

Oak pollen concentration in the air of selected Polish cities in 2020

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Abstract:

The study aims to compare the oak pollen season in selected Polish cities: Białystok, Bydgoszcz, Cracow, Katowice, Piotrków Trybunalski, Lublin, Olsztyn, Opole, Szczecin, Warsaw, and Wrocław in 2020. Measurements were made using the volumetric method, with a Hirst-type sampler. Oak pollen season, defined as the period with 98% of the annual total catch, started between April 14th (in Opole) and April 25th (in Lublin). The season ended on June 1st at the latest; in Sosnowiec, Bydgoszcz, Olsztyn, and Białystok. It lasted from 30 to 47 days (37 days on average). The maximum daily oak pollen concentrations were observed between April 24th and May 11th. The highest annual sum of oak pollen grains (SPI) was recorded in Lublin, while the lowest in Białystok. The highest concentrations of 596 oak pollen grains/m³ were noted in Lublin on April 28th. The longest exposure to high concentrations of oak pollen (> 91 grains/m³), lasting 12–13 days, was recorded in Lublin, Opole, and Wrocław.

Key words: pollen concentration, oak (*Quercus*), allergens

Introduction

The genus *Quercus*, belonging to the *Fagaceae* family, includes 600 species found almost exclusively in the northern hemisphere; mainly in the temperate climate zone [1]. Oak trees grow abundantly in Europe and contribute to pollen concentration in spring [2].

In Poland, two species and the hybrids are found wild. The most common, growing throughout

the country in deciduous and mixed forests and the mountains up to 700 m above sea level, is pedunculate oak (*Quercus robur* L.). Sessile oak, (*Quercus petraea* [Matt.] Liebl) occurs less frequently, mostly in the lowlands, while in north-eastern Poland it does not grow at all. Pubescent oak (*Quercus pubescens* Willd.), which grows on the slopes of the Odra valley in the Bielinek nature reserve, is sometimes mentioned as the third

wild-growing species in Poland [1, 3]. A dozen alien species are planted in parks and gardens.

The clinical significance of oak pollen in pollinosis is considered to be moderate [4, 5]. European Academy of Allergy and Clinical Immunology in Global Atlas of Allergy lists major oak pollen allergen, *Que a 1* as one of eight major tree allergens within *Bet v 1*-related proteins [6]. The presence of homologous allergens is responsible for IgE cross-reactivity among *Fagales* pollen (birch, hazel, alder, beech, oak, and hornbeam) and with various fruits and vegetables, a condition known as oral allergy syndrome [7, 8].

Aim

This study aims to compare the oak pollen season in selected Polish cities: Białystok, Bydgoszcz, Cracow, Katowice, Piotrków Trybunalski, Lublin, Olsztyn, Opole, Szczecin, Warsaw and Wrocław in 2020.

Material and method

Pollen measurements were performed using the volumetric method, with a Hirst-type sampler operating in a continuous volumetric mode. Counts were recorded over 7-day cycles and analyzed separately for each 24-hour period.

The analysis was based on the following variables:

- duration of the pollen season, determined by the 98% method, where the beginning and the end of the season fell on days with 1% and 99% of the annual total pollen catch, respectively [9]
- sum of the daily average pollen concentrations over the season expressed by the SPI (seasonal pollen integral) [10]
- maximum daily pollen concentration in the season and peak date
- the number of days with above-threshold pollen level, which was adopted according to the litera-

ture. According to Burge [11], the threshold level of oak pollen concentration in the air, causing the initial symptoms of inhalant allergy in sensitized individuals, is 16 pollen grains per 1 m³ of air. While the level of high pollen concentration, at which symptoms are present in most individuals allergic to oak allergens, is 91 grains per 1 m³ of air.

Results and discussion

In 2020, the oak pollen season began between April 14th and 25th and lasted until the third decade of May or even the beginning of June (tab. 1). It started on April 14th at the earliest in Opole and on April 16th in Wrocław and Sosnowiec, and on April 25th at the latest in Lublin (tab. 1, fig. 1–3). In Lublin, Warsaw, Piotrków Trybunalski, and Wrocław the onset of the season occurred on dates similar to the previous year, in Białystok, Bydgoszcz, and Sosnowiec; 6–7 days later than in 2019, while in Szczecin even 18 days later than in 2019 (tab. 1) [12]. The year 2020 is in line with the tendency to delay the beginning of the oak pollen season in Szczecin observed over many years by Puc [13]. In 2017, the oak pollination season began in Szczecin on April 1st, in 2018 on April 17th, while in 2020 on April 24th [13, 14].

