Institution: University of Worcester

Unit of Assessment: 5 Biological Sciences

Title of case study: Improving outcomes for people experiencing seasonal respiratory allergies through refining pollen and fungal spore forecasts

Period when the underpinning research was undertaken: 2000-2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Professor Jean Emberlin	Professor of Aerobiology	1994-2010
Dr Beverley Adams-Groom	Chief Palynologist and Research Fellow	1995-present
Dr Matthew Smith	Research Fellow	2004-2011
Professor Roy Kennedy	Professor of Plant and Microbial Science	2011-2016
Professor Carsten Skjoth	Professor of Atmospheric Sciences	2012-present

Period when the claimed impact occurred: Aug 2013 - Dec 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

Seasonal Respiratory Allergies such as Hay Fever have significant health and economic costs for the UK, as well as negative impacts for individual sufferers. Research has enabled the development of increasingly detailed forecasts and calendars for allergens (pollen and fungal spores) which allow sufferers to make more informed decisions about their day-to-day activity and their medication improving their quality of life, whilst also informing the practice of allergy clinicians, allergy charities and businesses.

2. Underpinning research

The University of Worcester has produced pollen forecasts since 1995 based on the research of its *Pollen and Aerobiology Research Group*. Over a period of 20+ years, the group's research has underpinned the development of increasingly refined forecasts, through:

(i) ***Development of pollen assay methods***
Expertise in preparation of air sampled material and in pollen allergen detection using immunoassays has been developed to a very high level for several pollen types. The most important of these, grasses, have been the focus of an international project to detect the presence of grass pollen allergens in the air compared to the amount of whole pollen (Reference 1, Grants a, b & c).

(ii) ***Increasing understanding of the spatial distribution of source plants***
Research has focused on identifying source areas using various mapping methods, for example: satellite mapping techniques have determined that small woodlands are the key sources of three important UK allergens (Reference 2, Grant d); whilst twelve allergenic pollen types were mapped through analysis of land cover maps (Reference 3).

(iii) ***Identification of spatial and temporal patterns of allergens in the atmosphere (including fungal spores)***
Research has shown that pollen seasons are very variable in their onset and severity both spatially and temporally (Reference 4). Further, several studies have revealed more on the temporal patterns of fungal spores, which currently affect around 10% of

respiratory allergy sufferers, leading to the development of a calendar which provides detail on specific spore types (Reference 5, Grant d).

(iv) ***Development of molecular detection methods for determining specific species in the atmosphere***

Until very recently, it has been difficult to detect individual species of grass pollen in the air, since traditional methods of detection using microscopy could only arrive at genus level identification. NERC-funded research has used molecular detection techniques to successfully determine which species of grass pollen are airborne, where they occur in the UK and the extent of their contribution to the atmospheric pollen load (Reference 6, Grant e).

This research has enabled a detailed presentation of the spatial and temporal distribution of tree, grass and weed pollen types at a UK regional level (regional pollen calendars) and has enhanced pollen forecasting and led to the development of fungal spore calendars and forecasts at the level of the spore type.

