somehow explain disinformation and persistence of unrealistic expectations among patients. Therefore, it is necessary to generate websites housing reliable, high quality information about dental implants, whose contents are both independent from commercial interests and easy to understand by the average patient.

5.2 OBJETIVE 2.

VARELA-CENTELLES, P., LEDESMA-LUDI, Y., SEOANE-ROMERO, J.M. and SEOANE, J., 2015. Information about oral cancer on the Internet: our patients cannot understand it. The British Journal of Oral & Maxillofacial Surgery, 53(4), pp. 393-395. (Annex 3)

5.2.1 Introduction

Growing numbers of patients with cancer are using the Internet (Eysenbach, 2003; Rogers et al, 2012). About 54% of those with cancer of the head and neck rely on it to find information about their treatment (often regarding side effects) and how to maintain their health in the future (Ziebland et al, 2004; Rogers et al, 2012).

Online information on cancer can not only increase a patient's knowledge, favour realistic expectations, and improve outcome (Ziebland et al, 2004), but can also ease communication between patients and physicians. Comprehension is essential if information on health is to be useful, and although it has been reported that the readability of websites on cancer must be improved (Friedman et al, 2006), we could find no investigations that did so. This study was designed to assess the readability of online information on oral cancer.

5.2.2 Materials and methods

5.2.2.1 Searching strategy

We used 3 search engines: Google® (www.google.com), Yahoo!® (www.yahoo.com), and HONsearch section for patients (www.hon.ch/HONsearch/Patients/index.html), to identify websites using the term "oral cancer". We chose the English language for the interface and operative system with no predetermined location or filters.

We considered the first 100 consecutive results from each search engine. We excluded sites that were irrelevant, duplicated, or exclusively commercial, sites for professionals, forums and discussion groups, non-operative sites, and password-protected webpages.

5.2.2.2 Assessment of readability

We used an online program (www.readabilityformulas.com) to assess the websites using the Flesch-Kinkaid Reading Grade Level (FKRGL), Flesch Reading Ease Score (FRES), Gunning Fog Index, Coleman-Liau Index, Automated Readability Index, and the Simple Measure of Gobbledygook Index (SMOG) (Table 1), which are widely used to assess readability of information in English (Bravos, 2010; Jayaratne et al, 2014).

Readability grades according to the Flesch Reading Ease Score are: 0-30 = very difficult; 30-50 = difficult; 50-60 = fairly difficult; 70-80 = fairly easy; 80-90 = easy; and 90-100 = very easy. Text that is graded as "easy" by the Flesch-Kinkaid Reading Grade level is considered readable by people up to 12 years' of age; text graded as "difficult" is suitable for people aged over 16.

The Gunning Fog and the SMOG indices consider the number of complex words and predict the grade required for 100% comprehension, whereas the Coleman-Liau and the Automated Readability indices are based on characters instead of syllables.

5.2.2.3 Statistical analysis

Data were coded, recorded, and analysed using SPSS 15.0 (SPSS Inc, Chicago, USA). They are expressed as mean (SD) and median (IQR).

5.2.3 Results

Of the 100 sites found using each search engine, 47 from Google®, 57 from Yahoo!®, and 89 from HON-search were excluded. A total of 119 websites were included.

Readability indices reached mean scores within the range of "difficult to read" (Flesch Reading Ease Score = 36.04 (14.87)) requiring high levels of comprehension (Flesch-Kinkaid Reading Grade level = 11.44 (3.27)) (Table 4).

Table 4. Readability índices of websites on oral cancer designed for patients.

Index	Median (IQR)	Range
Flesch Reading Ease score	38.55 (25.51–45.25)	1.00–64.95
Gunning Fog index	11.16 (10.38–13.17)	8.39–16.69
Coleman-Liau index	19.34 (16.72–22.87)	10.78–49.50
Flesch-Kincaid grade	10.55 (9.17–13.26)	6.49–21.56
Automated Readability Index	14.37 (12.63–17.82)	8.06–38.79
Simple measure of Gobbledygook index (SMOG)	10.62 (9.83–11.69)	8.43–15.56

5.2.4 Discussion

Websites for patients on oral cancer and precancerous lesions have been found to vary in accuracy (Ni Riordain & McCreary, 2009) and to be of a low standard (Lopez-Jornet & Camacho-Alonso, 2009). Often, patients need high-level reading skills to understand the information (readability). Previous studies of online information on cancer have shown disparities in readability between information on different types of cancer, information on colon cancer being more difficult to read than that on breast and prostate neoplasms (Friedman et al, 2006). Websites on oral cancer, despite avoiding complex words (polysyllabic), often need higher reading skills than sites on other cancers, which hampers the understanding of people with low levels of literacy (Canadian Council on Learning, 2008).

Information is easier to read when technical words (pharynx, larynx, or glottis) are replaced by more common alternatives (throat, mouth, tongue) (Bates et al, 2006), and sentences are shorter. A consideration of the specific geographical locations for each language would help to reduce the potential for cultural bias in understanding and would also help to improve readability.

5.3 OBJECTIVE 3.

MIGUENS-VILA, R., LEDESMA-LUDI, Y., RODRIGUEZ-LOZANO, F., VARELA-CENTELLES, P., SEOANE-ROMERO, J.M. and CASTELO-BAZ, P., 2018. Disparities between English and Spanish in readability of online endodontic information for laypeople. Journal of the American Dental Association (1939), 149(11), pp. 960-966. (Annex 4).

Approximately 3.7 billion people, mostly from Asia, America (the majority of studies on oral health literacy have been conducted in North America), and Europe, use the internet on a regular basis (Internet World Stats, 2018), and more than 70% of them have searched for health-related information at some time (Fox & Duggan, 2013; Kong & Hu, 2015). These online health seekers request information useful for making decisions about health maintenance, diagnoses, and treatment alternatives and their undesired effects (Rogers et al, 2012). Despite being commonplace, this behaviour is particularly frequent among patients with cancer (Couper et al, 2010), for whom Web-based information can improve both disease outcome and the patient-physician relationship, providing appropriate expectations and increasing patients' quality of life (Ziebland et al, 2004). In this vein, the Google® search engine is the tool most frequently used for seeking health-related information (Kong & Hu, 2015).

The most frequently searched topics in dentistry are related to aesthetics, implantology, and potential problems related to amalgam restorations (Chestnutt & Reynolds, 2006; Fox & Duggan, 2013). Although caries Web sites have an acceptable readability (Blizniuk et al, 2016), available electronic health information about dental implants written in English is difficult for the average patient to read and is poor in quality (Leira-Feijoo et al, 2015).

Data about endodontic-related searches are scarce but have had an acceptable readability in convenience samples, both for Web sites and patient education brochures in endodontics (Woodmansey, 2010). In addition, investigators in some studies have warned about the low standards of patient-addressed endodontic information (Woodmansey,

2010; Nason et al, 2016; Rossi-Fedele et al, 2016). This information has undergone no quality control, has not been peer reviewed, and is not evidence based (Nason et al, 2016). In this sense, both the reliability and the quality of the information have been assessed as moderate or low (Rossi-Fedele et al, 2016). To our knowledge, the only study on the readability of endodontic-related information on the internet was focused on a small sample of arbitrarily selected English-language sites by using the Flesch Reading Ease Score (FRES) and Flesch-Kincaid Reading Grade Level (FKRGL) indexes (Woodmansey, 2010). Despite the lack of consensus about the best way to assess readability, it is widely recommended that investigators use a combination of these tools to increase the validity of the results (Badarudeen & Sabharwal, 2010). The Health Literacy Advisor suggests using at least the FKRGL, Gunning Fog Index (GFI), and Simple Measure of Gobbledygook (SMOG) index (Health Literacy Innovations, 2018).

