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Plant Allergenicity in Urban Parks Across Diverse Climatic Zones of Iran

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ABSTRACT

Objective: Urban parks planning must address allergy risks from pollen and chemicals, despite parks' importance for nature connection. This pioneering study assessed the allergenicity of plant collections in four urban parks located in three climatic zones of Iran.

Materials and Methods: A total of 1160 respondents participated to complete questionnaires during spring pollination. We assessed the effects of age, occupation, gender, and climate on allergy symptoms. Regarding general allergy symptom severity, 21.66% reported mild, 18.46% moderate, and 6.13% severe symptoms. Among those with symptoms, 31.58% reported no change in park use behavior.

Results: Results indicated women were significantly more likely than men to experience pollen allergy symptoms, physical weakness due to allergens, and specifically, nasal symptoms (runny nose, congestion), sneezing, and watery eyes. Students and full-time employees were more likely to experience symptoms than retirees or unemployed individuals. Comparing parks, allergy incidence was significantly lower in Mellat Park. Yazd University Park (arid climate) had a significantly higher incidence of reported intellectual and mental problems. Regarding park management suggestions, regular dust cleaning was most frequent. For future planning, planting more female trees was the top suggestion. For prevention, most respondents suggested predicting and announcing harmful pollen presence in advance.

Conclusion: The findings suggest implementing enhanced preventive measures for women, full-time employees, and residents of hot, arid regions regarding allergic symptoms especially associated with urban green spaces.

Keywords: Allergy, green space, pollen, urban management

INTRODUCTION

Urban parks serve as important connections between human and nature. However, it is necessary to take care of humans, for allergy diseases, in urban areas. The increase in temperature associated with climate change is accompanied by an increase in plant pollen production and a shift in the timing of flower pollination (1). In the past century, allergic diseases have transformed from a relatively rare condition into a pandemic health problem, and half a billion people worldwide suffer from allergic rhinitis. Estimates indicate that pollen allergens are a significant risk factor for seasonal allergic rhinitis and asthma (2).

An allergy is an overreaction of the immune system to an unknown substance that is usually harmless, accompanied by symptoms such as itching, red eyes, eczema, hives, and even asthma attacks. Allergy risks from trees in urban green spaces are primarily determined by the composition of tree species (i.e., allergenic versus non-allergenic species) and the number of trees present in the area. The allergenicity of individual trees depends on their size, es-

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pecially the volume of the tree crown (3). The allergenicity of tree species may vary from region to region, as there are regional differences in pollen allergen allergy (4). For example, olives and some maples may be highly allergenic throughout their native range but mildly allergenic in new areas. In some cases, introduced species may become allergenic plants outside their natural range, mainly when these species are artificially cultivated.

A study has reported that the removal of allergenic tree species, such as birch and plane trees, from urban green spaces in Brussels, Belgium, is not recommended due to conservation considerations (5). The risks of human allergy to tree pollen grains can increase significantly when environmental changes lead to longer pollen seasons. Preventive removal of allergenic tree species cannot adequately combat the allergy risks from other plant species that are enhanced by environmental changes. This study highlights the importance of carefully selecting tree species in urban green space planning. The relationship between green spaces and the mental health of individuals with the presence of allergenic pollen grains has been investigated (1). Results have revealed that individuals living near green spaces with higher levels of allergenic pollen grains experienced worse mental health compared to those living near green spaces with lower levels of allergenic pollen grains.

A large-scale study was conducted in the UK to quantify the relationship between green space tree density and asthma-related hospitalizations. The results indicated that more tree cover, gardens, and green space in residential areas were associated with fewer asthma-related hospitalizations. Green spaces and gardens were associated with fewer asthma-related hospitalizations when nitrogen dioxide was lower (6). Another study in northern Belgium examined the effects of green space exposure on stress in a subpopulation of adults sensitive to tree pollen allergens. Short-term stress was found to be higher in the studied subpopulation compared to the general population. Green space had a protective effect against short-term stress. However, stress was higher in patients who reported the presence of allergenic trees near their residences (5).

The information on children's allergy symptoms up to the age of four was obtained from questionnaires completed by parents (7). The study included 2474 participating children from two biogeographical regions (Euro-Siberian and Mediterranean) in Spain. Among these children, having more greenery around the residential area and greater proximity to green spaces were associated with fewer allergy symptoms. Another study examined the relationship between urban green spaces and physical and mental health through a systematic review (8). The results revealed a negative association between exposure to urban green spaces and mortality, heart rate, and violence, as well as a positive association between exposure to urban green spaces and mood and physical activity. The results of studies on exposure to urban green spaces and general health, body weight status, depression, and stress (as measured by cortisol concentration) were mixed, with no apparent association found. In a study, questions about allergy symptoms were investigated in Leipzig, Germany, using 186 questionnaires. Most respondents reported experiencing symptoms related to pollen allergies. Of the respondents with symptoms, 82% stated that they had not changed their park visit patterns due to pollen exposure (9).

