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Profile of Positive Specific Immunoglobulin E (IgE) in Children Tested for Aeroallergens

Sara Mansoor Rahmt Alla Mansoor[1*], Omaima Abdelmajeed Mohammed Salih[2] and Omer Saeed Magzoub[3]

[1]*Pediatrician, Ministry of Health, Sudan*
[2]*Pediatric consultant, Associate professor Faculty of Medicine OIU, Sudan*
[3]*Pediatrician, Ain Al-Khaleej Hospital, Alain, Abu-Dhabi, UAE*

**Corresponding author*

A B S T R A C T

Aeroallergens are various airborne substances or inhalants, such as pollens, spores, and other. The prevalence of aeroallergens is quite variable from one region or country to another. Objectives: This study is aimed at study profile of positive specific Immunoglobulin E (IgE) test to aeroallergens in Sudanese patients at Al-Rayan laboratory, Khartoum from January 2018 to December 2020. Methodology: A cross sectional study was conducted in -Rayan laboratory in Khartoum state Sudan from 1st of January 2018 to 30th December 2020 among children with positive specific IgE test for aeroallergens. Total coverage of all children with positive specific IgE test for aeroallergens was done. All records with positive specific IgE to aeroallergens have been collected. The aeroallergens were compared to age, gender, and at which time year reach its peak. The positivity of result depends on the antibody detection and its titer. Statistically significant data were analyzed by computer using SPSS program of *P*-value of equal or less than 0.05. Result: The study included 58 participants. Males were more prevalent (63.8%), and female were (36.2%). The most common affected age was school age. The most prevalent aeroallergen was alder which was positive in all patients, Timothy grass which was positive among (56.9%) followed by cultivated rye, common ragweed and oak. The sensitivity test was positive in (34.5%) of the patients for cockroach, in (27.6%) for cats, in (15.5%) for horses, in (8.6%) for dogs, and in (8.6%) for camels. Months in which aeroallergens were more prevalent were July & December 2018, October of 2019 and October & November of 2020. Conclusion: This study demonstrates that the most common affected age group was school age and the most common aeroallergens were alder, timothy grass and cultivated rye fallowed by common ragweed and oak. There is no statistically significant relation between the patient's age gender and test months for the tested animals, fungi, trees, grass, and house dust mites.

Keywords

Aeroallergen, specific IgE test, pollen, children, fungi, trees, grass

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Introduction

Aeroallergens are various airborne substances or inhalants, such as pollens, spores, and other biological or non-biological airborne particles that can cause allergic disorders. Inhalation or cutaneous contact with aeroallergens can trigger a release of proteins in the form of an allergic reaction on the skin and mucous membranes. Airborne particles can also cause irritant reactions without causing an immunological response (Chapman, 2008; NIH, 2003).

Aeroallergens are particulates in the air which induce an atopic response. Agents commonly associated with inducing an atopic response include, but are not limited to, pollen, fungal spores, mold and animal dander. Aeroallergens are of particular interest in relation to air pollutants as they have an interactive effect wherein air pollutants can increase the development of pollen allergies and pollen in heavily polluted areas contains more allergenic proteins (Senechal *et al.,* 2015).

Pollen grains are male gametophytes of seed plants ranging from 10 µm to 100 µm in size that carry proteins which compose the allergenic material. Allergy symptoms (e.g. sneezing, nasal congestion and itching) are collectively referred to as allergic rhinitis (AR) and have been reported in variable prevalence, such as 8%–24% self-report in China and in contrast 11%–30% self-report in the US.

AR is an immunoglobulin E (IgE) mediated response, and result in both localized and systemic inflammation. Pollen counts have also been positively associated with asthma-related hospital admissions. Pollen types and concentrations vary both spatially and temporally. However, pollen can be classified in an overarching fashion into tree, grass and weed (Ghosh *et al.,* 2012; Kim *et al.,* 2010).

The most common aeroallergens causing disease are pollens and house dust mites. Pollens are derived from: Grasses, Trees, Rye and Weeds. Aeroallergens may presents as AR, atopic dermatitis and asthma.

Allergies only affect susceptible individuals whereas irritant reactions can affect anyone. The prevalence of aeroallergens is quite variable from one region or country to another, depending on the climate, the local plants and animals, and the degree of pollution (Sheffield *et al.,* 2011; Beggs, 2010).

Climate change has been reported to contribute to the rise of some types of aeroallergens and to a surge in allergic disorders (Sheffield *et al.,* 2011; Beggs, 2010). House dust mites are prevalent in developing countries, Pollen aeroallergens are prevalent in temperate zone countries, their counts vary with exact location and flora, time of year, altitude, temperature, humidity, wind, electrical activity and rain (The New Zealand pollen forecast, 2019).

