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Assessment of Google Trends terms reporting allergies and the grass pollen season in Ukraine

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ABSTRACT

Background: Grass pollen allergy is an important trigger for the development of respiratory disorders. Defining the grass pollen season onset is critical for correct allergy diagnosis and personalized therapy. The development of a pan-European sentinel network for allergic diseases has raised the problem of translating the Google search terms into different European languages as well as defining specific pollen season characteristics in different regions. Grass pollen allergy was investigated due to high allergenicity and wide expansion of grass pollen in Europe.

Objectives: The aim of this study was to examine which translations of "hay fever", "grass", and "rhinitis" could be used in the native Cyrillic languages, especially in Ukrainian and Russian, and to compare the seasonality of allergic respiratory queries in Ukraine with the grass pollen counts.

Methods: Google Trends (GT) was used to search Google queries concerning grass pollen allergy: "allergy", "hay fever", "runny nose", "grass", "asthma", and "pollen". The Cyrillic terms in Ukrainian and Russian were used. The search was done for the period from 2013 to 2017. Pollen collection from 2013 to 2016 was conducted using volumetric methods. Average daily temperatures were obtained from http://gismeteo.ua. Correlations were assessed by Spearman (R) test.

Results: The Ukrainian Google users searched the Cyrillic equivalents for "runny nose", "grass", and "asthma". Due to the GT queries profile, Ukraine had a "D" pattern according to the classification, developed by Bousquet J et al (2017). In Ukraine, the *Poaceae* pollen season generally occurred between the second ten-day period of May and the last ten-day period of July. The *Poaceae* pollen season started with a concentration of pollen grains of 8.0 m^{-3}. This concentration provoked the growth of GT "grass", "allergy", "hay fever", and "asthma" queries.

Conclusions: The terms "grass", "allergy", "hay fever", and "asthma" (in their Cyrillic equivalents) are required in Ukraine to account for the grass pollen exposure by GT. The study of GT may be a useful tool to make an assessment of the grass pollen season for the prevention and minimization of exposure to significant grass pollen concentrations.

Keywords: Allergy, Hay fever, Asthma, Grass pollen season, Google Trends

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INTRODUCTION

Pollen exposure is a major cause of respiratory allergies worldwide. However, it is unclear how everyday exposure is related to symptoms and how exactly allergic patients may be affected spatially and temporally.[1]

Grass pollen is one of the most important triggers for exacerbations of allergic diseases such as rhinitis and asthma.[2] A precise definition of the grass pollen season onset is crucial for the confirmation of a pollen allergy diagnosis and personalized treatment of patients with allergic rhinitis and asthma. The high costs of the instruments and procedures required for pollen counting limit the capacity to constitute a comprehensive pollen network covering all planes. The possibility was shown to use a geographically customized search option of Google and further fine-tuned analysis techniques to extract local query data about the regional patient concern from the Internet with possible complement pollen measurements.[3]

To determine the precise onset of the grass pollen season, the innovative web-based surveillance tools which are provided by Google Trends (GT) could be used.[4–7] This approach has raised the problem of translating Google search terms into different European languages, especially, into Cyrillic alphabet-based languages.[8] The correct translation is important for the development and functioning of a pan-European sentinel network for seasonal allergic diseases.[9]

For further development of this approach, Google search profiles were assessed for allergic rhinitis and related topics for grass (*Poaceae*) pollen allergy. Grass pollen allergy was investigated due to the high prevalence in Europe.[10,11] The term "grass" as a plant requires its translation into the native language in order to investigate the grass pollen allergy pattern using GT.[12] There are also difficulties in the choice of the correct translation for "hay fever" and "rhinitis" in the Cyrillic-based languages.

The aim of this study was to examine which GT translations of "hay fever", "grass", and "rhinitis" could be used in the native Cyrillic languages, especially in Ukrainian and Russian, and to compare the seasonality of queries in Ukraine with the grass pollen counts.

