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Pattern of allergen sensitivity among bronchial asthma patients in Sohag governorate, Egypt

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Abstract

The purpose of this study was to identify the pattern of allergen-sensitivity in asthmatic patient in Sohag governorate, Egypt, and to provide data for therapeutic management of those patients by immunotherapy. The study included patients with bronchial asthma diagnosed clinically and by pulmonary function tests. Patients were subjected skin prick test to diagnose their sensitization to different allergens including aero-allergens, contact, and food allergens. Clinical and demographic data of the patients were collected for correlating it with the pattern of the sensitivity. The most frequent aero-allergen reported in asthmatic patients was birch (38.7%), followed by sunflower seeds and mixed grass (29.5% and 26.4% respectively), While the most frequent contact allergen reported was common wasp venom followed by honey bee venom (25.7% and 20.6% respectively). the most frequently reported food allergen was banana followed by milk and *Sollanaceae* (12.2%, 11.5%, and 11.0% respectively). In conclusion, our study provided useful information on the pattern of allergen sensitization in this part of the country; such information would be helpful in treating allergic patients.

Keywords: Asthma, Skin prick test, IgE-specific.

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Introduction

Allergy (immunological hypersensitivity) includes different clinical forms and manifestations.[1] Respiratory allergy is mediated by IgE and manifested as asthma and allergic rhinitis that are referred to as united airway diseases (UADs) because they show many common characteristics.[2] The prevalence of allergy is increasing and affects 30–40% of population throughout the world.[3] The WHO reported that about 300 million patients have asthma and 400 million patients have allergic rhinitis worldwide.[4] In 2025, it is predicted that 400 million of individuals will suffer from allergic asthma and 500 million from allergic rhinitis.[5, 6]

Allergic rhinitis and asthma are considered atopic disorders. Atopy is defined as a genetic predisposition to production of IgE upon exposure to an environmental allergen with subsequent development of allergic reaction. The first atopic manifestation appears in childhood as atopic dermatitis and can further progress to allergic rhinitis and/or asthma at school age; this transition is called the atopic

march.[7, 8] The main criterion of atopy is the ongoing production of allergen-specific IgE. This phenomenon is called sensitization. Sensitization is indispensible for diagnosis allergic diseases. The natural history of allergy is characterized by an increasing number and amplitude of sensitizations which is called poly-sensitization phenomenon.[9]

Asthma is defined as a heterogeneous, chronic inflammatory disease of the respiratory tract that leads to transient variable symptoms, such as wheezing, shortness of breath, chest tightness, coughing in alternating intensity, and expiratory airflow limitation defined by lowered forced expiratory volume.[10] Asthma causes long-term morbidity,[11] restrictions in the patient's quality of life, and high costs of hospitalization, medication, and work/school absenteeism.[12]

Detection of IgE-specific antibody against the offending allergens can be conducted in vivo by skin prick test (SPT) or in vitro by IgE-specific serum measurement.[13] World Allergy Organization (WAO) stated that skin prick test is the gold standard in detecting IgE-specific antibodies.[14] SPT is considered the first line diagnostic method, and specific-IgE assays as second line, SPT is cheap, quick, and sensitive. However, it has some drawbacks as it may cause severe local skin reaction and anaphylactic risk.[15]

The types of inhalant allergens that predominate in the environment of the patient differ widely depending on locality and can also vary within the same country.[16] So, it is important to determine the local allergy pattern in patients of allergy and asthma. This study aimed at identifying the pattern of allergen sensitivity among patients with bronchial asthma using SPT against various indoor and outdoor inhalant and allergens. The study emphasis was on the impact of gender, age, and demographic data on the pattern of allergens responsible.

Patients and Methods

This cross-sectional study was conducted during the period from March 2019 to March 2021. It included 417 patients diagnosed to have bronchial asthma and visited the outpatient clinic of chest diseases and tuberculosis department of Sohag University hospitals. Age, gender, residence, occupation, socioeconomic status, and marital status data were recorded.

Inclusion criteria: Patients were included in the study if they were diagnosed with asthma; defined as a clinical syndrome consisting of wheeze, breathlessness, chest tightness and sometimes cough and confirmed by pulmonary function tests. Their Age ranged between 14 and 59 years.

Exclusion criteria included the following: Children, less than 14 years of age were not included as they might develop automatic remission beyond this age. Patients who had taken short-acting oral antihistaminic agents, beta-blockers, steroids, tricyclic antidepressants or any other drug that could affect the test within one week prior to testing were excluded**.** Patients on long-acting oral antihistaminic agents before four weeks of testing. Patients receiving corticosteroids 7 days before performing the SPT. Pregnant and lactating woman were excluded from this study**.** Finally, patients with history of severe life-threatening exacerbations of asthma.

All the study patients underwent SPT by using standard allergens obtained from Stallergenes (Paris, France). A total of 34 antigens were used which included three types of pollens; Birch, mixed grasses, and sun flower seeds. Three types of mites; *Dermatophagoids pteronyssinus*, *Dermatophagoids farinae*, house dust mites (HDM). Five types of fungi; *Alternaria alternate, Aspergilus niger, Aspergilllus flavus, Aspergilllus fumigatus and penicillium notatum*. Three types of insects; Honeybee venom, common wasp venom, and cockroach. Five types of pet dander and wool; sheep wool, dog dander and cat dander. Fifteen types of food items; fish, chicken, milk, egg white, maize, wheat, nuts, garlic, tomato, *Sollanaceae*, banana, chocolate. Histamine was used as a positive control, and buffered saline was used as a negative control to rule out dermographism, which makes the test results difficult to interpret.

