

Global search trends on common vaccine-related information in English on the Internet

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ABSTRACT

Background: The knowledge about Internet search trends helps to know the information-seeking behavior of the Internet users and this would help in formulating Information Education and Communication strategy. **Aim:** The aim of this study was to explore the global Internet search trends about vaccine-related information in English. **Materials and Methods:** First, we conducted a pilot interview with 15 participants (convenience sample from a tertiary care hospital) to make a list of five common query keywords (viz., When, Where, Cost, Side effect, Schedule) for vaccine-related search. Then, we obtained the search trends from “Google trends” for 5 years with the five query keywords prefixed with vaccine (e.g. vaccine when). In the second phase, individual vaccine search was conducted with a particular vaccine name and query keyword (e.g. measles vaccine side effect). **Results:** Five-year search trend showed that the highest volume of search was for “schedule” (36.79%), followed by “when” (26.57%), “cost” (21.97%), and “where” (11.99%). The “side effect” showed the lowest volume of search (2.68%) ($\chi^2 = 10595$, $P < 0.0001$). The search volume was increased over the years. The highest volume of the “when” and “where” were searched from the USA. The “cost” was searched in the highest volume from Australia. “Side effect” and “schedule” of the vaccine were searched with the highest volume from Philippines and Nepal, respectively. **Conclusion:** This study provides a glimpse of global vaccine-related search trends over a period of 5 years. Information on the “schedule” and “when” to get the vaccine should be strengthened for wider dissemination of knowledge.

Keywords: Google trends, immunization, information-seeking behavior, vaccination

Introduction

Vaccination is an issue that has got a mixed reaction from the population.^[1] Majority of the people easily accept the advantages of the vaccine; however, a fair number of people do not ready to accept it.^[2,3] The world has witnessed that the vaccination can keep the diseases under control or even can eradicate disease,^[4] smallpox being the first one which was eradicated in 1980.^[5] In that time, the Internet was not there for dissemination of information among the population. Only mass campaigning

and vaccination all over the world helped in the eradication of the disease.^[6] In today’s world, along with mass campaigning, the Internet can serve as a medium for spreading awareness. This may be attributed to the generous use of smartphone and other devices capable of browsing Internet pages, easy availability of the Internet connection, and accessibility of reliable information from different government and non-government websites.^[7-9]

The pattern of Internet search is influenced by an array of factors.^[10] A disease outbreak is the most common cause of a high volume search from a particular area.^[11] Seasonal disease occurrence also increases the search volume in particular time of the year.^[12] People commonly search about the disease, symptoms, and available treatment on the Internet, even before appearing the emergency department of the hospital.^[13] The Internet search

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pattern can be considered as a proxy of information-seeking behavior of the population. If the demand for information is known, the delivery strategy can be planned. If the search trends are known, online content can be designed to highlight the issue with a priority basis.^[14]

Google trends (<https://trends.google.com/trends/>) is a website that provides the search trends over time and geographical area. The online application also helps in comparing the search trends. However, it limits the comparison among five different keywords/phrases. A typical search result of 5 keywords is shown in Figure 1. The search trends are visually represented with a bar diagram and graph. However, the data set of the bar diagram and graph can be downloaded as comma-separated value (.csv) from the website and can be opened on spreadsheet software like Microsoft Excel. The geographical area and date range can be selected according to the need. Data of Google trends have been previously used in several medical studies.^[15,16] To the best of our knowledge, a global generalized vaccine-related search pattern has not been reported in any previous study.

With this background, the aim of this study was to find out the worldwide Internet search trends for vaccine-related information over a period of 5 years. The study was divided into two parts. The first part was to conduct an interview to find five common query keywords (as Google allows comparison of 5 phrases at a time) about vaccine. In the second part, these keywords would be used to find the search trends worldwide.

