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The Distribution of Sensitization to Common Inhalant Allergens in Adult Allergic Rhinitis Patients with or without Asthma in Batman

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ABSTRACT

Objective: The distribution of sensitization to inhalant allergens differs in every region of Turkey. This study aimed to determine the sensitization rates of common inhalant allergens in adult allergic rhinitis (AR) patients with/without asthma in Batman.

Materials and Methods: A total number of 260 AR patients with or without asthma who presented to the outpatient clinic of Adult Immunology and Allergy between April 2021 and May 2022 were retrospectively evaluated. The demographic, clinical and laboratory features such as skin prick test (SPT) results, eosinophil counts (n/mm^3), basophil counts (n/mm^3), Neutrophil/Lymphocyte ratio (NLR), Platelet/Lymphocyte ratio (PLR), total Ig-E and specific Ig-E levels were analyzed. The parameters were compared between the subjects who have mild and moderate/severe AR.

Results: The mean age was 31.9±9.7 years and more than half (62.5%) were female. When assessed separately, the most common inhalant allergens were Dermatophagoides (D.) farinae (n=128, 49.2%), Grass mix (n=119, 45.8%), Grass-cereal mix (n=112, 43.1%), D. pteronyssinus (n=94, 36.2%), Cockroach (n=77, 29.6%), Weed mix (n=57, 21.9%) and Aspergillus fumigatus (n=35, 13.5%), respectively. Additionally, the most common tree pollen allergen was Olive tree pollen (n=26, 10%), and the frequency of sensitization to Olive tree pollen was higher in moderate/severe (n=215, 82.7%) AR patients than in mild (n=45, 17.3%) ones (p=0.039).

Conclusion: This study demonstrated that pollen sensitization was the most commonly detected one when the sensitizations were assessed in general, and it was followed by house dust mite, cockroach, animal epithelium and mold sensitizations. Also, Olive tree pollen was the most common tree pollen allergen in Batman.

Keywords: Allergic rhinitis, asthma, inhalant allergen, skin prick test, specific Ig-E

INTRODUCTION

Rhinitis is defined as having one or more of the following symptoms: nasal itching, sneezing, nasal congestion, anterior or posterior rhinorrhea, and sometimes a decrease in the sense of smell. Herein, the most important thing is distinguishing allergic rhinitis (AR) from non-allergic rhinitis (NAR). Conjunctivitis occurs in approximately 50-70% of AR patients and is one of the best symptoms to differentiate AR (1). Furthermore, AR has a strong relationship with asthma (2). The main differentiation methods are positive skin prick tests (SPTs) or allergen-specific Ig-E measurements, which are commonly relevant with the symptoms triggered by aeroallergens (3). AR is also divided into subgroups. According to the time pattern, it is named seasonal AR when the symptoms appear in a certain season. If the symptoms appear throughout the year, it is called perennial AR. Also, it is called intermittent rhinitis if the duration of symptoms is less than 4 days a week or the symptoms last <4 weeks at a time, according to the frequency of symptoms. Otherwise, it is named persistent rhinitis (1, 4). Additionally, if the visual analogue scale (VAS) evaluating the severity of AR is under 5cm, it is defined as mild rhinitis. If it is equal to or above 5cm, it is moderate/severe rhinitis (5).

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The allergenic pollen distribution of Turkey was analyzed by using gravimetric and/or volumetric methods in a comprehensive study and Cupressaceae, Pinus, Populus, Morus, Betula, Carpinus, Salix, Fraxinus, Ambrosia, Quercus, Alnus, Cedrus, Compositae, Plantago, Artemisia, Amaranthaceae, Xanthium, Urticaceae and Gramineae were dominant pollen types in the Eastern and Southeastern Anatolian Regions (6). The frequency of AR in the Eastern Anatolia Region is 16.1% (7) and Batman is located in the Southeastern Anatolian Region with a total population of 626.319 (8). In a multicenter study conducted in three cities (Şanlıurfa, Diyarbakır, Mardin) located near Batman, pollens were the major aeroallergens followed by house dust mites (HDMs), cockroach, animal dander, and molds (9). In another study from Diyarbakır, grass (70.3%), wheat (46.5%) and tree (46.1%) pollens were detected as the three major allergens according to SPT results (10). However, these studies lack the determination of tree pollen allergens in detail and specific Ig-E measurements (9,10).

This study from Batman was conducted to determine the distribution of sensitization to common inhalant allergens in adult AR patients with or without asthma by using both SPT and specific Ig-E measurements. Additionally, the demographic and clinical data was compared between the subjects having mild and moderate/severe rhinitis.

