



Epidemiologic evolution of common cutaneous infestations and arthropod bites: A Google Trends analysis

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Background: Common cutaneous infestations and arthropod bites are not reportable conditions in most countries. Their worldwide epidemiologic evolution and distribution are mostly unknown.

Objective: To explore the evolution and geographic distribution of common cutaneous infestations and arthropod bites through an analysis of Google Trends.

Methods: Search trends from 2004 through March 2021 for common cutaneous infestations and arthropod bites were extracted from Google Trends, quantified, and analyzed.

Results: Time series decomposition showed that total search term volume for pubic lice decreased worldwide over the study period, while the interest for ticks, pediculosis, insect bites, scabies, lice, and bed bugs increased (in increasing order). The interest for bed bugs was more pronounced in the former Union of Soviet Socialist Republics countries, interest for lice in Near East and Middle East countries, and interest for pubic lice in South American countries. Internet searches for bed bugs, insect bites, and ticks exhibited the highest seasonal patterns.

Limitations: Retrospective analysis limits interpretation.

Conclusion: Surveillance systems based on Google Trends may enhance the timeliness of traditional surveillance systems and suggest that, while most cutaneous infestations increase worldwide, pubic lice may be globally declining. (JAAD Int 2021;5:69-75.)

Key words: bed bugs; head lice; infodemiology; pubic lice; scabies; ticks; Google Trends.

INTRODUCTION

Cutaneous infestations and arthropod bite reactions are common reasons for consultation with health care providers.^{1,2} Both infestations and bite reactions may result in severe pruritus with dermatologic distress. Head lice may harbor pathogens such as *Bartonella* or pathogenic *Acinetobacter* species, and bed bugs may act as competent vectors for >40 different pathogens; however, in contrast to ticks, their role in infectious disease transmission remains equivocal.³⁻⁵ It was also recently

hypothesized that arthropods may favor SARS-CoV-2 viral transmission.⁶ Although these parasites represent a significant public health concern throughout the world, they are not reportable conditions in most countries, limiting the high-quality epidemiologic data collection. Studying the population dynamics of these ectoparasitic organisms using traditional field methods is costly and time consuming, especially over wide geographic areas.

Moreover, traditional studies may be affected by data quality issues, underreporting of cases, and

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reporting delays, or even conflicts of interest, resulting in missed opportunities to respond to trends in disease prevalence. Over the last 2 decades, the use of the web (internet) as an initial information source has become almost ubiquitous in the general population. Google Trends (Google Inc) is an online tracking system of internet search volumes that allows to process and analyze “big data” collected worldwide in a certain amount of time.^{7,8} Since 2004, Google Trends is used to explore web behavior related to a topic or search term across various regions and languages, offering an interesting tool to monitor public attention with regard to specific infectious diseases. The use of Google Trends in health care research programs is increasing, which provides useful information about epidemiologic surveillance, screening, and treatment options. The association between the predictive power of Google Trends and the data of official surveillance systems of various countries has been studied by various authors for different diseases, concluding that there is a statistically significant association and therefore it can offer significant information on population behavior and disease-related phenomena.⁹⁻¹⁵ Previous studies have examined the utility of Google Trends to monitor infectious diseases such as influenza, dengue, Lyme disease, COVID-19, or genital warts.⁹⁻¹⁵ In the present study, we investigated whether Google Trends could reflect possible changes in the epidemiology of common cutaneous infestations and arthropod bites.

METHODS

Google Trends data

The data have been obtained from Google Trends, using the method recommended by Nuti et al.¹⁶ Google Trends is a public web facility of Google Inc, which has been aggregating data on Google search queries since 2004.¹⁷ Similar application of infoveillance in the investigation of health campaign effectiveness has been described previously.¹⁸

Google Trends generates data and allows the user to compare the relative search volume (RSV) of 2 or more search terms, offering geographic and temporal models based on the specific terms.^{17,19} It shows how frequently a given search term is entered into the Google search engine relative to the site's total

search volume over a given period of time. Google Trends can be used in comparative key word research and to discover event-triggered spikes in key word search volume.

