Review Article

Relevance of allergen specific immunoglobulin e testing in Indian population: A retrospective study

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A B S T R A C T

Prevalence of allergies has increased dramatically in recent decade and is now considered major chronic disease at the global level. Measurement of total and allergen specific IgE (Immunoglobulin E) is often requested to assess possible allergy. The main objective of our study was to understand the relevance of allergen specific IgE testing in Indian population. This retrospective study was conducted at a Global Reference Laboratory in Mumbai from May 2020 to May 2022. Total available data of 65431 patients was included in the study. The data was sub grouped as per age group, gender, and positivity for specific allergens. Of the total 65431 patients, 34601 (52.88%) were Females and 30830 (47.12%) were Males. Among those tested for specific IgE allergen, positivity was found to be 30%. The dust allergy was the most prevalent (62.18%) followed by Insect allergy (52.69%) and food allergy (51.78%). Out of the 18377 patients tested for Specific allergens, 7340 (39.94%) had at least one allergen positive. The availability of multiple and allergen specific panels has proved to be a major tool for the detection and diagnosis of multiple allergies. Detection of allergy is necessary to avoid wrong diagnosis and mismanagement of disease. Combination of total IgE with specific IgE can be used as evidence of allergy along with clinical findings. It is recommended to proceed with clinically appropriate allergen specific IgE tests, regardless of total IgE concentration in patients with a history of an acute allergic reaction.

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1. Introduction

Allergy is a disorder of the human immune system which causes an abnormal or intense reaction to any harmless substance present in the environment.[1] T2 helper white blood cells on contact with an allergen, produce Immunoglobulin E (IgE) antibody which is specific to a particular allergen. Re-exposure to the same allergen, triggers the release of inflammatory chemicals such as histamines, leukotrienes leading to allergy symptoms. Allergic reactions are characterized by the involvement of allergen specific IgE in anaphylaxis, allergic rhinitis, some food allergies, and allergic asthma.[2] Prevalence of allergic disease in India is 20 to 30% of the total population and mainly comprises of asthma, rhinitis, drug, food and insect allergy, eczema and urticaria. Prevalence of bronchial asthma was found to be 2.05% as per Indian study on Epidemiology of Asthma, Respiratory Symptoms and Chronic Bronchitis (INSEARCH).[1] Besides asthma, there is a rising trend of atopic rhinitis, anaphylaxis, drug, food and insect allergy, eczema, urticaria, and angioedema in India.[3] Certain studies showed that IgE-mediated food allergy affects as many as 6-8% children and 3-4% of adults.[4] Prevalence of atopic dermatitis in adults was found to be 10.2%.[5] Not all of the risk factors for allergy are known, but

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genetic and environmental factors are of importance besides lifestyle factors.[6] Some common triggers for inhalant allergies are advancing age, smoking, tobacco exposure, family history of asthma, use of cooking fuels indoor allergens, outdoor allergens and air pollution.[1,7] Asthma management in India remains poor leading to higher morbidity and a poor quality of life. 40-50% of paediatric asthma cases in India are uncontrolled or severe.[8]

Total IgE is used as a screening test for allergy. Its elevated levels are seen in allergic as well as non-allergic diseases. When combined with allergen specific IgE, it gives a comprehensive testing solution.[6] However, Total IgE has a low diagnostic efficiency, therefore ImmunoCAP ImmunoCAP Phadiatop is used as a screening method for patients without a history of allergy thus reducing the number of patients that must be referred for allergen-specific diagnostic testing.[9] Phadiatop is a qualitative assay and indicates whether patients are IgE sensitized with common inhalant allergens. Phadiatop has a high efficiency in screening of patients without a history of allergy to confirm diagnosis of atopy thus reducing the number of patients referred for allergen specific testing.[9] Immuno CAP can be performed irrespective of a patient's age, skin condition, medication, symptom, disease activity, pregnancy, and even in early infancy.

