

Google Search Trend of Dengue fever in developing Countries in 2013-2014: An Internet-Based Analysis

Ashraf A. EL-METWALLY^{a,1}

^aCollage of Public Health and Health Informatics, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

Abstract. With the emerging trend on internet used in every field of life, web-based tools have been developed for surveillance of novel diseases. Following the development of “Google Flu Trend” as a surveillance tool for Flu epidemics, Google Dengue Trends (GDT) was set up to monitor trends for Dengue fever. In this descriptive epidemiological study, data from GDT was used to depict and compare trend of internet search on Dengue in developing countries like India, Indonesia, Argentina, Bolivia, Brazil, Philippine, Singapore, Thailand and Venezuela for a two-year period (2013-2014). Trends of internet search in Bolivia and Indonesia depicted that internet search for dengue activity is low and minimal in these two countries. Argentina and Philippine showed a moderate internet search of dengue activity in the year of 2013 and 2014. Internet search for Dengue Activity for Brazil and India remained high for few months. Internet search of Dengue in the region of Singapore depicted a wide variety of activity with a maximum search reported during the months of May and June. Internet search of Dengue in the region of Thailand and Venezuela also showed wide variation with that in Thailand becoming more intense during June and July, particularly in 2014. As shown in the article, trends of internet search for dengue corresponds with the true epidemic of developing countries. Thus, systems like GDT might provide efficient means for estimating the burden of dengue in different countries. With a fast growing world the burden of diseases is increasing particularly in developing countries where epidemiological surveillance is under developed. Results of this study suggest that Internet-based systems like GDT can provides a rapid and cost-effective complement to current traditional systems.

Keywords. Google Trend; Dengue Fever; Developing Countries.

1. Introduction

Dengue fever (DF) is a viral illness that is mosquito born where 100 million new cases occur worldwide. It occurs primarily in tropical areas around the world affecting both children and adults [1]. The symptoms of DF are associated with hemorrhagic complications (DHF) or shock (DSS) as well as depression and fatigue [2]. Transmission of the disease primarily occurs in tropical areas where there is high humidity and a hot climate. The humidity lengthens the mosquito’s lifespan and shortens the time required for viral replication. The mosquito incubation period lasts between 3 and 14 days [2]. Human behavior such as water storage, trash disposal along with over population can also contribute as important risk factors for dengue [3-4].

¹**Corresponding Author:** Dr. Ashraf El-Metwally MD, PhD, Assistant Professor of Epidemiology & Biostatistics Department College of Public Health & Health Informatics, King Saud Bin Abdulaziz University For Health Sciences P.O. Box 22490, Riyadh 11426, Internal Mail Code 2350.

In the last 50 years, DF incidence has increased nearly 30 fold. Today, there are 100 countries in the America, South East Asia, the Eastern Mediterranean, the Western Pacific and Africa where 50 million DF infections occur annually and 22,000 deaths occur mainly among children [5]. This increase in burden of dengue in turns contributes in economical loss of both the government and individual [6]. To date, the primary level prevention at population level is not that efficient worldwide and also those population based preventions which are available are not very cost-effective [7]. The important reason for ineffectiveness of these population based preventions is poor surveillance system as resources are not fairly divided as per need. Lack of proper surveillance system also hinders evenly distribution of resources. Thus a proper surveillance is needed to identify high risk areas so that we can draw the attention of health care authority on those particular areas [7].

Many countries have their surveillance system. But those systems are not very efficient as data collection from practitioners and submission to the ministry takes some time as this whole process of data aggregation and dissemination require resources [7]. Particularly in developing countries it is difficult to maintain such systems because of limited budget and political uncertainties [8-9]. With the emerging trend on internet used in every field of life, the tools are also developed for the surveillance of novel diseases. In the past a tool was developed for the surveillance of Flu. By using the method of Google Flu Trend the tool for dengue surveillance was developed known as Google Dengue Trends (GDT) [10]. The advantages of this online surveillance system are that it is relatively fast than the traditional system and as reported that it has close proximity with the national level dengue surveillance system in many countries [11-14].

