# Comparison of Artemisia L. pollen concentrations and risk of development of allergy symptoms in different regions of Poland in 2020

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**Abstract:**

In Central Europe, mugwort pollen is a frequent cause of pollen allergy. Poland is one of the countries with the highest airborne concentrations of pollen of this taxon. Due to its high allergenic potential, *Artemisia* pollen may pose a significant threat to sensitive subjects during summer months. Plants from this genus often grow in urban and suburban areas.

The aim of the study was to compare mugwort pollen seasons and concentrations of airborne pollen of these plants in 12 cities located in different regions of Poland: Bialystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Opole, Piotrkow Trybunalski, Sosnowiec, Szczecin, Warsaw, Wroclaw, and Zielona Gora. The investigations were carried out with the volumetric method using a Hirst-type pollen sampler (Lanzoni or Burkard) operating on a 24-hour basis. The duration of the pollen season was determined with the 98% method. The earliest onset of the mugwort pollen season was noted in Opole (July 12$^{th}$), and the latest beginning was recorded in Cracow and Sosnowiec (July 23$^{th}$). The maximum pollen concentrations were reported on August 7$^{th}$ and 8$^{th}$ in Lublin (177 grains/m$^3$) and Wroclaw (100 grains/m$^3$). In all the cities, peak days were recorded on the first 10 days of August. The maximum pollen concentrations in the other cities were in the range of 18–89 grains/m$^3$. The highest annual pollen sum was recorded in Lublin (1423) and Wroclaw (1050). These values coincided with the highest pollen concentrations determined in these cities.

The annual *Artemisia* pollen sums in 2020 did not have the highest values in comparison with other years in these cities. The average annual pollen sum in the five-year period of 2001–2005 was estimated at 2065 in Lublin and 1662 in Wroclaw. Therefore, it can be concluded that the risk of mugwort pollen allergy in the pollen season 2020 was lower than in some previous years.

**Key words:** aeroallergens, pollen season, *Artemisia*, Central Europe, 2020

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## Introduction

In Poland, in addition to grass and birch pollen allergens, mugwort pollen is a frequent cause of allergic reactions in the upper respiratory tract [1]. It has been shown that symptoms of *Artemisia* pollen allergy affect 25% of adolescents aged 12–16 living in a large city [2]. The mugwort pollen has been classified as a high-allergenicity factor [1].

The genus *Artemisia* comprises 57 species growing in Europe [3]. A majority of species representing this taxon grow in warm and dry areas. Some of them form the main plant cover of steppes, while others are weeds, ruderal plants, and usable plants. The wormwood (*Artemisia absinthium*) and tarragon (*Artemisia dracunculus*) are seasoning and medicinal plants [4]. Many species of this genus occur in urban and suburban areas [5].

The mugwort (*Artemisia vulgaris*), which is a nitrophilic ruderal plant, is the most common species in Poland. It grows in wastelands, railway areas, landfills, field margins, roadsides, arable fields, ditches, and near rivers. The mugwort reaches 50–220 cm in height. Its stems are furrowed, highly branched, glabrous in the lower part, and woolly-haired in the upper part. It flowers from July to September [6].

As a medicinal plant, the mugwort is used to alleviate digestive problems. However, it can be toxic when used in larger amounts. Its essential oil is used to flavor soaps, dishwashing liquids, and washing powders [7]. Some components of the oil exhibit bacteriostatic and anticancer properties [8].

As demonstrated by some authors, the maximum annual sums of mugwort pollen in Europe reach almost 2300. The highest concentrations are recorded in Poland and Lithuania [9]. Very high total annual concentrations of *Artemisia* pollen grains were reported in 2003, i.e. 2533 in Lublin and 2309 in Sosnowiec [10]. High concentrations of mugwort pollen are most frequently recorded in the first half of August [1]. The first allergy symptoms develop at an airborne concentration of 30 grains/m$^3$ in subjects with hypersensitivity to mugwort pollen allergens and at 55 grains/m$^3$ in most patients. In turn, acute clinical symptoms appear at exposure to a concentration of 70 grains/m$^3$ [11].

