UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ODONTOLOGIA DE BAURU

PATRICIA ESTEFANIA AYALA AGUIRRE

Infodemiology of dental caries

Infodemiologia da cárie dentária

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Orientador: Prof. Dr. Thiago Cruvinel da Silva

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“Education is the most powerful weapon which you can use to change the world.”

Nelson Mandela

Resumo

RESUMO

O diagnóstico da cárie dentária pode levar as pessoas a procurar mais informações na internet, por meio de pesquisas estruturadas realizadas em buscadores digitais. Esta ação gera um volume considerável de dados que podem ser analisados para o melhor entendimento do comportamento dos usuários relacionado ao consumo de informações de saúde bucal. No entanto, as informações sobre saúde proveniente da Internet podem ser imprecisas e de baixa qualidade. Este estudo objetivou (1) avaliar o volume e perfil de buscas sobre cárie dentária realizadas pelos usuários do Google de diferentes países, e (2) determinar a leiturabilidade e qualidade da informação relacionada à cárie dentária encontrada em websites brasileiros. A variação mensal do índice *Search Volume Index* (SVI) relacionado à cárie dentária foi obtida na ferramenta *Google Trends* para o período compreendido entre janeiro de 2004 e setembro de 2016. Para a validação dos dados obtidos, os níveis de correlações entre as variações do índice SVI e do índice disability-adjusted life-years (DALYs) para cárie dentária em dentes permanentes foram determinados. Para avaliar a qualidade da informação disponível na Internet, websites foram selecionados através dos buscadores *Google*, *Bing*, *Yahoo!* e *Baidu*. Dois examinadores independentes realizaram a avaliação de 75 websites usando o questionário DISCERN e os critérios de referência JAMA. A leiturabilidade da informação escrita foi avaliada pelo uso dos escores Flesch Reading Ease (FRE), Flesch-Kincaid Grade Level (FKGL) e Férnandez-Huerta Readability Formula (FHRF). A análise estatística foi realizada com valores de $P<0,05$ sendo considerados significantes. Em todos os países, os resultados demostraram uma tendência crescente do aumento do interesse dos usuários do Google sobre temas relacionados à cárie dentária. As buscas mais populares foram fortemente relacionadas aos sintomas e tratamentos da cárie dentária, com menor interesse pela prevenção. O conteúdo dos websites mostrou-se de baixa qualidade em ambos os escores do DISCERN ($\overline{x}$=35.68, 19-64) e do JAMA ($\overline{x}$=1.12, 0-3). Os websites foram classificados como materiais de alto nível de dificuldade de leitura pelos escores do FRE e, ao contrário, como simples e acessíveis pelos escores do FHRF. Em conclusão, os dados provenientes do uso da internet poderiam auxiliar no estabelecimento das necessidades odontológicas de grupos populacionais

específicos, em tempo quase-real. O consumo de informação proveniente da web está se intensificando, parecendo ter uma relação direta com a cárie dentária não tratada. As informações relacionadas à doença disponíveis em websites brasileiros foram consideradas simples, acessíveis e de baixa qualidade. Estes achados indicam a necessidade de desenvolvimento de politicas para a produção e publicação de informações relacionadas à saúde bucal, motivando os dentistas a orientarem seus pacientes na busca por websites recomendados.

Palavras-chave: Cárie dentária. Internet. Informação ao consumidor.

Abstract

ABSTRACT

Infodemiology of dental caries

The diagnosis of dental caries can lead people to seek additional information on the Internet, through the use of structured queries in search engine tools. This action generates a considerable volume of data, which can be analyzed to provide a better understanding of public's behavior linked to the consumption of oral health information. Nevertheless, health-related information found on the web is being reported to be misleading and of poor quality. This study aimed (1) to assess the volume and profile of web searches on dental caries-related queries performed by Google's users from different countries, and (2) to evaluate the readability and the quality of dental caries-related information from Brazilian websites. The monthly variation of the *Search Volume Index* (SVI) for dental caries was obtained in *Google Trends*, for the period between January 2004 and September 2016. To validate the data, the correlation levels between the variation of SVI and the disability-adjusted life-years (DALYs) for permanent teeth were determined. To assess the quality of information, the websites were selected through *Google*, *Bing*, *Yahoo!*, and *Baidu*. Two independent examiners evaluated the quality of 75 websites using the DISCERN questionnaire and JAMA benchmark criteria. The scores Flesch Reading Ease (FRE), Flesch-Kincaid Grade Level (FKGL), and Férnandez-Huerta Readability Formula (FHRF) were used to assess the readability of the websites. The statistical analysis was performed with $P<0.05$ considered significant. In all countries, results revealed a trend of an increasing interest of Google users in dental caries issues. The most popular queries were markedly associated with symptoms and dental treatment, with little interest in prevention. The content of websites showed a poor quality by the analysis of both DISCERN ($\overline{x}$=35.68, 19-64) and JAMA ($\overline{x}$=1.12, 0-3) scores. The websites were classified as high-difficulty reading materials by FRE scores and, in contrast, as simple and accessible by FHRF scores. In conclusion, the Internet data mining could be helpful to establish the dental needs of specific population groups in a near real-time, since the consumption of dental information is increasing in importance and appears to have a direct relation with untreated dental caries. Dental caries-related contents found in Brazilian websites were considered simple, accessible and of poor quality. These findings indicate the need of the

development of policies for the production and publication of digital oral health information, encouraging dentists to guide their patients in searching for recommended oral health websites.

Keywords: Dental Caries. Internet. Consumer Health Information.

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1 Introduction

1 INTRODUCTION

Infodemiology is defined as *"the science of distribution and determinants of information in an electronic medium, specifically the Internet, or in a population, with the ultimate aim to inform public health and public policy"* (EYSENBACH, 2009).

The rapid dissemination of the Internet allows a useful manner to reach a vast range of contents (WORLD BANK DATA, 2016), becoming the most important media source of health information (PLETNEVA et al., 2011). The awareness of a disease as dental caries might lead people to seek additional knowledge on the Internet [Brigo et al., 2014]. The Internet data mining has already shown a great potential to elucidate the public attitudes associated with the consumption of health information [Bakker et al., 2016; Foroughi et al., 2016]. Millions of health-related queries are entered in Google daily (EYSENBACH; KÖHLER, 2003). These metadata can be analyzed to detect regional interests of Google users in a time range, contributing to the completion of statistics produced by traditional epidemiological methods, with near real-time evidence. Notwithstanding, the online health-related information might be misleading, incomplete or even inaccurate (IMPICCIATORE et al., 1997; PLETNEVA et al., 2011; MUTHUKUMARASAMY et al., 2012). Although the good quality of information can reduce the anxiety of people towards health care [Michie et al., 1996], the inaccurate information could leave the patients at risk, especially regarding their health condition [Breckons et al., 2008].

Despite the decrease of the incidence and prevalence of dental caries over time [Lagerweij and van Loveren, 2015], it is still the most relevant non-communicable and chronic oral disease [Marcenes et al., 2013], challenging the health planners to control its biological, social, and financial burden [Petersen et al., 2005], which includes several consequences, such as pain and/or discomfort, mouth infection, dental loss and impairment of eating, chewing, speaking and smiling [Federation Dentaire Internationale, 2015]. Regarding the burden of all diseases and injuries, untreated dental caries in permanent teeth was ranked in the 80th place according to the units of disability-adjusted life-years (DALYs) [Salomon et al., 2013], accounting for 4.56 million DALYs globally, implying a mean of 73 years of health loss per 100,000 people [Marcenes et al., 2013; Murray et al., 2013].

The structure of health care delivery is in a rapid transition, from a paternalistic-approach to a person-centered model, in which the views of patients are considered preeminent to the improvement of health outcomes (BRAGAZZI, 2013; WORLD HEALTH ORGANIZATION, 2017). In this context, information must be given by professional teams to empower patients to be more participative in the resolutions and actions about their own health, engaged in the decision-making process actively (NUTBEAM, 1998; COTTEN; GUPTA, 2004; SALMON; HALL, 2004; FAHY et al., 2014; WORLD HEALTH ORGANIZATION, 2017). The free access to health information and health literacy is one of the challenges to this novel model (PATIENT-CENTERED CARE, 2010). Barriers as low education, and social and economical deprivation make persons less interested in health seeking information and, consequently, in self-care management. On the other hand, it seems to have a significant association between the frequency of access of health information and the personal health outcomes (BARRY; EDGMAN-LEVITAN, 2012; PLUYE et al., 2013; LEE et al., 2015; MCCLOUD et al., 2016).

Taking into consideration the aforementioned facts, we hypothesized that the diagnosis or suspicion of untreated dental caries leads adults to seek web information about the disease. We also hypothesized that available contents on dental caries of Brazilian websites present a poor quality.

Hence, the aims of this study were:

1. Analyze the volume and profile of Google searches on dental caries-related information in different countries;
2. Assess the quality of dental caries information available in Brazilian websites.

2 Articles

2 ARTICLES

The articles below were written according to the Caries Research and the Journal of Medical Internet Research instructions and guidelines.

- ARTICLE 1 – What Google could inform us about the people's interests on dental caries in different populations?
- ARTICLE 2 – The assessment of quality of dental caries-related information in Brazilian websites

2.1 ARTICLE 1

What Google could inform us about the people's interests on dental caries in different populations?

Abstract

The diagnosis or suspicion of dental caries can lead people to seek additional information on the Internet, through the use of structured queries in search engine tools. This action generates a considerable volume of data, which can be analyzed to provide a better understanding of public's behavior linked to the consumption of oral health information. This study aimed to assess the volume and profile of web searches on dental caries-related queries performed by Google's users from different countries. The monthly variation of the *Search Volume Index* (SVI) for dental caries was obtained in *Google Trends*, for the period between January 2004 and September 2016. The validity of SVI data was assessed by their levels of stability and correlation with the disability-adjusted life-years (DALYs) for permanent teeth. In all countries, a trend of an increasing interest of Google users in dental caries issues was revealed, especially by the comparison of the means of predictive models with the values of the last 12 months. The interest levels vary throughout the year, with the observation of the highest SVI values in the spring and the lowest SVI values in the summer. The most popular queries were markedly associated with symptoms and dental treatment, with a little interest in prevention. In conclusion, the use of Internet data mining could be helpful to establish the dental needs of specific population groups in a near real-time, since the web consumption of dental information is increasing in importance and appears to have a direct relation with untreated dental caries.

Keywords: Dental caries; Community Dentistry; Epidemiology; Informatics

Despite the decrease of the incidence and prevalence of dental caries over time [Lagerweij and van Loveren, 2015], it is still the most relevant non-communicable and chronic oral disease [Marcenes et al., 2013], challenging the health planners to control its biological, social, and financial burden [Petersen et al., 2005], which includes several consequences, such as pain and/or discomfort, mouth infection, dental loss and impairment of eating, chewing, speaking and smiling [Federation Dentaire Internationale, 2015]. Annually, 27 new dental caries lesions are diagnosed in permanent teeth of every 100 people [Kassebaum et al., 2015], restricting their activities at school, work, and home, and incurring in millions of lost work hours [Shoaee et al., 2015]. Regarding the burden of all diseases and injuries, untreated dental caries in permanent teeth is ranked in the 80th place, according to the units of disability-adjusted life-years (DALYs) [Salomon et al., 2013]. In 2010, it accounted for 4.56 million DALYs globally, implying a mean of 73 years of health loss per 100,000 people [Marcenes et al., 2013; Murray et al., 2013].

The awareness of a disease as dental caries might lead people to seek additional knowledge on the Internet, especially after the widespread of the web facilitates the access to health issues [Brigo et al., 2014]. Seventy-two percent of all adult Internet users residing in the U.S. admitted that they searched by online health information; of whom, 59% frequently utilize the Internet as a source of diagnosis of medical conditions that supposedly disturb their lives in a direct or indirect way [Fox and Duggan, 2013]. Also, the users share their health experiences or even ask for counseling by their engagement in social media [Heaivilin et al., 2011]. These digital behaviors generate a considerable volume of data that can help researchers in the understanding of the communities' needs about particular diseases and/or alterations [Cho et al., 2013; Bragazzi et al., 2016].

