

Influence of birch bark dusting intensity on the peculiarities of the course of pollinosis in children

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Abstract

Rationale: the problem of the growth of allergic diseases associated with plant pollination is urgent. At present, numerous works discuss the influence of global warming on the onset, intensity and duration of plant pollination. An increase in the total annual pollen concentration in the aeropalynological spectrum is noted. For the Central Federal District (CFD) of Russia, pollination of woody wind-pollinated plants, particularly birch, is of the greatest clinical significance.

Objective: to study the clinical characteristics of birch pollinosis in children of the city of Ryazan and Ryazan region in the season of 2023 in conditions of intensive dusting of birch (*Betula*).

Materials and methods. An open single-centre retrospective randomized uncontrolled cohort study was conducted. The study included 211 children who sought emergency medical care from 01.02.2023 to 30.06.2023 in hospital or polyclinic with symptoms of bronchial asthma, allergic rhinitis and atopic dermatitis. The time frame of the study was February to June 2023. In parallel, prospective aerobiological monitoring with the help of Lanzoni volumetric trap ‘VPPS 2000’ and analysis of search queries of residents of Ryazan and Ryazan region in the system ‘Yandex Wordstat’ were conducted. For statistical processing of the obtained results, Past 4.03 software and SPSS V24.0 package were used, including descriptive statistics.

Results. According to the data of aerobiological studies in the season 2023 record high concentration of birch pollen for the last 9 years of observations. This resulted in a high incidence of emergency visits to health care facilities with symptoms of pollinosis. The main age group of children who applied was from 7 to 12 years old, but there were also cases of children under 3 years old, which indicates rejuvenation of the pollinosis debut. There was a dependence on sex, as the number of boys who applied was 2.5 times higher than the number of girls who applied. Bronchial asthma predominated in the structure of clinical phenotypes of children urgently hospitalised, and half of all asthma cases were its manifestation. A moderate positive association ($r=0.4$; $p=0.002$) between airborne pollen concentration and the number of children who sought care was found in hospitalised patients when aeropalynological monitoring and clinic data were compared.

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Conclusion. The peculiarity of the pollen season in 2023 in the Ryazan region (Central Federal District of the Russian Federation) is the record high concentration of birch pollen for the last 9 years of observations. This led to an increase in the number of children with emergency symptoms of respiratory and cutaneous pollinosis.

Keywords: pollinosis, allergy, bronchial asthma, pollen, aeropalynological spectrum, birch, children

Conflict of interests

The authors declare that they have no competing interests.

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Влияние интенсивности пыления березы на особенности течения поллиноза у детей

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Аннотация

Обоснование: проблема роста аллергических заболеваний, связанных с пылением растений является актуальной. В настоящее время в многочисленных работах обсуждается влияние глобального потепления на начало, интенсивность и продолжительность пыления растений. Отмечается увеличение суммарной годовой концентрации пыльцы в составе аэропалинологического спектра. Для Центрального Федерального округа (ЦФО) России наибольшее клиническое значение имеет пыление древесных ветроопыляемых растений, в частности березы.

Цель: показать зависимости между симптомами, уровнем пыления березы и госпитализациями, изучить клинические характеристики березового поллиноза у детей города Рязани и Рязанской области в сезоне 2023 года в условиях интенсивного пыления березы (*Betula*).

Материалы и методы. Проведено открытое одноцентровое ретроспективное выборочное неконтролируемое когортное исследование. В исследование было включено 211 детей, обратившихся за экстренной медицинской помощью с 01.02.2023 по 30.06.2023 в стационар или поликлинику с симптомами бронхиальной астмы, аллергического ринита. Временные рамки исследования: февраль — июнь 2023 года. Параллельно проводился проспективный аэробиологический мониторинг с помощью волюметрической ловушки и анализ поисковых запросов жителей г. Рязани и Рязанской области в системе «Яндекс Вордстат». Для статистической обработки полученных результатов использовались программное обеспечение Past 4.03 и пакет SPSS V24.0, включая описательную статистику.

Результаты. По данным аэробиологических исследований, в сезоне 2023 года рекордно высокая концентрация пыльцы березы за последние 9 лет наблюдений. Это привело к высокой обращаемости в медицинские учреждения за экстренной помощью с симптомами поллиноза. Основная возрастная категория обратившихся детей была от 7 до 12 лет, однако также отмечены обращения детей в возрасте до 3 лет, что свидетельствует об омоложении дебюта поллиноза. Прослеживалась зависимость от половой принадлежности, так как количество обратившихся мальчиков в 2,5 раза превышало количество обратившихся девочек. В структуре клинических фенотипов детей, экстренно госпитализированных в стационар, преобладала бронхиальная астма, причем половина всех случаев астмы составила ее манифестация клинических проявлений. При сопоставлении данных аэропаллинологического мониторинга и клиники у госпитализированных пациентов была выявлена умеренная положительная связь ($r=0,4$; $p=0,002$) между концентрацией пыльцы в воздухе и количеством обратившихся за помощью детей.

