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RESEARCH ARTICLE

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The Aero-Allergen Sensitization Patterns with Adult Allergic Rhinitis Patients in Van Province

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ABSTRACT

Objective: Allergic rhinitis is a common disease all over the world and allergy tests play an important role in the diagnostic process. Inhalant allergen susceptibility varies by region. We aimed to assess the distribution of aero-allergens in adult patients with allergic rhinitis in Van province.

Materials and Methods: We included 583 adult allergic rhinitis patients with compatible history, physical examination, and an allergy test. We evaluated the demographic features and allergy test results in addition to clinical and laboratory findings on patients with allergic rhinitis. The characteristics of the patients allocated into two groups with moderate/severe and mild allergic rhinitis were compared.

Results: Seventy-four percent of the patients were female and the median age of the patients was 29 years. The most common allergic comorbidities were allergic conjunctivitis (28%) and asthma (22%) while the non-allergic comorbidity was chronic rhinosinusitis (23%). The most frequent inhalant allergen sensitization was the grass mix (n=382, 65%), followed by cereal mix (n=308, 52%), dermatophagoides farinae (n=258, 44%), dermatophagoides pteronyssinus (n=256, 43%), english plantain (n=118, 20%), wall pellitory (n=54, 9%), olive tree (n=37, 6%), ragweed (n=21, 3%), birch (n=14, 2%), alternaria alternata (n=15, 2%), cat (n=13, 2%), aspergillus fumigatus (n=4, 0.6%), bird (n=3, 0.5%), and dog (n=1, 0.1%). Moderate/severe allergic rhinitis was associated with older age, longer disease duration and the presence of a family history of an allergic disease (p=0.003, p<0.001, p=0.004, respectively). Additionally, polysensitization was found to be higher in patients with moderate/severe allergic rhinitis while asthma and chronic rhinosinusitis were more common in patients with moderate/severe allergic rhinitis (p<0.001, p=0.009, p<0.001, respectively).

Conclusion: This study showed that pollen is the most common in the distribution of allergens in the sensitization of patients with adult allergic rhinitis in Van province. This study will guide physicians in the management of allergic rhinitis especially in terms of allergen immunotherapy.

Keywords: Allergic rhinitis, aero-allergen sensitization, inhalant sensitization, allergic diseases, allergy test

INTRODUCTION

Allergic rhinitis (AR) is a disease characterized by runny nose, sneezing, nasal congestion, and nasal itching (1). AR is a common illness all over the world, with a frequency of up to 40% (2). Its prevalence in Turkey is similar to the world (1). On the other hand, it was found to be 24.1% in a study conducted in the adult population in Van the easternmost province of Turkey (3). AR negatively affects the social life of patients and leads to a decrease in the quality of life (4). In addition, it causes loss of labor and increases the health resources required (5,6).

The correct diagnosis and treatment are very important for AR because it is not rare all over the world and affects the daily life of the patient (5,6). Allergy tests are very important in differentiating allergic rhinitis from non-allergic rhinitis (1). For the diagnosis of AR, it is necessary to show allergen sensitization with the skin prick test (SPT) or specific Ig E (1). It is not possible to evalu-

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ate all allergens because there are hundreds of inhalant allergens. In addition, it is not necessary and cost effective to evaluate all allergens since allergen immunotherapy used in the treatment of AR has limited product options. Knowing the distribution of aero-allergens in the residential area plays an important role in the accurate diagnosis and appropriate treatment of AR. House dust, mold, and pollen load and diversity vary due to different climates in different regions of Turkey. When the atmospheric pollen density was measured, tree pollen and weed pollen differed by regions (7). Additionally, the distribution in tree pollen also varies according to the regions. While olive tree pollen was more common in the Aegean and Marmara regions, pine pollen was more common in the Black Sea and Central Anatolia regions (7). Grass pollens were common in all regions of Turkey (7). Atmospheric pollen distributions were measured in the 1-year period between 2001 and 2002 in the city of Bitlis, located near the Van province. Walnut tree, oak tree and cypress tree were in the top 3 in the arboreal plants while grasses, nettles, and umbellifers were among the non-arboreal plants (8).

House dust was the most common allergen in studies conducted on patients with adult AR in relatively warm/hot regions of Turkey such as Istanbul and Antalya (9,10). However, in cold regions such as Erzurum, the frequency of house dust decreased and pollen replaced house dust in the first place among allergens (11). There was no study which exactly evaluated the distribution of sensitization to common inhalant allergens in adult patients with AR in the province of Van.

