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ORIGINAL PAPER

Seasonal variation in the internet searches for psoriasis

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Abstract

Some researches with different designs investigated the seasonal pattern of psoriasis; however, the seasonal variation in public interest in psoriasis has not yet been examined. The monitoring of internet search activity has increasingly been used to gain insights into public interest in health-related topics. The aim of the investigation is to employ the Google Trends datasets to evaluate whether a seasonal trend exists in the internet searches of psoriasis by the general public. In the observational investigation, the Google Trends was queried for the [psoriasis] in the United States, the United Kingdom, Canada, Ireland, Australia, and New Zealand between January 2004 and December 2018. The cosinor analysis demonstrated a statistically significant seasonal pattern of searches for [psoriasis] in the United Kingdom ($p < 0.001$), Canada ($p = 0.002$), Ireland ($p < 0.001$), Australia ($p < 0.001$), and New Zealand ($p < 0.001$), and a trend towards a seasonal variation in searches in the United States ($p = 0.079$), with the zenith in late winter/early spring and through in late summer/early fall. A zenith in late winter/early spring and valley in late summer/early fall presented an approximately 6-month difference between hemispheres. Public interest in seeking psoriasis information through internet searches displayed a seasonal pattern, with the highest interest in the late winter/early spring. If a more comprehensive study validated the association of psoriasis flares with patterns in online searches, beyond investigating only seasonality in public interest, the internet data could be used to guide public health interventions and to manage the care of patients with psoriasis.

Keywords Seasonality · Season · Psoriasis · Skin · Google Trends · Environmental factors

Introduction

Psoriasis is a chronic systemic inflammatory skin disorder most commonly characterized by the raised, well-demarcated, erythematous round plaques covered by silvery scales [15, 29, 36]. Psoriasis may appear on any site of the skin, but the elbows, knees, scalp and the lumbosacral region are the most affected sites by the disease [36]. According to the recent comprehensive worldwide systematic review about the epidemiology of psoriasis, the estimates for the prevalence on psoriasis ranged from 0.5 to 11.4% in adults and from 0 to 1.4% in children, with no gender differences [33]. While the pathophysiology of psoriasis remains not entirely clarified, substantial evidence supports that a multifactor etiology comprising a complex interaction between environmental and genetic factors is a critical event in disease pathogenesis [36, 54]. Previous studies have shown that the environmental risk factors, which might activate and/or exacerbate psoriasis, were smoking, obesity, infections, alcohol, vitamin D deficiency and psychological stress [1, 2, 7, 11, 13, 14, 21, 31, 43, 46, 48, 54].

Over the last decade, the internet has been a credible and popular channel of information for people [10]. With the aid of keyword-driven internet search engines people around the world can access an enormous and wide range of information within seconds [9, 10]. The Pew Research Center's Internet and American Life Project found that 80% of American internet users go online in search of medical information through the internet on at least one health-related topics [16]. These internet users search for information mostly on a particular disease or medical condition [16]. If gathered and used strategically, the online search traffic records might become one of the largest data in the field of health and

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medicine, providing insight into human behavior and acting a valuable source in the detection of outbreaks and monitoring public interest [32, 37]. Google company has made its search engine traffic data freely available to the public [20]. The Google Trends has been presenting these search query data that can be pulled from as early as 2004 [19]. Up to this point, several studies have used Google Trends data in examining the public interest in a wide spectrum of acute health issues, including aneurysmal subarachnoid hemorrhage [28], foot and ankle pain [49], ankle swelling [30], tanning practices [50], and cellulitis [55]; and also a wide range of chronic health issues such as depression [53], mental health problems [3], restless legs [24, 38], snoring and sleep apnea [23], bruxism [27], multiple sclerosis [34], nocturnal leg cramp [17, 38], tinnitus [42], vitamin D [35], lupus [45], gout [26], and rhinitis [8]. These studies have also demonstrated the Google Trends data as useful in testing the seasonal trends of seeking out online health information [3, 8, 17, 23, 24, 26–28, 30, 32, 34, 35, 38, 42, 45, 49, 50, 53, 55].

Some researches with different designs investigated the seasonal pattern of psoriasis [4, 22, 40]; however, the seasonal variation in public interest in psoriasis has not yet been examined. This monitoring of internet search activity may complement and expand the traditional datasets by yielding insights into public interest in psoriasis [9, 10, 32, 37]. Therefore, the aim of the investigation is to employ the Google Trends datasets to evaluate whether a seasonal trend exists in the internet searches of psoriasis by the general public.