The Internet data mining has already shown a great potential to elucidate the public attitudes associated with the consumption of health information [Bakker et al., 2016; Foroughi et al., 2016]. Google Trends is an online tool that evaluates a percentage of billions of daily structured queries entered into Google, the leading company in the industry of search engines [NetMarketShare, 2016]. These metadata can be analyzed to detect regional interests of Google users in a time range, contributing to the completion of statistics produced by traditional epidemiological methods with near real-time evidence.

Taking into consideration the aforementioned facts, we hypothesized that the diagnosis or suspicion of untreated dental caries lead adults to seek web information about the disease. Hence, the aim of this study was to assess the volume and profile of Google searches on dental caries-related information in different countries.

Materials and Methods

Study Design

This longitudinal retrospective study analyzed the dental caries-related computational metadata of eight countries, using the online tool Google Trends. The topic “Dental Caries – Syndrome” was accessed to determine the Search Volume Index (SVI) and the main queries applied to find specific information about the disease. DALYs indices and the Internet penetration were also obtained for each country. Thus, the collected data were evaluated in accordance with the following aspects: (i) test-retest reliability, (ii) correlation between SVI and DALYs indices, (iii) search volume trends, (iv) seasonality, (v) development of forecasting models, and (vi) most popular related queries.

Search Volume Trends

The results of Google Trends are depicted as time series curves of the weekly or monthly variation of SVI, which ranges between 0 and 100. These values represent the ratio between the search volume of a particular query by the volume of whole queries performed on *Google Search*, normalized in function of the maximum value of the time series in a given time (SVI=100). Google Trends also provides the lists of the most popular queries used in a specific country/region to retrieve information about distinguishing issues. All results can be filtered by location, time, category, and source.

In special situations, Google Trends displays results originated from the topics created since automatic algorithms. To find the adequate topic to analyze the SVI for dental caries, we entered the query *“Caries”* on Google Trends. Following, the platform displayed the topic “Dental Caries – Syndrome” that represents the synthesis of searches linked to this issue. The resource was available for Brazil, France, Germany, India, Italy, Japan, the United Kingdom (U.K.), and the United States (U.S.). The data were collected for all available countries, in two distinct dates

(April 02, 2016 and September 26, 2016), adopting the inclusion criteria of “all categories and sources”. We retrieved the monthly variation of the SVI between January 2004 and one month before of each collection date. The lists of the top-10 most popular queries and the top-10 sudden rising terms related to dental caries were also obtained.

DALYs indices and population estimates

DALYs indices for dental caries in permanent teeth were retrieved from the database of the Institute for Health Metrics and Evaluation (http://vizhub.healthdata.org/gbd-compare/), which contains the results of the project *Global Burden Disease*. The data cover the period from 2000 through 2013, both genders and specific age groups (5-14, 15-49, 50-69, 70+ year olds).

The estimates of the absolute population of each country were calculated through the projections found in the database of the United Nations Department of Economic and Social Affair (http://www.un.org/en/development/desa/population/). They were used to define the relative weights of each gender and age group in order to establish the mean values of DALYs in the years 2000, 2005, 2010, and 2013.

The Council on Ethics in Human Research from the Bauru School of Dentistry considers that research using publicly available data does not involve human subjects, as defined by federal regulations. Therefore, the institutional review board approval was not required.

Data Analysis

Data were analyzed with the Statistical Package for Social Science (version 21.0; SPSS, Chicago, USA), according to:

(i) Test-retest reliability: it was assessed by the determination of the Intraclass Correlation Coefficient for absolute concordance of the SVI time series for dental caries, comparing the data collected in distinct dates (April 2016 and September 2016).

(ii) Correlation of SVI and DALYs indices: the missing data of DALYs for the year 2004 were replaced by the linear interpolation. Then, the mean variation of both SVI and DALYs were calculated between the years 2004, 2005, 2010 and 2013.

Pearson's test was applied to observe the correlation levels between the differences of two indicators.

(iii) Search volume trends: the trends of SVI time series for dental caries were analyzed by the autocorrelation and partial autocorrelation plots. Also, Pearson's test was used to compare the directions and changes in dental caries interests of Google users from different countries.

(iv) Seasonality: the effect of seasonality on the time series was evaluated by generalized additive model (GAM). It consisted in a previous detrending of each long-term curve by its lag-1 difference, and subsequently, the application of two distinct generalized linear models on these differences, each model comprised by one variable (*"year quarters"* or *"months"*).

(v) Development of forecasting models: Autoregressive Integrated Moving Average (ARIMA) models were developed with the intention of constructing 12-month forecasts for dental caries-related SVI values, through the data collected in September 2016. The best-fitted models were chosen in accordance with the lowest values of Normalized Bayesian Information Criteria (Normalized BIC), Root Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE). To validate this method, preliminary forecasting models were constructed using the data retrieved on April 2016, and their results were confirmed by the real data achieved in September 2016.

(vi) Most popular queries: the top-10 queries and sudden rising terms related to dental caries were compared qualitatively among countries.

For all analyses, P values < 0.05 were considered for significant differences.

Results

Test-Retest Reliability

The test-retest reliability of SVI data for dental caries-related terms was excellent for most countries, varying between 0.77 (95% CI:0.68-0.83) in the U.K. and 0.95 (95% CI:0.93-0.96) in India. On the other hand, only a good stability of data was observed in Italy (0.65, 95% CI: 0.51-0.75).

Correlation Between SVI and DALYs

When considering the total population, the direction of variation of SVI and DALYs indices were coincident in 0% in Japan, 33.3% in the U.K. and India, 50% in Brazil and Italy, 66.6% in Germany, 83.3% in the U.S., and 100% in France. The variation of both indices was strongly correlated in at least one demographic stratum of each country, except for Italy. The significant correlations were predominantly positive in Brazil, France, Germany and U.S., whereas they were predominantly negative in India, Japan and U.K. (Table 1).

Search Volume Trends

Table 2 depicts three groups of results of cross-correlation between pairwise countries: i) strong positive correlation between the U.S., Germany, and Japan; ii) moderate positive correlation between India and Brazil, India and Italy, and France, Italy, and U.K., which are also correlated moderately with the U.S., Germany, and Japan; and iii) moderate negative correlations of India with Germany, Japan, and U.S.

The heuristic analysis of the time series denotes a general increase of the interest in dental caries-related information in France, Germany, Italy, Japan, U.K. and U.S. Differently, a decreasing interest was observed in Brazil and India (fig. 1). These trends are compatible with the patterns of non-stationary time series as seen in the autocorrelation plots (fig. 2).

Seasonality

Fig. 3 presents the detrended SVI curves and the heat map of monthly variation of the predictive GAM values for dental caries in the eight countries. The GAM analysis showed no influence of seasonality on data from India and Italy, instead of the interference of monthly significant differences on the results of Germany and Japan. The quarterly seasonal pattern of SVI were demonstrated in the U.S., U.K., France, and Brazil, with the lowest and highest SVI means detected respectively in the third and second year-quarters in the Northern countries, and in the first and fourth year-quarters in Brazil.

Development of Forecasting Models

Table 3 summarizes the fit statistics of 12-month forecasting models for dental caries-related interest. An excellent adequacy of ARIMA models was demonstrated by low values of Normalized BIC (<5.0) and MAPE (<15.0). In all countries, the

means of predictive SVI values were higher than those of the last 12 months, with significant differences in Brazil, Germany, India, and U.S. (Table 4). In addition, all forecasts were considered adequate after the confirmation of the outstanding performances of preliminary models, constructed with data collected in April 2016 (data not shown).

Most Popular Queries

The lists of most popular queries were similar among the eight countries. They were markedly associated with symptoms and dental treatment, e.g. *"tooth"*, *"dentist"*, *"toothache"*, *"pain"*, and *"dental restoration"*. Alternative therapies for prevention and treatment of dental caries lesions were found among rising terms from India and U.S., such as *"Ayurveda"*, *"oil pulling"*, and *"coconut oil"* (Table 5).

Discussion

To our knowledge, this is the first study that uses the statistics of Google to produce evidence about the people's interest on dental caries. This methodological approach can be considered reliable, through an excellent stability of data, a significant correlation of the volume of dental caries-related searches with the burden of dental caries for permanent teeth, and the grouping of similar SVI time series according to the socioeconomic development level of each country.

Our findings show an increasing search activity in relation to dental caries web information, except for Brazil and India, where a downward-pattern of SVI was observed over time. Although not all differences were statistically significant, the annual means of predictive SVI were higher in comparison with those from the last year, which indicates a trend of rising attraction for the Internet content on dental caries in the next years. But what could explain this seeking behavior when the literature describes an overall decrease in dental caries across time?

The prevalence of dental caries has declined in the past decades because two main reasons: the use of fluoride and the effectiveness of preventive dental programmes [Fehr and Haugejorden, 1997; Lagerweij and van Loveren, 2015]. Nevertheless, its prevalence is returning to increase with the aging of the population, through the simultaneous reduction of dental loss and the maintenance of teeth throughout the lifetime [Pitts et al., 2011; Bernabe and Sheiham, 2014; Lagerweij and van Loveren,

2015; Edman et al., 2016]. For instance, approximately 27% of adults between 20-64 years old were diagnosed with untreated dental caries lesions in permanent teeth; additionally, one in five adults aged 65 and over presented untreated lesions, suggesting a growing experience of dental caries among adults [Whelton, 2004; Bernabe and Sheiham, 2014]. Currently, the global prevalence of untreated dental caries lesions in permanent teeth is higher than 40%, affecting 3.9 billion people around the world [Federation Dentaire Internationale, 2015]. It is considered the most prevalent condition out of 291 diseases included in the Global Burden of Disease Study [Listl et al., 2015; Murray et al., 2013]. Moreover, untreated dental caries alone corresponds to an average of health loss of 70 years per 100,000 people [Marcenes et al., 2013; Murray et al., 2013].

Regarding the burden of untreated dental caries and the changes in the structure of health care, from a doctor's decision-centered model to a shared decision-making process [Cotten and Gupta, 2004; Bragazzi, 2013], we assume that at least a percentage of adults experiencing dental caries lesions could seek for related information on the web, since 72% of all U.S. adults who accessed the Internet admitted they searched for health knowledge, of whom 59% concerned about their own medical conditions [Fox and Duggan, 2013]. Also, health information seekers decide to contact a health professional based on their online findings [Ybarra and Suman, 2006].

The diffusion of the Internet penetration, even among the poorest countries in the world [The World Bank, 2016], also could influence our results, since low-income groups consistently become new Internet users along the years. As it is well known, dental caries is more prevalent among deprived populations [Bagramian et al., 2009; Mascarenhas, 2016]; therefore, the advance of the Internet among more susceptible people might increment the interest for information to control the disease, including treatments and/or home remedies. On the other hand, general downtrends of the search volume of dental caries in India and Brazil may be affected by the lower penetration of the Internet of these countries when compared to high-income ones, especially in the first years of availability of data. Originally, this type of surveillance method was better indicated to developed countries, characterized by a great amount of web users and high Internet penetration [Carneiro and Mylonakis, 2009]; nevertheless, the rapid increase of the Internet penetration has proven the efficiency

of digital epidemiological studies on the middle-income countries in the last years [Bagramian et al., 2009; Aguiar et al., 2010; Zheluk et al., 2013].

We confirmed the relationship of the data obtained in Google Trends with dental caries available measures, by the correlation between the differences of SVI and DALYs indices. Significant correlations were observed in whole countries in at least one demographic stratum (total population, gender or age group), except for Italy. Although Italy presents a good Internet penetration (>60%), it is still low compared to the other developed countries [The World Bank, 2016]. Strong positive correlations were observed in most strata of France, Germany and the U.S. In contrast, a strong negative correlation was verified in 5-14 and 50-69 age groups from the U.K. In Japan, we believe that the low correlation could be justified by the dominance of Yahoo! (57%) among search engine machines [Wakabayashi, 2010], i.e., the diversity of vehicles could make difficult the demonstration of the influence of the burden of disease on the interest of specific information. India showed a significant negative correlation of SVI and DALYs in males and 70+ years age group, which could be explained by the expressive gender imbalance in its Internet penetration, with the predominance of males (71%) among the Internet users [Internet and Mobile Association of India, 2015]. Finally, the significant correlations found in Brazil coincided with official statistics, which demonstrated that young adults and females access the Internet more frequently than other groups [Instituto Brasileiro de Geografia e Estatística, 2011].