## Aim

The aim of the study was to compare the course of pollen seasons and determine the risk of allergy to mugwort pollen in 12 Polish cities located in different regions of the country.

## Material and method

The aerobiological tests were carried out in 2020 in the following cities: Bialystok, Bydgoszcz, Cracow, Lublin, Olsztyn, Opole, Piotrkow Trybunalski, Sosnowiec, Szczecin, Warsaw, Wroclaw, and Zielona Gora. Aerosol samples were collected volumetrically using a Hirst-type pollen sampler (Lanzoni and Burkard) operating on a 24-hour basis in a 7-day cycle. Pollen was identified and quantified with the use of a light microscope in alkaline fuchsin-stained preparations. Microscopic analyses were carried out in accordance with the recommendations of the European Aerobiology Society [12].

The length of the pollen season was determined with the 98% method. The pollen grain concentrations are presented as the number of pollen grains in 1 m$^3$ of air (grains/m$^3$) per day. The onset, end, and length of the pollen season were determined in each city. The maximum daily concentration and peak date were recorded and the annual pollen grain sum was calculated. The risk of allergy was determined at three pollen concentration levels. The study results are presented in a table and the dynamics of the seasons is represented graphically.

## Results

The earliest onset of the *Artemisia* pollen season in 2020 was recorded in Opole (July 12$^{th}$), Piotrkow Trybunalski (July 14$^{th}$), and Olsztyn (July 15$^{th}$). The latest onset was noted in Cracow and Sosnowiec (July 23$^{th}$) (tab. 1). The earliest and latest end of the pollen season was recorded in Lublin (September 1$^{st}$) and Bialystok (September 30$^{th}$), respectively.

High concentrations of mugwort pollen were noted in all cities in the first half of August, and their maximum values were recorded at most measurement stations on August 7$^{th}$ and 8$^{th}$ (tab. 1, fig. 1–6). Very high maximum pollen concentrations were noted in Lublin and Wroclaw, i.e. 177 grains/m$^3$ and 100 grains/m$^3$, respectively. In turn, the lowest concentration of *Artemisia* pollen was recorded in Bialystok (18 grains/m$^3$). The values of pollen concentrations in the other cities were in the range of 46–89 grains/m$^3$.

The highest annual pollen sum of daily concentrations was recorded in Lublin (1423) and in Wroclaw (1050). The lowest values of this parameter were noted in Bialystok (218) followed by Cracow (409) and Szczecin (423).

The number of days with a pollen concentration above 30 grains/m$^3$ ranged between 5 (Cracow, Olsztyn) and 15 (Lublin). A high risk of occurrence

**Table 1.** *Characteristics of mugwort pollen season in 2020.*

| Site | Pollen season period by the 98% method | Peak value [grains/m³] | Peak date | Days number with concentration above threshold | | | Annual pollen sum |
|---|---|---|---|---|---|---|---|
| | | | | 30 grains/m³ | 55 grains/m³ | 70 grains/m³ | |
| **Bialystok** | 16.07–30.09 | 18 | 7.08 | 0 | 0 | 0 | 218 |
| **Bydgoszcz** | 17.07–19.09 | 46 | 8.08 | 8 | 0 | 0 | 608 |
| **Cracow** | 23.07– * | 58 | 8.08 | 5 | 1 | 0 | 409 |
| **Lublin** | 19.07–1.09 | 177 | 7.08 | 15 | 7 | 6 | 1423 |
| **Olsztyn** | 15.07–23.09 | 57 | 7.08 | 5 | 1 | 0 | 584 |
| **Opole** | 12.07–24.09 | 54 | 6.08 | 6 | 0 | 0 | 647 |
| **Piotrkow Trybunalski** | 14.07–25.09 | 58 | 7.08, 11.08 | 8 | 2 | 0 | 717 |
| **Sosnowiec** | 23.07–20.09 | 58 | 7.08 | 6 | 1 | 0 | 552 |
| **Szczecin** | 19.07–10.09 | 47 | 8.08 | 4 | 0 | 0 | 423 |
| **Warsaw** | 18.07–24.09 | 89 | 3.08 | 13 | 4 | 2 | 979 |
| **Wroclaw** | 18.07–7.09 | 100 | 8.08 | 12 | 8 | 6 | 1050 |
| **Zielona Gora** | 20.07–25.09 | 67 | 7.08 | 8 | 1 | 0 | 626 |

* In the period 1–14.09 a damage of the pollen trap.

