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Impact of Environmental Factors on the Prevalence of Pediatric Allergies

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ABSTRACT

Background: The increasing incidence of allergy disorders in children is probably caused by shifting environmental factors. However, it is unclear which allergen sensitization is linked to the emergence of allergy disorders and if environmental exposures cause allergen sensitizations. To guide future preventive measures.

Objective: This study aimed to explore the relationship among environmental exposure, allergen sensitization, & the emergence of allergy disorders.

Methods: We studied Taiwanese kindergarten students in Taiwan Childhood Environment & allergic diseases study. Six allergens were tested using skin pricks. Standardized questionnaires were used to gather data on environmental exposure and the emergence of allergy disorders. The relationship between environmental variables, allergen sensitization, and the emergence of allergy disorders was estimated using multiple logistic regressions.

Results: 3192 children in all were enlisted. Atopic dermatitis (AD) affected 485 children (15.2%), allergic rhinitis (AR) affected 1126 children (35.3%), and asthma affected 552 children (17.3%). According to ORs (95% CIs), children who were exposed to ambient tobacco smoke & fungi on the wall of their homes were more likely to develop asthma. The highest rate of mite sensitization was discovered. Significant increases in the risks of AD, AR, & asthma were linked to mite sensitization, with ORs (95% CIs) for each condition, respectively. With an OR (95% CI), cockroach sensitivity also raised the likelihood of asthma. Milk sensitization was linked to the length of nursing, while mite sensitization was linked to the home's carpet and fungus on the wall.

Conclusion: The development of allergy disorders is influenced by environmental exposures. Certain environmental exposures were linked to allergen sensitizations. There is an urgent need for early environmental treatments to stop childhood allergy disorders from developing.

Keywords: Allergic diseases, Asthma, Atopic dermatitis, Allergen sensitization, Environmental exposures.

INTRODUCTION

In industrialized nations, the prevalence of childhood allergy disorders has skyrocketed in recent decades. Asthma is the most prevalent chronic condition in children, & its prevalence may have sharply increased. About 38% of asthmatic patients had allergic asthma, which was the subject of most of the earlier atopic disease research done in Taiwan and overseas. But during the past few decades, atopic dermatitis (AD) has also become more common in the industrialized world. Most individuals with AD experience skin symptoms in their 1st few years of life. AD is a chronic inflammatory skin disease that peaks in onset during infancy. Additionally, one of the most prevalent chronic illnesses in children is allergic rhinitis (AR). The rise in the number of people with asthma, AD & AR diagnoses is probably caused by shifting environmental factors because population genetic diversity does not change as quickly [1].

Children with atopic disorders are more likely to have significant health care costs, family stress, and absences from school. Most young children today live inside, where there are several allergies. Thus, it is critically necessary to identify indoor environmental factors among Taiwanese infants who are genetically sensitive. Allergens are one of the most significant environmental exposures. Mold, cockroaches, animal dander, and host dust mites are common indoor allergens for asthma. The environmental determinants of AD's early-life appearance have been assessed in a few research. For instance, atopic dermatitis is linked to sensitization to food allergens (egg, milk, wheat, soy, & peanuts), and the severity of the condition is correlated with this sensitivity. Additionally, additional documented environmental variables, such as pets, cats, exposure to second hand tobacco smoke, and air pollutants, can lead to respiratory allergies. Allergens and their links to AD are still up for debate, even though numerous investigations on allergen sensitivity in AD, AR, and allergic asthma have been carried out. There isn't, however, a thorough assessment of environmental elements. Thus, this study assessed the connections among children's allergy illnesses, environmental exposures, and allergen sensitization. We carried out a cross-sectional study to find out how common allergy disorders & allergen sensitization are in a representative Taipei paediatric community. We also investigated the relationships between environmental exposures, asthma, AD, & AR development, and the sensitivity to six selected indoor allergens [2].

METHODS

Study population: In 2024, we surveyed kindergarten students about allergic illnesses at their schools. To guarantee a certain level of social and geographic diversity and to produce a representative assessment. Schools in Cairo City were selected using stratified systematic sampling. Cluster sampling was used to choose subjects from each school. Children were enlisted, and their guardians or their own written informed consent was acquired. The parents were asked

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to fill out a structured survey. Prematurity, congenital, and chronic disorders [3].