Заключение. Особенность сезона пыления в 2023 году в Рязанской области (ЦФО Российской Федерации) заключается в рекордно высокой концентрации пыльцы березы за последние 9 лет наблюдений. Это привело к увеличению числа обращаемости детей с экстренными симптомами респираторного и кожного поллиноза.

Ключевые слова: поллиноз, аллергия, бронхиальная астма, пыльца, аэропаллинологический спектр, береза, дети

Конфликт интересов

Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с проведенным исследованием и публикацией настоящей статьи.

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JUSTIFICATION

Hay fever is a group of allergic diseases caused by an IgE-dependent reaction to pollen irritation of the respiratory tract, characterized by inflammatory changes in the mucous membranes and skin. The pathology has a recurring seasonal pattern and occurs during the flowering period of certain plants. In different countries around the world, a large number of people suffer from pollinosis, from 5 to 50% of children and from 10 to 30% of adults, depending on various factors [1, 2]. In Russia, this figure ranges from 10 to 24% of the population [3].

According to literary sources, over the past 30 years, the length of the growing season in Europe has increased by 10–11 days. The reduction in the number of cold days per year causes changes in the timing of plant pollination: an earlier start is observed, and the duration and intensity increase [4, 5].

Changes in atmospheric air circulation play an important role in pollen dispersal. In the 21st century, maximum meridional transport of air masses is observed in the lower troposphere. At the same time, the core of the aeropalynological spectrum is pollen from wind-pollinated plants, which has good aerodynamic properties. Therefore, pollen grains and other biological particles (in particular, proteins) can be transported over long distances [4, 6, 7]. As a result,

the first appearance of allergenic pollen taxa in the air is observed several weeks before the start of the main pollen season for these taxa in the region. This leads to an increase in the concentration of pollen allergens in the air, which results in the development of sensitization and hay fever symptoms in people living far from sources of pollen allergens.

Extreme weather conditions also influence the development of pollen sensitization. It has been established that during thunderstorms and precipitation, pollen releases allergenic epitopes — macromolecules of antigen that are much smaller than the original pollen grains [8]. Such particles penetrate the respiratory tract much more easily [8], causing outbreaks of allergic asthma and sometimes severe asthmatic crises and even death in patients suffering from pollinosis [9].

Another factor that increases pollen penetration is pollutants from exhaust gases, industrial waste, and atmospheric emissions [10, 11, 12]. Thus, many clinical studies show that the incidence of respiratory hypersensitivity symptoms was higher in children in urban areas than in rural areas [10, 13, 14, 15, 16]. Pollutants consist of a carbon core on which high-molecular organic chemical components and heavy metals are deposited, which has a destructive effect on the epithelium of the barrier tissues of the skin and respiratory

ry tract, opening the gateway for an allergic attack by pollen [10, 11, 12]. Air pollutant particles, when they come into contact with pollen, can destroy it and cause the release of micron-sized particles ($<0.1\ \mu\text{m}$ in diameter), which easily settle in the deepest parts of the lower respiratory tract [10, 17].

The nature and severity of clinical manifestations of pollinosis are highly individual and depend on the body's sensitivity to allergens, concomitant allergic reactions, and the presence of chronic diseases [18]. The disease can manifest itself in symptoms affecting the respiratory system, skin, and cross-food allergies affecting the gastrointestinal tract (GIT). Pollen sensitization is characterized by comorbidity between allergic diseases such as allergic rhinitis (AR), allergic conjunctivitis (AC), bronchial asthma (BA), and sometimes skin manifestations [1, 19, 20]. Available publications show that about 16% of adult patients with AR suffer from BA, and up to 70% of children with AR subsequently develop BA, and about 80% of BA patients have concomitant AR [21, 22, 23].

In various regions of the world, as well as in the Russian Federation, the spectrum of pollen sensitization is geographically heterogeneous [10]. The Ryazan region, being a region with developed industry, is part of the Central Federal District, where birch is the main allergen causing pollen sensitization [24]. The allergenic activity of birch pollen is mediated by a major T-cell epitope located at the C-terminal positions of amino acid residues 142–156 and is one of the most common causes of IgE-mediated allergy. The main sensitizing allergen present in birch pollen is Bet v 1, which is considered a marker allergen in primary sensitization to birch. It is the first plant allergen that has been characterized and cloned.

A large nationwide study conducted in Germany in 2013 on a population sample of children and adolescents revealed the presence of IgE to birch pollen allergens in 15% of patients in the 3 to 17 age group (of whom 15.7% were girls and 21.7% were boys). Approximately half of all sensitized children showed symptoms of AR, AC, or allergic asthma [25], with increased birch pollen aller-

nicity observed after exposure to nitrogen oxides (NO_x), ozone (O_3), and sulfur dioxide (SO_2) [19].

Possible prevention of severe allergic reactions associated with pollen allergies consists of monitoring the amount of pollen in the air. Such measures have been carried out in certain regions of Russia and other countries for over 30 years. Volumetric traps are used to collect pollen from various plants [26]. It is examined under a microscope and processed using neural network-based programs that can recognize pollen by its appearance from microscope photographs and classify it into taxa. Such developments show an accuracy of 80 to 97.88%, which is a very high indicator [27]. The data from the traps is processed and sent to a center that generates online maps showing the movement of pollen in space in real time. Incorrect pollen flight forecasts can have health consequences for sensitive individuals [28].

