

# Global Search Trends of Oral Problems using Google Trends from 2004 to 2016: An Exploratory Analysis

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## ABSTRACT

**Introduction:** Oral diseases are pandemic cause of morbidity with widespread geographic distribution. This technology based era has brought about easy knowledge transfer than traditional dependency on information obtained from family doctors. Hence, harvesting this system of trends can aid in oral disease quantification.

**Aim:** To conduct an exploratory analysis of the changes in internet search volumes of oral diseases by using Google Trends<sup>®</sup> (GT<sup>®</sup>).

**Materials and Methods:** GT<sup>®</sup> were utilized to provide real world facts based on search terms related to categories, interest by region and interest over time. Time period chosen was from January 2004 to December 2016. Five different search terms were explored and compared based on the highest relative search volumes along with comma separated value files to

obtain an insight into highest search traffic.

**Results:** The search volume measured over the time span noted the term “Dental caries” to be the most searched in Japan, “Gingivitis” in Jordan, “Oral Cancer” in Taiwan, “No Teeth” in Australia, “HIV symptoms” in Zimbabwe, “Broken Teeth” in United Kingdom, “Cleft palate” in Philippines, “Toothache” in Indonesia and the comparison of top five searched terms provided the “Gingivitis” with highest search volume.

**Conclusion:** The results from the present study offers an insight into a competent tool that can analyse and compare oral diseases over time. The trend research platform can be used on emerging diseases and their drift in geographic population with great acumen. This tool can be utilized in forecasting, modulating marketing strategies and planning disability limitation techniques.

**Keywords:** Dental, Internet, Pandemic, Research

## INTRODUCTION

Oral health is an indispensable way to qualitative general health. World Health Organization (WHO) has stated oral diseases to be chronic and pandemic cause of morbidity and the most frequently noted oral diseases are dental caries, oral infectious diseases such as fungal, bacterial or viral infections, periodontal diseases, oral cancers, trauma from injuries and hereditary lesions [1]. Globally 60-90% of school aged children and 100% of all adult age groups suffer from dental cavities. The gum diseases are found in 15-20% of middle-aged (35-44 years) adults. Further dental caries and periodontal pathologies can be a root cause of tooth loss. Universally, 30% of people between 65-74 years are edentulous [2].

In this technology infused era, the mankind is used to easy knowledge transfer than traditional dependency on information obtained from family doctors [3]. From the commencement of this century the persistent craving for facts has led populaces to indulge in web based information research. So, a tangible tool was required to quantify the trends in search made by different geographic populations globally [4]. A tool that has changed the web based interactive search was developed by Google Inc., called GT<sup>®</sup> [5].

GT<sup>®</sup> is a freely accessible online portal developed in 2004 and has transformed the way how a health information seeker can investigate and how users analyse health problem for themselves or their loved ones [5]. As stated by Preis T et al., much evident statistical result can be expected from such unrestricted surveys than conventional surveys that rely on pay for service model [6]. Currently, Google<sup>®</sup> being a world leader in information technology, it ought to give a precise picture about the search trends. Geissbuhler A and Boyer C found that healthcare terminologies are the most recurrently searched subjects on search engines [7].

Over the years, it has been instituted that internet data with

comparable accuracy have been effective for surveillance of contagious diseases than traditional methodologies [8]. The evidence seeking tendency follows temporal trends that point towards sudden spikes in epidemics and health related states. Thus, provides a strong correlation between search trends and overall disease status. Letchford A et al., analysed demographic search behaviours in United States and found that the geographic areas with higher birth rates searched about pregnancy [9].

Global insight into GT<sup>®</sup> pointed out to its utility in prevention, surveillance, planning and disease limitation. GT<sup>®</sup> turns out to be a dependable platform for quantifying medical information on demand [10], while dental problems are unwavering diseases that do not show temporal variations and might tend to show variation in trends according to press releases [11]. Such knowledge needs to be examined with the best available data resources to quantify, to interpret and to evaluate the dental complications prevailing among the common populace with the common search terms they might be using.