Materials and Methods

Ethical statement

All the research participants of the survey were adults (age >18 years) and provided written consent for participation. The interviewees were informed that the conversation would be recorded for analysis purposes only and their anonymity would be maintained. They were further informed that they can exit from the study at any moment of the interview or

post-interview before the data analysis without stating any reason. The interviewees were not provided any monetary or other benefits. For the interview, a convenience sample was taken from a tertiary care hospital. The interview was conducted by an expert interviewer in accordance with the World Medical Association Declaration of Helsinki (2013).^[17]

For the second part of the study, the data were collected from a public domain website—Google trends (<https://trends.google.com/trends/>). “Google trends” does not restrict the user to analyze their data. We provided acknowledgment of the source of the data and using it for a non-commercial purpose. Hence, no formal permission was obtained from the Google Inc.

The interview

The face-to-face in-depth interview was conducted by an expert interviewer (previous experience of qualitative data collection) who was appointed for this task by the second and third author. A convenience sample was taken from different age group including pregnant women and parents having child/children from a tertiary care hospital situated in eastern India till data saturation. The inclusion criterion was the attainment of adulthood (age >18 years according to Indian law) who are capable of providing legal consent for participation. There was no exclusion criterion. The interview was conducted with open-ended question (with pre-defined probe) about their queries on the vaccine and related issues. The details of the interview guide and results are not presented in this manuscript as the primary aim of the interview was to collect the most common 5 query keywords. However, the guide and detailed result can be obtained from the corresponding author via email.

Generating keywords

The qualitative data of the interview were analyzed and categorized into different themes. Among the theme, the first 5 were taken as the keywords for searching on the Google trends. According to the response of the interviewees, the most common query was about the time “when” the vaccine should be given.

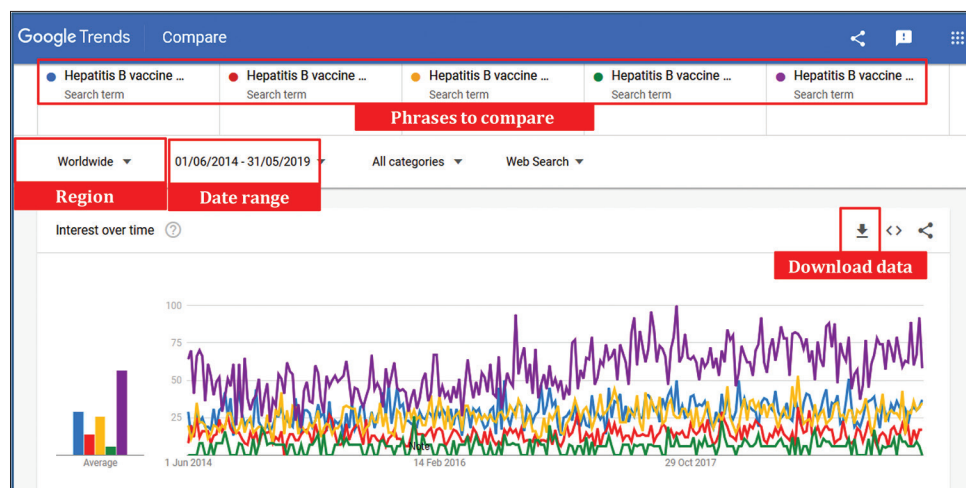


Figure 1: Example of search trend on “Google Trends” website comparing five phrases

The second was the health care facility from “where” the vaccine can be taken. The next most common query was the “cost” of the vaccine. “Side effect” was the next keyword. The last keyword was about the whole “schedule” of the vaccine.

Vaccine list

A flow chart of the number of vaccines is presented in Figure 2. The available vaccine in the WHO website was taken as the initial list.^[18] When this list was searched for testing data availability, six vaccines returned no results due to the lack of enough data on Google trends server. Hence, those six vaccines were removed from the list. Then, two abbreviations of the vaccine (viz., Hib, HPV) were added from the WHO list. The prefixes were removed from 2 vaccine names (viz., Japanese encephalitis and Meningococcal meningitis) to make it more generalized term (viz. encephalitis and meningitis). Two commonly used abbreviations of combination vaccine were included (viz., DPT, MMR). Then, two common abbreviations of disease names were added (viz., JE, TB). After that, common disease names (viz., Chicken pox, Flu, Polio, Pneumonia, Whooping cough) were included in the list. Though the term is “chickenpox,” “chicken pox” was considered due to higher search volume found during the comparison. Finally, BCG was added as the vaccine is popular by the name of the component of the vaccine.

