



# A Descriptive Study on Aeroallergen Sensitivity Pattern in Children with Bronchial Asthma and/or Allergic Rhinitis

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## Abstract

**Background** The growing prevalence of allergy and asthma in India has become a major health concern, with symptoms ranging from mild rhinitis to severe asthma, and aeroallergens play a major role in the pathogenesis of reactive airway diseases. The distribution of aeroallergen and the knowledge of allergen sensitivity pattern in northern India (Rajasthan) are limited. The aim of our study was to determine the prevalence of various aeroallergens in children with bronchial asthma and/or allergic rhinitis by skin prick test at a tertiary care center in Jaipur, Rajasthan, India.

**Methods** Children who had presented to the Department of Pediatrics (outpatient department and inpatient department), Mahatma Gandhi Medical College, Jaipur, from January 2018 to June 2019 fulfilling the inclusion criteria, were included in this prospective study. A total of 15 antigens were used. Skin prick testing was performed as per standard protocol.

**Result** Among total 60 children with respiratory allergic diseases, overall the highest percentage of skin prick test positivity was found among house dust mite (66.6%), storage mite (41.6%), wheat (33.3%), animal dander (30%), and Kentucky bluegrass (26.6%), in that order.

**Conclusion** It is advised to avoid common inhaled allergens found with SPT in our region in children with allergic airway diseases.

## Keywords

- ▶ reactive airway diseases
- ▶ skin prick test
- ▶ house dust mite
- ▶ storage mite

## Introduction

Reactive airway diseases (RADs) such as bronchial asthma (BA) and allergic rhinitis (AR) represent a major burden worldwide from both an epidemiological and economical point of view.<sup>1</sup> A survey conducted by the World Allergy Organization estimated that a worldwide prevalence of AR is 16 to 25% and that of BA is 6 to 15%.<sup>2</sup> Allergic disorders are not just a public health problem for developed countries, but their prevalence is also rising dramatically in developing countries like India that has an uprising trend in terms of both prevalence and severity.<sup>3</sup> Children are bearing the greatest burden of the rising trend of these diseases. Asthma

is the commonest chronic disorder among children, and the prevalence has been estimated to range from 3 to 38% in children.<sup>4</sup> Aeroallergens play a major role in the pathogenesis of RAD. Pollens, molds, house dust mites (HDMs), fungal spores, and pets are one of the most common allergens prevalent in India. Skin prick test (SPT) is considered the gold standard for the diagnosis of immunoglobulin E (IgE) mediated type 1 allergy. Allergen evaluation is required for allergen-specific therapy but does not depend on allergen dispersion due to climate. India is expected to have a wide range of allergens as it is a country with diverse climatic and geographic conditions. Data are scarce regarding allergen sensitivity in Rajasthan, especially in children. Hence, our

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study was conducted to identify the pattern of allergen sensitivity among children with BA and/or AR using SPT, which would further help in appropriate diagnosis, disease monitoring, and treatment of these children.

## Materials and Methods

This study aimed to determine the prevalence of various aeroallergens in children with BA and/or AR by SPT at Mahatma Gandhi Medical College (MGMC) in Jaipur, Rajasthan. The study design was a prospective cross-sectional study. The study place was the Department of Pediatrics (Outpatient department [OPD] and inpatient department), Mahatma Gandhi Medical College, Jaipur, Rajasthan, which is a 1,000-bed tertiary care center. The study period was January 2018 to June 2019. The study population was 60 children fulfilling inclusion criteria who presented to the Department of Pediatrics, MGMC.

### Inclusion Criteria

The inclusion criteria were children attending the Pediatrics OPD of Mahatma Gandhi Hospital, children diagnosed with BA and/or AR according to the GINA and ARIA guidelines, and age between 5 and 15 years of either sex.