Definition of a case: A positive response to a doctor-diagnosed asthma & nocturnal cough or exercise-induced wheeze within the preceding twelve months was considered asthma, according to the International Study of Asthma & Allergies in childhood questionnaire.

The following questions were used to classify AD cases: "Has your child ever had AD diagnosed by a physician?" as well "Has your child ever experienced a recurring itchy rash over the elbows, knees, face, wrists, neck, periauricular areas, or eyebrow areas for at least 6 consecutive half-month periods?" "Has your child ever been diagnosed as having AR by a physician?" was one of the questions used to classify cases of AR. and "Has your child ever experienced a runny or blocked nose or sneezing problem when they weren't sick with the flu or a cold?" [3]

Exposure measurements: Children were asked about their exposure to environmental allergens at home, and their parents responded. The questionnaire was also used to gather data on family history of atopic diseases, basic demographic characteristics, and residential environmental factors (Like indoor smoke use, cockroaches & pets, moisture in the house, wall fungus, & carpets) [4].

The skin prick test (SPT): The following 6 common allergens were tested using skin prick tests (SPTs): **house dust mites** (HDMs) mix, including Dermatophagoides pter-onyssinus [Der p], Dermatophagoides farinae [Der f], Dermatophagoides microceras [Der m], & Blomia tropicalis [Blo t] allergens, **dog dander**, **cockroaches**, **egg**, **milk**, and **crab allergens**. When an allergen triggers a positive reaction, the skin becomes itching for a few minutes before turning red and swollen. Positive and negative controls were histamine (0.1%) in phosphate-buffered saline & regular saline, respectively. It was recommended that children refrain from using antihistamines for seventy-two hours before their clinic session [5]. The mean wheal diameters were computed by dividing the sum of the longest diameter & the diameter perpendicular to it by 2. The test results were recorded within fifteen minutes. When a positive control (> 3 mm) was present. An allergen was considered present if the mean wheal diameter was at least 3 mm larger than the negative control.

Ethical approval

It was approved by the ethics committee of Ain Shams University and it was started from March 2020 to August 2023 at Department of Paediatrics, Ain Shams University, Egypt. An informed written consent was obtained from the participants (approval No. 00493/2023). This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Analysis of statistics

After controlling for relevant confounders, multiple logistic regressions were used to determine the relationship among environmental factors, allergen sensitivity & the emergence of allergy disorders. It was also assessed how environmental exposures affected the development of allergen sensitivity. Based on the literature and normal statistical processes, the model's confounders were chosen to account for a 10% change in the point estimate. Every test was predicated on a 2-sided alternative hypothesis and a significance level of 0.05 [6]. SAS software version 9.1 was used to conduct all two-sided hypothesis tests at the significance level of 0.05 (SAS Institute, Cary, NC, USA) [5].

RESULTS

3192 children in all were enlisted. Table (1) displayed the demographic properties of the study population. In particular, 552 children (17.3%) had asthma, 1126 children (35.3%) had AR, and 485 children (15.2%) had AD. Children who had fungi on their home walls were more likely to have AD [OR (95% CI): 1.27 (1.04–1.55)], AR [OR (95% CI): 1.18 (1.01–1.37)], & asthma [OR (95% CI): 1.22).

Table (1): Participants' demographic details

	All eligible participants (3192)	
	n	**percent**
Children		
Infant gender (percent)		
Male	1725.00	54.10
Female	1467.00	45.90
Premature birth (<37weeks) (percent)		
Yes	261.00	8.20
No	2833.00	88.80
Missing	98.00	3.00
Birth body weight (gm)		
Mean SD	3106.07 ± 457.961	
Mother		
Maternal age at delivery (years) Mean SD	29.32 4.49	
Maternal education (percent)		
Junior high school and below Senior high school and above	185 3007	5.8 94.2
Maternal Nationality (percent)		
Cairo	3005.0	94.10
Foreign countries	187.0	5.90
Maternal history of atopy (percent)		
Yes **No**	1060 2132	33.2 66.8
Family income per month (NT$) * (percent)		
< 600,00	930.0	29.20
≥600,00	2262.0	70.80

Standard deviation (SD) and *NT$ per year are abbreviations. a. Due to incomplete data, the number of participants did not equal N.

