THE SOCIO-ECONOMIC IMPACT OF ALLERGENIC WEEDS: PREVENTION AND COSTS OF THEIR SUPPRESSION IN VUKOVAR-SYRMIA COUNTY

F. STEFANIC[1], Natasa RADOJCIC[2], M. LUKACEVIC[3], Edita STEFANIC[4]

[1]ECORYS, Brussels, Belgium, Young researcher
[2]PhD student J. J. Strossmayer University, Biology department
[3]PhD student J.J. Strossmayer University, FAZOS
[4]full professor, J.J. Strossmayer University, FAZOS
Corresponding author: estefanic@fazos.hr

Abstract: *The incidence of pollen-induced allergy diseases increased globally over the last decades. The impact of allergenic diseases was studied in 2019 based on aero-palynological monitoring performed in Vukovar with a distributed anonymous questionnaire assessing patients during their visit to a general practitioner's office. During the study period, the month with the highest pollen concentration was August with significant domination of all weed pollen types, followed by April where the pollen of trees dominated over the grass and weed pollen spectrum. The predominant plants found in the air of Vukovar (Ambrosia artemisiifolia, Urtica, Betula, and Poaceae) account for two-thirds of the total pollen sum. Patients with the symptoms of pollen allergies peak in the 25-64-year-old age group, equally both male and female, but reside predominantly in urban areas. Symptoms related to pollen allergy are a runny nose or sneezing, affecting roughly 95% of patients, followed by swollen eyes (47%) and coughing or wheezing (34%). For the treatment of symptoms, they were prescribed antihistamines (90,14%), corticosteroids (67,61%) and other drugs (14,44%). The price of weed control to suppress or eradicate unwanted allergenic weeds from urban areas is almost 30% higher than annual medical treatments. However, the long-term effect of continuous mowing will be beneficial for improving the quality of life for allergic people.*

Keywords: *allergenic weeds, pollen season, health risk assessment, economic impact*

INTRODUCTION

Allergies today are a public health problem and numerous studies have confirmed a rapid increase in allergic conditions and asthma over the last decades worldwide. Current estimates suggest that up to 30% of Europeans could suffer from allergic rhinitis or conjunctivitis (Berger et al., 2021). The previously low prevalence is now increasing with 20 to 30% in adults, and up to 40% among the young population (Hoyte and Nelson, 2018; Savouré et al., 2022). People with allergic conditions experience many disadvantages, which affect their school performance, work performance, and social life (Calderon et al., 2012). Moreover, the impact of allergies caused by allergenic pollen is detrimental both for individual sufferers and for society as a whole.

Allergies related to pollen are seasonal respiratory allergic diseases. The symptoms are associated with the blooming period of allergenic plants and their abundance in particular regions.

Many different pollen types are present in the atmosphere, and knowledge of the taxonomic spectrum, seasonality, concentration, and allergenicity of airborne pollen grains has been significant for public health and also enabled guidance to individuals suffering from allergic rhinitis, and hay fever (Gehrig et al., 2018; Camacho et al., 2020). The most important allergenic pollen types in Europe are grasses (Poaceae), birch (*Betula*), and ragweed (*Ambrosia*).

This study aimed to identify allergenic pollen content and seasonal variation in Vukovar-Syrmia County, evaluate the relationship between pollen concentration and quality of life, and,

particularly, explore the prevention methods and costs of allergy treatment among the population in the investigated area.

MATERIAL AND METHODS

Data source

The aerobiological study was conducted in 2019 in the easternmost county (Vukovar-Syrmia) of the Republic of Croatia. A Burkard 7-day recording volumetric spore trap (https://burkard.co.uk/product/7-day-recording-volumetric-spore-trap/) situated on the roof of a building in the Vukovar city center, was used to collect the airborne pollen from the air. Pollen grains were observed and counted on the surface of 4 horizontal bands, and pollen concentration was expressed as the daily average of pollen grains per cubic meter of air.