Literature search revealed, no previous literature concerned with standardised internet search trends for oral diseases as stated by the WHO. So, this study was conducted with an aim to investigate the changes in internet search volumes related to oral diseases as categorized by the WHO [12].

## MATERIALS AND METHODS

The present study is an exploratory analysis to ascertain the link between global search trends and oral diseases. The real-time data was successful in enumerating this analysis over time and did not signify a necessity for statistical analysis and the result was presented using “search volume index graphs” as enumerated by GT<sup>®</sup>.

GT<sup>®</sup> provides real world facts based on search terms related to categories, interest by regions, subregions and interest over time. Furthermore, the user can choose a time period, ranging from January 2004 to present, divided by months or days. The portal regulates the user specified search terms over time, place and provides a Related Search Volume (RSV) that explains a search query for a particular expanse of region and time frame, which is normalised by the top search query over the destined span of time. The user can explore upon one to five different search terms at a time or the RSV of a single search term between geographic areas and time periods. With reference to search input, a combination of multiple terms with “+” sign could be added to examine and compare with the current search terms. The Comma Separated Values (CSV) files were also included to obtain an insight into the comparison of the highest quantity of search traffic among various countries for each search term. Each query was further evaluated based on top trending related search terms on a global basis. Supplementary analysis of CSV as provided by GT<sup>®</sup> under multi-timeline evaluation was done to determine and compare the top five RSVs. GT<sup>®</sup> has a complimentary advantage of frequent update over other search engines and also provides related search queries in foreign languages.

All efforts were made to include the terms that seemed common to an ordinary individual or a health information seeker, that are relevant to the terms as recommended by the WHO as CSV. Based on the findings, a descriptive exploratory analysis was carried out by the authors under the aegis of Department of Public health dentistry, Divya Jyoti College of Dental Sciences and Research, Modinagar, India, during a time frame of fifth week of December to fifth week of January. The comparison strategy was based on standardised technical terms as suggested by the WHO and related popular search queries as posted on google trends. The search terms based on common oral diseases/lesions as stated by the WHO [12] are as follows [Table/Fig-1]:

1. Dental cavities;
2. Periodontal diseases;
3. Dental trauma;
4. Oral lesions in HIV;
5. Cleft lip and palate;
6. Tooth loss;
7. Toothache;
8. Oral cancer.

The results after exploratory analysis were depicted using “search volume index graphs” [5].

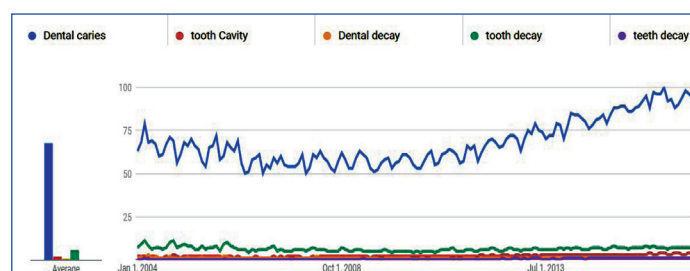
Common Oral Diseases*	Search Terms With Top RSV's
1.Dental decay	Dental decay, Dental caries, Tooth cavity, Tooth decay, Teeth decay
2.Periodontal diseases	Periodontal diseases, Pyorrhoea, Gum disease, Bleeding gums, Gingivitis
3.Oral cancer	Oral cancer, Mouth cancer, Cancer of mouth, Cancer oral, Symptoms oral cancer
4.Tooth loss	Missing tooth, Edentulous, Missing teeth, Tooth loss, No teeth
5.Oral lesions of HIV	Oral HIV, HIV from oral, AIDS from oral, HIV symptoms, AIDS symptoms
6.Dental trauma	Dental trauma, Fractured teeth, Fractured tooth, Broken teeth, Broken tooth
7.Cleft lip and palate	Cleft lip, Cleft palate, Hare lip, Harelip, Cleft lip palate
8.Toothache	Dental pain, Toothache, Tooth pain, Teeth pain, Jaw pain