RSV is assigned to the search terms. The values of RSV represent the goal of the research based on the highest point of the plot with respect to a region or a specific period. They do not represent absolute search volume numbers but rather a normalized value reflected on a scale from 0 to 100, where 100 is the point of maximum popularity among the search terms or topics over a specified time frame. The 0 score indicates that no sufficient data were found regarding the search term.^{8,15,20,21} Relative monthly scores for all search terms and topics are expressed as relative interest scores, which are surrogates for the relative popularity of a particular search term and topic over that time frame.

A “search term” query on Google Trends provides searches for an exact search term, whereas a “topic” query includes related search terms (in any language, including, eg, Spanish, Portuguese, Persian, Ukrainian, and Thai).²² We focused our analysis on the “Related Searches” section, which shows queries (and not key words) that are related to the entered terms (which are instead true key words). The data have been obtained using “topic” queries, in the “Global” category (all available categories on Google Trends were included), “gale, as disease” (“scabies” in English), “poux, as insect” (“lice” in English), “pou du pubis, as insect” (“pubic lice” in English), “tiques, as animal” (“ticks” in English), “punaises, as insect” (“bed bugs” in English), and “piqûres et morsures d'insectes, as subject” (“insect bites” in English). The data have been obtained in the time frame elapsing from January 1, 2004, to March 31, 2021 (n = 207 months) worldwide and aggregated by month. Ethics approval for this type of study was not required as none of the queries in the Google database can be associated with any identity and/or physical location, as specified in Google's privacy policy (<http://www.google.com/privacypolicy.html>).

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Data and statistical analysis

For the entire period (n = 207 months), decomposition time series multiplicative models (Value = [Mean] × [Trend] × [Seasonality] × [Cycle] ×

CAPSULE SUMMARY

- The worldwide epidemiologic evolution and distribution of common cutaneous infestations and arthropod bites are mostly unknown.
- Surveillance systems based on Google Trends suggest that, while the interest in interest in scabies, bed bugs, ticks, and head lice increases worldwide, pubic lice may be globally declining.

Abbreviations used:RSV: relative search volume
STI: sexually transmitted infection

[Random]) were used with 12 as the number of seasons on the RSV index (dependent variable) representing a normalized value, ranging from 0 (no searches) to 100 (for the peak of the search). They were performed separately for several variables of interest in common cutaneous infestations with time as an independent variable. Their trends over the past 17 years were compared. Their seasonality amplitudes were compared based on the differences between the highest and lowest seasonality coefficients.²³ The statistical softwares used were IBM SPSS V27.0 (International Business Machines Corporation) and NCSS V10 (NCSS LLC).

RESULTS

The temporal evolution for the worldwide 17-year Google Trends data (from January 2004 to March 2021) regarding the variables mentioned under the “Methods” section is presented in Fig 1. Because the prevalence of head lice is much higher than that of pubic lice,^{5,24} we assumed that most searches for the query “lice” are related to pediculosis capitis. Moreover, in the common language, there are generally specific words for phthiriasis (ie, “crabs” in English or “morpion” in French). The trends of the time series decomposition showed that the patients’ interest in pubic lice decreased (trend = -0.0039), while the interest in other common cutaneous infestations increased. The relative importance of the positive trends are in increasing order as follows: ticks (0.0006), insect bites (0.0020), scabies (0.0032), lice (0.0042), and bed bugs (0.0063) (Table I).