The average length of the pollination season in 2020 was 37 days. It was between the values for 2017 (44 days) and 2018 and 2019 (33 days) [12–14]. There was a marked variation in duration between monitoring sites. The shortest season was recorded in Piotrków Trybunalski (30 days), while the longest in Sosnowiec (47 days) (tab. 1, fig. 2, 5). Analyzing oak pollen seasonality and severity across Europe, Grundströma et al. [15] noticed that the length of the oak pollen season varied significantly between analyzed sites across Europe. Long seasons, exceeding 50 days, were recorded at southern and non-coastal sites (Badajoz, Lyon, Worcester, Leicester), while shorter ones at northern and coastal areas (Leiden, Malmö,

Table 1. Characteristics of oak pollen season in 2020.

| Features of pollen season | Białystok | Bydgoszcz | Cracow | Piotrków Trybunalski | Lublin | Olsztyn | Opole | Sosnowiec | Szczecin | Warsaw | Wrocław |
|--|--------------------|--------------------|--------------------|----------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Duration of pollen season (number of days) | 23 IV–1 VI (39) | 24 IV–1 VI (38) | 18 IV–28 V (36) | 24 IV–23 V (30) | 25 IV–31 V (37) | 22 IV–1 VI (41) | 14 IV–23 V (40) | 16 IV–1 VI (47) | 24 IV–27 V (34) | 23 IV–24 V (32) | 16 IV–21 V (36) |
| Seasonal pollen integral | 184 | 1143 | 1279 | 2238 | 4545 | 549 | 3499 | 1228 | 913 | 2290 | 2976 |
| Peak value and peak date | 30 (5 V) | 98 (8 V, 11 V) | 94 (25 IV) | 211 (11 V) | 596 (28 IV) | 45 (5 V) | 378 (28 IV) | 147 (11 V) | 85 (9 V) | 324 (11 V) | 336 (24 IV) |
| Days ≥ 16 grains/m ³ | 2 | 22 | 29 | 28 | 31 | 12 | 32 | 20 | 20 | 26 | 31 |
| Days ≥ 91 grains/m ³ | 0 | 2 | 1 | 6 | 13 | 0 | 12 | 2 | 0 | 8 | 12 |

Figure 1. Oak pollen concentration in the air of Lublin in 2020.