[Table/Fig-1]: Relative search volumes of oral diseases. (AS STATED BY WHO) [12]

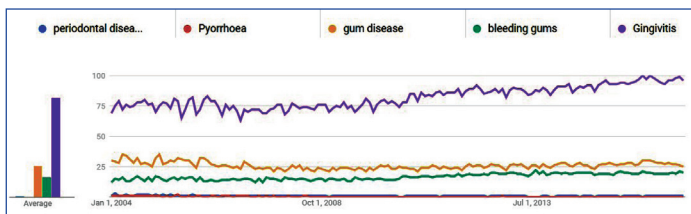
## RESULTS

[Table/Fig-2-11] shows the correlated normalised search data

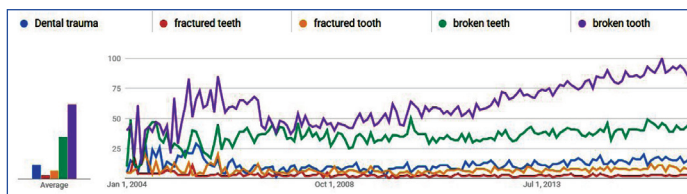
spanning over a period of 13 years from January 2004 to December 2016. The search volume variation represents the real time comparison of incidence among various common oral diseases as stated by the WHO [12]. [Table/Fig-1] presents the standardised comparative search terms with top RSVs utilised with regard to the common oral diseases, as suggested by the WHO. [Table/Fig-2] shows the comparative RSVs of the keywords namely “dental caries”, “tooth decay”, “tooth cavity”, “teeth decay” and “dental decay”. The keyword that yielded the greatest RSV was “Dental caries”, followed by “Tooth decay”, then by “Tooth cavity” followed by “Dental decay” and the least with “Teeth decay”. [Table/Fig-3] illustrates the comparative RSV of the keywords namely “Gingivitis”, “Gum disease”, “Periodontitis”, “Bleeding gums” and “Pyorrhoea” where the highest RSV was yielded by “Gingivitis” followed by “Gum disease” then by “Bleeding gums” followed by “Periodontal disease” in comparison to the least by “Pyorrhoea”. [Table/Fig-4] denotes the comparative RSV of the keywords namely, “Oral cancer”, “Mouth cancer”, “Cancer of mouth”, “Oral mouth cancer” and “Symptoms of oral cancer” where the highest RSV was presented by “Oral cancer” followed by “Mouth cancer” then by “Cancer of mouth” followed by “Oral mouth cancer” and the least of among all by “Symptoms oral cancer”. [Table/Fig-5] represents the comparative RSV of the keywords namely No teeth, Missing tooth, Missing teeth, Tooth loss and edentulous, where the highest RSV was presented by “No teeth” followed by “Missing tooth” then “Missing teeth” and “Tooth loss” showed similar small changes overtime followed by the least presented RSV of the keyword “Edentulous”. [Table/Fig-6] represents the comparative RSV of the keywords namely Oral HIV, AIDS from oral, HIV symptoms, AIDS symptoms and HIV from oral, where the highest RSV was presented by “HIV symptoms” followed by “AIDS symptoms” then “Oral HIV” after that “HIV from oral” and “AIDS from oral” showed similar small changes overtime. [Table/Fig-7] denotes the comparative RSV of the keywords namely “Broken teeth”, “Broken tooth”, “Dental trauma”, “Fractured tooth” and “Fractured teeth”, of which the highest RSV was recorded by “Broken tooth” followed by “Broken teeth” followed by “Dental trauma” then by “Fractured tooth” and the least by “Fractured teeth”. [Table/Fig-8] presents the comparative RSV of the keywords namely “Cleft palate”, “Cleft lip”, “Cleft lip palate” “Harelip” and “Hare lip”, of which “Cleft palate” presented with the highest RSV followed by “Cleft lip palate” then by “Cleft lip” trailed by “Harelip” and the least was recorded by “Hare lip”. [Table/Fig-9] records the comparative RSV of the keywords namely “Toothache”, “Teeth pain”, “Dental pain”, “Tooth pain” and “Jaw pain”, where the highest RSV was plotted by the term “Toothache” followed by “Tooth pain”, “Jaw pain” and “Teeth pain”, where the three terms showed similar changes from the year 2004 till 2010 then a gradual rise in the plots were noted where on comparison “Tooth pain” was higher followed by “Jaw pain” then by “Tooth pain” and of all the terms “Dental pain” was noted to least comparative RSV. [Table/Fig-10] illustrates the comparative graphs with respect to the top five terms under study. It is noted that “Gingivitis” stood out with the highest RSV followed by “Cleft palate” then by “Dental caries” followed by “Broken teeth” and the least of all by “Tooth loss”.