Allergy is becoming a significant health issue worldwide. This study aimed to investigate the allergenicity of plant collections from several parks in Iran, a first-time endeavor in Iran conducted through a questionnaire. The study examined the effect of visitors' gender, age, and occupation on the development of allergy and symptoms, and the use of medication for allergy treatment. We have also compared several parks in different climates with varying plant diversity. Additionally, we have inquired about visitors' opinions regarding management recommendations.

MATERIAL and METHODS

This study was conducted in four parks across three Iranian cities with distinct climates: Tabriz (dry steppe), Zanjan (mountainous), and Yazd (desert). The selected parks were: Mellat Park (Zanjan): 53 hectares at 1,662 m, featuring species like acacia, ash, juniper, maple, and oak, Abbas-Mirza Park (Tabriz): 1,800 hectares at 1,500-1,800 m, with a diverse mix of trees including ash, elm, and poplar, and herbaceous plants, Hafte-Tir Park (Tabriz): 5.5 hectares at 1,237 m, containing species such as elm, pine, and plane tree, and Yazd University Park (Yazd): 30 hectares at 1,238 m, hosting a wide variety of plants including pine, cypress, oleander, and olive.

The number of questionnaires to be distributed was determined using the Cochran formula. For this purpose, considering the size of the statistical population (the population of cities) and a 5% error rate, 384 questionnaires were required for each city. In this study, a questionnaire designed by Kabisch et al. was used and completed during visits to the parks (9). During the spring, these ques-

tionnaires were completed gradually over three months, simultaneously with the pollination of different plant species. The frequency percentage of responses to each option in the questionnaire, including those based on the Likert scale, was calculated. To examine the effect of gender on allergy incidence and its symptoms, the nonparametric Mann-Whitney test was employed, using the rank scale of the data. The effect of age on allergy incidence and its symptoms was examined using the Spearman test, and the effect of occupation on allergy incidence and its symptoms was examined utilizing the Chi-square test. The four studied parks were also compared in terms of responses by the Kruskal-Wallis test. SPSS (Version 26) software was used to perform statistical analyses.

This study was conducted using an anonymous questionnaire. No ethical approval was required for this research from an institutional review board (IRB) or ethics committee, as per the national regulations and institutional policies applicable to this study. The research involved no risk to participants, and no personally identifiable information was collected.

RESULTS

A survey of 1160 respondents (547 female, 609 male) found that the largest age group was 20-30 years (36.42%), while the smallest was 60+ (1.83%). Only 11.12% lived within 250m of a park, compared to 29.95% living over 3000m away. Occupations included students (480), full-time employed (292), housewives (165), part-time employed (120), job seekers (47), retired (39), and other (31). Common park uses were seeing nature (466), going out in a group (399), walking (354), meeting friends (347), relaxing (326), playing with children (324), having lunch/dinner (254), running (111), and singing/listening to music (82). Primary park functions were being outdoors (706), getting out of the home (477), being active/exercising (345), and seeing other people (307). Regarding allergies, 21.66% reported mild, 18.46% moderate, and 6.13% severe symptoms. Overall, 46.25% experienced tree pollen allergies, predominantly in the spring (634). Allergy symptoms included sneezing, runny nose, watery eyes, breathing difficulties, itchy skin, and mental effects like irritability and poor concentration. In total, 21.61% took allergy medication, with 10.54% of allergy sufferers taking it weekly. While 31% reported physical health impairment from allergies, a smaller proportion (22.4%) reported mental health impairment (Figure 1).

Table I presents the frequency of respondents who changed or adapted their park visitation behaviors in response to expected pollen exposure. Of the respondents who experienced allergy symptoms, 31.58% reported no change in park use behavior patterns. No respondents

