Table S1: Areas of study, their main climatic characteristics and European Aeroallergen Network monitoring stations included.

|  |  |  |
| --- | --- | --- |
| **Region** | **Climatic characteristics** | **EAN stations** |
| Pannonian lowlands region of Austria | Climate with a continental influence, characterized by hot summers but only moderately cold winters | Vienna, Oberpullendorf, Bad Tatzmannsdorf |
| Southern region of Finland | Continental sub-arctic climate, characterized by cold winters yet with more mild and wet summers | Turku, Turku2, Helsinki, Helsinki-Pasila, Tampere |
| Rhône-Alps region of France | Variable climate that includes hot and in many cases humid summers and mild to cold winters | Annecy, Annemasse, Aurillac, Bourg en Bresse, Bourgoin, Chalon-sur-Saone, Chambery, Clermont-Ferrand, Gap, Grenoble, Lyon, Lyon2, Montluçon, Roussillon, Saint-Etienne |

Table S2a: Basic descriptive statistics (minimum [min], maximum [max], mean and standard deviation [std]) for daily averaged birch and grass pollen concentration levels and TNSMS for the Pannonian lowlands region of Austria and for the years 2014, 2015, 2016. Pollen concentrations are calculated as the average of the monitoring stations employed, and are rounded to the nearest integer; TNSMS is rounded to the nearest first decimal.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year 2014 | | | | |
|  | **min** | **max** | **mean** | **std** |
| Birch | 0 | 857 | 29 | 114 |
| Grass | 0 | 117 | 11 | 22 |
| TNSMS | 0.2 | 3.3 | 1.3 | 0.7 |
| Year 2015 | | | | |
|  | **min** | **max** | **mean** | **std** |
| Birch | 0 | 438 | 11 | 50 |
| Grass | 0 | 161 | 13 | 27 |
| TNSMS | 0 | 3.5 | 1.5 | 0.7 |
| Year 2016 | | | | |
|  | **min** | **max** | **mean** | **std** |
| Birch | 0 | 1616 | 28 | 150 |
| Grass | 0 | 74 | 7 | 14 |
| TNSMS | 0 | 3.7 | 1.5 | 0.8 |

Table S2b: Basic descriptive statistics (minimum [min], maximum [max], mean and standard deviation [std]) for daily averaged birch and grass pollen concentration levels and TNSMS for the southern region of Finland and for the years 2014, 2015, 2016. Pollen concentrations are calculated as the average of the monitoring stations employed, and are sounded to the nearest integer; TNSMS is rounded to the nearest first decimal.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year 2014 | | | | |
|  | **min** | **max** | **mean** | **std** |
| Birch | 0 | 17078 | 213 | 1250 |
| Grass | 0 | 71 | 3 | 9 |
| TNSMS | 0.5 | 5.1 | 2.5 | 0.9 |
| Year 2015 | | | | |
|  | **min** | **max** | **mean** | **std** |
| Birch | 0 | 661 | 11 | 58 |
| Grass | 0 | 75 | 4 | 11 |
| TNSMS | 0.4 | 5.3 | 2.8 | 0.8 |
| Year 2016 | | | | |
|  | **min** | **max** | **mean** | **std** |
| Birch | 0 | 2543 | 46 | 261 |
| Grass | 0 | 69 | 3 | 8 |
| TNSMS | 0.5 | 3.8 | 2.4 | 0.7 |

Table S2c: Basic descriptive statistics (minimum [min], maximum [max], mean and standard deviation [std]) for daily averaged birch and grass pollen concentration levels and TNSMS for the Rhône-Alps region of France and for the years 2014, 2015, 2016. Pollen concentrations are calculated as the average of the monitoring stations employed, and are sounded to the nearest integer; TNSMS is rounded to the nearest first decimal.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year 2014 | | | | |
|  | **min** | **max** | **mean** | **std** |
| Birch | 0 | 385 | 17 | 58 |
| Grass | 0 | 194 | 22 | 42 |
| TNSMS | 0.3 | 4 | 2 | 0.8 |
| Year 2015 | | | | |
|  | **min** | **max** | **mean** | **std** |
| Birch | 0 | 339 | 8 | 37 |
| Grass | 0 | 357 | 27 | 57 |
| TNSMS | 0 | 4.5 | 2 | 1.1 |
| Year 2016 | | | | |
|  | **min** | **max** | **mean** | **std** |
| Birch | 0 | 283 | 13 | 39 |
| Grass | 0 | 196 | 25 | 45 |
| TNSMS | 0.3 | 4.7 | 2.5 | 0.8 |

Table S3a: Pollen Season (PS) and Peak Pollen Period (PPP) start and end for birch and for the three years of study for all countries-regions. Numbers indicate calendar days.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Area** | **Pannonian lowlands region of Austria** | | | **Southern region of Finland** | | | **Rhône-Alps region of France** | | |
| **Year** | **2014** | **2015** | **2016** | **2014** | **2015** | **2016** | **2014** | **2015** | **2016** |
| **PS start** | 76 | 97 | 86 | 107 | 116 | 117 | 77 | 97 | 90 |
| **PS end** | 109 | 118 | 130 | 149 | 148 | 162 | 115 | 118 | 132 |
| **PPP #1** | 78-84 | 99-106 | 90-98 | 112-128 | 125-130 | 123-136 | 88-98 | 102-106 | 101-103 |
| **PPP #2** | 85-98 | 109-114 | 102-107 | 130-143 |  |  | 100-105 |  |  |