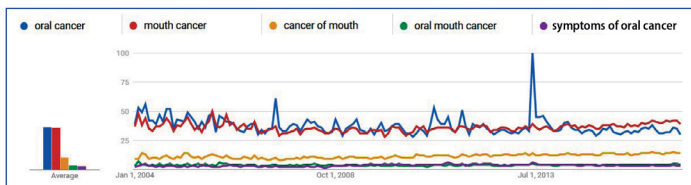
[Table/Fig-2]: Comparative relative search volumes of dental caries, tooth decay, tooth cavity, teeth decay, dental decay.



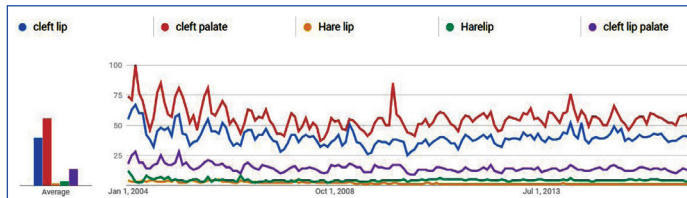
[Table/Fig-3]: Comparative relative search volumes of gingivitis, gum diseases, periodontitis, bleeding gums, pyorrhoea.



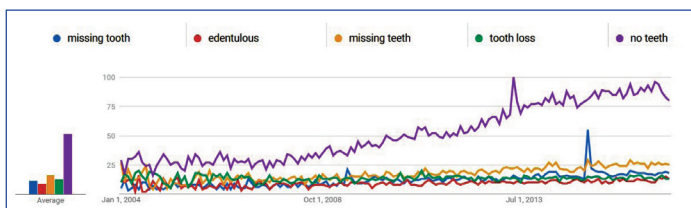
[Table/Fig-7]: Comparative relative search volumes of broken teeth, broken tooth, dental trauma, fractured tooth, fractured teeth.



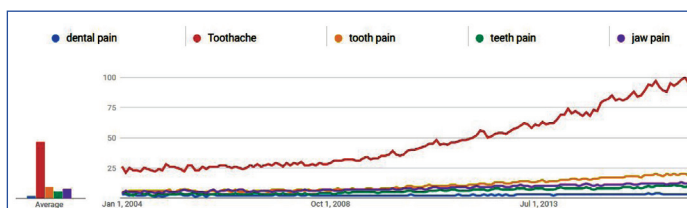
[Table/Fig-4]: Comparative relative search volumes of oral cancer, mouth cancer, cancer of mouth, oral mouth cancer, symptoms of oral cancer.



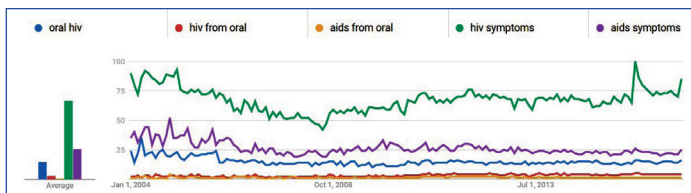
[Table/Fig-8]: Comparative relative search volumes of cleft palate, cleft lip, cleft lip palate, harelip, hare lip.