Study population

A one-hundred-and-twenty-five people with allergic symptoms filled out an anonymous questionnaire, which assessed their socioeconomic status, allergy symptoms, and current symptomatic treatment. The questionnaire was offered to them during the 12 calendar months of 2019 when they visited their general practitioners' offices. The economic impact of pharmacological treatment versus the cost of weed control was evaluated.

RESULTS AND DISCUSSION

Monitoring the pollen presence in the air

The traditional way to measure the presence and quantity of pollen allergens in the atmosphere is to assess the airborne pollen concentration. Figure 1 presents the distribution of pollen type throughout the 2019 vegetation season in Vukovar.

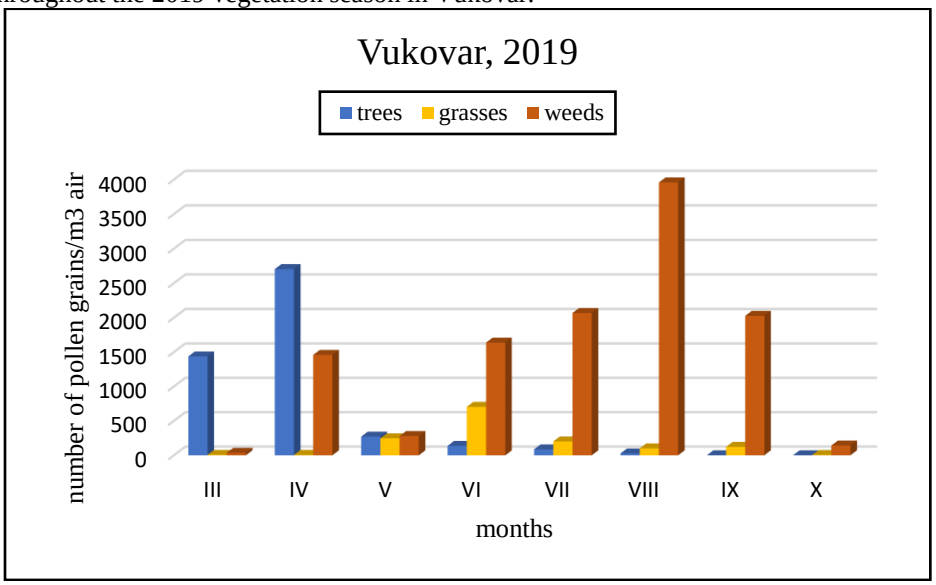

Figure 1. Distribution of pollen types (trees, grasses, weeds) throughout the vegetation season in Vukovar, 2019

The month with the highest pollen concentration (number of pollen grains/m^3 of air) was August with a significant domination of weed pollen types, followed by April where pollen of trees dominated over the grass and weed pollen spectrum.

The predominant plants found in the air of Vukovar (*A. artemisiifolia*, *Urtica*, *Betula*, and Poaceae) account for two-thirds of the total pollen sum. During the vegetation period, a very high and long concentration of ragweed (*Ambrosia artemisiifolia* L.) pollen was recorded, particularly in August and September, while in April pollen of birch (*Betula* sp.) and nettle (genus *Urtica*) dominated for a short period (Figure 2).