METHODS

Google Trends terms and analyses

GT terms, a public web facility of Google Inc., based on Google Search, shows how often a particular search term is entered in relation to the total search volume across various regions of the world and in various languages (http://en.wikipedia.org/wiki/Google_Trends). The following terms were used: "allergy", "hay fever", "runny nose", "grass", "asthma", and "pollen". The Cyrillic terms in Ukrainian and Russian were used. In GT, data are normalized to the highest number of searches for each topic. The score of 100 means that a certain query was entered on that day for the highest number of times for the entire search period in Ukraine. For further comparison of Ukrainian data with the data from other countries, the country patterns were assessed as was proposed previously. In pattern A countries, "allergy" queries were reported at a lower level than "hay fever" and did not show any clear seasonal pattern. In pattern B, C and D countries, "allergy" queries were higher than the other terms and showed a seasonal pattern. When all countries with a seasonal pattern were examined, the peak of queries was the same for "allergy" and "hay fever" (pattern B) or D, the seasonal patterns were similar between countries for the five years.[12] The 5-year GT graphs were used to examine GT queries from January 1, 2013 through January 1, 2018 in Ukraine to determine the pattern of inquiries. The grass pollen counts were compared with GT queries during the 2013 through 2016 pollen seasons.

Grass pollen count

Pollen collection for 2013–2015 2016 was conducted using volumetric methods, applying a Burkard trap of a Hurst type. The pollen count was performed by the twelve vertical transects method. Pollen grains were identified by using the pollen reference slides of Ukraine, The Pollen Identification Key Program and The Pollen Atlas edited by the American National Aerobiology Bureau.[13,14] Pollen sampling and identification were harmonized with the requirements of the

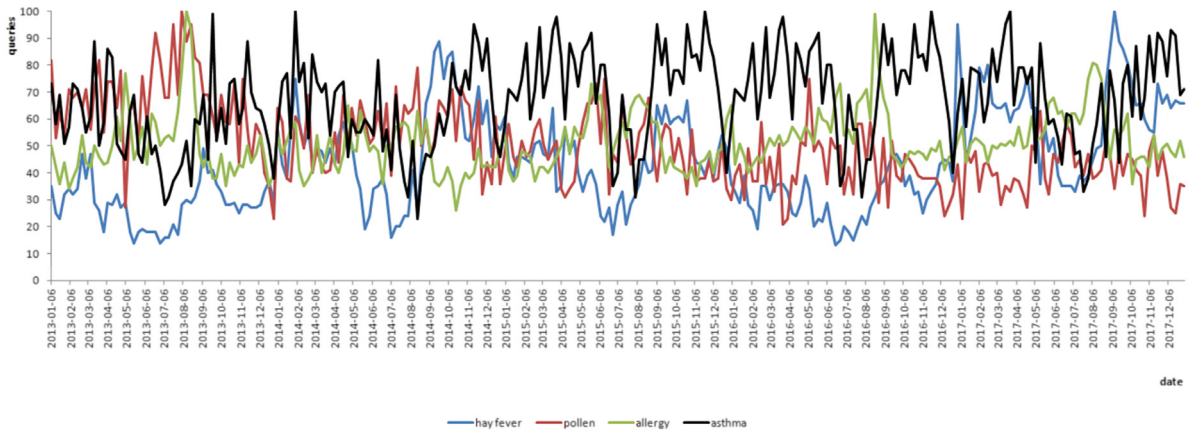

Fig. 1 Five-year Google Trends for allergy-related queries using manually translated terms (Cyrillic) in Ukraine

European Aerobiology Society and the European Aeroallergen Network.[15] The mean daily pollen count data were used for analysis of the airborne pollen spectrum from 2013 through 2016.

The grass pollen season and the grass high pollen season were determined as described in the position paper of the European Academy of Allergy and Clinical Immunology (EAACI).[16]

Average daily temperatures were obtained from the web-site http://gismeteo.ua.

Statistical analysis

Correlations were studied by Spearman (R) test. A probability of <0.05 was considered statistically significant.

RESULTS

The five-year GT queries graph for "hay fever", "allergy", "asthma", and "pollen" using manually translated terms is shown in Fig. 1. The query statistics for "hay fever" were assessed by the Cyrillic equivalent of "runny nose".[8] The peaks for "hay fever" and "pollen" were lower than those for "asthma". Thus, Ukraine had the "D" pattern.[12] Moreover, this seasonality was similar over the period of 5 years. The analysis of GT graphs revealed 2 major peaks of "allergy" queries – the first one (early summer), characteristic for grass pollen allergy, and the second one (late summer – early autumn), representative of the weed pollen season.