The top 5 countries where the queries for lice were the most popular were mostly Near East and Middle East countries, whereas the top 5 countries where the queries for pubic lice were the most popular were South American countries. The top 5 countries where the queries for bed bugs were the most popular were all located in the former Union of Soviet Socialist Republics countries (Table II). Seasonality in worldwide internet searches (reflecting mainly the northern hemisphere, since 90% of the world’s population and most of the internet users live there)^{25,26} was quantified as the difference between the highest and lowest seasonality coefficients, which were in decreasing order as follows: bed bugs, insect stings, ticks, lice, pubic lice, scabies, and pediculosis (Table I). The peaks of interest for

bed bugs, insect stings, and ticks were in October, May, and July, respectively (Table I).

DISCUSSION

Because common cutaneous infestations and arthropod bites are not reportable conditions in most countries, studies on their changing trends and geographic distribution remain scarce. Search engine data have been shown to be truly reliable for the prediction of disease outbreaks^{12,15,27} and potentially facilitate efficient enhancement of established surveillance-reporting systems. Google Trends, an online tracking system of internet hit-search volumes, has been extensively used in the field of infectious diseases, both for monitoring and surveillance purposes and for investigating public interest for epidemic outbreaks.^{9-15,28} Freely available internet search data provided by Google Trends were used for this study.

Head lice are believed to infest >100 million people worldwide⁵ and isolated reports from various countries suggest an increasing prevalence.²⁹ However, these epidemiologic studies were conducted during different seasons, among vastly different populations, using different examination methods, and relied on varying measures to define the basis of an infestation.²⁹ Variations in reported prevalence were found even in data from the same country.³⁰ Our data, generated from surveillance systems based on Google Trends, indicate growing interest among the general public for lice, which corroborates the claims of the increasing prevalence of head lice infestations worldwide.²⁹ Notably, countries with the highest web-based interest for lice were Near East and Middle East countries, which does not support traditional epidemiologic studies suggesting that the highest prevalence of pediculosis capitis is in Central and South America.³¹

Pediculosis pubis is an infectious disease caused by infestation with the parasite *Phthirus pubis*. It is sexually transmitted and has often been found in combination with other sexually transmitted infections (STIs).^{32,33} However, while epidemiologic data suggest alarming rising rates of STIs worldwide, potentially fueled by the following: (1) rapid spread of drug resistance for bacterial STIs; (2) unprecedented impact of recreational drugs and internet for facilitating exposure to multiple sex partners; and (3) growing rates of sexual violence and commercial sex, associated with wars, refugees, migrations, traveling, and sexual tourism³⁴; few data are available on the global epidemiology of pubic lice. By opposition to most other STIs for which internet searches are increasing,¹⁵ our findings indicate decreasing interest among the general public

