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The effect of meteorological factors on the start of the grass pollen season in Lublin in the years 2001-2004

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Summary

Grasses' pollen produces allergens, which are the main cause of pollinosis in Poland and in many countries of Europe. In Poland the beginning of season falls in different days of May. Pollen monitoring was carried out in Lublin by volumetric method in years 2001-2004 by means of Lanzoni VPPS 2000 trap. Start of grass pollen season was marked by methods 98 % and Σ 75 as well as by the Clot's method. Differences between them ranged from 1 to 7 days. The most approximate deadlines of beginning of pollen season were qualified according to methods 98 % and the Clot's one, except year 2002. It was defined the pollen season in Lublin begins between 5. and 21. of May. In that study impact of meteorological factors on the beginning dates of pollen seasons was estimated. It was stated statistically positive, essential correlation among the beginning of season and the daily mean, the minimum and maximum air temperature.

Key words: grass pollen, start pollen season, meteorological factors

INTRODUCTION

Pollen allergy is a more and more frequently diagnosed chronic disease in persons at different ages. Air pollution and the so-called “western style of living” can be numbered among the most essential factors which favour the development of this disease condition (Liebhart, 2000). In Poland, over 90 % of persons who have pollinosis suffer due to grass pollen (Obtułowicz et al., 1990). The grass pollen season is relatively long, and in the conditions of Poland it lasts about four months (Piotrowska and Weryszko-Chmielewska, 2004; Puc and Puc, 2004). However, every year there are variations in the start and end dates of the season, as well

as in concentrations of these plants' pollen in the air. Information on the start of grass pollination is very relevant for allergic persons. Studies conducted in different sites show that this date may be moved by 20 days (Kasprzyk, 2002), 22 days (Puc and Puc, 2004), 28 days (Emberlin et al., 1994), 35 days (Ong et al., 1997) and 37 days (Spieksma and Nikkels, 1998).

Meteorological factors play an important role in the intensity of flowering, the production and dispersal of plant pollen. Different authors give different minimum temperatures at which the growth of most plants begins (Falkowski, 1982; Norris-Hill, 1997). In this study, an attempt was made to assess the effect of selected weather conditions on the start dates of the grass pollen seasons in Lublin, and three methods of determination of pollen seasons over a period of four years were compared.

MATERIAL AND METHODS

The occurrence of grass pollen (Poaceae) in the aeroplankton of Lublin was analysed. The climate of the Lubelszczyzna region is characterised by great weather variability and significant variations in the course of the seasons in particular years (Woś, 1995). It is affected by the influence of continental air masses. 40-year studies (1951-1990) show that the mean annual temperature in Lublin reaches 7.4°C. The mean long-term air temperature in the months preceding grass pollination is as follows: 1.1°C in March, 7.4°C in April, 13.2°C in May. The mean total annual rainfall in Lublin is 550 mm (Kaszewski et al., 1995). The vegetation period in Lublin lasts 215 days (Woś, 1995).

Daily pollen concentrations in Lublin were measured in the years 2001-2004. The Lanzoni VPPS 2000 trap, sited on the roof of the Agricultural University of Lublin, 18 m above ground level, was used for pollen monitoring. Pollen grains were sampled and counted in four horizontal bands. Results are presented as the number of pollen grains in m^3 of air within 24 hours ($P \cdot m^3$ per day).

The start of the grass pollen season was calculated by using the 98% method and the $\sum$ 75 method (Emberlin et al., 1994; Spieksma and Nikkels, 1998), as well as Clot's method (1998). Clot suggested that the second rainless day, when the cumulative mean daily temperature from 1 March reaches 500°C, should be defined as the start of the grass pollen season.

Given the reports about threshold values lower than 50 $P \cdot m^3$ per day for grass pollen (Davies and Smith, 1973; Rantio-Lehtimäki et al., 1991; Rapiejko and Weryszko-Chmielewska, 1998), dates were defined at which concentrations of pollen of this taxon higher than 10, 20, 30 and 50 pollen grains in m^3 per day occur.

For the comparative analysis, the following meteorological factors were selected: daily mean, minimum and maximum air temperature, precipitation and daily mean relative air humidity. Weather data was provided by the Department of Meteorology and Climatology of the Maria Curie-Skłodowska University in Lublin, which is located at a distance of 1.5 km from the measurement site.

