

Why is the 2024 mugwort pollen season worth your attention?

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Abstract:

Artemisia (mugwort) is one of the largest and most widely distributed genera of the *Asteraceae* family and can be found mainly in Europe, Asia, and North America. However, only a few genera, including *Artemisia*, are potential but significant sources of allergens. The aim of the study was to compare the mugwort pollen seasons in Białystok, Lublin, Olsztyn, Piotrków Trybunalski, Szczecin, Wrocław, Warsaw and Łódź in 2024. The investigations were carried out using the volumetric method. Seasonal Pollen Index (SPI) was estimated as the sum of daily average pollen concentrations in the given season. The mugwort pollen season is mainly observed in June, July and at the beginning of September. It is worth noting that in 2024, the peak of the mugwort pollen season shifted to September – because, most likely for the first time in Poland, in the last two decades of pollen monitoring, the maximum concentration of mugwort pollen was recorded so late, in September. This was observed at all measurement points, except for Wrocław. In 2024 the pollen season of mugwort started first in Szczecin and Łódź, on the 21st of June. At the latest, a pollen season ended in Warsaw and Lublin, and also in Olsztyn, Piotrków Trybunalski and Łódź, September 23rd and later. Differences in the length of pollen seasons were small, ranging from 83 to 93 days. The highest, record-breaking airborne concentration of 265 pollen grains/m³ was noted in Lublin on the 17th of September. In previous years this took place in July or August. The maximum values of seasonal pollen count in Polish cities occurred within five days, between 16th and 20th of September. The exception was Wrocław, with a seasonal maximum recorded on August 8th. The highest mugwort pollen allergen hazard occurred in 2024 in Lublin, Warsaw and Piotrków Trybunalski and was 4–5 times higher than in other cities. The highest variability in the analysed seasons was found in peak value and SPI value. In the pollen season in 2024 (similar to previous years), two peaks of *Artemisia* pollen concentrations were observed as a result of the order of flowering of *A. vulgaris* and *A. campestris*. Information on the pollination of various *Artemisia* species will be used to avoid excessive exposure to allergens of these pollen grains.

Key words: pollen count, aeroallergens, mugwort, *Artemisia L.*, 2024, record peak date

Artemisia L. (mugwort) flowers from mid-July to September, with peak pollen production occurring in the 3rd decade of July and the first and second decades of August. However, mugwort pollen is increasingly observed also in September and the highest pollen concentration is recorded on dry, hot days. In northern Europe, the optimum of pollination falls in mid-August. After peak day, the flowering season may last until September. *Artemisia* is one of the very few genera in the family *Asteraceae* comprising wind-pollinated plants. Despite wind dispersal and high pollen productivity (an individual plant produces 38 million pollen grains), mugwort pollen is relatively poorly distributed. Much of the pollen does not rise higher than 3–10 m above ground level, which limits its wider distribution [1–3]. Additionally occurrence of the *Artemisia* species is associated with dry or slightly moist habitats and full exposure to light [4]. However, ongoing global warming effectively supports the spread of mugwort, extending its growing season and increasing pollen intensity, which negatively impacts allergy sufferers. From an aerobiological point of view the most important *Artemisia* species are considered to be pioneer plants that colonise disturbed soils in urban and rural environments and are especially found on agricultural fields, roadside verges, abandoned places and where building activities take place [2].

Pollen allergens of the *Artemisia* L. genus are among the most frequent and serious causes of pollinosis in many parts of the world. About 40–50% of the world's population suffers from one or more allergic disease [5]. The threshold for allergic reactions in *Artemisia* pollen-sensitive subjects is estimated to be only 5–15 pollen grains/m³ [1]. Polish research indicates 30 g/m³ as the threshold value for the first symptoms of allergy [6]. Despite the clinical importance of *Artemisia* pollen in allergic respiratory diseases, the process of release and distribution of *Artemisia* allergens in the air is poorly understood [7].