India is the most diverse country in the world with respect to religions, languages, food, clothes, races, tribes, socioeconomic strata, diet and climate. Though the incidence of allergic disorders is rising alarmingly, the number of studies done is not adequate. In view of limited data as well as studies pertaining to Allergic testing in Indian subcontinent, it is important to understand and review the various factors which may help the Clinicians decide the timely future course of action. In our retrospective study, we reviewed the positivity of specific IgE allergens in Indian Population. We have majorly focused on the allergen groups and how this information can be used to address health concerns in adults and children. Comparison between total and specific IgE was analysed along with quantification of IgE antibodies in the diagnosis of allergic patients. It is necessary to make this comparative assessment for better understanding of impact of allergies. Identifying the causative allergen can help in early diagnosis and management of the disease.

2. Materials and Methods

This retrospective study was conducted at Global Reference Laboratory, Mumbai, Maharashtra, India, from May 2020 to May 2022 from the data available in Laboratory Information System (LIS) of the laboratory.

The approval was obtained to use this Laboratory Information Management System (LIMS) data for publication from Independent Ethics Committee.

2.1. Inclusion criteria

Total available data of 65431 patients from May 2020 to May 2022 tested for various tests (Total IgE, Phadiotop, and specific IgE either all tests performed or tested in specific combinations) were included Total IgE in serum was analyzed on Roche Cobas 8000 by Electro chemiluminescence (ECLIA). Serum samples from all patients including children and adults were analysed for allergen– specific IgE antibodies using the Thermo Scientific ImmunoCAP specific IgE Test on Phadia 250 analyser. Individual allergens belonging to animal allergy, dust allergy, drug allergy, food allergy, pollen grass group, micro-organism allergen group, tree pollen and weed pollen group were tested.

The results were interpreted as follows.

1. The Total IgE concentration in healthy, non-atopic subjects is greatly dependent on age.
2. ImmunoCAP Phadiatop screening a positive result is >0.35 Kilo allergy unit per litre (kUA/L). A negative result indicates that the symptoms are not due to common food and inhalant allergies and other differential diagnoses must be considered. Individual allergens are reported as Quantitative. Cut-off of quantitative result is 0.10 (kUA/L).[10]

Age	IU/mL
Neonates	< 1.5
Infants in 1st year of life	<15
Children aged 1-5 years	< 60
Children aged 6-9 years	< 90
Children aged 10-15 years	< 200
Adults	< 100

2.2. Data analysis

The data was analysed using "R Studio version 1.4.1103". Descriptive analyses were made to obtain the frequency and percentage of age group, gender, IgE total Antibody and specific allergens. Chi Square test were used to obtain association of age group, gender, and specific allergens with IgE total antibody. Similarly, gender comparison of specific Allergens was done using Chi Square test and Fisher Exact t test. A two-sided p value of <0.05 was statistically significant.

3. Results

3.1. Overall demographic distribution

Of the total 65431 patients, 34601 (52.88%) were females and 30830 (47.12%) were males. 7114 (10.87%) were children up to 12 years and 18699 (28.58%) were above 50 years of age. (Table 1).

Table 1: Demographic distribution

Age Group	Sex					
	Female		Male		Total	
	N	%	N	%	N	%
0-3	768	39.16%	1193	60.84%	1961	3.00%
4-6	715	39.97%	1074	60.03%	1789	2.73%
7-12	1382	41.08%	1982	58.92%	3364	5.14%
13-19	2307	48.21%	2478	51.79%	4785	7.31%
20-29	6293	54.00%	5361	46.00%	11654	17.81%
30-39	7184	56.55%	5519	43.45%	12703	19.41%
40-49	6073	57.98%	4401	42.02%	10474	16.01%
>50	9878	52.83%	8821	47.17%	18699	28.58%
Not given	1	-	1	-	2	-
Total	34601	52.88%	30830	47.12%	65431	100.00%

N=Number of participants, % =Percentage

Table 2: Age and gender wise distribution of total IgE

	IgE Total antibody				p value
	Negative		Positive		
	N	%	N	%	
Age Group					
0-3	385	26.74%	1055	73.26%	
4-6	273	19.42%	1133	80.58%	
7-12	659	24.80%	1998	75.20%	
13-19	782	20.84%	2971	79.16%	<0.0001
20-29	1909	20.94%	7209	79.06%	
30-39	2473	24.77%	7512	75.23%	
40-49	2275	28.24%	5780	71.76%	
>50	3769	28.95%	9251	71.05%	
Gender					
Female	7909	29.63%	18781	70.37%	<0.0001
Male	4616	20.30%	18128	79.70%	
Total	12525	25.33%	36909	74.66%	