The effect of seasonality detected in the time series of Brazil, France, U.S. and U.K. seems to have a logical interpretation. The lowest volume of searches was observed between July and September (3rd year-quarter) in the Northern countries and between January and March (1st year-quarter) in Brazil. These periods correspond to the summer months, when usually people travel, change their routines, and become more carefree while on vacation; consequently, it would be expected that people were less careful about dental diseases, neglecting oral health habits more frequently. On the other hand, the highest volume of searches occurs three months earlier vacation. These results can aid dental teams in the adoption of a specific calendar in order to optimize the oral health outcomes, through the concentration of their educational efforts in times of greater interest of their patients.

The top terms used to find dental caries-related information were similar in the eight countries. People searched preponderantly by the symptoms and treatments of the disease, i.e., independently when the variation of SVI was positively or negatively correlated with DALYs indices, the interests in preventive methods were secondary. Based on these results, we hypothesize that some people initially interested in dental pain might migrate their searches toward the main cause of that symptom, dental caries lesions. Social media users frequently express negative remarks about their dental pain in microblogs, being 43% of those reports related to self-medication [Heaivilin et al., 2011]. Corroborating with this evidence, our results demonstrate the rising interest of Google users on "*oil pulling*", with the aim of improving the oral health levels. Currently, there are several websites describing the dental benefits of "*oil pulling*", which could confuse Internet users in seeking a satisfactory dental treatment. This is an important issue that should be discussed by panels of specialists [American Dental Association, 2014], especially because one in three individuals who access health information on the Internet is trying to apply the new knowledge to treat him/herself [Ybarra and Suman, 2006]. Further studies assessing the quality of dental caries information contained in websites are needed to guide the patients toward the useful counseling.

These findings must be interpreted with caution. First, Internet data mining studies analyze exclusively seeking behaviors of the Internet users and, in this case, Google users. The queries performed in other search engines were not considered. This was especially problematic in Japan, where the search engine Yahoo! has the largest market share. Additionally, the personal identities of individuals cannot be disclosed, preventing the association of the interests with sociodemographic characteristics. Second, since not all people have access to the Internet or perform searches to obtain information about a particular disease, the results produced by this method could not be representative of whole population groups; however, this disadvantage should be decreased with the advance of the Internet penetration in low and middle-income countries. Third, the same person interested in dental caries-related information might perform his/her searches multiple times, from different electronic devices, which leads to the duplicate registration of the Internet activity. Even though this could affect the sensitivity of our results, this repetitive behavior may indicate the difficulty of these individuals in solving their dental problems, perhaps due to the lack

of adequate counseling, or the influence of health barriers, such as the unavailability of specialized dental services and unfavorable financial conditions. Fourth, overestimations might be produced for individuals without dental caries, whose search by the condition as a result of other stimuli, such as media reports, health campaigns, and personal behaviors [Metcalfe et al., 2010]. Fifth, the automatic algorithms provided by Google Trends are kept in secret, as a “black box” [DeRouen, 2015]. To minimize this “unknown effect”, a pilot study was performed to construct and analyze structured queries in English and Brazilian Portuguese. The queries produced similar results than those given automatically by Google Trends in the U.K., U.S., and Brazil (data not shown), demonstrating the reproducibility and the comparability of data. Eventually, since we started this research in March 2015, Google Trends experienced numerous upgrades, especially in the availability of data. Initially, the topic “Dental Caries-Syndrome” was only available for seven countries. Subsequently, Google Trends also provided the data for Japan. In this study, we included all countries with available data in September 2016.

It is critical to note that we do not attempt to use these data as an indicator of the incidence or prevalence of dental caries in different countries. This study merely demonstrates the pattern of the interest of Google users on dental caries-related information; however, this novel approach could be useful for policy makers to understand the dental users’ interests, contributing to the early patient referral for specialized treatment systems, and preparing dental teams with the basis on the relevant questions that arise from their own communities.

In conclusion, the interest of Google users in dental caries-related information is increasing over time, especially in the last years. These outcomes appear to have a direct connection with the burden of untreated dental caries lesions in permanent teeth. Therefore, the use of Internet data mining could be helpful to provide the establishment of the needs of population groups from different countries in a near real-time; however, this strategy must be applied with caution, without replacing the statistics produced by traditional epidemiological methods.

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TABLES

Table 1. Pearson's coefficient of correlation between DALYs for dental caries in permanent teeth and SVI for dental caries in different countries, according to the total population, sex, and age groups.

	Brazil	France	Germany	India	Italy	Japan	U.K.	U.S.
Total	0.73	0.97**	0.83*	-0.61	-0.01	-0.62	-0.42	0.97**
	0.10	0.001	0.04	0.20	0.98	0.19	0.40	0.002
Male	-0.04	0.97**	0.95**	-0.83*	-0.68	0.02	-0.12	0.91*
	0.94	0.001	<0.001	0.04	0.13	0.98	0.82	0.01
Female	0.85*	0.88*	0.40	-0.50	0.65	-0.78	-0.85*	-0.31
	0.03	0.02	0.43	0.31	0.17	0.07	0.03	0.55
5-14 years	0.32	0.94**	0.86*	-0.04	0.28	0.20	-0.98**	-0.91*
	0.54	0.01	0.03	0.95	0.59	0.71	<0.001	0.01
15-49 years	0.94**	0.95**	0.94**	0.06	0.28	-0.39	0.78	0.95**
	0.01	<0.001	0.004	0.91	0.60	0.45	0.07	0.01
50-69 years	0.50	0.95**	0.90*	-0.60	0.01	-0.81	-0.98**	0.93**
	0.32	<0.001	0.02	0.21	0.98	0.05	0.001	0.006
70+ years	-0.59	0.95**	0.89*	-0.83*	-0.56	-0.93*	-0.79	0.90*
	0.22	<0.001	0.02	0.04	0.25	0.01	0.06	0.01

(*) $P<0.05$; (**) $P<0.001$.

Table 2. Pearson's cross-correlation between the time series of pairwise countries.

	Brazil	**France**	**Germany**	**India**	**Italy**	**Japan**	**U.K.**	**U.S.**
Brazil		0.19*	-0.11	0.59**	0.16*	-0.17*	-0.03	-0.17*
		0.02	0.17	<0.001	0.05	0.03	0.75	0.04
France	0.19*		0.78**	-0.12	0.68**	0.69**	0.69**	0.75**
	0.02		<0.001	0.13	<0.001	<0.001	<0.001	<0.001
Germany	-0.11	0.78**		-0,52**	0.67**	0.88**	0.76**	0.92**
	0.17	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
India	0.59**	-0.12	-0,52**		-0.24**	-0.66**	-0.36**	-0.63**
	<0.001	0.13	<0.001		0.01	<0.001	<0.001	<0.001
Italy	0.16*	0.68**	0,67**	-0.24**		0.64**	0.72**	0.64**
	0.05	<0.001	<0.001	0.01		<0.001	<0.001	<0.001
Japan	-0.17*	0.69**	0,88**	-0.66**	0.64**		0.70**	0.92**
	0.03	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001
U.K.	-0.03	0.69**	0,76**	-0.36**	0.72**	0.69**		0.76**
	0.75	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
U.S.	-0.17*	0.75**	0,92**	-0.63**	0.64**	0.92**	0.76**	
	0.04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	

(*) $P<0.05$; (**) $P<0.001$.

Table 3. ARIMA model fit statistics and parameter estimation of SVI for dental caries-related queries by country.

Country ARIMA model	Normalized BIC	MAPE	Ljung-Box			Estimate	SE	*P*
Brazil	3.28	9.16	0.10	AR	Lag 1	0.98	0.01	<0.001
				MA	Lag 1	0.89	0.04	<0.001
(1,0,1)(0,1,0)								
France	3.61	7.72	0.89	MA	Lag 1	0.76	0.06	<0.001
				MA, Seasonal	Lag 1	0.64	0.08	<0.001
(0,1,1)(0,1,1)								
Germany	3.29	5.35	0.40	MA	Lag 1	0.75	0.06	<0.001
				MA, Seasonal	Lag 1	0.72	0.08	<0.001
(0,1,1)(0,1,1)								
India	3.28	6.21	<0.001	AR	Lag 1	-0.87	0.06	<0.001
				MA	Lag 2	0.68	0.09	<0.001
(1,1,2)(0,0,0)								
Italy	4.67	11.06	0.01	MA	Lag 1	0.84	0.05	<0.001
				AR, Seasonal	Lag 1	1.00	0.05	<0.001
(0,1,1)(1,0,1)				MA, Seasonal	Lag 1	0.96	0.30	<0.001
Japan	2.56	4.55	0.91	MA	Lag 1	0.52	0.08	<0.001
				MA, Seasonal	Lag 1	0.79	0.09	<0.001
(0,1,1)(0,1,1)								
U.K.	3.87	6.97	0.28	MA	Lag 1	0.84	0.05	<0.001
				MA, Seasonal	Lag 1	0.72	0.08	<0.001
(0,1,1)(0,1,1)								
U.S.	2.18	3.18	0.17	MA	Lag 1	0.58	0.07	<0.001
				MA, Seasonal	Lag 1	0.74	0.08	<0.001
(0,1,1)(0,1,1)								

Table 4. Comparison between the annual means of the last 12 months and the predictive SVI for dental caries-related queries. The asterisk indicates significant statistical differences between the periods.

	Last 12 months		Predictive 12 months			
	Mean	**SD**	**Mean**	**SD**	***P***	**Trend**
Brazil	47.67	4.75	52.67	4.75	0.02	Increase*
France	83.25	7.07	88.00	4.77	0.07	Increase
Germany	91.92	4.14	95.92	2.94	0.01	Increase*
India	35.08	1.31	37.08	0.79	<0.001	Increase*
Italy	91.50	6.35	92.50	3.32	0.63	Increase
Japan	92.33	4.89	93.50	4.34	0.54	Increase
U.K.	89.17	7.87	92.42	5.96	0.27	Increase
U.S.	94.58	2.97	99.42	2.81	<0.001	Increase*

Table 5. The top 10 dental caries-related searches and their respective SVI for each country. Break means a sudden increase in the use of a specific query to find information about dental caries in Google.