Another relevant issue to consider is the low level of oral health literacy (degree to which people have the capacity to understand basic oral health information) reported from America (mainly North America), Asia, and Europe (Blizniuk et al, 2014), which results in a communication gap for patients (Safeer & Keenan, 2005). Although Reading level (ability to understand written material) is a key component of health literacy (Walsh & Volsko, 2008), to our knowledge, no investigations focusing only on the readability of Web-based, endodontic-related materials have been conducted. Therefore, in this study, we assessed the readability of Web-based, patient addressed information about endodontic treatments, in both the English and Spanish languages.

5.3.1 Methods

5.3.1.1 Search strategy

We performed our investigation in May 2016 and updated it in December 2017 by using Google® (www.google.com) as a search engine. The search query was “root canal treatment” with no limits or filters because this is the descriptor most frequently used in online

searches on this topic by laypeople (Nason et al, 2016; Rossi-Fedele et al, 2016). We set the English-language option for both the interface and the operating system. In addition and because of the lack of previous research on this topic in Spanish and to increase the external validity of the study, we undertook a pilot study in January and February 2016 by using a questionnaire administered to a consecutive sample of 162 patients (mean [standard deviation] age, 46.8 [14.2] years; 42% male) attending our endodontics unit (School of Medicine and Dentistry, University of Santiago de Compostela, Santiago de Compostela [A Coruña] Spain) to identify the most frequently searched-for topic on the internet. This topic was *"¿Qué es una endodoncia?"* ("What is a root canal treatment?").

To check whether this query was the typical query patients might use for searching for information about endodontic treatment, we used the Google Trends program (http://trends.google.com/trends/explore). This tool was validated previously to assess public interest by detecting internet search activity about a particular topic according to time and geographic location (Nuti et al, 2014). The periodogram Google Trends produced showed a high use of this term in Spanish-speaking countries. Therefore, we included this question in our search strategy. We displayed the results of each search (10 hits per page) and selected the first 100 sites identified for each language for the investigation. The study inclusion criteria were the topic of the Web sites (endodontic treatment) and their intended audience (patients). We excluded sites displaying only commercial information or irrelevant content, as well as duplicated Web sites, non-working pages, password-protected sites, and forums and discussion groups (Leira-Feijoo et al, 2015). Although we excluded purely commercial sites, we included those Web sites showing relevant information for patients in a clear, differentiated manner, independent of the commercial content.

Two endodontists with expertise in the analysis of health information on the internet (R.M-.V., P.C-.B.) reviewed all sites (n = 200) according to the inclusion and exclusion criteria set for the study until they reached consensus. If they did not reach consensus, a third

reviewer (J.M.S-.R.) mediated. The concordance level attained between observers was substantial (Cohen κ, 0.63).

5.3.1.2 Evaluation of readability

Once we filtered, classified, and reviewed the sites, we assessed readability by using a set of tools. We used the FKRGL, FRES, GFI, Coleman-Liau index (CLI), automated readability index (ARI), and SMOG index (Coleman & Liau, 1975; Fitzsimmons et al, 2010; Jayaratne et al, 2014).

We used these instruments in Readability Test Tool® (WebFX. Harrisburg, PA, EE.UU.), a free, straightforward online program (http://www.webpagefx.com/tools/read-able), by pasting each URL into this site to obtain an automated result for these indexes for a given Web page. We checked the accuracy of the online method by using readability formulas with a manual calculation (Table 1 and 2) (Leira-Feijoo et al, 2015).

The FRES score categories were very difficult (0-30): college graduates (scientific literature); difficult (30-50): high school (academic); fairly difficult (60): some high school; normal (60-70): seventh or eighth grades (digests); fairly easy (70-80): sixth grade; easy (80-90): fifth grade; and very easy (90-100): fourth grade (comics). We also graded the Web sites according to the FKRGL scale as easy (≤ sixth-grade level) or difficult (≥ 10^{th}-grade level) to read (Parekh & Gill, 2014). This index had a significant correlation with the GFI (Spearman ρ, 0.93) and with the SMOG index (Spearman ρ, 0.94). All other indexes involve consideration of the number of years of formal education needed to understand the text.

We calculated the readability for Spanish-language Web sites by using the Fernández-Huerta index (an adaptation of the FRES to Spanish), which takes into account that Spanish involves using larger words and sentences than does English, and the INFLESZ (Ines-Barrio; Szigrizst-Pazos perspicuity index validated for patient-addressed text in Spanish) (Barrio-Cantalejo et al, 2008). We validated this latter scale by using 210 documents of 3 types selected at random -popular culture magazines, school textbooks, and scientific

magazines- by means of automatized calculations (http://www.legible.es) using the formulas depicted in Table 2.

The Fernández-Huerta readability scale has categories exactly as the FRES index does, whereas the INFLESZ scale classifications are scores from 0 to 40, very difficult (scientific journals); 40 to 55, fairly difficult (popular science, specialized press); and 55 to 65, normal degree of difficulty (daily newspapers, sports journals). Scores in the range from 60 through 80 indicate that the text is quite easy to read (gossip magazines and successful novels), and those ranging from 80 to 100 are considered very easy to read (comics) (Blanco Pérez & Gutiérrez Couto, 2002; Barrio-Cantalejo et al, 2008). These 2 indexes (Fernandez-Huerta and INFLESZ) have a significant correlation (Spearman ρ, 0.96).

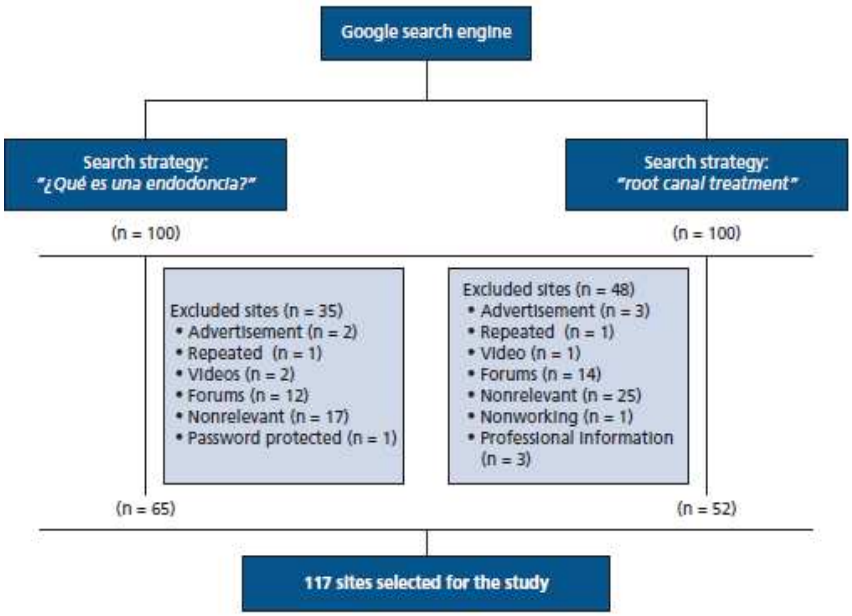
5.3.1.3 Statistical analysis

We analyzed the data (SPSS 15.0, IBM) descriptively by using the mean and median (P_{50}) as indicators of the central trend and the standard deviation and interquartile range as spread indicators. We used non-parametric (Mann-Whitney U and x^2) tests for comparing variables. The significance level we chose for this investigation was 5%. We calculated confidence intervals for the difference of proportions by using software (Epidat 4.2, Consellería de Sanidade, Santiago de Compostela, Spain).

5.3.2 Results

We assessed the first 100 consecutive sites identified through Google® by using each search strategy *("¿Qué es una endodoncia?"* and "root canal treatment"), and only 35 Web sites in Spanish and another 48 in English did not meet the inclusion criteria. Therefore, we selected 117 sites for the study (Figure 5).

