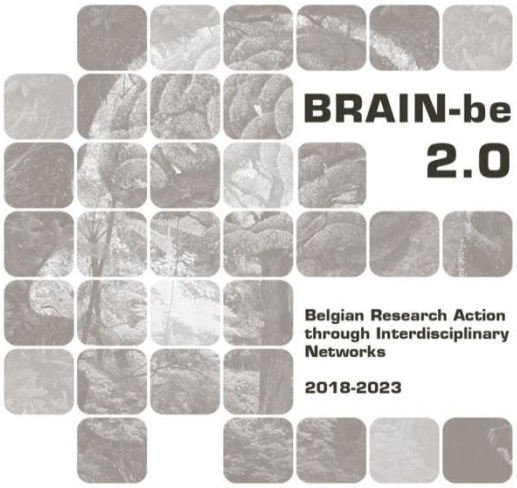

RETROPOLLEN

Reconstructing four decades of spatio-temporal airborne pollen levels for Belgium to assess the health impact

Contract - B2/191/P2/ RETROPOLLEN

Summary

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Context

Worldwide, allergic respiratory diseases are increasing, with pollinosis affecting about a quarter of European adults and a third of children. Anthropogenic emissions and climate change amplify immune responses and biogenic pollen emissions, affecting patients with asthma or cystic fibrosis (CF) badly. Globally, air pollution has caused 4.2 million premature deaths in 2019 (WHO). Patients with rhinitis symptoms and asthma can only take optimal measures if they know their potential exposure risk at the place of residence requiring forecasting systems of pollen levels some days in advance and if the effects on public health are well understood.

Objectives & Methods

The overall aim of RETROPOLLEN is to assess public health effects of airborne pollen of birches and grasses in relation to surface air pollution, weather and climate change in Belgium using up to four decades of historical observations in an interdisciplinary consortium of universities, medical institutes and governmental research structures. This is accomplished by

(i) reconstructing the spatio-temporal distributions of airborne pollen levels of birches and grasses near the surface in Belgium based on the pollen transport model SILAM (operational at the RMI) by ingesting meteorological datasets and four decades of land-use and land-use change data combined with long time series of vegetation indices derived from satellite remote sensing platforms.

(ii) compiling and making available historical datasets on airborne pollen observations (from 1982 on, Sciensano), medical data on patients suffering from cardiovascular and respiratory diseases including rhinitis, asthma and cystic fibrosis (from Erasme-ULB hospital & Zeepreventorium De Haan), data on economical, sociological and mortality rates of inhabitants of Belgium (STATBEL), surface air pollution data (IRCEL-CELINE) and meteorological data (RMI).

(iii) evaluating the impact of (co-)exposure to pollen with air pollutants and meteorological processes on the public health based on statistical health and epidemiology models (UHasselt).

Ultimately, a robust forecast model for pollen levels and new insights for prevention measures against pollinosis in Belgium was aimed at, potentially leading to the development of a pollen app for Belgium including new insights in the critical allergy threshold of pollen levels in combination with unfavourable conditions of air pollution and meteorology.

Results, conclusions and recommendations

We report that for 2,000 birch pollen/m^3 and 100 grass pollen/m^3, the lung function decreased by 4.4% and 7.6% in patients with cystic fibrosis, and 5.8% in patients with asthma for birch pollen, posing significant health impacts. Stronger birch pollen effects with particulate matter emphasize the need for public health measures to protect vulnerable groups from ambient pollutants.

This study further analyzed natural mortality in all Belgian municipalities, encompassing a population of 11,697,557 inhabitants (2023). Individuals residing in Belgium at the time of their death between 1992 and 2022, were included. Birch pollen exposure increased the odds of all-cause mortality with 4.5% at a

concentration of 2,000 grains/m³. Synergistic effects under extreme weather and with higher surface ozone concentrations were found, emphasizing significant health impacts of pollen in the context of climate change and air quality.

Finally, during the RETROPOLLEN project a robust forecast model for birch and grass pollen levels near the surface was developed. It provides a 4-day forecast that is now continuously disseminated to the public at large using the RMI website and weather app, and via the AirAllergy app and website of Sciensano. During the final course of the project also alder pollen forecasts were made available and the forecast of mugwort pollen is scheduled for operations in 2025.

Patients with respiratory diseases may benefit from more research considering additional allergenic pollen types, and pollen forecasts at more detailed spatial resolutions, i.e. at the scale of citizens. This requires the development and integration of very detailed pollen emission source maps with very detailed meteorological data fields into the pollen transport model. Also the potential roles of heat waves and thunderstorm-asthma conditions in combination with pollen exposure on the public health must be investigated into more detail. What is more, also complex processes that might affect the variability in the allergenic power of pollen due to various environmental factors must be investigated and unraveled (Daelemans et al., 2025). Integrating these allergenic power of pollen with pollen amounts and air pollution data into the pollen forecasting model might inform patients with respiratory diseases about the allergy impact on a timely manner for the location they live.

Keywords
Airborne birch and grass pollen levels, air pollution, meteorology, climate, forecasts, public health