The evidence that links climate change to the exacerbation and the development of allergic disease is increasing and appears to be linked to changes in pollen seasons (duration, onset and intensity) and changes in allergen content of plants and their pollen as it relates to increased sensitization, allergenicity and exacerbations of allergic airway disease. This has significant implications for air quality and for the global food supply (https://www.pnas.org/doi/10.1073/pnas.2013284118#bibliography).

In this study we describe the profile of positive specific IgE test to aeroallergens in Sudanese pediatrics patients which is the first study in the pediatric field.

Materials and Methods

This study is observational descriptive cross sectional retrospective Laboratory records-based conducted in Al-Rayan laboratory in Khartoum state, Sudan. The study was conducted within the period from 1st of January 2018 to 30th December 2020. All pediatric patients with positive specific IgE for aeroallergens in Al-Rayan laboratory during the study period were included in the study.

All records with positive specific IgE to aeroallergens collected from Al Rayan Laboratory center. The immunoblotting technique (Euroline food gulf (IgE)) detects the IgE antibody against specific aeroallergens.

The aeroallergens detection was compared according to gender and age (the cut point of age is 18 years old). The positivity of the result depends on the antibody detection and titer.

Data cleaned and entered into Microsoft excel data sheet and analyzed using SPSS latest version software. Categorical data represented in the form of frequencies and proportions. Chi-square test used as test of significance for qualitative data. Continuous data represented as mean and standard deviation. ANOVA (Analysis of Variance) is the test of significance to identify the mean difference between more than two groups for quantitative data. Graphical representation of data: MS Excel and MS word used to obtain various types of graphs. P value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests and level of confidence.

Results and Discussion

This study included 58 patient with wide different ages, younger patient was one year; age one to five (32.8%-n=19) five to ten years (34.5%-n=20) more than 10 years (32.8%-n=19) (Table1). More than half of the patients (63.8% - n=37) were males, and 36.2% (21) were females with a male: female ratio of 1.7:1. (Figure1).

More than half of the patients (56.9%) had positive sensitivity test toward timothy grass, 55.2% of the patients had allergy for cultivated rye, 55.2% for common ragweed, and 44.8% for mugwort. (Figure2). Regarding the timothy grass sensitization test, 10.3% (6) of the patients in our study had very high antibody titter, in 6.9% (4) of them strong antibodies were detected, and in 20.7% (12) definite antibodies were detected. Regarding the patient's degree of sensitization toward other grasses, 12.1% (7) of the participants in our study had very high antibody titer for cultivated rye, 3.4% (2) of the cases for Mugwort and in 1.7% (1) of the patients had very high antibody titer common ragweed. (Table2).

58.6% of patients had sensitization for oak, 53.4% for birch, 51.7% for olive tree. Further, all the patients tested positive for allergy test for alder (Figure3). Further, in 1.7% (1) of the patients very high antibody titter was detected for birch, olive tree, alder, and 3.4% for oak(Table 3). The sensitivity test was positive in 34.5% of the patients for cockroach,

6.9% of the patients had positive allergy test for Dermaptera and 12.1% had positive test for Dermatofarinae (Figure 4). Regarding the indoor pollen sensitization among the patients, no specific antibodieswere detected in 93.1% of the cases for Dermaptera, in 87.9% for Dermatofarinae, and definite antibody detection in 15.5% (9) for cockroach (Table 4).

The sensitivity test was positive in, in 27.6% for cats, in 8.6% for dogs, in 15.5% for horses, and in 8.6% for camels (Figure 5). Regarding the animal sensitization, very high antibody titter was detected in 12.1% (7) of the patients for cats, in 3.4% (2) of them for horses, and in 1.7% (1) for camels. (Table5). The sensitivity test was positive in 13.8% of the patients for penicillin, in 3.4% for Cladosporium, in 13.8% for Aspergillus, in 20.7% for Candida, and in 10.3% for Alternaria (Figure 6).

Regarding the degree of sensitization toward fungal mold among our patients, only one patient (1.7%) had very high antibody titter for Aspergillus. Strong antibodies were detected in 3.4% of the patients for penicillin and candida, and in 1.7% for Aspergillus (Table 6).

Comparative study: (Figure 7, 8)

No association was found between the patient's gender, and the tested grass, trees, Indoor pollen, animal and fungal molds, except for Dermaptera in indoor pollens was statistic significant (*P*-value = .014). No association was found between the patient's age, and the tested grass, trees, animals, indoor pollen and fungal mold, except for birch in trees was statistic significant (*P*-value = .005). The highest frequency of birch allergy was found among the patients aged between 1 to 5 years old.

During the following months, results of Timothy grass tests were mostly positive: September 2019 (50%) November 2020 (27.3%) and July & December 2019 (16.7%), cultivated rye allergic responses were mostly in March 2019 (13.6%). With regard to Mugwort test, it was positive mostly in March 2020 (13.6%).

