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Trends In Highly Personalized Health Search: Analysis On Google Search Behaviors

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ABSTRACT

Purpose: The purpose of this research is to deepen the knowledge for America's leading health concerns such as depression, chlamydia and scabies and get insights for when the searches are being made, from where they are being made, and what type of searches are made.

Design/methodology/approach: The primary source for the datasets collected on keywords for depression, chlamydia, and scabies was retrieved using Google Trends and the Pytrends API. All the data collected were publicly available and obtained legally. The primary search for three diseases was conducted on Google Trends for the United States of America.

Findings: It was observed that in a comparative study of the timing of searches of all the three diseases are late nights or early in the morning. Wednesdays have the highest peak in case of searches of the week has the probability of searches more as compared to weekends. Also based on type of searches, it was observed that from January to May there are more searches being conducted.

Discussion: Although data from search results requires advanced technical skills to be retrieved and analyzed, Google Trends data can be used to better understand user behavior. Early tracking of various medical conditions could drive better treatment and prevention methods.

Keywords: Google search, depression, health searches, search trends

1. INTRODUCTION

There are certain medical conditions like sexually transmitted diseases that people do not openly talk about with their peers and are also many times hesitant about asking questions about it due to the social stigma it holds. They are often hesitant to even consult a doctor in person with the fear of getting diagnosed which will confirm their fears. So, they often resort to various platforms that can answer their questions either through another individual or expert who shares information online eliminating the need to interact with others. In 2019, chlamydia was the most reported condition in the United States as per the Centers for Disease Control and Prevention with over '1.5 million' cases reported. Rates of reported chlamydia are highest among adolescents and young adults with almost two-thirds (61.0%) of all reported chlamydia cases being among persons aged 15–24 years (Centers for Disease Control and Prevention, 2021). Yet as startling as these numbers are, they conservatively reflect the true extent of infection, since several years often elapse between the time of infection and diagnosis. eHealth as an industry has great potential in the current market. The internet provides an opportunity for its users to interact with millions of other users from around who either has the necessary expertise, knowledge, experiences, or any combination of the three. Forrester Research found that as many as 84% of American Internet users have researched health information online in 2006, and most of the searches involve queries to health conditions (2006). In 2008, there were an estimated 110 million prevalent sexually transmitted infections among women and men in the United States. Of these, more than 20% of infections (22.1 million) were among women and men aged 15 to 24 years. Approximately 19.7 million incident infections occurred in the United States in 2008; nearly 50% (9.8 million) were acquired by young women and men aged 15 to 24 years (Satterwhite et al., 2013). Slightly more than half (54%) of the public say they or someone they know has had a sexually transmitted infection (STI). Nearly six in 10 (58%) women say they know someone who has ever had an STI, as do half of the men. Older adults are less likely to know someone compared to younger age groups (18-29-year-olds: 54%; 30-49-year-olds: 63%; 50-64-year-olds: 57%; 65 and older: 36%). Only a fraction of the public (8%) is worried about contracting an STI in the next year, but larger shares of younger people, ages 18-29, express concern (20%) (KFF, 2020).

This research will lighten up the information regarding searches made on search engines like Google and help us understand what necessary information the users look for and how they get their health concerns answered. According to Penn Medicine, after analyzing Google searches of selected patients, it was found that health-related searches doubled in the week before patients visited the emergency department (ED) (Asch et al., n.d.). Such research work could help find associations between search histories and clinical conditions to ensure patients receive their treatment at the right time.

The searches vary as per the platforms that individuals use also vary as per the time of the day and the device that is being used for searching. With the vast amount of health-related information available for consumers, there seems to be no clear understanding of these personalized health searches. There is little to no information available on personalized health searches for companies to better target their potential customers with necessary services. Health and wealth are domains where digital users have a heightened expectation of privacy. By understanding patterns in a highly personalized health search, one can gain insights into potential interaction points. Search in specific disease states (ex. HIV, STI, etc.) is highly personal and often conducted via mobile device or desktop. Infected people search at different times or days. The goal of this research is to develop a better understanding of these online searches through trend analysis and post-analysis using various tools and draw necessary conclusions for three selected diseases which are depression, chlamydia, and scabies.

1.1. Depression Disease

Depression is personnel feeling related to sadness, lack of focus and interest for a persistent period of time. It is a mood disorder, and it may affect a person in terms of how they feel, think, and behave.