The aim of this paper is to compare the recent trends of online search on dengue in developing countries like India, Indonesia, Argentina, Bolivia, Brazil, Philippine, Singapore, Thailand and Venezuela by using Google trend for dengue and to relate it with recent epidemics of that particular country. As in the past dengue fever has highest incidence in these countries and hence these countries were covered by the GDT and therefore we aimed to compare the trends of dengue in these countries.

2. Methods

GDT was used to retrieve data on the trend of Dengue in developing countries like India, Indonesia, Argentina, Bolivia, Brazil, Philippine, Singapore, Thailand and Venezuela. Google trends use aggregated Google search data that estimated the trend of dengue in current time. It updated its results every day and for multiple countries that are in turn provides a complement to the existing surveillance system. The data has been validated by official data of dengue provided by each country except the experimental data. The idea on which Google Dengue Trends built up was that during epidemic of dengue many people do search for dengue on internet and there is a relationship between how many people search for dengue related activity and how many people actually suffering from dengue. GDT appeared because of the pattern between online dengue search and people suffering from dengue, and when compared with the traditional dengue surveillance system they found that people search more about dengue during epidemic of dengue. Thus, this pattern causes the emergence of Google Dengue Trends that counts how often the people search for dengue related activity and through this they estimates the burden of dengue in different countries.

As our aim was to compare the recent search trend, thus we compared the results of different quarters of 2013 and 2014 for different countries. For Philippine, Singapore and Thailand the trends are from January 2013 until December 2013 and January 2014 until December 2014. For Argentina, the trends are from July 2013 until December 2013 and January 2014 until December 2014. For Bolivia, Brazil and Indonesia the trends are from October 2013 until December 2013 and from January 2014 until December 2014. For India and Venezuela, the trends are given from April 2013 until December 2013 and January 2014 until December 2014. Dark blue line indicates the trend of 2014-2015 and light blue correspond to the internet search on dengue activity of 2013-2014. The shade bar further describes the intensity of internet search on dengue activity as minimal, low, moderate and high, darker the shade higher the intensity.

3. Results

Graphs of Argentina depicts that the internet search for dengue activity was low in mid of 2013 and remained low until January 2014. In February 2014, the increased interest in internet search activity of Dengue became moderate for few days only as reported that from February 2 the internet search activity became moderate and till February 9th it became low again and till date interest in internet search remains low. (Fig 1)

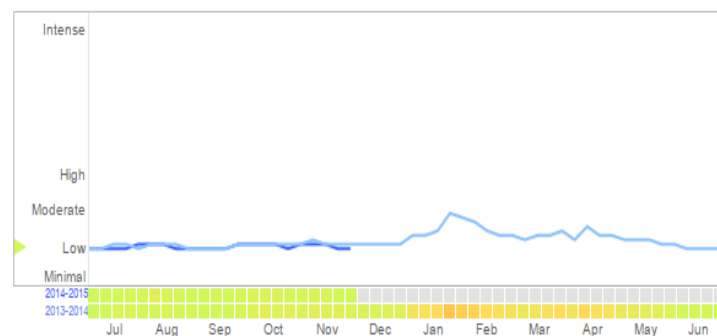


Fig 1. Dengue Search Trend in Argentina (2013-2014)

In Bolivia, the interest in internet search activity of Dengue remained low throughout the year. During July 13 2014 and July 27 2014, internet search activity was reported as null. From August 10 2014 until December 10 2014 internet search activity of Dengue remained low. (Fig 2)

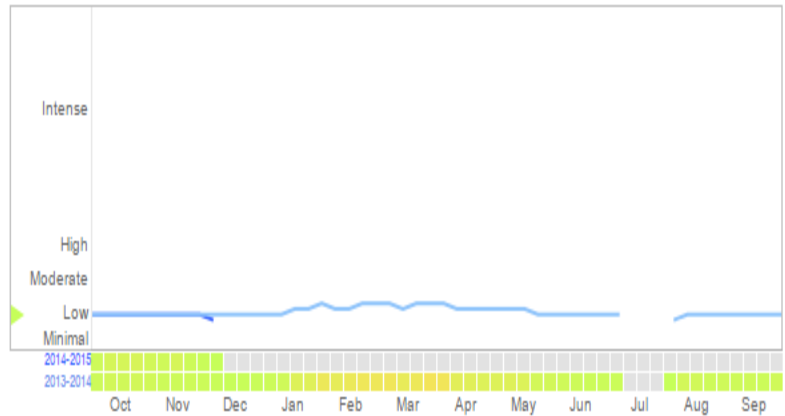


Fig 2. Dengue Search Trend in Bolivia (2013-2014)