Test for Alder allergen was positive in March 2019 the most (13.6%), But, Birch allergen test were positive in July 2018 & September 2019 (11.1%) in addition to Test for Oak allergen came positive in July & December 2018 March 2019 with the respective percentages (11.1%, 11.1%, 13.6%). Olive tree and common ragweed aeroallergen reactions came equally positive in July 2018 & September 2019 & March 2020 the most (13.6%).

Dermatophagoidespter allergies were mainly in the following months: June &August December 2018, (5.6%). Cat allergen test were positive in equal percentages during October 2019 (11.1%) and February 2020 (9.6%). Test for Dog allergens was positive in April& July 2018 (5.6%) as well in addition to October 2019 (5.6%) August 2020 (5.6%). Participants tested positive for Horse allergens mainly in April & July December 2018 (5.6%), October 219 (5.6%) and August

2020 with the respective (5.6%). Test for Camel allergens came positive mainly in August 2020 and September 2018, October 2019 (5.6%).

For *penecillium notatum*, tests were positive the most in November 2019 & 2020 (5.6, 9%) respectively. *Cladisporium herbarium* test was positive only in November 2020 and (5.6%).

With regard to *Aspergillus fumigatus, Candida albicans, Alternaria alternate*, all these allergen tests were positive (Figure 7).

This study took place in the period from 1st of January 2018 to 30th of December 2020. Generally, months in which aeroallergens were more prevalent were July & December 2018 (5.6%), October 2019 (15.5%) and October & November of 2020 (20.7%, 17.2%) respectively (Figure 8).

Worldwide the allergic diseases are one of the important causes of morbidity and mortality especially asthma and allergic rhinitis which are constantly rising due to increasing of pollution (https://lisbdnet.com/what-is-the-scientific-name-of-cockroach/, 2022). It's very important to identify the factors that eliciting the immune response leading to this diseases and their distribution (https://www.primidi.com/shoot_buds; Sharma *et al.,* 2018).

This study demonstrated that aeroallergens specific IgE test panel over the 36 months. As far as we know there is no study conducted in our country to assess the patterns of aeroallergen in term of common demographic characteristic for participants who were positive for specific IgE test aeroallergens panel.

The males were more prevalent than female exposed for aeroallergen and this finding is in concordance with study done in India by Sharma *et al.,* (2018) and in Shanghai, China by Mao *et al.,* (2020) (Sharma *et al.,* 2018; Mao *et al.,* 2020).

The most common patterns of aeroallergen were (Timothy grass, cultivate drye, common ragweed and oak) obviously all of this were pollens which is in concordance with antecedent study in Egypt by Ishak, *et al.,* (2020), India by Sharma *et al.,* (2020) and in Southwestern Iran by Assarehzadegan *et al.,* (2013).

Among the pollens timothy grass were most common in concordance to Canadian study by Ahmed *et al.,* (2019). The cockroaches comes after most of plants allergens that is going with the result from Egypt that concluded German cockroach by Ishak *et al.,* (2020), fungi, and house dust mite was the main sensitizing aeroallergens in Egyptian asthmatic patient (Ishak *et al.,* 2020).

Furthermore, fungi were less common in our study. In contrast to study in south India by Mahesh *et al.,* (2010); the most common allergens found was house dust mite, trees, and German cockroach.

Sensitization to fungi was higher in younger subjects from the rural area and cockroach sensitization were higher in younger subjects from urban areas (Mahesh *et al.,* 2010).

A previous study that included various regions of Turkey by Tantilipikorn *et al.,* (2021) showed that the presence of mites was related to an increase in both mean temperature (>15 °C) and humidity (40%), as well as low altitude (<300 m).

In our study, high sensitization to house dust mites was expected due to the regional geography with 69% humidity and a location at an altitude of 100 m above sea level (Tantilipikorn *et al.,* 2021).

Ngahane *et al.,* (2016) in Cameroon found that the most common allergens causing sensitization were house-dust mite, trees and cockroaches. This finding corroborates previous study Sensitization to the other allergens such as moulds, as well as cat and dog dander had relative low prevalence in this study (Ngahane *et al.,* 2016).

There is no relationship between aeroallergens patterns and age, genderof those who tested positive. Generally, months in which aeroallergens were more prevalent were October of 2019, September of 2020 and November of 2020.

In fact, the allergen isn't so much the mites themselves as the mites' faeces. These are smaller than ordinary pollen grains, coated with a thin hull layer which decays in time, releasing even smaller allergenic particles (62).

In our study Cockroach (German) allergic tests came positive mostly in August and September in concordance with UK study by Lyons, Sarah *et al.,* (2021). Test for Camel allergens came positive mainly in August which was different from UK study because it found throughout the year (Lyons, Sarah *et al.,* 2021).