Depression cannot be perceived as the usual daily emotional up and down changes or short-lived emotional responses to challenges in everyday life. Depression may become serious especially when it starts to be long-lasting or re-occurring very often by increasing the intensity. Depression is a common illness worldwide, with an estimated 3.8% of the population affected, including 5.0% among adults and 5.7% among adults older than 60 years. It can cause the affected person to suffer greatly and function poorly at work, at school and in the family (World Health Organization, 2021).

Although there are known, effective treatments for mental illnesses like depression, there are barriers for missing treatments such as lack of resources, lack of trained healthcare providers and so on. In countries of all income levels, there might people still a big portion of patients who experience depression but may not be properly diagnosed. Maybe another important portion with the disorder has been diagnosed not properly and just prescribed with generic antidepressant drugs.

1.2. Chlamydia Disease

Chlamydia trachomatis or commonly known as chlamydia is one of the most prevalent sexually transmitted infections (STI) with more than 90 million cases occurring worldwide (Cirruzzo, 2021). Also referred to as a ‘silent’ infection, chlamydia can be asymptomatic by its nature and the initial damage caused by it often goes unnoticed. In women, the bacteria initially infect the cervix and in men symptoms typically have urethritis, with a mucoid or watery urethral discharge (Centers for Disease Control and Prevention, 2021). These infections are primarily a woman’s health care issue and can have major effects on reproduction due to scarring of fallopian tubes which could lead to infertility and can also cause pelvic inflammatory disease (PID) (Steiner et al., 2015).

Chlamydia is often the most reported sexually transmitted infection in the United States. It is suggested that sexually active individuals should get tested for chlamydia regularly. Especially for men with male partners yet many do not get tested often due to a lack of understanding of the severity and the effects of the infection (Paavonen, 1999b). With two-thirds of infections occurring among the 15-24 years of age, one can assume that awareness relating to such a contagious virus could be low (Centers for Disease Control and Prevention, 2021). Preliminary research in trying to comprehend the digital epidemiology behavior of American users can help improve targeting measures that can assist public and private institutions to curb the spread of such an infection in a targeted population or a region.

1.3. Scabies Disease

Scabies can be considered as one of the common dermatological conditions, accounting for an important portion of skin diseases. Globally, it is estimated to affect more than 200 million people at any time, although further efforts are needed to assess this burden. Prevalence estimates in the recent scabies-related literature range from 0.2% to 71% (World Health Organization, 2021).

All these three diseases will be analyzed under the light of digital search tools. Google is one of the most used search engines for getting various queries answered. Google processes over 8.5 billion searches per day (Internet Live Stats, 2022) which amounts to a vast amount of data that can be used to analyze public search behavior over the internet. Recently health-related queries are constantly among the top in the list of topics searched on Google. The potential application of this study can help monitor various medical conditions.

Health-related searches are often isolated and insight into these searches can expand understanding and help come up with new intersections points to improve public health.

The major benefit of using data from Google Search is the public access it provides through its platform of Google Trends. Google Trends (Google Inc) is a freely available, online tracking system. In more detail, for each keyword or string of keywords, searches can be performed using search terms or search topic strategies (Adawi et al., 2017a). It provides various filters to extract data based on various single search terms or combinations of them. One can filter their data based on geographic location and based on different states of the United States. There is also an option to set the time frame in terms of hours, days, months, or years for a sample data of relative search volume. Google also stores and presents data for each type of search made namely, Web, Image, YouTube, News and Shopping. Even though the purpose of hourly data for a time frame of more than seven days is not possible through Google Trends, with the help of an unofficial Python-based Application Programming Interface, a set of sample hourly data could be extracted for better analysis of search behavior. Analysis of hourly data filtered based on regions helps provide insight to health searches which are highly personalized and could give access to new avenues for better targeting practices for various organizations that provide health-based services.

Specifically concerning Google Trends, the validity of the data it provides for the purpose of epidemiology has been questioned by many scholars due to the relative search volume data it provides and the methods and the sample it uses to calculate the search volume is unknown. The inaccuracy could be found in the past papers which carried out influenza surveillance (Cook, 2011) which was publically withdrawn but there also have another set of data for both West Nile virus (Watad, 2019) and pertussis (Gianfredi, 2018) outbreak which were well correlated with the number provided by Google Trends. Hence it can be useful provided certain analytical and statistical techniques are utilized to improve the reliability of Google Search data and Google Trends.