The skin prick test: The selected allergens were dropped on a marked area on the volar side of the forearm, and the area was pricked using Stallerpoint (Stallergenes, Paris, France) at least 2 cm apart. After 15 minutes, the area was wiped. Results were evaluated by measuring wheal and flare reaction for each allergen. A positive reaction was defined as the presence of a wheal and flare. Wheals twofold larger in diameter than the histamine control or showing pseudopods were classified as 4+. If the wheal was 3 mm or up to two times larger than the histamine control, it was classified as 3+. More than one-half the size of the positive control it was scored as 2+. More than one-quarter of the size of the positive control it was scored as 1+; and less than one-quarter of the size of the positive control scored as 0**.** Scores of 2+ or more were defined as positive reactions [17].

Statistical analysis

Data was analyzed using STATA version 14.2 (Stata Statistical Software: Release 14.2 College Station, TX: StataCorp LP.). Data were presented as number and percentage and compared using either Chi square test or fisher exact test. The strength of association of different allergen with each other was measured using cross tabulation and Kendall rank correlation test. Graphs were produced by using the Excel program. P value was considered significant if it was less than 0.05. The correlation coefficient takes on values ranging between +1 and -1. The following points were the accepted guidelines for interpreting the correlation coefficient: Values between 0 and 0.3 (0 and -0.3) indicated a weak positive (negative) linear relationship. Values between 0.3 and 0.7 (0.3 and -0.7) indicated a moderate positive (negative) linear relationship. Values between 0.7 and 1.0 (-0.7 and -1.0) indicated a strong positive (negative) linear relationship.

Results

The study included a total of 417 asthmatic patients; 182 females (43.6%) and 235 males (56.4%). The age of patients ranged from 14 to 65 years, The age categories of the patients included in the study were as follows; 172 (41.2%) patients were (14-<25 years of age), 173 (41.4%) patients (25-<45 years of age), and 71 (17%) patients (45-<65 years of age). Residence and occupations of the patients were recorded. Patients live in rural environment were 190 (45.9%), while patients residing in urban environment accounted for 226 (54.1%).

The most frequent aero-allergen reported in asthmatic patients was birch (38.7%), followed by sunflower seeds and mixed grass (29.5% and 26.4% respectively), While the most frequent contact allergen reported was common wasp venom followed by honey bee venom (25.7% and 20.6% respectively). The most frequently reported food allergen was banana followed by milk and *Sollanaceae* (12.2%, 11.5%, and 11.0%, respectively). (Tables 1, 2, and 3) (Figures 1, 2).

The frequency of sensitivity to aeroallergens in various age groups was as determined: the most frequently reported sensitivity in all age groups was to birch, while the lowest percentages were to *Aspergillus niger, Penicillium notatum, Aspergillus fumigatus.* Sensitivity to common wasp venom was more frequently observed in the age group (45-≤65). However, sensitivity to honeybee venom and cockroaches was more frequent in the age group (25-≤45 years of age). The sensitivity to milk and egg white was higher in the age group (14-≤25 years of age). The sensitivity to banana and *Sollanaceae* was higher in the age group (25-≤45 years of age). There was no significant difference in the frequency of allergy to the same allergen in different age groups except for *Dermatophagoids farina* (*P* = 0.002). (Table 4).

Table 1. Frequency of sensitivity to aeroallergens in asthmatic patients

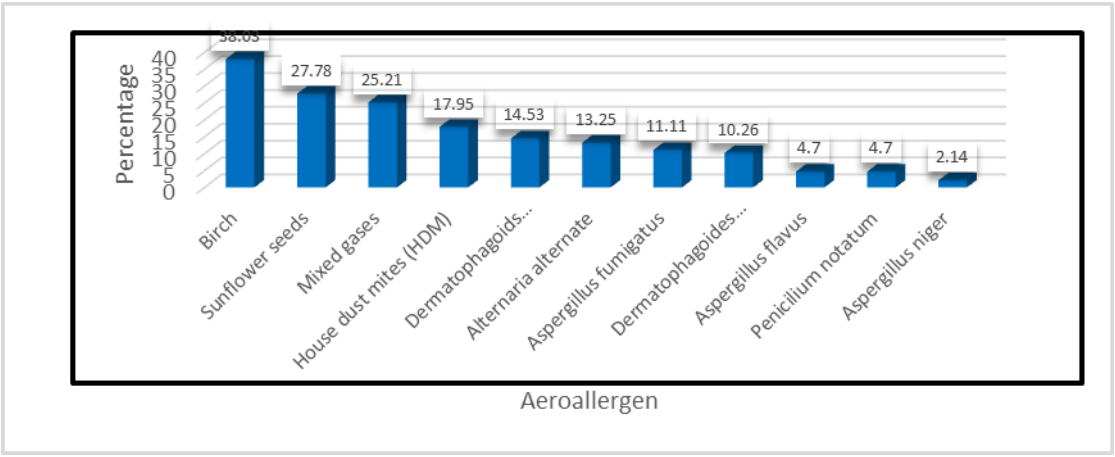
Allergen	Number (%)
Birch	161 (38.70%)
Sunflower seeds	123 (29.57%)
Mixed gases	110 (26.44%)
House dust mites (HDM)	80 (19.23%)
Alternaria alternate	64 (15.38%)
Dermatophagoids pteronyssinus	63 (15.14%)
Aspergillus fumigatus	58 (13.94%)
Dermatophagoides farina	46 (11.06%)
Aspergillus flavus	19 (4.57%)
Penicillium notatum	14 (3.37%)
Aspergillus niger	8 (1.92%)

Table 2. Frequency of sensitivity to contact in asthmatic patients.