**Figure 1.** *Mugwort pollen concentration in Bialystok and Olsztyn in 2020.*

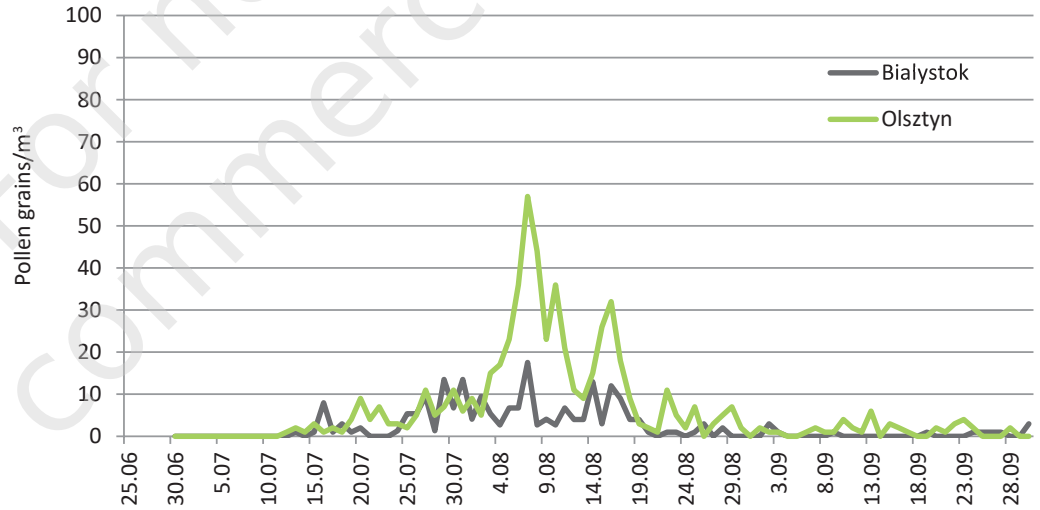



**Figure 2.** *Mugwort pollen concentration in Cracow and Szczecin in 2020.*

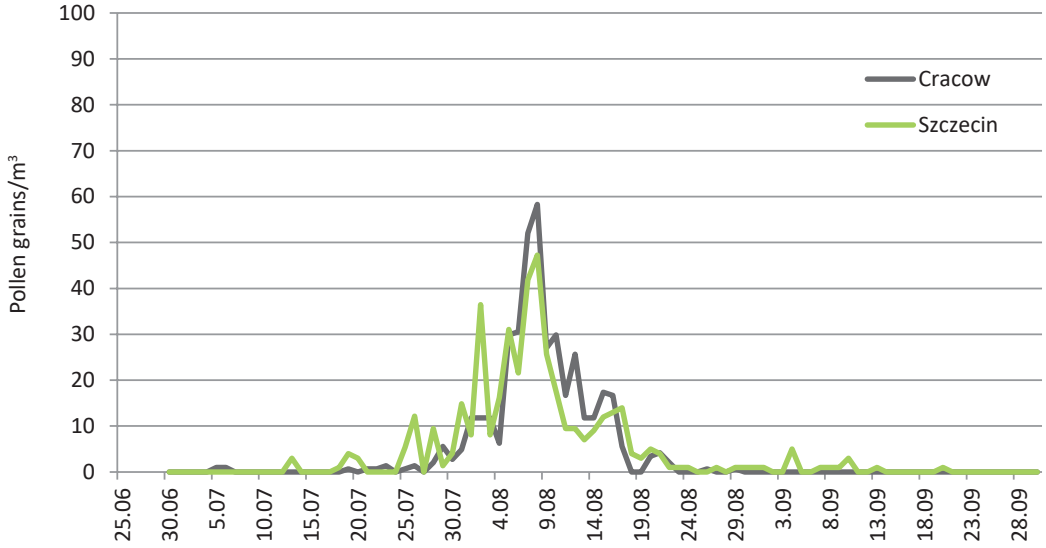