Searching on Google trends

The search was carried out in a personal computer (ASUS VivoBook Max X541N; Intel 4 core processor N4200, Windows 10 operating system) and on an Internet browser (Mozilla Firefox version 67.0.4). The website (<https://trends.google.com/trends/>) was opened on the browser.

In the first phase, the word “vaccine” was searched with a combination of “when,” “where,” “cost,” “side effect,” and “schedule” with the comparison. These common words

(e.g., vaccine when) would give us the trends for all the searches done with these two keywords. Hence, it is a generalized search trend.

In the second phase, individual vaccines were searched. For example, for searching “Hepatitis B” related queries, the phrases were—“Hepatitis B vaccine when,” “Hepatitis B vaccine where,” “Hepatitis B vaccine cost,” “Hepatitis B vaccine side effect,” and “Hepatitis B vaccine schedule.”

For both the phases, the region was selected as “Worldwide” and the date range was selected “1/6/2014 to 5/31/2019” [Figure 1]. The rest default setting remained—“All categories” and “Web Search.” After the appearance of search trends, the.csv file was downloaded by clicking on the download icon [Figure 1].

Data handling and statistical analysis

The raw interview audio files were transcribed to text by the third author. The similarity of the audio and the transcribed text was checked by the second author for any missing data. The qualitative textual data were thematically analyzed. The age of the research participants was expressed in mean and standard deviation and other demographics were presented in numbers as categorical data and statistically tested by Binomial test and Chi-square test.

In the.csv file, Google provides week-wise data. Figure 3 shows an example data with truncated cells. All the data of a particular column were added to get 5 years’ volume which was used to create the bar diagram. Yearly data were calculated (e.g. July 2014 to June 2015) to get total yearly search volume [Figure 3]. These year-wise data were used to find the trends over the years.

The volume of five search categories was tested by Chi-square test. Across the years, the frequency of data was statistically tested by one-way Analysis of Variance (ANOVA).

Data handling and analysis were carried out in Microsoft Excel® 2010 and GraphPad Prism 6.01 (GraphPad Software, Inc., CA, USA). The geographical heat map was created on Microsoft Office 365. For all the statistical tests, a $P < 0.05$ was considered as statistically significant.

Results

Till data saturation, a total of 15 participants were included in the interview. The demographics of the interviewees are presented in Table 1. All of them were from India.

Five-year relative volume of search of the keywords “when,” “where,” “cost,” “side effect,” and “schedule” prefixed with “Vaccine” showed [Figure 4] that the highest volume of search was for the “vaccine schedule” (36.79%) and the lowest volume was for “vaccine side effect” (2.68%). “When” (26.57%) to give vaccine was searched more than “cost” (21.97%) and “where” (11.99%) query ($\chi^2 = 10595$, $P < 0.0001$).