The odds ratios (ORs) for AR and asthma in children exposed to environmental tobacco smoke (ETS) were 1.23 (1.06–1.43) & 1.23 (1.06–1.52), respectively. The final risk factor mentioned is the length of time spent breastfeeding. AD was strongly correlated with breastfeeding for longer than six months [OR (95% CI): 1.66 (1.20–4.31)] (Table 2).

Table (1): The odds ratio of environmental risk factors for allergy disorders

Characteristics	No. of Subject	AD Rate (percent)	OR	95% CI	AR Rate (percent)	OR	95% CI	Asthma Rate (percent)	OR	95% CI
Environment										
Duration of breastfeeding (%)										
No < 6 months ≥ 6 months	669 1577 535	11.4 15.2 17.6	1.00 1.39 1.66	(1.06–1.84) * (1.20–4.31) *	29.6 32.7 27.7	1.00 1.16 0.91	(0.95–1.41) (0.71–1.17)	10.8 13.0 14.4	1.00 1.24 1.39	(0.93–1.65) (0.99–1.97)
Older siblings (%)										
No < 2 ≥ 2	866 1631 563	16.1 15.7 13.5	1.00 0.97 0.82	(0.78–1.22) (0.60–1.10)	37.6 35.1 32.7	1.00 0.90 0.80	(0.75–1.06) (0.64–1.01)	16.9 16.7 18.1	1.00 0.99 1.09	(0.79–1.23) (0.83–1.44)
Day care (%)										
No Yes	2328 704	14.8 17.8	1.00 1.25	(1.00–1.56)	34.8 35.8	1.00 1.05	(0.88–1.25)	16.7 17.0	1.00 1.03	(0.82–1.29)
Furry pets at home (%)										
No Yes	2500 550	16.1 13.6	1.00 0.82	(0.63–1.08)	35.7 33.6	1.00 0.91	(0.75–1.11)	16.8 17.3	1.00 1.03	(0.81–1.32)
Cockroaches at home										
No Yes	557 2541	14.9 15.3	1.00 1.03	(0.80–1.34)	34.5 35.5	1.00 1.07	(0.82–1.39)	14.7 17.6	1.00 1.23	(0.96–1.59)
Carpets at home (%)										
No Yes	2947 196	15.0 17.9	1.00 1.23	(0.84–1.80)	32.3 35.7	1.00 1.01	(0.75–1.37	16.8 21.9	1.00 1.40	(0.98–1.98)
Fungi on house walls (%)										
No Yes	1873 1168	14.4 17.6	1.00 1.27	(1.04–1.55) *	33.8 37.6	1.00 1.18	(1.01–1.37) *	15.8 18.6	1.00 1.22	(1.01–1.47) *
Environmental tobacco smoke exposure (%)										
No Yes	1282 1758	15.9 15.0	1.00 0.93	(0.76–1.13)	32.4 37.1	1.00 1.23	(1.06–1.43) *	15.2 18.3	1.00 1.25	(1.03–1.52) *
Incense burning at home (%)										
No Yes	1382 1612	14.8 16.5	1.00 1.14	(0.94–1.39)	33.9 36.4	1.00 1.12	(0.96–1.30)	16.8 17.9	1.00 1.08	(0.90–1.31)
Residence location										
Urban Country	1009 38	17.1 7.9	1.00 0.41	(0.13–1.36)	47.4 35.5	1.00 0.61	(0.32–1.17)	18.4 15.6	1.00 0.82	(0.35–1.89) (Continued
Living near the main road										
<1 km ≥1 km	326 2524	14.4 15.7	1.00 1.11	(0.80–1.53)	35.0 37.7	1.00 0.89	(0.70–1.13)	17.8 17.0	1.00 0.95	(0.70–1.28)

*P < 0.05, Due to missing data, the total number of participants does not equal N.