N=Number of participants, % = Percentage, p<0.05 is considered statistically significant

Table 3: Overall specific IgE levels

Specific IgE & Allergy panel	Negative	Positive	Total	% Positive
Food Allergen	3122	3352	6474	51.78%
Dust Allergen	1427	2346	3773	62.18%
Grass Pollen Allergen	1782	985	2767	35.60%
Tree pollen Allergen	1444	804	2248	35.77%
Weed pollen Allergen	1301	1040	2341	44.43%
Micro-organism Allergen	5901	5586	11487	48.63%
Drug Allergen	1241	14	1255	1.12%
Animal Allergen	2541	875	3416	25.61%
Insect Allergen	1247	1389	2636	52.69%
Phadiatop allergen screening - Infant	64	69	133	51.88%
Phadiatop Allergen screening - Adult	2846	3036	5882	51.62%

Table 4: Positivity of specific causative allergens

Specific IgE Allergens Food	Negative	Positive	Total	% Positive
Allergen-Crab (Cancer pagurus)	2	7	9	77.78%
Allergen-Lobster (Homarus gammarus)	2	2	4	50.00%
Allergen-Shrimp / Prawns	1374	1242	2616	47.48%
Allergen-Banana (Kela / Musa Spp.)	233	140	373	37.53%
Allergen-Wheat (Gehon / Triticum aestivum)	2927	1379	4306	32.03%
Allergen-White Bean (Phaseolus vulgaris)	92	43	135	31.85%
Allergen-Chick Pea (Kabuli Chana / Cicer arietinus)	271	125	396	31.57%
Allergen-Cow Milk (Doodh)	3448	1568	5016	31.26%
Allergen-Spinach (Palak / Spinachia oleracea)	277	124	401	30.92%
Allergen-Garlic (Lehsoon / Allium Sativum)	888	374	1262	29.64%
Allergen-Pistachio	56	23	79	29.11%
Allergen-Corn (Maize / Makka / Zea Mays)	322	132	454	29.07%
Allergen-Pineapple (Ananas)	1242	505	1747	28.91%
Allergen-Lemon (Nimbu / Citrus limon)	1254	491	1745	28.14%
Allergen-Lentil (Masoor Dal / Lens esculenta)	1362	522	1884	27.71%
Allergen - Brinjal (Aubergine, eggplant / Solanum melongena)	241	91	332	27.41%
Allergen-Almond (Badam / Amygdalus communis)	547	200	747	26.77%
Allergen-Papaya (Carica papaya)	134	48	182	26.37%
Allergen-Green Pea	107	38	145	26.21%
Allergen-Peanut (Moongfali / Arachis hypogaea)	3130	1097	4227	25.95%
Allergen-Walnut (Juglans californica)	153	52	205	25.37%
Allergen-Tomato (Tamatar / Lycopersicon lycopresicum)	1460	496	1956	25.36%
Allergen-Onion (Piaz / Allium cepa)	921	303	1224	24.75%
Allergen-Egg White (Anda)	2831	927	3758	24.67%
Allergen-Soyabean (Glycine max)	3115	1014	4129	24.56%
Allergen-Cabbage (Gobi / Brassica oleraceavar.Capitata)	300	95	395	24.05%
Allergen-Paprica (Simla Mirchi / Capsicum annuum)	272	86	358	24.02%
Allergen-Chilipepper Capsicum frutescens	19	6	25	24.00%
Allergen-Orange (santra / Citrus sinensis)	92	29	121	23.97%
Allergen-Peach (Prunus persica)	271	85	356	23.88%
Allergen-Coconut (Narial /Cocos nucifera)	549	171	720	23.75%
Allergen-Coffee	13	4	17	23.53%
Allergen-Hazelnut (Corylus avellana)	278	84	362	23.20%
Allergen-Gluten	439	131	570	22.98%
Allergen- Celery (Apium graveolens)	210	59	269	21.93%
Allergen-Apple (Safarchand / Malus X Domestica)	290	81	371	21.83%
Allergen-Beef Cow meat (Bos spp.)	1043	288	1331	21.64%
Allergen-Rape Pollen (Sarson / Brassica napus)	124	34	158	21.52%
Allergen-Cashew (Nut Kaju / Anacardium occidentale)	350	90	440	20.45%