Fig. 5. Flowchart of websites about root canal treatment



Among the 52 English-language sites, the readability indexes were in the category of normal to read, easily understood by 13- through 15-year-old students (FRES, 63, interquartile range (IQR) [53.9-66.2]; GFI, 10.4, IQR [8.8-12]; CLI, 12.5, IQR [11.6-13.3]; ARI, 8.6, IQR [6.7-9.8]). The SMOG index -the preferred measure of readability when evaluating consumer-oriented health care material- led to the estimation that only 7 years of education would be needed to understand these contents (SMOG, 7.6, IQR [6.5-8.8]) (Table 5). Likewise, sites in Spanish had a readability index normal for an adult, equivalent to a seventh or eighth school year (Fernandez-Huerta, 62.3, IQR [59.7-66.6]; INFLESZ, 57.5, IQR [55.1-62.1]). These results did not permit the identification of significant differences between the readability indexes of sites in Spanish or English.

Table 5. Distribution of readability scores for English- and Spanish-languages sites.

Language and index	Mean (standard deviation)	Median	10th percentile	25th percentile	75th percentile	90th percentile
English (n=52)						
Flesch-Kincaid Reading Grade Level	8.2 (2)	8.3	5.5	6.8	9.7	10.8
Flesch Reading Ease Score	60.6 (8.2)	63.0	48.0	53.9	66.2	69.9
Gunning Fog Index	10.2 (2.4)	10.4	6.4	8.8	12.0	13.7
Coleman-Liau Index	12.7 (1.6)	12.5	10.8	11.6	13.3	15.0
Automated Readability Index	8.3 (2.3)	8.6	4.6	6.7	9.8	10.8
Simple Measure of Gobbledygook index	7.7 (1.6)	7.6	5.3	6.5	8.8	10.0
Spanish (n=65)						
Fernández-Huerta index	62.4 (6.8)	62.3	54.0	59.7	66.6	69.4
INFLESZ	57.8 (6.8)	57.5	49.0	55.1	62.1	64.8

Both for English-language (53.8%) and Spanish-language (69.2%) Web sites, the classification of normal difficulty, which ensures an adequate comprehension of the written information, is the most important and showed no significant difference of proportions between both groups (-0.15; 95% confidence interval, -0.33 to 0.02). However, when we compared different degrees of Reading difficulty, we found that 36.6% of English-language sites posed some degree of difficulty for readers in understanding their content, whereas 23% of Spanish-language sites had some degree of difficulty (14.46; 95%

confidence interval, -3.16 to 30.08). In particular, English-language Web sites assessed as difficult or very difficult to read accounted for 15.3% of the sites analyzed, whereas the Spanish-language sites scoring equivalent levels of reading difficulty (difficult or very difficult) were only 1.5% of the study sample. This difference reached statistical significance (Table 6).

Table 6. Comparison of the degrees of readability difficulty found for English- and Spanish-language Web sites.[□]

Grade	English, no.(%) (n=52)	Spanish, no.(%) (n=65)	Difference of proportions (95% confidence interval)
Difficult or very difficult	8 (15.38)	1 (1.54)	0.13 (0.01 to 0.25)†
Fairly difficult	11 (21.15)	14 (21.54)	0.00 (-0.17 to 0.16)
Normal	28 (53.85)	45 (69.23)	-0.15 (-0.33 to 0.02)
Fairly easy, easy or very easy	5 (9.62)	5 (7.69)	0.01 (-0.10 to 0.14)

□ Mean (standard deviation) for the Flesch Reading Ease Score for English was 60.6 (8.2) and for INFLESZ for Spanish was 57.8 (6.8). The estimated difference between the two index means (X_i – X_j) was 2.8 (95% confidence interval, 0.05 to 5.47). † Statistically significant.

5.3.3 Discussion

The absence of a regulatory policy for the internet seems to have influenced the poor standards of patient-addressed information (Jiang, 2000), which frequently clashes with existing codes of ethics and professionalism (Parekh & Gill, 2014). Thus, the quality aspects of the endodontic contents in devoted Web sites, such as reliability, accessibility, and usability of the information, have reached scores in the range from low to medium (Rossi-Fedele et al, 2016).

The strengths of our study are the non-restrictive search strategy ("root canal treatment") and the use of several formulas to calculate readability (Jayaratne et al, 2014), including the SMOG index, which is considered the standard for evaluating consumer-oriented health care materials (Fitzsimmons et al, 2010). The SMOG formula is the tool of choice of the American Cancer Society because it is based on stricter criteria than are other measures and requires 100%

comprehension; essentially, the more polysyllabic words a site includes, the higher the SMOG score becomes (Walsh & Volsko, 2008; Badarudeen & Sabharwal, 2010). Moreover, investigators use the CLI and ARI widely in the dental literature because of their reliability (Leira-Feijoo et al, 2015).

English is the second largest language in the world (983 million people), and Spanish is the third, with 527 million speakers (Simons, 2017), so the readability analysis performed for both languages increases the external validity of our study. Conversely, there are certain limitations to this research that need to be addressed. This cross-sectional study likely involves a potential selection bias related to the search engines and the variation in the order in which their results are presented. In seeking medical information on the internet, most laypeople view only the first 3 search results, only occasionally viewing the first page of results (Wang et al, 2012), and the fact that we considered a sample of 117 Web sites, well above the average number of sites visited by patients (Wang et al, 2012), should improve the validity and reproducibility of our study. Another potential limitation of our study is linked to the use of readability formulas based on the length and structure of the sentence (quantitative linguistics), without considering images, layout, experiences, and motivation of the readers (Health Literacy Innovations, 2018).

Furthermore, the classification of the academic level of a given text also has generated multiple controversies in the assessment of health-related messages in different countries with different education models. The Fernández-Huerta formula used in this study resulted from the adaptation of FRES to Spanish, giving both of them grade 8 as the estimated level for understanding a text of normal difficulty (standard). Thus, to ascertain the readability level, the equivalence of studies in the education systems of the United States and Spain has to be taken into account, which matches the eighth grade in both countries with a reading level typical of a 13-year-old student (Blanco Pérez & Gutiérrez Couto, 2002). However, there are regional differences among speakers of the same language that include both linguistic and cultural variations (for example, Spanish from Cuba, Mexico, and Spain). Bearing in mind that the validation of the

readability index scale was undertaken in populations using Castilian Spanish and that variations of Spanish in other geographic areas exist, readability could be different. Therefore, additional studies of comprehension of health-related messages from an intercultural perspective seem to be necessary.

Investigators have identified a wide range of variations in terms of readability of dental-related Web sites. Although sites dealing with oral cancer and precancer are particularly difficult to read (Varela-Centelles et al, 2015; Wiriyakijja et al, 2016), along with those about xerostomia (Delli et al, 2015), burning mouth syndrome (Alnafea et al, 2017), or dental implants (Leira-Feijoo et al, 2015), Web site about orthodontic treatments seem to be easier to read (Livas et al, 2013; McMorrow & Millett, 2016).

Investigators in a previous report described endodontic-related sites as acceptably readable, with FRES values within the normal range (median, 60); that is, easily understood by 13- to 15- year-old students. Our results agree with these findings in that they show readability scores within this range of normal difficulty for both English and Spanish, although we categorized a relatively high number of Web sites (significantly more for English) within the fairly difficult and very difficult categories. Therefore, an important part of online endodontic information does not meet the literacy, cultural, and linguistic needs of both English- and Spanish-speaking populations.