In this study, it was aimed to determine the sensitization pattern in accordance with the patient's complaints and by evaluating the adult AR patients with the SPT or/and specific Ig E test in Van province. In addition, the relationship between the demographic characteristics of the patients and their clinical and laboratory findings was investigated.

MATERIALS and METHODS

Study Groups and Study Design

The population of Van was 1,128,749 at the time of the study and the frequency of AR in adults was 24% (3). The minimum sample size was 281, calculated by using a web-based program. Patients with AR who presented to our adult allergy outpatient clinic between December 2021 and April 2023 were included in the study. All patients underwent rhinoscopy examination to rule out causes other than AR and to detect the presence of nasal polyps. AR was diagnosed with the history, physical examination, and at least one skin test and/or specific Ig E positivity including a common inhalant allergen compatible with the clinical symptoms for at least one year. Demographic data and clinical features of the patients were recorded prospectively. Age, sex, smoking history, body mass index (BMI), AR duration, seasonal pattern, persistency, the severity of symptoms, and anti-allergic drugs for AR were registered. Moreover, the pulmonary function tests, eosinophil counts, and total Ig E values of the patients were evaluated. The FEV1 (forced expiratory volume in one second) and FVC (forced vital capacity) measurements were assessed in the pulmonary function tests. Additionally, whether allergic conjunctivitis and asthma were accompanied, and if so the disease duration, asthma control test, asthma severity, and medications for asthma were assessed. Furthermore, other allergic and non-allergic comorbidities and the planned use of an allergen immunotherapy were evaluated. Rhinitis symptoms were graded using the visual analogue score (VAS). A VAS score of less than 5 cm was defined as mild rhinitis and a VAS score of 5 cm or more was defined as moderate/severe rhinitis (12). The severity of asthma was categorized as mild, moderate and severe according to the stage of the controller therapy (13).

Persistent and intermittent rhinitis was determined according to the frequency of the symptoms in certain time periods (14). Perennial rhinitis was defined if rhinitis symptoms were present throughout the year, and seasonal rhinitis if they only occurred in the spring-summer period. In addition to these, there was another pattern with complaints throughout the year but seasonal increase (14). House dust, molds, and animal epithelia were defined as perennial allergens and caused perennial symptoms. Pollens caused only seasonal symptoms, or perennial symptoms that exacerbated seasonally (14). If the patient's complaints were perennial, the patient was considered to be fully compatible if at least one of the perennial allergens was positive in the allergy tests. If their complaints were only seasonal and at least one of the pollens was positive in their tests, the patient was again considered to be fully compatible. Additionally, patients who had perennial rhinitis with seasonal exacerbation were considered to be fully compatible when at least one of the perennial allergens together with at least one pollen sensitivity was found or only at least one pollen sensitivity was found in the allergy tests. When patients' complaints were perennial but only pollen sensitivity was observed or when symptoms were only seasonal but sensitive to one of the perennial allergens these were evaluated as incompatible and excluded from the study. Although the complaints of the patients were perennial, at least one pollen sensitivity and at least one of the perennial allergens was found and it was defined as compatible but extra sensitivity. For the patient whose complaint was only seasonal but at least one of the perennial allergens was found in addition to at least one pollen sensitivity, it was defined as compatible but extra sensitivity. Although the complaints of the patients were perennial with exacerbation in the seasonal period, only at least one of the perennial allergens was found in the allergy tests and it was defined as compatible but incomplete sensitization.

All the study subjects provided written informed consent and the study was approved by the Local Ethics Committee with reference number 2021/16-03. This study was conducted according to the principles of the Helsinki Declaration.

Diagnostic Work-Up for Allergy

SPTs were performed with a positive control (histamine dihydrochloride 0.1%), a negative control (NaCl 0.9%), and aero-allergen solutions (Allergopharma® Reinbek, Germany and Lofarma® Milan, Italy) including house dust mites (Dermatophagoides farinae, Dermatophagoides pteronyssinus), molds (Aspergillus fumigatus, Alternaria alternata), pollens (Grass mix, Cereals mix, Birch, Olive tree, Wall Pellitory, Ragweed and English Plantain) and animal epithelium (Cat, Dog and Bird). The grass mix contained orchad grass, Timothy grass, Kentucky blue grass, meadow grass, perennial rye grass and meadow fescue. The cereals mix contained wheat, rye, barley, and oat. The bird epithelium was a budgerigar feather.

A wheal of 3 mm or more was defined as a positive SPT. While 13 prick test panels were administered to all patients, tests with animal epithelium were performed on only patients who had an animal at home or had frequent contact with animals. The specific Ig E value ≥0.35 kUA/L was defined as positive. If prick tests were negative or compatible with incomplete sensitization, specific Ig E was requested. If the prick tests were fully compatible, no specific Ig E was requested. More than one allergen positivity in the SPT or/and specific Ig E test was defined as polysensitization.