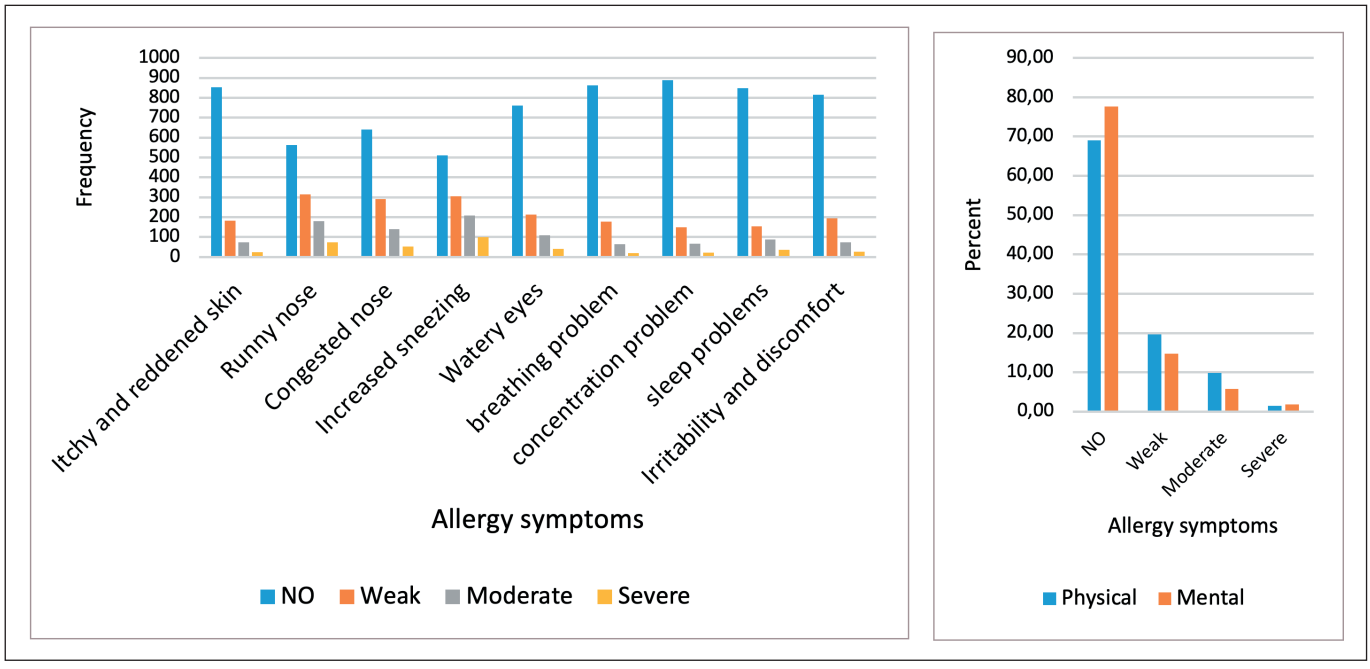

Figure 1: Frequency of allergic symptoms, classified by reported severity and physical and mental impairment

Table I: Frequency of respondents reporting changes in park visit behavior due to pollen

		Change in park use pattern						
		No change	Other parks	More in the morning	More in the evening	Avoid being outdoors	Other	Total
Reported allergic symptom	Weak	173	33	22	18	4	1	251
	Medium	143	32	17	16	3	2	213
	Strong	50	11	4	4	2	0	71
Total		366	76	43	38	9	3	535

Table II: Study results on the effect of gender on having allergies and types of related problems

	Gender	Mean rank	Total N	Mann-Whitney U	p-value
Having allergy symptoms	Male	550.5[b]	1153	181798.000	0.002
	Female	606.4[a]			
Having physical weakness	Male	553.4[b]	1151	178777.500	.003
	Female	601[a]			
Having mental problems	Male	580[a]	1152	163285.000	0.599
	Female	572[a]			
Using drugs for allergy	Male	548[b]	1153	183305.000	<0.001
	Female	649[a]			

Table III: Effect of occupation on the severity of allergy symptoms

	Runny nose	Watery eyes	Breathing problem	Concentration problem	Sleep problems	Irritability and discomfort
Chi-Square Value	53.8	39.9	33.9	40.8	30.9	29.1
p	0.001	0.002	0.013	0.002	0.029	0.047
The most affected group	Students and full-time employees	Students	Students	Students	Students and full-time employees	Students and full-time employees
The least affected group	Retired	Retired	Retired and unemployed	Retired and unemployed	Retired and unemployed	Retired and unemployed

(0.78%) with mild, moderate, or severe symptoms reported avoiding outdoor activities altogether, going to parks at other times of the day (7.42%), or using other parks (6.56%).

The Mann-Whitney test results revealed that women were significantly more likely than men to experience symptoms of allergy to pollen. Moreover, women were more likely than men to experience physical weakness due to allergens in parks. At the same time, there was no significant difference between men and women in terms of mental and emotional problems. The results also revealed that women were more likely than men to use medication to treat allergy symptoms (Table II).

Analysis revealed that while no significant gender differences existed for symptoms like skin irritation, breathing difficulties, or mental effects, women reported more nasal and ocular symptoms. Age showed no correlation with allergy severity or symptoms. However, occupation was significantly associated with symptom severity; students and full-time employees experienced more runny nose, watery eyes, respiratory issues, and mental concentration problems than retirees and unemployed individuals (Table III).