The species of the genus *Artemisia* are involved in strong cross-reactions observed in the pathomechanism of allergy. Mugwort pollen cross reacts with almost all other composites, especially with ragweed pollen. Further cross reactions are known with dandelion, goldenrod, sun flower, chamomilla, and all the daisy-like flowers. Very important cross-reactions are known in the frame of food-allergies with celery [1].

Aim

The aim of the study was to compare the mugwort pollen concentrations in the air of Białystok, Lublin, Olsztyn, Piotrków Trybunalski, Szczecin, Wrocław, Warsaw and Łódź in 2024 as well as to indicate the highest risk of pollen allergens in individual cities.

Material and method

Measurements of bioaerosol were carried out in the selected cities of Poland, in Białystok, Lublin, Olsztyn, Piotrków Trybunalski, Szczecin, Wrocław, Warsaw and Łódź in 2024. Measurements were performed by the volumetric method. The used devices, which are recommended by the IAA (International Association for Aerobiology), take air samples (Burkard and Lanzoni pollen sampler) in volumes corresponding to average human respiratory parameters [8].

The duration of the pollen season was determined by the 98% method [9], assuming that the onset and end of the season were days with recorded 1% and 99% of the annual total of pollen grains, respectively. The total pollen count over this period was expressed by the SPI (Seasonal Pollen Index).

On the basis of literature data, the number of days was determined in which concentrations of pollen of the *Artemisia* genus exceed the threshold values of consecutive allergy symptoms' development (tab. 1) [6].

Results and discussion

Phenological research from Poznań revealed the following order of flowering of mugwort species (the most commonly represented) in Poland: was observed: *Artemisia vulgaris* first began flowering, then *A. absinthium* and *A. campestris* [10]. From the perspective of the studies analyzed in this paper (2024), the presented flowering order of mugworts indicates that *A. campestris* is likely responsible for the September pollination peak. In Poland, the *Artemisia* pollen season usually lasts from July until September, with a peak in July or in August. Over the last decade, *Artemisia* pollen has also been recorded in late September [11–13]. This trend became apparent also in the second half of September 2024, when pollen concentrations were very high and exceeded the average daily pollen counts during the summer, as illustrated in figures 1–4 of this article. The blue and grey arrows on the graphs (fig. 1–4) indicate the dates of increased pollen concentration for *A. vulgaris* and *A. campestris*, respectively. Which confirms that the flowering and pollen release of *A. campestris* is responsible for the second, September peak of the pollen season. Information on the appearance of various *Artemisia* species in the air can be

Table 1. Characteristics of mugwort pollen season in 2024.

Features of pollen season/ city	Białystok	Lublin	Olsztyn	Piotrków Tryb.	Szczecin	Wrocław	Warsaw	Łódź
Duration of pollen season (from-to) (number of days)	25.06–20.09 (88)	11.07–24.09 (85)	1.07–23.09 (85)	28.06–23.09 (88)	21.06–21.09 (93)	29.06–19.09 (83)	4.07– 26.09 (85)	21.06–23.09 (87)
Seasonal Pollen Index (total)	731	2025	825	1214	728	545	1483	1088
Peak value and peak date (bold indicates September)	59 (16.09)	265 (17.09)	76 (16.09)	95 (18.09)	55 (20.09)	27 (9.08)	134 (18.09)	113 (18.09)
Days ≥ 30 g/m ³ [6]*	2	16	3	12	3	0	13	7
Days ≥ 55 g/m ³ [6]**	1	10	1	2	2	0	4	3
Days ≥ 70 g/m ³ [6]***	0	4	1	1	0	0	3	2

* First allergy symptoms.
 ** Allergic reactions in all patients.
 *** Acute symptoms in most patients.

used by allergy sufferers to avoid excessive exposure to the allergens of this plant.

The study by Grewling et al. 2020 [14], on seasonal and species-specific allergenicity of *A. vulgaris* and *A. campestris*, shows that the immune response in sensitized individuals increased by 63% during the flowering period of *A. campestris* compared to *A. vulgaris*.