The readability of dental-related Web sites is a key issue because a high proportion of dental patients seek online information about treatments, and approximately 50% of dentists prefer to discuss information from the internet with their patients (Parekh & Gill, 2014). One of the main objectives of Healthy People 2020 is to improve health literacy, which includes the use of easy-to-understand instructions for health conditions (Healthy People, 2018). In this sense, low reading skills and poor health are related strongly, and inadequate health literacy may produce inequalities in accessing health care (Safeer & Keenan, 2005). These shortcomings may be addressed by generating Web-based, patient-focused information in simple text with few syllables per word and shorter sentences, avoiding scientific jargon and illustrating the text with images and

explanatory drawings (Eltorai et al, 2014). In this sense, investigators have proposed some guidelines for improving the readability of written text in patient education materials. These recommendations include using familiar language in an active voice, placing relevant information at the beginning of the text, limiting the number of messages, avoiding ambiguous terms, using analogies known to the audience's cultural environment, and avoiding the use of symbols (Centers for Disease Control and Prevention, 2018). In this way, endodontists can use a wide range of resources to write plain language, effective health messages that are tailored to match the characteristics of the intended audience (Plainlanguage, 2018).

5.3.4 Conclusions

In conclusion, Spanish- and English-language electronic health information about endodontic treatment is acceptable to read, but particularly for English-language sites there is an important proportion of sites with difficulty levels well above the recommendations. Accordingly, it is necessary for professionals to play a greater role in patient education by generating easy-to-read, endodontic specialized Web sites that meet ethical standards and display high-quality endodontic information in understandable terms.

6. Discussion

The results of the research presented, which were designed to help to clarify the most confusing aspects in the evaluation of the dental information available on web pages, reinforce in a certain way what has been observed in other health areas: there is a significant proportion of websites referring to very popular dental topics that demand an educational level above that reached by the majority of the population. This is particularly true on sites published in English, with their consequent derivatives, to which we must add a generally poor quality of the information provided. As a result, the promising role that the Internet could have as a source of information to facilitate communication between professionals and patients, contributing to the generation of adequate treatment and decision-making expectations, is seriously compromised. In this sense, the need to provide content in plain language and with a solid quality should be a premise for the authors of health information pages, so that technical details are avoided (usually with a more complex lexicon) and an adequate understanding is sought for the message as a whole.

This research, despite obtaining results that point in the same direction as the information available in the literature, is not free from potential limits. One of them refers to the vehicular languages of information: investigations have focused on the English language, supplemented only by Spanish in one case. It is necessary to acknowledge the possible existence of information on the Internet on the investigated topics published in other languages that could get better scores in terms of both readability and quality. However, it seems reasonable to admit that the varied characteristics of the authors of these pages (with an unquestionable impact on the quality and

presentation of information) are reproduced in other cultural settings. If we add that the studies that make up this doctoral thesis have considered the most spoken language in the world and most used on the Internet (Ethnologue, 2019) and not the geographical origin of the information, the aforementioned constraint may not have conditioned the magnitude of the problem detected in the investigations that make the foundations of this doctoral thesis.

As mentioned earlier, search engines do not act neutrally and could have introduced a selection bias in our investigations. In the three articles Google® search engine has been used, in two of them it has been supplemented with Yahoo!® and a third party also used HONsearch for patients. Since Google® is the most used search engine with 90% of the market share of search engines and Yahoo!® ranks in second or third place (Statcounter, 2018), most of the queries that an individual could make, particularly in the healthcare field, are gathered when using these two search engines (Fox & Duggan, 2013).

The order of the results provided by the search engines is not random or identical for all cases and this could have also influenced our results. This problem is aggravated by the fact that general population only accesses the first three search engine results (Wang et al, 2012). To minimize all these inconveniences, a large sample of websites has been selected which included the first 100 websites resulting from each search, which is a much larger sample than an average user would check, and thus we ensure that we analyzed more websites than the average patients would visit.

Another hypothetical limit comes from the use of readability mathematical formulas (quantitative linguistics), without considering images, design, experiences and motivations of the reader. Reducing the complexity of a language only to the extent of its words and sentences is not entirely correct and may not accurately reflect the information acquired by the reader (Notorc, 2006). The frequency of use of a word also affects the readability of the text (Seely, 2013). Variations in the same language must also be taken into account: United Kingdom English is not the same as American English or Spanish from Argentina varies from the language spoken in Spain, a fact that has not been considered in our investigations.

Readability formulas also pose certain problems of interpretation. All of them are based on the reading level corresponding to the US education system. For example, if the FKRGL scores 8 it is equivalent to the eighth grade of the US. (Approximately 13-14 years) which in turn is the score that a text aimed at the general population should have (Readable, 2011), which is not necessarily equivalent in other countries. This misinterpretation has consequent qualitative differences so as to which reading level may be considered as suitable for the general public according to the language and country reviewed.

There are a limited number of articles in the literature that focus on the analysis of quality and/or readability of the websites with dental information provided by search engines. In the field of dental implants, two articles that focus on this topic were published in 2014, although they analyze different aspects. One research studies the quality of online information on dental implants but focuses on websites in the United Kingdom, which implies a geographical constraint (Ali et al, 2014). Even so, its conclusions match our findings that such online information on implant treatment is generally of poor quality, and in addition to this they underline a lack of information on long-term results and complications. The second article is solely based on readability and concludes that all patient-oriented websites on dental implants obtained scores above the recommended level, the majority of them being classified as difficult to read (Jayaratne et al, 2014), which it also matches our results. In terms of quality and about decision-making based on online information on either endodontics or extracting the tooth and placing a dental implant (Rossi-Fedele et al, 2016), this report deals with a very specific clinical question and therefore with less information available to the public. In this case, the quality turned out to be from moderate to low. Another aspect related to implantology (periimplantitis) has also poor information in terms of quality and readability (Leira et al, 2019).

In the field of oral cancer, a greater number of studies have been carried out, although they are still scarce if we compared it to other types of cancer. The quality of online information proved to be very variable in terms of accuracy in English (Ni Riordain & McCreary,

2009), or directly very poor (Lopez-Jornet & Camacho-Alonso, 2009). Also in the case of oral precancerous lesions, important problems have been observed in both quality and readability (Wiriyakijja et al, 2016; Alsoghier et al, 2018).

Irwin et al published a study in 2007 and another in 2011, both focusing on English and Spanish in which they obtained similar results: low quality of information on oral cancer with worse values for Spanish websites (Irwin et al, 2007; Irwin et al, 2011). This whole picture seems to concur with the findings of our research. On the other hand, disparities between online information on different types of cancer have been shown, for example, information about colon cancer is more difficult to understand than breast and prostate cancer (Friedman et al, 2006).

Only one article focusing entirely on assessing the readability of endodontics information has been found (Woodmansey, 2010) with results ranging from moderate to difficult to read. Although the same results have been obtained in our study, it should be mentioned that in Woodmansey's article they mix the analysis of web pages with that of informative brochures, which introduces a bias since it is not recommended to analyze analogical and digital materials with the same tools (Oxman et al, 1993). In this vein, no study was found analyzing the quality of written online information, apart from the article already mentioned on decision making between endodontics and dental implants (Rossi-Fedele et al, 2016) that focuses on this clinical aspect and not on the subject of endodontics in general.

Future efforts should combine the increase of the levels of instruction on oral health to the general public (National Institute of Dental and Craniofacial Research, National Institute of Health, US Public Health Service, Department of Health and Human Services, 2005) with the production of easily readable contents with few syllables per word and few words per sentence (Pothier & Pothier, 2009). Potential users, patient associations, etc. should be involved in the development of websites related to health, which would also help improve health literacy and provide an intercultural perspective. It is necessary to create websites, or assist in their design, that have

reliable, accessible, useful, quality information and with the correct readability and contents independent from commercial interests.

Given that poor reading skills and poor health standards are closely related and that insufficient health literacy can lead to inequalities in access to medical care (Safeer & Keenan, 2005), it is important to screen periodically the health-related information available to the general public, study online health information in more languages, instruct patients and professionals in the search for quality and readable information, analyze how to improve readability analysis methods and apply them in all possible areas.