2. METHOD

2.1. Research Model

The methodology design of this research has started by looking at the insight on the topics and eventually twenty topmost searched diseases were taken into consideration. Out of twenty, three diseases were included for further detailed analysis. Data is mainly collected from Google Trends. The data available on Google Trends is presented to the public in a relative search volume format and it does not provide an exact number on the total searches. Through Google Trends one can get an unbiased sample of Google search data which is in real-time which can help understand the global reaction to major events and topics. Normalization of data into relative value helps us to find parity between different years which can help gain deeper insights into changes (Rogers, 2016). The results are scaled on a range of '1-100' based on the topic's proportion to all searches of the topic. The period with the highest proportion of searches related to a particular search term which can either be a single keyword or a combination of keywords receives a value of 100 and all other related searches receive a proportionate value.

The data available on Google Trends is available to download by the public directly through their portal or it can also be extracted using Application Programming Interface (API) which is designed for data extraction from Google Trends.

The search terms that are used: 'Depression', 'Chlamydia' and 'Scabies' to find the hourly and monthly sample data for the United States regions for 2020 and 2021. For the purpose of hourly data, the starting date was set on January 1st, 2020 with the time set at '00:00:00' (12.00 midnight) Eastern Standard Time (EST) and the ending date was set on December 31st, 2020 with the time set at '23:00:00' Eastern Standard Time (EST) and the geography location was set to the United States of America for the initial extraction of each keyword with the type set to 'Web Search' by default.

The data processing was built Python software program, which includes the Pytrends open-source library that provides access to Google Trends (Cherry et al., 2020). Since Google trends only give hourly data for up to 7 days prior, an unofficial Google Trends Application Programming Interface called Pytrends was used in order to extract hourly data for a longer time frame. It is based on the Python programming language. The Python script was run on Google Colab. Google has made Google Collaboratory, which is the online framework where one can write, execute

Deep Learning and Machine Learning codes (Kanani* & Padole, 2019). The data was extracted to Google sheets for further analysis.

Top states in the United States of America are also considered for analysis. Using the Google Trends platforms, a list of 'Top 10' states for the search term was extracted for the year 2021, and sample data was also extracted on other types of searches, namely 'Image Search', 'Web Search' and 'YouTube Search' for the United States regions for each search term.

2.2. Data Analysis

The primary source of the three datasets collected on keywords for depression, chlamydia, and scabies was retrieved using Google Trends and the Pytrends API. It is confirmed that all the data collected for this research were publicly available and obtained legally. The primary search for 'Depression', 'Chlamydia' and 'Scabies' was conducted on Google Trends for the United States of America. The period was set from 1/17/2021 to 1/17/22 and datasets for 'Top 10' states, Web, YouTube, and image searches were retrieved. For hourly data analysis and analysis based on the weekly, PyTrends was used to extract the datasets for each of the three search terms from 1/1/2020 to 1/31/2020 because incomplete data was present for the year 2021 on Google Trends. The following data was presented in a '24 hour' format and in a weekly format starting from Sunday and ending on Saturday.

3. FINDINGS

The findings are summarized by showing the trends for search timings hourly, weekday search on the type of searches, from January 17th, 2021, including all the days till January 17th, 2022, as the time frame and the geographic location set to the United States America. Besides, the results were extracted for three types of searches, namely 'Web Search', 'Image Search' and 'YouTube Search' and monthly the data was visualized to compare the different types of searches trends.

3.1. Depression

For extraction related to depression following results were extracted using the Google Trends platform and API. The results were obtained for a single search term 'Depression'.

3.1.1. 'Depression' Searched Timings

As per Figure 1, it was observed that in the year of 2020 search for depression was highest (34,729) at '12.00 midnight (EST)' followed by '1.00 a.m. (EST)' and '2.00 a.m. (EST) with the lowest at 7.00 a.m. (EST).