Materials and methods

The observational investigation complied with the principles of the Declaration of Helsinki, and the provisions of terms and policies of Google [18]. As emphasized in the previously published investigations, the present study does not necessitate a review by institutional ethical committee [23, 24, 26–28, 30, 42, 49, 50], while it included freely accessible anonymized dataset with non-personally identifiable information. The present work followed the checklist and guidance of systematic review of Nuti et al., which evaluated the utilization of Google Trends in medicine-related literature, to document and clearly report the search strategy [37].

Google Trends search

The Google Trends creates datasets for query frequencies with which the public is searching for by putting a keyword or a term in the Google search bar [19]. To allow easier comparison among, and to rank the searches the Google Trends adjusts the search traffic data to the time, and geography with dividing the searches of each query by the overall search traffic originating from the corresponding region in the same time frame, and after that Google Trends scales the resulting numbers on a relative score from 0 to 100 according to the proportion of overall searches that the selected query corresponds [19]. The higher values represent the greater relative search volume (RSV) [19]. The Google Trends datasets are downloadable in the form of comma separated values (CSV) files to analyze the dataset further. To avoid selection bias, Google Trends does not take into account duplicate queries from the same user over a short time period [19].

On March 14, 2019, the Google Trends was queried and the datasets were downloaded for the [psoriasis]. When searching the Google Trends with this term, the Google Trends results would contain all the searches involving the word "psoriasis" (e.g., "psoriasis treatment" or "scalp psoriasis"); therefore, no other query term was interrogated. The term was queried in the United States, the United Kingdom, Canada, Ireland, Australia, and New Zealand between January 2004 and December 2018 selecting all categories. The reason behind the selection of the United States, the United Kingdom, Canada, Ireland, Australia, and New Zealand was that most of the people of these regions speak English as a first language. The inclusion of regions from the two hemispheres permits the examining of seasonal trends in which 6-month difference in zenith and valley is expected to exist between hemispheres, as highlighted in the previously published investigations [3, 8, 17, 23, 24, 26–28, 30, 34, 35, 38, 42, 45, 49, 50, 53, 55].

The exported data are the monthly basis and had 180 (12-month in a year × 15-year) points for each region. Supplementary file 1, Supplementary file 2, Supplementary file 3, Supplementary file 4, Supplementary file 5, Supplementary file 6 present these data to enable the study analyses to be reproduced by the readers.

Statistical analysis

Similar to the previously published investigations assessing the seasonal pattern in the internet searches for health-related topics by leveraging Google Trends data [23, 24, 35, 42, 50], the cosinor analyses were employed to assess the seasonal patterns. Cosinor analyses and the application by which the cosinor analysis is executed has been explained somewhere else [5, 6]. Shortly, the cosinor analyses capture a seasonal pattern using a sinusoidal equation:

$$\mathrm{St} = A\cos\left(\frac{2\pi t}{c} - P\right), \quad t = 1, \ldots, n,$$

in which: A represents an amplitude, P represents a phase, c represents a length; t represents time and n represents the number. As aforementioned, the number of data points was 180 for each country in the present work. Amplitude

describes the amount of change of a cycle and a phase describes where the cycle reaches the zenith. The cosinor analysis can be fitted utilizing standard linear regression methods. The cosinor analysis involves two expressions, a sine expression and a cosine expression that collectively form the model. Thus, the cosinor tests have two p values, a sine and a cosine p value. In cosinor analyses, the level for statistical significance was established at $p < 0.025$ to avoid the multiplicity issue, and later sine and cosine p values were separately assessed. A sine or cosine p value is expressed, as advised [5, 6]. The Poisson model was selected; and to normalize days of the month, an offset was selected in analyses in the present work. In addition, time series plots were created to examine the constancy in seasonal patterns [5, 6]. All statistical analysis and tests were carried out on R [6] with "season" packages [44].

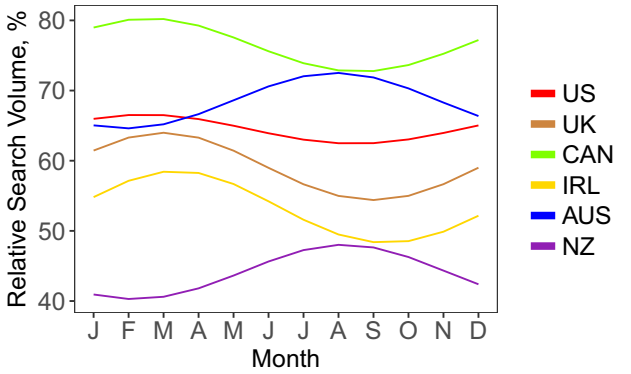

Fig. 2 The plots of cosinor models for the seasonal variation in the relative search volume on psoriasis in the United States, the United Kingdom, Canada, Ireland, Australia, and New Zealand†. †The months are as follows: January, February, March, April, May, June, July, August, September, October, November, and December. *US* United States, *UK* United Kingdom, *CAN* Canada, *IRL* Ireland, *AUS* Australia, *NZ* New Zealand