Further studies are also needed to help improve our understanding of health information status on the Internet, bypassing language barriers (for example including pages in Chinese or Hindi, since Asians make up more than 50% of global internet users and their figures are increasing), analyzing the influence of a specific search engine on the information understood by the average user, or even improving the readability indexes by multidisciplinary task groups so that intercultural differences or the contribution of graphics or images were taken into account to the comprehension of information.

It has been shown that in addition to the search for health information on Google® or Yahoo!® (Fox & Duggan, 2013), one of the most popular activities on the internet is watching videos on YouTube®. There are some articles that review health information available on this audiovisual platform (Nason et al, 2016), although they lack a methodology that can analyze quality in a totally empirical way. We are compelled to expand our research beyond written information and analyze the audiovisual contents listed by search engines, since they now provide not only written websites but an extensive catalogue of videos that they list ahead of other results.

It has already been shown that social networks have become part of health education, with a broader promotion of health (Balatsoukas et al, 2015) being able to generate a change in behaviour in terms of healthy habits (Latkin & Knowlton, 2015). That is the reason why it is important to study the written contents that are generated in social networks in terms of quality and readability, without putting aside the audiovisual material that is also available in them.

7. Conclusions

1. Information about dental implants available on websites has been assessed as of difficult reading for the general public and with important constraints on their quality, which goes from serious to potentially important shortcomings. However, these websites have presented acceptable standards in terms of usability and reliability. In addition to this, different search engines seem to slightly affect to the quality of the information. A Search on Yahoo!® provide one information more relevant and usability than that found on Google®.
2. Readability of information on oral cancer hosted on websites is in the range of difficult to very difficult, and requires a high level of understanding in the general public, which affects less educated population, in a particularly sensitive subject.
3. Online information related to endodontics has a similar readability in both Spanish and English. However there is a greater proportion of websites in English which show some difficulty to read compared to websites in Spanish. In spite of this, information about endodontic treatments hosted in English websites are found as normal reading and easy to understand. In addition to this, consumer-driven health care contents for root canal treatment requires a lower level of education for the reading comprehension than information related to the oral cancer and dental implants.

8. References

ALI, S., WOODMASON, K. and PATEL, N., 2014. The quality of online information regarding dental implants. British dental journal, 217(9), pp. e16.

ALNAFEA, S., FEDELE, S., PORTER, S. and NI RIORDAIN, R., 2017. Online Information on the Treatment of Burning Mouth Syndrome: Quality and Readability. Journal of oral & facial pain and headache, 31(2), pp. 147-151.

ALSOGHIER, A., NI RIORDAIN, R., FEDELE, S. and PORTER, S., 2018. Web-based information on oral dysplasia and precancer of the mouth - Quality and readability. Oral oncology, 82, pp. 69-74.

ARMSTRONG, J.S., 1982. Research on scientific journals: Implications for editors and authors. Journal of Forecasting, 1(1), pp. 83-104.

ASOCIACIÓN PARA LA INVESTIGACIÓN DE MEDIOS DE COMUNICACIÓN, March 6, 2018-last update. Infografía Resumen 20º Encuesta Navegantes en la Red. Available: https://www.aimc.es/otros-estudios-trabajos/navegantes-la-red/infografia-resumen-20o-navegantes-la-red/ [September, 2019].

AUDISIO, R.A., STAHEL, R.A., AAPRO, M.S., COSTA, A., PANDEY, M. and PAVLIDIS, N., 2009. Successful publishing: how to get your paper accepted. Surgical oncology, 18(4), pp. 350-356.

BADARUDEEN, S. and SABHARWAL, S., 2010. Assessing readability of patient education materials: current role in orthopaedics. Clinical orthopaedics and related research, 468(10), pp. 2572-2580.

BALATSOUKAS, P., KENNEDY, C.M., BUCHAN, I., POWELL, J. and AINSWORTH, J., 2015. The Role of Social Network Technologies in Online Health Promotion: A Narrative Review of Theoretical and Empirical Factors Influencing Intervention Effectiveness. Journal of medical Internet research, 17(6), pp. e141.

BARRIO-CANTALEJO, I.M., SIMÓN-LORDA, P., MELGUIZO, M., ESCALONA, I., MARIJUÁN, M.I. and HERNANDO, P., 2008. Validation of the INFLESZ scale to evaluate readability of texts aimed at the patient. Anales del sistema sanitario de Navarra, 31(2), pp. 135-152.

BASCH, C.H., ETHAN, D., CADORETT, V., KOLLIA, B. and CLARK, A., 2019. An assessment of the readability of online material related to fluoride. Journal of prevention & intervention in the community, 47(1), pp. 5-13.

BASCH, C.H., FERA, J. and GARCIA, P., 2019. Readability of influenza information online: Implications for consumer health. American Journal of Infection Control, 47(11), pp. 1298-1301.

BATES, B.R., ROMINA, S., AHMED, R. and HOPSON, D., 2006. The effect of source credibility on consumers' perceptions of the quality of health information on the Internet. Medical informatics and the Internet in medicine, 31(1), pp. 45-52.

BERGE, T.I., 2000. Public awareness, information sources and evaluation of oral implant treatment in Norway. Clinical oral implants research, 11(5), pp. 401-408.

BERNSTAM, E.V., SHELTON, D.M., WALJI, M. and MERIC-BERNSTAM, F., 2005. Instruments to assess the quality of health

information on the World Wide Web: what can our patients actually use? International journal of medical informatics, 74(1), pp. 13-19.

BJERKAN, J., HEDLUND, M. and HELLESO, R., 2015. Patients' contribution to the development of a web-based plan for integrated care - a participatory design study. Informatics for health & social care, 40(2), pp. 167-184.

BLACKWOOD, J., WRIGHT, F.C., HONG, N.J.L. and GAGLIARDI, A.R., 2019. Quality of DCIS information on the internet: a content analysis. Breast cancer research and treatment, 177(2), pp. 295-305.

BLANCO PÉREZ, A. and GUTIÉRREZ COUTO, U., 2002. Legibilidad de las páginas web sobre salud dirigidas a pacientes y lectores de la población general. Revista Española Salud Pública, 76(4), pp. 321-331.

BLIZNIUK, A., FURUKAWA, S., UENO, M. and KAWAGUCHI, Y., 2016. Evaluation of English Websites on Dental Caries by Using Consumer Evaluation Tools. Oral health & preventive dentistry, 14(4), pp. 363-369.

BLIZNIUK, A., UENO, M., FURUKAWA, S. and KAWAGUCHI, Y., 2014. Evaluation of a Russian version of the oral health literacy instrument (OHLI). BMC oral health, 14, pp. 141.

BRAVOS, K., 2010-last update. Readability tests and formulas. Available: http://www.ideosity.com/ourblog/post/ideosphere-blog/2010/01/14/ readability-tests-and-formulas [April 6, 2014].

CANADIAN COUNCIL ON LEARNING, february, 2008-last update. Health Literacy in Canada: A Healthy Understanding 2008. Available: http://www.en.copian.ca/library/research/ccl/health/health.pdf [october, 2019].

CENTERS FOR DISEASE CONTROL AND PREVENTION, 2018-last update. Health literacy for public health professionals: plain language and effective health messages. Available: http://www.cdc.gov/healthliteracy/training/page1623.html [August 13, 2018].

CHANG, K., BERTHELET, E., GRUBBS, E., HAMILTON, S., KARVAT, A., TRAN, E., WU, J. and INGLEDEW, P.A., 2019. Websites, Websites Everywhere: How Thyroid Cancer Patients Use the Internet. Journal of cancer education, DOI: 10.1007/s13187-019-01576-5.

CHARNOCK, D., SHEPPERD, S., NEEDHAM, G. and GANN, R., 1999. DISCERN: an instrument for judging the quality of written consumer health information on treatment choices. Journal of epidemiology and community health, 53(2), pp. 105-111.