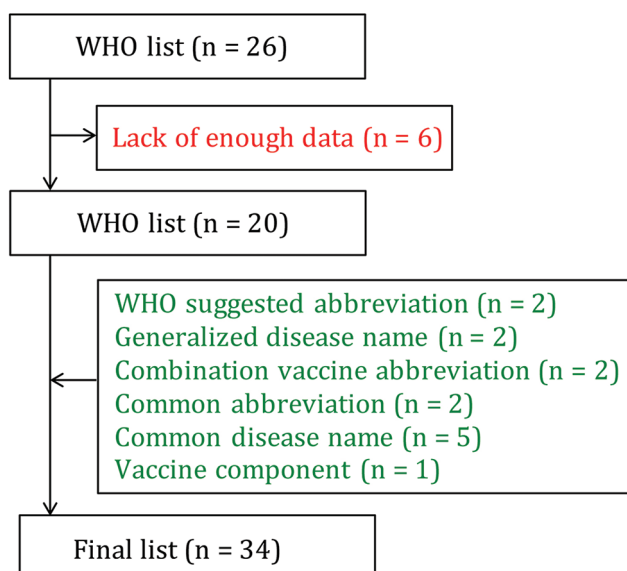


Figure 2: Flow chart for selection of vaccine name

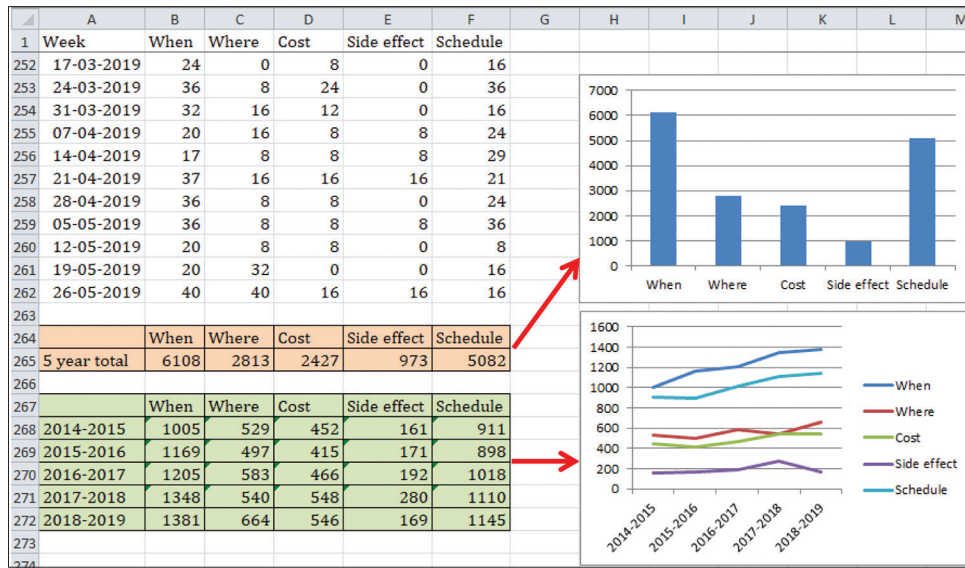


Figure 3: Screenshot of a.csv file opened in a spreadsheet software [calculation example: Cell B265 calculated the sum from B2 to B262. Cell B268 calculated the sum of cells for the weekly data ranging from 1st June 2014 to 31st May 2015]

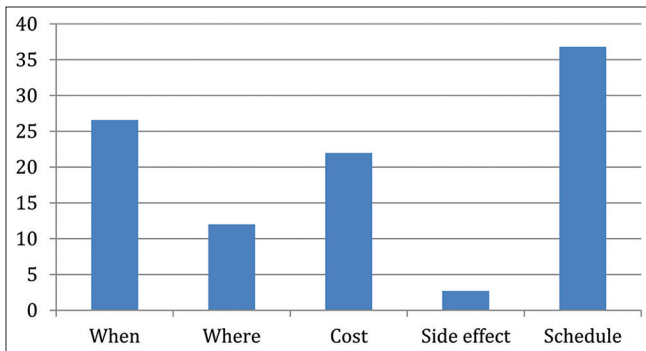


Figure 4: Five-year relative search volume in percentage for vaccine-related queries from Google trends

The year-wise relative volume of search is shown in Table 2 and the trend is graphically presented in Figure 5. Majority of the search volume increased gradually over time with a dip in 2015–2016. Year-wise data for an individual vaccine is available in additional file obtainable from Zenodo: <https://doi.org/10.5281/zenodo.3538584>.

Country-wise relative search volume is shown in the geographical heat map in Figure 6a-e. The “when” query was searched in the highest volume from the USA followed by Australia. The “where” query was also searched in the highest volume from USA followed by Kenya. The “cost” was searched in the highest volume from Australia followed by New Zealand. The “Side effect” of the vaccine was searched highest volume from the Philippines followed by Singapore. The “Schedule” got the highest volume of search from Nepal followed by the USA.