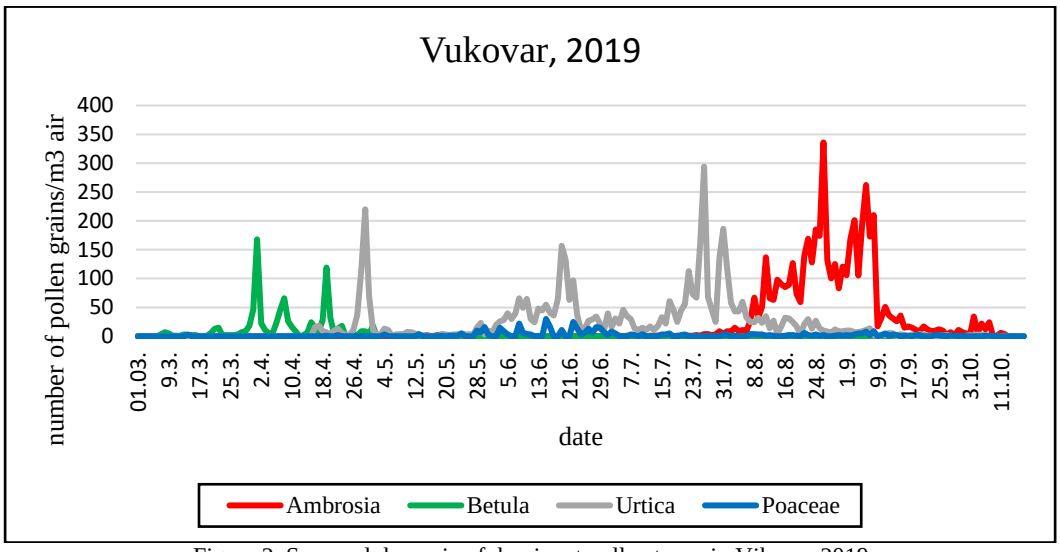

Figure 2. Seasonal dynamic of dominant pollen types in Vikovar 2019

Many scientific papers have been published regarding these particular plant taxa and their threshold concentration values at which allergy symptoms occur (Ščevkova et al., 2015). The information about pollen concentration in urban and as well as in suburban areas which includes pollen amount, pollen allergenicity, pollen season, plant and pollen distribution, and other plant attributes may serve as important information for preventive illness actions, aimed at patients afflicted with respiratory diseases who are dependent on weather and ambient air quality (Makra et al., 2008; Cariñanos et al., 2011).

The impact of pollen allergy on the quality of life

Patients with the symptoms of pollen allergies peak in the 25-64-year-old age group (mean 39; STD 27) and are equally male and female, but reside predominantly in urban areas (Table 1). On a public health level, people with allergic conditions are at a disadvantage, since allergic diseases have a detrimental impact on personal development, career progression, and lifestyle choices (Crown et al., 2003, Rudnai et al., 2014).

Table 1.

Socioeconomic characteristics of patients who participated in the questionnaire

	Total number of surveyed patients (N=125)
average age (years + STD)	39 (STD ± 27)
≤ 7 years	0
8 - 17	24
18 – 24	20
25 - 64	70
≥ 65 years	12
sex	
male	66 (53%)
female	58 (47%)
residence	
City	100 (80%)
Village	25 (20%)

Plant-based aeroallergen season in Vukovar-Syrmia County in terms of aerobiological and clinical aspects can be divided as follows: allergy to weeds dominates with 61%, followed by grass with 29%, and tree pollen allergy with 10% (Figure 3). The pollen spectrum in the air reflected the floristic sources of the investigated region and indicated the agricultural background of the territory. Since this is the most fertile agricultural area of Croatia where farming is characterized by capital-intensive and market-oriented production, with maize, wheat, sugar beet, soybeans, sunflower, oilseed rape, and barley as the main crops (Štefanić et al., 2020). The pollination of overspread and very abundant weeds, particularly ragweed (*A. artemisiifolia*) and nettle (*Urtica*) has caused the most significant public health problems (D'Amato et al., 2007) as well as problems in the agronomic domain (Pinke et al., 2007).