RESULTS

The start dates of the grass pollen season calculated by three methods are shown in Table 1. According to the Σ 75 method, the grass pollen season in the years 2001-2004 started 1-2 days later than the season calculated by using the 98% method. The start dates of the seasons calculated by the 98% method and Clot's method are also similar in the years of study, except for the year 2002 (Tab. 1).

Table 1

Start dates of the grass pollen season in Lublin calculated by different methods.

Year	The method		
	Σ 75	98%	by Clot (1998)
2001	10.05	9.05	9.05
2002	12.05	10.05	5.05
2003	20.05	19.05	18.05
2004	21.05	19.05	18.05

It can be generally stated that the differences between the methods used were 1-3 days, and exceptionally 7 days in 2002. Intermediate values were obtained by using the 98 % method.

The start of the grass pollen season was generally preceded by several days during which very low (< 10 P·m ^{3} per day) or low (11-20 P·m ^{3} per day) pollen concentrations were observed. The first grains of grass pollen in the years of study were recorded at the beginning of May. The number of days was determined with the daily pollen concentration ≥10, 20, 30 and 50 P·m ^{3} per day, which occurred before the start date of the grass pollen season identified by the 98% method. Grass pollen concentrations reaching over 10 grains in 1 m^3 of air per day were recorded the earliest in 2001 (4 May), whereas the latest in 2004 (19 May) (Tab. 2). There were at a maximum 3 days (in 2001) with a pollen concentration of more than 10 pollen grains in m^3 per day before the start of the grass pollen season determined by the 98% method. In 2002 a low concentration of grass pollen was reported for two days before the season, and in the next year for one day, whereas in 2004 the grass pollen concentration over that period was not more than 10 grains. No grass pollen concentrations of more than 20 P·m ^{3} per day were recorded before the start of the season. High grass pollen concentrations (above 50 P·m ^{3} per day) were recorded in the second half of May or at the beginning of June (Tab. 2).

Table 2

The first day of occurrence of selected threshold values of grass pollen in Lublin in the years 2001 2004.

Year	≥10	≥ 20	≥ 30	≥50
	P·m^{-3} per day			
2001	4.05	11.05	14.05	15.05
2002	5.05	10.05	13.05	18.05
2003	18.05	20.05	20.05	26.05
2004	19.05	30.05	31.05	6.06

The relation between the number of days with daily minimum temperature of more than 5.6°C and the start of the grass pollen season was demonstrated in the study. It was calculated that the number of days with minimum temperature of more than 5.6°C in the period starting from 1 March until the start of the pollen season (the 98% method) was similar in the years of study. In 2001 it was 31 days, and in the successive years 30, 30 and 33 days.

The comparative analysis of meteorological factors shows that the mean monthly temperatures in March and April were higher in all the years of study than the long-term means. In the abovementioned months, the highest temperature was recorded in 2002, and the lowest in 2003. The May temperature in 2004 was slightly lower than the long-term mean, and higher in the other years. Over the four years of study, the grass pollen season was identified the earliest in 2001. In the next year, though the mean air temperature in the months March-May was higher by 5.1°C than in 2001, the pollen season started on 10 May. It was probably affected by exceptionally weak rainfall in April 2002, which was lower than the long-term means by 24.9 mm. In 2003 the later onset of the season was attributable to relatively low mean temperatures in March and April, whereas in 2004 to a lower temperature in May (Figure 1).

Table 3

Coefficients of linear correlation between the start date of the grass pollen season and meteorological factors.

Years	Meteorological factors				
	Temperature			Rainfall	Mean relative air humidity
	mean	minimum	maximum		
2001	0,4323*	0,4018*	0,4045*	-0,0492	-0,1424
2002	0,5405*	0,4883*	0,5131*	-0,0963	-0,1011
2003	0,3446*	0,3338*	0,3108*	0,0313	-0,0795
2004	0,3007*	0,3237*	0,2773*	-0,0855	0,0085

* The statistically significant correlation coefficient

The statistical analysis confirmed the dependence between the onset of the grass pollen season and air temperature. A positive, statistically significant correlation was found between the start of the grass pollen season and the daily mean, minimum and maximum temperature. But no statistically significant correlation was found between the onset of the grass pollen season and rainfall and the mean relative air humidity (Tab. 3).