Brazil		France		Germany		India	
Tooth	100	Tooth	100	Tooth	100	Tooth	100
Dental restoration	45	Dentist	70	Dentist	50	Dentistry	30
Dentistry	35	Pain	40	Dental restoration	25	Traditional medicine	15
Pain	30	Symptom	30	Toothache	20	Pain	15
Toothache	15	Toothache	20	Pain	20	Dental restoration	15
Gums	10	Therapy	15	Therapy	15	Toothache	15
Healing	10	Gums	15	Karius and Bactus	15	Therapy	10
Dentist	10	Molar	10	Symptom	15	Gums	5
Fluoride	10	Crown	5	Childhood	15	Preventive healthcare	5
Molar	5	Calculus	5	Periodontitis	15	Fluoride	5
Tooth caries	Break	Symptom	Break	Childhood	Break	Pain	Break
Tooth decay	Break	Toothache	Break	Radiography	Break	Dental restoration	Break
Toothache	Break	Molar	Break	Halitosis	Break	Fluoride	Break
Canal	Break	Dental abscess	Break	Gelatin dessert	Break	Symptom	Break
Dental photos	Break	Tooth brushing	Break	Fluor corporation	Break	Amalgam	Break
Tooth extraction	Break	Mouthwash	Break	Dental floss	Break	bacteria	Break
Calculus	Break	Dental extraction	Break	Chewing gum	Break	Ayurveda	Break
Deciduous tooth	Break	bacteria	Break	Mark Schwarzer	Break	Laser	Break
Caries symptoms	Break	Anesthesia	Break	Stillen	Break	Cure	Break
Wisdom tooth	Break	Abscess	Break	Chlorhexidine	Break	Body cavity	Break
Italy		**Japan**		**U.K.**		**U.S.**	
Tooth	100	Tooth	100	Tooth	100	Tooth	100
Symptom	15	Dentist	40	Dentistry	40	Dental restoration	45
Pain	15	Headache	15	Dental restoration	25	Dentistry	35
Curare	15	Alveolar consonant	10	Cavity wall	20	Pain	30
Dentistry	10	Dental extraction	10	Pain	15	Toothache	15
Dentist	10	Tooth brushing	10	Wall	15	Gums	10
Inlays and onlays	5	Loxoprofen	10	Toothache	10	Healing	10
Gums	5	Periodontitis	10	Gums	10	Dentist	10
Therapy	5	Halitosis	5	Fluoride	10	Fluoride	10
Endodontic Therapy	5	Anesthesia	5	Thermal insulation	10	Molar	5
Pain	Break	Sodium bicarbonate	Break	Toothache	Break	Oil pulling	Break
Dentistry	Break	Imabari	Break	Brick	Break	Coconut oil	Break
Dentist	Break	Astronaut	Break	Periodontitis	Break	Clear aligners	Break
Gums	Break	Diclofenac	Break	Colgate	Break	Pain management	Break
Therapy	Break	Gums	Break	Dental extraction	Break	Healing	700%
Caria	Break	TMD	Break	Toddler	Break	Tooth brushing	400%
Calculus	Break	Dental floss	Break	Risk	Break	Molar	400%
Al dente	Break	Trygeminal neuralgia	Break	Crown	Break	Traditional medicine	350%
Latte	Break	Dental braces	Break	Mouthwash	Break	Brush	350%
Dopo	Break	Cement	Break	X-ray	Break	Anatomical terms of location	350%

FIGURES

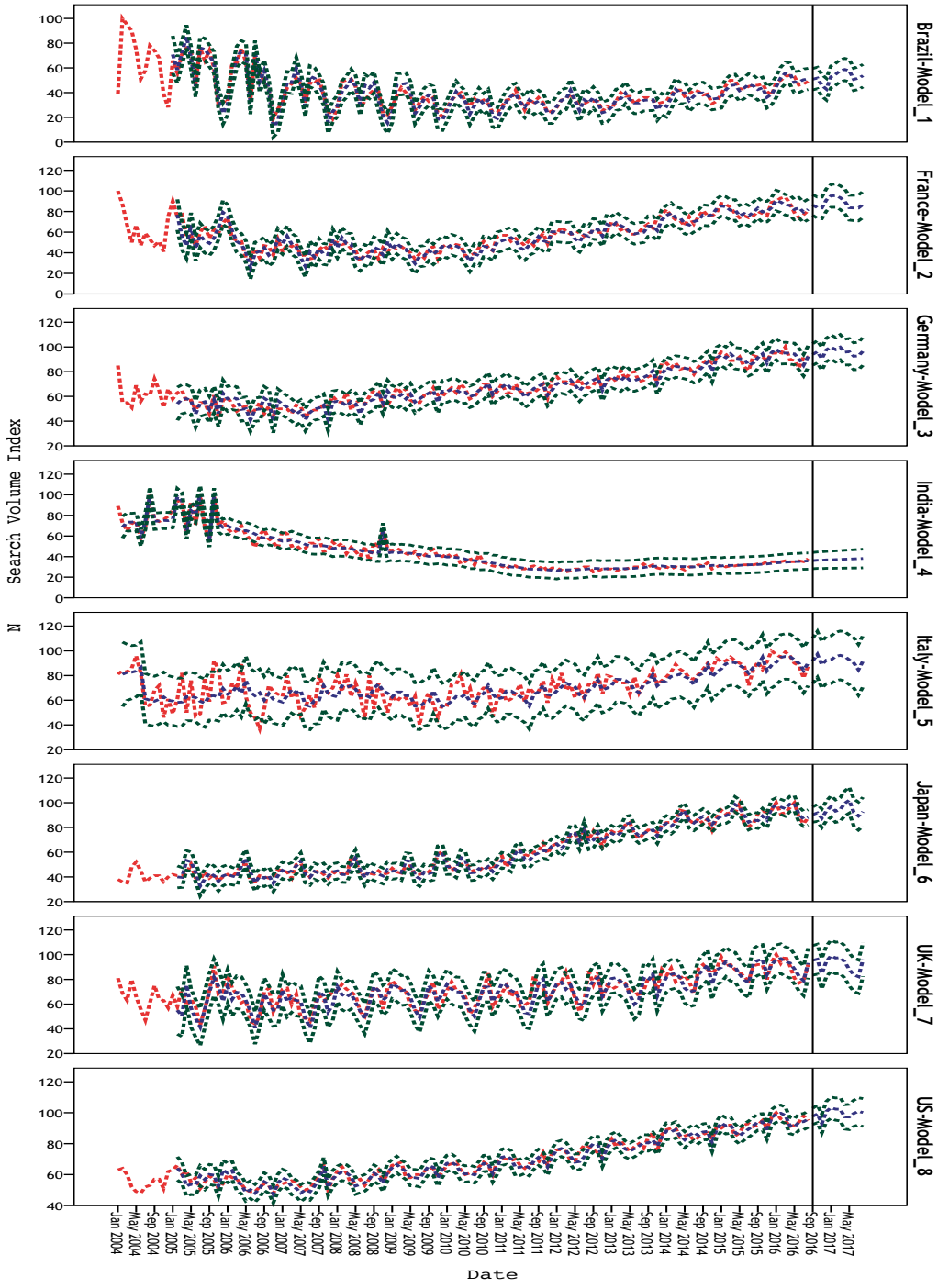

Fig. 1. Predictive charts of SVI for dental caries-related searches performed in Brazil, France, Germany, India, Italy, Japan, the U.K., and the U.S. The curves of observed values (red lines), fit and forecast values (blue lines), and upper and lower bound of confidence intervals (green lines) are depicted from January 2004 through September 2017.

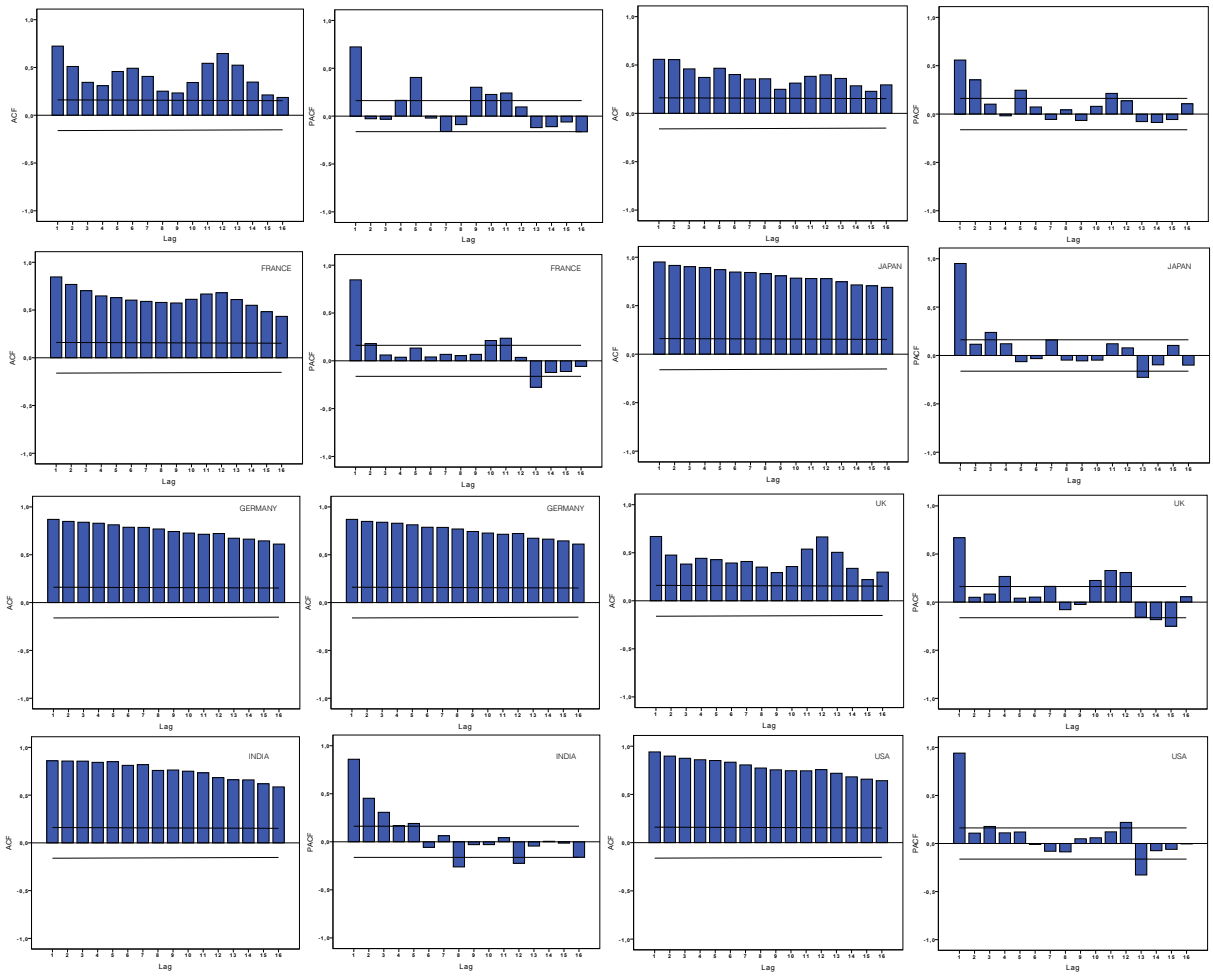

Fig. 2. Autocorrelation (ACF) and partial autocorrelation (PACF) plots for the monthly variation of SVI for dental caries-related queries.