Discussion

With the aim of finding out the global search trend about vaccine-related queries, this study first sorted out common

Table 1: Demographics of the research participants			
Parameters	Values	P	
Age (years) (mean±SD)	32±9.02	-	
Age range (n)	18-22	2	0.99
	23-27	3	
	28-32	3	
	33-37	3	
	38-42	2	
	43-47	2	
Sex (n)	Male	9	0.61*
	Female	6	
Marital status (n)	Unmarried	5	0.04
	Married	9	
	Divorced	1	
Child/Children (n)	None	3	0.82
	Planning pregnancy	2	
	Pregnant	2	
	21 days after delivery	3	
	Having baby below 1 year	1	
	Having baby 1 year and above	4	
Educational level (n)	Up to class 10	1	0.29
	Class 10-below class 12	1	
	Class 12-below Graduation	3	
	Graduation-below post-graduation	4	
	Post-graduation-below post-doctoral	5	
	Post-doctoral	1	
Internet use (n)	<5 years	2	0.25
	5-10 years	7	
	>10 years	6	

*P of Binomial test, all other P values are of Chi-square test, SD: Standard deviation, n: number, -: value not obtainable

queries about the vaccine by an in-depth interview with 15 research participants (male 9, female 6) with mean age 32 ± 9.02 years [Table 1]. As the immediate postpartum period is the time when parents search about vaccine,^[19] we also recruited participants from that group. Thematic analysis revealed that the

time when a vaccine should be given to the recipient was the most common query followed by where, cost, and side effect. The schedule of a vaccine was the least common query among the top five queries from the research participant from India. However, when we compared the global search trend, it was found that the “Schedule” is the most common keyword searched with a combination of the vaccine [Figure 4]. This discordant finding may be due to the sample of the interview. The sample was a convenience sample from a tertiary care hospital from eastern

India. This is obviously a limitation of the study. In addition, the sample was of young and middle age. Hence, we missed the input from older age group. However, during the interview, we could not recruit aged participant who has experience of using the Internet. If we look at the country-wise search volume, Nepal was the country where the “Schedule” was searched with the highest volume [Figure 6e] and India, from where the sample was chosen, was at 13th position.

Government-aided immunization program helps in dissemination of vaccine-related information among the population. Though penetration at the population level is satisfactory, still some question remains unanswered; the most common being the query about “side effect.”^[20] Broadcast media is playing a vital role in promoting vaccine acceptance.^[21] However, for searching a particular query, the Internet may be the most easily available resource nowadays. Along with public domain websites, social media also contribute to dispersing vaccine-related information.^[22] Hence, the governmental and non-governmental organization can emphasize on the keywords hierarchy for planning their websites. The first five countries searching for the vaccine “schedule” was Nepal, United States, Philippines, Myanmar, and Canada [Figure 6e]. Hence, these countries may think about dissemination of vaccine “schedule” among the