3. References to the research

1. Buters, J.T.M., Prank, M., Sofiev, M., Pusch, G., Albertini, R., Annesi-Maesano, I., Antunes, C.M., Behrendt, H., Berger, U., Brandao, R., Celenk, S., Galán, C., Grewling, L., Jackowiak, B., Kennedy, R, Rantio-Lehtimäki, A., Reese, G., Sauliene, I., Smith, M., Thibaudon, M., Weber, B. and Cecchi, L. (2015) Variation of the Group 5 Grass Pollen Allergen Content of Airborne Pollen in Relation to Geographical Location and Time in Season. Journal of Allergy and Clinical Immunology, 136 (1). pp. 87-95. https://doi.org/10.1016/j.jaci.2015.01.049
2. Skjøth CA, Baker P, Sadys M & Adams-Groom B. (2015) Pollen from alder (Alnus sp.), birch (Betula sp.) and oak (Quercus sp.) in the UK originate from small woodlands. Urban climate, 14: 414-428. https://doi.org/10.1016/j.uclim.2014.09.007
3. McInnes RN, Hemming D, Burgess P, Lyndsay D, Osborne NJ, Skjøth C, Thomas S, Vardoulakis S. (2017) Mapping Allergenic Pollen Vegetation in UK to Study Environmental Exposure and Human Health. Science of the Total Environment, 599: 483-499. https://doi.org/10.1016/j.scitotenv.2017.04.136
4. Grundström M, Adams-Groom B, Pashley CH, Dahl Å, Rasmussen K, de Weger LA, Thibaudon M, Fernández-Rodríguez S, Silva-Palacios I, Skjøth CA. Oak pollen seasonality and severity across Europe and modelling the season start using a generalized phenological model. Science of the Total Environment 2019; 663: 527-536. https://doi.org/10.1016/j.scitotenv.2019.01.212
5. Skjøth C, Damialis A, Belmonte J, De Linares C, Fernández-Rodríguez S, Grinn-Gofroń A, Jędryczka M, Kasprzyk I, Magyar D, Myszkowska D, Oliver G, Páldy A, Pashley CH, Rasmussen K, Satchwell J, Thibaudon M, Tormo-Molina R, Vokou D, Ziemianin M and Werner M. (2016) Alternaria Spores in the Air Across Europe: Abundance, Seasonality and Relationships with Climate, Meteorology and Local Environment. Aerobiologia, 32 (1): 3-22. https://doi.org/10.1007/s10453-016-9426-6
6. Brennan GL, Potter C, de Vere N, Griffith GW, Skjøth CA, Osborne NJ, Wheeler BW, McInnes RN, Clewlow Y, Barber A, Hanlon HM, Hegarty M, Jones L, Kurganskiy A, Rowney FM, Armitage C, Adams-Groom B, Ford Col R, Petch GM, The PollerGEN Consortium & Creer S. (2019) Temperate airborne grass pollen defined by spatio-temporal shifts in community composition. Nature Ecology and Evolution. 3 (5): 750-754. https://doi.org/10.1038/s41559-019-0849-7

Grants

a. Jean Emberlin (Co-I), SPRING (System for Pollen Related Information Gathering), eTEN, EU Framework Programme), (01/2001-07/2002), €490,000.

b. Jean Emberlin (Co-I), MONALISA (MOnitoring Network of Allergens by Immuno-Sampling), Life, EU Framework Programme, (01/2005-04/2008), €667,362.

c. Jean Emberlin (Co-I), HIALINE (Health Impacts of Airborne Allergen Information Network) Health, EU Framework Programme, (01/2009-01/2012), €878,926.

d. Carsten Skjøth (PI) SUPREME, Marie Curie Career Integration Grant, EU Framework Programme, (07/2014-06/2018), £88,047.

e. Carsten Skjøth (Co-I) PollerGEN, National Environmental Research Council, (03/2016-12/2020), £166,373.

Output 6 is included in the UOA5 output submission; outputs 3 and 5 are included in the UOA14 output submission. All outputs were subject to peer review as set out in the University's REF2021 Code of Practice and identified as of at least 2* standard.

4. Details of the impact

Around 10 million people in the UK suffer from seasonal respiratory allergies (SRAs), most commonly hay fever, triggered by pollen or fungal spores. A Met Office survey in 2016 estimated that hay fever cost the UK 29 million lost working days per annum due to sickness absence or reduced productivity. Whilst a hay fever "attack" can be a miserable experience for anybody, it can be fatal for asthma sufferers (an estimated 80% of whom also have hay fever). SRAs thus have very significant health and economic costs for the UK.

One effective way for people to manage their SRAs and mitigate the impact of their condition is to use forecasts to limit their exposure to pollen and spores (e.g. by staying in on days with high counts) and to understand the best time to take appropriate medication. As research has enabled calendars and forecasts to become progressively more detailed, this has allowed sufferers to take an increasingly nuanced approach to limiting exposure, has enabled clinicians to develop more personalised treatments, has benefitted allergy charities in providing information to their users and pharmaceutical companies and other businesses in providing advice and guidance on the use of their allergy medications.