Allergen	Number (%)
Common wasp venom	107 (25.72%)
Honeybee venom	86 (20.67%)
Cockroaches	73 (17.55%)
Sheep wool	7 (1.68%)
Dog dander	7 (1.68%)
Cat dander	5 (1.20%)

Table 3. Frequency of sensitivity to food in asthmatic patients

Allergen	Number (%)
Banana	51 (12.26%)
Milk	48 (11.54%)
Sollanaceae	46 (11.06%)
Egg white	35 (8.41%)
Tomato	28 (6.73%)
Fish	20 (4.81%)
Nuts	16 (3.85%)
Garlic	10 (2.40%)
Wheat flour	8 (1.92%)
Chicken	8 (1.92%)
Chocolate	8 (1.92%)
Maize	6 (1.44%)



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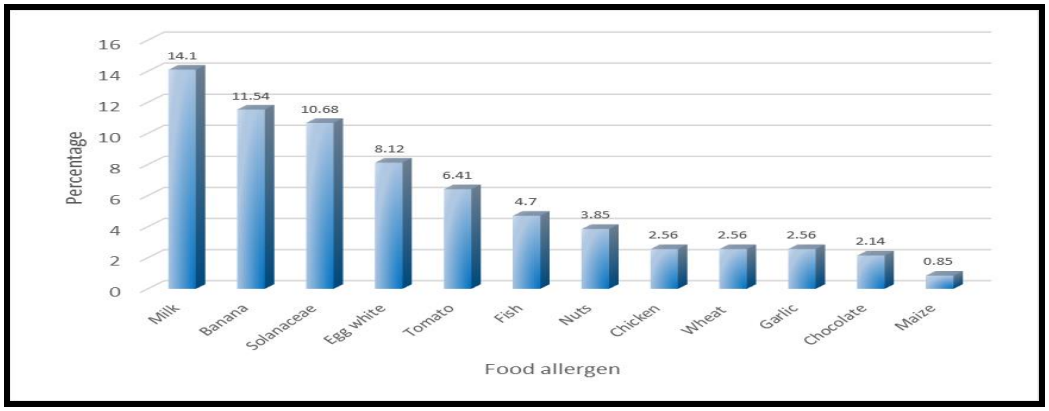

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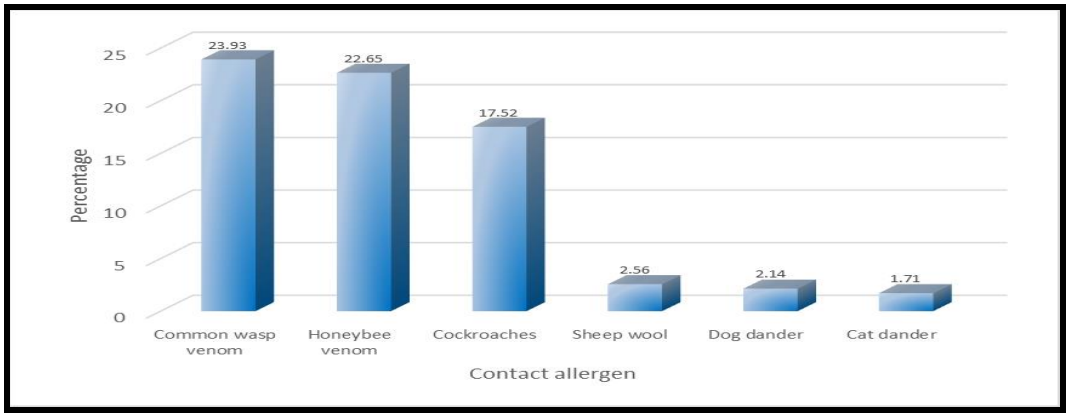