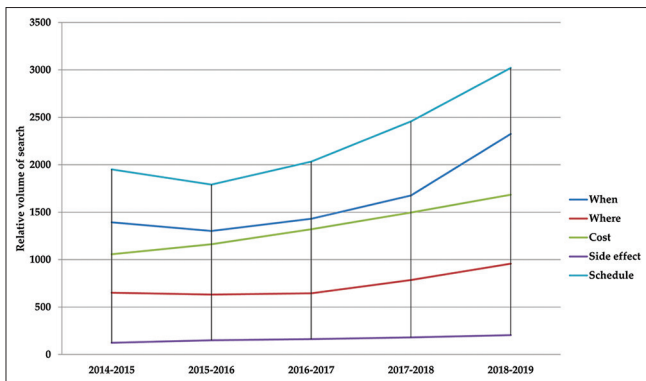


Figure 5: Year-wise relative search volume ranging from mid-2014 to mid-2019

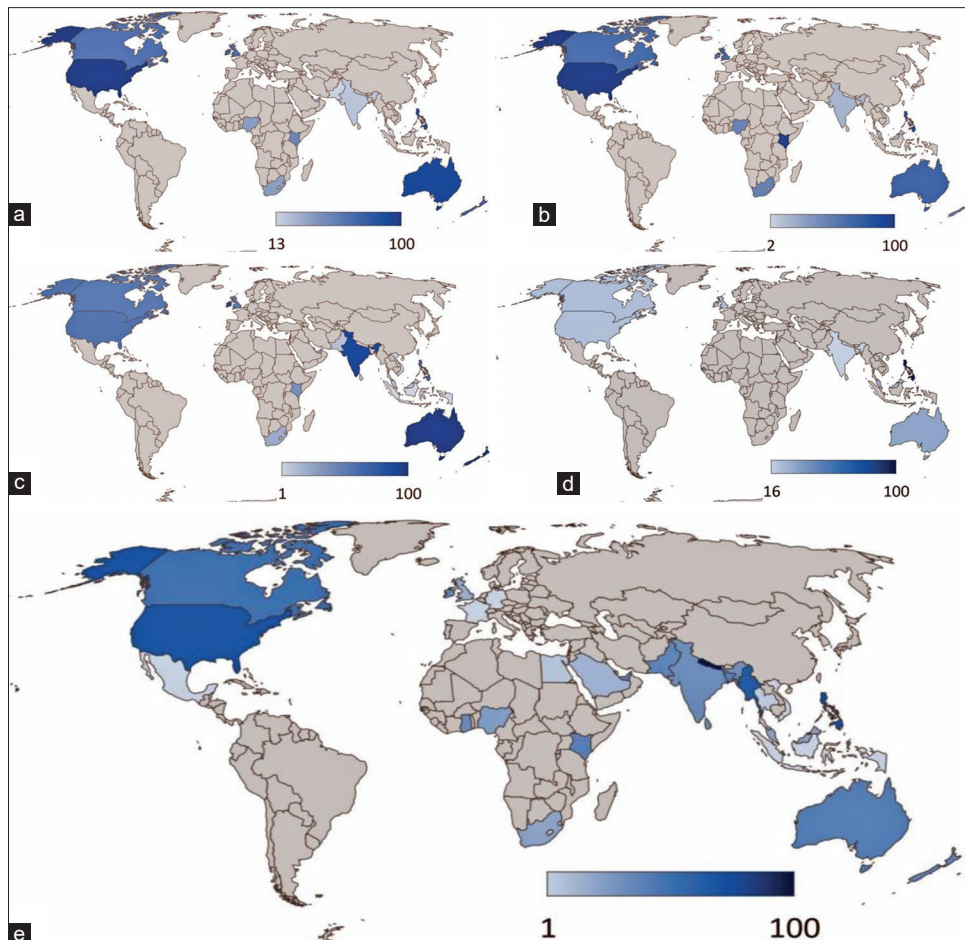


Figure 6: Country-wise relative search volume (a) for “when,” (b) for “where,” (c) for “cost,” (d) for “side effect,” and (e) for “schedule”

Table 2: Year-wise relative search volume

Year	When	Where	Cost	Side effect	Schedule	χ^2, P
2014-2015	1393	650	1056	124	1951	1880, <0.0001*
2015-2016	1302	631	1162	150	1790	1589, <0.0001*
2016-2017	1430	644	1320	162	2032	1890, <0.0001*
2017-2018	1675	785	1496	180	2457	2302, <0.0001*
2018-2019	2325	957	1684	204	3020	2994, <0.0001*
ANOVA <i>F, P</i>	38.18, <0.0001†	48.58, <0.0001†	95.12, <0.0001†	29.28, <0.0001†	71.81, <0.0001†	-
2014-2019	8125	3667	6718	820	11250	10595, <0.0001*

*Statistically significant *P* value of Chi-square test of the data across the row, †Statistically significant *P*-value of ANOVA of the data across the column, mean and SD are not shown here

population. They can also strengthen easily accessible lucidly presented online materials for educating people.