### Exclusion Criteria

The inclusion criteria were as follows:

- Children having skin diseases such as eczema, dermatographism, severe dermatitis, or any other chronic skin diseases.
- Immune compromised children, those with HIV, those with nephrotic syndrome, and those on oral steroids (> 2 mg/kg/day for > 2 weeks).
- Children having tuberculosis, diabetes, or any other chronic systemic illness.
- Patients in acute exacerbation of BA.
- Refusal to give consent to be a part of the study or uncooperative during the SPT.

After ethical clearance obtained from the Institute's Ethical Committee (Ethic No. MGHCH/IEC/JPR/2018/05) and informed parental/guardian consent taken from all eligible study patients, a cross-sectional prestructured proforma-based study was conducted. The proforma included demographic profile, symptomatology, examination, severity, and control of BA/AR along with investigation reports. Investigations included were complete blood count, total eosinophil count, specific IgE test, chest X-ray, peak expiratory flow rate, and SPT.

SPT panel consisted of the following groups of aeroallergens using standard allergen extracts from Merck Allergo-SPT: pollens, grasses, mites, dander, and molds. SPT was performed as per the standard protocol. The allergens used for SPT were *Dermatophagoides pteronyssinus* (HDM), *Chenopodium album* (lamb's quarter), *Ambrosia artemisiifolia* (ragweed), *Plantago lanceolata* (English plantain), *Cynodon dactylon* (Bermuda grass), *Lolium perenne* (ryegrass), *Poa pratensis* (Kentucky bluegrass), *Robinia pseudoacacia* (locust black), *Triticum aestivum* (wheat), *Zea mays* (corn), *Aspergillus Fumigatus*, *Helmin-*

*thosporium halodes*, animal epithelia (animal dander), *Acarus siro* (storage mite), and *Hordeum vulgare* (barley).

### Method

SPT was performed by applying a drop of antigen on the healthy skin on the volar surfaces of the forearm and pricking it with a lancet with a point length of 1 mm. Reading was interpreted after 15 to 20 minutes. Assessment of skin reactivity was performed by calculating the mean diameter as  $(D + d)/2$ , where  $D$  = the largest diameter and  $d$  = orthogonal or perpendicular diameter at the largest width of  $D$  after 15 to 20 minutes. **SPT interpretation:** mean wheal diameter 1+ = < 3 mm, 2+ = 3 to 5 mm, 3+ = 5 to 7 mm, 4+ = 7 to 9 mm. A positive result (2+ and above) to a specific allergen is indicated by a mean wheal diameter measuring 3 mm or more, greater than the negative control (buffered saline). If patients were on oral drugs including antihistaminic (cetirizine, hydroxyzine) or topical steroid, SPT was withheld and performed 7 days after stopping the drug. If patients were on short-term oral steroids (<2 mg/kg/day for <10 days), SPT was withheld and performed 3 days after stopping the drug as it can give false-negative SPT results. If patients were on other drugs such as inhaled/topical steroids, beta-agonists (salbutamol, formoterol, terbutaline), and montelukast, SPT was performed and drugs were continued as it would not interfere with SPT interpretation.

## Results

► **Table 1** shows that among 60 children with RADs, the majority of children (58.3%) belonged to the age group of 5 to 10 years, and the remaining (41.7%) belonged to the age group of 11 to 15 years.

► **Table 2** shows that in our study, males (76.7%) were higher recorded as compared with females (23.3%). Among 60 children, 51.7% were from the urban locality and 48.3% were from rural backgrounds. Out of 60 patients, 38 (63.3%) patients have perennial distribution, whereas 36.7% of patients have seasonal distribution. Among the total children in the study, 55% had a positive family history of atopy and 45% had a negative family history.

► **Table 3** shows that in our study, there was 60% positivity, that is, 36 patients have positive SPTs.

► **Table 4** shows SPT interpretation in our study. There was 1+ in 24 patients (40%), 2+ in 2 patients (3.33%), 3+ in 18 patients (30%), and 4+ in 16 patients (26.66%).

► **Table 5** shows that high serum IgE level (>500IU/ml) was recorded in 44 (73.33%) patients.