The occurrence of a second peak of *Artemisia* pollen season in September is also confirmed by studies from Vienna [15]. The authors found a significant positive correlation between higher temperatures in autumn and the occurrence of *Artemisia* pollen grains during this period. This suggests that in years with a mild, summer-like autumn, a significant change in the *Artemisia* pollen season can be expected. Considering the impact of global climate change, the change in the *Artemisia* pollen season described in this study and in the Vienna study [15] may prove permanent and contribute to increased exposure to pollen allergens.

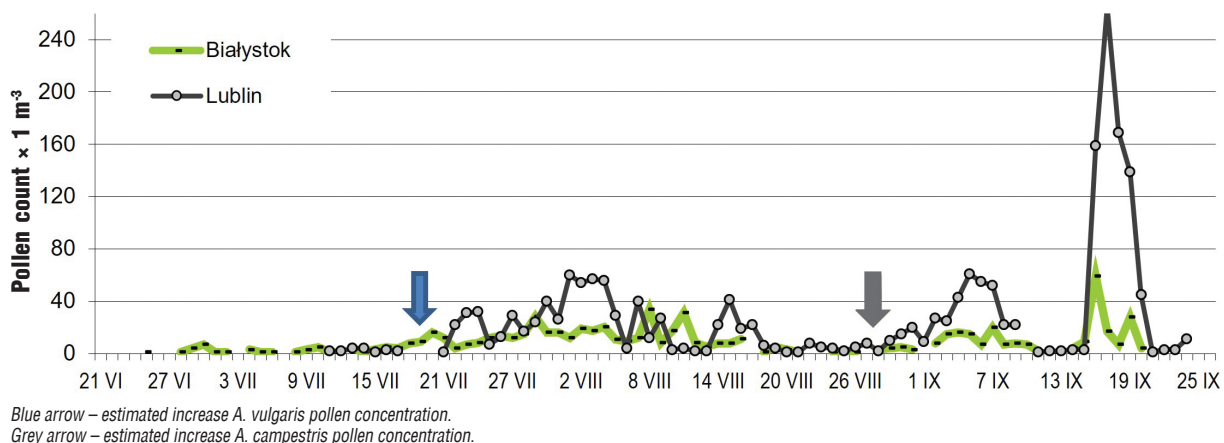
Interestingly, the start date of the 2024 pollen season was earlier than in previous years (21st of June) and at the same time the peak and the end dates shifted

later in this year (tab. 1). For example, in 2019 mugwort pollen season started between 26th of June in Opole and 24th of July in Wrocław [16], similarly in 2015 the mugwort pollen season began only at the beginning of July [11] and also in 2022, the *Artemisia* pollen season began in the second half of July and lasted until the end of the first half of September [13]. Whereas the longest pollen season in 2019, in Warsaw [16], lasted 83 days; a year earlier, in 2018 in Zielona Góra and Bydgoszcz, the season exceeded 3 months (110 days) [12]. In 2024 differences in the length of pollen seasons in individual cities were small, ranging from 83 to 93 days (tab. 1, fig. 1–4).

In 2014 SPI exceeded 1300 in Lublin [17]. In 2018, in Polish cities SPI ranged between 350 and 1100; while in 2019 these values also were similar within 600–1200 [11, 12]. In this study from 2024, the lowest SPI was recorded in Wrocław (545), but a record value was observed in Lublin, with as many as 2025 mugwort pollen grains per season (tab. 1).

In 2014 [17] the maximum daily concentration was observed 19th of August in Poznań (172 g/m³); in 2018 [12] – 3rd of August in Lublin (only 88 g/

Figure 1. Mugwort pollen count in Białystok and Lublin in 2024.



Blue arrow – estimated increase *A. vulgaris* pollen concentration.
 Grey arrow – estimated increase *A. campestris* pollen concentration.

Figure 2. Mugwort pollen count in Olsztyn and Piotrków Trybunalski in 2024.