CHARNOCK, D. and SHEPPERD, S., 2004. Learning to DISCERN online: applying an appraisal tool to health websites in a workshop setting. Health education research, 19(4), pp. 440-446.

CHESTNUTT, I.G. and REYNOLDS, K., 2006. Perceptions of how the Internet has impacted on dentistry. British dental journal, 200(3), pp. 161-165.

CHOWDHARY, R., MANKANI, N. and CHANDRAKER, N.K., 2010. Awareness of dental implants as a treatment choice in urban Indian populations. International Journal of Oral & Maxillofacial Implants, 25(2), pp. 305-308.

CLEMENT, J., september 6, 2019-last update. Media usage in an internet minute as of March 2019. Available: https://www.statista.com/statistics/195140/new-user-generated-content-uploaded-by-users-per-minute/ [October 23, 2019].

COLEMAN, M. and LIAU, T.L., 1975. A computer readability formula designed for machine scoring. Journal of Applied Psychology, 60(2), pp. 283-284.

COUPER, M.P., SINGER, E., LEVIN, C.A., FOWLER, F.J., FAGERLIN, A. and ZIKMUND-FISHER, B., 2010. Use of the Internet and Ratings of Information Sources for Medical Decisions: Results from the DECISIONS Survey. Medical Decision Making, 30(5), pp. 106-114.

DARAZ, L., MORROW, A.S., PONCE, O.J., BEUSCHEL, B., FARAH, M.H., KATABI, A., ALSAWAS, M., MAJZOUB, A.M., BENKHADRA, R., SEISA, M.O., DING, J.F., PROKOP, L. and MURAD, M.H., 2019. Can Patients Trust Online Health Information? A Meta-narrative Systematic Review Addressing the Quality of Health Information on the Internet. Journal of general internal medicine, 34(9), pp. 1884-1891.

DAVIES, K. and HARRISON, J., 2007. The information-seeking behaviour of doctors: a review of the evidence. Health information and libraries journal, 24(2), pp. 78-94.

DELLI, K., LIVAS, C., SPIJKERVET, F.K. and VISSINK, A., 2015. Internet information on xerostomia: what should patients expect? Oral diseases, 21(1), pp. 83-89.

DIAZ, J.A., GRIFFITH, R.A., NG, J.J., REINERT, S.E., FRIEDMANN, P.D. and MOULTON, A.W., 2002. Patients' Use of the Internet for Medical Information. Journal of General Internal Medicine, 17(3), pp. 180-185.

ELTORAI, A.E.M., GHANIAN, S., ADAMS, C.A. JR., BORN, C.T. and DANIELS, A.H., 2014. Readability of patient education materials on the American association for surgery of trauma website. Archives of trauma research, 3(2), pp. e18161.

ETHNOLOGUE, 2019-last update. What are the top 200 most spoken languages?. Available: https://www.ethnologue.com/guides/ethnologue200 [september 15, 2019].

EYSENBACH, G., 2003. The impact of the Internet on cancer outcomes. CA: a cancer journal for clinicians, 53(6), pp. 356-371.

EYSENBACH, G. and KÖHLER, C., 2002. How do consumers search for and appraise health information on the world wide web? Qualitative study using focus groups, usability tests, and in-depth interviews. BMJ (Clinical research ed.), 324(7337), pp. 573-577.

FAHY, E., HARDIKAR, R., FOX, A. and MACKAY, S., 2014. Quality of patient health information on the Internet: reviewing a complex and evolving landscape. The Australasian medical journal, 7(1), pp. 24-28.

FITZSIMMONS, P.R., MICHAEL, B.D., HULLEY, J.L. and SCOTT, G.O., 2010. A readability assessment of online Parkinson's disease information. The journal of the Royal College of Physicians of Edinburgh, 40(4), pp. 292-296.

FOX, S. and DUGGAN, M., January 15, 2013-last update, Health Online 2013. Available: https://www.pewinternet.org/2013/01/15/health-online-2013/ [September, 2019].

FRIEDMAN, D.B., HOFFMAN-GOETZ, L. and AROCHA, J.F., 2006. Health literacy and the World Wide Web: comparing the readability of leading incident cancers on the Internet. Medical informatics and the Internet in medicine, 31(1), pp. 67-87.

FUZZELL, L.N., RICHARDS, M.J., FRAENKEL, L., STARK, S.L. and POLITI, M.C., 2019. What information can the lay public find about osteoporosis treatment? A descriptive study coding the

content and quality of bisphosphonate information on the internet. Osteoporosis international: a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA, 30(11), pp. 2299-2310.

GAGLIARDI, A. and JADAD, A.R., 2002. Examination of instruments used to rate quality of health information on the internet: chronicle of a voyage with an unclear destination. BMJ (Clinical research ed.), 324(7337), pp. 569-573.

GOOGLE PRIVACY AND TERMS, 2019-last update. HOW GOOGLE USES COOKIES. Available: https://policies.google.com/technologies/cookies?hl=en-US [october, 2019].

GOOGLE TRENDS, December, 2018-last update. Google Trends. Available: https://trends.google.es/trends/?geo=ES [December, 2018].

HEALTH LITERACY INNOVATIONS, 2018-last update. Health Literacy Innovations. Newsletter. Available: http://www.healthliteracyinnovations.com/newsletter/ [January 17, 2018].

HEALTH ON THE NET FOUNDATION, october 2, 2018-last update. Health On the Net Foundation. Available: https://www.hon.ch/home.html [October, 2019].

HEALTHY PEOPLE, 2018-last update, Health communication and health information technology. Available: https://www.healthypeople.gov/2020/topics-objectives/topic/healthcommunication-and-health-information-technology/objectives [August 13, 2018].

HEDMAN, A.S., 2008. Using the SMOG Formula to Revise a Health-Related Document. American Journal of Health Education, 39(1), pp. 61-64.

HOUCK, D.A., KRAEUTLER, M.J., BELK, J.W., MCCARTY, E.C. and BRAVMAN, J.T., 2019. Evaluation of information available on the internet regarding reverse total shoulder arthroplasty. Shoulder & elbow, 11(2), pp. 29-34.

HU, J., LUO, E., SONG, E., XU, X., TAN, H., ZHAO, Y., WANG, Y. and LI, Z., 2009. Patients' attitudes towards online dental information and a web-based virtual reality program for clinical dentistry: a pilot investigation in China. International journal of medical informatics, 78(3), pp. 208-215.

INTERNET WORLD STATS, October 4, 2019-last update. INTERNET USAGE STATISTICS. Available: https://www.internetworldstats.com/stats.htm [october, 2019].

INTERNET WORLD STATS, 2018-last update. Internet usage statistics. Available: http://www.internetworldstats.com/stats.htm. [August 13, 2018].

INTERNET WORLD STATS, 2013-last update. Miniwatts Marketing Group. Internet Usage Statistics. Available: www.internetworldstats.com/stats.htm. [October 12, 2013].

IRWIN, J.Y., THYVALIKAKATH, T., SPALLEK, H., WALI, T., KERR, A.R. and SCHLEYER, T., 2011. English and Spanish oral cancer information on the internet: a pilot surface quality and content evaluation of oral cancer web sites. Journal of public health dentistry, 71(2), pp. 106-116.

IRWIN, J.Y., WALI, T., FERNANDO, S. and SCHLEYER, T., 2007. Quality assessment of English and Spanish oral cancer websites. AMIA.Annual Symposium proceedings.AMIA Symposium, pp. 987.

JAFFE, J., TONICK, S. and ANGELL, N., 2014. Quality of Web-Based Information on Epidural Anesthesia. Obstetrics & Gynecology, 123(1), pp. 115S.

JAYARATNE, Y.S., ANDERSON, N.K. and ZWAHLEN, R.A., 2014. Readability of websites containing information on dental implants. Clinical oral implants research, 25(12), pp. 1319-1324.