MATERIAL and METHODS

Study Population

The minimum sample size to present the AR subjects in Batman was calculated as 207 subjects using the variables of the population (626.319) in Batman and the AR frequency (16.1%) in the Eastern Anatolia Region. This study consists of 260 patients aged ≥18 years who presented to the outpatient clinic of Allergy and Immunology Unit of Batman Training and Research Hospital between the beginning of April, 2021 and the end of May, 2022. The first specialist on Adult Immunology and Allergy in Batman evaluated the patients having rhinitis with or without asthma symptoms, and determined the allergic subjects when a clinically relevant sensitization to at least one common inhalant allergen was confirmed with SPTs and/or serum specific Ig-E measurements (1). Antihistamines, corticosteroids and some antidepressants, which may affect SPT results, were discontinued one week before SPT (11). The non-atopic subjects (having negative test results according to SPTs and/or specific Ig-E measurements) and those who did not want to stop the medications mentioned above were excluded from the study.

Diagnostic Work-Up for Allergy

Laboratory values such as peripheral eosinophil counts, peripheral basophil counts, total Ig-E levels, Neutrophil/Lymphocyte ratio (NLR), Platelet/Lymphocyte ratio (PLR), and specific Ig-E levels against Dermatophagoides (D.) farinae, D. pteronyssinus, Cockroach (Blatella germanica), Aspergillus fumigatus, Aspergillus niger, Alternaria alternata, Cladosporium herbarum, Grass pollen 1 (Orchard grass, Meadow fescue, Perennial rye grass, Timothy grass, Kentucky blue grass) and Grass pollen 2 (Bermuda grass, Perennial rye grass, Timothy grass, Kentucky blue grass, Johnson grass, Bahia grass) were evaluated. A positive value for specific Ig-E was defined if it was ≥0.35 kUA/L (12).

SPTs were performed with positive control (Histamine dihydrochloride 0,1%), negative control (NaCl 0.9%), and common inhalant allergen solutions (Allergopharma® Reinbek, Germany and ALK-Abelló® Hørsholm, Denmark) such as HDMs (D. farinae, D. pteronyssinus), molds (Aspergillus fumigatus, Alternaria alternata), Cockroach (Blatella germanica), Weed mix (Cocklebur, Rough Pigweed, English Plantain, Lamb's Quarters), Grass mix (Velvet grass, Orchard grass, Rye grass, Timothy grass, Kentucky Blue grass, Meadow fescue), Grass-cereal mix (Grasses, Barley, Oat, Rye, Wheat), English Plantain, Wall Pellitory, Poplar, Oak, Plane Tree, Birch, Olive tree, Beech, Dog epithelia, Cat epithelia, Mouse epithelia and Bird epithelia. A positive SPT result was defined as a wheal of ≥ 3 mm. The longest diameter of a wheal in a positive SPT result was also noted (11). Poly-sensitization was defined if more than one allergen was present (13). The allergic sensitization to an inhalant allergen was defined if a positive SPT result and/or specific Ig-E level was present.

Study Design

Age, sex, Body Mass Index (BMI), smoking history, allergic and non-allergic comorbidities, rhinitis and asthma duration, medications for allergic rhinitis and asthma, family atopy histories, and allergen immunotherapy use were evaluated. The rhinitis symptoms were assessed by the Visual Analogue Scale (VAS) (5) and Total Symptom score-6 (TSS-6) (14). Quality of life (QoL) evaluations below 5cm of VAS were defined as mild rhinitis and those equal to or above 5 cm as moderate/severe rhinitis (5).

When the rhinitis symptoms lasted < 4 weeks at a time or <4 days a week, it was classified as intermittent rhinitis. The others formed persistent rhinitis. Also, it was classified as seasonal or perennial rhinitis according to the time pattern (1, 4). In addition, a third group was formed and consisted of patients who had perennial symptoms but with an exacerbation in the seasonal period. In subjects with asthma, the scores of 20-25 in the asthma control test were designated as well-controlled, 16-19 as not well-controlled, and 5-15 as poorly controlled asthma. The severity of asthma was categorized as mild, moderate, and severe according to the step of the controller treatment (15).

The distribution of sensitization to common inhalant allergens in patients according to SPTs and specific Ig-E results was analyzed, and the demographic, clinical, and laboratory data was compared between the subjects having mild and moderate/severe rhinitis.

Ethics Statement

The ethical approval was obtained from the Ethics Committee of Batman Training and Research Hospital (Approval no: 314, date: 30.05.2022). All patients gave written informed consent.