Currently, there are relatively few studies combining clinical data with aeropalynological monitoring indicators. This study presents the experience of comparing the clinical manifestations of pollinosis in children with the characteristics of birch pollen during the 2023 pollen storm season.

STUDY OBJECTIVE — To study the clinical characteristics of birch pollen allergy in children in the city of Ryazan and the Ryazan region during the 2023 season under conditions of intense dusting.

STUDY MATERIALS AND METHODS

An open, single-center, retrospective, selective, uncontrolled cohort study was conducted using statistical and analytical research methods. Inclusion criteria: children aged 0 to 17 years who sought emergency medical care at a hospital or clinic during the study period, with established diagnoses of seasonal AR, AC, and BA according to current clinical guidelines (GINA 2023, ARIA 2020). Confirmed pollen allergy to birch pollen or symptoms that first appeared during the study season. Exclusion criteria: acute and chronic infections of the upper and lower respiratory tract within 30 days prior to the study. In parallel

with the assessment of clinical manifestations, aerobiological monitoring was carried out in Ryazan using a Lanzoni VPPS-2000 volumetric pollen trap. The latter was installed on the roof of the four-story building of the Ryazan State University named after S. A. Yesenin (54.6269° N, 39.6916° E) by staff of the Department of Biology and Teaching Methods. Observations were carried out using standard international methods and covered the period from late February to late June [29]. The material in the preparations was counted and identified under a MICMED-5 light microscope at 400× magnification. Pollen grains in the sample were counted using twelve continuous transects perpendicular to the longitudinal axis of the preparation. This analysis method made it possible not only to determine the total pollen concentration in the sample, but also to analyze the hourly pollen count pattern at 2-hour intervals.

The study was conducted at the pulmonology department of the N. V. Dmitrieva Regional Children's Clinical Hospital and the City Children's Polyclinic No. 7.

Pollen monitoring was carried out at the Department of Biology and Teaching Methods of the S. A. Yesenin Ryazan State University, on the roof of which a Lanzoni VPPS-2000 pollen trap was installed.

The study plan was approved by the local ethics committee of the Ryazan State Medical University of the Ministry of Health of Russia (Protocol dated March 9, 2021). The parents of all children who participated in the study were familiarized with the study regulations and signed informed consent forms.

The study was conducted from February 1 to June 30, 2023.

Between February 1 and June 30, 2023, medical records (form 003/U) and outpatient cards (form 112/u) of children who sought emergency medical care at a hospital or clinic with symptoms of asthma (J45), AR (J30), and AC (L50.0).

At the same time, year-round pollen monitoring was carried out at the Department of Biology and Teaching Methods of the S. A. Yesenin Ryazan State

University, on the roof of which a Lanzoni VPPS-2000 pollen trap was installed (Fig. 1).

In addition, we used the Yandex Wordstat service to compare aerobiological and medical indicators. This tool displays statistics on search queries in the Yandex system. With its help, you can see how the popularity of queries of interest has changed and how it differs in different regions of Russia, as well as build top queries with the necessary words.

The search query history in Yandex Wordstat allows you to track trends in queries made by users of the Yandex search engine. The results are presented both in numbers and in weekly and monthly graphs. This section allows you to track the seasonality of queries, i.e., it allows you to analyze how many users were interested in a given question during a specific week or month of a specific year.

Search queries in Yandex were analyzed between March and June 2023. For this purpose, a list of the following search queries was compiled: "pollen," "birch pollen," "hay fever," "allergy," "itching," "sneezing," "redness," and "shortness of breath." When conducting our study, we tried to use not only scientific terms, but also simple phrases that users might use (for example, "shortness of breath").

To obtain results, the above word or phrase was entered into the search bar. Next, the Ryazan region was sorted in the "Region" section. Since Yandex. Word Selection displays the absolute search volume for predefined geographical, temporal, and search terms, in our work this indicator was defined as the number of queries per week. After filtering a specific time period, we obtained the exact number of queries for the specified word or phrase. To compare aerobiological data and search indicators, pollen concentration was also summarized by week.

The main outcome of the study is to assess the correlation between the concentration of birch pollen in the atmosphere and the clinical structure of pollinosis in children in Ryazan and the Ryazan region in unfavorable environmental conditions.