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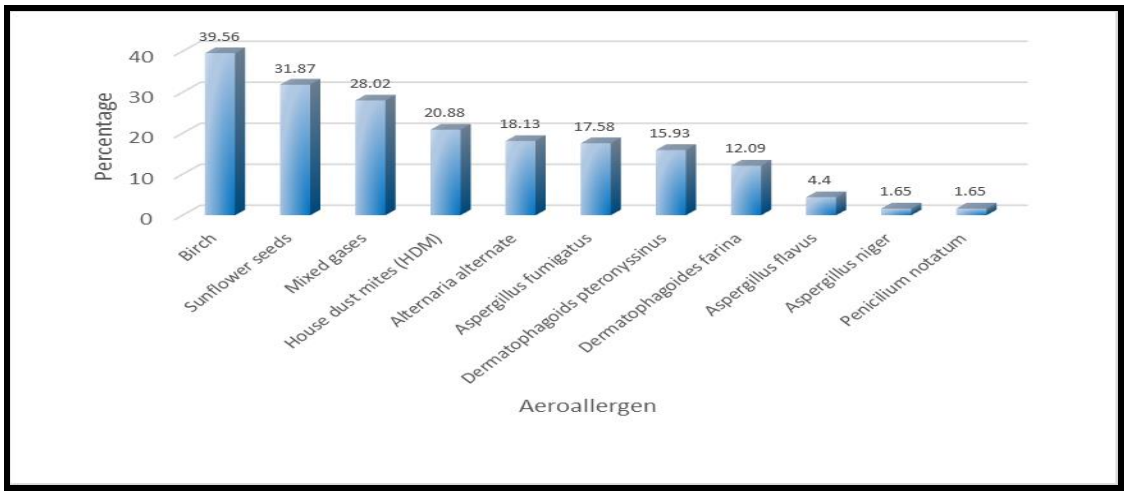
Figure 1. Distribution of sensitivity to various allergens in male asthmatic patients: a) Aeroallergens, b) Food allergens, and c) Contact allergens



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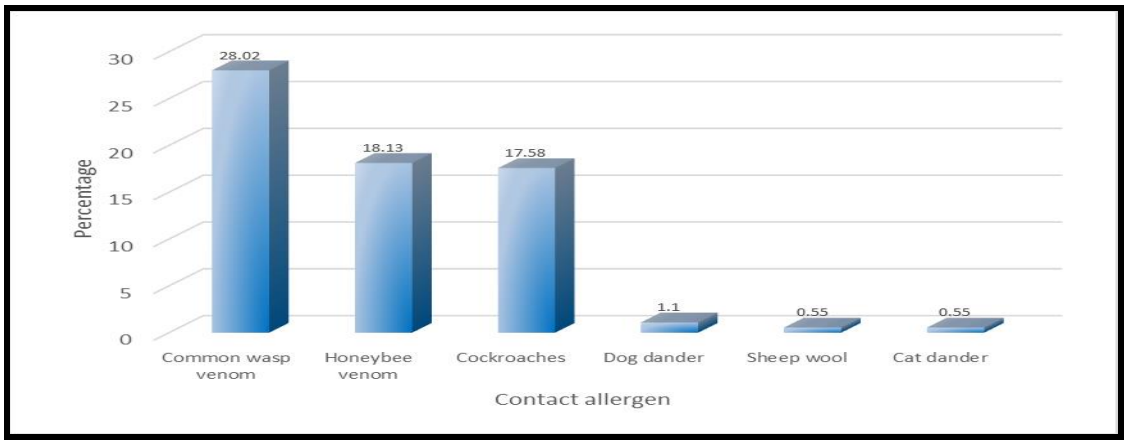

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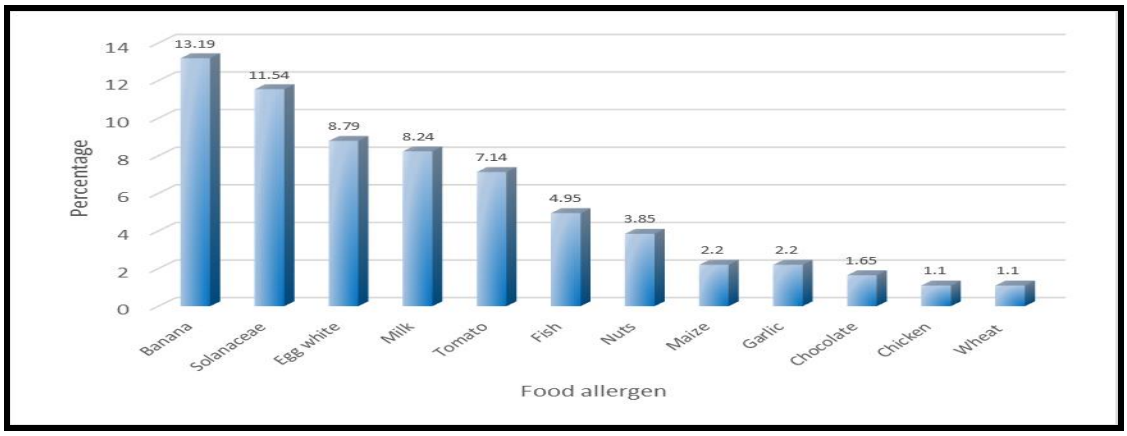

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Figure 2. Distribution of sensitivity to various allergens in female asthmatic patients: a) Aeroallergens, b) contact allergens, and c) food allergens

Table 4. Relation between age and frequency of sensitivity to different allergens