Internet search trends of Brazil depict variation in the activity of dengue. From 6 October 2013 until March 6th 2014 the interest in internet search activity of Dengue was minimal and low, while from 23rd March 2014 until 30th it became moderate and became high in the month of April and May 2014. From May 18 2014, the interest in internet search activity again slow down to moderate and became low in June, July and August. The interest in internet search activity of Dengue became minimal in September and October for few days. There were times in September, October and November where the interest in internet search activity had become low. From 27th of November 2014 until date, the interest in internet search activity of Dengue remains minimal in Brazil. (Fig 3)

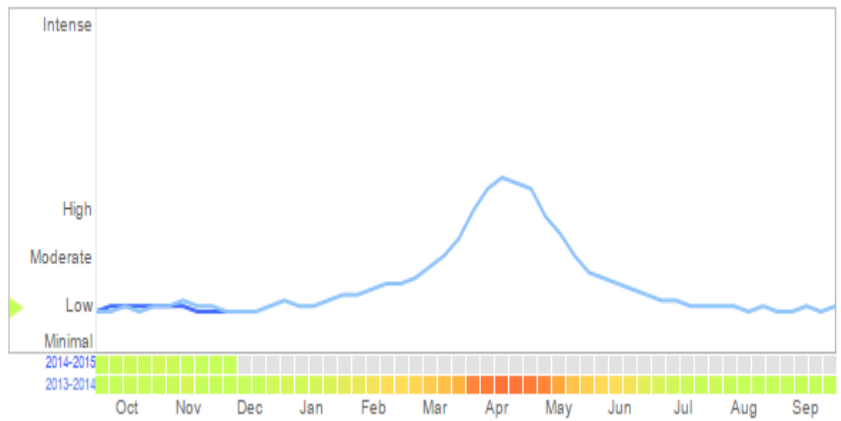


Fig 3. Dengue Search Trend in Brazil (2013-2014)

Trends of internet-based search of Dengue in India also showed wide variation. The internet-based search activity of Dengue remained minimal during April until 12 May 2013. From 19 May 2013, until August 2013 the interest in internet-based search activity of Dengue became low. The internet-based search activity increased from low to moderate to high from 27th of August until 17th of November. From then the interest in internet-based search activity of Dengue again slow down and became minimal until

June 2014. From mid-June the internet-based search activity of Dengue raised from minimal to low until September 28 2014. The internet-based search activity of Dengue became moderate in October 2014 and in November; the internet-based search activity of Dengue became high for few days, again slopes down to moderate, and gradually became low until December 2014. (Fig 4)

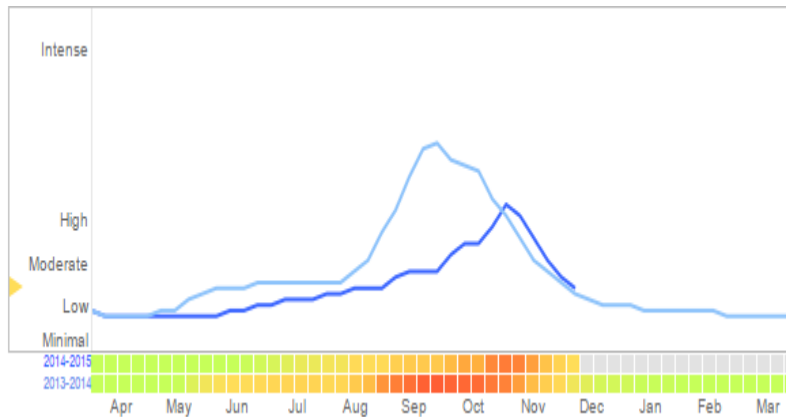


Fig 4. Dengue Search Trend in India (2013-2014)