Statistical Analysis

Categorical variables were summarized as frequencies and percentages, and continuous variables were defined as median with interquartile range (IQR) values or mean with standard deviation when appropriate. To compare the continuous variables for the data of two groups, two-tailed t and Mann-Whitney U tests were used where appropriate. The frequencies of categorical variables were compared using the Chi-square test and Fisher's exact test where appropriate. P values <0.05 were considered significant. All statistical analyses were done using the Statistical Package for the Social Sciences version 24.0 (SPSS Inc., Chicago, IL, USA). The graphs were generated using GraphPad Prism version 8.4.3 software (GraphPad Software Inc., San Diego, CA, USA). The minimum sample size to present the AR subjects in Batman was calculated with a 95% confidence level by a web-based program (OpenEpi).

RESULTS

Demographic and Clinical Characteristics of Study Participants

More than half (n=163, 62.7%) of the 260 participants were women. The mean age and BMI were 31.9±9.7 years and 24.36±3.79, respectively. The most frequent allergic comorbidities were allergic conjunctivitis (85.4%) and asthma (25.8%), respectively. Eight (3.1%) patients had negative SPT results despite having positive specific Ig-E levels. Specific Ig-E measurements were performed in 169 (65%) patients and found to be positive in 76 of them (45%). Allergen immunotherapy was initiated in 13 (%5) patients. Of these, 5 received immunotherapy for HDM only, 5 for pollen only, and 3 for both HDM and pollen. One subject had hypersensitivity reactions to both plant-derived foods (kiwi, peach) and latex, and was diagnosed with latex-fruit syndrome. The demographic and clinical characteristics of the study participants are given in Table-I. In general, pollen sensitization (n=156, 60%) was found to be the most common sensitization, followed by HDM (n=154, 59.2%), Cockroach (n=77, 29.6%), animal epithelium (n=49, 18.8%), and mold (n=46, 17.7%) sensitizations.

When assessed separately, the most frequent inhalant allergen sensitization was D. farinae sensitization (n=128, 49.2%), followed by Grass mix (n=119, 45.8%), Grass-cereal mix (n=112, 43.1%), D. pteronyssinus (n=94, 36.2%), Cockroach (n=77, 29.6%), Weed mix (n=57, 21.9%), Aspergillus fumigatus (n=35, 13.5%), Mouse epithelia (n=29, 11.2%), English plantain (n=29, 11.2%), Olive tree (n=26, 10%), Wall pellitory (n=24, 9.2%), Poplar (n=18, 6.9%), Oak (n=16, 6.2%), Birch (n=15, 5.8%), Cat epithelium (n=14, 5.4%), Plane tree (n=13, 5%), Alternaria alternate (n=13, 5%), Bird epithelium (n=8, 3.1%), Dog epithelium (n=3, 1.2%), Beech (n=2, 0.8%) and Aspergillus niger (n=1, 0.4%) sensitizations. The most common tree pollen sensitization was the one to Olive tree pollen (n=26, 10%). Poly-sensitization was present in 216 (83.1%) patients. All the patients sensitized to Olive tree pollen were also poly-sensitized. The distribution of sensitization to common inhalant allergens in all patients is illustrated in Figure I.

Comparison of the Data Between Mild and Moderate to Severe AR Patients

A total number of 45 (17.3%) patients had mild rhinitis while 215 (82.7%) subjects had the moderate/severe type. The patients with allergic comorbidities including conjunctivitis and asthma were more frequent among moderate/severe AR subjects than in others (p<0.001, p<0.001, p=0.013). Besides, the subjects with a family history of allergic diseases and AR were more common among moderate/severe AR subjects than in mild ones (p=0.001, p=0.015). Intranasal corticosteroid, inhaled corticoster-

Table I: The demographic, clinical and laboratory characteristics in mild, moderate/severe and all allergic rhinitis patients

