

Seasonal variations of Google searches for joint swelling: implications for patient-reported outcomes

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Seasonal variation of symptoms and signs in rheumatic diseases are well recognised, whether it is due to sunlight for photosensitive rashes [1], temperature for Raynaud's phenomenon [2], or less tested theories such as humidity or atmospheric pressure for arthralgia. A recent interrogation of Google search data suggested that gout attacks may follow seasonal patterns, peaking in the late spring/early summer [3]. Gout has characteristic clinical features that can make it a clinical spot-diagnosis, but individuals with an acute monoarthritis are far more likely to report to their doctor with (or search online for) "I have a painful, swollen toe", rather than "I have gout" (although no doubt with the help of Google, this is increasingly common). While a lay impression or suspicion of gout may not be an acceptable definition to infer seasonality of gout incidence, Google search data for joint swelling – a symptom of many rheumatic diseases – is of major clinical significance. If patients' self-report of joint swelling changes throughout the year, then many patient-reported outcomes may be impacted; for example the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), which asks patients to self-report "the overall level of pain or swelling in joints other than neck, back, hips." We therefore examined seasonal variations in joint swelling using Google search data.

We used publicly available, anonymous data from Google Trends, which provides weekly relative Google search volumes for key terms. More detailed descriptions of this data source is described in reference [3]. We analysed search data for the key phrases "swollen X" or "X swelling" for toe, foot, knee, hand and finger. Searches were arbitrarily restricted to within the past 5 years, in the "Health" category, and in the United States and United Kingdom. Local polynomial smoothing (with 95% confidence interval) [4] was superimposed onto scatter plots of the weekly relative search volumes, to visualise trends and variations without restrictions of using a model. We also showed the monthly search volume distributions over the 5 years using box plots. Analyses were performed in Stata v14.

Figure 1 shows clear seasonal variations in search volumes for each of the 5 anatomical sites. Search volumes were highest in the summer months, with clear and consistent trends particularly seen for feet and knees (large-amplitude variations with tight 95% confidence interval bands). For feet swelling, summer peaks in searches were consistently twice that of winter troughs. Seasonal fluctuations were more subtle for hands and fingers, and the smallest for toes (note scale change in y-axis).

Seasonal variations in joint swelling have many possible explanations, such as increased vasodilatation and antidiuretic hormone activity, leading to soft-tissue oedema with higher summer temperatures [5]. As previously noted, there is no evidence that internet-usage changes over the year [3]. These findings have important clinical implications. The management of many rheumatic diseases rely on patient-reported symptom severity, often

as components of global clinical assessment, but sometimes as the sole source for severity scores (e.g., BASDAI). Many of these questions are not specific to inflammatory swelling. In addition to BASDAI discussed above, several other self-administered indices include questions on swelling; for example in rheumatoid arthritis: “in terms of joint tenderness and swelling, how active is your arthritis today?” [6] or “please put an ‘X’ on each joint you see on a mannequin that corresponds to the joints you feel are swollen. The joints may feel swollen or look swollen.” [7] Use of these self-reported indices will grow in clinical practice and research, as the trend for remote monitoring, such as using smart phone apps, continues to increase [8,9]. Studies on seasonal fluctuations of these self-reported indices are scarce. One study in psoriatic arthritis found that BASDAI was higher in summer than winter months [10]; it would be interesting to examine whether the question on swelling was the main contributor to this variation. This study highlights the potential of using open-access, readily available Google search data to generate hypotheses and inform clinical practice, although longitudinal questionnaire data are needed to confirm these seasonal patterns. Healthcare providers should be aware that any summer increases in disease activity may not be limited to inflammatory activity.