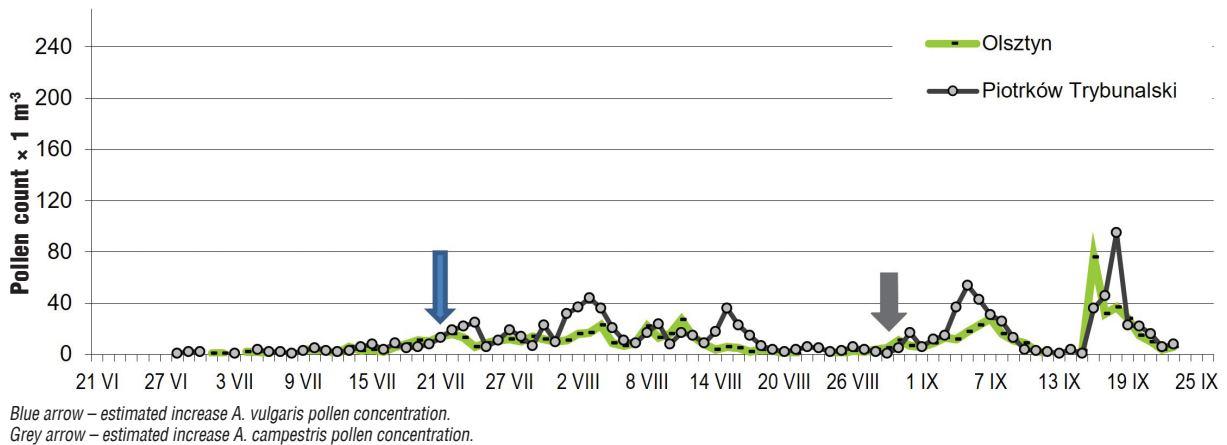


Figure 3. Mugwort pollen count in Szczecin and Wrocław in 2024.

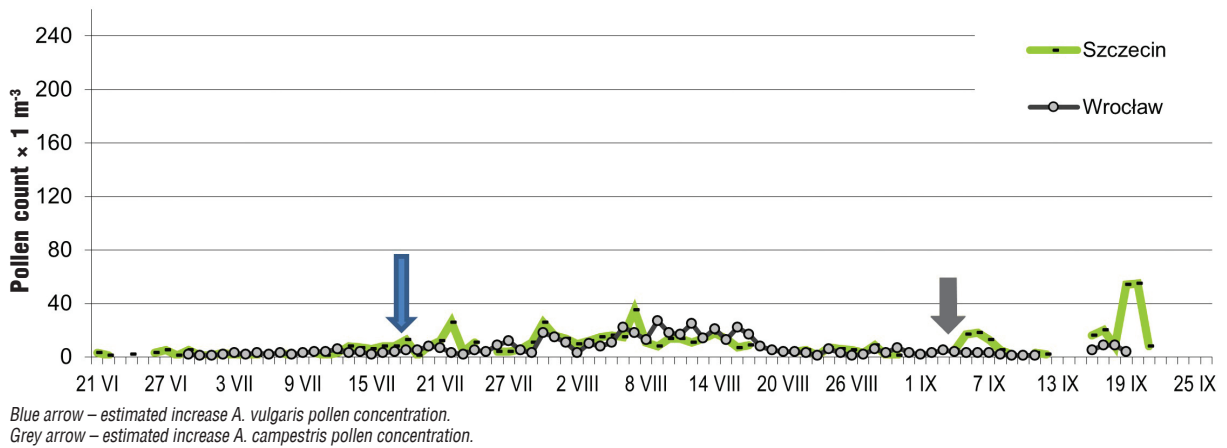
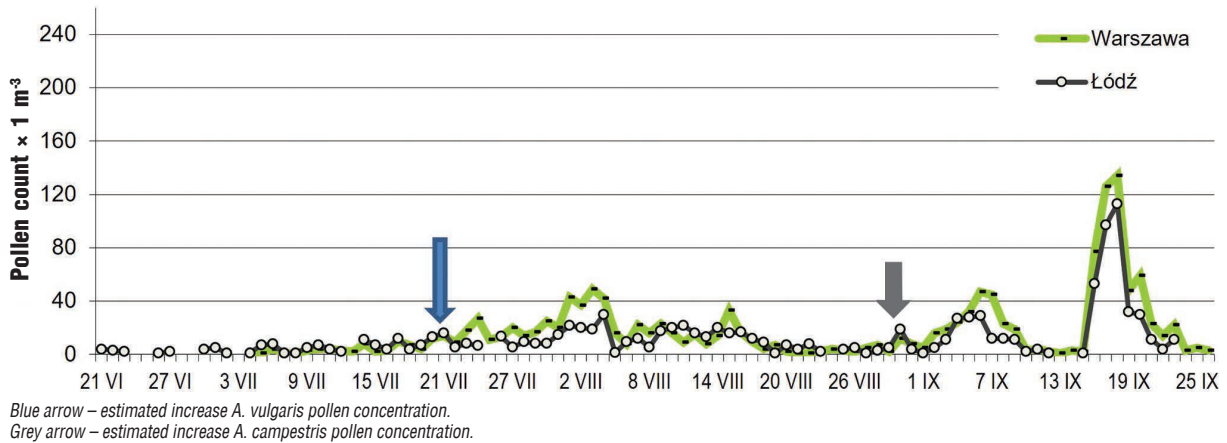