		Severity of Rhinitis		
	All patients (n=260)	**Mild (n=45)**	**Moderate/severe (n=215)**	***p***
Age (Mean±SD)	31.9±9.7	31.8±12.51	31.93±9.07	>0.05
Sex, n (%)				
Female	163 (62.7)	25 (55.6)	138 (64.2)	>0.05
Male	97 (37.3)	20 (44.4)	77 (35.8)	>0.05
Body Mass İndex (BMI) (Mean±SD)	24.36±3.79	23.34±3.52	24.56±3.83	>0.05
Smoker, n (%)	45 (17.3)	5 (11.1)	40 (18.6)	>0.05
Allergic comorbidities, n (%)	231 (88.8)	32 (71.1)	199 (92.6)	**<0.001**
Allergic conjunctivitis	222 (85.4)	29 (64.4)	193 (89.8)	**<0.001**
Allergic asthma	67 (25.8)	5 (11.1)	62 (28.8)	**0.013**
Nasal polyps	2 (0.8)	0 (0)	2 (0.9)	>0.05
Food allergy	8 (3.1)	1 (2.2)	7 (3.3)	>0.05
Drug allergy	11 (4.2)	3 (6.7)	8 (3.7)	>0.05
Atopic dermatitis	1 (0.4)	0 (0)	1 (0.5)	-
Allergic contact dermatitis	6 (2.3)	0 (0)	6 (2.8)	>0.05
Chronic urticaria	15 (5.8)	1 (2.2)	14 (6.5)	>0.05
Latex hypersensitivity†	1 (0.4)	0 (0)	1 (0.5)	-
Non allergic comorbidities, n (%)	43 (16.5)	8 (17.8)	35 (16.3)	>0.05
Diabetes Mellitus	6 (2.3)	2 (4.4)	4 (1.9)	>0.05
Hypertension	7 (2.7)	1 (2.2)	6 (2.8)	>0.05
Coronary artery disease	1 (0.4)	0 (0)	1 (0.5)	-
Hyperlipidaemia	3 (1.2)	0 (0)	3 (1.4)	>0.05
Hypothyroidism	6 (2.3)	1 (2.2)	5 (2.3)	>0.05
Hyperthyroidism	1 (0.4)	1 (2.2)	0 (0)	-
Depression	2 (0.8)	1 (2.2)	1 (0.5)	>0.05
Hepatitis b infection	9 (3.5)	2 (4.4)	7 (3.3)	>0.05
Anaemia	3 (1.2)	0 (0)	3 (1.4)	>0.05
Cardiac arrhythmia	1 (0.4)	0 (0)	1 (0.5)	>0.05
Gastritis	9 (3.5)	1 (2.2)	8 (3.7)	>0.05
Migraine	1 (0.4)	1 (2.2)	0 (0)	-
Acne Vulgaris	4 (1.5)	1 (2.2)	3 (1.4)	>0.05
Epilepsy	1 (0.4)	0 (0)	1 (0.5)	-
Patients with a family history of allergic disease, n (%)	155 (59.6)	17 (37.8)	138 (64.2)	**0.001**
Allergic rhinitis	141 (54.2)	17 (37.8)	124 (57.7)	**0.015**
Allergic asthma	60 (23.1)	7 (15.6)	53 (24.7)	>0.05
Food allergy	7 (2.7)	0 (0)	7 (3.3)	>0.05
Drug allergy	3 (1.2)	0 (0)	3 (1.4)	>0.05
Atopic dermatitis	3 (1.2)	0 (0)	3 (1.4)	>0.05
Chronic urticaria	15 (5.8)	0 (0)	15 (7)	>0.05
Aeroallergen sensitization, n (%)				
House dust mite	154 (59.2)	29 (64.4)	125 (58.1)	>0.05
Pollen	156 (60)	24 (53.3)	132 (61.4)	>0.05
Olive tree pollen ‡	26 (10)	1 (2.2)	25 (11.6)	**0.039***