Allergen	Age (12-<25 years) N=172	Age (25-<45 years) N=173	Age (45-≤65 years) N=71	*P* value
Aeroallergen				
Dermatophagoides farina	8 (4.65%)	27 (15.61%)	11 (15.49%)	0.002
Dermatophagoids pteronyssinus	20 (11.63%)	35 (20.23%)	8 (11.27%)	0.051
House dust mites (HDM)	31 (18.02%)	36 (20.81%)	13 (18.31%)	0.79
Aspergillus flavus	10 (5.81%)	7 (4.05%)	2 (2.82%)	0.54
Aspergillus niger	5 (2.91%)	3 (1.73%)	0	0.32
Aspergillus fumigatus	23 (13.37%)	26 (15.03%)	9 (12.68%)	0.86
Alternaria alternate	26 (15.12%)	31 (17.92%)	7 (0.28%)	0.28
Penicillium notatum	7 (4.07%)	5 (2.89%)	2 (2.82%)	0.80
Birch	59 (34.30%)	75 (43.35%)	27 (38.03%)	0.22
Sunflower seeds	45 (26.16%)	52 (30.06%)	26 (36.62%)	0.26
Mixed gas	42 (24.42%)	52 (30.06%)	16 (22.54%)	0.35
Contact allergen				
Honeybee venom	30 (17.44%)	40 (23.12%)	16 (22.54%)	0.39
Common wasp venom	34 (19.77%)	51 (29.48%)	22 (30.99%)	0.06
Cockroaches	22 (12.79%)	36 (20.81%)	15 (21.13%)	0.10
Sheep wool	5 (2.91%)	1 (0.58%)	1 (1.41%)	0.24
Cat dander	3 (1.74%)	2 (1.16%)	0	0.52
Dog dander	2 (1.16%)	4 (2.31%)	1 (1.41%)	0.70
Food allergen				
Fish	9 (5.23%)	6 (3.47%)	5 (7.04%)	0.47
Chicken	3 (1.74%)	2 (1.16%)	3 (4.23%)	0.28
Egg white	18 (10.47%)	13 (7.51%)	4 (5.63%)	0.40
Milk	20 (11.63%)	16 (9.25%)	12 (16.90%)	0.24
Maize	2 (1.16%)	3 (1.73%)	1 (1.41%)	0.91
Wheat flour	2 (1.16%)	4 (2.31%)	2 (2.82%)	0.62
Nuts	9 (5.23%)	3 (1.73%)	4 (5.63%)	0.17
Chocolate	3 (1.74%)	3 (1.73%)	2 (2.82%)	0.83
Banana	19 (11.05%)	21 (12.14%)	11 (15.49%)	0.63
Sollanaceae	17 (9.88%)	21 (12.14%)	8 (11.27%)	0.80
Tomato	13 (7.56%)	13 (7.51%)	2 (2.82%)	0.35
Garlic	4 (2.33%)	4 (2.31%)	2 (2.82%)	0.97

P<0.05 is significant.

The sensitivity to mites, birch, sun flower seeds, mixed grass, and most of contact and food allergens was higher in male asthmatic patients than in females but the difference did not reach a statistical significance (Table 5). Furthermore, no significant difference was observed in the frequency of sensitivity to various allergens in relation to urban versus rural environments, except for allergy to *Dermatophagoids farina*, *Aspergillus niger*, and *Alternaria alternata* which were more frequently reported in employees who live in an urban environment. (Table 6).

Table 5. Relation between sex and frequency of sensitivity to different allergens.

Allergen	Female N=182	Male N=234	*P* value
Aeroallergen			
Dermatophagoides farina	22 (12.09%)	24 (10.26%)	0.56
Dermatophagoids pteronyssinus	29 (15.93%)	34 (14.53%)	0.69
House dust mites (HDM)	38 (20.88%)	42 (17.95%)	0.45
Aspergillus flavus	8 (4.40%)	11 (4.70%)	0.88
Aspergillus niger	3 (1.65%)	5 (2.14%)	1.00
Aspergillus fumigatus	32 (17.58%)	26 (11.11%)	0.06
Alternaria alternate	33 (18.13%)	31 (13.25%)	0.17
Penicillium notatum	3 (1.65%)	11 (4.70%)	0.09
Birch	72 (39.56%)	89 (38.03%)	0.75
Sunflower seeds	58 (31.87%)	65 (27.78%)	0.36
Mixed gas	51 (28.02%)	59 (25.21%)	0.52
Contact allergen			
Honeybee venom	33 (18.13%)	53 (22.65%)	0.26
Common wasp venom	51 (28.02%)	56 (23.93%)	0.34
Cockroaches	32 (17.58%)	41 (17.52%)	0.99
Sheep wool	1 (0.55%)	6 (2.56%)	0.14
Cat dander	1 (0.55%)	4 (1.71%)	0.39
Dog dander	2 (1.10%)	5 (2.14%)	0.48
Food allergen			
Fish	9 (4.95%)	11 (4.70%)	0.91
Chicken	2 (1.10%)	6 (2.56%)	0.48
Egg white	16 (8.79%)	19 (8.12%)	0.81
Milk	15 (8.24%)	33 (14.10%)	0.06
Maize	4 (2.20%)	2 (0.85%)	0.41
Wheat flour	2 (1.10%)	6 (2.56%)	0.48
Nuts	7 (3.85%)	9 (3.85%)	1.00
Chocolate	3 (1.65%)	5 (2.14%)	0.72
Banana	24 (13.19%)	27 (11.54%)	0.61
Sollanaceae	21 (11.54%)	25 (10.68%)	0.78
Tomato	13 (7.14%)	15 (6.41%)	0.77
Garlic	4 (2.20%)	6 (2.56%)	0.81

P<0.05 is significant.