Table.1 Age distribution of the patients in our study (n=58)

Age	Frequency	Percent
1-5	19	**32.8%**
5-10	20	**34.5%**
More than 10	19	**32.8%**
Total	58	**100%**

Table.2 The degree of Grass pollen sensitization among patients (n=58)

	Timothy	Mugwort	Common ragweed	Cultivated rye
Negative				
No specific antibodies	43.1(25)	**55.2(32)**	44.8(26)	44.8(26)
Positive				
Very weak antibody detection	3.4(2)	**10.3(6)**	**10.3(6)**	3.4(2)
Weak antibody detection	15.5(9)	13.8(8)	**17.2(10)**	13.8(8)
Definite antibody detection	**20.7(12)**	15.5(9)	15.5(9)	20.7(12)
Strong antibody detection	6.9(4)	1.7(1)	**10.3(6)**	5.2(3)
Very high antibody titter	10.3(6)	3.4(2)	1.7(1)	**12.1(7)**
Total	**100.0%**	**100.0(58)**	**100.0(58)**	**100.0(58)**

Table.3 The degree of tree pollen sensitization among patients (n=58)

	Alder	Birch	Oak	Olive tree
Negative				
No specific antibodies	0(0)	46.6(27)	41.4(24)	**48.3(28)**
Positive				
Very weak Ab detection	**74.1(43)**	13.8(8)	12.1(7)	8.6(5)
Weak Ab detection	12.1(7)	20.7(12)	20.7(12)	**22.4(13)**
Definite Ab detection	13.8(8)	8.6(5)	10.3(6)	**15.5(9)**
Strong Ab detection	0(0)	8.6(5)	**12.1(7)**	3.4(2)
Very high Ab titter	0(0)	1.7(1)	**3.4(2)**	1.7(1)
Total	**100.0(58)**	**100.0(58)**	**100.0(58)**	**100.0(58)**

Table.4 The degree of indoor pollen sensitization among patients (n=58)

	Cockroach	Dermaptera	Dermatofarinae
No specific antibodies	56.5(38)	**93.1(54)**	87.9(51)
Very weak antibody detection	**8.6(5)**	1.7(1)	3.4(2)
Weak antibody detection	**6.9(4)**	0(0)	3.4(2)
Definite antibody detection	**15.5(9)**	1.7(1)	1.7(1)
Strong antibody detection	**3.4(2)**	1.7(1)	1.7(1)
Very high antibody titter	0(0)	1.7(1)	1.7(1)
Total	**100.0(58)**	**100.0(58)**	**100.0(58)**

Table.5 The degree of animal dander sensitization among patients (n=58)

	Cat	Dog	Horse	Camel
Negative				
No specific antibodies	72.4(42)	**91.4(53)**	84.5(49)	**91.4(53)**
Positive				
Very weak antibody detection	**3.4(2)**	1.7(1)	**3.4(2)**	0(0)
Weak antibody detection	0(0)	0(0)	**1.7(1)**	**1.7(1)**
Definite antibody detection	3.4(2)	3.4(2)	3.4(2)	3.4(2)
Strong antibody detection	**8.6(5)**	3.4(2)	3.4(2)	1.7(1)
Very high antibody titter	**12.1(7)**	0(0)	3.4(2)	1.7(1)
Total	100.0(58)	100.0(58)	100.0(58)	100.0(58)

Table.6 The degree of Fungal molds sensitization among patients (n=58)

	Penicillin	Cladosporium	Aspergillus	Candida		Alternaria
Negative						
No specific antibodies	86.2(50)	**96.6(56)**	86.2(50)	79.3(46)		89.7(52)
Positive						
Very weak Ab detection	1.7(1)	1.7(1)	1.7(1)	**5.2(3)**		3.4(2)
Weak Ab detection	3.4(2)	1.7(1)	3.4(2)	**5.2(3)**		3.4(2)
Definite Ab detection	5.2(3)	1.7(1)	5.2(3)	**6.9(4)**		3.4(2)
Strong Ab detection	**3.4(2)**	0(0)	1.7(1)	**3.4(2)**		0(0)
Very high Ab titter	0(0)	0(0)	**1.7(1)**	0(0)		0(0)
Total	100.0(58)	100.0(58)	100.0(58)	100.0(58)		100.0(58)

Figure.1 Gender distribution of the patients (n=58)