Results

The outcomes of cosinor analyses were graphed in Fig. 1, and plots of cosinor analyses were shown in Fig. 2. Cosinor analysis demonstrated a statistically significant seasonal pattern of searches for [psoriasis] in the United Kingdom (Amplitude $\{A\} = 4.99$, phase month $\{P\} = 3.0$, low point month $\{L\} = 9.0$, $p < 0.001$), Canada ($A = 3.89$, $P = 2.6$, $L = 8.6$, $p = 0.002$), Ireland ($A = 5.37$, $P = 3.4$, $L = 9.4$, $p < 0.001$), Australia ($A = 4.07$, $P = 7.9$, $L = 1.9$, $p < 0.001$), and New Zealand ($A = 4.05$, $P = 8.2$, $L = 2.2$, $p < 0.001$), and a trend towards a seasonal variation in searches in the United States ($A = 2.11$, $P = 2.5$, $L = 8.5$, $p = 0.079$). Zeniths were detected in late winter/early spring (February/March for northern hemisphere regions; August for southern hemisphere regions) and valley in the late summer/early fall (August/September for northern hemisphere regions; February for southern hemisphere regions). A zenith in

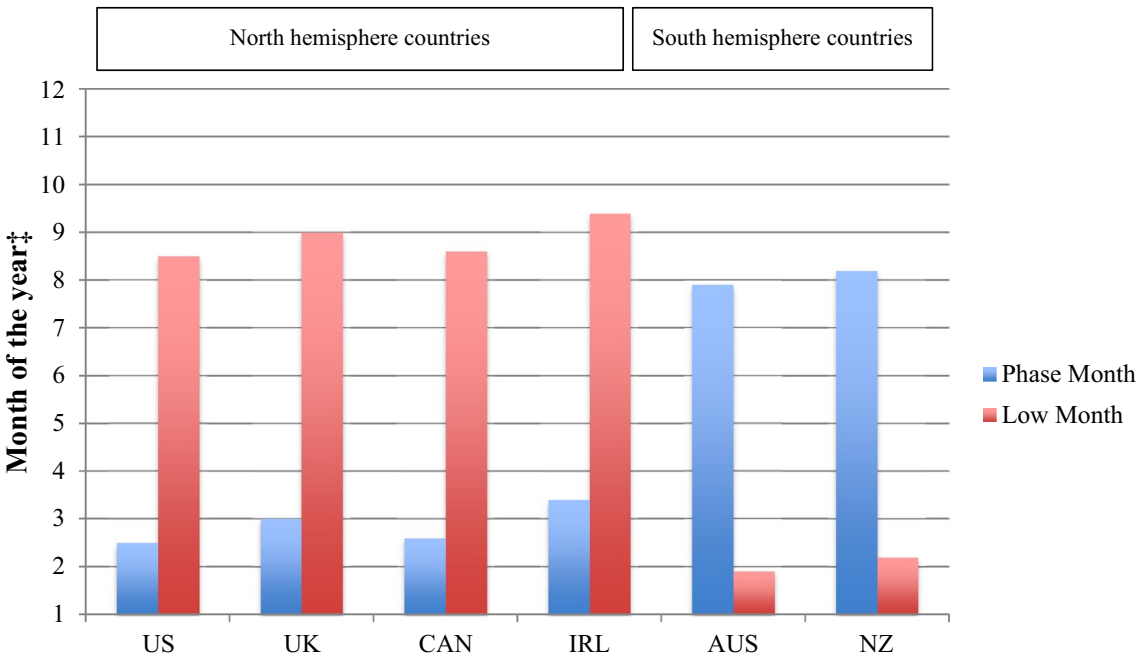

Fig. 1 Relative search volume on psoriasis†. †Cosinor test was used. *US* United States, *UK* United Kingdom, *CAN* Canada, *IRL* Ireland, *AUS* Australia, *NZ* New Zealand. ‡Numeric values correspond to months as follows: January = 1, February = 2, March = 3, April = 4, May = 5, June = 6, July = 7, August = 8, September = 9, October = 10, November = 11, and December = 12

late winter/early spring and valley in late summer/early fall presented approximately 6-month difference between hemispheres (Figs. 1, 2).

The time series plots have underlined the consistency in seasonal patterns that were identified in cosinor analyses (Fig. 3).