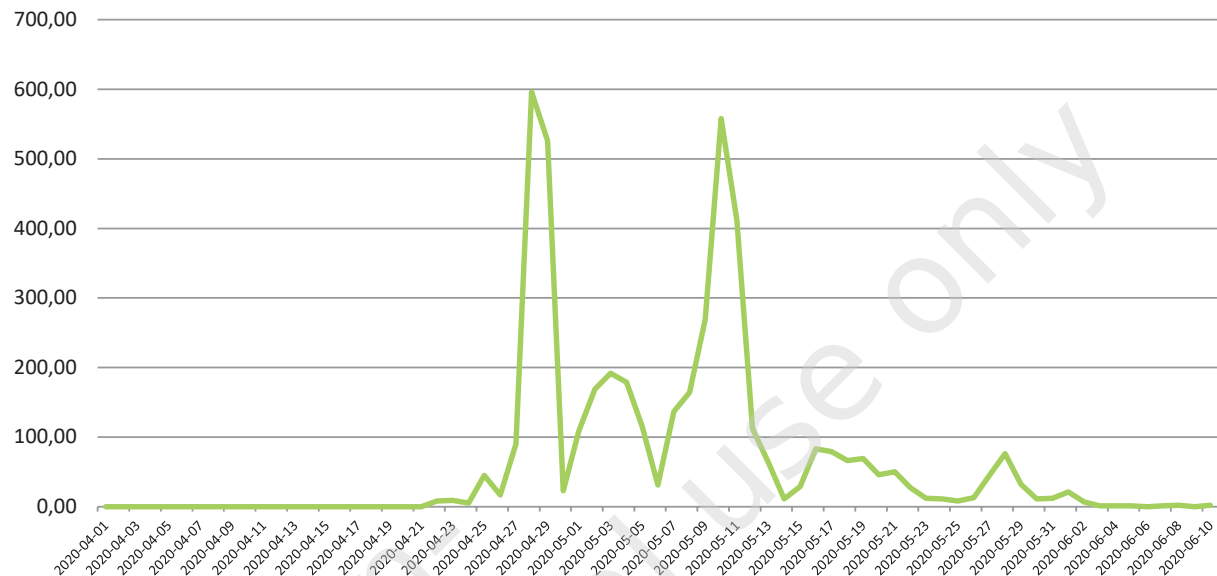


Figure 2. Oak pollen concentration in the air of Cracow and Sosnowiec in 2020.

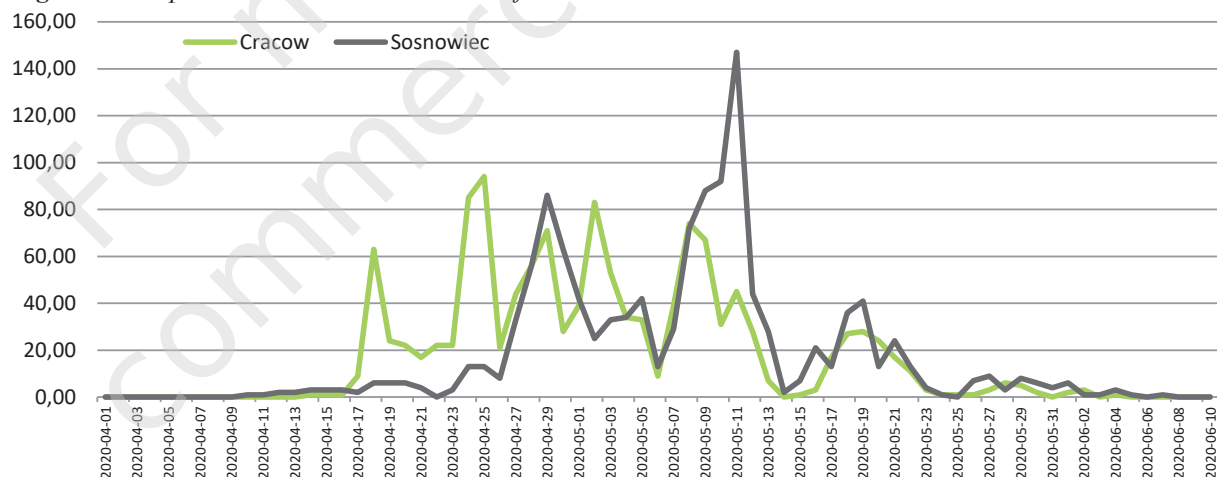


Figure 3. Oak pollen concentration in the air of Wroclaw and Opole in 2020.