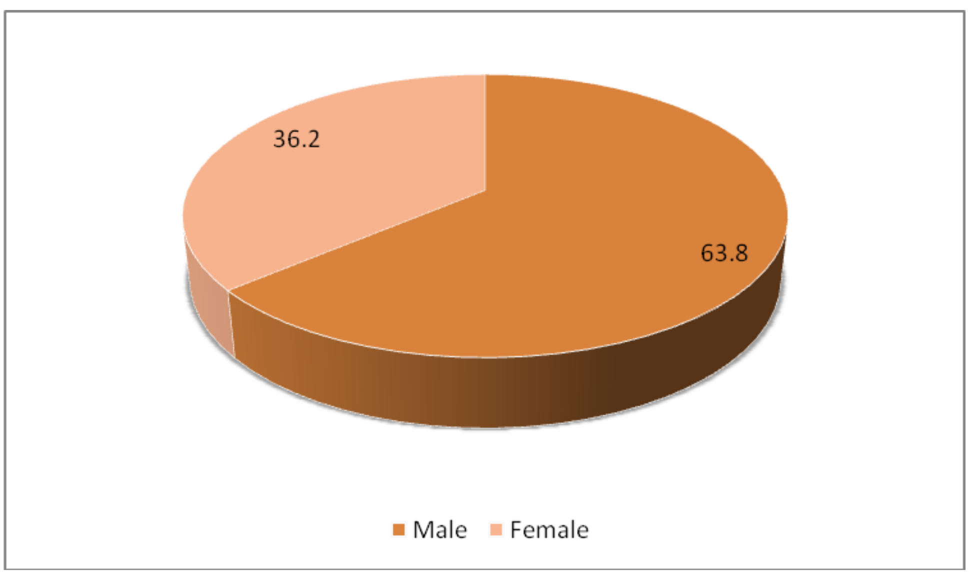


Figure.2 Results of sensitivity test of grass pollen (n=58)

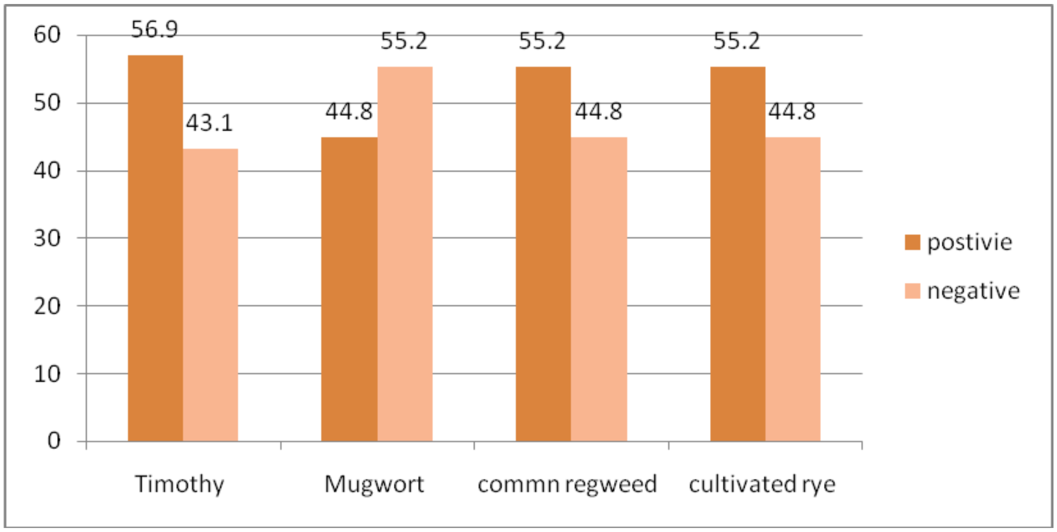


Figure.3 Results of sensitivity test of tree pollen (n=58)

