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Evaluation of internet search trends of some common oral problems, 2004 to 2014

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Objective: Internet search trend volumes can provide free, fast and pertinent information about peoples' online interests. No study has yet been conducted on internet search trends in dentistry. This study aims to investigate ten years' data on internet search volumes regarding some oral problems: "toothache", "tooth decay", "gum disease", "wisdom teeth" and "oral cancer". The study also aims to investigate the most common geographic search locations and to examine related searches. ***Research Design****:* Worldwide internet search trend data over a period of 532 weeks (4 January 2004 and 15 March 2014) retrieved from the Google Trends web site was interrogated for each search term to identify search trends, regional interests, and related searches. ***Results****:* The search volumes for the terms "toothache "and "wisdom teeth" increased over the decade while "tooth decay", "gum disease", and "oral cancer" showed slight changes. Each term was most commonly searched in different counties: "toothache", Philippines; "tooth decay", Singapore; "Gum Disease", Ireland; "Wisdom Teeth", United States; and "Oral cancer", India. Related searches were mainly focused on symptoms and remedies of these problems. ***Conclusions****:* Regional and time-related variations in search volumes may provide dental professionals with readily- and freely-available pertinent information on populations' internet searches regarding dental complaints.

Key words: *internet, dental informatics, toothache, dental caries, periodontal diseases, oral cancer*

Introduction

The spread of internet is an information revolution and now provides access to a popular information resource. An estimated 60% of adults have made internet searches for healthcare information (Yeap and Slack-Smith, 2013). Web-based health information can be easily updated and tailored to match the health and communication needs of diverse audiences (Kreps and Neuhauser, 2010). The internet is also the primary venue for global health information exchange among doctors, between doctors and patients, and from patient to patient (Geissbuhler and Boyer, 2006; McMullan, 2006; Preis *et al*., 2012).

Health information seekers are often investigating specific medical problems they or their loved-ones face and health-related websites have considerable potential to influence their attitudes and behaviour (Ybarra and Suman, 2006). Information can improve patients' understanding of their medical condition and their self-efficacy. Also, it can empower them to make health decisions and to talk to their physician, resulting in a more patient-centred interaction between patient and health professional (McMullan, 2006).

Search engines are among the most popular web pages and their general purpose is to rank other pages by relevance and popularity (Geissbuhler and Boyer, 2006). They help both patients and physicians to locate web-based information quickly and efficiently (Dickerson *et al*., 2004; Seifter *et al*., 2010; Yang *et al*., 2011). Health-related terms are among those most frequently searched for (Geissbuhler and Boyer, 2006). The Google search engine, one of most popular, indexes billions of web pages and daily conducts more than 3 billion searches (D'Auria, 2012). Google Trends is a service which provides trend data regarding the number and geographic location of key words used in those searches making it possible to collate in a few seconds an enormous quantity of information on common human behaviours (Google, 2014). This free service might replace some otherwise expensive surveys (Preis *et al*., 2012). The service allows analysis of a cross section of Google web searches so that the number of searches for specified terms in a given period can be computed relative to the total number of Google searches made. This analysis indicates the likelihood of a typical user searching using a particular term from a given location at a certain time. The data do not encompass terms below a certain threshold volume. The system also eliminates repeated queries from a single user over a short period of time, so that usage data are not artificially increased by that type of user activity.

Strong associations have been found between changes in the information users seek online and real world events. In June 2009 during the World Health Organization's (WHO's) influenza pandemic alert, Ginsberg's group (2009) presented a method for tracking influenza-like illnesses in a population by monitoring health-seeking behaviour in the form of online web search queries by millions of world-wide users daily. They predicted influenza epidemics using these data. Currently, Google Flu Trends can detect regional outbreaks of influenza 7-10 days ahead of conventional centres for disease control and prevention surveillance systems (Carneiro