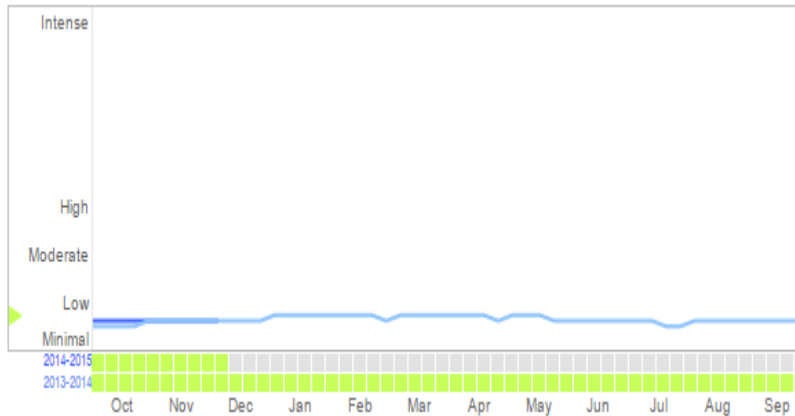


Fig 5. Dengue search Trend in Indonesia (2013-2014)

In Indonesia, the interest in internet-based search activity of Dengue remained minimal throughout the year 2013 and 2014. (Fig 5) In Philippines, slight variations were depicted. In the beginning of 2013 the interest in internet-based search activity of Dengue remained low until March 10 and then further declines to minimal and remained minimal until 26th May. From June 2 until July 21, the interest in internet-based search activity of Dengue rose to low and became moderate and it remained moderate throughout the month of August. The interest in internet-based search activity of Dengue declined to low again in September and remained low until 17 of November. In December 2013 and January 2014, the interest in internet-based search activity of Dengue remained low and it further declines to minimal in February 2014 and remained minimal until June 22 2014.

From 29 June 2014, the interest in internet-based search activity of Dengue rose to low and remained low till September 14. From 21 September, the interest in internet-based search activity of Dengue once again declined and remained minimal until 5 October. In October, the interest in internet-based search activity of Dengue once again became low and remained low until December 2014. (Fig 6)

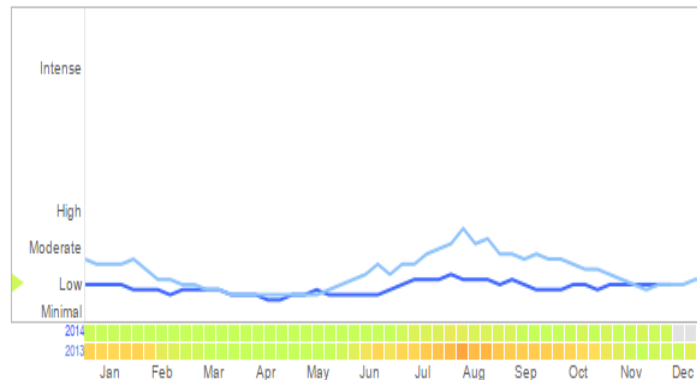


Fig 6. Dengue Search Trend in Philippines (2013-2014)

Singapore also showed wide variation in internet-based search for dengue trend throughout the year. The interest in internet-based search activity of Dengue remained low from January until 7th of April 2013 and then rose to moderate and remained moderate till 26th May 2013. The interest in internet-based search activity of Dengue became high in the month of June and in the end of June, it declined to moderate again and remained moderate until 7 of July 2013. Until then internet-based search activity of Dengue further declined to low and remained low until July 13 2014. The interest in internet-based search activity of Dengue became moderate in July for few days and again in August the activity declined to low and remained low until 14 September 2014. In September, the interest in internet-based search activity of Dengue declined to minimal and remained minimal until 16th of November. The interest in internet-based search activity of Dengue again rose to low and remained low until 7th of December 2014. (Fig 7)