Statistical Analysis

The statistical evaluation was performed with the SPSS 24.0 program (SPSS Inc., Chicago, IL, USA). The descriptive datas were shown with percentages and mean±standard deviation (SD) or median with interquartile range (IQR) according to the distribution. The variables were investigated using analytical methods (Kolmogrov-Smirnov/Shapiro-Wilks test) to determine whether they were normally distributed or not. The Chi-square test or Fisher's exact test (when chi-square test assumptions did not hold due to low expected cell counts) was used to compare the categorical features between different groups. In the comparison of numerical variables, the Mann-Whitney U test or Kruskal-Wallis test was used according to the number of the groups. A p-value of less than 0.05 was considered to show a statistically significant result. The graphs were generated using GraphPad Prism version 8.4.3 software (GraphPad Software Inc., San Diego, CA, USA). The minimum sample size was calculated with a 95% confidence level by a web-based program (XLSTAT by Lumivero).

RESULTS

Demographic and Clinical Features of the Patients

We included a total of 583 patients and the median age (minimum-maximum) was 29 (18–80) years among the patients with AR. The majority (73.6%) of the patients were female and the mean BMI value was 23.8±3.2. Seventy-six (13%) patients were smokers among whom the average smoking history was 5 package years. Two hundred and twenty (38%) patients had a family history of at least one allergic disease. The median (IQR) duration of AR of the patients was 4 (2-9) years. The median value of the VAS score was 8 (5-8), and a total number of 144 (24.7%) patients had mild rhinitis while 439 (75.3%) patients had the moderate/severe type. While the symptoms of 162 (28%) patients were perennial, 209 (36%) patients' were only seasonal, and 212 (36%) patients' were perennial with exacerbation in the seasonal period. The symptoms of 3 out of 4 patients were persistent (n=438, 75.1%) in AR. The number of patients who had a pet at home or had a history of frequent contact was 72. Forty-five subjects had cats, 24 had birds, and 3 had dogs.

The median FEV1 values of all the patients were 3.43 L (2.86-4.09) and 111% (99-125). The median value of FEV1/FVC (%) was 90 (85-95). More than half (65%) of the patients were accompanied by allergic comorbidities, while the rate of accompanying non-allergic comorbidities was only 17.3 percent. The most common allergic comorbidities were allergic conjunctivitis (28.5%) and allergic asthma (22.5%). Allergic conjunctivitis and asthma were found together in 27 patients. The median duration of ocular disease in patients with allergic conjunctivitis was 4 (2-5) years, while the median duration of asthma disease in patients with asthma was 2 (1-5) years. The most common non-allergic comorbidity was chronic rhino-sinusitis (22.8%). The other common allergic and non-allergic comorbidities are summarized in Table I.

Among 131 asthmatic patients, 77 (59%) were mild, 37 (28%) were moderate, and 17 (13%) were severe. The median value of asthma control tests of the asthmatic patients was 22 (20-23). The median FEV1 values of the asthmatic patients were 2.94 L (2.44-3.52) and 105% (85-118). The median value of FEV1/FVC (%) was 87 (80-93).

Skin Prick Test and Laboratory Results

While the allergy test results were fully compatible in 90% of the patients, 7% were evaluated as compatible with extra sensitivity and 3% as compatible with incomplete sensitization. Ninety percent of the patients were polysensitized and the median number of allergens found positive was 2 (2-3). The most frequently observed inhalant agent in allergy tests was pollen with 72%, followed by house dust (45%), mold (3%), and animal epithelium (3%) (Figure 1). When evaluated in more detail, the most common inhalant allergen was the grass mix (65%), followed by the cereals mix (52%), Dermatophagoides farinae (44%), Dermatophagoides pteronyssinus (43%), english plantain (20%), wall pellitory (9%), olive tree (6%), ragweed (3%), birch (2%), Alternaria alternata (2%), cat (2%), Aspergillus fumigatus (0.6%), bird (0.5%), and dog (0.1%) (Figure 2). Among the participants with cats, the allergy test of 13 (28%) patients were positive. The allergy tests for 3 (12%) patients among those who owned birds and for 1 (33%) patient among those who owned dogs were positive. Eighty-two percent of patients with a pollen sensitivity had at least 2 or more sensitivities. The SPT was positive for 95% (n=555) of the patients. The majority of the patients (n=423, 73%) did not require the specific Ig E test. The specific Ig E test was evaluated for 151 patients while 9 patients did not have the test performed. Positivity was found in 36% of the specific Ig E tests for the 151 patients. The SPT and specific Ig E results of the patients are shown in Table II separately.