Table I continue

Mold	46 (17.7)	9 (20)	37 (17.2)	>0.05
Cockroach	77 (29.6)	10 (22.2)	67 (31.2)	>0.05
Animal epithelium	49 (18.8)	11 (24.4)	38 (17.7)	>0.05
Poly-sensitization, n (%)	216 (83.1)	35 (77.8)	181 (84.2)	>0.05
Anti-allergic drug use, n (%)				
Only antihistamine	23 (8.8)	6 (13.3)	17 (7.9)	>0.05
Only montelukast	7 (2.7)	0 (0)	7 (3.3)	>0.05
Antihistamine and montelukast	99 (38.1)	5 (11.1)	94 (43.7)	**<0.001**
Intranasal corticosteroid	90 (34.6)	9 (20)	81 (37.7)	**0.023**
Inhaled corticosteroid	42 (16.2)	2 (4.4)	40 (18.6)	**0.019**
Systemic corticosteroid	6 (2.3)	0 (0)	6 (2.8)	>0.05
Duration of rhinitis symptoms (months) [Median (IQR)]	60 (24-120)	48 (15-120)	60 (36-120)	>0.05
Total Symptom Score-6 (Mean±SD)	12±3.35	8±3.32	12.84±2.71	**<0.001**
VAS Symptom Score [Median (IQR)]	8 (6-9)	4 (3-5)	8 (7-9)	**<0.001**
VAS Quality of Life [Median (IQR)]	8 (6-9.37)	4 (3-4.5)	9 (7-9.5)	**<0.001**
Persistence of rhinitis symptoms, n (%)				>0.05
Persistent	203 (78.1)	34 (75.6)	169 (78.6)	
Intermittent	57 (21.9)	11 (24.4)	46 (21.4)	
Time of exposure to aeroallergens, n (%)				>0.05
Perennial rhinitis	102 (39.2)	21 (46.7)	81 (37.7)	
Seasonal rhinitis	63 (24.2)	11 (24.4)	52 (24.2)	
Perennial but exacerbated in seasonal period	95 (36.5)	13 (28.9)	82 (38.1)	
Duration of asthma symptoms (months) [Median (IQR)]	24 (12-60)	12 (3-66)	24 (12-60)	>0.05
Asthma control test score [Median (IQR)]	19 (15-22)	21 (12.5-22)	19 (15.75-22)	>0.05
Patients by asthma control categories (n of N§, %)				>0.05
Well controlled	31 of 67 (46.3)	3 of 5 (60)	28 of 62 (45.2)	
Not well controlled	21 of 67 (31.3)	2 of 5 (40)	19 of 62 (30.6)	
Poorly controlled	15 of 67 (22.4)		15 of 62 (24.2)	
Asthma severity (n of N§, %)				>0.05
Mild	32 of 67 (47.8)	3 of 5 (60)	29 of 62 (46.8)	
Moderate	23 of 67 (34.3)	2 of 5 (40)	21 of 62 (33.9)	
Severe	12 of 67 (17.9)		12 of 62 (19.4)	
Allergen immunotherapy use, n (%)	13 (5)	0 (0)	13 (6)	>0.05
Only House dust mite immunotherapy	5 (1.9)	0 (0)	5 (2.3)	>0.05
Only Pollen immunotherapy	5 (1.9)	0 (0)	5 (2.3)	>0.05
Both pollen and house dust mite immunotherapy	3 (1.2)	0 (0)	3 (1.4)	>0.05
Neutrophil/ Lymphocyte ratio [Median (IQR)]	1.86 (1.47-2.33)	1.89 (1.57-2.49)	1.86 (1.45-2.25)	>0.05
Platelet/Lymphocyte ratio [Median (IQR)]	110.86 (92.92-141.93)	118.23 (92.85-155.98)	110.42 (92.93-136.78)	>0.05
Eosinophil counts (cells/mL) [Median (IQR)]	220 (120-385)	220 (110-380)	220 (120-390)	>0.05
Basophil counts (cells/mL) [Median (IQR)]	30 (20-40)	40 (30-50)	30 (20-40)	>0.05
Hs-CRP (mg/L) [Median (IQR)]	2.1 (1.6-2.9)	2 (1.6-4.22)	2.1 (1.6-2.8)	>0.05
Total Ig-E levels (IU/mL) [Median (IQR)]	92 (34.4-230)	89.9 (45.7-611.1)	92.1 (33.4-213.37)	>0.05

* Fischer exact test used, † The patient had both fruit (kiwi, peach) and latex hypersensitivities, ‡ The only different frequency in inhalant allergen sensitizations, **§ N:** Number of asthmatic patients

oid, and combined antihistamine and montelukast uses were significantly higher in moderate/severe patients than in others (p=0.023, p=0.019, p<0.001). TSS-6, VAS (symptom) and VAS (QoL) scores were also higher in moderate/severe AR subjects than in others (all p<0.001). The number of subjects sensitized to Olive tree pollen was significantly higher in moderate/severe AR patients than in mild subjects (p=0.039). The comparison of the demographic, clinical and laboratory data between the mild and moderate/severe AR patients is given in Table I.

Skin Prick Test and Specific Ig-E Results

The highest rate of SPT positivity was detected against D. farinae (47.3%), followed by Grass mix (44.2%), Grass-cereal mix (43.1%), D. pteronyssinus (35%), Blatella germanica (29.2), Weed mix (21.9%), Aspergillus fumigatus (13.1%), English Plantain (11.2%), Mouse epithelium (11.2%), Olive tree (10%), Wall pellitory (9.2%), Poplar (6.9%), Oak (6.2%), Birch (5.8%), Cat epithelium (5.4%), Plane tree (5%), Alternaria alternata (5%), Bird epithelium (3.1%), Dog epithelium (1.2%) and Beech (0.8%). However, the two largest mean wheal diameters were detected in the Grass mix (10.53 mm) and Grass-cereal mix (11.1 mm) SPT results. The SPT positivity rate of Olive tree pollen was significantly higher in moderate/severe AR patients than in mild subjects (p=0.039). The results of the wheal diameters, and SPT and specific Ig-E positivity rates are given in Table II.