**Table 1** Age distribution of the children

Age (y)	Frequency	Percentage
5–10	35	58.3
11–15	25	41.7
Total	60	100
Mean ± SD	9.28 ± 2.94	

Abbreviation: SD, standard deviation.

**Table 2** Demographic profile distribution of children

Variants	Variable 1	Variable 2	Total
<b>Gender</b>	<b>Male</b>	<b>Female</b>	
Frequency	46	14	60
Percent	76.7	23.3	100
<b>Geographical area</b>	<b>Rural</b>	<b>Urban</b>	
Frequency	29	31	60
Percent	48.3	51.7	100
<b>Perennial/seasonal</b>	<b>Perennial</b>	<b>Seasonal</b>	
Frequency	38	22	60
Percent	63.3	36.7	100
<b>Family history of atopy</b>	<b>Yes</b>	<b>No</b>	
Frequency	33	27	60
Percent	55	45	100

**Table 3** Skin prick test result

	Frequency	Percentage
Negative	24	40
Positive	36	60
Total	60	100

**Table 4** SPT interpretation

	Frequency	Percentage
1+	24	40
2+	2	3.33
3+	18	30
4+	16	26.66
Total	60	100

Abbreviation: SPT, skin prick test.

► **Table 6** shows that HDM (60%) was recorded highest followed by storage mite (41.6%), wheat (33.3%), animal dander (30%), and Kentucky bluegrass (26.6%). Many positive patients showed polysensitization.

## Discussion

Our study aimed to determine the aeroallergen prevalence in both BA and/or AR pediatric patients in the age group 5 to 15 years. The age of patients ranged from 5 to 15 years, and the mean age was 9.28 years. Raj et al<sup>5</sup> also found a mean age of 9.2 years in the Indian population.

Our study indicates that males have a higher prevalence of concomitant asthma as compared with females. Similar trends were seen in a Finnish study, where the risk of asthma was significantly higher in males than in females.<sup>6</sup> Our study has a male predominance, with 76.7% males and 23.3% females. It is consistent with finding by Prasad et al<sup>7</sup> and Dave and Srivastava.<sup>8</sup> This gender difference in the study

**Table 5** Serum IgE (high/normal)

	Frequency	Percentage
High	44	73.33
Normal	16	26.66
Total	60	100

Abbreviation: IgE, immunoglobulin E.

**Table 6** Allergen-wise distribution of the study

	Frequency	Percentage
<i>Dermatophagoides pteronyssinus</i> (house dust mite)	36	60
<i>Ambrosia artemisiifolia</i> (ragweed)	10	16.66
<i>Plantago lanceolata</i> (English plantain)	14	23.3
<i>Cynodon dactylon</i> (Bermuda grass)	12	20
<i>Lolium perenne</i> (ryegrass)	10	16.66
<i>Poa pratensis</i> (Kentucky bluegrass)	16	26.6
<i>Robinia pseudoacacia</i> (locust black)	10	16.66
<i>Triticum aestivum</i> (wheat)	20	33.3
<i>Zea mays</i> (corn)	12	20
<i>Aspergillus fumigatus</i> (fungus)	8	13.3
<i>Helminthosporium halodes</i> (fungus test)	9	15
Animal epithelia (animal dander)	18	30
<i>Acarus siro</i> (storage mite)	25	41.6
<i>Hordeum vulgare</i> (barley [cereal grain])	8	13.3

could be because of gender bias in India, that is, bringing a male child more often to the hospital than a female child.

The patients of asthma and/or rhinitis had a positive family history of atopy (55%). This is consistent with Moitra et al's<sup>9</sup> study, where 40.19% of diseases mediated by allergy were strongly familial. Ibekwe and Ibekwe<sup>10</sup> found in their study on AR patients that a family history of atopy was present in 56.8% ( $n = 42$ ) of AR cases. Han et al<sup>11</sup> found the family history to be positive in 52.5% ( $n = 906$ ) cases of asthma, similar to our study.