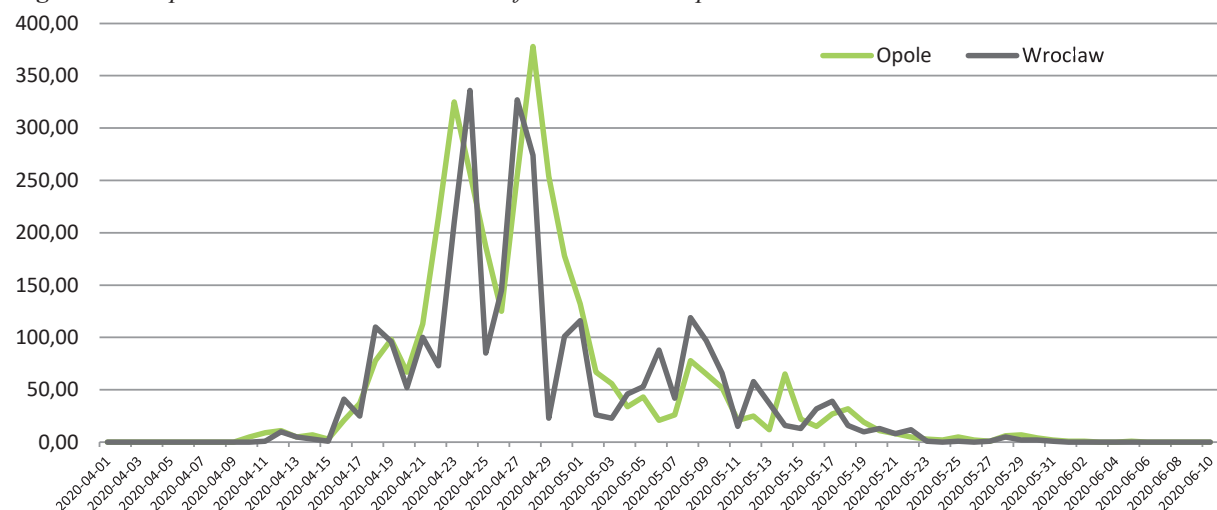


Figure 4. Oak pollen concentration in the air of Szczecin and Warsaw in 2020.

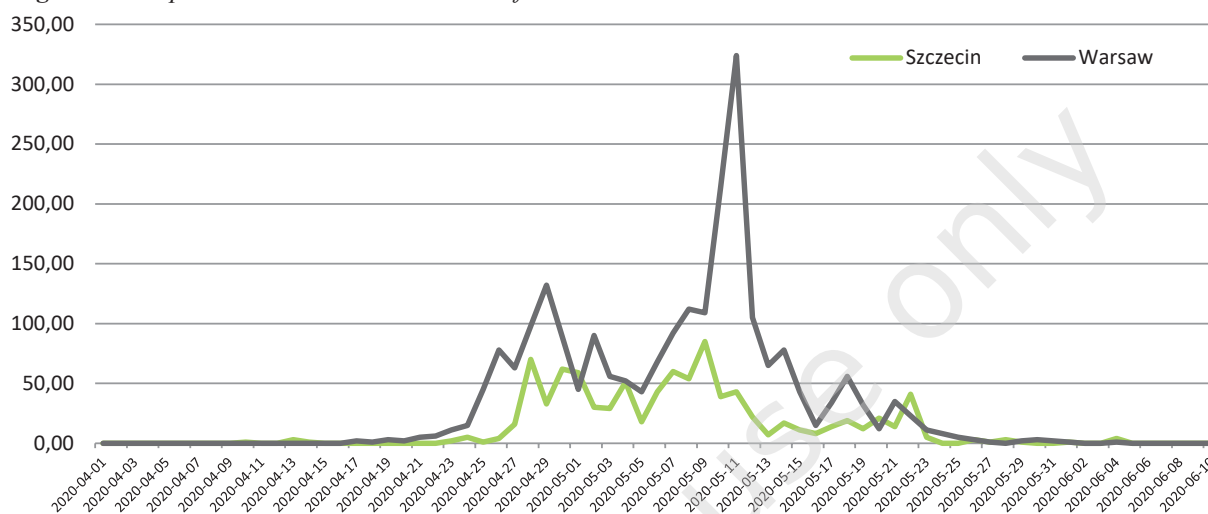


Figure 5. Oak pollen concentration in the air of Piotrkow Trybunalski and Bydgoszcz in 2020.