The primary disseminator of the UK Pollen Forecast is the Met Office whilst in Ireland it is Met Eireann. The Pollen and Aerobiology Research Group has supplied the pollen forecast to the Met Office for over 20 years and to Met Eireann for over 15 years. It has also worked collaboratively with the Met Office to enhance the forecast through research projects. Testimony from the Met Office's strategic lead for all health-related research and services is explicit in stating the role the group has played in enhancing the quality and accuracy of the pollen forecasts (Source A).

The Met Office forecast has very significant reach through its forecast pages and its Twitter account. In 2018, for example, its pollen forecast received 1.3 million page-views; whilst in 2019, its Twitter account recorded just under 9 million impressions and 95,000 engagements (Source B). It should be noted that the Met Office forecast also underpins more general forecasts presented by, for example, the BBC and traditional "print" media such as the Daily Telegraph. In addition, the University of Worcester provides its own detailed pollen forecast and calendar pages, which received over 50,000 page-views in 2019 (Source C).

Adams-Groom, the UK's chief pollen forecaster, plays a key role in increasing public understanding of pollen and spore forecasts and their value to SRA sufferers. She is prominent during the pollen season in national and regional newspapers (print and online), including the Mail Online and The Guardian online which each reach approximately 2 million people, online news providers such as Sky and Yahoo, magazines such as *Good Housekeeping*, and national and local radio. In 2019, for example, she had 376 media engagements (Source D).

To elaborate on the benefits for the various users of pollen forecasts and calendars:

(i) Benefits to SRA sufferers

A survey of SRA sufferers using the University's pollen information pages identified the following range of benefits (Source E):

- Alleviation or prevention of symptoms by using pollen/spore calendars to plan activities, such as travel, holidays, etc. to avoid peak periods or high pollen areas.
- Alleviation or prevention of symptoms by using pollen/spore calendars to plan when to take medication.
- Reduction in hospitalization due to asthma attacks.
- Increased understanding that symptoms are pollen-induced, rather than something else. In Spring 2020 when Covid-19 was prevalent, people used the pollen calendars to check whether or not their symptoms were likely to be triggered by pollen, particularly as the peak of the tree pollen season coincided with peak Covid-19 cases.
- Ability to plan outside activities and exercise, with the health and well-being benefits these bring, by avoiding high risk periods.
- Allowing people to feel more in control of their allergy.

(ii) Benefits to clinicians

Clinicians can use enhanced pollen and spore information to provide a more personalised service to SRA patients. The unit works closely with Worcestershire Acute Hospitals NHS Trust to provide patients in the region with this information, e.g. through a dedicated Worcester Allergy Twitter account. Testimonies from a Consultant on respiratory medicine and a Consultant Paediatrician at Worcestershire Acute Trust set out how nuanced pollen information benefits their practice (Source F and G).

(iii) Benefits to allergy charities

The unit has provided data for allergy charities, such as the Asthma Society for Ireland. Pollen forecast information provided by the unit has informed their campaigns to increase understanding of hay fever and its impact on asthma and underpinned their pollen tracker launched in Summer 2020 (Source H).

(iv) Benefits to businesses

The unit has also provided pollen forecast data for a range of businesses, including pharmaceutical companies (e.g. Sanofi) and businesses providing environmental data to their customer base (e.g. Breezometer). Testimonies from these companies show how they have used this data to improve the service they provide for customers (Source I).

5. Sources to corroborate the impact

A. Testimony from Relationship Manager (Research and Health), Met Office

B. Data on user engagement with Met Office Forecast webpages and Met Office Twitter account

C. Data on user engagement with the University of Worcester's Pollen Forecast pages

D. Data on Adams-Groom's media engagement

E. Data from a 2020 survey of users of the University of Worcester Pollen and Spore calendars

F. Testimony from Consultant Respiratory Physician, NHS Worcester Acute Hospitals Trust

G. Testimony from Consultant Paediatrician, NHS Worcester Acute Hospitals Trust

H.	Weblink to Asthma Society of Ireland pollen tracker: https://www.asthma.ie/about-asthma/living-well-with-asthma/lifestyle/asthma-hay-fever
I.	Testimony from Breezometer