Additional study outcomes. Determination of gender and age characteristics of patients with pol-

Table 1. **The number of children who sought medical attention for emergency reasons from 01.02.2023 to 30.06.2023 (author's table)**Таблица 1. **Состав детей, обратившихся за медицинской помощью по экстренным показаниям с 01.02.2023 по 30.06.2023 (таблица автора)**

Indicator	Outpatient clinic		Inpatient		Total	
	n	%	n	%	n	%
Number of children who sought emergency medical care	92	43,7	119	56,3	211	
Patients seeking emergency care in March	25	11,8	0	0	25	11,8
Patients seeking emergency care in April	21	22,4	73	77,6	94	44,5
Patients seeking emergency care in May	32	41,1	46	58,9	78	36,9
Patients seeking emergency care in June	14	6,6	0	0	14	6,6
Age group of children 0–3 years	11	57,9	8	42,1	19	9,0
Age group of children 4–6 years	14	48,3	15	51,7	29	13,7
Age group of children 7–12 years	41	44,1	52	55,9	93	44,0
Age group of children over 12 years	26	37,2	44	62,8	70	34,1
Number of boys seeking assistance	61	67	90	76	151	71,5
Number of girls seeking assistance	31	24	29	48	60	28,5

linosis and bronchial asthma, assessment of clinical manifestations of pollinosis, identification of the age of its onset.

Statistical analysis. Past 4.03 software and SPSS V24.0 package, including descriptive statistics, were used for statistical processing. To describe the quantitative indicators of the data under study, the median Me was used, which falls within the interval with the first quartile Q1 as the lower limit and the third quartile Q3 as the upper limit in the format Me [Q1; Q3]. Only independent data groups were considered in the study.

RESULTS AND DISCUSSION

According to preliminary estimates, as of January 1, 2022, the number of children under the age of 18 in the city of Ryazan, Central Federal District of the Russian Federation, and its region was 194,400 [30]. Most children live within the city limits of Ryazan — 73.3%, in the Ryazan region — 26,7%.

The total number of patients studied was 211 aged 0 to 17 years [P25; P75] = 11 [7; 14] who sought emergency care for acute symptoms of asthma, allergic rhinitis, allergic conjunctivitis, and skin manifestations. 119 people were admitted to the hospital, and 92 children sought help at

the clinic. Among the cohort of children studied, sIgE to birch allergen extracts was detected by indirect immunofluorescence on an automatic analyzer using ImmunoCAP technology in the group of children aged 4 to 6 years — 13.7% (n = 29), 44.0% (n = 93) in the 7–12 age group, and 34.1% (n = 70) in the over-12 age group. In April 2023, the number of hospitalizations was 73 patients, and in May, 46 patients. Outpatient emergency visits began earlier: in March 2023, there were 2 children, in April, 21 children, in May, 32, and in June, 14 patients. The maximum number of children with hay fever symptoms was recorded from early April to mid-May, which is typical for the peak of birch pollen season. However, the onset of acute symptoms in March may indicate either an earlier start to the birch pollen season or clinically significant long-distance pollen transport. Earlier visits by children with hay fever symptoms were recorded in urban areas (Table 1).

Assessing the regional epidemiology of pollinosis in terms of age, it can be noted that most cases occurred in children aged 7 to 12 years, which is the typical age for the manifestation or exacerbation of allergic diseases. However, it should be noted that respiratory symptoms associated with birch pollen ex-