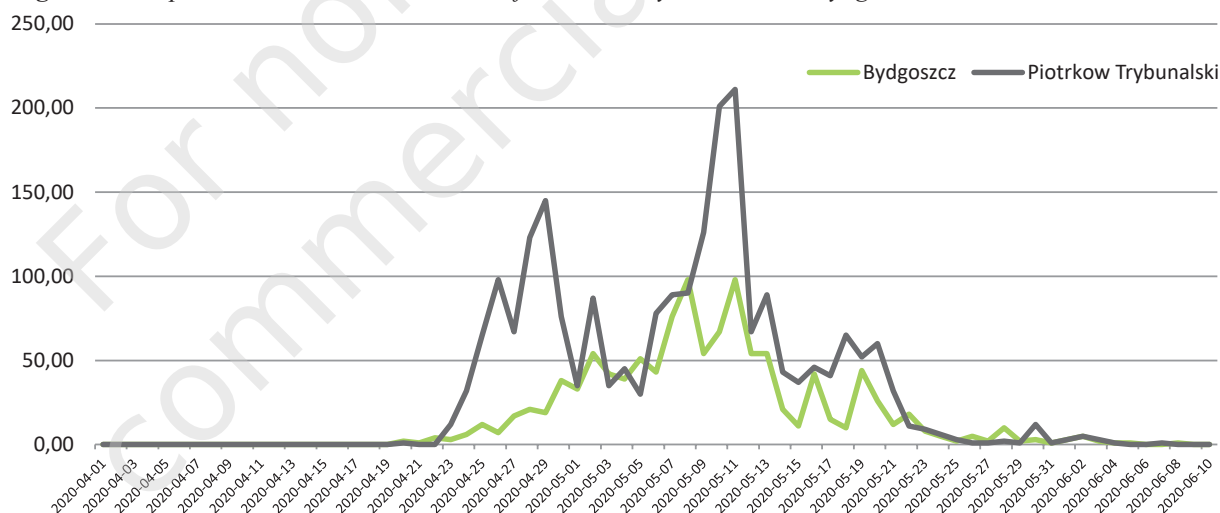
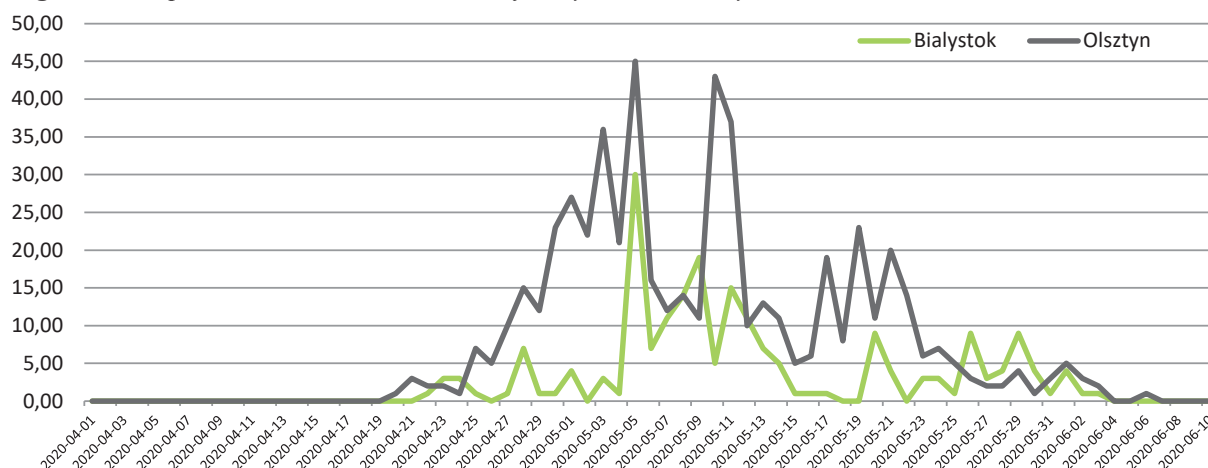


Figure 6. Oak pollen concentration in the air of Bialystok and Olsztyn in 2020.



Copenhagen, Viborg, and Goteborg) [15]. More oak species with different flowering times may contribute to the length of pollen season.

The highest annual sum of oak pollen grains (SPI) was recorded in Lublin, while the lowest in Białystok (tab. 1). The average SPI for the oak pollen season in 2020 was 1895. It was similar to the level in 2018 (1816) and higher than in 2017 (1363) and 2019 [12–14].

The highest daily pollen concentration was noted in Lublin (596 grains/m³ on April 28th), followed by records in Opole (378 grains/m³ on the same day) and Wrocław (336 grains/m³ on April 24th) (tab. 1). The maximum daily pollen concentration in 2020 (reached in Lublin) exceeded over 2 times the level reached in 2019. For all analyzed sites these were much higher values than those recorded in 2019 (tab. 1) [12]. The maximum daily concentrations in the analyzed monitoring sites were recorded between April 24th and May 11th (tab. 1). As in previous years, the curves illustrating the oak pollen season are characterized by more than one peak, which is related to the different time of flowering of different oak taxa [12–14].