Table S3b: Pollen Season (PS) and Peak Pollen Period (PPP) start and end for grass and for the three years of study for all countries-regions. Numbers indicate calendar days.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Area** | **Pannonian lowlands region of Austria** | | | **Southern region of Finland** | | | **Rhône-Alps region of France** | | |
| **Year** | **2014** | **2015** | **2016** | **2014** | **2015** | **2016** | **2014** | **2015** | **2016** |
| **PS start** | 116 | 111 | 125 | 153 | 152 | 151 | 100 | 102 | 115 |
| **PS end** | 207 | 260 | 220 | 223 | 241 | 217 | 251 | 208 | 252 |
| **PPP #1** | 138-145 | 137-139 | 146-168 | 188-190 | 181-186 |  | 136-144 | 129-133 | 146-149 |
| **PPP #2** | 162-170 | 150-167 |  |  |  |  | 148-168 | 136-138 | 155-164 |
| **PPP #3** |  |  |  |  |  |  | 170-173 | 140-159 | 171-193 |
| **PPP #4** |  |  |  |  |  |  | 176-179 | 179-185 |  |

Table S4a: Pearson and Spearman correlation coefficient between the TNSMS and the pollen concentration levels for birch, calculated for the years 2014, 2015 and 2016 and for the PS start to PS end period per year for the Pannonian lowlands region of Austria (AU), the Southern region of Finland (FI) and the Rhône-Alps region of France (FR). Correlation coefficients marked with an asterisk indicate values that are statistically significant.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **2014** | | | **2015** | | | **2016** | | |
| **Region** | AU | FI | FR | AU | FI | FR | AU | FI | FR |
| **rPearson** | 0.78\* | 0.71\* | 0.68\* | 0.61 | -0.03 | 0.63\* | 0.74\* | 0.62\* | 0.55\* |
| **rSpearman** | 0.82\* | 0.84\* | 0.74\* | 0.69\* | 0.01 | 0.71\* | 0.81\* | 0.50 | 0.59\* |

Table S4b: Pearson and Spearman correlation coefficient between the TNSMS and the pollen concentration levels for grass, calculated for the years 2014, 2015 and 2016 and for the PS start to PS end period per year for the Pannonian lowlands region of Austria (AU), the Southern region of Finland (FI) and the Rhône-Alps region of France (FR). Correlation coefficients marked with an asterisk indicate values that are statistically significant.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **2014** | | | **2015** | | | **2016** | | |
| **Region** | AU | FI | FR | AU | FI | FR | AU | FI | FR |
| **rPearson** | 0.79\* | 0.55\* | 0.54\* | 0.60\* | 0.48\* | 0.50\* | 0.67\* | 0.09 | 0.25 |
| **rSpearman** | 0.77\* | 0.51\* | 0.41\* | 0.34\* | 0.19 | 0.38\* | 0.65\* | 0.07 | 0.11 |

## S1: correlation calculations

The estimation of the relationship of pollen concentrations and other environment-related parameters like meteorological conditions has been done with the aid of several correlation coefficients (1), while the same approach has been employed in the analysis of relationships between pollen concentrations and related symptoms (2, 3, 4). For this reason, as well as for being compliant with the analysis done by Karatzas et.al in (5), the investigation of the relationship between pollen concentration levels and TNSMS in our study firstly employs the Pearson’s product-moment correlation coefficient (or Pearson correlation coefficient, for short). This coefficient is used here as a relative measure of association, yet without presupposing any linear dependency between the studied parameters, and is calculated according to the following formulae:

(1)

where represents the TNSMS, represents pollen concentration levels and the number of available data records per year of study.

The Pearson’s correlation coefficient tries to “draw” a line of best fit among the data points of the couple of parameters being studied, in an effort to determine if there is a linear component of association between two variables. As we do not presuppose the existence of such a relationship, and in order to investigate how well a monotonic function can describe the relationship between the studied parameters, the Spearman rank-order correlation coefficient was also applied, calculated as follows:

(2)

where represents the difference between the two sets of data, and , denoting that both datasets are ranked from higher to lower values (6), and and represents TNSMS and pollen concentrations respectively. It should be noted that Spearman's correlation is the nonparametric version of the Pearson product-moment correlation and measures the strength and direction of association between two ranked variables.

In order to complement the correlation coefficient calculations, the p-values for a significance level of a=0.001 were calculated. Therefore, if the p value is smaller than a, then the association resulting from the corresponding correlation coefficient is considered statistically significant.

## S2: graphical representation and investigation of data

The descriptive statistics of the parameters of interest (Tables S2a-c) provided information on their value range: there are differences in the magnitude of the parameters involved in the analysis, (pollen concentration levels exceeding one thousand while symptom data not being able to exceed the value of ten), and for this reason we decided to normalize the data, so that they will all have a zero minimum and a maximum equal to one. For each one of the initial parameters of interest, a normalized parameter was estimated, calculated as follows:

(3)

where and are the maximum and minimum values, is the initial value and is the normalized value for each pollen and symptom data value included in the analysis.

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