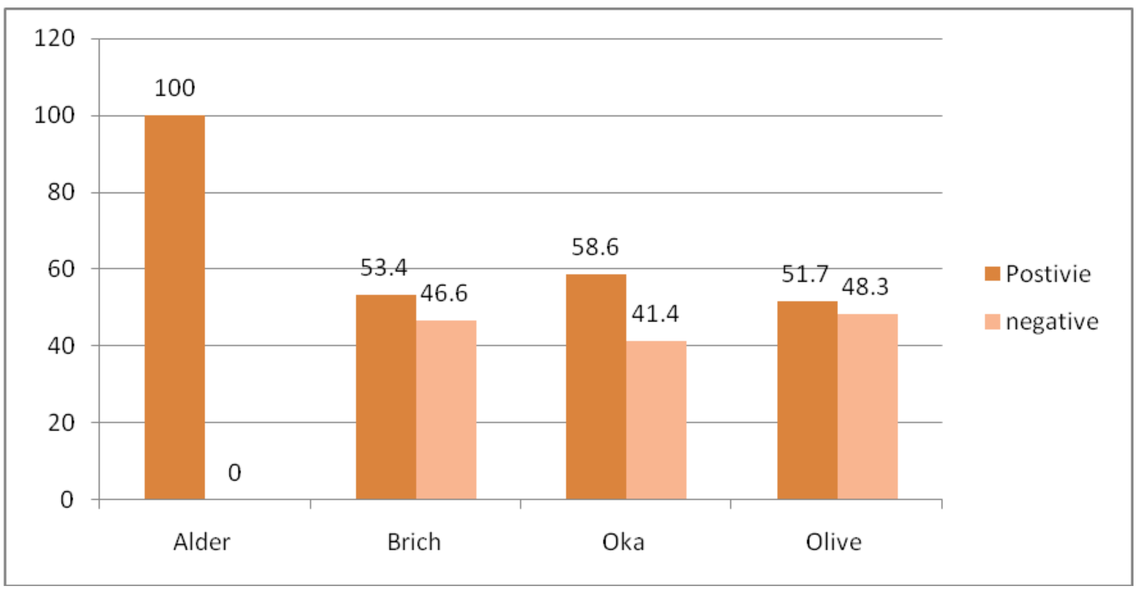


Figure.4 Results of sensitivity test of indoor pollen (n=58)

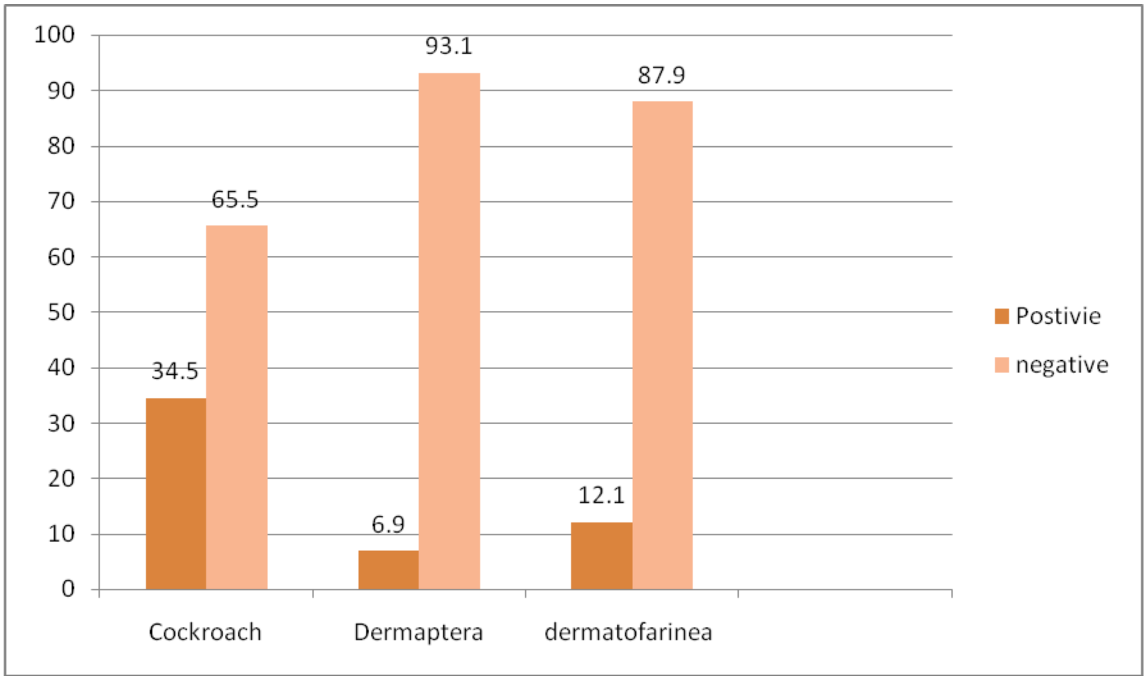


Figure.5 Results of sensitivity test of animal's dander (n=58)