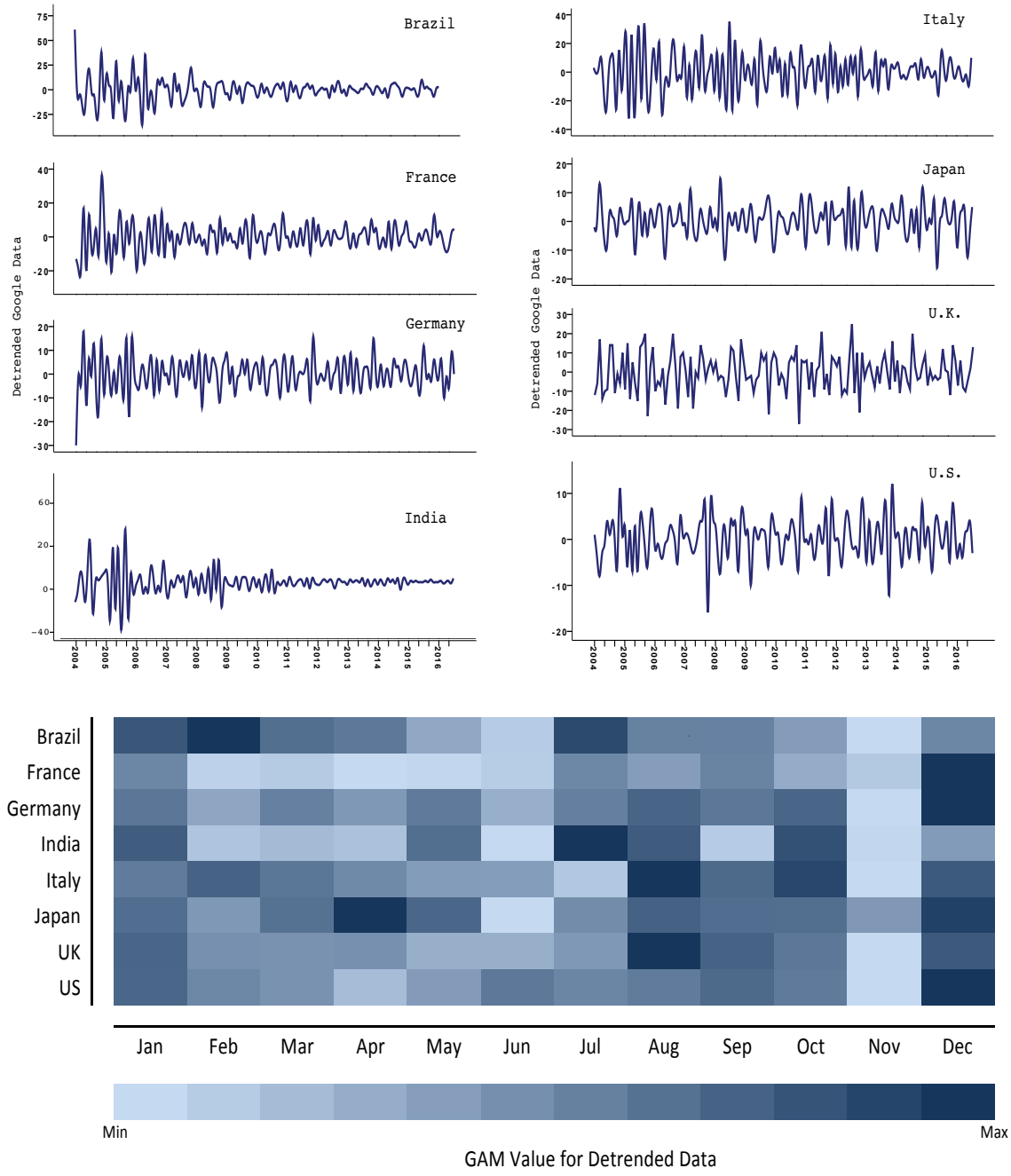

Fig. 3. Seasonality of the interests of Google users on dental caries. It was estimated by fitting a generalized additive model (GAM) to the detrended Google Trends data (lag-1 difference). GAM values using monthly SVI as a predictive variable for Google data are represented in the heat map.

2.2 ARTICLE 2

The assessment of quality of dental caries-related information in Brazilian websites

Abstract

Health seekers can easily reach a vast range of contents in the Internet, among which dental caries knowledge. The aim of this study was to assess the readability and the quality of dental caries-related information from Brazilian websites. The websites were selected through *Google*, *Bing*, *Yahoo!*, and *Baidu*. The order that each website was ranked in the engines was registered. Two independent examiners evaluated the quality of websites using the DISCERN questionnaire and JAMA benchmark criteria. The Flesch Reading Ease (FRE), Flesch-Kincaid Grade Level (FKGL), and Férnandez-Huerta Readability Formula (FHRF) were used to assess the readability of the websites. The statistical analysis was performed with $P<0.05$ considered significant. The content of websites showed a poor quality in both DISCERN ($\overline{x}$=35.68, 19-64) and JAMA ($\overline{x}$=1.12, 0-3) scores. The websites were classified as high-difficulty reading materials by FRE scores and, in contrast, as simple and accessible by FHRF scores. A weak negative correlation was found between the ranking and the quality scores (Spearman's rank test). The information found in health and non-health websites was similar in quality (Mann-Whitney U test). The quality of websites that presented a greater variety of information on dental caries was significantly better than those with limited contents (hierarchical clustering analysis by Ward's minimum variance method, Kruskal Wallis and post-hoc Dunn's test). In conclusion, dental caries-related contents found in Brazilian websites were considered simple, accessible and of poor quality, without differences among health and non-health websites. These findings indicate the need of the development of policies for the production and publication of web health information, encouraging dentists to guide their patients in searching for recommended oral health websites.

Keywords: Dental Caries; Internet; Consumer Health Information; Health Education

Introduction

Dental caries is a multifactorial oral disease that involves the interplay between the tooth surface, the dental biofilm, the availability of dietary fermentable carbohydrates, and genetic and behavioral factors [1, 2]. Concisely, a sugar-rich environment promotes the predominance of acidogenic and aciduric microorganisms in dental biofilms. The ability of these microorganisms in metabolizing sugars and producing acids results in the drop of local pH that favors the demineralization. The maintenance of mineral loss conditions in detriment of remineralization causes the break down of dental tissues over time [3, 4]. Dental caries is still considered the most common chronic oral disease [5], with an average DMFT of 2.11 [6] and a prevalence of 40% in all age groups, which represents 2.4 billion affected people worldwide [7, 8]. It represents a major function, economic and social impact on patients, threatening the quality of their daily lives [9, 10]. Untreated dental caries could lead to several complications, being the first cause for toothache (24.3%) and tooth loss (86%) among Brazilian population [11, 12]. In addition, the treatment of dental caries is the fourth-most expensive among oral conditions, according to the World Health Organization [13].

The structure of health care delivery is in a rapid transition, from a paternalistic-approach to a person-centered model, in which the views of patients are considered preeminent to the improvement of health outcomes [14, 15]. In this context, information must be given by professional teams to persons in order to construct a shared decision-making process [16, 17], with emphasis on the empowerment of patients to be more active in the resolutions and actions about their own health [15, 18, 19]. The free access to health information and health literacy is one of the challenges to this novel model [20]. Barriers as low education, and social and economical deprivation make persons less interested in health seeking information and, consequently, in self-care management. For instance, the poor health education was significantly correlated with tooth loss caused by dental caries, suggesting the importance of a constant oral health education throughout lifetime [12]. Nevertheless, when the free Internet service is offered for social deprived individuals, they are still more interested and curious about health information than whose with easily access [21]. On the other hand, individuals who frequently access

health information seemed to be more engaged, participative and have better health outcomes [22-25].

The rapid dissemination of the Internet allows a useful manner to reach a vast range of contents [26], becoming the most important media used as a source of health information [27]. Notwithstanding, the online health-related information might be misleading, incomplete or even inaccurate [27-29]. Although the good quality of information can reduce the anxiety of people towards health care [30], other ones could even get more anxious about their online findings, which could hamper the person-professional relationship [21]. Moreover, the inaccurate information could leave the patients at risk, especially regarding their health condition [31]. It has suggested that heavily health seekers are more able to recognize and reject poor quality websites than new Internet users; however, this choice is based on empirical features: design factors as *"boring web design"* and *"busy layout"* are important characteristics that they analyze in the screening for relevant health web sources [32]. These concerns encouraged the development of special instruments to assess the quality of health information provided on the Internet [33]. The DISCERN questionnaire and JAMA benchmark criteria are one of the most commonly applied and well documented tools, developed for the assessment of information by healthcare professionals and the public in general [33-36].

Several studies have already assessed the quality of web information of different health conditions [37-46]. To the best of our knowledge, however, there is no evidence about the quality of the dental contents found in Brazilian websites. The aim of this study was to assess the readability and the quality of Brazilian dental caries-related information retrieved by web search engine tools.

Materials and Methods

Study Design

This study was performed by the analysis of the quality of dental caries-related information of Brazilian websites. After the development of a specific search strategy, 188 websites were retrieved by *Google Search*, *Yahoo!*, *Bing*, and *Baidu*, in accordance with their market share. One hundred and thirteen links were discarded for the following causes: duplication, non-specificity, inaccessibility, and scientific content. Thus, 75 websites were evaluated by two independent examiners, by the

application of the DISCERN questionnaire and the Journal of American Medical Association (JAMA) benchmark criteria, in addition of three readability measures, the Flesch Reading Ease (FRE), the Flesch-Kincaid Grade Level (FKGL), and Férnandez-Huerta Readability Formula (FHRF). Moreover, the websites were also identified according to the type of information provided (etiology, prevention, and/or treatment of dental caries). The results were compared between websites of distinct quality levels (DISCERN <48/DISCERN ≥48), natures (health/others), and identities (three clusters that represent the types of combination of provided information).

Search Strategy

The search strategy was used to find Brazilian websites containing dental caries-related information. It was developed according to the following steps: (1) possible dental caries-related words in Brazilian Portuguese were randomly tested in *Google Search*™ to confirm their link to the disease; (2) then, the selected words sourced the *Keyword Planner*™ to generate additional terms with potential to be applied as web queries. A list of 66 terms was obtained after this process; (3) the relevance of each keyword was determined in the *Google Trends*™, a tool that demonstrates the monthly variation of the Search Volume Index (SVI) of specific queries, with values ranging between 0 and 100. The values represent the ratio between the search volume of a particular term by the volume of all searches performed on the engine *Google Search* in a given time period, normalized in function of the maximum value of the time series (SVI=100). In this study, each term was analyzed by using quotation marks in order to obtain a specific query (e.g., “dental caries”). The results of *Google Trends*™ were displayed for all categories of Brazilian web queries performed between 2004 and 2015. Sixty-three keywords with insufficient search volume were excluded. The final search strategy was composed by the combination of only three terms [*“cárie”* + *“carie”* + *“carie dentaria”*], which correspond to synonyms and typos of dental caries.

Selection of Websites

The websites were selected through the four most popular search engine tools, according to their market share [47]. One hundred and eighty-eight websites were obtained from the first links retrieved by *Google Search*™ (n=120), *Baidu* (n=25), *Yahoo!* (n=23) and *Bing* (n=20). Duplicates (n=63), non-specific websites

(n=21), inaccessible links (n=7) and scientific contents (n=22) were discarded. Finally, 75 websites met the inclusion criteria for the analysis, as shown in Figure 1.

The websites were registered using the WebCite© [48], an online service that makes a snapshot of the media content in order to maintain the same information retrieved in the day of the access, avoiding changes and updates for further analysis.

The websites were classified as (i) health-related and (ii) non-health-related websites. They were also identified according to the content of information - etiology (1), prevention (2), and/or treatment (3) of dental caries, which determined the websites' identities [49]. The ID of each website was graphically represented by the software Genesis (version 1.7.7, Graz, Austria) [50]

The Assessment of Quality of Websites

Two independent examiners (PEAA and MMC) evaluated the quality of websites using two different instruments, the DISCERN questionnaire [33, 51] and the Journal of the American Medical Association (JAMA) benchmark criteria [52]. The DISCERN questionnaire is applied to assess the quality of written information on treatment choices for a health problem. It consists of 16 questions with 5-level Likert scale, where the score "1" means that the criterion was not fulfilled and the score "5" means that the criterion was completely satisfied. The total DISCERN score varies between 15 and 80, because when the first question is scored as "1", the second question must be disregarded. The theoretical framework of the DISCERN indicates that as higher the score as greater the quality of information. The instrument is divided into three sections: the first section addresses the reliability of the publication, the second section focuses on the specific details of the information about treatment choices, and the third section refers about the overall quality rating of the document.

The JAMA benchmark consists of a series of four criteria that refer to the description of the (1) authorship (author's name, affiliations and credentials), (2) attribution (effective references of content), (3) currency (presence of dates of posts and updates of information), and (4) disclosure (the statement of any potential conflicts of interest) of websites. It is given one point for each satisfied criterion, varying from 0 to 4.

For both instruments, when it was observed a divergence of judgment between the examiners, the website was re-assessed and a consensus score was adopted.

Readability Measures

The Flesch Reading Ease (FRE) [53], Flesch–Kincaid Grade Level (FKGL) [54] and Férnandez-Huerta Readability Formula (FHRF) [55] were used to assess the readability of the websites, through the online tool Readability-Score.com [56]. The readability measures indicate the reading difficulty of a text. They are based on specific metrics, such as average sentence length (ASL) and average number of syllables per word (ASW). The formula to calculate the Flesch Reading Ease is expressed as FRE=206.835 – (1.015 x ASL) – (84.6 x ASW). A text scored between 90 and 100 is considered easily understandable by an average 5^{th} grader. Scores between 60 and 70 indicate a text easily understandable by 8^{th} and 9^{th} graders, while scores between 0 and 30 are related to difficult texts, understandable only by college graduates. The formula to calculate the Flesch-Kincaid Grade Level is expressed as FKGL=(0.39 x ASL) + (11.8 x ASW) – 15.59. The score indicates the number of years of education that a person needs to have a good comprehension of the information presented [56]. The Fernández-Huerta Readability Formula (FHRF) is a modified version of the Flesch Reading Ease formula for Spanish texts, in which 0 is the score for the greatest difficulty and 100 is the score for the easiest reading, similarly to FRE [57]. Its formula is expressed as FHRF= 206.84 – (0.6 x number of syllables per 100 words) – (1.02 x number of sentences per 100 words).