JIANG, Y.L., 2000. Quality evaluation of orthodontic information on the World Wide Web. American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, its Constituent Societies, and the American Board of Orthodontics, 118(1), pp. 4-9.

KHATOON, B., HILL, K.B. and WALMSLEY, A.D., 2013. Can we learn, teach and practise dentistry anywhere, anytime? British dental journal, 215(7), pp. 345-347.

KIM, P., ENG, T.R., DEERING, M.J. and MAXFIELD, A., 1999. Published criteria for evaluating health related web sites: review. BMJ, 318(7184), pp. 647-649.

KINCAID, J.P., FISHBURNE JR, R.P., ROGERS, R.L. and CHISSOM, B.S., 1975. Derivation of new readability formulas (automated readability index, fog count and flesch reading ease formula) for navy enlisted personnel.

KLOOSTERBOER, A., YANNUZZI, N.A., PATEL, N.A., KURIYAN, A.E. and SRIDHAR, J., 2019. Assessment of the Quality, Content, and Readability of Freely Available Online Information for Patients Regarding Diabetic Retinopathy. JAMA ophthalmology, DOI: 10.1001/jamaophthalmol.2019.3116.

KOCYIGIT, B.F., KOCA, T.T. and AKALTUN, M.S., 2019. Quality and readability of online information on ankylosing spondylitis. Clinical rheumatology, 38(11), pp. 3269-3274.

KONG, K. and HU, A., 2015. Readability Assessment of Online Tracheostomy Care Resources. Otolaryngol Head Neck Surgery, 152(2), pp. 272-278.

KUCUKDURMAZ, F., MUTLU, S., MUTLU, H. and PARVIZI, J., 2015. A comparison of the quality of online information about total knee arthroplasty available in Turkish and English: a cross-sectional study. Acta orthopaedica et traumatologica turcica, 49(4), pp. 370-374.

LATKIN, C.A. and KNOWLTON, A.R., 2015. Social Network Assessments and Interventions for Health Behavior Change: A Critical Review. Behavioral medicine (Washington, D.C.), 41(3), pp. 90-97.

LEE, K.C., BERG, E.T., JAZAYERI, H.E., CHUANG, S.K. and EISIG, S.B., 2019. Online Patient Education Materials for Orthognathic Surgery Fail to Meet Readability and Quality Standards. Journal of oral and maxillofacial surgery: official journal of the American Association of Oral and Maxillofacial Surgeons, 77(1), pp. e180-181.

LEIRA, Y., CASTELO-BAZ, P., PEREZ-SAYANS, M., BLANCO, J. and LORENZO-POUSO, A.I., 2019. Available patient-centered Internet information on peri-implantitis. Can our patients understand it? Clinical oral investigations, 23(4), pp. 1569-1574.

LEIRA-FEIJOO, Y., LEDESMA-LUDI, Y., SEOANE-ROMERO, J.M., BLANCO-CARRION, J., SEOANE, J. and VARELA-CENTELLES, P., 2015. Available web-based dental implants information for patients. How good is it? Clinical oral implants research, 26(11), pp. 1276-1280.

LINDBERG, D.A. and HUMPHREYS, B.L., 1998. Medicine and health on the Internet: the good, the bad, and the ugly. JAMA, 280(15), pp. 1303-1304.

LIVAS, C., DELLI, K. and REN, Y., 2013. Quality evaluation of the available Internet information regarding pain during orthodontic treatment. The Angle Orthodontist, 83(3), pp. 500-506.

LOPEZ-JORNET, P. and CAMACHO-ALONSO, F., 2010. The quality of internet information relating to oral leukoplakia. Medicina oral, patologia oral y cirugia bucal, 15(5), pp. 727.

LOPEZ-JORNET, P. and CAMACHO-ALONSO, F., 2009. The quality of internet sites providing information relating to oral cancer. Oral oncology, 45(9), pp. 95.

MCMORROW, S.M. and MILLETT, D.T., 2016. Adult orthodontics: a quality assessment of Internet information. Journal of orthodontics, 43(3), pp. 186-192.

MELEO-ERWIN, Z., BASCH, C., FERA, J., ETHAN, D. and GARCIA, P., 2019. Readability of online patient-based information on bariatric surgery. Health promotion perspectives, 9(2), pp. 156-160.

MERIC, F., BERNSTAM, E.V., MIRZA, N.Q., HUNT, K.K., AMES, F.C., ROSS, M.I., KUERER, H.M., POLLOCK, R.E., MUSEN, M.A. and SINGLETARY, S.E., 2002. Breast cancer on the world wide web: cross sectional survey of quality of information and popularity of websites. BMJ (Clinical research ed.), 324(7337), pp. 577-581.

MGBEOKWERE, U., OKOYE, L. and EKWUEME, O., 2011. A Survey of the Knowledge of Dental Implants as a Choice in Treatment of Edentulous Jaws among Health Workers in Government Dental

Clinics in Enugu. Annals of medical and health sciences research, 1(1), pp. 91-95.

MINERVATION, October 24, 2012-last update. Is the Lida website assessment tool valid?. Available: https://www.minervation.com/category/lida/ [October 23, 2019].

MUÑOZ FERNÁNDEZ, A., 2016-last update, Lecturabilidad de Fernández Huerta. Available: https://legible.es/blog/lecturabilidad-fernandez-huerta/#id1 [2019].

NASON, K., DONNELLY, A. and DUNCAN, H.F., 2016. YouTube as a patient-information source for root canal treatment. International endodontic journal, 49(12), pp. 1194-1200.

NATIONAL INSTITUTE OF DENTAL AND CRANIOFACIAL RESEARCH, NATIONAL INSTITUTE OF HEALTH, U.S. PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH AND HUMAN SERVICES, 2005. The invisible barrier: literacy and its relationship with oral health. A report of a workgroup sponsored by the National Institute of Dental and Craniofacial Research, National Institute of Health, U.S. Public Health Service, Department of Health and Human Services. Journal of public health dentistry, 65(3), pp. 174-182.

NI RIORDAIN, R. and MCCREARY, C., 2009. Head and neck cancer information on the internet: type, accuracy and content. Oral oncology, 45(8), pp. 675-677.

NOTORC, November 2, 2006-last update. Clear Writing: How to Achieve and Measure Readability. Available: http://notorc.blogspot.com/2006_11_01_archive.html [September, 2019].

NUTI, S.V., WAYDA, B., RANASINGHE, I., WANG, S., DREYER, R.P., CHEN, S.I. and MURUGIAH, K., 2014. The use of

google trends in health care research: a systematic review. PloS one, 9(10), pp. e109583.

OLKUN, H.K., DEMIRKAYA, A.A. and ARAS, B., 2019. The quality of Internet information on lingual orthodontics in the English language, with DISCERN and JAMA. Journal of orthodontics, 46(1), pp. 20-26.

OXMAN, A.D., GUYATT, G.H., COOK, D.J., JAESCHKE, R., HEDDLE, N. and KELLER, J., 1993. An index of scientific quality for health reports in the lay press. Journal of clinical epidemiology, 46(9), pp. 987-1001.

PAREKH, J. and GILL, D.S., 2014. The quality of orthodontic practice websites. British dental journal, 216(10), pp. e21.

PATEL, U. and COBOURNE, M.T., 2011. Orthodontic extractions and the Internet: quality of online information available to the public. American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, its Constituent Societies, and the American Board of Orthodontics, 139(2), pp. e103-e109.

PLAINLANGUAGE, 2018-last update. Plain language makes it easier for the public to read, understand, and use government communications. Available: https://www.plainlanguage.gov [August 13, 2018].

POMMER, B., ZECHNER, W., WATZAK, G., ULM, C., WATZEK, G. and TEPPER, G., 2011. Progress and trends in patients' mindset on dental implants. I: level of information, sources of information and need for patient information. Clinical oral implants research, 22(2), pp. 223-229.