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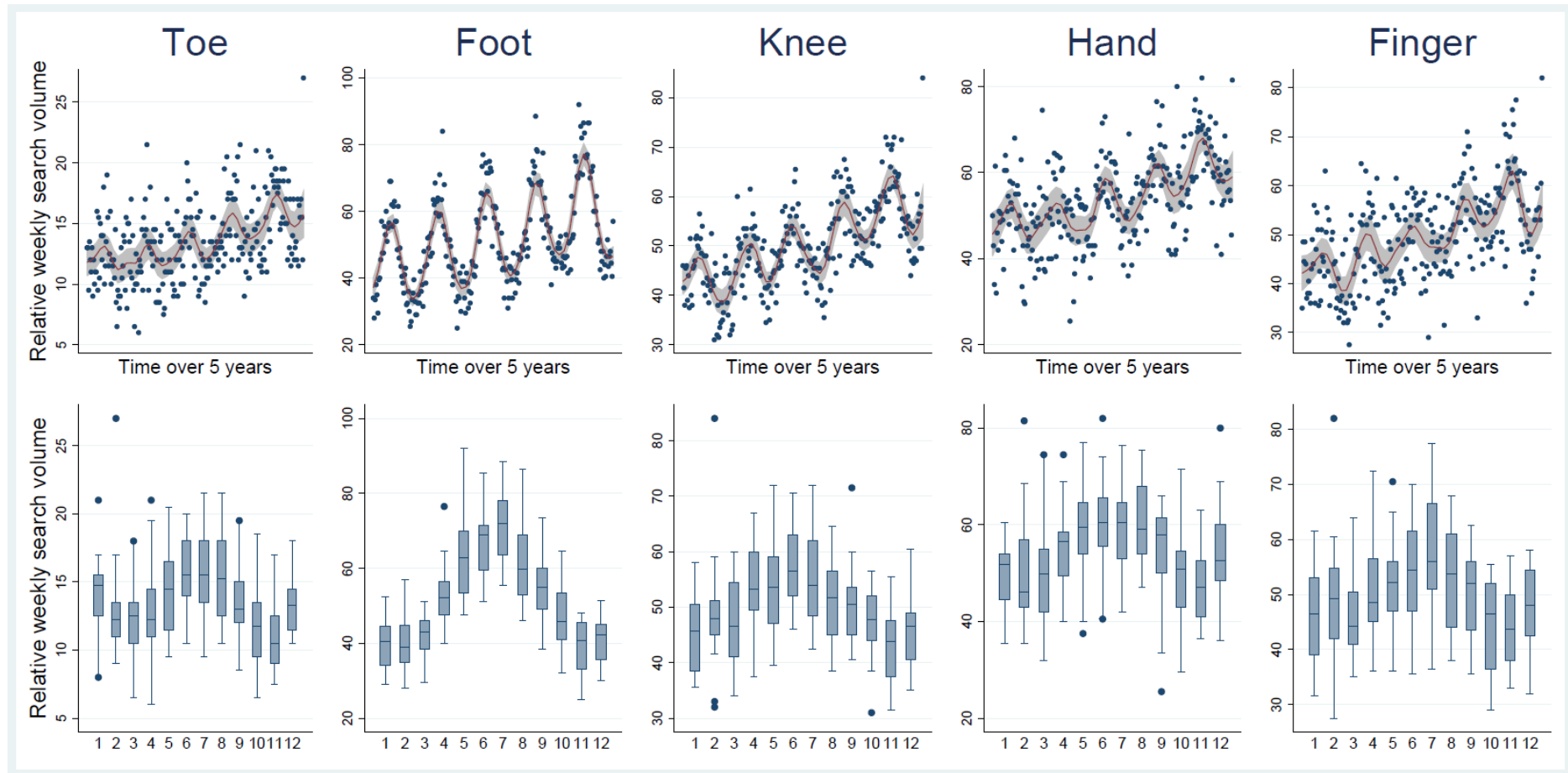


Figure 1. Seasonal variation in Google search volumes for swelling of the toe, foot, knee, hand and finger. Top panels (local polynomial smoothing) show annual variation over 5 years. Bottom panels (box plots) show monthly search distributions averaged over the 5 years.

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