Statistical analysis

Data were analyzed with the Statistical Package for Social Science (version 21.0; SPSS, Chicago, USA). Since the hypothesis of normal distribution of data was not confirmed by the Kolmogorov-Smirnov test, the statistical analysis was performed by the application of non-parametric tests. The significant differences between health-related and other websites and between low- and adequate-quality websites were observed by Mann-Whitney U test. The correlation levels between distinct instruments and measures were demonstrated by Spearman's rank correlation coefficient. The determination of clusters of similar websites' identities was provided by the hierarchical clustering analysis using the Ward's minimum variance method. The clusters were compared by Kruskal-Wallis and post-hoc Dunn's test. The Intraclass Correlation Coefficient was used to assess the absolute concordance of

scores of DISCERN and JAMA benchmark given by the different examiners. For all analyses, *P* values < 0.05 were considered significant.

Results

It was observed a good concordance level between the examiners to the application of the DISCERN questionnaire (ICC=0.73, 95% CI: 0.38 – 0.86) and JAMA benchmark (ICC=0.72, 95% CI: 0.56 – 0.82).

The DISCERN and JAMA scores for each website is shown in Table 1. The content of websites presented a poor quality, with mean of 35.68 (19-64) for DISCERN and 1.12 (0-3) for JAMA (Table 2). These results were significantly correlated (*P*=0.58, *P*<0.001) (Table 3). Only seven websites were scored ≥48 for DISCERN, with a mean of overall quality of text (3rd section) of 3.71 (Table 4).

The readability measures Flesch Reading Ease and Fernández-Huerta Readability Formula showed controversial results. FRE scores classified the websites as high-difficulty reading materials. Conversely, FHRF scores led to classify the websites as simple and accessible for the most people (Table 2). Moreover, the readability measures seemed to have no influence on the quality of dental caries-related information, except for FRE scores that were weakly negatively correlated with DISCERN scores (Table 3).

The ranking of the websites was also weakly negatively correlated with DISCERN and JAMA Benchmark. No significant correlation was found between ranking and readability measures (Table 3).

Health-related and non-health-related websites were similarly scored by DISCERN, JAMA benchmark, and readability measures. The information of both website categories was classified as of poor quality (Table 5).

The hierarchical clustering analysis yielded three distinct clusters of websites, according to the presence and/or absence of the following issues: etiology (1), treatment (2), and/or prevention (3) of dental caries, as shown in Figure 2. When comparing the clusters 1 and 3, a significant statistical difference was observed between the DISCERN scores. The scores of FKGL in the clusters 1 and 2 were significantly different (Table 6). Overall, websites containing all three categories of contents (cluster 1) showed higher quality scores than those websites containing only one (cluster 3) or two (cluster 2) issues.

Discussion

To our knowledge, this is the first study that assessed the quality of dental caries-related information in Brazilian websites. In general, our results showed a predominance of low quality contents through both instruments, DISCERN questionnaire (mean score=35.68) and JAMA benchmark (mean score=1.12), with a good concordance level between the two examiners. A low rate of the websites (9.3%) were classified in the range of acceptable to high levels of quality (DISCERN≥48), which is consistent with studies that evaluated the web-based quality of other specific health issues [37, 58-60]. This result might be influenced by a possible bias from a more strict investigation performed by two health professionals. Nevertheless, Griffiths and Christensen [61] showed no significant differences between the scores of DISCERN given by professionals and laypersons. The readability metrics and the ranking of websites were not correlated with the quality of information.

Our study is similar to other two previous works. Blizniuk et al. (2014) demonstrated a lack of quality of dental caries-related information published in English websites (DISCERN=44), without connection with specific topics or languages. Leite and Correia (2011) identified 4 out of 75 Portuguese websites certified with the Health On the Net Foundation (HON) code, which posted knowledge on dental caries in pediatric patients. The HON code is the oldest and the most used ethical and trustworthy certification granted by a non-governmental institution that evaluates the quality of medical and health related information available on the Internet [62]. We did not consider this analysis in our methods because the low number of HON certified Brazilian websites, probably due to the lack of awareness of this certification in the country [37]. Among the websites included in this study, only one was decorated with HON code; surprisingly, its contents were qualified as inadequate by the both instruments applied in this research. The application of the DISCERN showed a general low trustworthiness for the websites on acute myocardial infarction and stroke showed (54.2%) [58], and caesarean section reports (DISCERN=43.6) [59]. Regarding the JAMA scores, our results are consistent with previous works [44, 49, 63]; however, there is not dental caries-related evidence considering this method.

As DISCERN and JAMA were only fairly correlated, we believe that the application of both instruments improved the assessment of quality of websites,

especially because their scores are based on distinct criteria. When comparing health-related and non-health-related websites, no significant differences were found between DISCERN and JAMA scores, suggesting that dentists and/or dental companies are not concerned with the accuracy of the production of dental information. According to the DISCERN scores, the websites of this study were divided in two groups with the threshold of 48, which was determined by the multiplication of the number of questions of DISCERN (16) by the score that refers to an “acceptable” quality of information in the Likert scale (3). The websites were also grouped in three different clusters in accordance with the publication of the issues etiology, prevention and/or treatment. The performance of websites that presented the three issues in their contents were distinctly better than websites that treated about only one of those issues, which can reflect the concern with the completeness of information.

The adoption of diverse readability scores yielded divergent outcomes, such as the classification of the websites as high complexity of reading by the FRE, and as simple and accessible contents by FHRF. The latter score is derived from the analysis of texts written in Spanish, differently of FRE that was developed to measure English materials. Taking into consideration that there is no available consistent readability metrics for Portuguese texts, we performed multiple analyses to decide the best fitting measure for our data. Two aspects deserve to be highlighted: (i) the length of Portuguese words is closer to the Spanish than the English words [64, 65] and (ii) the contents of websites evaluated in this study seemed to be of low complexity. Based on these inferences, we considered the FHRF more relevant to the interpretation of our results. Although the observation of weak or even no significant negative correlations between readability measures (FRE and FHRF) and the DISCERN scores, this trend should be regarded as an exacerbating factor for the impact of the low quality of information on the Internet users, since it demonstrates that more accessible contents are even worse in quality. Moreover, the understanding of medical information probably requires more advanced abilities than those related with basic literacy [31]. The percentage of Brazilian people with basic literacy among youths (15-24 y) and adults is 99% and 93%, respectively [66].

Dental caries is still the most common chronic oral disease in the world [5]. For this reason, we believe that many people could search for online information about this oral condition. In a recent research, our team demonstrated that the interest on

dental caries-related information of Google users is increasing over time in different countries (data not published). Also, 50% of online health seekers looking for dental conditions were searching to improve their own knowledge or to learn about their future dental procedures [67].

When individuals conduct a query on any health topic, the terms used to perform the first search could depend on health education level [68]. With this in mind, the search strategy was designed with focus on the relevance of terms employed by real Internet users. The flow of the development of search strategy started with a general query on Google Search [47], following by the consideration of other several possibilities proposed by *Keyword Planner*^{TM}, and subsequently tested by the relevance of their application in real queries. The final strategy was constructed by the combination of the terms with significant search volume trends. In our opinion, this methodological approach improved the chances of retrieving the websites in a similar way that performed by the netizens.

The demand for health information depends on the behavior of people. According to the Vital Signs report [71], there are four types of individuals regarding health care situation: a) who that agree and accept the treatment decision, b) who access the web to confirm the diagnosis given by a professional, c) who involved with the decision-making process, and d) who that in complete control of their treatment, relying on information found by themselves. In this context, although physicians and health professionals are still considered the most important source of advise, the easier and more affordable access to the Internet predisposes people to seek health counseling online [32]. Sixty-five percent of people generally begin their health searches using an engine bar instead of looking information on specific health portals [71]. Consequently, millions of health queries are entered in *Google Search* daily [72].

According to Eysenbach and Köhler [73], people are exclusively interested in the links retrieved on the first page of results. However, to evaluate the correlation of the order of availability of links in the search engines with the quality of their contents, we assessed a quite larger number of websites than the Internet users could be interested. Google's PageRank uses more than 200 factors to order the links in accordance with the query, which was determined by the algorithms created by Larry Page [74]. As expected, links of the advertisements were found on the first page of all search engines. For instance, the links of Google's first page were represented by

five blogs, four commercial websites and one famous encyclopedia. The contents of these links were alarming, e.g., with the description of “treatments without dentists” and “a ten minute-rinse with coconut oil” for preventing dental caries; additionally, none of these contents presented good or even standard quality of information. By the way, our results showed a negative correlation of the DISCERN (-0.294) and JAMA benchmark (-0.229) with the position where each website was listed. Therefore, search engines are not displaying their ranks based on the quality of the available dental information, i.e., the burden of the inadequate accessible information on health education is enormous.

The consumption of misleading knowledge could deteriorate the person-dentist relationship; hence, the professional should be prepared to face this challenge effectively, advising and encouraging their patients to explore information on recommended websites, warning people about the risks of health home practices, and contributing with the production of good quality materials, since one out of three health seekers treat themselves with online information [75].

The process of making regulations in this field is arduous, requiring an intense debate, since it may suppress the rights to freedom of expression and opinion [76]. Moreover, it is almost impossible to control the publication of web contents, especially because the diffusion of personal opinion contained in health blogs. The use of codes and/or seals for the certification of websites could be a good approach to signal the useful health information, particularly if the accreditation is based on rigorous criteria, and if the Internet users can easily view the seal in the website.

In conclusion, dental caries-related contents found in Brazilian websites were considered as simple, accessible and of poor quality with basis on the Férnandez-Huerta Readability Formula, DISCERN and JAMA benchmark scores, respectively. This pattern does not seem to depend on the specificity of the nature of the website, but the type of information covered. These findings indicate the need of the development of special policies focused on the production and publication of web health information, encouraging dentists to guide their patients in searching recommended oral health websites.

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Tables

Table 1. List of websites and respective identities, ranking, DISCERN and JAMA benchmark scores

ID	Ranking	Webcite© links	DISCERN	JAMA
1	1	http://www.webcitation.org/6gAssu22A	27	1
2	3	http://www.webcitation.org/6gAszf6Ya	54	2
3	4	http://www.webcitation.org/6gAt8Th7T	46	2
4	5	http://www.webcitation.org/6gAt9Lrow	22	0
5	6	http://www.webcitation.org/6gAtAGfc5	29	3
6	8	http://www.webcitation.org/6gAtJtqBf	29	1
7	9	http://www.webcitation.org/6gAtK9Hkx	28	2
8	10	http://www.webcitation.org/6gAtUCdLk	22	0
9	11	http://www.webcitation.org/6gAtUUbOc	38	2
10	12	http://www.webcitation.org/6gAtUjjpS	34	1
11	13	http://www.webcitation.org/6gAtav5BA	30	0
12	15	http://www.webcitation.org/6gAtbErYI	43	3
13	16	http://www.webcitation.org/6gAtojv8r	23	0
14	18	http://www.webcitation.org/6gAtpPO6c	43	2
15	19	http://www.webcitation.org/6gAtpZQVN	35	2
16	20	http://www.webcitation.org/6gAuCOnjX	43	1
17	22	http://www.webcitation.org/6gAu5qIze	33	1
18	23	http://www.webcitation.org/6gAuFvS95	35	2
19	27	http://www.webcitation.org/6gAubHtOy	52	2
20	28	http://www.webcitation.org/6gAubZIvp	55	2
21	29	http://www.webcitation.org/6gAucjtlE	44	1
22	30	http://www.webcitation.org/6gAukt1zx	53	2
23	34	http://www.webcitation.org/6gAv4y0BP	26	0
24	35	http://www.webcitation.org/6gAv5uAe0	32	1
25	37	http://www.webcitation.org/6gAvEe4M3	27	0
26	39	http://www.webcitation.org/6gAvFBPGY	33	1
27	40	http://www.webcitation.org/6gAvPf181	38	1
28	44	http://www.webcitation.org/6gAvbJoIa	33	2
29	48	http://www.webcitation.org/6gAvnme4x	39	0
30	53	http://www.webcitation.org/6gCNJxpyQ	35	1
31	57	http://www.webcitation.org/6gCNUA2Zf	62	3
32	58	http://www.webcitation.org/6gCNUQl1H	43	2
33	62	http://www.webcitation.org/6gCNYnUcQ	47	3
34	63	http://www.webcitation.org/6gCNiSeRG	24	0
35	66	http://www.webcitation.org/6gCNlfQun	44	1
36	68	http://www.webcitation.org/6gCNvAUE2	46	2
37	70	http://www.webcitation.org/6gCO37i9v	47	3
38	71	http://www.webcitation.org/6gCO3HEtI	42	2
39	72	http://www.webcitation.org/6gCO3OdWH	26	0
40	73	http://www.webcitation.org/6gCPyhQyD	41	3
41	74	http://www.webcitation.org/6gCPyrck1	35	2
42	76	http://www.webcitation.org/6gCQ5kGPk	35	1
43	77	http://www.webcitation.org/6gCQ5sJK7	25	1
44	78	http://www.webcitation.org/6gCQ61Crc	35	1