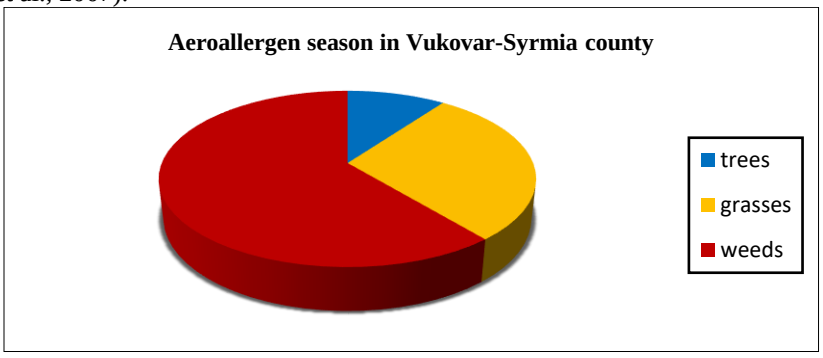

Figure 3. Plant-based aeroallergen season in Vukovar-Syrmia County in 2019.

Figure 4. presents the allergy symptoms estimated from replies received in the questionnaire. Direct medical costs related to pollen allergy are in most cases treated by short-term

symptoms or long-term anti-inflammatory drugs (Crown et al., 2003). A runny nose or sneezing affected 95% of patients, followed by swollen eyes (47%) and coughing or wheezing (34%). For the treatment of symptoms, they were prescribed antihistamines (90,14%), corticosteroids (67,61%) and other drugs (14,44%).

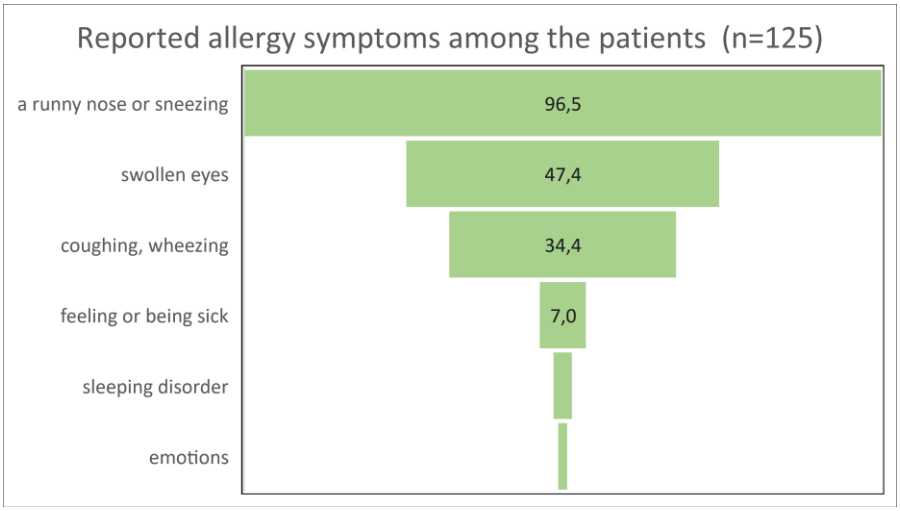

Figure 4. The prevalence of allergy symptoms in Vukovar-Syrmia County in 2019.

The impact of allergies on the quality of life for allergy sufferers is very high. Those symptoms (Figure 4) affect the patient's everyday life and are associated with productivity reduction and the rising number of sick days (Calderon et al., 2012).

The health economic parameters of allergy costs and prevention

Allergy health costs and their continuing escalation affect the economy due to both direct and indirect costs. Estimation of the economic impact of allergy was presented in Table 2.

Table 2.

Possible costs of pollen allergy

	Individual	Health sector	Industry	Public sector
Direct costs	-Drug expenses -Other out-of-pocket expenses	-Cost of primary care	-Loss of sales revenue	-Outreach and social care
Indirect costs	-Loss of income -Loss of education	-Public-health campaigns	-Lost work from sick employees	-Regulation

The estimation of medical costs of patients with pollen allergy, based on the sample of 10% of the allergic population in Vukovar-Syrmia county amounts to 503.162,76 Euros annually (Table 3). However, several studies have projected a substantial increase in the number of patients with allergic diseases (Stoian et al., 2024), therefore this number will increase in the coming years, both in direct and indirect costs to the region's economy. The estimated treatment costs vary from country

to country and are an overall very large and complex issue. Treatment costs and lost working time at the country level were found to be around 7.4 billion Euros in Europe annually (Stoian et al., 2024). Therefore, it is important to strengthen and optimize preventive and treatment strategies.