Table 6. Relation between residence and frequency of sensitivity to different allergens.

Allergen	Rural N=190	Urban N=226	*P* value
Aeroallergen			
Dermatophagoides farina	19 (10.00%)	27 (11.95%)	0.53
Dermatophagoids pteronyssinus	27 (14.21%)	36 (15.93%)	0.63
House dust mites (HDM)	36 (18.95%)	44 (19.47%)	0.89
Aspergillus flavus	6 (3.16%)	13 (5.75%)	0.21
Aspergillus niger	5 (2.63%)	3 (1.33%)	0.48
Aspergillus fumigatus	23 (12.11%)	35 (15.49%)	0.32
Alternaria alternate	32 (16.84%)	32 (14.16%)	0.45
Penicillium notatum	7 (3.68%)	7 (3.10%)	0.74
Birch	76 (40.00%)	85 (37.61%)	0.62
Sunflower seeds	62 (32.63%)	61 (26.99%)	0.21
Mixed gases	50 (26.32%)	60 (26.55%)	0.96
Contact allergen			
Honeybee venom	36 (18.95%)	50 (22.12%)	0.43
Common wasp venom	48 (25.26%)	59 (26.11%)	0.85
Cockroaches	34 (17.89%)	39 (17.26%)	0.87
Sheep wool	5 (2.63%)	2 (0.88%)	0.25
Cat dander	5 (2.63%)	0	0.02
Dog dander	4 (2.11%)	3 (1.33%)	0.71
Food allergen			
Fish	14 (7.37%)	6 (2.65%)	0.03
Chicken	4 (2.11%)	4 (1.77%)	1.00
Egg white	15 (7.89%)	20 (8.85%)	0.73
Milk	19 (10.00%)	29 (12.83%)	0.37
Maize	1 (0.53%)	5 (2.21%)	0.23
Wheat flour	4 (2.11%)	4 (1.77%)	1.00
Nuts	9 (4.74%)	7 (3.10%)	0.39
Chocolate	4 (2.11%)	4 (1.77%)	1.00
Banana	26 (13.68%)	25 (11.06%)	0.42
Sollanaceae	23 (12.11%)	23 (10.18%)	0.53
Tomato	13 (6.84%)	15 (6.64%)	0.93
Garlic	5 (2.63%)	5 (2.12%)	1.00

P<0.05 is significant.

Assessment of the association between sensitivity to various aeroallergens: There was a statistically significant positive correlation between the sensitivity to *Dermatophagoids farina* and *Dermatophagoids pteronyssinus*, which indicated that common allergy to both of them is frequently detected ($P < 0.0001$).

In addition, there was a significant positive correlation between *Aspergillus niger* and *Alternaria alternata* ($P < 0.0001$). The highest significant positive association was between allergy to birch, sunflower seeds, and mixed grass ($P < 0.0001$). As regards to contact allergens there was a statistically significant positive correlation between allergy to common

wasp venom and honeybee venom, and between allergy to common wasp venom and cockroaches (*P* 0.001 and 0.0001, respectively. In food allergens it was noticed that there was moderate positive correlation between milk and egg white allergy (r=0.46, *P* <0.0001), and weak positive correlation between allergy to tomato and *Sollanaceae* (r=0.33, *P* <0.0001). (Tables 7, 8, and 9).

Table 7. Association between allergies to various aeroallergens.

Allergen	*Dermato-phagoides farina*	Dermato-phagoids pteronyssinus	*House dust mites (HDM)*	*Aspergillus flavus*	*Aspergillus niger*	*Aspergillus fumigatus*	*Alternaria alternate*	*Penicillium notatum*	Birch	Sunflower seeds
Dermatophagoids pteronyssinus	r=0.54 *P*<0.001									
House dust mites (HDM)	r=0.02 *P* =0.65	r=-0.05 *P* =0.28								
Aspergillus flavus	r=0.03 *P* =0.50	r=0.10 *P* =0.04	r=-0.02 *P* =0.70							
Aspergillus niger	r=-0.05 *P* =0.32	r=-0.05 *P* =0.23	r=-0.09 p=0.16	r=-0.03 *P* =0.54						
Aspergillus fumigatus	r=-0.03 *P* =0.52	r=-0.09 *P* =0.06	r=-0.04 *P* =0.44	R0.01= *P* =0.81	r=0.04 *P* =0.36					
Alternaria alternate	r=-0.02 *P* =0.64	r=0.02 *P* =0.62	r=-0.02 *P* =0.65	r=-0.03 *P* =0.55	r=0.33 *P* <0.0001	r=0.002 *P* =0.98				
Penicillium notatum	r=-0.03 *P* =0.64	r=0.04 *P* =0.40	r=0.02 *P* =0.63	r=-0.04 *P* =0.41	r=-0.03 *P* =0.60	r=-0.04 *P* =0.46	r=0.07 *P* =0.17			
Birch	r=-0.03 *P* =0.56	r=0.10 *P* =0.03	r=-0.01 *P* =0.81	r=-1.10 *P* =0.04	r=-0.004 *P* =0.95	r=-0.09 *P* =0.06	r=-0.07 *P* =0.18	r=0.10 *P* =0.046		
Sunflower seeds	r=-0.01 *P* =0.84	r=-0.04 *P* =0.43	r=-0.05 *P* =0.32	r=-0.02 *P* =-0.75	r=-0.01 *P* =0.78	r=-0.02 *P* =0.72	r=-0.03 *P* =0.57	r=0.05 *P* =0.27	r=0.31 *P* <0.001	
Mixed gases	r=0.03 *P* =0.52	r=0.02 *P* =0.68	r=-0.02 *P* =0.75	r=-0.08 *P* =0.11	r=0.07 *P* =0.13	r=-0.10 *P* =0.04	r=0.03 *P* =0.52	r=0.04 *P* =0.43	r=0.58 *P* <0.0001	r=0.20 *P* <0.0001

P<0.05 is significant

Table 8. Association of different contact allergen with each other.