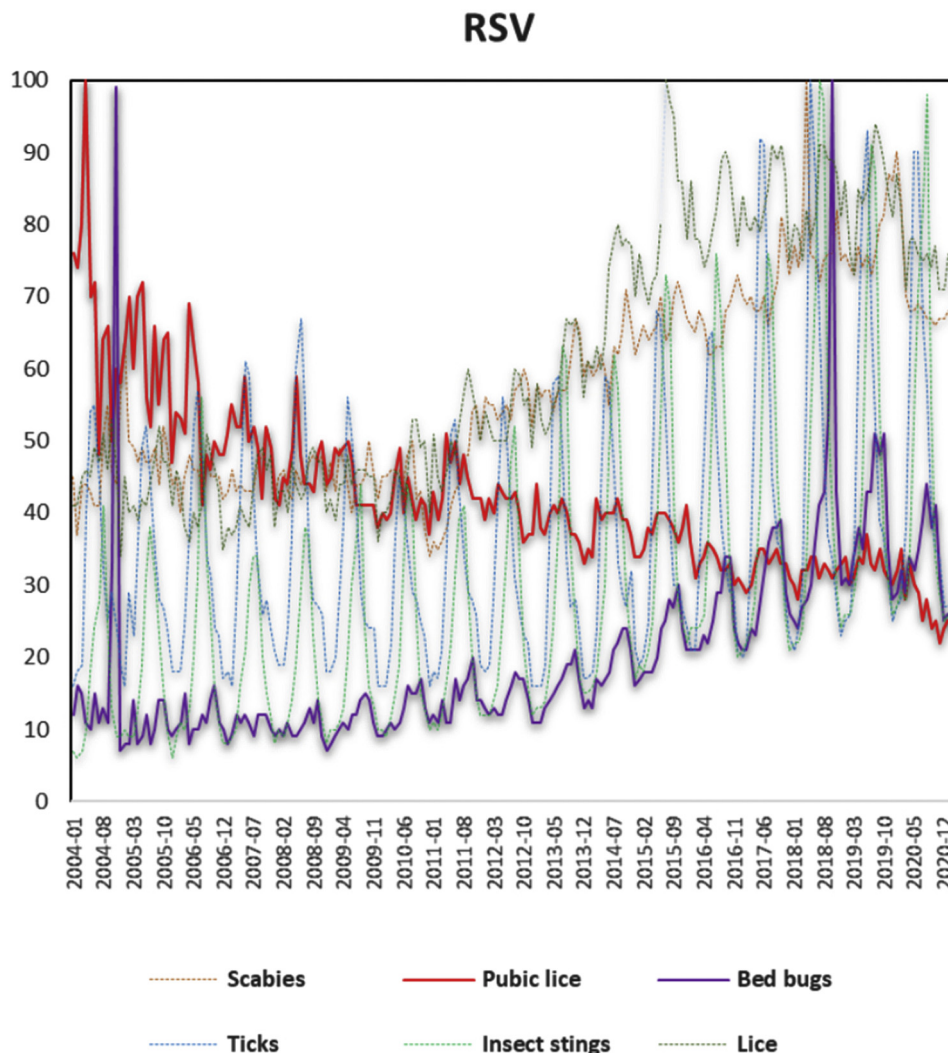


Fig 1. Data providing from searches for scabies, pubic lice, lice, insect stings, bed bugs, and ticks. Google Trends time data (17 years; 207 months). To compare the temporal evolution of the searches, data for each search have been downloaded separately and are presented as relative search volume index. They do not represent absolute search volume numbers but rather a normalized value, ranging from 0 (for no searches) to 100 (for the peak of the search). *RSV*, Relative search volume.

regarding pubic lice, suggesting that their global incidence is decreasing. It is estimated that 70% to 80% of adults now remove pubic hair in part or entirely, using a variety of methods. It is hypothesized that the destruction of this pubic hair habitat may account for the falling incidence of pubic lice and may possibly lead to its eradication.³⁵

After World War II, bed bugs became uncommon in developed countries due to social and economic progress and insecticide development, whereas infestation in developing countries never decreased.³ Since the 1990s, reports of clusters or epidemics from many countries across the world suggest a resurgence of bed bugs.^{3,36-38} Our findings

indicate that, during the last 17 years, interest among the general public regarding bed bugs did not stop growing, suggesting a further increase in their prevalence. Notably, we noted that the countries with the highest search volume for bed bugs were all located in the former Union of Soviet Socialist Republics countries, suggesting a higher incidence of this infestation in this geographic area.

Tick bites and associated diseases are important public health concerns. Our data and other previously published infodemiology data show a worldwide increased internet interest for ticks.^{14,39} This is consistent with epidemiologic studies showing that the incidence of tick-borne diseases in humans

Table I. Trends and seasonality in worldwide internet searches for pubic lice, ticks, insect stings, scabies, lice, and bed bugs, quantified as the difference between the highest and lowest seasonality coefficients

Topic	Trend slopes	Seasonality		Seasonality coefficients	
		Lowest	Highest	Lowest	Highest
Pubic lice	-0.0039	December	May	0.9359	1.0947
Ticks	0.0006	January	May	0.8466	1.1903
Insect stings	0.0020	December	July	0.8078	1.2673
Scabies	0.0032	June	October	0.9637	1.0575
Lice	0.0042	December	August	0.9124	1.1063
Bed bugs	0.0063	January	October	0.7737	1.3773