DISCUSSION

This study is very significant due to being the first study evaluating the sensitization rate of inhalant allergens in Batman. The big majority of adult AR patients in Batman had pollen sensitization, followed by HDM, cockroach, animal epithelium and mold sensitizations. Another important finding of the study is the highest rate

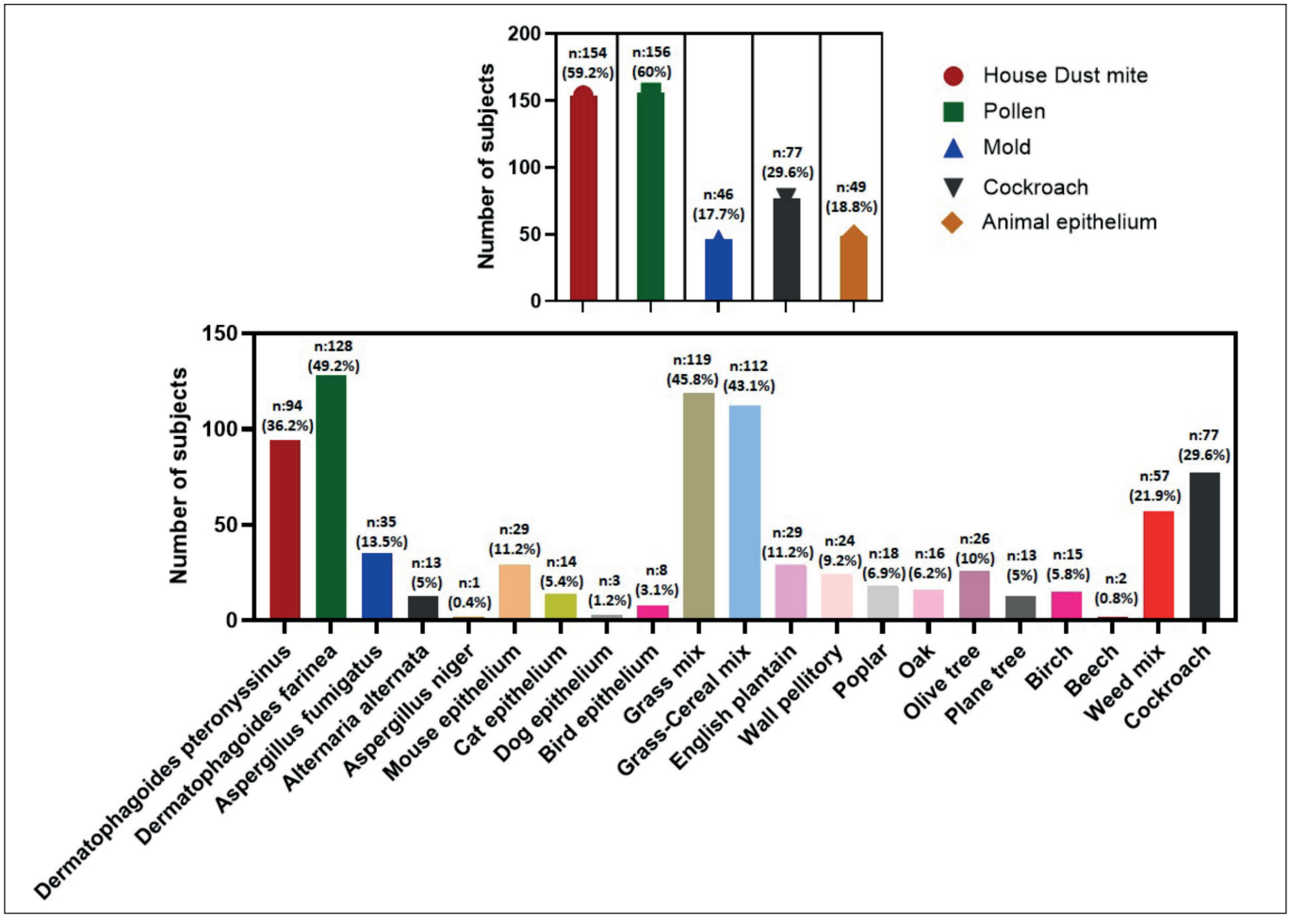

Figure 1. The distribution of sensitization to common inhalant allergens in Batman.