Table I: The concomitant allergic and non-allergic diseases of patients.

Allergic comorbidities	**n (%)**
Allergic conjunctivitis	166 (28.5)
Allergic asthma	131 (22.5)
Nasal polyps	65 (11.1)
Chronic urticaria/ angioedema	30 (5.1)
Drug allergy	21 (3.6)
Venom allergy	14 (2.4)
Food allergy	9 (1.5)
Atopic dermatitis	6 (1)
Non-allergic comorbidities	
Chronic rhinosinusitis	133 (22.8)
Gastroesophageal reflux	25 (4.2)
Hypertension	19 (3.2)
Atherosclerotic heart disease	16 (2.7)
Thyroid diseases	15 (2.5)
Diabetes mellitus	14 (2.4)
Psychiatric disorders	8 (1.3)
Obstructive sleep apnea	6 (1)

*Patients have more than one allergic or non-allergic comorbidity.

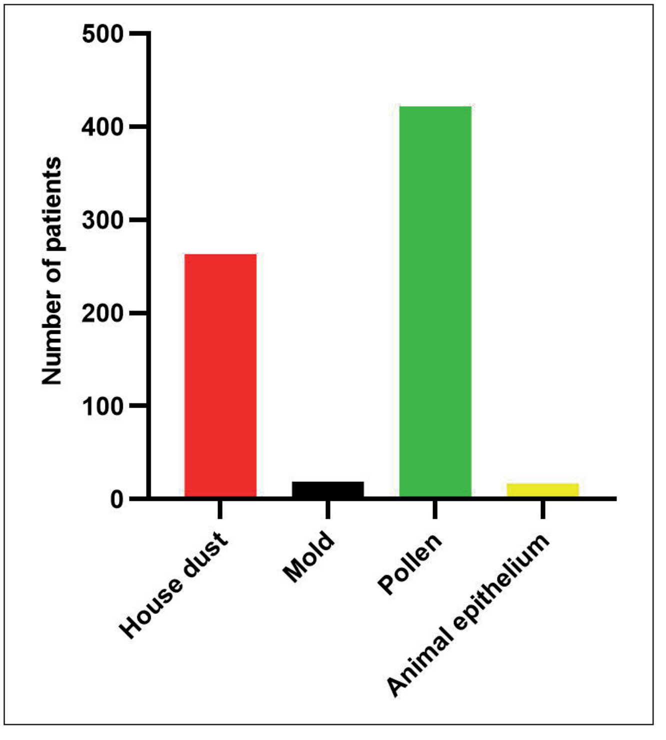

Figure 1. The allergy test results according to the main categories.

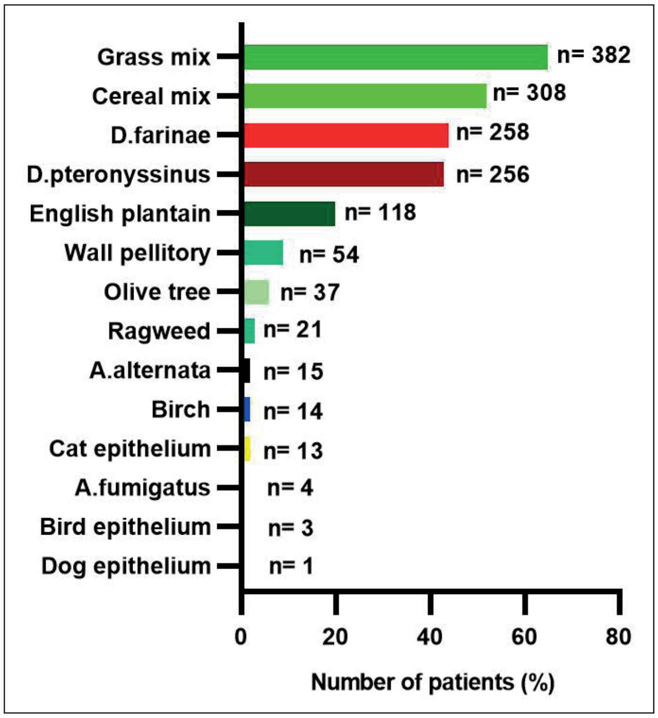

Figure 2. The distribution of sensitization to inhalant allergens.