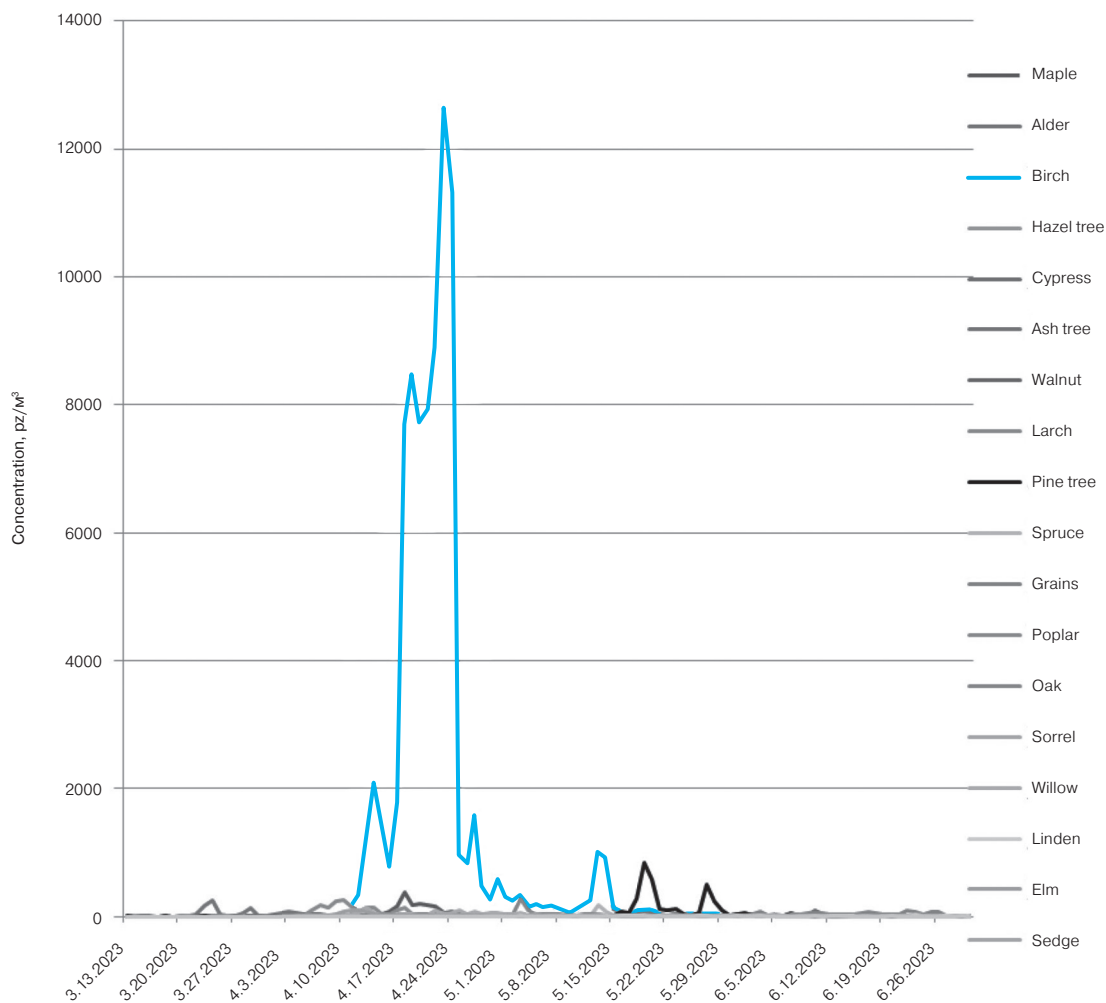


Fig. 1. Dynamics of dusting of plants in Ryazan in 2023 (from 13 March to 30 June 2023) (the author's fig.)
Рис. 1. Динамика пыления растений г. Рязани в 2023 г. (с 13 марта по 30 июня 2023 г.) (рис. автора)

posure have been observed in younger children (aged 0–3 years), which may be a sign of the “rejuvenation” of modern pollinosis, not characteristic of the classic atopic march (Table 1).

According to the patients' gender, the onset of hay fever symptoms was more common in boys — 151 children (71.5%) — and only 60 girls (28.5%) who sought treatment at both the hospital and the clinic. In percentage terms, this amounted to 76% of boys and 24% of girls in the hospital, 67% of boys and 33% of girls in the polyclinic, which correlates with data from literary sources (Table 1).

Assessing the clinical phenotypes of birch pollen allergy in the 2023 season in the Ryazan region, it can be noted that the majority of children hospitalized during the study period had ex-

acerbated bronchial asthma (61%, $n = 72$), with half of them manifesting pollinosis with asthma symptoms during the study period (49%, $n = 35$) without a history of previous AR and AC symptoms. Other nosologies included seasonal allergic rhinitis, severe exacerbations (9%, $n = 11$), allergic conjunctivitis with eye swelling (9%, $n = 11$), and skin symptoms, mainly in the form of urticaria (14%, $n = 17$). Children with obstructive bronchitis accounted for 7% (7%, $n = 8$). This distribution is not typical for the clinical manifestation of pollinosis, as it usually starts with manifestations of allergic rhinitis and allergic conjunctivitis and, corresponding to the atopic march, can cause bronchial asthma in the second or third season after the onset of manifestations.

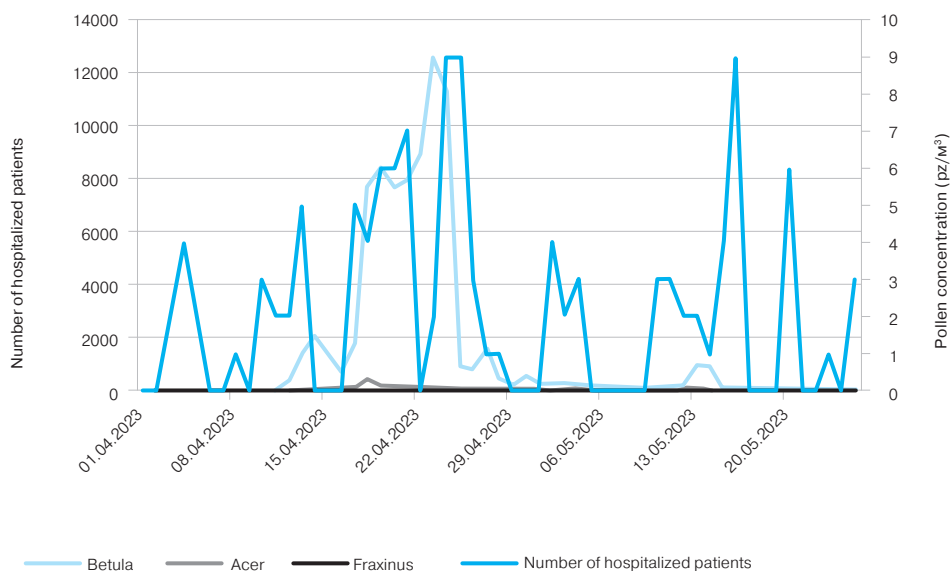


Fig. 2. Number of emergency visits to hospital and polyclinic (the author's fig.)
Рис. 2. Количество экстренных обращений в стационар и в поликлинику (рис. автора)