There was a strong positive correlation between the pairs "hay fever – asthma" ($R = 0.46$; $p = 0.01$), "pollen – allergy" ($R = 0.54$; $p = 0.01$), and "pollen – asthma" ($R = 0.46$; $p = 0.01$).

Further validation of "hay fever" and "grass" terms was provided by the comparison of these GT terms queries with the average daily temperature (Fig. 2). A strong positive correlation between the "grass" queries and the average daily temperature was observed ($R = 0.67$; $p = 0.01$). Analysis of the five-year graphs revealed that the peak of the "grass" queries came before the maximum of the average daily temperature.

The frequency of GT queries was compared with the average daily temperature and *Poaceae* pollen count (Fig. 3). Firstly, the time periods of the pollen exposure times were defined.

In 2013, the season of *Poaceae* pollination started on May 12, 2013 and ended on July 28, 2013. In 2014, the *Poaceae* pollen season lasted from May 11, 2014 until July 13, 2014. In 2015, the *Poaceae* pollen season lasted from May 17, 2015 until July 19, 2015. In 2016, the *Poaceae* pollen season lasted from June 3, 2016 until August 21, 2016.

To detect the grass peak high pollen seasons, unfortunately, when the concentration of *Poaceae* pollen ≥ 50 pollen/m^3 was used as a criterion, it was not possible to recognize the peak of the high grass pollen seasons. During the *Poaceae* pollen seasons, the highest pollen concentration in 2013 was 25.9 pollen m^{-3} (June 07); in 2014 was 48.7 pollen m^3 (June 06); in 2015 was 16.0 pollen/m^3

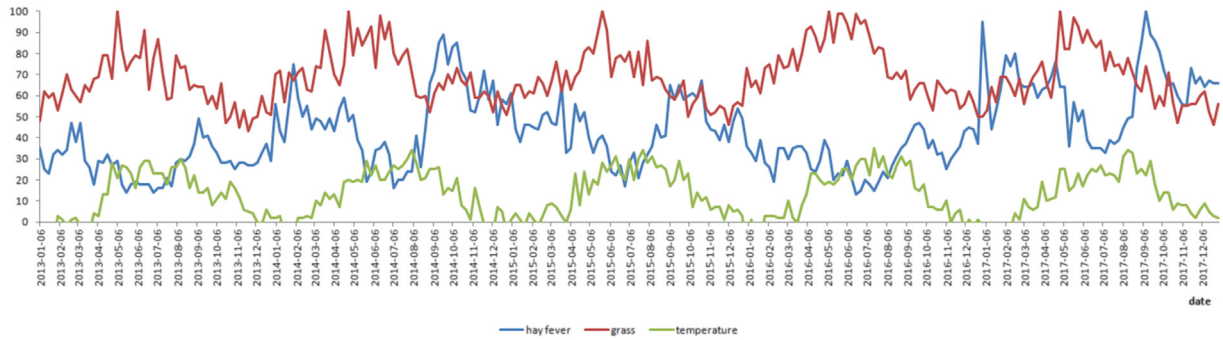

Fig. 2 Five-year Google Trends for "hay fever" and "grass" queries using manually translated terms (Cyrillic) and average daily temperature in Ukraine. y axis – GT queries per day and temperature °C

(June 21) and in 2016 was 11.1 grains/m^3 (July 10). Generally, the growth of allergy symptoms determined as increasing of GT queries was observed with pollen counts of more than 8 pollen/m^3.

There was a strong positive correlation between *Poaceae* pollen counts and "grass" ($R = 0.42$; $p = 0.01$) and "allergy" queries ($R = 0.47$; $p = 0.01$), and average daily temperature ($R = 0.72$; $p = 0.01$), and also between "allergy" and "grass" queries ($R = 0.55$; $p = 0.01$), and the average daily temperature ($R = 0.55$; $p = 0.01$).

DISCUSSION

In this study, the GT queries were examined, which could be used as Cyrillic equivalent terms to describe the grass pollen seasons in Ukraine. Using these terms, the GT queries were compared with *Poaceae* pollen counts and the meteorological parameter of the average daily temperature.