The longest exposure to high concentrations of oak pollen (91 grains/m³ and above), lasting 12–13 days, was recorded in Lublin, Opole, and Wrocław. In Warsaw and Piotrków Trybunalski, the highest risk of oak pollen allergens lasted 8 and 6 days, respectively, while in Szczecin, Białystok and Olsztyn oak pollen concentration did not reach the level of 91 grains/m³ at all (tab. 1). In 2019, the longest intense exposure to oak pollen allergens was also recorded in Lublin, but it did not exceed 7 days and in 5 analyzed cities the level of 91 grains/m³ was not reached at all [12].

Conclusions

The oak pollen season in 2020 began between mid-April in Opole, Wrocław, and Sosnowiec; and last days of April in Lublin. It lasted from 30 to 47 days, depending on the monitoring site (37 days on average).

The highest concentrations of oak pollen were recorded in Lublin, Opole, Wrocław, Warsaw, and Piotrków Trybunalski, whereas the lowest, in Białystok. The longest exposure to high concentrations of oak pollen, lasting 12–13 days, was recorded in Lublin, Opole, and Wrocław.

The oak pollen season in 2020, compared to the season in 2019, was characterized by longer average pollen season, the higher average sum of daily concentrations over the season (SPI), higher

maximum daily concentrations, and longer exposure to high concentrations of oak pollen in the majority of investigated sites.

References

1. Seneta W, Dolatowski J. *Dendrologia*. Wydawnictwo Naukowe PWN, Warszawa 2009.
2. Skjøth CA, Šikoparija B, Jäger S. *EAN-Network. Pollen sources. Allergenic Pollen*. Springer Netherlands, Dordrecht 2013: 9-27.
3. Bugala W. *Drzewa i krzewy*. Państwowe Wydawnictwo Rolnicze i Leśne, Warszawa 2000.
4. Egger C, Focke M, Bircher AJ et al. The allergen profile of beech and oak pollen. *Clin Exp Allergy*. 2008; 38: 1688-96.
5. Rapijko P, Lipiec A, Jurkiewicz D. Alergogenne znaczenie pyłku dębu. *Alergia*. 2004; 2: 38-41.
6. Ferreira F, Gadermaier G, Wallner M. *Tree pollen allergens. Global Atlas of Allergy* 2014: 18-21.
7. Breiteneder H, Kleine-Tebbe J. PR-10-like allergens. In: Maticardi PM, Kleine-Tebbe J, Hoffmann HJ et al. *EAACI Molecular Allergology. User's Guide* 2016: 299-309.
8. Scala E, Asero R, Niederberger V. *Tree pollen allergens*. In: Maticardi PM, Kleine-Tebbe J, Hoffmann HJ et al. *EAACI Molecular Allergology. User's Guide* 2016: 71-83.
9. Emberlin J, Savage M, Jones S. Annual variations in grass pollen seasons in London 1961-1990: trends and forecast models. *Clin Exp Allergy*. 1993; 23(11): 911-8.
10. Galan C, Artaitti A, Bonnini M et al. Recommended terminology for aerobiological studies. *Aerobiologia*. 2017: 293-5. <http://doi.org/10.1007/s10453-017-9496-0>.
11. Burge HA. Monitoring for airborne allergens. *Ann Allergy*. 1992; 9: 9-21.
12. Dąbrowska-Zapart K, Chłopek K, Malkiewicz M et al. Oak pollen season in selected cities of Poland in 2019. *Alergoprofil*. 2019; 15(2): 12-6.
13. Puc M, Myszkowska D, Chłopek K et al. Oak pollen in the air of Poland in 2017. *Alergoprofil*. 2017; 13(3): 124-8.
14. Sulborska A, Weryszko-Chmielewska E, Piotrowska-Weryszko K et al. The oak pollen concentration in the air of selected cities in Poland in 2018. *Alergoprofil*. 2018; 14(3): 67-71.
15. Grundströma M, Adams-Groom B, Pashley CH et al. Oak pollen seasonality and severity across Europe and modeling the season start using a generalized phenological model. *Sci Total Environ*. 2019; 663: 527-36.

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The authors declare that they have no competing interests.

Ethics:

The contents presented in this paper are compatible with the rules of the Declaration of Helsinki, EU directives, and standardized requirements for medical journals.

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