45	79	http://www.webcitation.org/6gCQHdyA2	21	0
46	84	http://www.webcitation.org/6gCQKg5QM	38	2
47	85	http://www.webcitation.org/6gCQKpFZj	37	1
48	87	http://www.webcitation.org/6gCQRmTFz	34	0
49	89	http://www.webcitation.org/6gCQaLGNj	36	1
50	90	http://www.webcitation.org/6gCQaV7BJ	28	0
51	91	http://www.webcitation.org/6gCQac813	37	1
52	94	http://www.webcitation.org/6gCQt800K	39	0
53	95	http://www.webcitation.org/6gCQtDHZz	22	1
54	96	http://www.webcitation.org/6gCQtKyoa	34	1
55	97	http://www.webcitation.org/6gCR3KMa1	19	2
56	100	http://www.webcitation.org/6gCRLFpG6	22	0
57	101	http://www.webcitation.org/6gCRLMPz3	29	1
58	104	http://www.webcitation.org/6gCRXzWtD	32	2
59	105	http://www.webcitation.org/6gCRY6VUk	29	0
60	107	http://www.webcitation.org/6gCRfqghB	28	0
61	108	http://www.webcitation.org/6gCRYWA6g	19	0
62	109	http://www.webcitation.org/6gCRfyE1x	40	1
63	111	http://www.webcitation.org/6gCRlar4K	31	1
64	115	http://www.webcitation.org/6gCRy27Ro	29	0
65	116	http://www.webcitation.org/6gCRyCLjT	27	0
66	118	http://www.webcitation.org/6gCS4jqA6	28	0
67	16	http://www.webcitation.org/6hGaF3NKE	45	0
68	1	http://www.webcitation.org/6hGbGKOK4	52	0
69	2	http://www.webcitation.org/6hGbJu0jN	64	3
70	5	http://www.webcitation.org/6hGbTSraL	39	2
71	12	http://www.webcitation.org/6hGbxGKvz	41	1
72	13	http://www.webcitation.org/6hGc0ogdT	45	1
73	15	http://www.webcitation.org/6hGcCMSLW	30	0
74	16	http://www.webcitation.org/6hGcL60Ya	31	0
75	14	http://www.webcitation.org/6hGXUeroU	37	1

Table 2. Descriptive statistics of scores of DISCERN, JAMA benchmark, and readability measures.

	S1	S2	S3	DISCERN	JAMA	FRE	FKGL	FHRF
Mean	18.89	14.59	2.20	35.68	1.12	29.74	10.96	80.19
SD	5.70	5.40	0.85	9.85	0.97	11.35	2.01	7.39
Median	18.00	14.00	2.00	35.00	1.00	30.70	10.70	80.69
Minimum	8.00	7.00	1.00	19.00	0.00	6.00	5.00	62.62
Maximum	34.00	28.00	4.00	64.00	3.00	67.50	15.60	98.72

S1, S2, and S3=Three different sections of DISCERN
FRE=Flesch Reading Ease
FKGL=Flesch-Kincaid Grade Level
FHRF=Fernández-Huerta Readability Formula

Table 3. Cross-correlation between ranking, DISCERN, JAMA benchmark and readability measures.

	Ranking	**DISCERN**	**JAMA**	**FRE**	**FKGL**	**FHRF**
Ranking		-0.29*	-0,23*	0.05	-0.09	-0.03
		0.01	0.05	0.64	0.46	0.83
DISCERN	-0.29*		0.58**	-0.24*	0.22	-0.10
	0.01		<0.001	0.04	0.06	0.42
JAMA	-0.23*	0.58**		-0.14	0.14	-0.07
	0.04	<0.001		0.22	0.23	0.53
FRE	0.05	-0.24*	-0.14		-0.92**	0.56**
	0.64	0.04	0.22		<0.001	<0.001
FKGL	-0.09	0.22	0.14	-0.92**		-0.28*
	0.46	0.06	0.23	<0.001		0.01
FHRF	-0.03	-0.10	-0.07	0.56**	-0.28*	
	0.83	0.42	0.53	<0.001	0.01	

(*) *P*<0.05
(**)*P*<0.001
FRE=Flesch Reading Ease
FKGL=Flesch-Kincaid Grade Level
FHRF=Fernández-Huerta Readability Formula

Table 4. Descriptive statistics of scores of low- and adequate-quality websites for DISCERN, JAMA benchmark, and readability measures. Different lower case letters mean significant statistical differences between the two groups (Mann-Whitney U test, $P<0.05$).

Websites		S1	S2	S3	DISCERN	JAMA	FRE	FKGL	FHRF
Low-quality DISCERN<48 (n=68)	Mean	18.04[a]	13.50[a]	2.04[a]	33.59[a]	1.03[a]	29.81[a]	10.96[a]	80.50[a]
	SD	5.14	4.25	0.72	7.57	0.93	11.71	2.06	7.42
	Median	17.00	14.00	2.00	34.00	1.00	31.50	10.70	80.71
	Minimum	8.00	7.00	1.00	19.00	0.00	6.00	5.00	62.62
	Maximum	33.00	26.00	3.00	47.00	3.00	67.50	15.60	98.72
Adequate-quality DISCERN≥48 (n=7)	Mean	27.14[b]	25.14[b]	3.71[b]	56.00[b]	2.00[b]	29.01[a]	10.94[a]	77.24[a]
	SD	4.56	2.97	0.49	4.93	1.00	7.64	1.46	6.83
	Median	26.00	26.00	4.00	54.00	2.00	27.30	11.60	80.60
	Minimum	21.00	20.00	3.00	52.00	0.00	19.80	8.40	68.58
	Maximum	34.00	28.00	4.00	64.00	3.00	42.50	12.60	86.76

S1, S2, and S3=Three different sections of DISCERN
FRE=Flesch Reading Ease
FKGL=Flesch-Kincaid Grade Level
FHRF=Fernández-Huerta Readability Formula

Table 5. Descriptive statistics of scores of health and other websites for DISCERN, JAMA benchmark, and readability measures. Different lower case letters mean significant statistical differences between the two groups (Mann-Whitney U test, $P<0.05$).

Websites		S1	S2	S3	DISCERN	JAMA	FRE	FKGL	FHRF
Health (n=38)	Mean	19.58[a]	14.68[a]	2.34[a]	36.61[a]	1.05[a]	30.40[a]	10.99[a]	80.37[a]
	SD	5.76	5.02	0.82	9.60	1.01	11.24	2.26	5.57
	Median	18.00	14.00	2.00	35.00	1.00	29.45	10.95	80.70
	Minimum	11.00	7.00	1.00	19.00	0.00	13.00	5.00	62.66
	Maximum	34.00	26.00	4.00	62.00	3.00	67.50	15.60	92.76
Others (n=37)	Mean	18.19[a]	14.49[a]	2.05[a]	34.73[a]	1.19[a]	29.06[a]	10.93[a]	80.02[a]
	SD	5.67	5.75	0.88	10.13	0.94	11.58	1.74	8.96
	Median	18.00	15.00	2.00	35.00	1.00	31.70	10.70	80.69
	Minimum	8.00	7.00	1.00	19.00	0.00	6.00	7.60	62.62
	Maximum	33.00	28.00	4.00	64.00	3.00	50.00	14.40	98.72

S1, S2, and S3=Three different sections of DISCERN
FRE=Flesch Reading Ease
FKGL=Flesch-Kincaid Grade Level
FHRF=Fernández-Huerta Readability Formula

Table 6. Descriptive statistics of scores of different clusters of websites for DISCERN, JAMA benchmark, and readability measures. Different lower case letters mean significant statistical differences between the groups (Kruskal-Wallis test and post-hoc Dunn's test, $P<0.05$).

Cluster		S1	S2	S3	DISCERN	JAMA	FRE	FKGL	FHRF
1 (n=22)	Mean	19.05[a]	18.05[a]	2.41[a]	39.50[a,b]	1.05[a]	26.65[a]	11.83[a]	80.96[a]
	SD	5.64	6.26	1.01	11.41	1.00	8.57	1.81	7.57
	Median	18.50	17.50	2.50	38.50	1.00	27.25	11.45	80.77
	Minimum	8.00	9.00	1.00	22.00	0.00	13.00	9.40	68.51
	Maximum	32.00	28.00	4.00	64.00	3.00	38.50	15.60	92.76
2 (n=26)	Mean	18.85[a]	15.50[a]	2.35[a]	36.69[b,c]	1.19[a]	33.66[a]	10.15[b,c]	81.35[a]
	SD	4.65	3.78	0.75	8.19	0.85	11.68	2.09	5.96
	Median	18.00	16.00	2.00	35.00	1.00	33.40	10.05	80.70
	Minimum	12.00	8.00	1.00	22.00	0.00	7.30	5.00	62.62
	Maximum	34.00	24.00	4.00	62.00	3.00	67.50	14.40	86.89
3 (n=27)	Mean	18.81[a]	10.89[b]	1.89[a]	31.59[c]	1.11[a]	28.49[a]	11.02[a,c]	78.45[a]
	SD	6.82	3.33	0.75	8.69	1.09	12.31	1.83	8.37
	Median	16.00	11.00	2.00	29.00	1.00	29.70	11.20	80.67
	Minimum	11.00	7.00	1.00	19.00	0.00	6.00	7.60	62.66
	Maximum	33.00	19.00	3.00	47.00	3.00	50.00	14.00	98.72

S1, S2, and S3=Three different sections of DISCERN
FRE=Flesch Reading Ease
FKGL=Flesch-Kincaid Grade Level
FHRF=Fernández-Huerta Readability Formula

Figures

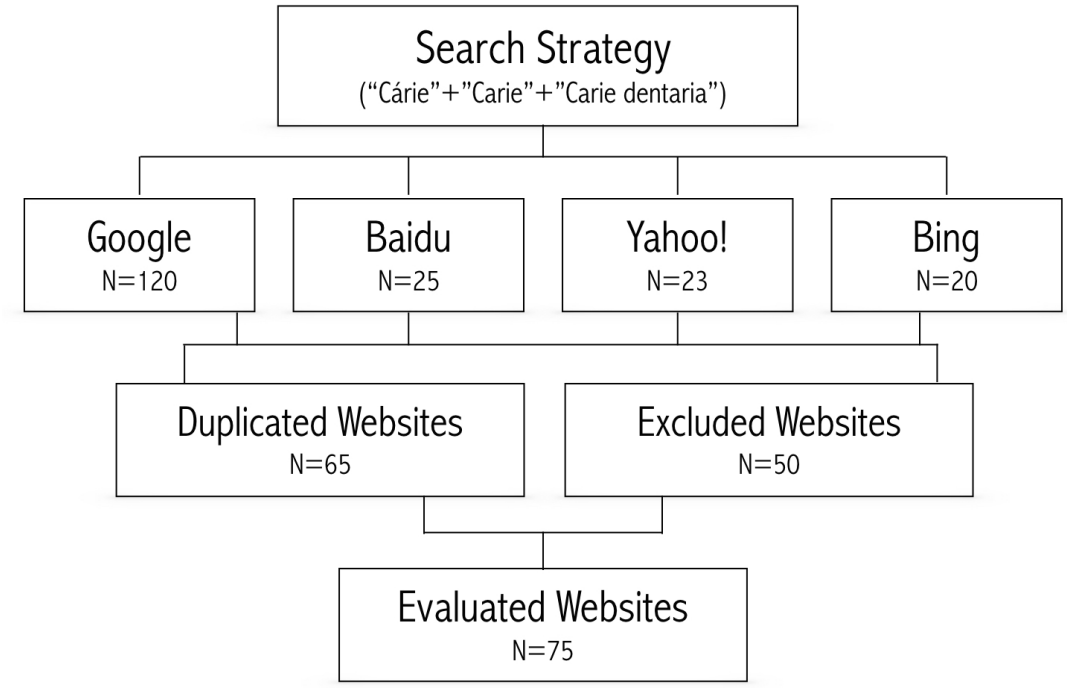

Figure 1. Flowchart depicting the systematic selection of dental caries-related Brazilian websites.