**Figure 3.** *Mugwort pollen concentration in Piotrkow Trybunalski and Warsaw in 2020.*

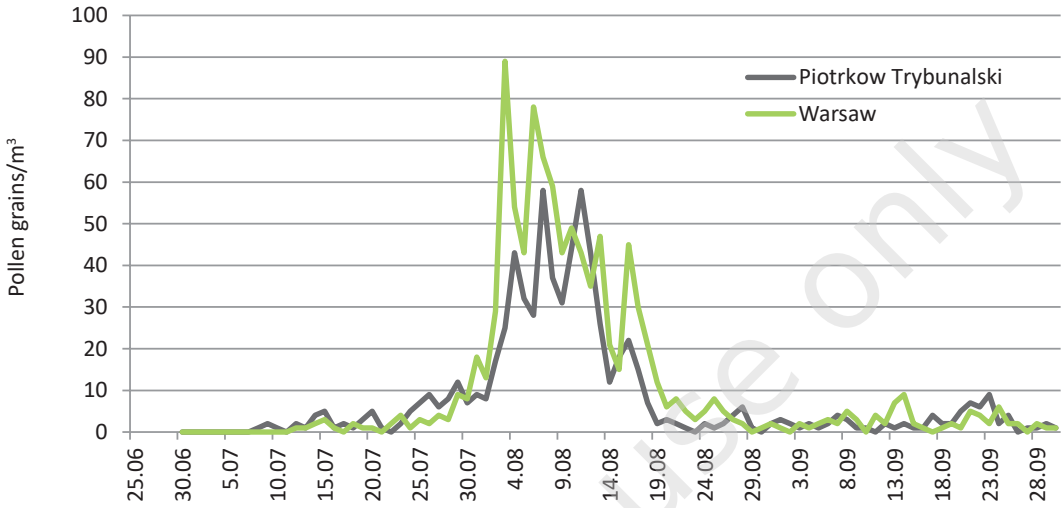



**Figure 4.** *Mugwort pollen concentration in Bydgoszcz and Sosnowiec in 2020.