POTHIER, L. and POTHIER, D.D., 2009. Patient-orientated web sites on laryngectomy: is their information readable? European journal of cancer care, 18(6), pp. 594-597.

READABLE, 2011-last update. Readability formulas. Available: https://readable.com/features/readability-formulas/ [September, 2019].

ROGERS, S.N., ROZEK, A., ALEYAASIN, N., PROMOD, P. and LOWE, D., 2012. Internet use among head and neck cancer survivors in the North West of England. The British journal of oral & maxillofacial surgery, 50(3), pp. 208-214.

ROSSI-FEDELE, G., MUSU, D., COTTI, E. and DOGRAMACI, E.J., 2016. Root Canal Treatment versus Single-Tooth Implant: A Systematic Review of Internet Content. Journal of endodontics, 42(6), pp. 846-853.

ROTHROCK, A., CHAVEZ, V., ROMNEY, J., ISAAK, S., PAGANE, M., SWETLAND, S., ROTHROCK, S. and CHAVEZ, S., 2019. Quality, trustworthiness, readability, and accuracy of medical information regarding common pediatric emergency medicine-related complaints on the web. Archives of Disease in Childhood, 104(3), pp. A94.

RUSTEMEYER, J. and BREMERICH, A., 2007. Patients' knowledge and expectations regarding dental implants: assessment by questionnaire. International journal of oral and maxillofacial surgery, 36(9), pp. 814-817.

SAFEER, R.S. and KEENAN, J., 2005. Health literacy: the gap between physicians and patients. American Family Physician, 72(3), pp. 463-468.

SEELY, J., 2013. Oxford Guide to Effective Writing and Speaking: How to Communicate Clearly. Oxford, United Kingdom. Oxford University Press.

SIMONS, G., February 21, 2017-last update. Welcome to the 20th edition. Available: https://www.ethnologue.com/ethnoblog/gary-simons/welcome-20th-edition [January 15, 2018].

SLYH, R.E. and HANSEN, E.G., 2010. Detecting the Difficulty Level of Foreign Language Texts. Air Force Research lab Wright-Patterson AFB OH Human effectiveness directorate sensemaking organizational effectiveness branch.

SMITH, E.A. and SENTER, R.J., 1967. Automated readability index. Cincinnati University OH.

STATCOUNTER, October, 2018-last update, Statcounter. Available: https://statcounter.com/ [October, 2018].

SUPRAKASH, B., AHAMMED, A.R., THAREJA, A., KANDASWAMY, R., NILESH, K. and BHONDWE MAHAJAN, S., 2013. Knowledge and attitude of patients toward dental implants as an option for replacement of missing teeth. The journal of contemporary dental practice, 14(1), pp. 115-118.

UNITED NATIONS: POPULATION DIVISION, 2019-last update. World Population 2019: Wall Chart. Available: https://www.un.org/en/development/desa/population/index.asp [September, 2019].

VARELA-CENTELLES, P., LEDESMA-LUDI, Y., SEOANE-ROMERO, J.M. and SEOANE, J., 2015. Information about oral cancer on the Internet: our patients cannot understand it. The British journal of oral & maxillofacial surgery, 53(4), pp. 393-395.

VERHOEF, W.A., LIVAS, C., DELLI, K. and REN, Y., 2015. Assessing the standards of online oral hygiene instructions for patients with fixed orthodontic appliances. Journal of the American Dental Association (1939), 146(5), pp. 310-317.

WALSH, T.M. and VOLSKO, T.A., 2008. Readability assessment of internet-based consumer health information. Respiratory care, 53(10), pp. 1310-1315.

WANG, L., WANG, J., WANG, M., LI, Y., LIANG, Y. and XU, D., 2012. Using Internet search engines to obtain medical information: a comparative study. Journal of medical Internet research, 14(3), pp. e74.

WANG, L., MILLER, M.J., SCHMITT, M.R. and WEN, F.K., 2013. Assessing readability formula differences with written health information materials: Application, results, and recommendations. Research in social administrative pharmacy, 9(5), pp. 503-516.

WASSERMAN, M., BAXTER, N.N., ROSEN, B., BURNSTEIN, M. and HALVERSON, A.L., 2014. Systematic review of internet patient information on colorectal cancer surgery. Diseases of the colon and rectum, 57(1), pp. 64-69.

WIRIYAKIJJA, P., FEDELE, S., PORTER, S. and NI RIORDAIN, R., 2016. Web-based information on the treatment of oral leukoplakia - quality and readability. Journal of oral pathology & medicine: official publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology, 45(8), pp. 617-620.

WONG, L., YAN, H., MARGEL, D. and FLESHNER, N.E., 2013. Urologists in cyberspace: A review of the quality of health information from American urologists' websites using three validated tools. Canadian Urological Association journal, 7(3-4), pp. 100-107.

WOODMANSEY, K., 2010. Readability of educational materials for endodontic patients. Journal of endodontics, 36(10), pp. 1703-1706.

ZIEBLAND, S., CHAPPLE, A., DUMELOW, C., EVANS, J., PRINJHA, S. and ROZMOVITS, L., 2004. How the internet affects patients' experience of cancer: a qualitative study. BMJ, 328(7439), pp. 564.

ZIMMER, C.M., ZIMMER, W.M., WILLIAMS, J. and LIESENER, J., 1992. Public awareness and acceptance of dental implants. The International journal of oral & maxillofacial implants, 7(2), pp. 228-232.

9. Annexes

9.1 ANNEX 1

Quality indications of the contributions for the thesis by compendium of articles.

Contributions	Impact Factor	Ranking JCR (Dentistry)	Quartile
Disparities between English and Spanish in readability of online endodontic information for laypeople.Miguéns-Vila R, Ledesma-Ludi Y, Rodríguez-Lozano F, Varela-Centelles P, Seoane-Romero JM, Castelo-Baz P. J Am Dent Assoc. 2018 Nov;149(11):960-966.	2,572	19/91	Q1
Information about oral cancer on the Internet: our patients cannot understand it.Varela-Centelles P, Ledesma-Ludi Y, Seoane-Romero JM, Seoane J. Br J Oral Maxillofac Surg. 2015	1,237	49/91	Q3
Available web-based dental implants information for patients. How good is it?Leira-Feijoo Y, Ledesma-Ludi Y, Seoane-Romero JM, Blanco-Carrión J, Seoane J, Varela-Centelles P. Clin Oral Implants Res. 2015 Nov;26(11):1276-80.	3,464	7/91	Q1

9.2 ANNEX 2

LEIRA-FEIJOO, Y., LEDESMA-LUDI, Y., SEOANE-ROMERO, J.M., BLANCO-CARRION, J., SEOANE, J. and VARELA-CENTELLES, P., 2015. Available web-based dental implants information for patients. How good is it? Clinical oral implants research, 26(11), pp. 1276-1280.

https://onlinelibrary.wiley.com/doi/10.1111/clr.12451

9.3 ANNEX 3

VARELA-CENTELLES, P., LEDESMA-LUDI, Y., SEOANE-ROMERO, J.M. and SEOANE, J., 2015. Information about oral cancer on the Internet: our patients cannot understand it. The British Journal of Oral & Maxillofacial Surgery, 53(4), pp. 393-395.

https://www.bjoms.com/article/S0266-4356(15)00036-4/fulltext

9.4 ANNEX 4

MIGUENS-VILA, R., LEDESMA-LUDI, Y., RODRIGUEZ-LOZANO, F., VARELA-CENTELLES, P., SEOANE-ROMERO, J.M. and CASTELO-BAZ, P., 2018. Disparities between English and Spanish in readability of online endodontic information for laypeople. Journal of the American Dental Association (1939), 149(11), pp. 960-966.

https://jada.ada.org/article/S0002-8177(18)30485-9/fulltext