Table 4 continued				
Allergen-Potato (Aaloo / Solanum tuberosum)	803	205	1008	20.34%
Allergen-Baingan	12	3	15	20.00%
Allergen-Rice (Chawal / Oryza sativa)	1698	424	2122	19.98%
Allergen-Pear (Pyrus communis)	189	47	236	19.92%
Allergen-Mutton (Ovis Spp.)	89	22	111	19.82%
Allergen-Kiwi Fruit (Actinidia deliciosa)	26	6	32	18.75%
Allergen-Mushroom champignon / Agaricus hortensis	14	3	17	17.65%
Allergen-Blue Mussel (Mytilus Edulis)	2040	434	2474	17.54%
Allergen-Pecan nut (Carya Illinoensis)	147	30	177	16.95%
Allergen-Baker's Yeast (Saccharomyces cerevisiae)	248	49	297	16.50%
Allergen-Chicken Meat (Murgi)	1133	214	1347	15.89%
Allergen-Casein (Milk Protein / Dahi)	417	76	493	15.42%
Allergen-Mustard (Sarson / Brassica / Sinapsis Spp.)	39	7	46	15.22%
Allergen-Pork (Pig meat)	1104	192	1296	14.81%
Allergen-Olive (Olea europaea)	1463	252	1715	14.69%
Allergen-Brazil Nut (Bertholletia excelsa)	303	51	354	14.41%
Allergen-Mango (Mangifera indica)	27	4	31	12.90%
Allergen-Plaice Fish (Pleuronectes platessa)	109	16	125	12.80%
Allergen-Egg Yolk (Anda)	1186	167	1353	12.34%
Allergen-Black Pepper Piper nigrum	37	5	42	11.90%
Allergen-Tuna Fish (Pleuronectes platessa)	1193	158	1351	11.70%
Allergen-Cheese Cheddar	231	30	261	11.49%
Allergen-Cod Fish (Machhli / Gadus morhua)	2928	337	3265	10.32%
Allergen-Salmon (Rawas fish / Salmo salar)	1208	139	1347	10.32%
Allergen-Clove (Syzygium aromaticum)	18	2	20	10.00%
Allergen-Basil Ocimum Basilicum	19	2	21	9.52%
Allergen-Cocoa (Chocolate / Theobroma cacao)	230	24	254	9.45%
Allergen-Alpha -Lactalbumin (Milk protein)	267	0	267	0.00%
Allergen-Beta - Lactoglobulin- Milk (Milk protein)	267	0	267	0.00%
Allergen-Cardamon (Elettaria cardamomum)	21	0	21	0.00%
Allergen-Coriander	22	0	22	0.00%
Allergen-Strawberry (Fragaria vesca)	1	0	1	0.00%
Dust				
Allergen-Dermatophagoides Pteronyssinus (House Dust Mite)	1032	1479	2511	58.90%
Allergen - Dermatophagoides Farinae (House Dust Mite)	1538	2135	3673	58.13%
Allergen-House dust Greer Labs	1071	1147	2218	51.71%
Allergen - Hollister-stier Labs house dust	39	36	75	48.00%
Grass Pollen				
Allergen- Johnson Grass (Jowar grass / Sorghum Grass)	1085	523	1608	32.52%
Allergen- Bermuda Grass (Durva / Cynodon grass)	1858	878	2736	32.09%
Allergen- Cultivated Rye grass (Secale cereale)	268	104	372	27.96%

