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Original Article

Seasonal trends in restless legs symptomatology: evidence from Internet search query data

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ABSTRACT

Objective: Patients with Willis-Ekbom disease (restless legs syndrome [RLS]) frequently report seasonal worsening of their symptoms; however, seasonal patterns in this disorder have not been systematically evaluated. The purpose of our investigation was to utilize Internet search query data to test the hypothesis that restless legs symptoms vary by season, with worsening in the summer months.
Methods: Internet search query data were obtained from Google Trends. Monthly normalized search volume was determined for the term *restless legs* between January 2004 and December 2012. Using cosinor analysis, seasonal effects were tested for data from the United States, Australia, Germany, the United Kingdom, and Canada.
Results: Cosinor analysis revealed statistically significant seasonal effects on search queries in the United States ($P = .005$), Australia ($P = .00007$), Germany ($P = .00009$), and the United Kingdom ($P = .003$), though a trend was present in the search data from Canada ($P = .098$). Search queries peaked in summer months in both northern (June and July) and southern (January) hemispheres. Search query volume increased by 24–40% during summer relative to winter months across all evaluated countries.
Conclusions: Evidence from Internet search queries across a wide range of dates and geographic areas suggested a seasonality of restless legs symptomatology with a peak in summer months. Our novel finding in RLS epidemiology needs to be confirmed in additional samples, and underlying mechanisms must be elucidated.

1. Introduction

Willis-Ekbom disease (restless legs syndrome [RLS]) is a sensorimotor disorder characterized by the cardinal symptom of a compelling urge to move the extremities. These sensations emerge at rest, are relieved (at least partially or transiently) by movement, and exclusively or more prominently occur at night [1]. RLS is a common malady, with 1.9–4.6% of the population afflicted with the disorder [2]. RLS has been associated with considerable daytime consequences, including decreased quality of life, insomnia, daytime sleepiness, and impaired mood or concentration [3,4]. In addition, a burgeoning literature suggests possible associations of RLS with cardiovascular sequelae, highlighting the importance of research regarding the underlying pathophysiology and epidemiology of the disorder [5].

Seasonal variation in symptomatology has previously been suggested as a phenotypic pattern within RLS [6]. In support of this contention, previous reports of patients with both primary and secondary RLS have noted symptoms that were more frequent or intense during the summer [7–9]. Another study noted that patients with RLS often complained that a hot environment (e.g., summer season, blanket on the legs) aggravated their symptoms [10]. However, worsening of symptoms in the summer is not universal, as previous reports have conversely described worsening of RLS symptoms in the winter in some patients [11]. Despite these clinical observations, seasonal variation in RLS symptoms has not been systematically examined and represents an important gap in RLS epidemiology.

The development of the Internet and search engines has quickly made a vast amount of information easily accessible to the public and has opened a new avenue for epidemiologic research. Approximately 4.5% of all Internet searches are for health-related information [12]. Recently Google has made their search query data available to the public through the Google Trends tool (google.com/trends), which represents a large repository of search query data from around the globe since 2004. Previous studies have leveraged these data to study seasonal or other time-varying patterns of several health conditions, including influenza [13], depression [14], smoking habits [15], major mental illness [16], and health-related behavior changes [17].

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The purpose of our investigation was to utilize Internet search query data to test the hypothesis that there is seasonal variability to symptoms of RLS. Our hypothesis was that there would be a seasonal pattern to restless legs symptomatology, with relative worsening during summer months.

2. Methods

2.1. Query selection and data collection

Google Trends is a Web-based tool that analyzes a portion of all Google Web site searches. This process is described in detail elsewhere (support.google.com/trends) and is summarized below. For a given search term, Google Trends computes how many searches have been done relative to the total number of searches done on Google in an effort to provide the likelihood that a random user will enter a certain search term at a particular physical location and time. The system automatically eliminates searches that were repeated over a short period of time from the same user. Following normalizing the data against total search volume, results are displayed on a scale from 0 to 100 with individual values over time calculated by dividing each point on the graph by the highest value and multiplying by 100.