Analysis of the results of aerobiological studies in 2023 showed that during the study period (March 13 to June 30, 2023), the following pollen grains were recorded in the atmospheric air: *Betula* (81,916 grains/m³), *Acer* (1,653 pz/m³), *Alnus* (1,146 pz/m³), *Corylus* (155 pz/m³), *Cupressaceae* (103 pz/m³), *Fraxinus* (254 pz/m³), *Juglans* (16 pz/m³), *Larix* (32 pz/m³), *Pinus* (3550 pz/m³), *Piceae* (408 pz/m³), *Poaceae* (1254 pz/m³), *Populus* (1935 pz/m³), *Quercus* (825 pz/m³), *Rumex* (179 pz/m³), *Salix* (1333 pz/m³), *Tilia* (122 pz/m³), *Ulmus* (457 pz/m³), *Carex* (64 pz/m³), *Apiaceae* (38 pz/m³) and *Castanea* (22 pz/m³) (Fig. 1).

Among them, pollen from anemophilous plants (specifically *Alnus*, *Corylus*, *Betula*, *Acer*, *Cupressaceae*, *Fraxinus*, *Poaceae*, *Quercus*, *Ulmus*, *Salix*) is considered a strong allergen, found in high concentrations in the air. It should be noted that in aeropalynological studies, pollen from plants belonging to the same genus or family is usually impossible to identify to species under a light microscope, since pollen grains within many taxonomic groups are morphologically similar. For this reason, different groups of pollen are classified to the genus or family level (very rarely to the species level).

To compare the concentration of pollen from the above taxa in the air with the number of hospitalized patients, the period from April 1 to May 25, 2023, was selected as the time interval during which the highest number of visits to hospitals and clinics by allergy sufferers was recorded. Thus, a significant positive correlation between the above indicators was found only in the case of *Betula* ($r = 0.4$, $p = 0.002$), *Acer* ($r = 0.4$, $p = 0.004975$), and *Fraxinus* ($r = 0.4$, $p = 0.0072972$). At the same time, the concentration of pollen grains in the atmospheric air from April 1 to May 25, 2023, was insignificant compared to *Betula* (Fig. 2). The share of birch pollen during the above-mentioned period was 81,330 pz/m³, which accounted for 98.8% of its total annual content.

The intensity of dusting (total pollen content per season) for *Betula* in Ryazan over 9 years of research varied within a very wide range ($M = 30,639$, $Cv = 77.6\%$, $Me = 28,985$, $min = 12,441$, $max = 82,320$). It is claimed that birch is one of the few tree taxa in which inter-seasonal pollen rhythms with a two- or three-year cycle are clearly evident, depending on the geographical region [33, 34]. The intensity of pollen production in any given year largely depends on meteorological parameters, and not only current

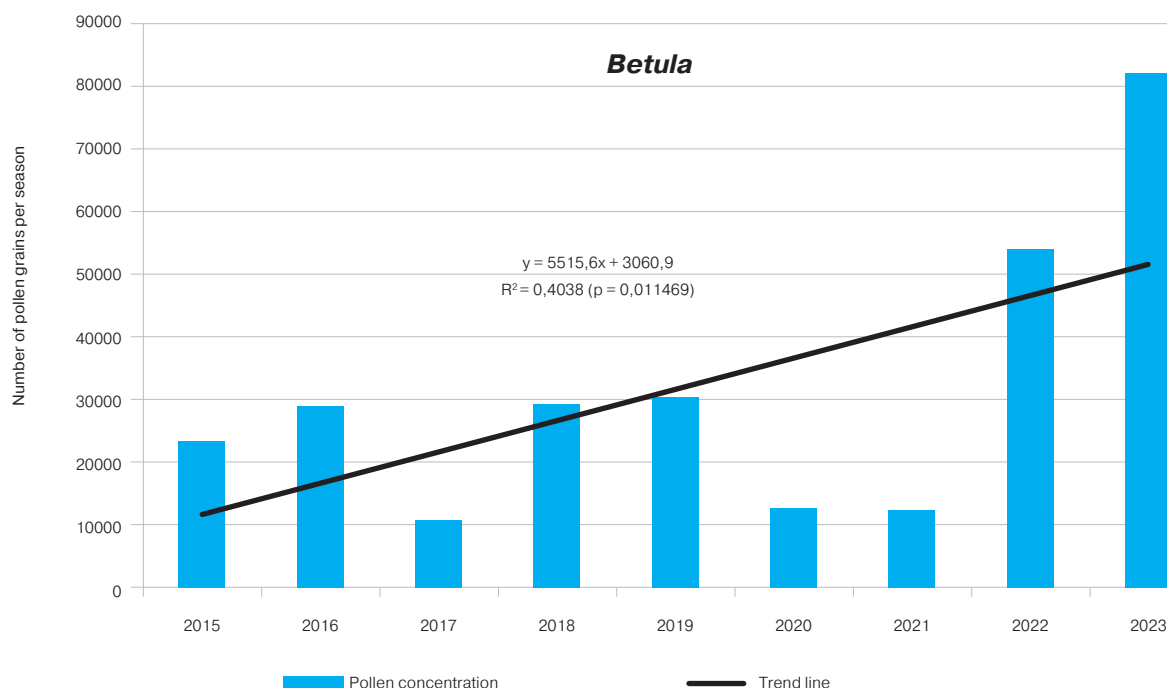


Fig. 3. Interseasonal dynamics of *Betula* dusting (2015–2023) (the author's fig.)