The eosinophil counts were evaluated in all patients and the median eosinophil value was 200 (110-320) cells/mL. A high eosinophil count was observed in only 8% (n=48) of the patients when the upper limit of eosinophils was defined as 500 cells/mL, while a high eosinophil number was found in 26% (n=153) of the patients when the upper limit of eosinophils was defined as 300. Total Ig E was evaluated in 28% (n=162) of the patients and the median value for the evaluated patients was 203 (85-451) IU/mL. A high total Ig E level was found in 70% (n=113) of the patients when the upper limit of 100 IU/mL was defined as high total Ig E in the evaluated patients.

Table II: The results of the skin prick test and specific Ig E value of the patients.

Skin prick test results	n / N (%)
Grass mix	369 / 583 (63.3)
Cereals mix	306 / 583 (52.5)
Dermatophagoides farinae	226 / 583 (38.8)
Dermatophagoides pteronyssinus	230 / 583 (39.5)
English plantain	117 / 583 (20.1)
Wall pellitory	54 / 583 (9.3)
Olive tree	37 / 583 (6.3)
Ragweed	21 / 583 (3.6)
Birch	13 / 583 (2.2)
Alternaria alternata	4 / 583 (0.7)
Aspergillus fumigatus	3 / 583 (0.5)
Cat	6 / 45 (13.3)
Bird	2 / 24 (8.3)
Dog	1 / 3 (33.3)
Specific Ig E results	
Grass mix	14 / 42 (33.3)
Cereals mix	2 / 2 (100)
Dermatophagoides farinae	32 / 122 (26.2)
Dermatophagoides pteronyssinus	28 / 120 (23.3)
English plantain	1 / 2 (50)
Olive tree	0 / 1 (0)
Birch	1 / 1 (100)
Alternaria alternata	12 / 127 (9.4)
Aspergillus fumigatus	1 / 5 (20)
Cat	7 / 39 (17.9)
Bird	1 / 22 (4.5)
Dog	0 / 2 (0)

n: the number of positive patients, **N:** the number of patients evaluated.

Pharmacological Therapies in Disease Management

Seventy-one (12%) patients were not receiving any treatment for allergy. Among 512 patients receiving anti-allergic therapy, 497 (97%) were using antihistamines, 278 (54%) were using montelukast, 422 (82%) were using intranasal steroid spray, and 44 (9%) were using intranasal antihistamine (azelastine hydrochloride) spray. Intranasal steroid spray+anti histamine+montelukast (n=209, 40%) and intranasal steroid spray+anti histamine (n=173, 33%) constituted the majority of the combination therapies. The most commonly used antihistamines by the patients were desloratadine (n=165, 33%) and levocetirizine (n=150, 30%) while the most commonly used intranasal steroids were mometasone furoate (n=179, 42%) and beclomethasone dipropionate (n=112, 26%). Other allergy treatment combinations and types of oral antihistaminic and intranasal steroid spray treatments received by the patients are listed in Table III. While 48 (36%) asthma patients were using the inhaler as needed, 83 (64%) patients were using it constantly. The most frequently used inhaler by asthmatic patients was the budesonide+formoterol combination (n=42, 32%). The other inhaler treatments that patients received are shown in Table III. Allergen immunotherapy was planned for 80 (18%) patients with moderate/severe

AR. Immunotherapy was not planned since moderate/severe AR was under control with medical treatment in 305 (70%) patients. Although AR was not under control with medical treatment, allergen immunotherapy was not planned because of some problems such as transportation challenges to the hospital (n=32), systemic auto-immune or auto-inflammatory diseases (n=9), pregnancy (n=4), severe asthma (n=3), unstable cardiovascular disease (n=2), severe psychiatric disorders (n=2), cancer (n=1), and immune deficiency (n=1).

The most frequently planned immunotherapies were for pollen (n=58, 72%) and house dust (n=35, 43%). The other planned single and combination immunotherapies are summarized in Table III.

Comparison of the Findings of Patients with Mild and Moderate/Severe AR

The patients were similar in terms of gender, smoking, and BMI (p>0.05). Moderate/severe AR was more common in the elderly patients and the duration of disease was longer in the moderate/severe group (p=0.003, p<0.001, respectively). Moderate/severe AR was more frequently accompanied by asthma, nasal polyp, urticaria, and chronic rhinosinusitis (p=0.009, p<0.001, p=0.003, p<0.001, respectively). While the number of positive allergens and polysensitization frequency was higher in the moderate/severe group, this association was more commonly related to the pollens (p<0.001, p<0.001, p=0.02, respectively) (Figure 3). There was no difference between