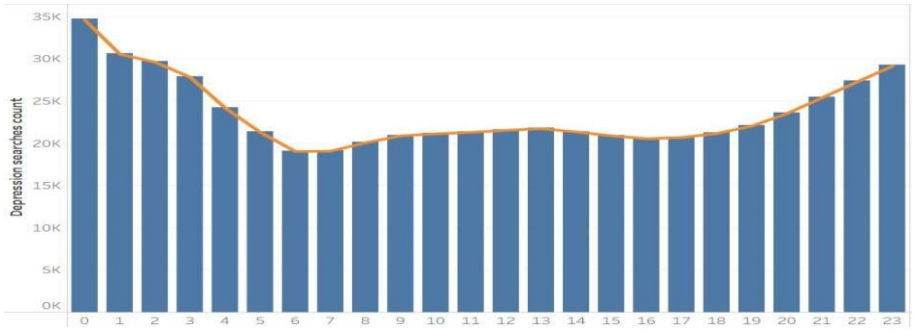

Figure 1. 'Depression' search timings as per Eastern Standard Time (EST) between January 1, 2020, and December 31, 2020

3.1.2 'Depression' Searched On Weekdays

As per Figure 2, according to Google Search Trends, it was observed that on Wednesday (88,875) people usually search more for the term 'Depression'. It was followed by Tuesday, Thursday, Monday, Sunday, Friday and on Saturday the least number of searches were carried out for 'Depression'.

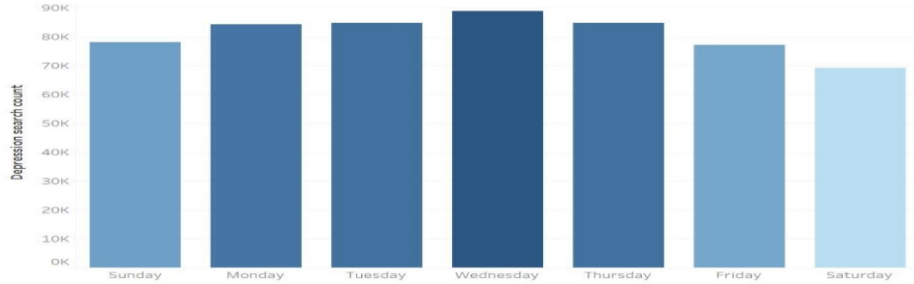

Figure 2. Weekly 'Depression' searches between January 1, 2020, and December 31,2020

3.1.3 Top Ten States in the USA Searched 'Depression'

According to the data from 2021-2022 which is visualized in Figure 3, it was observed that the state of Michigan ranked highest (100) for the search term 'Depression'. Utah was the second highest (89) state in terms of search rankings followed by Massachusetts, Maryland, Ohio, Washington, Illinois, New Jersey, Connecticut, and Oregon.

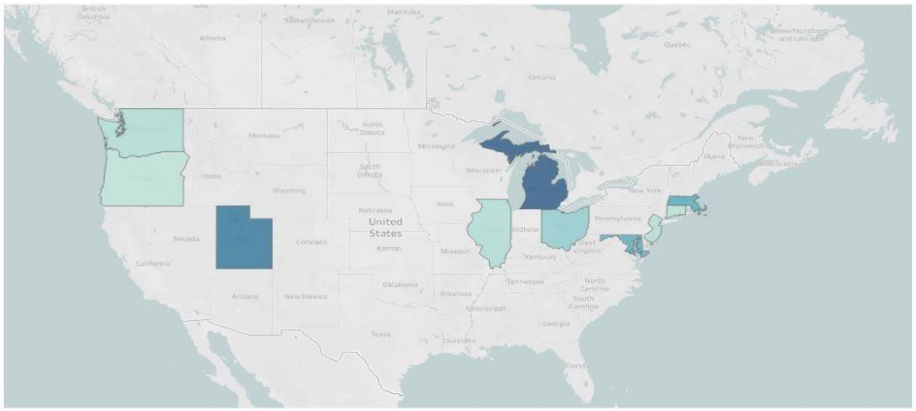

Figure 3. Top ten states for 'Depression' between January 17, 2021, and January 17, 2022

3.1.4 'Depression' Mode Of Search Comparison

According to the visualization shown in Figure 4, it was observed in the year 2021-2022 that the highest (370) number of image searches for 'Depression' was conducted in the month of January. It was followed by May, March, February, April, October, September, November, December, July, August, and June was the month with the least relative volume of image search. The highest (426) number of web searches for 'Depression' was conducted in the month of May. The following months are seen on the figure, and lastly December was the month with the least relative volume of 'Web Search'. At last, the highest (392) of YouTube searches for 'Depression' was conducted in the month of January. It was followed by May, September, October, August, April, March, July, February, June, November, and December was the month with the least relative volume of YouTube searches.