Discussion

The present investigation utilizing the Google Trends datasets is the first to examine the seasonality of public interest in seeking psoriasis information through internet searches. A statistically significant seasonal pattern was found in searches for psoriasis in the United Kingdom, Canada, Ireland, Australia, and New Zealand, and a trend towards a seasonal variation in searches of psoriasis in the United States, with the zenith in late winter/early spring and through in late summer/early fall.

As the study datasets comprised the searches originating from the regions of the two halves of the earth, namely, United States, the United Kingdom, Canada, Ireland, Australia, and New Zealand, the datasets seem to represent both hemispheres. Hence, it is viable to compare the seasonal trends between hemispheres, with seasons being reversed. When the seasonal variation compared between the hemispheres, a 6-month difference in zenith and valley is noted among them. This point indicates the variations being manifested by season rather than the calendar.

Some speculations could be made about the seasonal variation observed in the present study such as this variation may stem from the change in the internet use between seasons. Nevertheless, this speculation appears to be unsupported by the results of the previously published investigations since they displayed seasonal pattern in the internet searches of restless legs [24], nocturnal leg cramps [17], foot and ankle pain [49], ankle swelling [30], gout [26] and cellulitis [55] which increase in summer.

As the monitoring of online queries has been shown to be valuable and beneficial in predicting changes in human behavior and public interest, the utility of Google Trends in health and medicine-related publications is increasing [9, 10, 32, 37]. Similarly, the methodological approaches of assessing Google health data have been expanded to include from detecting/predicting outbreaks of acute health conditions (e.g., influenza) to examining seasonality in public interest in not only acute health conditions (e.g., subarachnoid hemorrhage [28], and cellulitis [55]), but also chronic health conditions (e.g., major mental illnesses [3], bruxism [27], and vitamin D [35]). Interestingly, two recent Google Trends studies showed that the seasonality of internet search queries was closely correlated with the seasonality of real-world epidemiology of rhinitis [8] and coronary heart disease [47]. The present work contained no real-world epidemiology data; therefore, it is not possible to comment on the possible correlation of internet data with clinical trends in psoriasis. However, the results of the study may be used as the basis for a more precisely designed study that will aim to investigate the possible association of actual clinical trends with online searches, beyond investigating only seasonality in public interest in psoriasis.

Seasonality of psoriasis

Up to now, some previous researches with different designs investigated the seasonal pattern of psoriasis [4, 22, 40]. Hancox et al. retrospectively investigated the National Ambulatory Medical Care Survey data from 1990 to 1998

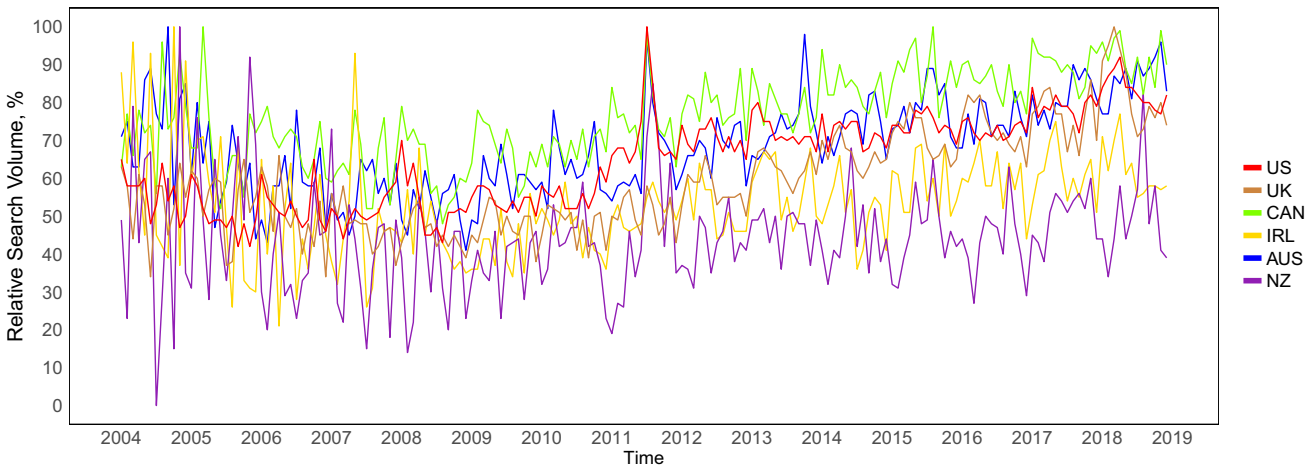

Fig. 3 Time series plots for the relative search volume on psoriasis in the United States, the United Kingdom, Canada, Ireland, Australia, and New Zealand from January 2004 to December 2018†. †*US* United States, *UK* United Kingdom, *CAN* Canada, *IRL* Ireland, *AUS* Australia, *NZ* New Zealand