The long-term and widely applicable options for the sustainable management of allergenic weeds should be applied to limit the pollination and spread of these allergenic weeds. Eradication programs inside urban settlements are one of the options to decrease pollen production and improve the quality of life for allergenic populations.

Table 3.

Comparison of the estimation of medical cost of pollen allergy and weed control measures in Vukovar-Syrmia County

Medical cost of pollen allergy (based on the estimation of 10% of the allergic population)		**Weed control measures inside the urban area** (based on the estimation for the city of Vukovar)	
Medical costs	475.568,40 eur	One mowing per 150 ha	58.530,76 eur
Work loss	27.594,36 eur	Whole season (12 x)	702.369,10 eur
Total	**503.162,76 eur**	**Total**	**702.369,10 eur**

Weed control measures in the city of Vukovar include intensive mowing (every two weeks during vegetation season) and the cost per year is 702.369,10 Euros. Mowing is a widely used mechanical method to control unwanted vegetation in urban areas (Rask and Kristoffersen, 2007).

The price of mowing per year is almost 30% higher than the price of treatment costs and lost working time of the allergic population in Vukovar-Syrmia County (Table 3). However, the long-term benefit of these control measures, together with specific legislation passed at the national level should have a positive impact on public health and quality of life for allergic people.

CONCLUSIONS

Pollinosis and a range of allergenic symptoms markedly relate to the spectrum and quantity of pollen grains in the air. The main pollen producers characterized by allergenic pollen were: common ragweed (*Ambrosia artemisiifolia* L.), nettle (genus *Urtica*), birch (*Betula* sp), and grasses (family Poaceae). Runny nose or sneezing affected 95% of patients, followed by swollen eyes (47%) and coughing or wheezing (34%); which significantly affected the quality of life and incurred both direct and indirect costs. The price of weed control to suppress or eradicate unwanted allergenic weeds from urban areas is almost 30% higher than annual medical treatment for persons who suffer from allergic diseases. However, the long-term effect of continuous mowing will be beneficial for improving the quality of life for allergic people.

BIBLIOGRAPHY

BERGER, M., BASTL, M., BOUCHAL, J., DIRR, L., BERGER, U. (2021) The influence of air pollution on pollen allergy sufferers. Allergologie Select, 5, 345-348. DOI: https://doi.org/10.5414/alx02284e

CALDERON, M.A., DEMOLY, P., VAN WIJK, R.G., BOSQUET, J., SHEIK, A., FREW, A., SCADDING, G., BACHERT, C., MALLING, H.J., ET AL., (2012) EAACI: A European Declaration on Immunotherapy. Designing the future of allergen-specific immunotherapy. Clinical and Translational Allergy, 2 (20), 2-8.

CAMACHO, I., CAEIRO, E., NUNES, C., MORAIS-ALMEIDA, M. (2020) Airborne pollen calendar of Portugal: a 15-year survey (2002–2017). Allergologia et Immunopathologia, 48 (2), 194-201. DOI: https://doi.org/10.1016/j.aller.2019.06.012

CARIÑANOS, P., CASARES-PORCEL, M. (2011) Urban green zones and related pollen allergy: a review. Some guidelines for designing spaces with low allergy impact. Landscape and Urban Planning, 101 (3), 205-214. DOI: https://doi.org/10.1016/j.landurbplan.2011.03.006

CROWN, W.H., OLUFANDE, A., PHARM D., SMITH, M.W., NATHAN, R. Seasonal versus Perennial Allergic Rhinitis: Drug and Medical Resource Use Patterns. Clinical and Translational Allergy, 2-8. DOI: https://dio.org/10.10246/j.1524-4733.2003.64231.x

D'AMATO, G., CECCHI, L., BONINI, S, ET AL. (2007). Allergenic pollen and pollen allergy in Europe. Allergy, 62 (9), 976-990. DOI: https://doi.org/10.1111/j.1398-9995.2007.01393.x.