Our previous study showed that Ukrainian Google users apply the GT query "runny nose" ("nasmork" in Cyrillic) as "hay fever".[8] Recent investigations showed that Ukrainian users apply the GT query "travy" (in Cyrillic) as "grass". Thus, in further analysis, this Cyrillic equivalent was used.

In Ukraine, we needed to use "grass" ("travy" in Cyrillic) in addition to "allergy" and "hay fever" ("nasmork" in Cyrillic) to account for the pollen seasons. According to the GT queries profile, Ukraine had the "D" pattern in compliance with the classification by Bousquet J et al (2017).[12]

Analysis of GT graphs revealed the peak of "allergy" queries in early summer, characteristic for grass pollen allergy. There was a strong positive correlation between the "pollen", "allergy", and "asthma" queries.

The comparison of GT queries with average daily temperature revealed a peak of "grass" queries before the maximum of average daily temperature. The number of "grass" queries correlated with the average daily temperature.

We analyzed the four-year *Poaceae* pollination, which revealed that *Poaceae* pollen seasons in Ukraine were similar to those in the Berlin and Brandenburg areas. Nevertheless, it was not possible to recognize the peak high pollen seasons using a concentration ≥ 50 pollen m^{-3} as a criterion as recommended by the EAACI definition.[11]

According to our data, the allergy symptoms were associated with pollen counts of more than 8 pollen/m^3 in the Ukrainian population. Thus, the correlation between regional pollen counts and Google searches for pollen allergy related terms might be a useful approach to determine pollen level induced allergy symptoms.[17] These data parallel with the results of a large 5-year case-crossover study in Australia[2] where grass pollen counts of 4.8 pollen/m^3 were significantly associated with asthma exacerbations. A significant increase in asthma hospitalizations was observed for an interquartile range increase in grass pollen concentrations (5.9%, 95% CI:0.0, 12.0) in the Brussels region.[18]

In Poland, a high variation of the total annual concentrations of grass pollen was reported from 13.604 pollen/m^3 in 2003 to 185 pollen/m^3 in 2009.[19] Three categories of *Poaceae* pollen daily concentration were recognized: 1–10 pollen/m^3 –