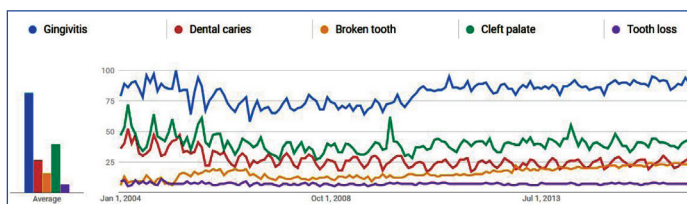
[Table/Fig-5]: Comparative relative search volumes of no teeth, missing tooth, missing teeth, tooth loss, edentulous.



[Table/Fig-9]: Comparative relative search volumes of toothache, teethpain, dental pain, toothpain, jaw pain.



[Table/Fig-6]: Comparative relative search volumes of oral HIV, AIDS from oral, HIV symptoms, aids symptoms, HIV from oral.



[Table/Fig-10]: Comparison of terms with highest relative search volumes.

## DISCUSSION

Health care organizations need to maintain a transparent data pertaining to prevalence and incidence of any region. Institutional documentation has a drawback of providing limited information, being costly and the requisite of large-scale manpower. Whereas web based search provide autonomy and the flexibility of patient centred preferences. Cameiro HA and Mylonakis E tracked and correlated the search preference along with real time surveillance of disease outbreaks and pointed out GT<sup>®</sup> based web tool to be an effective method of estimation, prediction and documentation of epidemics or diseases [13].

The present study was based on search terms derived from common oral health diseases as stated by WHO. Dental diseases or conditions stand out to be pandemic in nature affecting large number of population with meagre tendency to show sudden outbursts [14]. Dental caries is a disease that affects age groups and ethnicity. Pitts N et al., stated dental caries to be the one among the most prevalent diseases and they act as one of the chief complaints of patient visiting a dental office [15]. In the present study it was noted that the term “Dental Caries” scored the highest RSV in the time period under study, followed by the rest of the terms. The related queries pointed to a fact that the web users related search queries were cavitation- single or multiple and caries of tooth. Dental caries being a technical term might have posed a high search graph variation due to enquiry by patient on diagnosis at a dental office or by their well wishers. Searches were found to be highest in Japan, which shows agreement to a study by Morimoto M and Miyazaki H in Japan, that showed rise in DMFT scores to 5.9 due to lack of fluoride exposure and rise in sugar consumption [16].

Following which a vast public funding and health promotion led to state-wide community water fluoridation programmes as stated by Bernabé E and Sheiham A in Japan [17]. They noted a rapid rise in caries level through adolescence and thereafter a larger increase in adulthood over past span of time, owing to national health distress and public concern. On the contrary a GT<sup>®</sup> based study conducted by Harorh OT and Harorh H noted the term “dental caries” was most commonly searched in Philippines due to high caries situation in the region [18].

Another pandemic oral disease of concern is periodontal diseases; in the present study it was noted that the term “Gingivitis” reported the higher RSV in comparison to other related search enquiries. The list of related enquiries was topped by gums, symptoms and treatment options. Gingivitis is a common pathology affecting all age groups owing to greater search frequency though being a technical term. Trends related to “Interest by region” draws attention to the Arab kingdom in western Asia, Jordan. This finding is supported by a study conducted by Ababneh KT et al., and Rajab LD et al., in Jordan, where they noted that trends of healthy periodontium decreased substantially with age; multicentre studies within the kingdom spotted 76% adult prevalence for gingivitis along with school going children signifying high gingival disease prevalence of 69.9% [19,20]. These results symbolise the growing need and agony with respect to gingival diseases in the state of Jordan. Another remarkable finding was the trending related search term “Pyorrhoea”, an older term that is used to refer to any kind of gum or periodontal disease; was most frequently searched in India followed by the United States of America only.