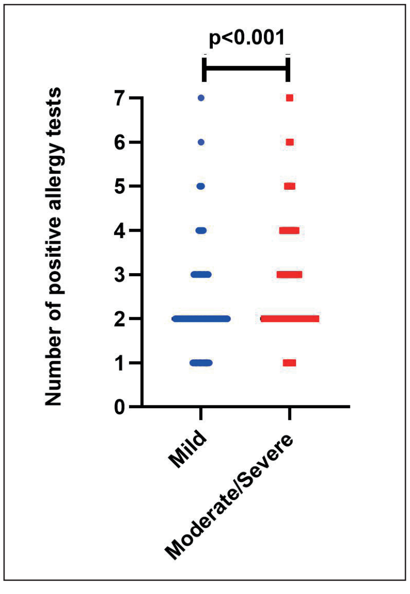

Figure 3. The relationship between the number of positive allergens and the severity of allergic rhinitis.

Table III: The distribution of anti-allergic and asthma treatments used by patients and planned immunotherapy.

Anti-allergic drug	n / N (%)
Intranasal steroid spray + Antihistamine + Montelukast	209 / 512 (40)
Intranasal steroid spray + Antihistamine	173 / 512 (33)
Antihistamine + Montelukast	45 / 512 (8)
Only antihistamine	28 / 512 (5)
Intranasal steroid and antihistamine spray + Antihistamine + Montelukast	15 / 512 (3)
Intranasal steroid and antihistamine spray + Antihistamine	10 / 512 (2)
Intranasal anti histamine spray + Antihistamine	10 / 512 (2)
Only intranasal steroid spray	9 / 512 (2)
Intranasal anti histamine spray + Antihistamine + Montelukast	6 / 512 (1)
Intranasal steroid and antihistamine spray	3 / 512 (0.5)
Intranasal steroid spray + Montelukast	3 / 512 (0.5)
Only montelukast	1 / 512 (0.1)
Types of antihistamine therapy	
Desloratadine	165 / 497 (33)
Levocetirizine	150 / 497 (30)
Fexofenadine	56 / 497 (11)
Bilastine	51 / 497 (10)
Cetirizine	40 / 497 (8)
Ebastine	19 / 497 (4)
Rupatadine	15 / 497 (3)
Loratadine	1 / 497 (0.2)
Types of intranasal steroid spray	
Mometasone furoate	179 / 422 (42)
Beclomethasone dipropionate	112 / 422 (26)
Fluticasone propionate	82 / 422 (19)
Fluticasone furoate	26 / 422 (6)
Triamcinolone acetonid	23 / 422 (5)
Types of inhaler medication	
Budesonide + Formoterol	42 / 131 (32)
Salmeterol + Fluticasone	30 / 131 (23)
Salbutamol	24 / 131 (18)
Beclometasone + Formoterol	23 / 131 (17)
Fluticasone + Vilanterol	10 / 131 (8)
Fluticasone + Formoterol	2 / 131 (1)
Types of immunotherapy	
Only pollen	42 / 80 (52)
Only house dust	20 / 80 (25)
Both pollen and house dust	15 / 80 (19)
Cat	2 / 80 (3)
Both pollen and mold	1 / 80 (1)

*__n:__ the number of patients receiving the related treatment, **N:** the number of patients receiving the same group of treatment

Table IV: The comparison of demographic, clinical and laboratory features of patients with allergic rhinitis according to the severity.

Demographic and clinical characteristics	Mild Rhinitis (n=144)	Moderate/Severe Rhinitis (n=439)	p
Age (year, median, IQR)	26 (21-33)	30 (24-36)	**0.003**
Sex (male/female, n)	44/100	110/329	NS
Smokers (%)	11.8	13.4	NS
BMI (mean±SD)	22.4±3.2	24.1±3.5	NS
Family history of allergic diseases (%)	27.8	41	**0.004**
Allergic rhinitis duration (years, median, IQR)	3 (1-5)	5 (3-10)	**<0.001**
VAS symptom score (median, IQR)	3 (2-4)	8 (7-9)	**<0.001**
Time Pattern of Symptoms			NS
Only perennial (%)	31.9	26.4	
Only seasonal (%)	38.2	35.1	
Perennial with exacerbation in the seasonal period (%)	29.9	38.5	
Persistency of symptoms (%)	67.4	77.7	**0.01**
Allergic Condition			
Allergic conjunctivitis (%)	27.1	28.9	NS
Allergic asthma (%)	14.6	25.1	**0.009**
Nasal polyps (%)	2.1	14.1	**<0.001**
Chronic urticaria/ angioedema (%)	1.4	6.4	**0.003**
Drug allergy (%)	2.1	4.1	NS
Venom allergy (%)	2.1	2.5	NS
Food allergy (%)	0	2	NS
Atopic dermatitis (%)	0	1.3	NS
Comorbid Diseases			
Chronic rhinosinusitis (%)	4.9	28.7	**<0.001**
Gastroesophageal reflux (%)	4.8	4.1	NS
Hypertension (%)	2.7	3.4	NS
Atherosclerotic heart disease (%)	2	2.9	NS
Thyroid diseases (%)	2	2.7	NS
Diabetes mellitus (%)	1.3	2.7	NS
Psychiatric disorders (%)	0	1.8	NS
Obstructive sleep apnea (%)	0	1.3	NS
Allergy Test and Laboratory Results			
Number of positive allergy test (median, IQR)	2 (2-3)	2 (2-3)	**<0.001**
Polysensitization (%)	81.9	92.7	**<0.001**
Allergy test positivity			
Pollens (%)	65.3	74.7	**0.02**
House dust (%)	41	46.5	NS
Molds (%)	2.1	3.6	NS
Animal epithelium (%)†	58.3	16.7	**0.002**
Grass mix (%)‡	52.1	69.9	**<0.001**
Cereal mix (%)‡	45.1	55.4	**0.03**