Table II: Skin prick test and specific Ig-E results

Aeroallergen	Tests	All patients (n=260)	Mild AR patients (n=45)	Moderate/severe AR patients (n=215)	*p*
Dermatophagoides farinea	SPT positivity	123 (47.3%)	22 (48.9%)	101 (47%)	>0.05†
	Wheal diameter*	7.01mm	6.86mm	7.04mm	>0.05
	Specific Ig-E positivity	25 (14.8%)	1 (5.9%)	24 (15.8%)	>0.05
Dermatophagoides pteronyssinus	SPT positivity	91 (35%)	21 (46.7%)	70 (32.6%)	>0.05†
	Wheal diameter*	7.79mm	7.71mm	7.81mm	>0.05
	Specific Ig-E positivity	20 (11.8%)	1 (5.9%)	19 (12.5%)	>0.05
Aspergillus fumigatus	SPT positivity	34 (13.1%)	7 (15.6%)	27 (12.6%)	>0.05†
	Wheal diameter*	6.41mm	6.71mm	6.33mm	>0.05
	Specific Ig-E positivity	3 (1.8%)	1 (5.9%)	2 (1.3%)	>0.05
Aspergillus niger	Specific Ig-E positivity	1 (0.6%)	0 (0%)	1 (0.7%)	-
Alternaria alternata	SPT positivity	13 (5%)	2 (4.4%)	11 (5.1%)	>0.05
	Wheal diameter*	6.3mm	6mm	6.36mm	>0.05
	Specific Ig-E positivity	1 (0.6%)	0 (0%)	1 (0.7%)	-
Cockroach	SPT positivity	76 (29.2%)	10 (22.2%)	66 (30.7%)	>0.05†
	Wheal diameter*	7.15mm	6.3mm	7.28mm	>0.05
	Specific Ig-E positivity	20 (11.8%)	1 (5.9%)	19 (12.5%)	>0.05
Grass mix	SPT positivity	115 (44.2%)	18 (40%)	97 (45.1%)	>0.05 †
	Wheal diameter*	10.53mm	10.33mm	10.56mm	>0.05
	Specific Ig-E positivity	54 (32%)	3 (17.6%)	51 (33.6%)	>0.05
Grass-cereal mix	SPT positivity	112 (43.1%)	20 (44.4%)	92 (42.8%)	>0.05†
	Wheal diameter*	11.1mm	9.6mm	11.43mm	>0.05
Weed mix	SPT positivity	57 (21.9%)	8 (17.8%)	49 (22.8%)	>0.05†
	Wheal diameter*	8.28mm	8.75mm	8.2mm	>0.05
English Plantain	SPT positivity	29 (11.2%)	3 (6.7%)	26 (12.1%)	>0.05†
	Wheal diameter*	8.65mm	10mm	8.5mm	>0.05
Wall Pellitory	SPT positivity	24 (9.2%)	4 (8.9%)	20 (9.3%)	>0.05
	Wheal diameter*	8.5mm	10.5mm	8mm	>0.05
Poplar	SPT positivity	18 (6.9%)	1 (2.2%)	17 (7.9%)	>0.05
	Wheal diameter*	7.66mm	6mm	7.76mm	>0.05
Oak	SPT positivity	16 (6.2%)	2 (4.4%)	14 (6.5%)	>0.05
	Wheal diameter*	9.18mm	8mm	9.35mm	>0.05
Plane tree	SPT positivity	13 (5%)	1 (2.2%)	12 (5.6%)	>0.05
	Wheal diameter*	9.38mm	8mm	9.5mm	>0.05
Birch	SPT positivity	15 (5.8%)	0 (0%)	15 (7%)	>0.05
	Wheal diameter*	8.2mm	-	8.2mm	-
Olive tree	SPT positivity	26 (10%)	1 (2.2%)	25 (11.6%)	**0.039**
	Wheal diameter*	8.27mm	8mm	8.28mm	>0.05
Beech	SPT positivity	2 (0.8%)	0 (0%)	2 (0.9%)	>0.05
	Wheal diameter*	10mm	-	10mm	>0.05

Table II continue

Dog epithelia	SPT positivity	3 (1.2%)	0 (0%)	3 (1.4%)	>0.05
	Wheal diameter*	6.66mm	-	6.66mm	-
Cat epithelia	SPT positivity	14 (5.4%)	5 (11.1%)	9 (4.2%)	>0.05
	Wheal diameter*	7.5mm	7.6mm	7.44mm	>0.05
Mouse epithelia	SPT positivity	29 (11.2%)	5 (11.1%)	24 (11.2%)	>0.05†
	Wheal diameter*	6.24mm	6.2mm	6.25mm	>0.05
Bird epithelia	SPT positivity	8 (3.1%)	3 (6.7%)	5 (2.3%)	>0.05
	Wheal diameter*	8mm	7.33mm	8.4mm	>0.05‡

* The mean values of the largest wheal diameters in positive SPTs
† Pearson's chi-squared test used. The other p values related to SPT positivity were calculated with Fisher's exact test
‡ Student T test used. The other p values related to wheal diameters were calculated with the Mann-Whitney U test

of sensitization among tree pollens to belong to Olive tree pollen. This can be explained by the cultivated Olive trees in Mardin, which is one of the closest cities to Batman. Besides, some of the patients might have been sensitized to Olive tree pollens during journeys to the Mediterranean and Aegean regions of Turkey.