A fatal pandemic condition affecting mankind is oral cancer. In accordance to exploratory findings of GT<sup>®</sup> "Oral cancer" stood out to be the highest searched RSV. The region that grossed the highest search query with respect to the pathology "Oral cancer" was the East Asian nation "Taiwan". Oral cancer accounts for one of the top 10 causes of death in the country since 1991. Lin WJ et al., and Kao SY et al., conducted studies on multiple age groups and found that 95% of all oral cancers are squamous cell carcinomas and 50% of the cases are diagnosed at TNM stage III or IV, leading to a low 5-year survival [21,22]. There is a greater prevalence of oral cancer among Taiwanese, made up of 2.5 million high risk groups who reveal habits of cigarette smoking as well as betel nut chewing. Related search queries pointed out to be a remarkable trend that 55% of the individual who searched for "Oral cancer" also searched for "Tongue cancer", "ulcer of mouth", "signs and symptoms" and it was highest searched in the North American nation, Canada. Current statistics from the Canadian cancer society and Canadian cancer registry estimates more than one third of the patients diagnosed with tongue cancer would die within five to six years from the date of their diagnosis [23].

Another disquieting concern for geriatric population is loss of teeth. The variation in the usage of terminology might have owed to the highest RSV to the term "No Teeth". The term was most frequently searched in the continent nation, Australia. Brennan DS et al., and Mariño R et al., studied the trends and factors associated with edentulism in Australia and found that there was no noteworthy change in edentulism between 1987–88 and 2004–06 [24,25]. But over time the rise in dental manpower utilization in Australia has catered to homogenous oral care over the past decades along with the widespread use of dental services by geriatric community-dwellers. Emphasis and awareness has been placed on diagnosis, prevention and retention of dentition than on prosthetics.

AIDS (Acquired Immuno Deficiency Syndrome) caused by HIV (Human Immunodeficiency Virus) and its associated lesions stands out to be a major global crisis in today's world. GT<sup>®</sup> based exploratory data showed no specific interest pertaining to oral lesions or dental conditions related to HIV, but search for the term "Oral lesions in HIV" lead onto to a finding that the highest RSV was marked by "HIV symptoms" and the top trending search was made by the Sub-Saharan nation, Zimbabwe. Though Zimbabwe is the fifth among the subsaharan countries with the highest prevalence in HIV, it suffers severely on suboptimal nutrition, lack of healthcare facilities leading to life threatening opportunistic infections, like Tuberculosis, Kaposi Sarcoma etc., [26]. Cowan FM et al., suggested that change in international norms, loosening of stigma associated with HIV/AIDS, increased use of condoms, delay in the first time as individual has sexual intercourse and reduction in sexual partners has all lead to motivation among young individuals to gain knowledge about cause, transmissibility, prevention and symptoms associated with HIV/AIDS [27].

Dental trauma has been a common oral problem affecting individuals of all age groups. Search trend reported highest RSV with respect to the term "Broken teeth" along with the region with top search was the island nation in the North western Europe, United Kingdom (UK). Keasberry J et al., and Kay D suggested that multifactorial aetiologies have led to "broken teeth" but systematic association of the NHS (National Health Service) and nongovernmental organizations like the "Dental Trauma UK" has set up systematic guidelines to save injured, damaged or avulsed tooth as a result of trauma [28,29]. These web based guidelines and patient assistance systems cater better care and prognosis while endorsing the use of online services to health seekers.

Oral diseases being a pandemic problem has many a times pulled global attention towards a congenital abnormality, "Cleft lip and Cleft palate". Oral clefts are of multifactorial aetiology and have been source of innovative researches since decades. The present quest

showed that the term "cleft palate" denoted the highest RSV and the Southeast Asian island nation; Philippines had the highest search plot of the decade pertaining to the terms "Cleft palate and also Cleft lip". Literature search pointed out to a fact that Southeast Asian countries like Philippines and to some extent Vietnam are prone to oral clefts. Lanteri AC et al., conducted a cross-sectional study on global oral cleft distribution and found the highest prevalence of clefts in Filipino population with 1 in every 500 live birth [30]. Further, Daack-Hirsch S and Gamboa H described that the Filipinos are predisposed to clefts and the prevalence has not reduced since the last two decades [31]. Multiple steps are being taken by the governmental and nongovernmental organizations to facilitate and to prevent congenital anomalies and focussed on prenatal micronutrient supplementation followed by foreign initiatives like, Operation smile, Operation rainbow, Operation hope and Operation smile train [31].