To investigate the seasonality of RLS symptoms, we utilized the search term *restless legs*. We consciously chose to use the cardinal symptom (i.e., *restless legs*) rather than the disorder itself (i.e., *restless legs syndrome*) as the primary search term for two reasons. First, we reasoned that using the symptom rather than the disorder as the search term would capture more individuals with RLS who may not have sought medical care or not have been given a diagnosis. This supposition was corroborated by the fact that simultaneous graphing of *restless legs* and *restless legs syndrome* on Google Trends revealed a ~3-fold higher average search volume for the former over the latter. Second, we reasoned that using symptom- rather than disorder-based search terms would be advantageous given the change in nomenclature from RLS to Willis-Ekbom disease in 2011, which might confound results due to increased search volume from nonpatient sources (e.g., journalistic coverage of the name change) [18]. Searches were limited by country of origin within a 9-year time period from January 2004 to December 2012 and were performed on April 14, 2013. Because the default unit of time that is outputted by Google Trends may vary (e.g., 1-week to 1-month bins) based on sparseness of the data, our study utilized monthly data that were collected by manually highlighting each data point on a given Google Trends graph and recording the value for offline analysis (12 points/year × 9 years × 5 countries = 540 data points in our study). For record-keeping purposes, a screenshot was taken of each of these data points at the time of collection.

2.2. Analysis plan

Consistent with previous studies that examined seasonal patterns of illness using Internet search query data, the a priori primary countries of interest in our study were the United States and Australia [14,16]. Because one country is in the northern hemisphere and the other in the southern hemisphere, this strategy allows for evaluation of seasonality of the data, as seasonal phenomena should be out of phase by approximately 6 months between these countries. To substantiate findings of the primary analysis, a secondary analysis was conducted which included other countries with sufficient monthly search volume since 2004 for analysis. This secondary analysis included data from Germany, the United Kingdom, and Canada. There were no other countries from the southern hemisphere with sufficient search volume for secondary analysis.

Within a given country, cosinor analysis was employed to test the hypothesis that there was significant seasonal variation in normalized search volume over time. This method and the software used for implementation are described in detail elsewhere [19]. Briefly cosinor analysis is a common parametric seasonal model in which a sinusoid is fit to an observed time series as part of a generalized linear model. The sinusoid consists of an amplitude ([*A*] magnitude of seasonal effect), phase ([*P*] timing of seasonal peak), and length of seasonal cycle (set at 12 for monthly data). This model assumes that the seasonal pattern is smooth and symmetric. Given that the sinusoid was part of a generalized linear model, this allowed for calculating the statistical significance of any seasonal effect. Because the seasonal component of the sinusoid is composed of both sine and cosine functions, all reported *P* values were the original *P* value multiplied by 2 to correct for multiple comparisons. The α was fixed at .05 for significance. Because of the normalized nature of the data available from Google Trends, the timing of the seasonal peak was considered the primary measure of interest. Cosinor analyses were performed using the season package in R version 2.15.2 [19]. Finally to quantify the magnitude of seasonal peaks or troughs, the percent change in search volume from winter months (northern hemisphere countries: December, January, and February; Australia: June, July, and August) to summer months (northern hemisphere countries: June, July, and August; Australia: December, January, February) was calculated by year for each country, which was similar to the process in previous investigations [16]. Differences in the magnitude of seasonal change between countries were further investigated using analysis of variance. Our project was deemed to not constitute human subjects research as defined by 45 CFR 46.102(f) of the Health and Human Services Policy for Protection of Human Research Subjects by the Health Sciences Institutional Review Board of the University of Wisconsin, Madison, and was exempt from Institutional Review Board oversight, which is consistent with institutional policy on use of existing data sets.

3. Results

Results of both primary and secondary analyses are presented in Fig. 1. Visual inspection of the search query data for the United States and Australia revealed definite peaks and troughs. Cosinor models confirmed this finding, with statistically significant seasonal effects found for *restless legs* in the United States (*A*, 4.9; *P*, 7.4) ($P = .005$) and Australia (*A*, 7.9; *P*, 1.3) ($P = .00007$). Notably, the peak for both countries was in the summer (mid-July for the United States; mid-January for Australia), which was almost exactly 6 months out of phase with each other, consistent with a seasonal pattern.

Secondary analysis demonstrated significant seasonal effects for *restless legs* in Germany (*A*, 7.1; *P*, 7.1) ($P = .00009$) and the United Kingdom (*A*, 6.0; *P*, 6.5) ($P = .003$), again with similar peaks occurring in summer months (June and July). There was a trend toward seasonal effects in the search data for Canada (*A*, 3.9; *P*, 7.9) ($P = .098$). Inspection of the plot of data from Canada demonstrated a less symmetrical pattern over the year, with a sharp increase from June to July (Fig. 1).

The magnitude of seasonal increase in *restless legs* search volume in summer relative to winter was similar across countries (mean, 38% [95% confidence interval {CI}, 13–63% for the United States]); (mean, 40%, [95% CI, 22–59% for Australia]); (mean, 24% [95% CI, 16–32% for Germany]); (mean, 25% [95% CI, 15–35% for the United Kingdom]); and (mean, 24% [95% CI, 1–48% for Canada]), with analysis of variance demonstrating no significant effect of country ($F_{[4,40]} = 0.75$; $P = .56$).