A comparison of parks showed a significantly lower allergy incidence in Mellat Park (K=16.16, p=0.001), with no significant difference between the other three parks, though Yazd University Park had a higher rate. Visitors

Table IV: Frequency of respondents' suggestions to urban green space planners

Suggested recommendations for urban planning for		%
Green space planning	Considering the allergic potential of species	10.69
	Creating a natural windbreak by non-allergic plants	6.56
	Planting more female trees	12.35
Park management	Pruning considering flowering time	10.58
	Regular dust cleaning	23.54
Prevention	Installing an information board about the allergenicity of park plants	14.51
	Predicting the presence of pollen	12.67
	Free mask during pollen season	9.09

to Yazd parks reported more physical weakness (K=24.8, p<0.001). Intellectual and mental problems were significantly higher in Yazd University Park and lower in Abbas-Mirza Park (K=54.3, p<0.001). For reducing allergies, key suggestions included regular dust cleaning for park management, planting more female trees for future planning, and the advance prediction and announcement of harmful pollen levels for prevention (Table IV).

DISCUSSION

Urban green spaces are vital for public health, yet their management must address the significant issue of pollen allergies, which affect a growing proportion of the global population. This study investigated the allergenicity of plant collections in four parks in Iran, examining visitor experiences, symptoms, and management recommendations through a questionnaire-based approach. The findings highlight a complex relationship between park visitation, allergy prevalence, and public health, underscoring the need for integrated planning.

A central finding was that 46% of the respondents reported experiencing seasonal allergic symptoms. This rate is notably higher than the approximately 30% of adults with allergies in Germany (10). Several factors may explain this high prevalence. Firstly, urban residents are generally more prone to allergic diseases (11). Secondly, avoiding allergens is difficult because plant pollen can travel for kilometers in the air (12). It is also important to note that since allergy status was self-reported, some respondents may have misattributed their symptoms to pollen allergies (9).

A critical insight from the study is visitor behavior in response to allergies. Despite a high reported symptom rate, most respondents did not alter their park visitation patterns. This may be linked to the finding that over 10% of participants took allergy medication at least once a week. This suggests a preference for managing symptoms pharmacologically rather than forfeiting the benefits of green space access. This pattern aligns with a similar study in Leipzig, Germany, where 82% of symptomatic respondents did not change their park visits and almost two-thirds used medication weekly (9). This consistency across different cultural contexts underscores the high value people place on urban parks, even when they pose a potential health risk. Consequently, urban planners must consider these associated health costs (10).

The analysis revealed demographic and location-based variations in allergy impact. Women were more likely than men to report physical weakness from allergens. This may be linked to immunomodulatory effects of sex hormones, which influence immune cell development, antibody production, and the prevalence of atopic diseases (13). A comparison of the parks showed that Mellat Park had a statistically significant lower allergy incidence, while Yazd University Park had a higher rate, potentially due to its greater diversity of flowering plants. This mirrors findings from Bratislava, Slovakia, where parks differed in allergenic potential based on tree density and the proportion of allergenic species (14).

Allergies were also shown to have a significant impact on mental health, which is a recognized comorbidity of allergic diseases (15). The study found that the incidence of mental health problems was significantly higher in Yazd University Park and lower in Abbas-Mirza Park. As the majority of visitors to Yazd University Park are students, this suggests that this group may be more vulnerable to the mental health consequences of allergies, possibly due to academic pressures. This is supported by research in Tabuk, Saudi Arabia, which found allergic rhinitis significantly impaired sleep quality, emotional health, and social interactions (16). Furthermore, variation in asthma symptoms among students in different schools has been observed, potentially linked to air pollutants (17), highlighting the need for careful environmental management in educational settings.

Based on these findings, the respondents offered several key recommendations for urban green space planning.

There is a clear need for the further development and improvement of urban green spaces through the careful selection of appropriate tree species. This requires close collaboration between urban planners, botanists, landscape designers, and allergy specialists (10). In addition to allergenic potential, selection criteria should include a tree's resistance to biotic and abiotic stresses (e.g., drought, heat, disease) and its provision of ecosystem services, such as air purification, bird nesting, and food for pollinators (18). Respondents also emphasized the need for accessible pollen information, including forecasting and city-wide modeling to provide precise, regular updates on health risks (18,19), similar to services already available in Germany (20).

In conclusion, this study demonstrates that while urban parks are essential for well-being, their allergenic impact is a significant public health concern. The high use of medication and reluctance to change visitation habits highlight the deep value of these spaces. Future efforts should focus on interdisciplinary planning to create safer, "allergy-friendly" green spaces. This includes selecting low-allergenicity trees, implementing pollen monitoring services, and conducting further research, particularly on the physiological responses of more vulnerable groups like women and students. Combining subjective questionnaire data with objective laboratory pollen analysis will provide a more accurate picture for deriving targeted policy recommendations.

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Conflict of Interest

The authors have no conflict of interest to declare.

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Author Contributions

Concept: **ME,** Design: **BK, ME,** Data collection or processing: **BY, VM, MA,** Analysis or Interpretation: **BK,** Literature search: **ME,** Writing: **BK, ME,** Approval: **MSN, RS.**

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