Mankind has strived since ages to contain a crisis that has affected every other dental pathology, a condition that pulls everyone to a dental office due to its multifactorial origin and colloquially termed as "dental pain". The exploratory findings from GT<sup>®</sup> inferred "toothache" to be the most commonly searched term in this context and the Southeast Asian republic, Indonesia to be the geographic region that showed up to the top search trend concerned with "toothache". Maharani DA and Pratiwi NL conducted a study on dental care delivery system in Indonesia and suggested that dental pain may lead to widespread disability in day to day activities and is a primary result of untreated dental diseases [32,33]. It was spotted that the two most common problems leading to "toothache" were dental caries and gingivitis. Self medication among urban Indonesians is a common condition leading to lower treatment prognosis along with ill distribution of dental healthcare providers [33].

Further, the present study provided an insight into the top five GT<sup>®</sup> terms related to common oral problems affecting mankind. Among the standardised CSV's, it was noted that the term "Gingivitis" presented the highest plot of search term from its inception. This points out to the concern and popularity that circle around the disease "Gingivitis" due to its heavy contribution towards the global burden of oral diseases. It was observed that there was a rapid rise in search trends related to "Gingivitis" in the continent of South America, with the highest comparative regional search volume in the country, Chile. Carvajal P et al., conducted a multicentre study in South America and found Santiago (Chile) with highest of 99.1% prevalence for gingival inflammation [34]. Oppermann RV, et al., suggested in agreement that the high prevalence of gingival diseases can be attributed to socioeconomic disparities, lower level of education, and lack of oral health awareness among the natives of Chile [35]. They also concluded that the native gingival condition was not entirely associated to establish risk factor but were further linked to demographics and socioeconomic factors of the nation.

### Public Health Significance

Oral diseases are chronic, pandemic conditions and lesions that affect people physically and mentally. Differentiating between various aspects of oral diseases like geographic distribution, demographic characteristic, characteristics of populace affected over time, tendency of spread can be an arduous task pertaining to close ailments like oral diseases. The 21<sup>st</sup> century has spearheaded the multimodal development in health care sector, allowing network based technologies to flourish and touch new vistas. Network based tools can act as a complimentary, supplementary and even principal techniques to broaden our vision of oral diseases. Internet based exploratory system, like GT<sup>®</sup> can be amplified to suit the day to day healthcare requisites of planning, screening, evaluating and controlling a disease. Health policy makers can plan a programme based on the felt needs and can adapt to unprecedented changes that may affect a geographic population. Further, this system may

be utilised to investigate extent to which various preventive and curative procedures can be effective in curbing oral diseases.

## LIMITATION

1. The study might not account to a small populace that still insists on told facts and are out of the spectrum of web based searches.
2. Traditional dependency on told health facts especially among rural populaces might have caused a lacuna.
3. Many countries in the world are developing, under-developed and only 40% of the global population account to internet usage. Thus, internet search trends might overlook the group of people outside the walls of information technology [36].

## CONCLUSION

The study was based on the most sought after search engine, considering top related search queries and RSV's thus, having an advantage of including every global citizen who is under the spectrum of information technology. Traditional patient-doctor relation is still to continue, though it would be laden with internet tools over time. The query of concern on "Web" might shift from time to time, but it ought to take the inflow of human infused interests. The trend research platform can give an instantaneous insight on emerging diseases and their drift in geographic populations. This tool can be utilized in forecasting, modulating marketing strategies and planning disability limitation techniques on a mass population. Results from the present study built on the GT<sup>®</sup> infers the use of this tool as a beneficial instrument for epidemiological studies, digital data maintenance and evidence based output. Further analytical and correlative studies may be performed that includes RSV's with number of cases over time and geographic location.

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