Figure 4. Mugwort pollen count in Warsaw and Łódź in 2024.



m³). In 2022 [13] – 11st of August in Opole (78 g/m³). In research from 2024, the pollen maximum occurred on September 17th (as much as 265 g/m³ – tab. 1) in Lublin (where similar records are often recorded). Interestingly, the very large decrease in mugwort pollen concentration between September 10th and 15th in 2024

(fig. 1–4), was caused by heavy, even torrential, rainfall across almost all of Poland [19].

A risk of allergy symptoms associated with mugwort pollen concentration exceeding 30 pollen/m³ (first allergy symptoms) was recorded in 2019 for a period of 0 to 5 days; in 2022: from 0 to 9 days

[13, 16]; and in this paper, in 2024, for a record-long period of 0 to 16 days (16 days noted in Lublin, of course; tab. 1). Interestingly, Lublin also recorded 4 days during the season when acute allergy symptoms occurred in most patients allergic to mugwort pollen. There is also a high risk of exposure to *Artemisia* allergens in Łódź. In 2024, 7 days were recorded with mugwort pollen concentrations exceeding 30 g/m³ (first allergy symptoms) and 3 days above 55 g/m³, when mugwort pollen allergy symptoms were present in all patients. However, a studies conducted in Łódź by Majkowska-Wojciechowska et al. [18], involving 1,711 patients and analysing their reactivity to inhalant allergens, revealed monovalent reactivity to mugwort in as many as 3.2% of the examined patients.

In this situation, the immune system responds primarily to one specific allergen, not to many different ones. In practice, allergy symptoms appear mainly during the mugwort pollen season, there is a lower likelihood of a “broad” allergy to many other plants, and treatment and avoidance of allergen exposure may be “easier” and more targeted.

As this research indicates, for mugwort, 2024 was an interesting, even record-breaking, year in many respects.

Conclusions

The 2024 mugwort pollen season began in late June and ended in late September. During this period, 2 main peaks in *Artemisia* pollen concentrations were observed resulting from the flowering sequence of *A. vulgaris* and *A. campestris*.

In 2024, in Poland a shift in the second *Artemisia* pollen peak was also noted until the second half of September. This indicates the occurrence of a prolonged period of exposure of patients to mugwort pollen allergens.

The increased risk for allergy sufferers is particularly pronounced, as the *Artemisia* pollen peak in September was 2–4 times higher than in July and August this year.

The highest risk of mugwort pollen allergens occurred in 2024 in Lublin (over 2 weeks with pollen concentrations above 30 pollen/m³) and in Warsaw and Piotrków Trybunalski (13 and 12 days with pollen concentrations above 30 pollen/m³, respectively).

The total SPI varied extremely between cities, from 728 pollen grains in Szczecin to 2025 pollen grains in Lublin, which clearly indicates how different the health situation of patients can be in individual cities.

In light of global climate change and a probable increase in temperatures, it is important to monitor other pollen seasons of mugwort.

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A – Research concept and design. B – Collection and/or assembly of data. C – Data analysis and interpretation. D – Writing the article. E – Critical revision of the article. F – Final approval of the article.

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