Allergen	Honeybee venom	Common wasp venom	Cockroaches	Sheep wool	Cat dander
Honeybee venom					
Common wasp venom	r=0.03 *P*=0.001				
Cockroaches	r=-0.03 *P*=0.51	r=0.35 *P* =0.01			
Sheep wool	r=0.03 *P* =0.60	r=0.009 *P* =0.86	r=-0.01 *P* =0.82		
Cat dander	r=0.05 *P* =0.28	r=-0.06 *P* =0.19	r=0.007 *P* =0.89	r=0.16 *P* =0.001	
Dog dander	r=-0.02 *P* =0.68	r=0.05 *P* =0.30	r=-0.01 *P* =0.82	r=-0.02 *P* =0.73	r=-0.01 *P* =0.78

P<0.05 is significant.

Table 9. Association of different food allergen with each other.

Allergen	Fish	Chicken	Egg white	Milk	Maize	Wheat flour	Nuts	Chocolate	Banana	*Sollanaceae*	Tomato
Chicken	r=0.05 *P*=0.31										
Egg white	r=-0.03 *P* =0.57	r=-0.04 *P* =0.39									
Milk	r=-0.05 *P* =0.35	r=-0.05 *P* =0.30	r=0.46 *P* <0.0001								
Maize	r=-0.03 *P* =0.58	r=-0.02 *P* =0.74	r=-0.04 *P* =0.46	r=0.02 *P* =0.69							
Wheat flour	r=-0.03 *P* =0.52	r=-0.02 *P* =0.69	r=0.02 *P* =0.68	r=0.004 *P* =0.93	r= *P* =						
Nuts	r=0.07 *P* =0.14	r=-0.03 *P* =0.57	r=-0.02 *P* =0.75	r=0.006 *P* =0.90	r=-0.02 *P* =0.63	r=0.06 *P* =0.20					
Chocolate	r=-0.03 *P* =0.52	r=-0.02 *P* =0.69	r=-0.04 *P* =0.39	r=-0.05 *P* =0.30	r-=0.02 *P* =0.74	r=-0.02 *P* =0.69	r=0.06 *P* =0.20				
Banana	r=0.02 *P* =0.70	r=0.001 *P* =0.99	r=-0.09 *P* =0.08	r=-0.09 *P* =0.07	r=0.08 *P* =0.11	r=0.11 *P* =0.03	r=-0.04 *P* =0.46	r=0.05 *P* =0.027			
Sollanaceae	r=-0.01 *P* =0.88	r=-0.05 *P* =0.32	r=-0.08 *P* =0.11	r=-0.03 *P* =0.57	r=0.09 *P* =0.08	r=0.06 *P* =0.21	r=-0.07 *P* =0.15	r=0.06 *P* =0.21	r=0.50 *P* <0.0001		
Tomato	r=-0.02 *P* =0.75	r=-0.04 *P* =0.45	r=-0.08 *P* =0.10	r=-0.007 *P* =0.89	r=-0.03 *P* =0.51	r=0.03 *P* =0.51	r=-0.004 *P* =0.94	r=-0.04 *P* =0.45	r=0.51 *P* <0.0001	r=0.33 *P* <0.0001	
Garlic	r=-0.04 *P* =0.47	r=-0.02 *P* =0.66	r=0.009 *P* =0.86	r=0.04 *P* =0.40	r-=0.02 *P* =0.74	r=0.06 *P* =0.21	r=0.05 *P* =0.31	r=-0.02 *P* =0.66	r=0.08 *P* =0.08	r=0.04 *P* =0.36	r=0.02 *P* =0.68

P<0.05 is significant

Discussion

Atopy is a risk factor for bronchial responsiveness and exposure to the offending allergens can be precipitating factor in initiation and exaggeration of the attacks and even for sudden respiratory arrest.[18, 19] Hence, identification of the specific responsible allergens that are most prevalent in the locality of the patient is valuable for diagnosis and treatment of bronchial asthma. SPT is a commonly used method for detecting the implicated allergens and provides faster results compared to Radio Allegro Sorbent Testing (RAST).[20]

In the present study, the most frequent aero-allergen observed in asthmatic patients was birch (38.7%), followed by sunflower seeds and mixed grass (29.5% and 26.4% respectively). Furthermore, the most frequent contact allergen reported was common wasp venom followed by honey bee venom (25.7% and 20.6% respectively). However, a study conducted by Bharti Chogtu et al., 2017[21] reported different findings as: the most common allergen was insects followed by dust, grass and tree pollens, fungus. Many studies reported that insects are the most common offending antigens, with percentage ranging from 17.5% to 43.9% of the overall antigens that have been studied.[22-24] Two studies conducted in India, reported similar data to our study findings, The first study was done in Allahabad, Uttar Pradesh, on a relatively smaller cohort (50 patients),[21] and the second study conducted in a medical college in Lucknow by Prasad et al., 2009,[23] reported data in agreement with our study results. While the first study revealed that dust mite (78%) was the most common offending allergen followed by dust (66%) and insects (44%), the second study reported that the pollen of *Amaranthus spinosus* was the most common allergen (39.5%). Note that the difference between data of various studies could be due to variations in study sample size and the geographical regions where they were conducted.