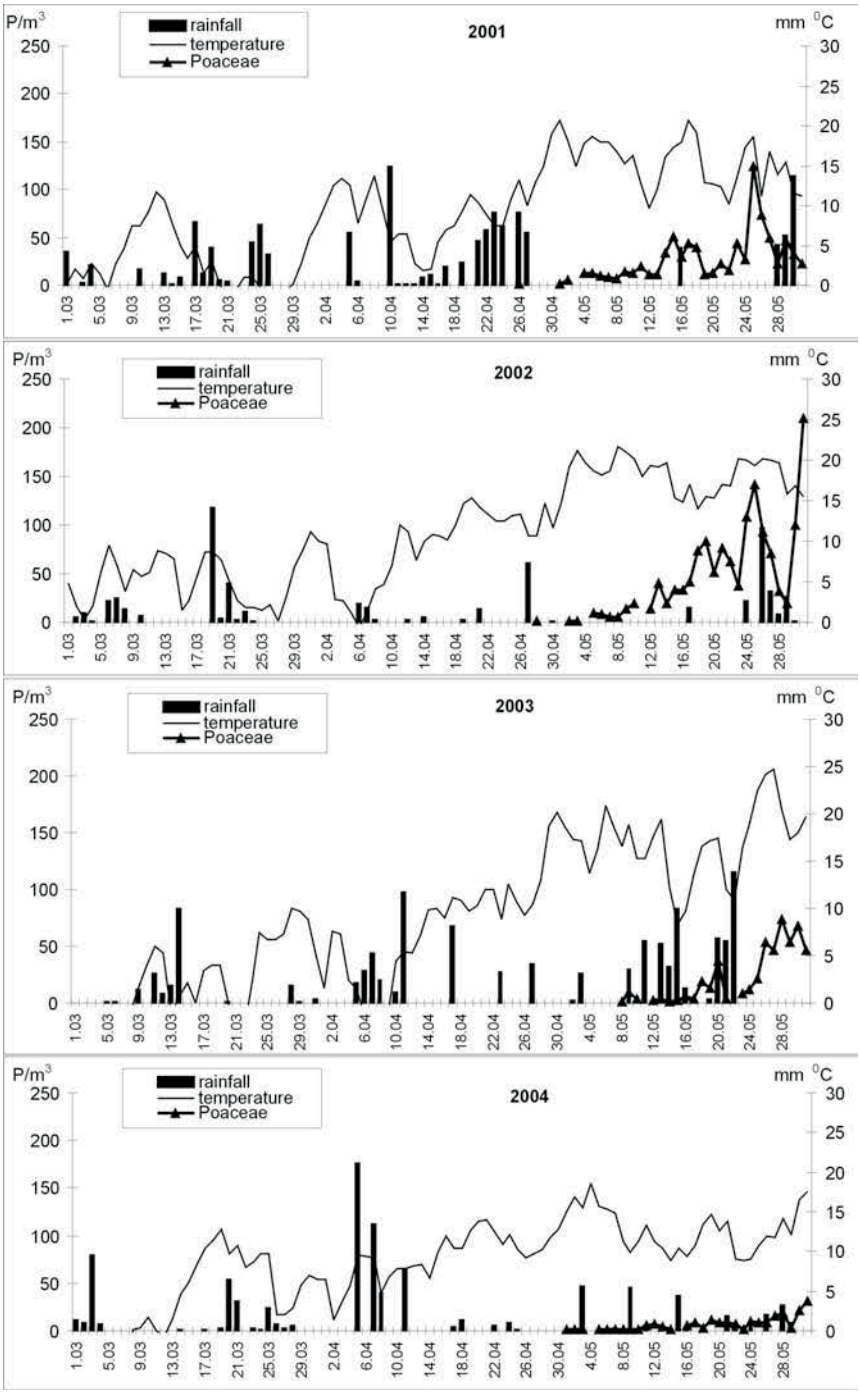

Fig. 1. The beginning of grass pollen season in relation to the selected weather factors.

DISCUSSION

Over the four years of study, the grass pollen season in Lublin determined by different methods started between 5 and 21 May. The maximum variation in this date between particular years was 10-13 days, depending on the method used (Tab. 1). In the years 2001-2004, the start of the season in Lublin determined by the Σ 75 method was reported a bit later than by using the 98% method. Similar tendencies in the conditions of the United Kingdom were found by Emberlin et al. (1994), whereas opposite results were obtained by Spieksma and Nikkels (1998) in the Netherlands.