Table IV continue

Eosinophils (cells/mL, median, IQR)	185 (100-300)	200 (120-330)	NS
Total IgE (IU/ml, median, IQR)†	177 (70-480)	208 (87-436)	NS
FEV1/FVC (%, median, IQR)	94 (88-97)	90 (84-94)	**<0.001**
Allergic conjunctivitis duration (median, IQR)§	2 (1-4)	5 (3-6)	**<0.001**
Asthma duration (median, IQR)||	1 (1-2)	2 (1-5)	**0.007**
Asthma control test (median, IQR)||	23 (21-24)	22 (20-23)	NS
Asthma severity (%)||			NS
Mild	71.4	56.4	
Moderate	23.8	29.1	
Severe	4.8	14.5	
FEV1/FVC (%, median, IQR) Ψ	94 (84-97)	86 (79-91)	**0.008**

* NS=not significant, IQR=interquartile range, BMI=body mass index, SD=standard deviation, VAS= visual analogue score, FEV1=forced expiratory volume in one second, FVC=forced vital capacity

† These results were calculated only for the patients for whom that test was evaluated

‡ The only different frequency in the inhalant allergen panel

§ only in patients with allergic conjunctivitis

|| only in patients with asthma

the two groups in terms of total Ig E levels and eosinophil counts (p>0.05). Comparisons of demographic and clinical characteristics and laboratory findings of patients with AR according to severity are shown in Table IV.

DISCUSSION

To the best of our knowledge, this is the first study to completely reflect the pattern of sensitization to inhalant allergens in adult patients with AR in the province of Van It is also very valuable because it contains all the options in the current allergen immunotherapy treatments. The most important finding in our study was that grass mix and cereal mix pollen sensitivity were the most common. Another important finding was that patients were mostly in the moderate/severe group and the number of allergens found positive in allergy tests was higher in patients with moderate/severe AR. Animal sensitizations were higher in the mild group although pollen sensitizations were higher in the moderate/severe group.

It is very important to follow a successful treatment path because AR is very common both in the world and in Turkey and affects the quality of life (2,4). Allergy tests play a very important role in allergen immunotherapy therapy, which is the only treatment that changes the course of the disease (15). Therefore, it is necessary to know the aero-allergen sensitivities in that area for a more accurate treatment option. In 2017, Gur et al. conducted a study in which prick test results were reported in patients with AR in the province of Van (16). This study was conducted on 220 patients and the sample size was below 281. Therefore, it did not exactly reflect the sensitization pattern of the Van region. Our study which had more than twice the number of patients with adequate sample size is important because it completely reflects the aero-allergen sensitivities in the city of Van In addition, only skin prick tests were performed and the number of allergens evaluated was very low in the previous study (16). It was also unknown whether the results found were compatible with the patients' complaints (16). In addition to the skin prick test, the specific Ig E values were also measured in the patients if deemed necessary in our study. Moreover, test results that were inconsistent with the complaints of the patients were not included in the study. In the previous study, only meadow, mixed grass, and flower mixture were evaluated as pollens and the contents of the pollen mixtures used were unknown (16). In our study, only two pollen mixtures were applied and these mixtures are among the treatment options in the current allergen immunotherapy. Furthermore, the detailed contents of these two mixtures were defined and five single pollens were additionally assessed.