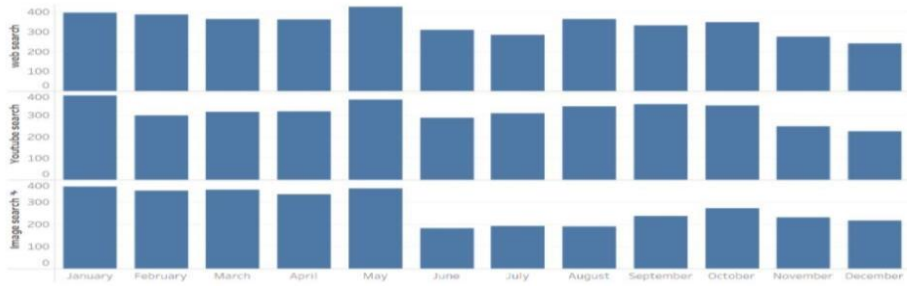

Figure 4. Web, YouTube, and image searches for 'Depression' between January 17, 2021, and January 17, 2022

3.2. Chlamydia

For extraction related to chlamydia following results were extracted using the Google Trends platform and API. The results were obtained for a single search term 'Chlamydia'.

3.2.1 'Chlamydia' Searched Timings

As per Figure 5, it was observed that in the year of 2020 search for 'Chlamydia' was highest (30,477) at '12.00 a.m. (EST)' followed by '1.00 a.m. (EST) and '3.00 a.m. (EST)' with the lowest (14,999) at '7.00 a.m. (EST).

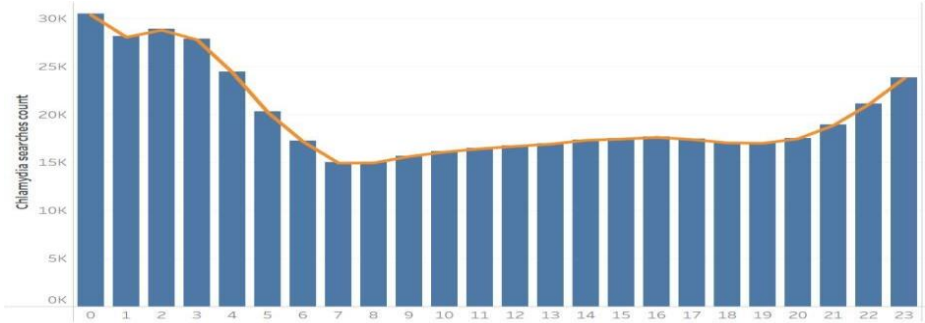

Figure 5. 'Chlamydia' search timings as per Eastern Standard Time (EST) between January 1, 2020, and December 31, 2020

3.2.2 'Chlamydia' Searched Weekdays

As per Figure 6, it was observed that on an average basis people in 2020 conduct most Google Web searches for the term 'Chlamydia' on Wednesday (77,944). It was followed by Tuesday, the other weekdays, and eventually Sunday was the least searched day.

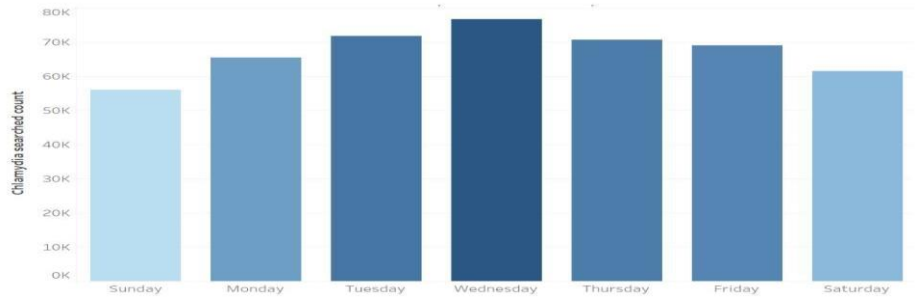

Figure 6. Weekly 'Chlamydia' searches between January 1, 2020, and December 31, 2020

3.2.3 Top Ten States in the USA Searched 'Chlamydia'

According to the data from 2021-2022 which is visualized in Figure 7, it was observed that people based in Mississippi ranked highest (100) for the search term 'Chlamydia'. Alaska was the second highest (87) state in terms of search rankings followed by the District of Columbia, Delaware, Louisiana, Georgia, Alabama, Texas, South Carolina, and Indiana.