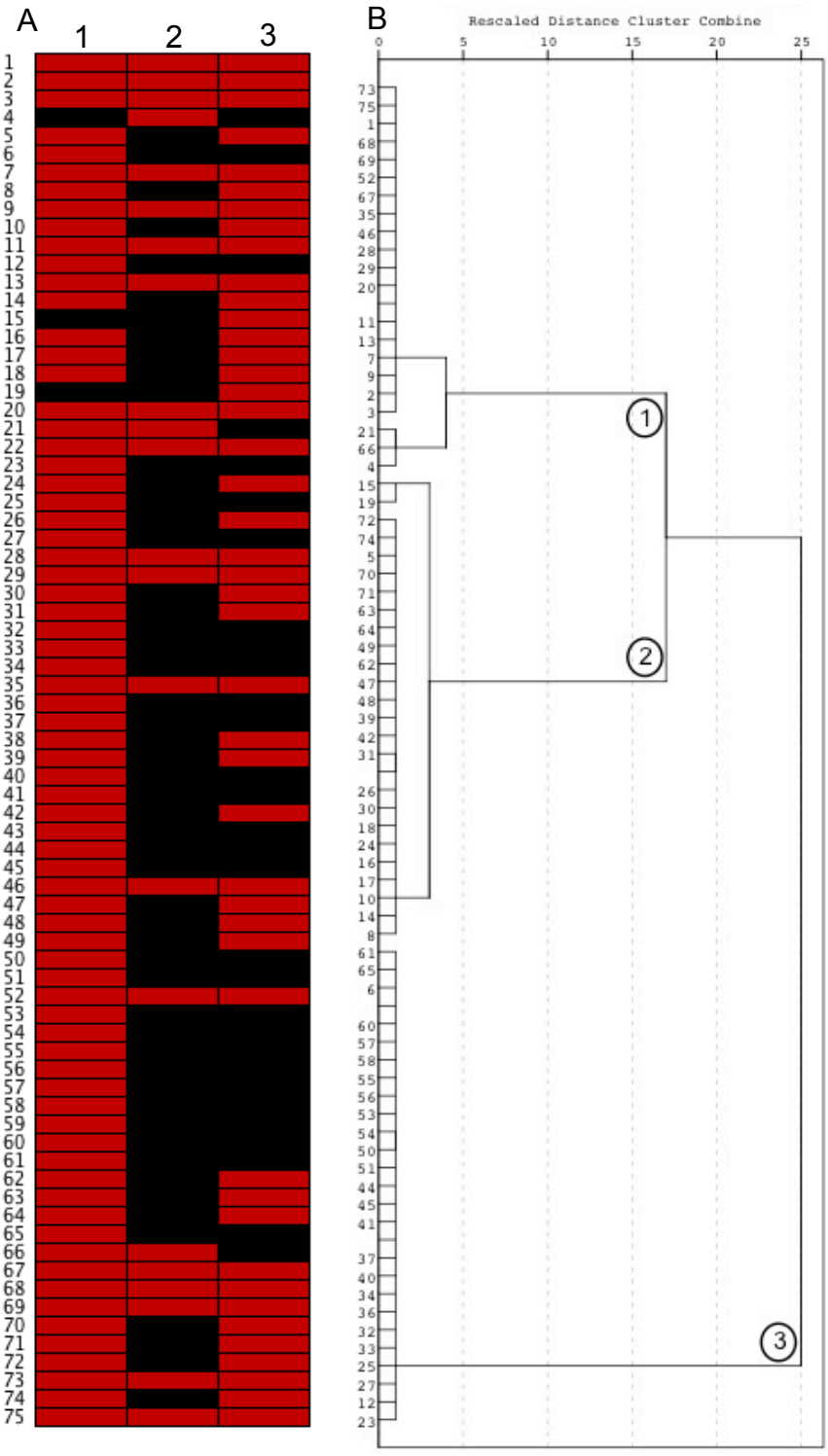

Figure 2. Cluster analysis of the websites. (A) The representation of websites' IDs regarding the content of information: etiology (1), treatment (2), and/or prevention (3) of dental caries. Red and black bars mean the presence and absence of the type of information, respectively. (B) Dendrogram depicts three clusters originated from the websites' IDs (hierarchical clustering analysis by Ward's minimum variance method).

3 Discussion

3 DISCUSSION

Our findings show an increasing search activity in relation to dental caries web information, except for Brazil and India, where a downward-pattern of SVI was observed over time. Although not all differences were statistically significant, the annual means of predictive SVI were higher in comparison with those from the last year, which indicates a trend of rising attraction for the Internet content on dental caries in the next years. But what could explain this seeking behavior when the literature describes an overall decrease in dental caries across time?

The prevalence of dental caries has declined in the past decades because two main reasons: the use of fluoride and the effectiveness of preventive dental programmes (GLASS, 1982; FEHR; HAUGEJORDEN, 1997; LAGERWEIJ; VAN LOVEREN, 2015). Nevertheless, its prevalence is returning to increase with the aging of the population, through the simultaneous reduction of dental loss and the maintenance of teeth throughout the lifetime (PITTS et al., 2011; BERNABE; SHEIHAM, 2014; LAGERWEIJ; VAN LOVEREN, 2015; EDMAN et al., 2016). For instance, approximately 27% of adults between 20–64 years old were diagnosed with untreated dental caries lesions in permanent teeth; additionally, one in five adults aged 65 and over presented untreated lesions, suggesting a growing experience of dental caries among adults (WHELTON, 2004; BERNABE; SHEIHAM, 2014). Moreover, untreated dental caries alone corresponds to an average of health loss of 70 years per 100,000 people (MARCENES et al., 2013; MURRAY et al., 2013). Regarding the burden of untreated dental caries and the changes in the structure of health care, from a doctor's decision-centered model to a shared decision-making process (COTTEN; GUPTA, 2004; BRAGAZZI, 2013), we assume that at least a percentage of adults experiencing lesions could seek for dental caries-related information on the web, since 72% of the U.S. adults who accessed the Internet admitted they searched for health knowledge, of whom 59% concerned about their own medical conditions (FOX; DUGGAN, 2013). Also, health information seekers decide to contact a health professional based on what they found online (YBARRA; SUMAN, 2006).

The demand for health information depends on the behavior of people. According to the Vital Signs report (TAYLOR; LEITMAN, 2001), there are four types of patients regarding health care situation: a) who that agree and accept the

treatment decision, b) who access the web to confirm the diagnosis given by a professional, c) who involved with the decision-making process, and d) who that in complete control of their treatment, relying on information found by themselves. In this context, although physicians and health professionals are still considered the most important source of advise, the easier and more affordable access to the Internet predisposes people to seek health counseling online (SILLENCE et al., 2007).

Regarding the quality of information that health users consume online, our results showed a predominance of low quality dental caries related contents through both instruments, DISCERN questionnaire (mean score=35.68) and JAMA benchmark (mean score=1.12), with a good concordance level between the two examiners. A low rate of the websites (9.3%) were classified in the range of acceptable to high levels of quality (DISCERN≥48), which is in accordance with studies that evaluated the web-based quality of specific health issues (DEL GIGLIO et al., 2012; BASTOS; PAIVA; AZEVEDO, 2014; FIORETTI et al., 2015; BLIZNIUK et al., 2016). As the current instruments were fairly correlated, we believe that the application of DISCERN and JAMA improved the assessment of quality of websites, especially because their scores are based on distinct criteria. When comparing “health-related” and “other” websites, no significant differences were found between DISCERN and JAMA scores, suggesting that dentists and/or dental companies are little concerned with the accuracy of the production of dental information. According to the DISCERN scores, the websites of this study were divided in two groups with the threshold of 48, value determined by the multiplication of the number of questions of DISCERN (16) by the score that refers to an “acceptable” quality of information in its Likert scale (3). The websites were also grouped in three different clusters in accordance with the publication of the issues etiology, prevention and/or treatment. The performance of websites that presented the three issues in their contents were distinctly better than websites that treated about only one of those issues, which can reflect the concern with the completeness of information. Taking into consideration that there is no available consistent readability metrics for Portuguese texts, we performed multiple analyses to decide the best fitting measure for our data. Two aspects deserve to be highlighted: (i) the length of Portuguese words is closer to the Spanish than the English words (DELATTRE, 1966; QUARESMA, 2008) and (ii) the contents of websites evaluated in this study seemed to be of low complexity. Based

on these inferences, we considered the FHRF more relevant to the interpretation of our results. Although the observation of weak or even no significant negative correlations between readability measures (FRE and FHRF) and the DISCERN scores, this trend should be regarded as an exacerbating factor for the impact of the low quality of information on the Internet users, since it demonstrates that more accessible contents are even worse in quality. Moreover, the understanding of medical information probably requires more advanced abilities than those related with basic literacy (BRECKONS et al., 2008). The percentage of Brazilian people with basic literacy among youths (15-24 y) and adults is 99% and 93%, respectively (WORLD BANK DATA, 2017).

The consumption of misleading knowledge could deteriorate the person-dentist relationship; hence, the professional should be prepared to face this challenge effectively, advising and encouraging their patients to explore information on recommended websites, warning people about the risks of health home practices, and contributing with the production of good quality materials, since one out of three health seekers treat themselves with online information (YBARRA; SUMAN, 2006).

In conclusion, first, the interest of Google users in dental caries-related information is increasing over time, especially in the last years. Therefore, the use of Internet data mining could be helpful to provide the establishment of the needs of population groups from different countries in a near real-time; however, this strategy must be applied with caution, without replacing the statistics produced by traditional epidemiological methods. Second, dental caries-related contents found in Brazilian websites were considered as simple, accessible and of poor quality with basis on the Férnandez-Huerta Readability Formula, DISCERN and JAMA Benchmark scores, respectively. This pattern does not seem to depend on the specificity of the website but the type of information presented. These findings indicate the need of the development of special policies focused on the production and publication of web health information, encouraging dentists to guide their patients in searching specific oral health websites.

4 Conclusion

4 CONCLUSION

Based on the results of this study, we concluded that:

- The interest of Google users in dental caries-related information is increasing over time, especially in the last years;
- The forecast models showed the continuation of the trend of increase in next months;
- The interest levels depend on the effect of seasonality in the most evaluated countries, with the highest values of SVI in the spring and the lowest values of SVI in the summer;
- The Internet is used predominantly to obtain information about the symptoms and treatment of dental caries lesions, including home strategies;
- Dental caries-related contents found in Brazilian websites were considered as simple, accessible and of poor quality;
- The dental caries-related contents of health and non-health websites were similar in quality;
- The websites that covered a greater diversity of dental caries-related issues were significantly better than websites that presented a specific topic related to that condition.

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