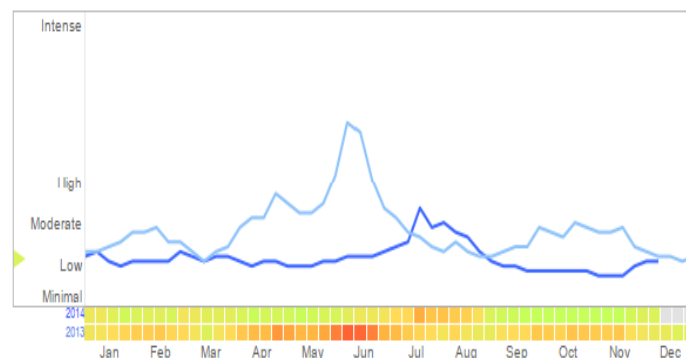


Fig 7. Dengue Search Trend in Singapore (2013-2014)

Internet-based search of Dengue activity was drastic in Thailand. As reported the interest in internet-based search activity of Dengue remained moderate in the beginning of the year and became high on 13 of March and remained high until 17 of March. The interest in internet-based search activity of Dengue declines to moderate. In Thailand, the interest in internet-based search activity of Dengue swing between moderate and high intensity throughout the year. From June 9 2013 until August 25 2013, the interest in internet-based search activity of Dengue became intense. Internet-based search for Dengue declined from intense to high in September and remained high until 6 of October. After October 6 the interest in internet-based search activity of Dengue became moderate and remained moderate till December 15 and it further declined to low and remained low till 29th of December 2013. In the beginning of 2014, the interest in internet-based search activity of Dengue rose to moderate and remained moderate until 16th of March then it further declined to low and remained low until May. From 11th of May the interest in internet-based search activity of Dengue rose to moderate again and rose to high in June and remained high until 7th of September. From 14th of September until seventh of December 2014, the interest in internet-based search activity of Dengue remained moderate in Thailand. (Fig 8)

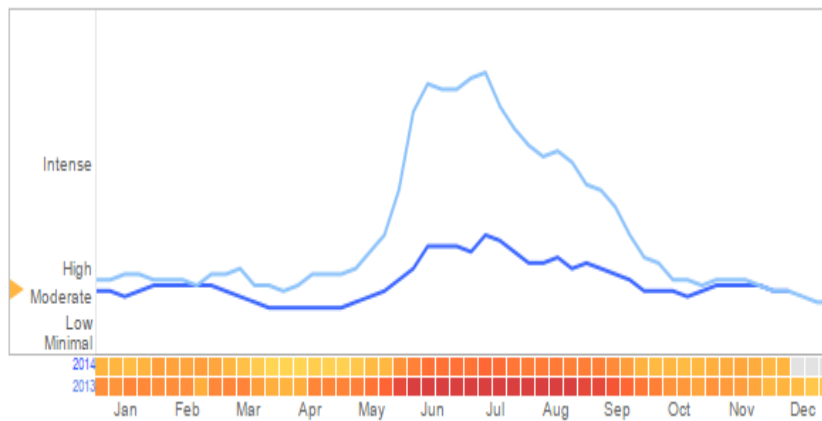


Fig 9. Dengue Search Trend in Thailand (2013-2014)

Internet-based search trend for Dengue activity in Venezuela varied throughout the year. From April until October 6 2013, the interest in internet-based search activity of Dengue remained low and rose to moderate after that and remained moderate till December 2013. In January 2014, the interest in internet-based search activity of Dengue rose to high and again declined to moderate in February. It further declined to low and remained low until 13 of July. In July mid the interest in internet-based search activity of Dengue again rose to moderate and became high on 17th of August and remained high until 16th of November and then declined to moderate and became low in December 2014. (Fig 9)