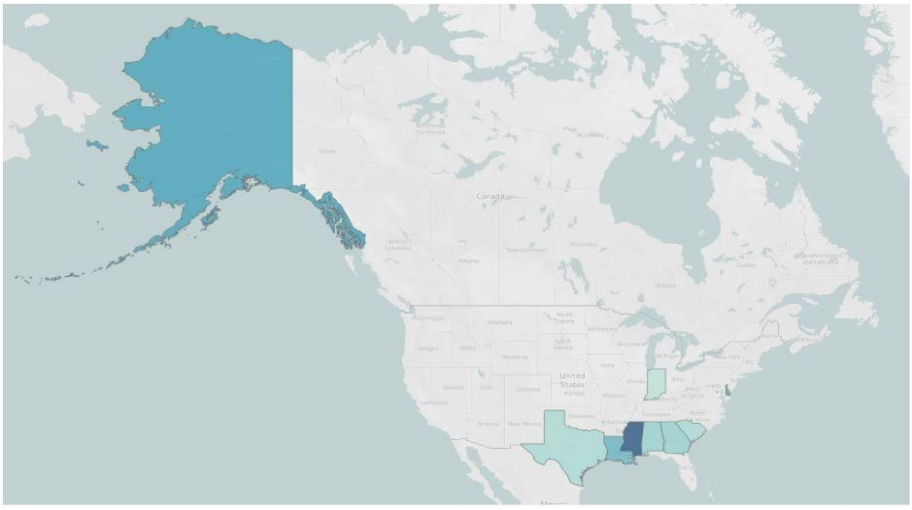

Figure 7. Top ten states for 'Chlamydia' between January 17, 2021, and January 17, 2022

3.2.4 'Chlamydia' Mode Of Search Comparison

According to the visualization in Figure 8, it was observed in the year 2021-2022 that the highest (318) number of image search for 'Chlamydia' was conducted in the month of August. It was followed by May, June, October, July, March, January, November, April, December, February, and September was the month with the least relative volume of image search. The highest (440) number of web searches for 'Chlamydia' was conducted in the month of May. It was showing less trend for the other months, and December was the month with the least relative volume of 'Web Search'. Finally, the highest number of YouTube searches for 'Chlamydia' was conducted in the month of May (205).

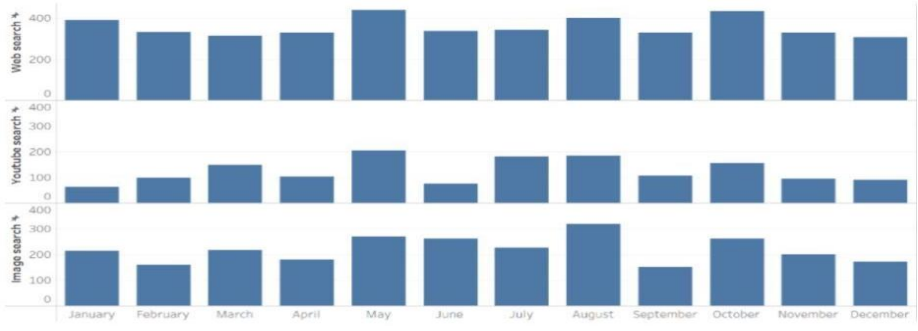

Figure 8. Web, YouTube and image searches for 'Chlamydia' searches between January 17, 2021, and January 17, 2022

3.3. Scabies

For extraction related to scabies following results were extracted using the Google Trends platform and API. The results were obtained for a single search term 'Scabies'.

3.3.1 'Scabies' Searched Timings

As per Figure 9, it was observed that in the year of 2020 search for 'Scabies' was highest (28,568) at '12.00 midnight (EST). It was followed by '2.00 a.m. (EST)' and '3.00 a.m. (EST)' with the lowest between '8.00 a.m. (EST)' to '12.00 noon (EST).

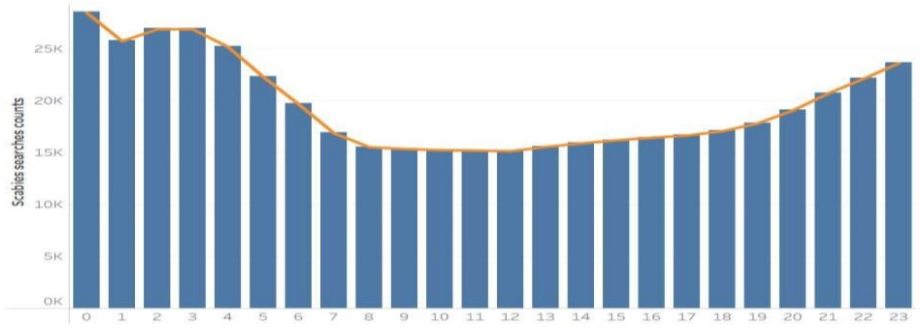

Figure 9. 'Scabies' search timings as per Eastern Standard Time (EST) between January 1, 2020 - December 31, 2020