Among all the allergens that were examined, the mite sensitization rate was the greatest, occurring in 29% of all individuals. For each allergen, the prevalence of other allergen sensitization by SPTs was less than four percent. Except for mites, where boys were somewhat more sensitive, there was no significant gender difference in allergen sensitivity (Table 3).

Table (2): The frequency of skin prick testing for allergy sensitizations

Characteristics	Total	Boys	%	Girls	%	P value
House dust mite	3192					0.007
–	2266	1191	69.0	1075	73.3	
D	926	535	31.0	391	26.7	
Cockroach						0.549
–	3092	1669	96.7	1423	97.1	
D	100	57	3.3	43	2.9	
Dog dander						0.926
–	3175	1717	99.5	1458	99.5	
D	17	9	0.5	8	0.5	
Milk						0.983
–	3166	1712	99.2	1454	99.2	
D	26	14	0.8	12	0.8	
Egg						0.366
–	3170	1712	99.2	1458	99.5	
D	22	14	0.8	8	0.5	
Crab						0.366
–	3170	1712	99.2	1458	99.5	
D	22	14	0.8	8	0.5	

Asthma risk was similarly elevated by cockroach sensitivity, with an OR (95% CI) of 0.97 (0.79 – 1.18). After controlling for confounding variables, the correlation among sensitization to food allergens & other aeroallergens & allergic disorders did not achieve statistical significance. Home carpets and fungi on the wall were linked to mite sensitization, with ORs (95% CIs) of 1.44 (1.06–1.94) & 1.24 (1.06–1.46), respectively (Table 4).

Table (3): Exposure to the environment and mite sensitizations

Characteristics	Total N = 3192	Mite sensitization		OR (95% CI)
		N	percent	
Day care (percent)				
No	2328.0	671	28.8	1.00
Yes	704.0	197	28.0	0.96 (0.80–1.16)
Furry pets at home (percent)				
No	2500	731	29.2	1.00
Yes	550	151	27.5	0.92 (0.75–1.13)
Cockroaches at home				
No	557.0	165.0	29.60	1.0
Yes	2541.0	735.0	28.90	0.97 (0.79–1.18)
Carpets at home (percent)				
No	2947	835	28.3	1.00
Yes	196	71	36.2	1.44 (1.06–1.94)*
Fungi on house walls (percent)				
No	1873.0	506.0	27.00	1.0
Yes	1168.0	368.0	31.50	1.24 (1.06–1.46) *
Environmental tobacco smoke exposure (percent)				
No	1758	505	28.7	1.00
Yes	1282	372	29.0	1.01 (0.87–1.19)
Incense burning at home (percent)				
No	1382	387	28.0	1.00
Yes	1612	485	30.1	1.11 (0.94–1.30)
Incense burning at home (percent)				
No	1382.0	387.0	28.00	1.00
Yes	1612.0	485.0	30.10	1.11 (0.94–1.30)
Residence location				
Urban	1009	274	27.2	1.65 (0.72–3.79)
Country	38	7	18.4	1.00
Living near the main road				
<1 km	2524.0	735.0	29.10	0.96 (0.74–1.23)
≥1 km	326.0	98.0	30.10	1.00

*P < 0.05), Due to missing data, the total number of participants did not equal N.

Breastfeeding duration was linked to milk sensitization, while cockroaches at home were linked to cockroach sensitization (Table 5). Sensitization to fuzzy pets and animal dander at home, however did not different.

Table 4: indicates a correlation between environmental exposures as assessed by a questionnaire and skin prick tests for allergy sensitization

Environment exposures	Total N = 3192	Total N = 3192		OR (95% CI)
			N	
Cockroaches at home				
No	No 557	No 10	557 1.9	No 1.00
Yes	Yes 2541	Yes 88	2541 3.5	Yes 2.00 (1.00–3.80)*
		Animal dander sensitization		OR (95% CI)
		N	%	
Furry pets at home (%)				
No	2500	13	0.5	1.00
Yes	550	4	0.7	1.40 (0.46–4.32)
		Milk sensitization		OR (95% CI)
		N	%	
Duration of breastfeeding (percent)				
No	669.0	1	0.1	1.00
< 6 months	1577.0	12	0.8	5.12 (0.67–39.47)
≥ 6 months	535.0	10	1.9	12.72 (1.62–99.71)*