In our study 17.5% of male- and female-asthmatic patients reported allergy to cockroaches, such findings were in accordance with several other studies. Agrawal et al., 2008,

from Uttar Pradesh, India stated that cockroach was the most common offending insect in asthmatic patients,[25] Sarinho et al., 2009, in a study from Brazil, conducted on adolescents, identified cockroach as the most common allergen.[27] Also, a study conducted in Malaysia on 200 asthmatic patients revealed that cockroach was the most common allergen demonstrating skin positivity. Cockroach-derived allergens come from its saliva and fecal material.[19] In contrast to our results, however, a study conducted by Bharti Chogtu et al., 2017,[21] reported that the commonest skin positivity against insects was to rice weevil as well as to grasshopper, followed by housefly and cockroach. They explained that their findings were due to the presence of protease allergens in the extracts obtained from reported insects, considered the cause of allergy.[15-17] Also, in contrast to our study findings, a study done by Kumar R et al., 2012[24] reported that the most common insect allergen was moth followed by mosquito.[24] Patel et al., 2012, has also reported that moth was the most common insect allergen.[26]

Allergy to fungi in our study was due to *Alternaria alternate* in 18.1% of female asthmatic patients and in 13.2% of male patients, While 17.5% of females and 11.1% of males were sensitive to *Aspergilus fumigatus*. The predominant fungus in a study of Bharti Chogtu et al., 2017[21] were *Aspergillus flavus* followed by *Aspergillus fumigates* and *Candida*. Also, some other studies have shown that *Aspergillus fumigatus* was the most common fungus.[23, 25] A Study conducted on 180 poultry workers by Sarinho et al., 2009[27] showed the predominance of sensitivity to *Aspergillus niger*.

Asthma and food allergy are frequently coexisting and both are increasing in prevalence.[28] In a Dutch cross sectional study with asthmatic children, half of the parents reported an allergic reaction to different types of food in their child's history.[28] In our study, the most common food allergy detected was due to banana (13.1% of females and 11.5% of males), followed by milk (8.2% of females and 14.1% of males) and *Solaneceae* (11.5% of females and 10.6% of males). In a study conducted by Liu et al.,2010[29] stated that the most common food allergies in adults were shellfish (2%), scaled fish (0.4%), peanut (0.6%), and tree nuts (0.5%).

IgE directed to cross-reactive allergens may be responsible for both respiratory reactions and allergic reactions to food. Cross-reactivity between pollen and allergens from fruits and vegetables is the best-known example of the link between inhalant and food allergy.[29] This information can explain the frequent presence of allergy to pollens in conjunction with allergy to banana and *Solaneceae* which was the commonest food allergy in our study.

In our study, we have measured the strength of association of different allergen with each other and we noticed the presence of a statistically significant positive association between allergy to *Dermatophagoids farina* and *Dermatophagoids pteronyssinus* (r=0.54, *P*<0.001). This could be explained by the common presence of both types of mites in the patient environment. There was also a statistically significant positive correlation between allergy to birch and sun flower seeds (r= 0.31, *P*<0.001), and allergy to sunflower seeds and mixed grasses (r=2.0, *P*<0.0001).

As regards to allergy to insects, there was also positive correlation between allergy to common wasp venom and honeybee venom (r=0.03, *P*=0.001), and common wasp venom and cockroaches (r=0.3, *P*=0.01). Such correlations could be explained by the presence of protease allergens in the extracts obtained from the insects which probably the cause of allergy as previously mentioned. As regards to food allergy there was a positive correlation between allergy to milk and egg white (r=0.46, *P*<0.0001), and between *Solaneceae* and tomato (r=0.46, *P*<0.0001). These associations deed further studies to confirm and explain them.

In conclusion, our study provided useful information on the pattern of allergen sensitization in this part of the country. Although, avoidance of the allergens may be difficult in respect to aeroallergens, while contact and food allergens can be avoided more easily. Therefore, it is advisable for the patient to do SPT to identify the allergen to which he/she is sensitized.

Author Contributions

ANT is responsible for ensuring that the descriptions are accurate and agreed by all authors; ANT, manuscript idea; ANT and KSA, practical work; KSA, responsible for the clinical evaluation and diagnosis of bronchial asthma; ANT, final supervision.

Declaration of Conflicting Interests

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Ethical approval

The study protocol was reviewed and approved by the local ethical committee of the Faculty of Medicine, Sohag University (dated February 2019).

Informed consent

Patients signed informed consent, indicated that they agreed to have the skin prick test. For children below 18 years the consent was signed by their first-degree relatives. Willingness of children to take the skin test was considered their assent.

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