Table 4 continued

Allergen- Meadow Grass (Poa pratensis)	375	132	507	26.04%
Allergen- Timothy Grass (Ghass / Phleum pratense)	255	84	339	24.78%
Tree Pollen				
Allergen- Oak Quercus Alba	372	180	552	32.61%
Allergen- Papdi Chibil / Elm	1357	625	1982	31.53%
Allergen-Mesquite (Pahadi Keekar / Prosopis Juliflora)	1010	435	1445	30.10%
Allergen-Eucalyptus (Nilgiri / Safeda)	87	32	119	26.89%
Allergen- Willow Salix Caprea	11	4	15	26.67%
Allergen-Acasia Babool (Acasia Longifolia)	88	31	119	26.05%
Allergen-Birch (Betula verrucosa)	1202	355	1557	22.80%
Allergen-Alder (Alnus Incana)	1179	345	1524	22.64%
Allergen-White Pine (Pinus strobus)	20	2	22	9.09%
Allergen- Mulberry Shahtoot (Morus alba)	21	2	23	8.70%
Weed Pollen				
Allergen-Goose Foot (Chenopodium Album)	708	566	1274	44.43%
Allergen-Common Ragweed (Close To Parthenium / Congress Grass / Ambrosia Elatior)	1450	857	2307	37.15%
Allergen-Cocklebur Xanthium commune	13	7	20	35.00%
Allergen-Mugwort (Sita Bani / Artemisia vulgaris / BanoBarna)	1031	489	1520	32.17%
Allergen-English Plantain (Plantago lanceolata)	88	39	127	30.71%
Allergen- Common Pigweed (Kaantewali Chauli / Amaranthus Retroflexus)	1092	430	1522	28.25%
Fungus				
Allergen-Aspergillus Fumigatus (Fungus)	6140	5261	11401	46.15%
Allergen-Candida Albicans (Fungus)	1026	510	1536	33.20%
Allergen-Penicillium Notatum (Fungus / Penicillium chrysogenum)	1611	287	1898	15.12%
Allergen-Alternaria alternata (fungus)	1816	297	2113	14.06%
Allergen-Cladosporium herbarum (Fungus)	647	105	752	13.96%
Drug				
Allergen-Insulin Human	5	2	7	28.57%
Allergen-Penicilloyl V (Antibiotic)	41	11	52	21.15%
Allergen-Penicilloyl G (Antibiotic)	95	13	108	12.04%
Allergen-ACTH	69	2	71	2.82%
Allergen-Amoxicillin (Antibiotic)	41	0	41	0.00%
Allergen-Ampicillin (Antibiotic)	12	0	12	0.00%
Allergen-Cephalosporin (Antibiotic)	52	0	52	0.00%
Allergen-Ciprofloxacin (Antibiotic)	50	0	50	0.00%
Allergen-Diclofenac (pain killer)	872	0	872	0.00%
Allergen-Ibuprofen (Pain killer)	857	0	857	0.00%
Allergen-Paracetamol	900	0	900	0.00%
Allergen-Sulpha (Antibiotic)	97	0	97	0.00%
Animal				
Allergen-Cow Dander	229	89	318	27.99%
Allergen-Dog Dander	2359	795	3154	25.21%
Allergen-Cat Dander	2427	394	2821	13.97%
Allergen-Horse Dander	271	42	313	13.42%

Table 4 continued

Allergen-Guinea Pig Epithelium	8	1	9	11.11%
Allergen-Animal Pigeon Feathers	207	0	207	0.00%
Insects				
Allergen-Mosquito (Machhar /Aedes communis)	6	9	15	60.00%
Allergen-Cockroach German (Blatella germanica)	1239	1374	2613	52.58%
Allergen-Honey Bee Venom (Madhu Makhhi / Apis mlifera)	9	9	18	50.00%
Phadiatop				
Phadiatop allergen screening - Infant	64	69	133	51.88%
Phadiatop Allergen screening - Adult	2846	3036	5882	51.62%
Total Tests	89374	38303	127682	30

3.2. Total IgE distribution

A total of 49434 patients tested for IgE total antibodies were divided into different age groups depending on their normal/abnormal values. High IgE levels were seen in 36909 (74.66%) patients and normal IgE levels were seen in 12525 (25.33%) (Table 2)

3.3. Overall positivity among the patients

Dust allergy was the most prevalent (62.18%) followed by Insect allergy (52.69%) and food allergy (51.78%). (Table 3)

Among those tested for specific allergens, overall, 30% were positive for allergies.