*P < 0.05, Due to missing data, the total number of participants does not equal N

DISCUSSION

For certain aeroallergens, there was a strong correlation between allergen sensitivity and allergy disorders. Significant increases in the risks of AD, AR, & asthma were linked to mite sensitization; the corresponding ORs (95% CIs) were 2.15 (1.53–3.03), 1.94 (1.46–2.58), and 2.31 (1.63–3.29) [7]. According to this study, the prevalence of allergy disorders among Cairo children is rapidly increasing. It was discovered that participants who had fungi on their home walls were more susceptible to these illnesses. Mite sensitivity was the most common allergen among those chosen, and it was linked to a significant rise in the chances of asthma, AR, & AD. Other significant risk factors included the length of time spent in breastfeeding, exposure to tobacco smoke in the environment, and the presence of carpets in the home, which is supported by others [8].

The frequency of AD in children rose significantly from 7.2% in 1998 to 18% in 2002, according to earlier research. **Ho *et al.*** [3] found a frequency of 10.7% in 2008. Preschoolers in our research had a prevalence of 15.2%, which is consistent with the trend that has been observed [9].

The figure is comparable to those found in other Asian countries with comparable levels of urbanization: over 11% in Korea and 12%–13% in Japan, in developed nations, the prevalence of AR in youngsters has also sharply grown to 20% to 40%. It is in line with our 35.3% result, which is higher than the 27.6% result from 2002 Taiwan poll. The current survey found that 17% of people had asthma, which is marginally higher than both earlier Taipei data and also information from other developed nations. Estimates of the allergic phenotype of asthma were forty-two percent, which is also marginally higher than those found in earlier research. Variations in air pollution, humidity, lifestyle, temperature, & housing conditions could be the cause. The rapidly increasing incidence suggests that the environmental influences are more important than genetics [10].

Of all the risk factors gathered for our research, children who were exposed to ETS and had fungus on their home walls were more likely to develop asthma and AR. According to our survey, children exposed to ETS had a risk increase of more than 20%, which is in line with findings from a prior meta-analysis. Fungi on home walls are another exposure that can be mistaken for obvious mold and moisture. Our findings are consistent with other European cohort studies, which showed that youngsters exposed to any mold or moisture had a greater risk [10].

Our investigation found substantial odds ratios for both the amount of time spent in breastfeeding and the presence of fungi on the wall of the house for AD. There is conflicting evidence about breastfeeding's ability to protect children against allergy diseases. It might potentially be a risk factor for AD based on the statistics, but we cannot rule out other possible advantages of breastfeeding. More research is needed to define the relationship between breastfeeding & the onset of allergy diseases. Furthermore, women who nurse their infants with AD may be engaging in reverse causation [10].

Notably, out of all the allergens examined in this study, mite sensitivity had the highest prevalence. Our findings demonstrated that HDMs were important AD triggers in addition to asthma and AR. It is generally

acknowledged that the mite allergy process mostly affects asthma and AR since it mostly takes place through the airway. It is still debatable whether HDM sensitivity contributes to the onset of AD. **Brauer *et al.*** [11] meta-analysis found no proof that avoiding dust mites can prevent AD. Nonetheless, the current study's findings are consistent with the positive correlation among mite sensitivity & AD. This could be described by systemic hypersensitivity to mites through the Ig E pathway or by the breakdown of the skin barrier, which leaves youngsters susceptible to contact with the allergen [12]. We strongly believe that mite avoidance may be beneficial for a subset of possible AD youngsters. More research is needed to confirm this.

This study found risk variables for sensitivity to certain allergens. We discovered that fungus on home walls and carpets were linked to mite sensitization. This finding suggests that regular carpet maintenance and an understanding of interior humidity levels are essential. This would eliminate some significant risk factors, even if we might not be able to eliminate all potential allergen particles. Some mite-avoidance techniques include installing a dehumidifier and simply removing any furniture that resembles carpet. Interestingly, there was no substantial correlation between allergic disorders and carpets in the house, only fungi on the wall. The causative pathway from mite exposure to mite sensitization & allergy disorders may be more easily penetrated by carpet-like furniture, which may be regarded as an allergen reservoir [12].