Рис. 3. Суммарное годовое содержание пыльцы *Betula* в воздухе г. Рязани (2015–2023 гг.) (рис. автора)

ones. Weather conditions in the early summer of the previous year (primarily moisture availability) have a huge impact on potential pollen production. It is during this period that male inflorescences and pollen, which will appear in the air the following spring, are formed and develop. In addition, severe frosts immediately before the start of pollination can damage male inflorescences, and rainy weather during pollination contributes to the washing out of pollen from the atmosphere, thereby alleviating the condition of allergy sufferers [31].

In our study, birch exhibited a three-year cycle that was disrupted (Fig. 3), so a longer series of observations is required to obtain reliable results. An analysis of *Betula* pollen dynamics in the region over the past nine years showed that, despite alternating seasons with high and low concentrations, the pollen productivity of the taxon is constantly increasing ($R = 0.4038$, $p = 0.011469$). However, it is premature to speak of a clear growth trend and its causes in our case (Fig. 3).

It should be noted that in 2023, the highest annual concentration of birch pollen grains in the history of aerobiological research in Ryazan was recorded (82,320 pz/m³) (Fig. 3, Table 2), exceeding previous values by 1.5 (2022) to 7.8 times (2017). This phenomenon may be related to the aftermath of the 2010 fires, after which the area covered by coniferous and hardwood (oak) trees in the region decreased significantly, while the area covered by softwood (birch, aspen) trees increased [35]. According to data from the Ministry of Natural Resources of the Ryazan Region, in 2010, the region's forest fund consisted of 343,000 hectares of coniferous forests, 71,100 hectares of hardwood forests (oak), and 388,600 hectares of softwood forests (birch, aspen). By 2021, these figures had fallen to 283,700 hectares, 65,700 hectares, and 496,000 hectares, respectively. Thus, over a period of 10–11 years, the area of coniferous and hardwood forests decreased significantly, while the area of softwood forests increased significantly (by 107,400 hect-

Table 2. **Dynamics of birch dusting in Ryazan (2015–2023) (author's table)**
 Таблица 2. **Показатели пыления березы в Рязани (2015–2023) (таблица автора)**

Year	First appearance of pollen (p.z./m ³)	Pollination period (start-end)	Dusting duration (in days)	Peak dusting (date)	Maximum daily content (p.z./m ³)	Amount for the season (p.z./m ³)	Last appearance of pollen (date)
2015	07.04	28.04 — 13.05	16	09.05	8671	23 363	22.09
2016	15.03	14.04 — 11.05	28	25.04	4 922	28 985	20.09
2017	13.04	13.04 — 25.05	43	03.05	2 403	10 589	02.10
2018	19.03	27.04 — 14.05	18	30.04	3 844	29 421	29.09
2019	15.03	23.04 — 09.05	17	26.04	6 190	30 355	02.10
2020	22.02	22.04 — 12.05	21	03.05	2 950	12 625	29.09
2021	29.03	18.04 — 12.05	25	23.04	1 761	12 441	26.09
2022	22.02	24.04 — 18.05	25	26.04	8 146	53 964	02.10
2023	14.03	15.04 — 07.05	23	23.04	12 647	82 320	02.10

ares). Severe forest fires caused changes in the hydrological regime and the burning of the top layer of humus, creating optimal conditions for the rapid growth of softwood trees (birch and aspen). At the same time, coniferous and hardwood trees are characterized by slow growth during the first three to four years after fires.

L. V. Vetchinnikova and A. F. Titov noted that fruiting following pollination occurs quite early in silver birch, at the age of 4–6 years (under conditions of free growth of isolated trees), and significantly later in plantations (at high density). G. B. Dubynin noted that the period of stable fruiting of birch trees can be observed at the age of 10 years [36, 37].

In addition to pollen grains, microscopic fungal spores can also cause allergic reactions. However, in this case, we do not associate the number of allergy sufferers visiting medical facilities during the period in question with spore production, as its peak in Ryazan occurs in early to mid-July to late August [32]. The above facts suggest that the main cause of hospitalization of allergy sufferers from April to May 2023 was *Betula* pollen.

