



Brief Communication

Summertime blues? A re-examination of the seasonality of web searches for restless legs and leg cramps



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ARTICLE INFO

Article history:

Received 2 May 2017

Received in revised form

21 June 2017

Accepted 24 June 2017

Available online 4 July 2017

Keywords:

Restless legs syndrome

Leg cramps

Seasonal trends

Internet searches

Google Trends

ABSTRACT

Objective: Studies that examined Internet searches for restless legs and leg cramps have found a strong seasonal effect with peaks in summer and troughs in winter months. The present study used an econometric approach to examine the seasonality of such searches in greater detail.

Methods: Monthly relative search volumes for 'restless legs' and 'leg cramps' from 2004 to March 2017 in the United Kingdom (UK) and Australia were obtained from Google Trends. Average percentage change from winter to summer months was examined. The TRAMO-SEATS procedure from the DEMETRA statistical software was used to decompose the data into trend, seasonal and noise components and to determine whether a combined seasonality test was positive.

Results: There were substantial percentage increases in Google Trends searches between winter and summer months regarding restless legs in the UK (median increase 46%) and Australia (33%) and regarding leg cramps in the UK (95%) and Australia (50%). However, the combined seasonality test was positive only for leg cramps and not for restless legs in both countries: although there was significant stable seasonality in restless legs searches, this was outweighed by substantial moving seasonality and noise components.

Conclusions: Examination of average percentage increase in search volume from winter to summer exaggerates the degree of seasonality. Seasonal effects for restless legs searches are non-significant when the trend and noise components of the data are considered, although this does not exclude a clinical significance for the identified stable seasonality. Significant seasonality, with a summer peak, is present for leg cramps searches and suggests an increase in the incidence or severity of leg cramps in summer.

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1. Introduction

A substantial proportion of all Internet searches is for health-related information. Google's search engine (<http://www.google.com>) is the most popular worldwide, and Google Trends (www.google.com/trends), a freely accessible online tool, has been used increasingly in recent years in epidemiological research to study the effects of location and time, including seasonality, on search patterns as a potential guide to the occurrence or severity of a disease [1–3].

Although it is well recognised that some patients with Willis–Ekbom disease (restless legs syndrome [RLS]) find that heat, such as the summer months or a warm bed environment, exacerbates their symptoms [4–6], worsening of symptoms in winter has

also been reported [7]. Recently, the first systematic investigation of this topic used Google Trends to examine the seasonal effect on searches for 'restless legs' [8]. It was found that relative search volume (RSV) increased by 24–40% during summer relative to winter months in both the Northern hemisphere (primarily the United States) and in Australia in the Southern hemisphere (where the seasons are reversed).

The effect of temperature on the occurrence of nocturnal leg cramps has also been uncertain [9,10]. A recent study of Google searches for 'leg cramps' in the United States and Australia again reported a substantial peak in RSVs in the summer months and peak-to-trough differences in Internet search volume 'were equivalent to 73.1% of the mean cramp-related search volume' [11].

The magnitude of the seasonal effects reported for restless legs and leg cramps searches in these studies, which potentially reflect variations in the severity or occurrence of these conditions, is somewhat surprising, as marked seasonal effects on these conditions had not been previously reported. Although the studies

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examining search trends for restless legs [8] and leg cramps [11] examined seasonality differently, the magnitude of the effect was mainly based on comparing observed peak-to-trough differences in search volumes. This may not fully consider the effects of random variation and longer-term trends.

In this study, I used an econometric statistical analysis to examine in greater detail the seasonal effect on Google searches for 'restless legs' and 'leg cramps' in the United Kingdom (UK) and Australia.

2. Methods

2.1. Google Trends search

Monthly search results for the exact terms 'restless legs' and 'leg cramps' between January 2004 and March 2017 were examined on 27 April 2017. Search results in Google Trends are proportionate to the total searches at a particular location and time [3]. The resulting numbers are then 'normalised': individual values over time are calculated by dividing each time-point value by the highest value and multiplying by 100 to provide an RSV of entered queries on a scale of 0–100. Absolute search numbers are not provided.