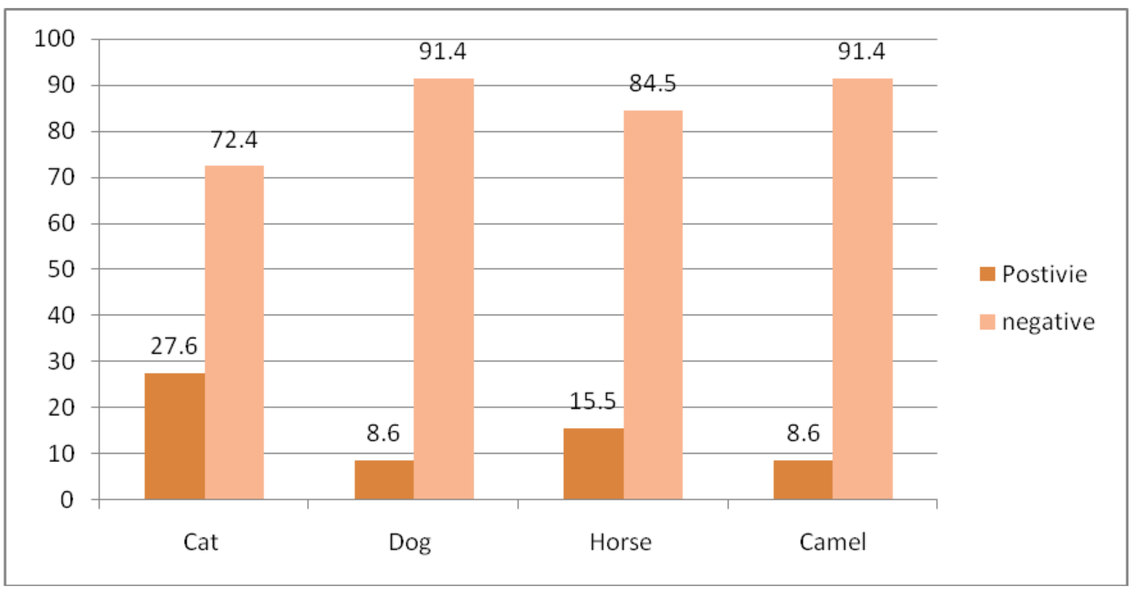


Figure.6 Results of sensitivity test of fungal molds (n=58)

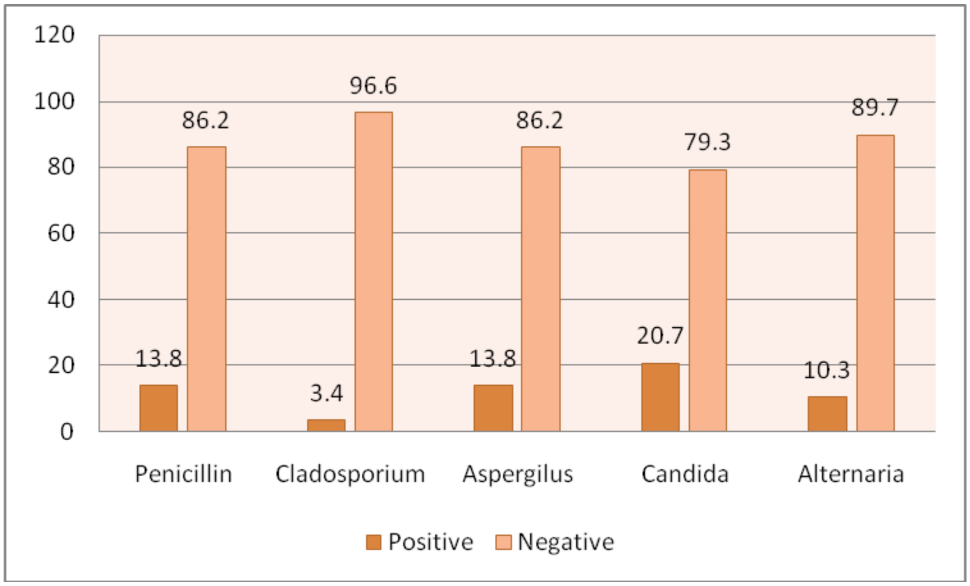


Figure.7 The distribution of the patient's allergy by month/years (n=58)