The higher relative humidity means higher HDM levels, and reducing the indoor relative humidity to less than 51% results in a significant fall in HDM levels. Mites are infrequent inhalant allergens in dry and hot climates unless evaporative coolers humidify the indoor air (16). In the Southeastern Anatolian Region, the climate has dry and hot characteristics because of Basra low pressure and temperatures see above 30°C (17,18). However, the climate may have changed with an increase in relative humidity due to the recently constructed water dams in Batman (e.g. Ilısu dam in Hasankeyf). Also, the dust storms have negative effects on some provinces (Hakkari, Kilis and Mardin) neighboring Syria and Iraq (17). A comprehensive study has shown that the quality of life in allergic rhinitis and asthma patients deteriorates during the dust storms (19). The dust storms may be a way of transport for outdoor inhalant allergens (e.g. Olive tree pollen) and the 59.2% sensitization rate to HDM in AR patients may be explained by the construction of water dams nearby. Another explanation for HDM sensitization can be the widespread use of evaporative air coolers in almost every house in Batman.

In some studies, the wheal diameters in SPTs were found to be associated with the severity of asthma or rhinitis symptoms (20,21). Similarly, in another study, the increasing wheal sizes in SPTs were found to predict current rhinitis and/or rhino-conjunctivitis, in addition to an association between the severity of rhinitis and the specific Ig-E levels/mean wheal diameters to grass (22). Moreover, wheal diameter responses in SPTs to latex allergen solution can predict the severity of clinical symptoms associated with latex (23). However, wheal diameter sizes were not found to predict the severity of symptoms in some studies (24,25). As another predictive marker, NLR and PLR were suggested for moderate/severe AR and found to be related to the persistence of rhinitis in some studies (26,27). In the present study, SPT wheal diameters did not differ by the severity of AR. Also, neither NLR nor PLR was higher in moderate/severe AR subjects than in mild ones. However, the presence of asthma was significantly higher in moderate/severe AR patients than in mild ones as shown previously (28).

In Kayseri from Central Anatolia, the most common inhalant allergen was Grass pollen and that was followed by D. pteronyssinus (29). In two different places (Sakarya, Kartal) from the Marmara region, the highest rate of inhalant allergen sensitization was detected for HDM (30). In Erzurum, Grass pollen and HDM were found to be the two most common inhalant allergens (31). A study conducted on the pediatric population in Mardin reported that the rate of sensitization was lower for HDM than for other inhalant allergens. Grass, weed and tree pollens were major tree inhalant allergens and Olive tree pollen sensitization was one of the major sensitizations in patients sensitized to tree pollens. Olive tree pollen concentrations were also found to be common in atmospheric measurements, which was consistent with the SPT results (32). In Diyarbakır, Grass, wheat and tree pollens were detected as three major inhalant allergens according to SPT results as well (10). In another study conducted in three nearby cities (Şanlıurfa, Mardin, Diyarbakır), major sensitizations were found to pollens, HDM and cockroach, respectively (9). In

accordance, the results in the present study showed that pollens, HDM and cockroach were similarly three major inhalant allergens in Batman. Olive tree pollens might also be common in atmospheric measurements like in Mardin, may be transported by dust storms, and may worsen the rhinitis symptoms in AR patients sensitized to olive tree pollen since these patients were all poly-sensitized.

This study has some limitations. First, the false positivity of inhalant allergen sensitization could not be exactly identified in poly-sensitized subjects due to the lack of component-resolved allergy diagnosis. Second, the inhalant allergen sensitization was not assessed along with inhalant allergen concentrations in the atmosphere. If it had been analyzed, the atmospheric measurements could have been supportive. Third, some AR patients in this study might have become sensitized to some inhalant allergens after journeys to other regions of Turkey.

In conclusion, when evaluated in general, the big majority of AR patients in Batman were sensitized to pollens, which was followed by HDM, cockroach, animal epithelium, and mold sensitizations. Moreover, olive tree pollen sensitization was the most frequent one among all tree pollen sensitizations and should be evaluated especially in moderate/severe AR patients.

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Conflict of Interest

The author declares no conflicts of interest

Author Contribution

Can Tuzer: Concepting and designing the work; Acquisition, Analysis and Interpretation of data; Drafting the manuscript; Approval of its final version; Agreement to be accountable for all aspects of the work.

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