*

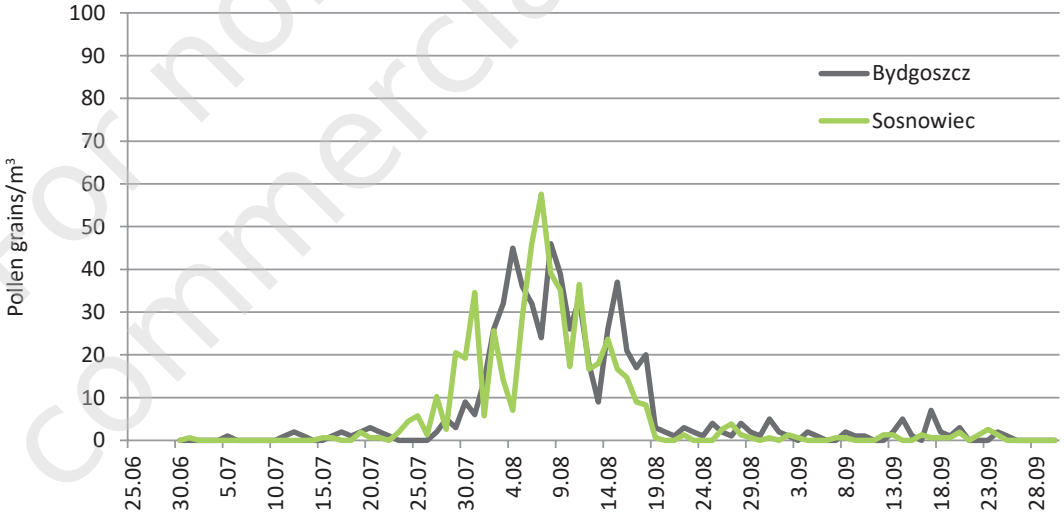



**Figure 5.** *Mugwort pollen concentration in Opole and Zielona Gora in 2020.*

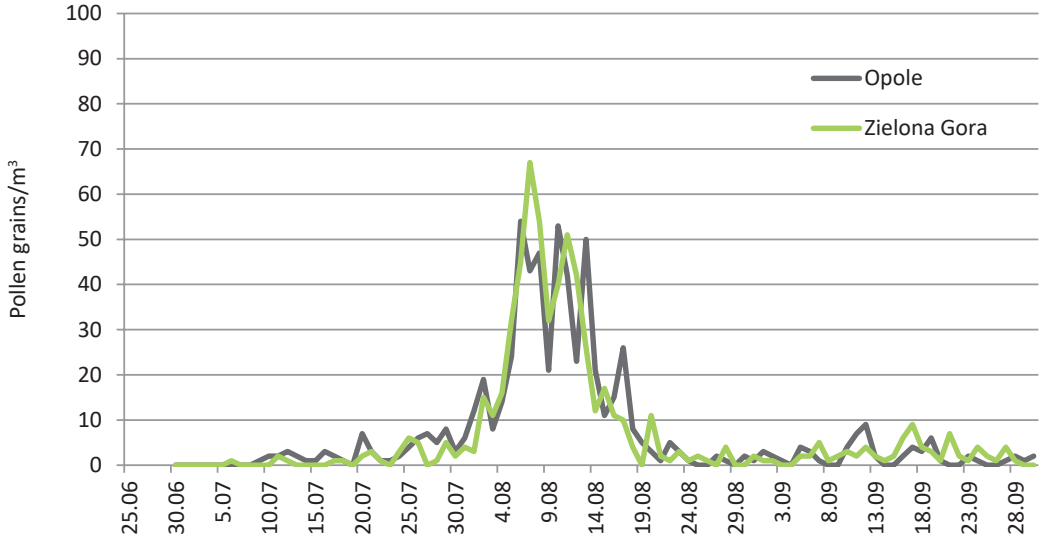
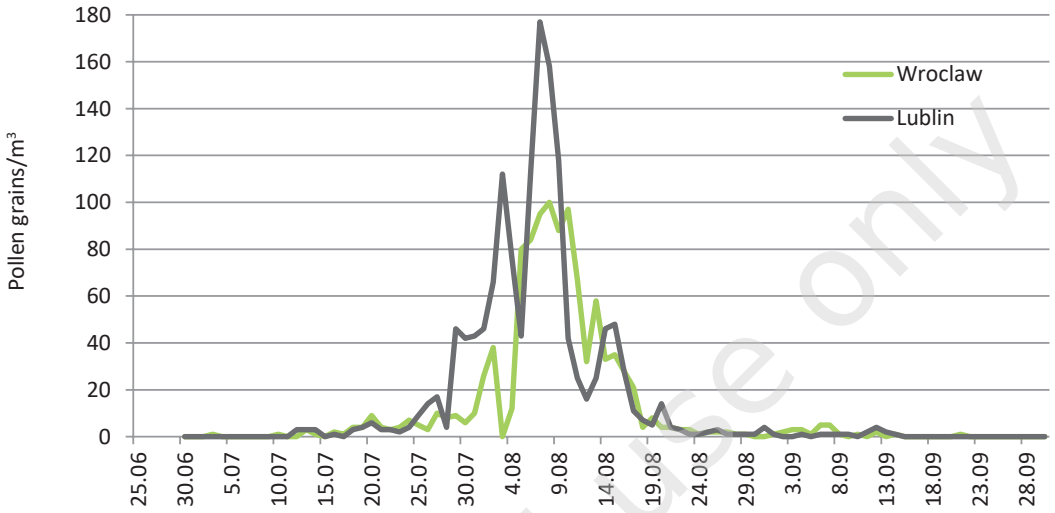