Table II. Top 5 countries for the queries for ticks, scabies, lice, pubic lice, and bed bugs

Ticks	Scabies	Lice	Pubic lice	Bed bugs
Iran	Venezuela	Lybia	Venezuela	Turkmenistan
Poland	Denmark	Syria	Chile	Hungary
United States	Norway	Iran	Guatemala	Kazakhstan
Canada	Saudi Arabia	Jordania	Panama	Russia
Australia	Puerto-Rico	Saudi Arabia	Czechia	Ouzbekistan

increased in many European countries and in the United States since the early 1990s.⁴⁰ It is disputed which factors are responsible for these trends. Climate trends, the density of key hosts for adult ticks, and changes in the landscape bringing their habitat closer to humans have been pointed as the main factors behind the spread of *Ixodes ricinus*.⁴¹

Local reports of scabies outbreaks along with the simultaneous increase in sales of scabies treatments suggest that the incidence of scabies is increasing in several countries.⁴²⁻⁴⁶ Our data support these traditional epidemiologic studies and show an increased interest in scabies between 2004 and 2021, which may be related to increasing population density in urban settings, migration, travels, and aging population.

The relative importance of the increase in internet searches for bed bugs, lice, and scabies was more pronounced than the increase in searches for insect bites or tick bites, which might suggest a more prominent role of increasing urban population density than climate changes in these trends.

Google Trends has been shown to be suitable for studying seasonal patterns of various skin problems.⁴⁷⁻⁵⁰ In line with previous studies, we found a seasonal pattern for the internet interest for ticks with peaks of interest in May.^{49,50} Expectedly, there was a peak of interest for insect stings in July. Additionally, similar to prior work,⁵¹ we found a peak of internet searches for bed bugs in October. These results should be interpreted with caution since we analyzed the worldwide interest in ectoparasitoses, including thus the southern and northern

hemispheres. This bias is probably minimized since 90% of the world's population and most of the internet users live in the northern hemisphere.^{25,26}

The main strengths of this study encompass the basic definition of big data, including "the 3 Vs": variety (linkage of many data sets in a single data set), volume (a large number of observations), and/or velocity (real-time or frequent data updates, fully automated).⁷ Google Trends supports credibility and transparency because these data are openly available, and our analyses are replicable by other investigators. Further, Google Trends topic queries encompass broad literature search terms, search volume data access has remained continuously available since 2008,⁵² and the search is not restricted by the language.

This study is limited by several factors. Google Trends provides only an RSV index, not the absolute search volume, and does not provide a way to calculate the search volume index. Google Trends also only provides data on search terms that the researchers chose. Although we chose search terms as inclusive as possible, people searching for diseases on Google may have chosen other terms. The mass media (eg, television, radio) influence the online research of the population.⁵³ The spike in internet searches may be attributed to various factors. It may be due to changes in case numbers in the community and changes given by the mass media or educational purposes. Another limitation is that the participant sample was biased toward internet users who use the Google search engine. However, this bias is mitigated by the fact that as of

March 2015, Google accounted for approximately two-thirds (64.4%) of all internet search traffic, whereas the next most popular search engine accounted for only 20.1% of traffic during a given month.⁵⁴ Although it is common among the whole population to make health-related searches, younger people tend to use the internet more often. Finally, the large amount of data does not eliminate and may amplify sources of systematic error.

In conclusion, our data, generated from surveillance systems based on Google Trends, suggest that, while interest in tick bites, bed bugs, and head lice is increasing worldwide, pubic pediculosis may be globally declining. These results may be explained by several factors, including migration, traveling, climate changes, and/or increasing population density in urban settings. Pubic shaving may account for the decreasing interest in of pubic lice. The potential of this approach could be used in the immediate future as a support to traditional surveillance systems.

Conflicts of interest

None disclosed.

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