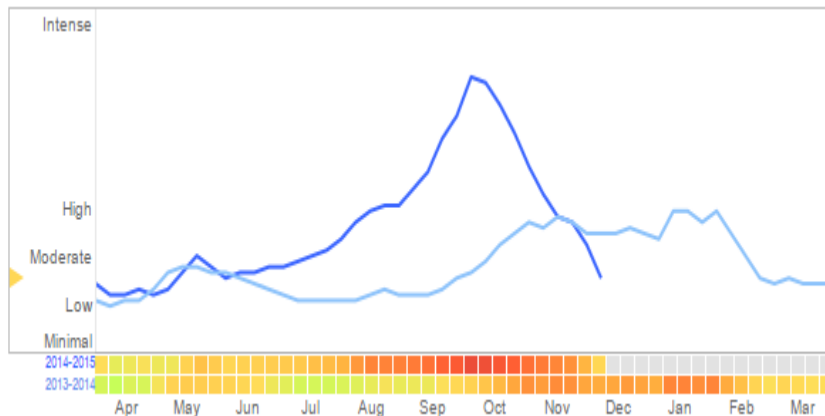


Fig 9. Dengue Search Trend in Venezuela (2013-2014)

4. Discussions

With reported 70-140 million cases per year, dengue has now become problematic for many countries worldwide [15]. However, the surveillance system is not growing proportionately. Thus with the raise in usage of social media, efficient methods have built for the purpose of internet based monitoring of fast growing diseases like Dengue. Google Dengue Trends is one of the tools, which aims to provide updated recent time data by analyzing search engine such as news, websites, images and YouTube. Google trends estimates the proportion of keywords from these search engine to estimates the search perform by using Google and relates those keywords and Google results [16]. It provides relative search volume (RVS) which is define as “the query share of a particular term for a given location and time period, normalized by the highest query share of that term over the time-series” [16]. Studies have also shown in the past, that GDT highly correlates with the incidence of dengue thus reliability of GDT is not questionable [10, 12].

The aim of this study was to compare the interest in internet-based search activity of Dengue activity of developing countries by using Google Dengue Trends for two years, 2013 and 2014. The trends of internet-based search in Bolivia and Indonesia depicted that internet-based search dengue activity is low and minimal in these two countries. Internet-based search of Dengue Activity for Argentina and Philippine remained moderate for the whole year. Internet-based search of Dengue Activity for Brazil and India remained high for few months. Internet-based search of Singapore depicted wide variety of activity and reached to high during the month of May and June. Internet-based search of Thailand and Venezuela also showed wide variation and in Thailand activity even became intense during June and July.

Transmission pattern of dengue is variable and it is not predictable thus, the variation in countries and different patterns are obvious [7]. As reported, that dengue season is also variable but it tends to coincide with the country’s rainy season. Study conducted in Mexico reported that GDT is accurate for the countries where the incidence of Dengue is high and have favorable climate for vector [7]. However, the results are not accurate

where the incidence is low and no favorable climate for vector in that case the incidence is most probably related to the infection among tourist visiting that particular country [7].

When we compared the results of GDT with the reported cases of dengue in the particular region we found that in Brazil the newspaper reported epidemic of dengue in the year of 2013 and thus the graph also depicted the interest of population regarding internet-based search of dengue activity. The graphs and the reported news from Brazil depicted the epidemic of dengue in the beginning of the year 2013 [26-27]. It was also depicted from Dengue surveillance of Argentina that few cases were reported from the mid December, but the cases were underreported. Also in Bolivia the cases were few in the year of 2013 and few cases that were present were unconfirmed thus the graphs also depicted the low internet based searched activity in these two countries [27-28]. WHO reported epidemic of dengue in India during first tenth months of 2013 [29]. Times of India also reported that dengue outbreak was worst in 2013 and 55063 cases were reported till October 28 [30]. Graph also depicted that the internet-based search was high during August, September and October. WHO reported that in Philippine the National Epidemiology Center of the Philippines' Department of Health reports 59943 cases from 1st January till 6th September in 2014 and the number of cases reduces from the past year that is in 2013 the cases were 148,279 [31]. The graph also depicted that the internet search for the dengue activity was higher in the beginning of two years and then during July until September and the intensity of internet search was higher for 2013 when compared to 2014. In 2013, 22318 cases of dengue were reported in Singapore from May until October [32-33]. National report on National Environmental Agency of Singapore reported outbreak of dengue, a total of 3122 cases from January 1st until 8th March 2014 [34]. However the graph does not depicts the same frequency if internet search for the year of 2014 and it remained low throughout 2014. In Thailand, the news reported that in the year of 2013, 49000 cases were reported in late June and the expected cases were 150000 to 200000 [35]. Graph also depicts rise of internet search in the mid of 2013. For the year of 2014, 11881 cases of dengue were reported in Thailand, 80 percent lower than the 2013 [36]. Graph also depicts that the internet search was higher in 2013 than in 2014. In Venezuela 12000 cases of dengue were reported in 2014 [36]. In first 18 weeks 21360 cases were reported in Venezuela and the numbers are higher than 2013 [37]. In 2013 the reported cases for first 18 weeks were 155832 [38]. A newspaper quoted "2014 is to be the period with more cases of dengue in the last four years. There is a national record of 75,020 people infected until week 44, covering from last October 26 to November 1" [39]. Graph also depicted the higher internet search in 2014 than 2013. But the search is higher during July till October.