for the 15 most commonly diagnosed skin conditions including psoriasis. In that study, psoriasis displayed a significant seasonality peaking in meteorological spring, and through in fall [22]. In a cross-sectional recall study, most patients reported that their psoriasis symptoms improved in summer, and worsened in winter [4]. Pascoe and Kimball showed summer clearing and winter flaring of psoriasis severity evaluated by the physician's global assessment [40]. Some mechanisms may be behind the seasonal pattern in psoriasis, and some potential elements may contribute to exacerbation of symptoms in the winter. To begin with, previously published investigations consistently showed that the ultraviolet radiation reverses the cytokine profile typically seen in psoriasis by up-regulation of T helper (Th) 2 cytokines and down-regulation of the Th1/Th17 pro-inflammatory pathways; and ultraviolet radiation has been suggested to induce apoptosis in several skin cell types [52, 54]. As the exposure to ultraviolet radiation from sunlight is the highest in summer and lowest in winter, the decreases in ultraviolet radiation in winter may exacerbate the clinical symptoms in people with psoriasis. In a related vein, it is reasonable that lower vitamin D levels in the winter, due to the decreased amount of its cutaneous synthesis following sun exposure [7, 31, 48], may contribute to the increases in psoriasis symptoms in the winter. Because, in psoriasis, vitamin D plays an important role in modulation of the innate and adaptive immunity; and it has anti-proliferative, pro-apoptotic and pro-differentiative effects on keratinocytes; and it is involved in the maintenance of the integrity of the cutaneous barrier [7, 31, 48]. Second, mechanistically, the relatively low humidity in winter increases skin permeability, induces epidermal thickening, and stimulates the production of inflammatory mediators [4, 40]. Third, the major risk factors of psoriasis that might be affected with season involve smoking, infections, and anxiety. The exposure to tobacco smoke is greater in winter than summer not only in people who smoke but also in people who do not smoke, due to the fact that the smoking in closed areas was more frequent [41]. In terms of infections, the flares of psoriasis after a β-hemolytic streptococcal infection such as tonsillitis or pharyngitis have been well documented [21, 43]. Notably, the β-hemolytic streptococcal infection pharyngitis is more common in winter, and in early spring [12]. Regarding anxiety, previous studies showed the seasonal change in the mood and anxiety, with the highest percentages of low mood and anxiety in winter months [39, 51]. The increases in the severity of risk factors in winter might be associated with the seasonality of psoriasis detected in previous studies [4, 22, 40]. Direct comparison of this investigation with earlier investigations examining the seasonality of psoriasis was limited due to differences in study designs. The results of this investigation may provide additional knowledge to the literature by demonstrating the seasonal variation in seeking out online psoriasis information through Google searches by the general public.

Strengths and limitations

The strengths of the present investigation included the long period of observation (15 years), and a covering of large geographic regions from the two halves of the earth. On the other hand, the investigation has also several limitations. The Google Trends provides no identifiable information of the people putting a keyword or a term in the Google search bar; thus, the seasonal pattern could not be evaluated with classifying the population into particular subpopulations based on their sociodemographic features (e.g., age, gender). Therefore, the results of the present investigation should only be interpreted with regard to the general public. Furthermore, the core presumption of Google Trends researches is that the Google searches were mainly performed by or on behalf of patients with psoriasis; however, other individuals (e.g., physicians or medical students) might search for information on psoriasis. Moreover, it is important to consider the other potential confounding factors when interpreting these type of researches, such as Google Trends data were only available as a relative scale (rather than raw search volume) according to the proportion of overall searches that the selected query corresponds. In other words, the results of Google Trends for a term depend on the overall popularity of other search terms. Finally, the only internet search engine leveraged in the present investigation was Google; nevertheless, it likely represents all internet search engines traffic data, as 65.2% of all searches executed in the search engines queried in Google [25]. Taking these limitations into consideration, it is impossible to draw conclusions from the study results about epidemiology, physiopathology, prognosis, and treatment of psoriasis.

Conclusion

Public interest in seeking psoriasis information through internet searches displayed a seasonal pattern, with the highest interest in the late winter/early spring. If a more comprehensive study validated the association of psoriasis flares with patterns in online searches, beyond investigating only seasonality in public interest, the internet data could be used to guide public health interventions and to manage the care of patients with psoriasis.

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Compliance with ethical standards

Conflict of interest The author declares that he have no conflict of interest.

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