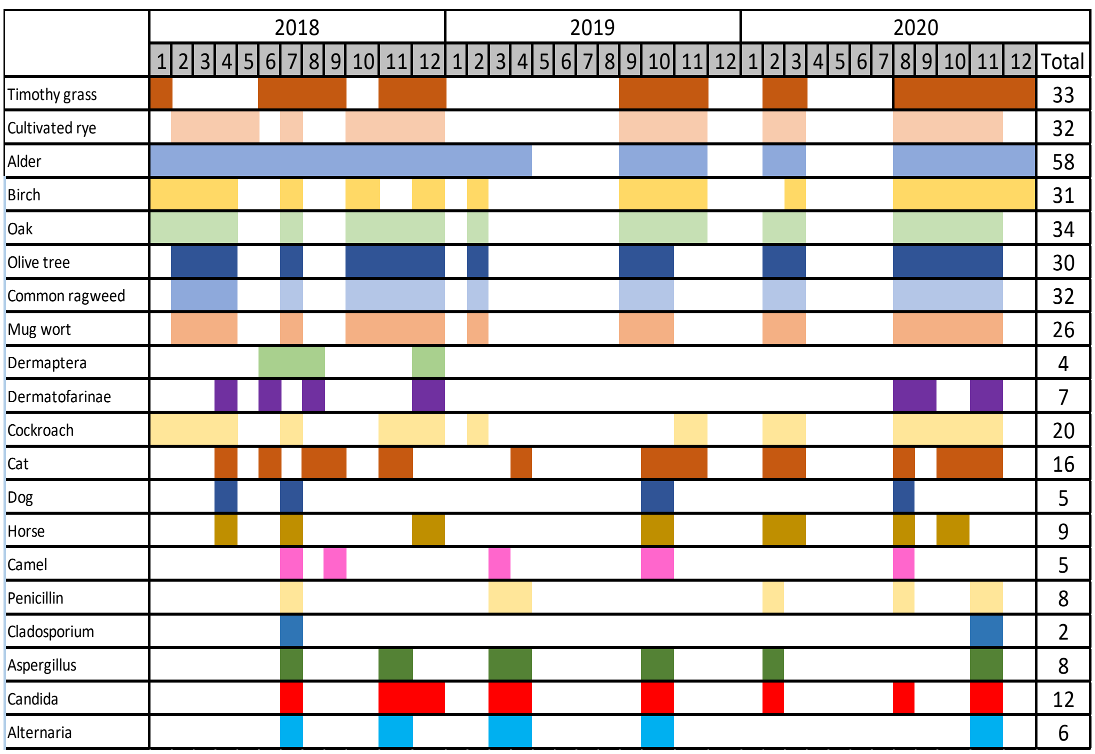
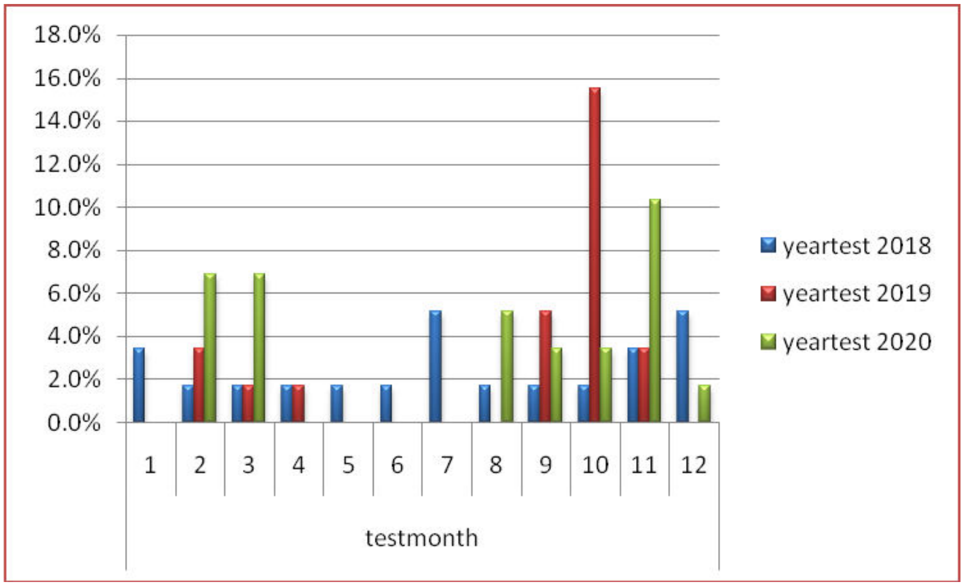


Figure.8 Distribution of Allergens according to months in the study period



The strengths of this study is give clear information about what is most common aeroallergens in Sudan and what is their relation Several limitations merit our consideration e.g. limited recourses. The study design was cross-sectional analysis, without correlation with clinical presentations. Future studies may be needed to address these issues.

1. This study demonstrates that the most common affected age group by aeroallergens was 5-10 years and most of them were males.
2. The study concluded that the most common aeroallergens were alder, timothy grass and cultivated rye fallowed by common ragweed and oak.
3. There is statistically significant relation between the patient's age, gender for (birch and cockroaches) and there is no statistical significance for the rest of the tested animals, fungi, trees grass, and indoor pollen.
4. The study demonstrates the pollen calendar according to sensitization.
5. It was found that months in which aeroallergens were more prevalent were July & December 2018, October 2019 and October & November 2020.

Recommendation

Based on the result strongly recommend:

1. Screen school environment for aeroallergens as the most affected age group with aeroallergens is school age.
2. Limited selected aeroallergens panel should be obtained based on deferent geographical region in Sudan by the conduction of more research to do the ideal pollen calendar according to seasonal sensitization
3. Allergy and clinical immunology centers should be established.
4. Correlate of aeroallergens patterns with clinical presentation.

Ethical Considerations

1. Written ethical clearance and approval for conducting this research obtained from Sudan Medical Specialization Board ethical Committee.
2. Written ethical clearance and approval from educational development center (EDC).
3. Written permission was obtained from the Administrative authority of AL Rayan Allergy Laboratory, Khartoum State, Sudan.
4. Study data/information was used for the research purposes only. The privacy issues were intentionally considered.

Author Contributions

Sara Mansoor Rahmt Alla Mansoor: Investigation, formal analysis, writing—original draft. Omaima Abdelmajeed Mohammed Salih: Validation, methodology, writing—reviewing. Omer Saeed Magzoub:—Formal analysis, writing—review and editing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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