Even among the dust allergies, house dust mite (58.90%) was seen to be most common. Among the insect allergy group, mosquito had the highest positive rate of 60% followed by Cockroach (52.58%). (Table 4)

3.4. Age wise prevalence of allergy

Incidence of food allergy was highest in the 0-3year age group. Amongst these, egg yolk allergies were highest (26.95%) followed by cow milk (25.51%). Food allergens such as Plaice fish (31.25%) and Pecan nut caused the highest allergy amongst 7-12 year age group. In fungal Allergy, Penicillium Notatum fungus is more prevalent (20.21%) in the 20-29 years age group. Incidence of House dust mite (Dermatophagoides Farinae) allergy was 16.77% and house dust hollister was 25% in 20-29 years age group. (Table 5)

3.5. Comparison of specific IgE and total IgE results

The comparative analysis of Total IgE and specific IgE showed that while Total IgE as well as specific IgE was raised in some patients, some patients with normal Total IgE levels showed raised specific IgE levels for specific allergens. (Table 6)

3.6. Number of specific IgE allergens in patients

Out of the 18377 patients tested for specific allergens, 7340 (39.94%) had at least one allergen positive. 667 patients (3.63%) were positive for two allergens. 393 patients (2.14%) were positive for three allergens. 202 patients (1.10%) had eight allergens detected. (Table 7)

4. Discussion

Allergic disorders have been showing an increasing trend in the world. The upsurge in allergies is observed as societies become more affluent and urbanized. It is not easy to distinguish which allergen is causing the clinical symptoms. A test should be able to identify the allergic condition along with disease causing allergen. Symptoms are not just dependent on IgE but also on plethora of factors.

Currently there is no gold standard for clinical diagnosis of allergic reactions. Barring a few allergy specialists who still are dependent on skin prick tests, most of the physicians use screening tests like Total IgE, ImmunoCAP Phadiatop screening and specific IgE tests against allergens, along with symptoms for clinical decisions. [11]

In our study, among those tested for specific allergens, overall, 30% were positive for allergies. In a similar study done on Jordanian cohort by Khasawneh R et al., prevalence of 20% was reported. [6] This was in agreement with another study conducted in South India by Nitin Joseph et al. where 28.7% of the participants reported having allergies. [12] Another Indian Study by Prasad R et al claimed that 20% to 30% of the population suffered from allergic disorders. [1] Contrary to above mentioned studies, a Swedish study done by Enroth et al. has reported 42.3% positivity of allergy based on self-reporting by patients. [12,13] Similarly, self-reporting by patients has shown an increase of 41.7% allergies in an American study by Seite S et al. [14]

In our study, the allergy testing was found to be slightly higher in women (52.88%) as compared to men (47.11%). As per an American study by National Health and Nutrition Examination (NHANES) women tend to self-document poor health and notice symptoms earlier than men. [14] As per study done in Vienna by Erika Jenson et al., women are more prone to develop allergies due to hormonal interactions. (18). Another study by Eva Untersmayr et al. also mentions that female sexual hormones elevate the risk for allergy. [15]

39.94% patients had at least one allergen positive while 3.63% patients were positive for two allergens in our study. This was in accordance with an American study by National Health and Nutrition Examination (NHANES) where 44.6% of patients had at least 1 allergen positive. [14] This describes the demographic distribution of allergic disorders and proves burden of allergic disorders is not lesser.

In our retrospective study, the positive rate of Total IgE among all age groups was 74.66%. The positive rate of Total IgE with Specific IgE was found to be between 75-95.9%, while 4-13.66% was found to be negative for Total IgE but positive for Specific IgE. As per study done in China by Man-Li Chang, 65% patients showed an increase in Total IgE. However positive correlation between IgE and Specific IgE was only 29% in their study contrary to our results. [16] Probable reason for this, is allergic disease being more probable when Specific IgE is high. However, increase in Total IgE is not specific for allergy and can be high in parasitic infections, multiple myeloma, liver disease and rheumatoid arthritis as well. [16]

To understand whether specific IgE is better than Total IgE or vice versa, we evaluated the usefulness of total serum IgE and allergen specific IgE. In our study, 40-60% of patients with normal IgE were negative for allergy which