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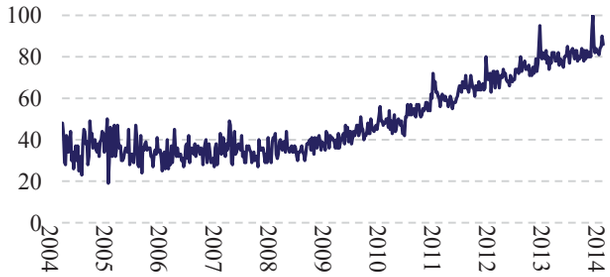

Figure 1. *Normalised query search volumes for "Toothache" 2004 to 2014*

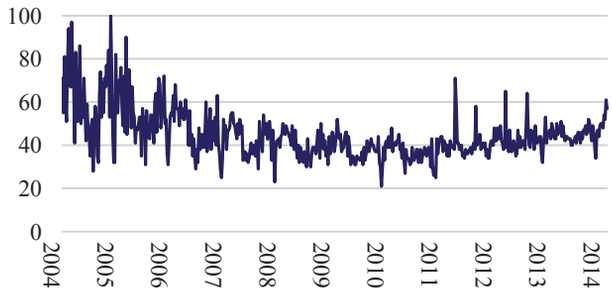

Figure 2. *Normalised mean search volumes for "Tooth Decay" 2004 to 2014*

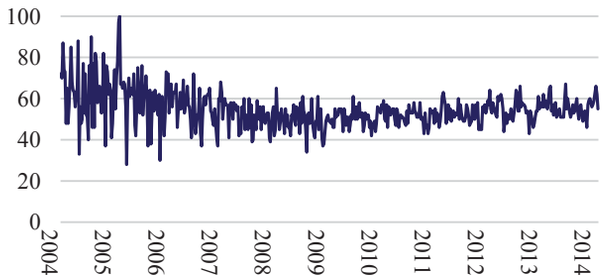

Figure 3. *Normalised query search volumes of "Gum Disease" 2004 to 2014*

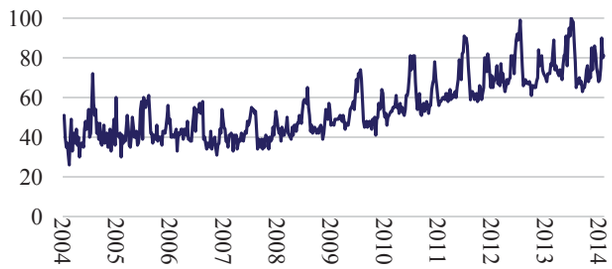

Figure 4. *Normalised query search volumes for "Wisdom Teeth" 2004 to 2014*

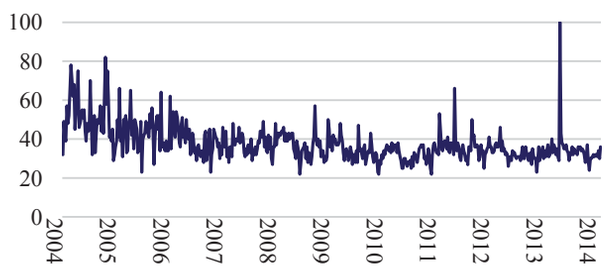

Figure 5. *Normalised query search volumes for "Oral Cancer" 2004 to 2014*

and Mylonakis, 2009). Elsewhere, by monitoring trends in suicide-related internet search volumes, a connection was shown between suicide and search activity and these methods may serve to provide a more effective early indicator of wide-ranging suicide risk than waiting for government-compiled suicide statistics (Gunn and Lester, 2013; Yang *et al*., 2011). In another example, searches for a car sales company correlated perfectly with their actual sales. Such data can be used to predict demand in the near future, helping manufacturers and dealers to better manage their resources (Braun and Harreus, 2013).

Oral health is an integral element of general health and well-being though oral diseases affect a significant proportion of the world's population exacting a heavy toll of morbidity and mortality (Petersen, 2008; Petersen *et al*., 2005). They affect people physically and psychologically and influence how they grow, enjoy life, look, speak, chew, taste food and socialise (Sheiham 2005). Data on oral health status for monitoring disease patterns and trends over time are an essential component of oral health information systems with standard epidemiological methods for the collection of such data designed by WHO and used worldwide (Petersen *et al*., 2005). The range of oral diseases includes dental caries, periodontal diseases and oral cancers (Petersen, 2008).