In our study, perennial activities were 63.3%. This was consistent with Moitra et al's,<sup>9</sup> which shows 67.64%. In a study by Sharma et al,<sup>12</sup> out of 134 patients of AR and asthma, 69 (51.49%) had seasonal variation and the rest 65 (48.51%) had perennial variation, whereas our study shows contrary results. Similarly, Spinozzi et al<sup>13</sup> found in their study that 71.2% ( $n = 222$ ) cases of AR showed seasonal trends. Observation by Kumar<sup>14</sup> on seasonality of asthma in North Indian patients showed that seasonal and perennial symptoms were

equal, whereas in asthma patients of our study, 63.6% ( $n = 89$ ) cases showed perennial symptoms.

In our study, among 60 children in whom SPT was performed, 36 children (60%) came out to be positive. This was consistent with Kumar et al's<sup>15</sup> study, which shows polysensitization in 71.5%. Raj et al<sup>5</sup> also found 55.5% positive SPT out of 180 children with at least 37.8% positive to more than one allergen. Our study was not consistent with Rasool et al's<sup>16</sup> study, which shows that positivity to the single allergen is 0.5%. Various studies from India and abroad showed a high prevalence of SPT positivity. Studies such as those by Siroux et al<sup>17</sup> found 88.2% ( $n = 122$ ) SPT positivity, Raj et al<sup>5</sup> found 55.6% ( $n = 100$ ) SPT positivity, Prasad et al<sup>7</sup> 89.5% ( $n = 43$ ) SPT positivity, and Kumar et al<sup>18</sup> found 71.3% ( $n = 3040$ ) SPT positivity.

In our study, 60% of children with allergic diseases were positive to *Dermatophagoides pteronyssinus* (HDM) and 13.3% to *Aspergillus fumigatus*. This was consistent with other Indian studies such as those by Moitra et al<sup>9</sup>, Prasad et al,<sup>7</sup> which shows HDM as a predominant allergen (86.27, and 25, respectively). Mathur and Mathur<sup>19</sup> showed that 21% of patients had house dust allergen positivity in the population of Western Rajasthan. Dey and Chakraborty<sup>20</sup> found Bermuda grass as the causative agent in 22.22% of AR cases.

The most common aeroallergens in our population were the pollens. Most of the patients were sensitive to one or more species of pollens. The reason could be that inhabitants were living in close proximity to farmlands, meadows, and forest areas. The surroundings in our country were highly enriched with natural flora. The patterns of aeroallergens in the environment widely differ in different localities and are affected by seasonal changes, particularly when they affect pollen. Duc et al<sup>21</sup> had also found house dust to be the most common allergen in patients of rhinitis with BA followed by grass pollens and animal dander. There were a few patients who were sensitive to sheep wool, as they used to deal with sheep husbandry. Neither of the patients was tested positive for dog or cat animal allergy, as there is no custom of keeping such animals as a pet. Usually, our people avoid coming into contact with dogs and cats.

In the study, Prasad et al<sup>7</sup> found that the common offending allergens were insects (21.8% [ $n = 10$ ]) followed by dusts (11.9% [ $n = 6$ ]), pollens (7.8% [ $n = 4$ ]), dander (3.1% [ $n = 2$ ]), and fungi (1.3% [ $n = 1$ ]). In a similar study by Acharya et al,<sup>22</sup> house dust followed by wheat dust, cotton dust, and paper dust was found to be common among patients with nasobronchial allergy. Raj et al<sup>5</sup> found some different patterns of prevalence of sensitization in North India. In their study, HDM was not the common allergen, but housefly was the commonest allergen (36.7% [ $n = 66$ ]) followed by grain dust (31% [ $n = 56$ ]) and female cockroach (18.3% [ $n = 33$ ]). A study from abroad, Ibekwe and Ibekwe<sup>10</sup> observed that HDMs allergen yielded the highest number of positive responses (22.6% [ $n = 43$ ]) followed by tree pollen (16.8% [ $n = 48$ ]). The sensitization pattern observed was different from other studies from the same geographical region. An earlier study from North India that assessed 480 asthmatics/allergics