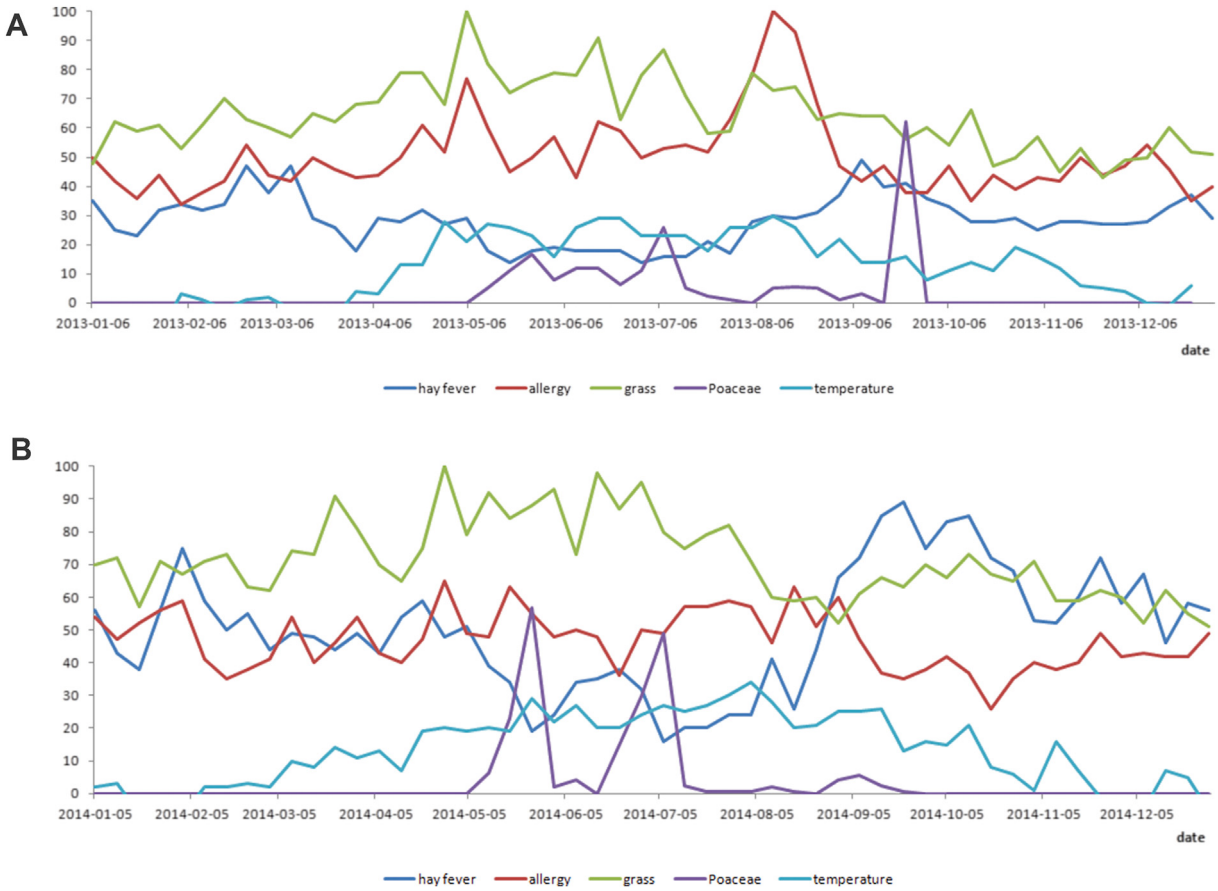

Fig. 3 Yearly profiles of Google Trends for "hay fever", "allergy", and "grass" queries, average daily temperature and *Poaceae* pollen count, A – 2013, B – 2014, C – 2015, D – 2016, y axis – GT queries per day; pollen count, grains m^{-3} and average daily temperature °C

symptoms in individual patients; 11–50 pollen/m^3 – symptoms in about 25% of patients, and >50 pollen/m^3 – symptoms in all patients.[20]

Generally, the pollen concentrations during the grass pollen seasons in Ukraine were lower than in 3 different European cities in the grass pollen season in 2015.[21]

Our study had some limitations including the location of the pollen within a large city which can interfere with pollen sedimentation.[22] In addition, the risk of allergy caused by *Poaceae* spp is much higher in the county rather than in the city.[23] Also our data supported the statement that predicting allergen exposure using GT alone could be valuable in those countries where limited pollen counting is available.[3]

We compared the four-year *Poaceae* pollination and GT queries, concluding that to account for grass pollen exposure by GT, 3 terms are required in Ukraine: "allergy", "grass", and "asthma" (in Cyrillic equivalents). The combination of GT tools with *Poaceae* pollen counts may also be used in large-scale epidemiological studies. For an accurate description of the *Poaceae* pollen season, average daily temperature is an important factor. The results of our study may be used in further development of the MACVIA-ARIA sentinel network,[9] especially for countries where the Cyrillic alphabet is used.

Our data can also be used for computation of grass pollen seasons and as a successful tool for allergy patients to prevent or minimize exposure to elevated pollen concentrations. This approach may also assist researchers, providing insight into various factors driving the pollen season. Moreover, thee data may improve the definition of the grass pollen season, which mirrors the symptom load for grass-pollen induced allergy. Allergen immunotherapy specialists can monitor GT query profiles in a specific geographic location to