Boys in the current study showed noticeably more HDM sensitivity than girls. Our research confirms earlier outcomes of a gender gap where male participants are more likely to experience childhood allergies, possibly because of anatomical variations and immune response profiles that make males more susceptible to allergens [13]. Additionally, we showed that the same environmental exposures were solely linked to sensitization to specific allergens. For instance, having cockroaches in the house was linked to cockroach sensitization. Cockroaches might not show up when individuals are awake, thus a positive SPT result could be a sign of trouble. Cockroaches in the home provide a risk of causing allergic disorders, particularly asthma, even though no symptoms of an allergy have been observed yet [14]. The study also found a considerable correlation between the length of breastfeeding and milk sensitization.

We used SPTs rather than multiple allergen simultaneous testing (MASTs) using blood to examine the relationships among environmental exposures, allergen sensitization & the onset of allergy illness. For kindergarten participants, SPT is favored since it is painless, easy to use, & well tolerated, even though some individuals had negative SPT findings but also experienced allergy symptoms or illnesses. Additionally, the results are available on-site in 20 minutes, and it is more sensitive and less costly. To assess the impact of total environmental exposures on children in a population size, we employ SPTs as a practical and non-invasive proxy. According to our research, the SPT is enlightening and could be a useful instrument for identifying allergy sensitivity following environmental exposures. This could aid in the early prevention of allergy illness development. The interpretation of our findings may be impacted by some possible limitations of the current investigation. First, we evaluated exposure using a questionnaire in the absence of objective data. Nonetheless, the questionnaire's validity for measuring exposures, including ETS & pet exposure, has been acknowledged & it can be used as a suitable alternative to laboratory data. Additionally, some researchers contend that participants often understate exposures, which skews the results in favour of the null hypothesis. Therefore, in such a huge population, the questionnaire remains a valid metric [15].

Second, an indirect evaluation of some environmental risk variables was conducted. However, in such a large-scale, population-based epidemiological investigation, direct environmental exposure assessment is extremely challenging. SPTs were therefore employed as a practical and non-invasive stand-in for allergy sensitization on a population level, particularly in children. Through allergen sensitivity profiles, we can still use indirect evidence to tell community members that there may be some environmental risk factors for allergy disorders. Another drawback, particularly about respiratory outcomes, is recall bias. Nonetheless, a subset of the study population was asked to recollect their status as having an allergic condition, and there was a positive correlation between parental accounts and medical records. Lastly, the causal association was not proven by the cross-sectional investigation. There should be more investigation [16].

The study does, however, have several advantages. We conducted the first population-based study to show how environmental risk factors, allergen sensitivity, and allergy disorders are related. A sizable number of people participated in Taiwan's largest cross-sectional preschool survey. There was no discernible demographic difference between the Taiwanese population of the same age and the research cohort [17].

Comprehensive environmental elements about possible health concerns associated with the atopic process pathway, which encompassed both the skin & the airways, were also discussed in our study. There are common risk variables for these environmental exposures that are very generalizable for comparison with those in other nations. To identify numerous important allergens, we also used SPTs to deliver an allergy sensitization survey [18].

We found that all three prevalent allergy disorders were substantially correlated with both mite sensitivity and fungus on home walls. Additionally, mite sensitization was the most prevalent. The findings provide credence to the idea that avoiding mites and

keeping the house dry may help stop allergy illnesses from developing. So, our contribution can provide pertinent information for long-term health policy making, community and mass media public education, and patients in medical systems [19].

CONCLUSIONS

The development of allergy disorders is influenced by environmental exposures. The development of allergy disorders may be avoided by lowering exposure to indoor allergens and environmental risk factors. There is an urgent need for early environmental interventions.

Abbreviations

OR: odd ratio; **CI:** confidence interval; **AD:** atopic dermatitis; **AR:** allergic rhinitis; **ISAAC:** International Study of Asthma & Allergies in Childhood; **ETS:** environmental tobacco smoke; **SPTs:** skin prick tests; **HDMs:** house dust mites.

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