When to take a vaccine was the second among the five queries. The USA, Australia, Philippines, Ireland, and New Zealand were the top five countries searching for the time when to get a vaccine [Figure 6a]. The cost of the vaccine, the next most common search showed high volume from the countries—Australia, New Zealand, India, Ireland, and Singapore [Figure 6b]. The USA, from where the schedule and time are mostly searched was not among the top five countries searching for the cost. However, where to get a vaccine was searched at the highest volume from the USA followed by Kenya, Philippines, Australia, and Canada. It is a positive finding that the side effect was the lowest volume that was searched among the five queries. This may be a reflection of education among the population about the on-going promotion of the vaccine with its major advantages over minor side effects. Philippines, Singapore, Australia, Malaysia, and Canada were the top five countries to search for the side effect. This global data has a major limitation that it included result from a single search engine. This was unavoidable as only Google Trends provides their search trends on a public domain. Other search engine providers like Yahoo and Bing do not provide such facility to access the search trends. Another limitation is the language. This study only included English. Again, this was unavoidable as the regional language search queries cannot be compared. However, English is the major language (54.1%) on the Internet and Google search shares 92.19% on all platforms and 94.54% of mobile global searches.^[23,24]

Year-wise search data shows that there was only a dip in the 2015–2016 and it then gradually increased over the years [Table 2, Figure 5]. The reason behind it may be the increase in the user base of the Internet. An increase in smartphone use may also be another cause of higher search volume.

Individual vaccine-related search, when done with a full term from the WHO available vaccine, two (“Haemophilus influenzae type b” and “Human papillomavirus”) returned inadequate data for comparison. However, the abbreviation returned adequate data. Hence, it is obvious that the general population search abbreviated term rather than the full term. Another four vaccine from the WHO list also returned inadequate data which may be either due to less popularity or due to proper disease name. One example is “poliomyelitis.” When this term

was searched, it showed inadequate data. However “polio,” the common term showed adequate data. This may be considered by the online content creators. Relative search volume of individual vaccine [Additional File <https://doi.org/10.5281/zenodo.3538584>] may be a guide for the creation of educational material, online or offline.

The awareness and attitude toward vaccination are still not adequate at the population level,^[25] even in some cases, among the resident doctors too.^[26] Educational intervention and effective communication on schedule, efficacy, and safety of vaccines should be promoted among the population for a smooth implementation of vaccination.^[27-29] Higher social support and campaigning from influential people are also needed.^[30,31] Primary care physicians are commonly the first contact between the patient and the health care system. Hence, for vaccine promotion, their role is utmost important. If they are aware of the information-seeking behavior of their patients, they can disperse trustable information to their patients. Hence, the finding of the study would help the primary care physicians for a better understanding of the need for information about vaccination.

The novelty of the study is the first report of the global search trends of vaccine-related information which is a proxy of information seeking behavior of Internet users. The result of this study would help the global agency and also the regional stakeholders to formulate their Information Education and Communication (IEC) materials, especially online content. The major limitation of the study is the analysis of a single search engine with only English language. This eliminates a search volume from non-English language. As Google trends allow only five searches to compare, the top five keywords were taken sacrificing other keywords.

Conclusion

This study explored the five-year trends on Internet search about vaccine-related information. The result of this study is the reflection of the interest of global population on vaccine-related information which is not readily available from other sources. “Schedule” of the vaccine should be of highest priority followed by “when,” “cost,” “where,” and “side effect” while creating online materials. This may be considered when stakeholders make their policy on IEC activity. The country-wise list may also help

in designing both online and offline vaccine-related educational materials for regional need. However, as we analyzed only English search trends in a particular search engine, the result of this study should be interpreted with caution.

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Declaration of patient consent

The authors certify that they have obtained all appropriate participant consent forms. In the form, the participants have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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