2.2. Analyses

Analyses were performed using the TRAMO-SEATS procedure from the DEMETRA® statistical software, 2.04 version (European Communities) [12]. (TRAMO-SEATS or the related X-12-ARIMA program, developed in the United States, are used for seasonal analysis of economic data by almost all Western countries). The TRAMO-SEATS program performs an autoregressive integrated moving average (ARIMA)-based decomposition of an observed time series into three unobserved components: a trend component, a seasonal component and a noise component.

The seasonal factor is a fluctuation repeatedly occurring in the same month or quarter each year, while the trend component incorporates long- and medium-term changes and cycles. The seasonal component of a time series includes both the intra-year variation that is repeated constantly (stable seasonality) and the intra-year variation that changes from year to year (moving seasonality). Seasonal analyses are based on the evaluation of the detrended series, consisting of both the seasonal and the noise components. Moving seasonality is an undesirable characteristic of a series as it introduces distortion into the model [13]. Identification of seasonality is also more difficult if the noise component is too large.

TRAMO-SEATS uses a combined test to check for the presence of 'identifiable seasonality', and this was the primary outcome in this study. 'Identifiable seasonality' has been defined as 'a seasonal

pattern that is not obscured by a high degree of irregular fluctuations and thus can be identified reliably' [14]. The combined seasonality test is regarded as the most accurate test for detecting seasonality in a time series [15]. The decision that there is identifiable seasonality is based on an algorithm (Appendix 1) combining the F tests for stable and moving seasonalities, along with a Kruskal–Wallis test for stable seasonality to identify (1) whether seasonality is present and, when present, (2) the degree of moving seasonality relative to stable seasonality. Three outcomes of the test are possible: identifiable seasonality present, identifiable seasonality probably not present and identifiable seasonality not present.

The median annual percentage change in search interest from winter months (UK: December, January and February; Australia: June, July and August) to summer months (UK: June, July and August; Australia: December, January and February) was also examined [8,11].

Correlations between monthly search results for restless legs and leg cramps in the UK and mean monthly temperatures for Britain, obtained from the Hadley Centre Central England Temperature (HadCET) dataset, were examined using Pearson correlation coefficients [16]. The HadCET dataset provides mean monthly data from 1659 searches and is representative of a roughly triangular area of England enclosed by Lancashire, London and Bristol.

3. Results

There were substantial increases in Google Trends searches regarding restless legs and leg cramps between winter and summer months in both the UK and Australia, albeit with large annual variations and some reversals (Table 1). In the UK, there were positive correlations between RSVs for restless legs (Pearson correlation coefficient 0.19) and leg cramps (0.25) and mean monthly British temperatures.

Analysis of the seasonal component after decomposition of the total search volumes confirmed that there was significant stable seasonality in searches for both restless legs and leg cramps in the UK and Australia with a summer peak and a winter trough in both countries. However, the combined seasonality test—the primary outcome measure—was positive only for leg cramps and not for restless legs in both countries. Thus, while there is some seasonal variation in restless legs searches, this is not significant overall.

Figs. 1 and 2 show the initial (without subsequent procedures to correct for or reduce any seasonal variations) decomposition of RSVs into seasonal, noise and trend components in the TRAMO-SEATS program for restless legs and leg cramps searches in the UK and Australia, respectively. The seasonal variation in the total RSVs is noticeably greater and better defined for leg cramps.

Table 1
Seasonality of relative search results.

	UK		Australia	
	RLS	Leg cramps	RLS	Leg cramps
Months peak/trough	August/December	July/December	January/August	December/June
Median (range; 95% CI) % change winter to summer	46 (7–134; 15–50)	95 (12–133; 88–102)	33 (–10.2–93; 4–63)	50 (–10–72; 39–61)
Friedman test	F = 10.51	F = 42.66	F = 3.81	F = 21.69
	P < 0.00001	P < 0.00001	P = 0.0001	P < 0.00001
Kruskal–Wallis test	F = 63.65	F = 119.58	F = 38.16	F = 97.18
	P < 0.00001	P < 0.00001	P = 0.0001	P < 0.00001
Test for seasonality assuming stability	F = 8.10	F = 33.14	F = 4.25	F = 18.02
	P < 0.00001	P < 0.00001	P < 0.00001	P < 0.00001
Moving seasonality test	F = 3.90	F = 6.60	F = 5.79	F = 1.04
	P < 0.00001	P < 0.00001	P < 0.00001	P = 0.42
Identifiable seasonality	Not present	Present	Not present	Present

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