**Figure 6.** *Mugwort pollen concentration in Szczecin and Wroclaw in 2020 (note different scale than in fig. 1–5).*




of the first allergy symptoms was also reported from Warsaw (13 days) and Wroclaw (12 days). The period with a pollen concentration exceeding 55 grains/m³ associated with the threat of development of symptoms in most patients lasted 1–8 days and persisted for the longest time in Wroclaw (8 days) and Lublin (7 days). The risk of acute clinical symptoms at 70 grains/m³ was indicated in only three cities: Lublin and Wroclaw (6 days each), and in Warsaw (2 days).

## Discussion

In 2020, the longest mugwort pollen season was recorded in Bialystok (77 days), whereas and the shortest duration was noted in Lublin (44 days). Over 70-day mugwort pollen seasons were previously reported as an average value from 2001–2005 in several Polish cities: Lodz (79 days), Sosnowiec (72 days), Lublin (71 days), and Szczecin (70 days). The shortest pollen season in the 5-year period was recorded in Cracow (52 days) [13]. Substantially shorter *Artemisia* pollen seasons lasting from the first week of August to the first week of September have been recorded in northwestern Europe [14].

The maximum concentrations of mugwort pollen in 12 Polish cities in 2020 varied within a large range (18–177 grains/m³). In turn, a considerably smaller range of the average values of this parameter (52–79 grains/m³) was reported from eight Polish cities analyzed in 2001–2005 [13].

The graphic representations of the course of *Artemisia* pollen seasons indicate similarities between some of the Polish cities analyzed in 2020, i.e. between Cracow and Sosnowiec, Cracow and Szczecin, Opole and Zielona Gora. The curves for a majority of the cities are unimodal with one very distinct peak during the season, which may indicate abundant flowering of one species that is a rich source of pollen. Earlier studies have shown that *Artemisia vulgaris* is the main source of this type of airborne pollen in Poland and other countries of Central Europe [15, 16].

The average annual *Artemisia* pollen sum for 12 cities in Poland in 2020 is 686. In contrast, the average sum from eight measurement stations determined in the five-year study (2001–2005) in Poland was 1271. These data indicate that the mugwort pollen production in 2020 was almost twofold lower than the average sum from the five-year period analyzed previously.

Some herbaceous plants respond to climate change, which is reflected in the course of pollen seasons. In the case of *Artemisia*, a negative trend in the pollen concentration was reported from Spain [17] and Poland [18]. In turn, an earlier onset of the mugwort season and an increase in its length was shown in Central and Northern Europe [19–21]. As shown by Skjøth et al. [9], Poland is ranked first among other European countries with the highest concentrations of mugwort pollen. In Poland, the highest concentrations of pollen of this taxon were recorded in Lublin both in 2020 and in the earlier study period (2001–2005) [13].

Therefore, it can be assumed that the mugwort pollen concentrations in Lublin are among the highest in Europe. Its content in the pollen spectrum in Lublin was estimated at 2.6% [22]. A greater proportion of pollen of this taxon, i.e. 3–7%, was found in the aeroplankton of the city of Vinnitsa (Ukraine) [23]. Ukraine is another country with very high concentrations of mugwort pollen [9].

Due to the high allergenic potential of mugwort pollen, there is a high risk of development of allergy

symptoms in August. This risk may increase considerably at co-occurrence of *Artemisia* and *Ambrosia* pollen, which is sometimes noted, especially in the south-eastern part of Poland [24].

## Conclusions

1. In 2020, the onset of the mugwort pollen season in most of the measurement stations in Poland was recorded in the 2nd decade of July.
2. The earliest onset of the pollen season was recorded in Opole, whereas the latest beginning was noted in Sosnowiec and Cracow.
3. The highest peak values and annual pollen sums were found in Lublin and Wroclaw.
4. The highest risk of development of *Artemisia* pollen allergy symptoms was determined in Lublin, Wroclaw, and Warsaw.

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