Trends in internet search data represents a fast and inexpensive way to research demand for medical information. To the best of our knowledge, no previous study has examined the internet search trends in dentistry. The aim of this study was to investigate the changes in internet search volumes for some terms related to oral health and diseases. Also investigated were related searches about these terms and the most active geographic locations searching for these terms.

Materials and Methods

The following five terms were selected for this study: "toothache", "tooth decay", "gum disease", "wisdom teeth", "oral cancer". Worldwide internet search trend data over a period of 532 weeks between 4 January 2004 and 15 March 2014 were retrieved as comma-separated value (CSV) files from the Google Trends internet page for each term as weekly normalized (relative search volumes scaled to give a maximum of 100 for each term) data for download and examination.

The CSV files also included normalized data for the cities and regions with the highest quantity of search traffic for a given term. For each query, regional interests were also investigated, with data qualitifying not absolute levels of search activity but proportions of all searches made. Also examined were related top searches, i.e. popular search terms that were searched in combination with the entered term.

Results

Figures 1-5 show normalised query search data over ten years. The incidence of "toothache" (Figure 1) and "wisdom teeth" (Figure 4) searches increased by time while the search volumes for"tooth decay" (Figure 2), "gum disease" (Figure 3), and "oral cancer" (Figure 5) showed small changes over the 532 weeks.

Table 1 presents the three geographical areas with the most search traffic for each term. In the Philippines especially in Quezon City, Manila and Makati "toothache" was commonly searched. The term "tooth decay" was also prevalent in Philippines. The top region where the term "tooth decay" commonly searched was Singapore followed by Philippines and Australia. In Ireland, United Kingdom and New Zealand, "gum disease" searches were frequent while the term "wisdom teeth" was popularly searched in United States, Canada and Australia. In Indian cities; Bangalore, Chennai and New Delhi the term "oral cancer" was widely searched.

When related searches were taken into account it was observed that the queries were mainly focused on pain and symptoms such as; "toothache pain", "wisdom teeth pain", "gum disease symptoms", and "oral cancer symptoms". Pictures of oral cancer and tooth decay also drew the attention of the internet users. Those searching with the term "toothache" frequently also searched for "remedies for toothache".

Discussion

In medicine, it is important to know the actual incidence of illnesses for disease prevention and healthcare planning. Official institutions collect the necessary statistics but this is time-consuming and costly. The internet is transforming health care, as in many other aspects of our lives and new technologies and web-based health applications are developing at a rapid rate (Kreps and Neuhauser, 2010; Ybarra and Suman 2006).

Dental caries is among the most prevalent chronic diseases affecting human populations and toothache due to dental caries reported as the most frequent complication and main source of patient complaints. (Shqair *et al*., 2012) The occurrence of caries is highly influenced by socio-behavioural conditions and exposure to disease prevention programs. In this study searches about "toothache" was most commonly found in Philippine cities. "Tooth decay" searches were also popular in Philippines (Table 1). Some 97% of 6-year-old Filipino children and 82% of 12-year-olds had caries with 20% and 16% of then respectively reporting pain when examined (Monse *et al*., 2012). The researchers found the health care system unable to cope with the problem and labelled the child caries situation as a public health crisis. In this study the top region searching for the term "tooth decay" was Singapore (Table 1) which also has severe oral health problems, especially in the Malay community and among poorer children (Gao, *et al.,* 2009). The third region where the "tooth decay" searches were popular is Australia (Table 1). It is reported that in the Northern Territory, Australia the experience of untreated caries was five times that of national estimates and untreated decay and periodontal disease were significantly more prevalent among a convenience sample of Indigenous Australians.