Many factors play an important role in the epidemic of dengue and thus the interest of people for internet search for the dengue and related terms are also related to those factors. As reported by studies conducted in India, Brazil and Venezuela reported that climatic factor plays an important role in the spread of dengue [17-19]. Study from India [17] reported high burden of dengue during post monsoon season while study from Brazil [18] reported increased burden of dengue during rainy season and study from Venezuela [19] reported correlation between burden of dengue and amount of rainfall. The high activity of dengue in India as reported are related to the climate change and various behavioral and environmental conditions [17]. One of the systematic review conducted for years 2000 and 2011 reported urbanization, population growth, limited control of spread of disease and improved surveillance are all related to incidence of dengue in Philippine [20]. As Thailand is the place for tourisms, the high rate might coincide with

the infection among tourist [22]. Systematic review conducted in Thailand reported higher incidence of dengue between May and September as these are the wettest month of that country and vector activity related to the climate changes [21]. The high incidence of Singapore is related to the climate change [23]. In Venezuela eco-epidemiological and other environmental factors seems to be related to high dengue activity [24-25].

This article only highlights the pattern of dengue in different countries to shade the light on importance and efficient work of GDT for dengue surveillance. Although the article is not comprehensive but it has covered wide range of countries and had given the broader picture of the burden of dengue in these countries. GDT is novel and free tool which allows user to search freely on the internet, which in turn provides deep understanding of human nature and their health related behavior [16]. GDT is however, a new system and it is emerging slowly but it does provide the true and rapid estimations of the disease. It may also provide values in distinct climatic and socio-economic context [7]. For prevention and treatment of the dengue what is lacking is proper surveillance system and the formal surveillance system in developing countries has many limitations that include delay between case occurrence and reporting. The use of social media and mobile technologies, as shown in previous studies, can help in improving access to health surveillance and reporting data [40-51]. Many sentinel sites miss out reporting of cases annually or periodically. Delay of reporting from higher authorities. Lacks of resources cause hinder in communication, training, proper equipment and reporting [9]. For prevention and treatment of the dengue what is lacking is proper surveillance system thus systems like GDT can provide a rapid mean of surveillance that predict real time burden of disease and that further can benefit public health officials and different governing bodies of different countries to build upon preventive and curative strategies to stop the spread of dengue. For developing countries that lack proper surveillance system, GDT can play a very crucial role in providing the estimates of dengue spread in that particular region. As GDT updated daily and it is available for many countries, it can become a good mean of disease surveillance system, which is both cost-effective and less time consuming unlike the traditional one. GDT could work as a complementary system along with the traditional surveillance system. This system can benefit both the epidemiologist and public health to fight against the disease at proper time and detect the disease as early as possible.

5. Conclusions

As shown in the article that the trends of internet search for dengue through GDT corresponds with the true epidemic of developing countries. Thus, systems like GDT might provide efficient means for estimating the burden of dengue in different countries. With the fast growing world the burden of diseases are also increasing with the present surveillance system it does not seems practical to prevent the spread of disease. As these surveillance systems are not that efficient and are not cost effective and required time to manage it properly. Thus, systems like GDT could complement the current surveillance system, as it is both rapid and cost-effective.

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