found *Prosopis juliflora* among pollen and *Alternaria alternata* as important sensitizers with 34.7 and 17.7% skin positivity, respectively.<sup>23</sup> Another study from Southern India in patients with nasobronchial allergy showed a high prevalence of mite allergy (73.7%) and pollen allergy (75.8%).<sup>24</sup> The reason for this difference from the same geographical area is probably because of seasonal and annual fluctuations in allergens. Heterogeneity in allergen extract composition can lead to the different patterns of sensitization observed in our study.<sup>25</sup> The variable composition and content of allergenic extract of different manufacturers may affect the allergenicity of the extract.<sup>26</sup>

The patients in our study were mainly from the urban and semiurban areas surrounding the hospital and belonged to a similar socioeconomic background; differences could not be elicited based on the residence of patients. There were no major changes in the climatic condition or flora and fauna. In a study conducted by Mahesh et al<sup>27</sup> on adults, it was found that sensitization patterns did not vary a lot according to different areas of residence except in younger patients. They found higher sensitization to fungi and cockroaches in younger patients from the rural and urban areas, respectively. Our study has opened a new avenue in the field of allergen testing in children and has shown that SPT is very much feasible even in younger age groups when needed. None of the patients suffered any severe reaction, and the most common reaction was mild local itching. However, a medication tray with the provision of adrenaline was always available at our OPD for managing any severe anaphylactic reaction if needed. Large, cross-sectional studies in other settings are required to be conducted to establish the SPT as an easy, cost-effective, and sensitive method of allergen study. It has already been shown by multiple studies that allergen avoidance can lead to a reduction in symptoms in AR and asthma.<sup>28</sup>

The idiopathic rhinitis, intrinsic asthma, and idiopathic urticaria patients with negative SPTs might nevertheless be suffering from allergic causes not detected by the SPTs used. One possible reason could relate to the intrinsic limitations of SPTs themselves (depending on the available allergens and their specificity and affinity for the circulating IgE).<sup>29</sup> In our study, 1+ grade (<3 mm) was 46.7%. 2+ grade (3–5 mm) was only 2%, 3+ grade (5–7 mm) was 23.3%, and 4+ grade (>7 mm) was 26.7%. In an Irani study by Gharagozlou et al,<sup>30</sup> the percentage of grade 2 or more of SPT positivity was 11% ( $n = 25$ ). Their most cases (84% [ $n = 196$ ]) had grade 1 positivity, whereas in our study, more than 50% ( $n = 60$ ) patients were having SPT grade 2 or more. A study by Kumar et al<sup>18</sup> found the grading of SPT as 2 or more in 46.75% ( $n = 1993$ ) of cases of respiratory allergy, which is quite similar to the finding of our study.

This study also sets the direction toward allergen avoidance, as depending on the prototype of allergens present in our region, allergen avoidance measures can be suggested to those children in whom SPT could not be performed due to age or other factors. However, the effect of allergen avoidance can be only studied in a separate study conducted over a longer period. The sample population included only the children attending the pediatric OPD of the hospital; therefore, the data may not be representative of the general

population of the area and the true prevalence of the disease may differ from our data. Another limitation was the small sample size of the population.

## Conclusion

On SPT, HDM (*Dermatophagoides pteronyssinus*) was positive in maximum number of patients followed by storage mite (*Acarus siro*). Among pollens, *Ambrosia artemisiifolia* was the commonest. Avoidance of common inhaled allergens found with SPT in our region in children with allergic airway diseases was advised. Patients may undergo immunotherapy if indicated. Our study did not encounter even a single adverse reaction; this further proves that SPT is quite a safe method.

### Ethical Approval

This study was approved by the Ethical Committee of Mahatma Gandhi Medical College, Jaipur, Rajasthan, India (no. MGHCH/IEC/JPR/2018/05).

### Funding

None.

### Conflict of Interest

None declared.

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