Table 5: Age wise prevalence of allergens

Age in years	0-3		4-6		7-12		13-19		20-29		30-39		40-49		>50		p value
Allergen Group	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Allergen-Cow Milk																	
Positive	400	25.51%	244	15.56%	216	13.78%	113	7.21%	156	9.95%	138	8.80%	113	7.21%	188	11.99%	<0.0001
Allergen-Egg Yolk																	
Positive	45	26.95%	31	18.56%	21	12.57%	18	10.78%	14	8.38%	6	3.59%	11	6.59%	21	12.57%	<0.0001
Allergen-Plaice Fish																	
Positive	1	6.25%	0	0.00%	5	31.25%	3	18.75%	1	6.25%	0	0.00%	1	6.25%	5	31.25%	0.0235
Allergen-Pecan nut																	
Positive	4	13.33%	3	10.00%	9	30.00%	5	16.67%	5	16.67%	1	3.33%	1	3.33%	2	6.67%	0.0054
Dust Allergen																	
Positive	137	5.84%	167	7.12%	330	14.07%	252	10.74%	402	17.14%	388	16.54%	248	10.57%	422	17.99%	<0.0001
Dermatophagoides Farinae (House Dust Mite)																	
Positive	129	6.04%	155	7.26%	315	14.75%	229	10.73%	358	16.77%	342	16.02%	231	10.82%	376	17.61%	<0.0001
Hollister-stier Lab's house dust																	
Positive	0	0.00%	1	2.78%	3	8.33%	7	19.44%	9	25.00%	4	11.11%	4	11.11%	8	22.22%	0.1442
Penicillium Notatum (Fungus)																	
Positive	8	2.79%	12	4.18%	37	12.89%	30	10.45%	58	20.21%	41	14.29%	45	15.68%	56	19.51%	0.0015

N = Number of participants, % = Percentage p<0.05 is considered statistically significant

Table 6: Comparison of specific IgE and total IgE results in all patients

Specific Allergens	Total antibody IgE				p value
	Negative		Positive		
	N	%	N	%	
Food					
Negative	989	57.04%	745	42.96%	<0.0001
Positive	349	13.66%	2206	86.34%	
Dust					
Negative	610	54.76%	504	45.24%	<0.0001
Positive	192	10.34%	1664	89.66%	
Grass Pollen					
Negative	618	39.67%	940	60.33%	<0.0001
Positive	67	7.60%	814	92.40%	
Tree pollen					
Negative	472	37.64%	782	62.36%	<0.0001
Positive	64	8.90%	655	91.10%	
Weed pollen					
Negative	469	43.47%	610	56.53%	<0.0001
Positive	66	7.32%	836	92.68%	
Micro organism					
Negative	631	37.88%	1035	62.12%	<0.0001
Positive	78	7.41%	975	92.59%	
Drug					
Negative	21	23.86%	67	76.14%	
Animal					
Negative	701	36.89%	1199	63.11%	<0.0001
Positive	27	4.07%	637	95.93%	
Insect					
Negative	561	45.87%	662	54.13%	<0.0001
Positive	118	8.75%	1231	91.25%	
Phadiatop Allergen screening - Infant					
Negative	2	40.00%	3	60.00%	<0.0001
Positive	0	0.00%	5	100.00%	
Phadiatop Allergen screening - Adult					
Negative	646	49.85%	650	50.15%	<0.0001
Positive	115	7.47%	1424	92.53%	

N= Number of participants, % = Percentage, p<0.05 is considered statistically significant

Table 7: Count of positive allergens in patients

Count of Allergy Positive	N	%
0	8862	48.22%
1	7340	39.94%
2	667	3.63%
3	393	2.14%
4	289	1.57%
5	200	1.09%
6	202	1.10%
7	222	1.21%
8	202	1.10%
Total	18377	100%

N= Number of participants, % = Percentage, p<0.05 is considered statistically significant

is in agreement with the study done by Rame Khasawneh et al. in Jordan which emphasized 44% of cases with normal Total IgE do not indicate absence of allergy and 20% of cases with high level of Total IgE do not indicate an allergy.[6] The probability of allergic reaction is high when the level of Specific IgE is high as the specific B cells are induced when allergens enter the body. Therefore, increased Specific IgE lead to increase in Total Ige. However, the level of specific IgE should be high enough to have a direct impact on Total IgE.[16]