Gingival inflammation is another frequent infectious disease of the oral cavity and could advance to periodontal diseases if not treated. In the UK, Ireland, and New Zealand, gum disease searches were relatively numerous (Table 1). It is reported that in England, periodontal disease prevalence and severity appear to have been underestimated in previous national studies of the elderly and because of aging and tooth retention trends, the periodontal disease problem of the elderly may be increasing in the face of dentists' tendency to underdiagnose the periodontal diseases (Douglass *et al*., 1993). In Ireland, 82% of dentists report an increase in patients presenting in pain while 84% say they have seen an increase in gum disease (Hourihan, 2011).

The public interest in "wisdom teeth" had an increasing number of online searches (Figure 4). Between 1992 and 2007, US dental treatments showed an increasing trend for third molar extractions while other tooth extractions were decreasing (Eklund, 2010). In the US, Canada and Australia "wisdom teeth" searches in internet were common (Table 1). Prophylactic extraction of third molars could be associated with the increase in searches. Searches about wisdom teeth were mainly focused on the pain and the extraction of third molars.

Table 1. Most poplar three regions, cities and terms that were searched for by broad search topic

Search Topic	*Top 3 regions*	*Top 3 cities*	*Top 3 related searches*
Toothache	Philippines	Quezon City (Philippines)	Toothache pain
	Trinidad and Tobago	Manila (Philippines)	Tooth
	United Kingdom	Makati (Philippines)	Toothache remedies
Tooth Decay	Singapore	Singapore (Singapore)	Decay teeth
	Philippines	Manila (Philippines)	Dental decay
	Australia	Chennai (India)	Tooth decay pictures
Gum Disease	Ireland	Dublin (Ireland)	Gum disease treatment
	United Kingdom	London (United Kingdom)	Gum disease symptoms
	New Zealand	Leeds (United Kingdom)	Dental gum disease
Wisdom Teeth	United States	Austin (United States)	Wisdom teeth removal
	Canada	Dallas (United States)	Wisdom teeth pain
	Australia	Chicago (United States)	Wisdom teeth out
Oral Cancer	India	Bangalore (India)	Oral cancer symptoms
	United States	Chennai (India)	Mouth cancer
	Canada	New Delhi (India)	Pictures oral cancer

Although other sources of information are still important, the internet has an important role in informing and supporting cancer patients (Rogers *et al*., 2012). Head and neck cancers constitute approximately 5% of all cancers globally with about 0.7 million new cases being diagnosed annually in India (Reddy *et al*., 2014; Reuter *et al*., 2007). In this study "Oral cancer" searches were more common in the Indian cities Bangalore, Chennai and New Delhi (Table 1). Oral cancers in India, unlike in the West are the most common cancers encountered with about a third of the 0.3 million annual cancer-related deaths ascribed to tobacco-related head and neck cancers (Reddy *et al*., 2014; Shukla, 2014).

People who searched the term "toothache" were also frequently searched for "remedies for toothache". Public interest in web-based toothache remedies was shown by Heaivilin and colleagues (2011) who demonstrated that Twitter users are extensively sharing their experiences of toothache and seeking advice from other users. De Boer *et al*., (2007) found patients reasonably certain that the internet information about pain-related medical problems was accurate and reliable. However the quality of information given in websites remains under discussion (Bailey *et al*., 2013). The large numbers of internet searches regarding dental health suggests it is crucial that accurate information is posted.

While this study was conducted using a single highly popular internet search engine and only considered search terms in the English language there may be advantages in analysing data from a broader range of sources. Internet information is dynamic and subject to daily change, in line with changing human behaviour so the methods used cannot reliably measure levels of disease though there may be value to dental professionals in monitoring trends to aid planning, marketing and communications about oral problems. A further limitation of this method is that some people do not use the internet to look for dental specialist information, and of those who do, some use a different search terms. Further, search terms used at low volumes do not register on the system.

The query search method might be used to detect and investigate new diseases by examining specific complaints and sudden changes in a local region though this method needs further investigation.

Computers will never replace the human touch associated with traditional doctor-patient communication but multimedia computer-based information resources will play an important role in future (Richards *et al.*, 1998). Society is becoming more dependent on the internet as a source of information and interrogating internet search data records could be a new tool for dental researchers.

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