When comparing clinical manifestations and birch pollen concentration in the air, a moderate positive correlation was found between these indicators ($r = 0.4$, $p = 0.002$). It was also found that an increase in the concentration of *Betula* pollen grains in the

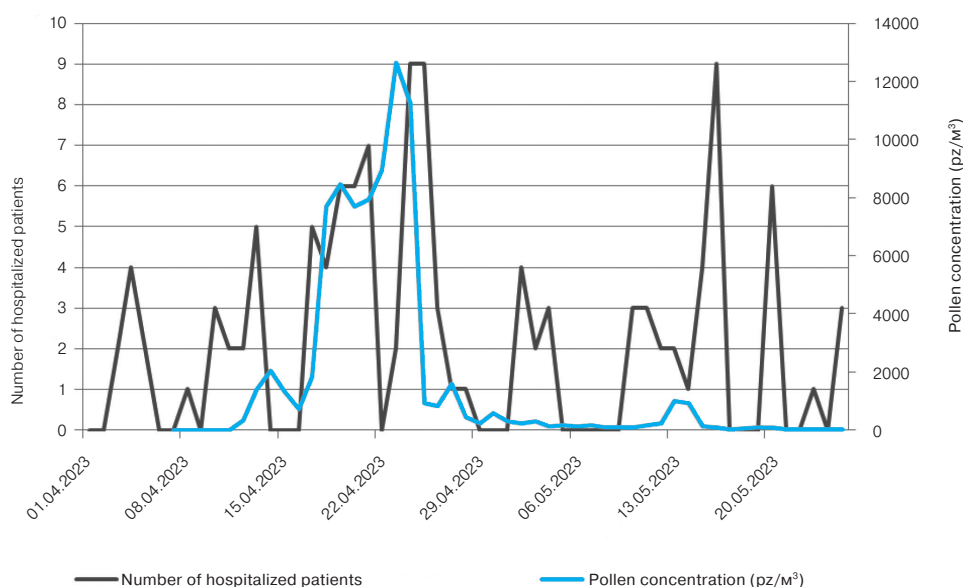


Fig. 4. **The number of emergency calls to the hospital and to the polyclinic (the author's fig.)**
 Рис. 4. **Количество экстренных обращений в стационар и в поликлинику (рис. автора)**

aeropalynological spectrum was followed by an increase in the number of hospitalized patients. Thus, the maximum content of birch pollen was recorded on April 23, 2023 (12,647 pz/m³), followed by the highest number of children with exacerbated asthma in the next two days (April 24, 2023, and April 25, 2023).

We attribute the lack of high consistency between medical indicators and aeropalynological data to the small sample size of patients. In addition, in today's world, most people first search for information on the Internet when they discover symptoms of a disease before consulting a doctor. In this regard, in 2023, we analyzed search queries related to pollinosis in the Ryazan region using the Yandex Wordstat service to establish a retrospective link between public interest and the actual concentration of pollen in the air. This makes it possible to record the onset of diseases and the processes associated with them. After analyzing the number of search queries for the entire growing season, we found that the most frequent query among the rest was "allergy". The term "pollinosis" is used much less frequently on the internet, as apparently not every user can associate their symptoms with plant flowering. When comparing *Betula* pollen concentrations and search queries between March 13, 2023, and June 25, 2023, it was found that very high correlation values were observed for search queries such as "birch pollen" ($r = 0.93$;

$p < 0.01$), "hay fever" ($r = 0.97$; $p < 0.01$), "allergy" ($r = 0.97$; $p < 0.01$). The maximum weekly content of *Betula* pollen grains was recorded between April 17, 2023, and April 23, 2023. During this same period, the highest number of search queries for the terms "birch pollen," "hay fever," and "allergy" was recorded.

RESEARCH LIMITATIONS

The interpretation of our results is limited by the small sample size and retrospective observation of the intensity of clinical symptoms without the use of VAS scales and monitoring of external respiratory function, which would have led to more objective results.

CONCLUSION

A retrospective clinical study conducted in parallel with aerobiological monitoring revealed the characteristics of the birch pollen allergy season in 2023. These include record high concentrations of birch pollen over the last nine years of observation. This led to an increase in the number of children seeking emergency care for symptoms of respiratory and skin pollinosis, the main phenotypic feature of which in 2023 was the clinical manifestation of asthma in the form of a debut syndrome. A link has been identified between the concentration of birch pollen grains in the air and the number of children seeking help for BA attacks.

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THE AUTHOTS' CONTRIBUTION THE WORK

All authors confirm that their authorship meets the international criteria of ICMJE (all authors have made a significant contribution to the development of the concept, the conduct of the study, and the preparation of the article, and have read and approved the final version before publication).

Elena V. Stezhkina — development of the concept, research design, analysis of the obtained data, and writing and editing of the article.

Natalya A. Belykh — general management and editing of the article.

Kirill I. Ulyanov — collection, processing, and analysis of the obtained data, and writing of the article.

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Anna I. Agapova — analysis of the obtained clinical data, statistical processing, and writing the article.

Julia M. Seleznyova — development of the concept, organization, and management of pollen monitoring.

Vera S. Karasyova — implementation of pollen monitoring, analysis of the obtained data, and statistical processing.

ВКЛАД АВТОРОВ В РАБОТУ

Все авторы подтверждают соответствие своего авторства международным критериям ICMJE (все авторы внесли существенный вклад в разработку концепции, проведение следования и подготовку статьи, прочли и одобрили финальную версию перед публикацией).

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

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