3.3.2. 'Scabies' Searched Weekdays

As per Figure 10, it was observed that on an average basis people in 2020 conduct most Google web searches for the term 'Scabies' on Wednesday (73,113). It was followed by Tuesday, Thursday, Friday, Monday, Saturday and on Sunday the least volume of Google searches were conducted for 'Scabies'.

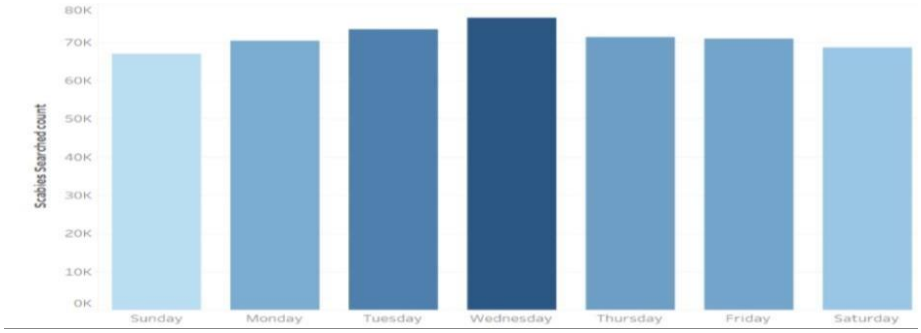

Figure 10. Weekly 'Scabies' searches between January 1, 2020, and December 31, 2020

3.3.3. Top Ten States in the USA Searched 'Scabies'

According to the data from 2021-2022 which is visualized in Figure 11, it was observed that people based in Oklahoma have searched the highest (100) about 'Scabies'. It was followed by Kentucky, West Virginia, Nebraska, Maine, Arkansas, Rhode Island, Michigan, Louisiana, and Alabama.

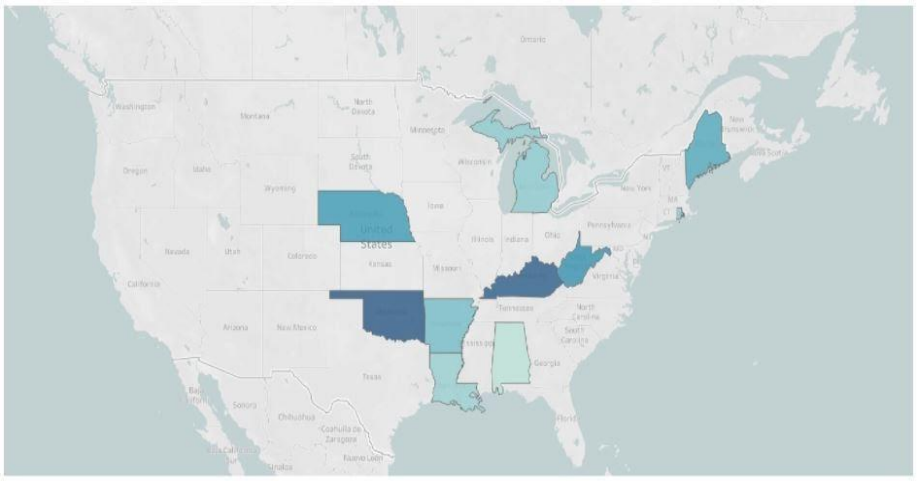

Figure 11. Top ten states for 'Scabies' between January 17, 2021, and January 17, 2022

3.3.4 'Scabies' Mode Of Search Comparison

According to the visualization in Figure 12, it was observed in the year 2021-2022 that the highest (359) number of image search for 'Scabies' was conducted in the month of August. It was followed by October, July, June, March, May, January, September, November, February, December, and April was the month with the least relative volume of image search. The highest (430) number of web searches for 'Scabies' was conducted in the month of August. It was followed by May, July, October, June, September, January, April, March, February, November, and December was the month with the least relative volume of 'Web Search'. Finally, the highest (173) number of YouTube searches for 'Scabies' was conducted in the month of May. December was the month with the least relative volume of YouTube Search. In search results, web search has the highest search volume followed by image search. YouTube search mode is least preferred as compared to web and image search.