Our study showed prevalence of dust allergy was 62.18%, insect allergen was 52.69%, and food allergy was 51.78%. House dust mite (58.90%) was seen to be most common. Among the insect allergy group, mosquito had the highest positive rate of 60% followed by Cockroach (52.58%). Incidence of food allergy was highest in the 0-3 year's age group. Amongst these, egg yolk allergies were highest (26.95%) followed by cow milk (25.51%). Food allergens such as Plaice fish (31.25%) and Pecan nut caused the highest allergy amongst 7-12 years age group. Dust and insect allergens are common in patients affected by Allergic Rhinitis and are the main causes of Allergic Rhinitis and Allergic Asthma.[7,17] In India alone, 20 to 30% of the population suffer from Allergic Rhinitis while global prevalence is around 15 to 30%.[17] Allergic disorders may be high owing to the diverse geographical area and seasonal variation.[17] Also smoking, drinking habits, pets and family history were common in Asian countries while focus is more on effects of pollens, drugs pets, and family history in western countries.[18]

Most common allergens reported were comparable to a study by Kammili Jyothirmayi et al. from Bengaluru, South India which reported highest prevalence of dust mite (32.48%) followed by pollens (27.48%).[17] This was coherent with a Jordanian study by Rame Khasawneh et al. who reported total house dust mite allergy as 24.2% (13.6% - dermatophagoides pteronyssinus, 10.6% - dermatophagoides farina) followed by grass mix and pollens 20.3% (grass mix- 12.8%, grass pollen- 7.5%) and cat 10.6%.[6]

Asthma symptoms were more prevalent in developed countries. Some areas in Africa and the Indian Subcontinent had the lowest prevalence. This may be due to genetic factors and changing environmental exposure in Asia & Africa.[19]

As per our study, Cow's milk allergy was 25.5% until 3 years of age which reduces to 15.5% by the sixth year of life. This bores resemblance to a study conducted in New York, USA by Sampson HA et al. who states that Cow's milk allergy affects 2.5% newborns in the first year of life who outgrow them by the third year.[20] This is also supported by a pediatric Japanese study by Uriso et al. which states that the number of patients decreases with increase in age for common causative food items like eggs,

wheat, dairy products, buckwheat, shrimp and peanuts.[21] A slower maturation of the immune response that normally occurs during the initial 12 to 18 months of life is what predisposes a child to the subsequent development of allergy and asthma.[21] Some epidemiological studies have shown a link between hygiene hypothesis and Immune response while in some studies there is no link.[22]

As physical, biochemical and immunological barriers are underdeveloped during the initial period of life, allergy to food is very common in pediatric age group. Currently management of allergy involves avoidance of the causative allergen and therapeutic remedy in case of unintended contact or ingestion. As allergy is a lifelong chronic condition, avoidance can be challenging and sometimes it is difficult to identify the allergen. Coping with allergy symptoms create a burden in day-to-day life contributing to poorer quality of life.[14]

5. Limitations

Clinical condition and treatment history for allergic symptoms was not available.

False positive results may occur in low positive IgE results (0.35 kUA/L– 3.00 kUA/L) due to cross-reactive carbohydrate determinant (CCD) interference in assays. Using a non cellulose based assay or a (CCD) inhibitor can alleviate CCD-IgE interference.[23]

6. Conclusion

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 even life-threatening anaphylaxis. We found that house dust mite allergen has been recorded to have the highest prevalence in Indian population followed by food and insect allergies. Total IgE and specific IgE can never replace each other, however combining the two tests together along with clinical manifestations will improve the interpretation. The positive correlation between IgE and specific IgE was found to around 95% in our study however 13% were negative for Total IgE but positive for specific IgE. Hence, it is proposed to test for clinically appropriate allergen specific IgE tests, regardless of Total IgE concentration in patients with a history of an acute allergic reaction to know the cause of allergy. The availability of multiple and allergen specific panels has proved to be a major tool for the detection and diagnosis of multiple allergies. Detection of allergy is necessary to avoid wrong diagnosis and mismanagement of disease. It is necessary to increase awareness and educate our healthcare workers and patients regarding allergy testing to propagate information to patients and caregivers. Partnering with regional, national, and international allergy societies may help to flatten the allergy epidemic curve.

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8. Conflict of Interest

None.

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