GEHRIG, R., MAURER, F., SCHWIERZ, C. (2018) Designing new automatically generated pollen calendars for the public in Switzerland. Aerobiologia, 34, 349-362. DOI: https://doi.org/10.1007/s10453-018-9518-6

HOYTE, F. C. L., NELSON, H. S. (2018) Recent advances in allergic rhinitis. F1000Research, 7, 1333. DOI: https://doi.org/10.12688/f1000research.15367.1

MAKRA, L., MATYASOVSZKY, I., TUSNÁDY, G., ZISKA, L. H., HESS, J. J., NYÚL, L. G., CHAPMAN, D. S., COVIELLO, L., GOBBI, A., JURMAN, G., FURLANELLO, C., BRUNATO, M., DAMIALIS, A., CHARALAMPOPOULOS, A., MÜLLER-SCHÄRER, H., SCHNEIDER, N., SZABÓ, B., SÜMEGHY, Z., PÁLDY, A., MAGYAR, D., BULLOCK, J. M. (2023) A temporally and spatially explicit, data-driven estimation of airborne ragweed pollen concentrations across Europe. Science of The Total Environment, 905, 167095. DOI: https://doi.org/10.1016/j.scitotenv.2023.167095

PINKE, G., KOLEJANISZ, Z., VER, A., NAGY, K., MILICS, G., SCHLOGL, G., BEDE-FAZEKES, A., BORRA-DUKAT, Z., CZUCZ, B. (2007). Drivers of *Ambrosia artemisiifolia* abundance in arable fields along the Austrian-Hungarian border. Preslia 91, 369-389.

RASK, A.M., KRISTOFFERSEN, P. 2007. A review of non-chemical weed control on hard surfaces. Weed Research, 47, 370-380. DOI: https://doi .org/10.1111/j.1365-3180.2007.00579.x.

RUDNAI, P., VARRO, M.J., MACSIK, A., TUSKE-SZABO, E., KOZEPESY, S., RUDNAI, T. ET AL., Urban-rural differences in the prevalence of respiratory symptoms of school children in Hungary. Cent Eur J Occ Envir Med, 20 (1-2): 67-78.

SAVOURÉ, M., BOUSQUET, J., JAAKKOLA, J. J., JAAKKOLA, M. S., JACQUEMIN, B., NADIF, R. (2022) Worldwide prevalence of rhinitis in adults: a review of definitions and temporal evolution. Clinical and Translational Allergy, 12 (3), e12130. DOI: https://doi.org/10.1002/clt2.12130

STOIAN, I.M., PARVU, S., MINCA, D.G. (2024). European Safety Measures and Specific Legislation to Control and Eradicate Common Ragweed (*Ambrosia artemisiifolia*). DOI: https://doi.org/10.20944/preprints202402.0647.v1

ŠČEVKOVÁ, J., DUŠIČKA, J., HRUBIŠKO, M., MIČETA, K. (2015). Influence of airborne pollen counts and length of pollen season of selected allergenic plants on the concentration of slgE antibodies on the population of Bratislava, Slovakia. Annals of Agricultural and Environmental Medicine, 22 (3), 451-455. DOI: https://doi.org/10.5604/12321966.1167712

ŠTEFANIĆ, E., ANTUNOVIĆ, S., KOVAČEVIĆ, V., TURALIJA, A., ZIMA, D. (2020): Impact of weeds from field margins on adjacent agriculture land. Arch. Biol. Sci., 72 (3), 403-411. DOI: https://doi.org/10.2298/ABS200605034S