The method most often used in the determination of the start and end dates of the grass pollen season is the 98% method (Emberlin et al., 1994; Spieksma and Nikkels, 1998). The results obtained in this study also indicate optimal, intermediate in relation to the other methods, data obtained by using the abovementioned method. However, it only allows for a retrospective determination of the start date of the pollen season, therefore, the Σ 75 method, which enables this date to be identified earlier, seems to be better for allergologists and their patients (Emberlin et al., 1994). Clot's method also allows an earlier determination of the grass pollen season, and the results obtained in the study presented demonstrate that the difference in the start date of the season between the two aforementioned methods was 1-7 days. Spieksma and Nikkels (1998) found a higher correlation between first symptoms of hay fever and the start of the grass pollen season determined by the Σ 75 method than if the 98 % method was used. Predicting the start of the grass pollen season in a given period of vegetation is possible thanks to meteorological observations (Clot, 1998). Among meteorological factors influencing the onset of the grass pollen season, temperature and precipitation proved to be the most relevant (Clot, 1998; Shäppi et al., 1998; Emberlin and Adams-Groom, 2004). The statistical analysis used in this study showed a significant positive correlation with respect to grass pollen and air temperature. Similar results were obtained by Gaweł et al. (2003). No correlation was found between the start of the season and rainfall and relative air humidity.

In the conditions of Poland, grass growth usually starts at a temperature above 5°C (Falkowski, 1982). It is accepted in many studies that the effective growth of plants occurs at an ambient temperature of more than 5.6°C or 6°C (Norris-Hill, 1997). The studies conducted in Lublin show that the start of the grass pollen season depends on the number of days from 1 March with a temperature above 5.6°C. The studies of Norris-Hill (1997) confirmed that the mean air temperature of more than 6°C in the period starting from 1 March is an important factor in predicting the start of the grass pollen season.

Persons with seasonal rhinitis and conjunctivitis demonstrate individual, varied sensitivity to pollen. According to different authors, the threshold value for grass pollen, that is, the minimum number of grains which induces allergy symptoms, is 10-50 (Davies and Smith, 1973), 30 (Rantio-Lehtimäki et al., 1991), 36-71 P·m^3 per day (Rapiejko and Weryszko-Chmielewska, 1998). In Israel, pollen allergy symptoms were identified with a daily grass pollen concentration of 2-4 P·m^3 (Geller-Bernstein et al., 2003). The authors suggest that threshold values of pollen concentration are different for particular geographic regions and

ethnic groups. Based on long-term studies, Spieksma and Nikkels (1998) found the occurrence of hay fever symptoms, on the average, 4 days (Σ 75) or 22 days (98 %) before the identified start date of the pollen season. In all the years of study, the daily mean pollen concentration in Lublin before the identified start of the season was not more than 20 P·m^3 per day, thus, the pollen concentration was lower than the threshold value for most allergy sufferers in Poland (Rapiejko and Weryszko-Chmielewska, 1998).

CONCLUSIONS

1. The grass pollen season determined by the 98% method starts in the conditions of Lublin in the first or second decade of May.

2. Air temperature has the greatest effect on the start of the grass pollen season.

3. The start of the grass pollen season depends on the number of days with minimum temperature above 5.6°C.

4. Clot's method may also be useful in the conditions of Lublin for predicting the start date of the grass pollen season.

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Wpływ czynników meteorologicznych na rozpoczęcie sezonu pyłkowego traw w Lublinie w latach 2001-2004

Streszczenie

Pyłek traw wytwarza alergeny, które są główną przyczyną pyłkowicy w Polsce i w wielu krajach Europy. W Polsce początek sezonu przypada w różnych dniach maja. Monitoring pyłkowy prowadzono w Lublinie w latach 2001-2004. Zastosowano metodę wolumetryczną z wykorzystaniem aparatu Lanzoni VPPS 2000. Początek sezonu pyłkowego traw wyznaczono metodą 98 % i $\sum$ 75 oraz metodą Clot'a. Różnice między metodami wynosiły 1 7 dni. Najbardziej zbliżone terminy początku sezonu pyłkowego określono metodami 98% i wg Clot'a, z wyjątkiem roku 2002. Ustalono, że sezon pyłkowy rozpoczyna się w Lublinie między 5. a 21. maja. W pracy oceniano wpływ czynników meteorologicznych na terminy rozpoczęcia sezonów pyłkowych. Stwierdzono dodatnią istotną statystycznie korelację pomiędzy początkiem sezonu a dobową średnią, minimalną i maksymalną temperaturą powietrza.