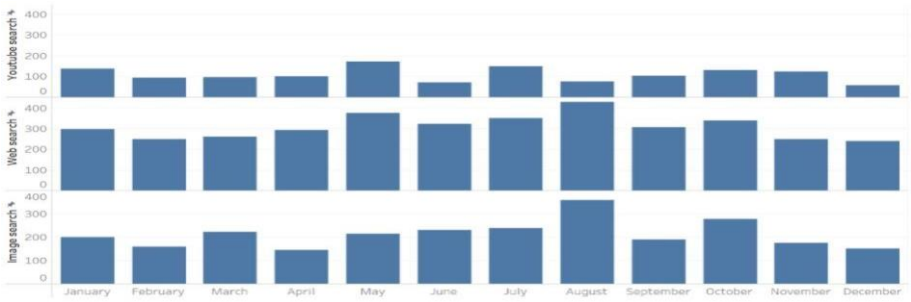

Figure 12. Web, YouTube and image searches for 'Scabies' between January 17, 2021, and January 17, 2022

4. CONCLUSION AND DISCUSSION

It was observed that in a comparative study of the timing of searches of all the three diseases, search time was almost the same and a U-shaped curved graph was obtained. Late nights or early in the morning are more searching for diseases. People search more between 11.00 p.m. (late night) to 4.00 a.m. in the early morning.

A comparative study of weekly searches showed that all the diseases have common weekdays with the highest number of searches. Wednesdays have the highest peak in case of depression, chlamydia and scabies searches of the week has the probability of searches more as compared to weekends.

As per the results, 'Web Search' for the keyword 'Depression' one can observe that people searched relatively more during midnight time with a gradual decrease as the hours passed by. On Monday, Tuesday, Wednesday, and Thursday people are searching more about the diseases. The top states where 'Depression' was searched are mostly located on the top half of the map and these states usually have harsher climatic conditions in terms of extreme winters or rains with lower levels of sunlight. This could be due to the 'Seasonal Affective Disorder' or commonly known as 'Winter Depression' which is a type of depression state that is often caused at the start of fall and continues till the end of winter could explain the kind of states that feature in the above list. Also based on type of searches, it can be observed that from January to May there are more searches being conducted for all three types.

Even for 'Chlamydia' the peak searches were made at midnight and based on days Wednesday, Tuesday and Thursday had the highest relative searches. Based on states, except for Alaska, all other nine states are situated in the southern region of the United States. Months like May, June, July, August, and October often had more searches made for each of the three types of searches.

'Scabies' followed the same trend in terms of hours where the highest searches were made at midnight time in 2020. The top 10 states where 'Scabies' was searched are relative or are often from the Central and Eastern regions of the United States in 2021-2022. May, July, and October often had more relative searches for each type of 'Web', 'Image' and 'YouTube' searches within 2021-2022.

One way to improve the gaps in the health industry is to understand how potential clients look for medical assistance. From an information acquisition processing point of view, the way in which information is sought could shed light on the decision processes involved in seeking answers. Results of this study could help potential health clients reduce the burden involved in health service search, as well as help counselors by providing recommendations on what information to provide in their websites or any other online communication media.

Nevertheless, there is no need for a researcher to capture all data or the exact number of searches with the tools provided from the specific API created for this purpose. Data handling should be adequate, and the data itself should be properly used for the analysis of threatening conditions in a way that can produce reliable results. The volume of the data that can be retrieved through the internet is very important.

From the literature review that has been done before the research, it seems that in many cases it is possible to have an estimation and create prediction patterns of health search by simply using internet search data. Google search engine data can produce a precise and usable estimation of the search timing for a particular medical condition.

As the traditional systems fading away due to power of technology and digital tools, internet systems have the potential to assist for better understanding of the health queries. Big data is growing enormously with the technological developments, and it requires effective management to process and analyze it. Even though there is an abundance of data on health, the data is still too complex to be managed through traditional methods and practice.

Although data from Google requires advanced technical skills to be retrieved and analyzed, Google Trends data can be used to better understand user behavior. Early tracking of various medical conditions could drive better treatment and prevention methods.

CONFLICT OF INTEREST

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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AUTHOR`S CONTIRUBTIONS

All authors have participated in drafting the manuscript. All authors read and approved the final version of the manuscript. All authors contributed equally to the manuscript and read and approved the final version of the manuscript.

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