The altitude of Van province is about 1726 meters and Van is dominated by dry climate with hard and long winters. It is one of the cities with the least rainfall in the Eastern Anatolia Region. The Van region consists of approximately 70% meadows and grassland, 20% cultivated land, and only 2% forest (17). The most frequently found inhalant allergen was grass mix pollen in our study and it was compatible with the vegetation and atmospheric pollen distribution of the region (8). House dust was in the first place in the studies previously reported from the warmer regions of Turkey (9,10). House dust and mold sensitization changes due to heat differences because temperature and humidity increases are more favorable conditions for house dust and molds (18,19). Pollen sensitivity was detected first, in line with the results in other regions with similar climatic conditions in our region. (11).

When the atmospheric pollen distribution was evaluated in terms of tree pollen, walnut and oak trees are in the first two places in our region (8). These tree pollens were not evaluated in our study because there are no allergen immunotherapy products against these pollens. There are hundreds of pollen types and the distribution of these pollens in different regions both of Turkey and in the world varies (7). Evaluation of all these pollens is not cost-effective and has limited benefits to the patient (6). While there are many prevention measures that can be taken for indoor allergens such as house dust and molds, the effectiveness of these prevention measures for pollen is limited (1, 6). Therefore, these pollens were not evaluated although atmospheric pollen distribution was high. In our study, only allergens that can be used for current allergen immunotherapy were evaluated except for Aspergillus fumigatus. Aspergillus fumigatus was used for the differential diagnosis of allergic bronchopulmonary aspergillosis in severe asthma (20).

Consistent with previous studies, the majority of those with allergic rhinitis were in the moderate/severe group in our study and polysensitization was more common in this group (9,21). In addition, pollen sensitivity was higher in the moderate/severe group compared to the mild group in our study. While no allergen positivity was found to be associated with the severity of AR in one study, more severe symptoms were observed in those with tree pollen and alternaria positivity in another study (21,22). However, animal sensitivity was higher in the mild group in our study. This result may be due to the fact that patients who have allergic complaints and have pets generally suspect the animal first in our country. Even people who are considering keeping a pet at home present to outpatient clinics for allergy tests to determine whether they have an animal allergy or not. Therefore, we can speculate that animal sensitivity was found to be higher in the mild group compared to other allergens due to early presentation to the hospital.

Another important finding was that more than one pollen was detected in 4 out of 5 pollen sensitive patients. Some of these were due to double or triple primary susceptibility, while a large portion is probably because of cross-reactivity. The reason for this is because homologous protein similarities were common among pollens (23). It is very important to decide whether it is primary sensitization or cross-reactivity, especially in patients who are considering starting allergen immunotherapy (24). It is important to make this distinction because it has been observed that at least 50% of patients who were planned to receive immunotherapy had their treatments changed after this distinction was made (25). It has been shown that immunotherapy choices will be more accurate with the recently used component resolved diagnostic methods (26). Allergen immunotherapy could not be planned for 32 patients due to transportation challenges to the hospital. In the current immunotherapy applications, the patients should come once a week in the first 2 or 3 months depending on the type of immunotherapy in the induction phase. In the allergoid immunotherapy type, the number of injections required to reach the maintenance phase is much lower than current immunotherapy (27). It is thought that access to allergen immunotherapy will become easier in the future with the widespread use of these products.

Although the current study had important findings, there were a few limitations. Specific IgE values were not assessed in all patients who needed a specific Ig E test. However, this rate was only 5% of the patients. Furthermore, the number of years the patients had lived in this region was not evaluated. There may be patients who have lived in another city for a long time and newly arrived in our region but this situation is a valid for all regions in real life. In our study, we did not confirm the results obtained with nasal allergen provocation. Proving the allergy test results with nasal allergen provocation shows the clinically responsible allergen more accurately, but it is only used for research purposes and is not used practically in our country (28). The component based diagnostic methods were not used to detect the primary sensitization in polysensitized patients. On the other hand, the majority of polysensitized patients had both grass mix and cereal mix pollen. We think that this problem has been largely eliminated by choosing a combination immunotherapy product containing both allergens.

In conclusion, the inhalant allergen sensitivity patterns of adult patients with allergic rhinitis in Van have been fully demonstrated. It was observed that the majority of patients with allergic rhinitis had pollen sensitivity and were polysensitized. This study will guide allergists and other specialists such as otorhinolaryngologists, pulmonologists, and ophthalmologists who work on allergic diseases. It will also further contribute to the allergen immunotherapy practices of physicians.

Conflict of interest

The author declares no conflict of interest.

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Authorship Contributions

Concept: **Ali Can,** Design: **Ali Can,** Data collection or processing: **Ali Can,** Analysis or Interpretation: **Ali Can,** Literature search: **Ali Can,** Writing: **Ali Can,** Approval: **Ali Can.**

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