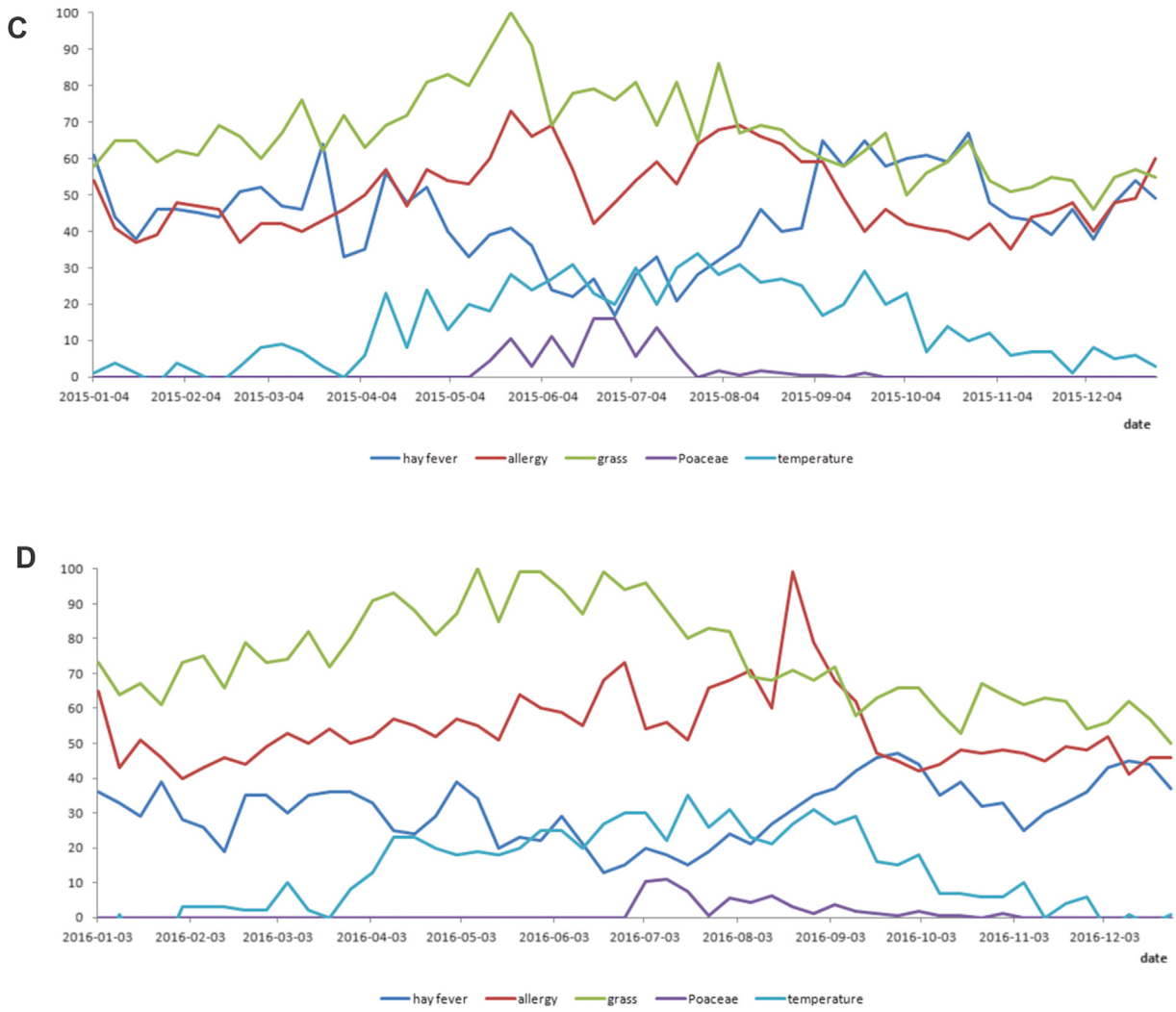

Fig. 3 Continued

determinatie the ideal time to begin allergen immunotherapy.

Abbreviations

GT: Google Trends; EAACI: The European Academy of Allergy and Clinical Immunology; MACVIA-ARIA: Contre les MAladies Chroniques pour un VIeillissement Actif (fighting chronic diseases for active and healthy ageing)-Allergic Rhinitis and its Impact on Asthma

Consent for publication, and availability of data and materials

All authors consent to the publication of this work. Contact the corresponding author for questions regarding data and materials.

Statement of ethics

The authors have no ethical conflicts to disclose.

Funding sources

The authors declare that no competing interests exist.

Author contributions

I. Kaidashev conducted and supervised the manuscript development; H. Morokhovets provided the Google Trends search and statistical processing of the results; V. Rodinkova managed the process of pollen count; L. Dubuske and J. Bousquet designed the conceptual framework of the present research.

Declaration of competing interest

The authors have no conflicts of interest to declare.

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