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Characteristics of Infants with Early Life Sensitization to House Dust Mites

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Characteristics of Infants with Early Life Sensitization to House Dust Mites

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Abstract

Sensitization to house dust mites (HDM) in early life is a risk factor for poor respiratory allergy outcomes. We analyzed characteristics of HDM sIgE positive infants and compare with negative infants under the age of 2. Of the 1,793 infants who tested for HDM sIgE, 96 (5.4%) had HDM sensitization. In the HDM (+) group, atopic dermatitis was 74.0% (90.9% at the age of less than 12 months), food allergies 57.3% (<12 months, 100%), egg white sensitization 71.9% (<12 months, 90.9%), and cow's milk sensitization 56.3% (<12 months, 81.8%). Atopic dermatitis, food allergy, ≥4 episodes of wheezing, physician-diagnosed asthma, allergic rhinitis, egg white sensitization, cow's milk sensitization, and sensitization to three or more food allergens were significantly more frequent in the HDM (+) group compared to the HDM (-) group. The HDM sIgE and total IgE levels and HDM sIgE and egg white sIgE levels showed significant correlations. HDM sensitization in infants is mostly accompanied by atopic dermatitis and egg white sensitization. Early sensitization to HDMs should be carefully observed in infants with atopic dermatitis and food allergies, especially those with high total IgE and egg white sIgE.

Keywords: allergens; House Dust Mites; Immunoglobulin E; infants

1. Introduction

House dust mites (HDM) were first suspected of causing allergens in 1928 and have been recognized as an important cause of allergic diseases since 1968 [1,2]. HDMs are the most common of all allergens that cause allergies, especially respiratory allergies. *Dermatophaoides farinae* (*D. farinae*) and *Dermatophagoides pteronysius* (*D. pteronysius*) account for 90% of all HDMs. Different regions have different rates of sensitization to *D. farinae* and *D. pteronysius*. The HDMs collected in Korea are predominantly *D. farinae* at 65%, followed by about 21% for *D. pteronysius* [3]. In Korea, the sensitization rate of *D. farinae* is higher than that of *D. pteronysius* overall and is more evident in children, so *D. farinae* tends to sensitize before *D. pteronysius* [4–6].

Children's allergic diseases have the characteristic of an "allergic march." In children who exhibit allergic marches, atopic dermatitis occurs first after they have been sensitized to food allergens, and food allergy symptoms then occur. When a child grows up to be preschool age, sensitization to inhalation allergens such as HDMs becomes more prevalent than food allergens and often leads to respiratory allergies such as rhinitis and asthma [7–9]. In Korea, HDM sensitization in patients with atopic dermatitis is reportedly 27.9%–68.8%, and 40%–60% of patients with respiratory allergies or allergic rhinitis and asthma are sensitive to HDMs [5]. More than 50% of asthmatics are sensitized to HDMs, and the incidence and severity of asthma are strongly linked to HDM allergies [10–12].

Early exposure to HDMs is an important factor in the development of HDM sensitization and infantile asthma [13,14]. Early sensitization to HDMs is reported to further degrade lung function and is an important risk factor for poor respiratory allergy outcomes [15,16]. Young children with HDM sensitization and allergies need a quick diagnosis and early treatment for a good prognosis, and it is important to know the characteristics of infant groups with early HDM sensitization.

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We aimed to identify the characteristics of infants under 24 months of age with sensitization to HDMs and to compare them with infants who were not sensitized.

2. Materials and Methods

Target Population

For this study, we targeted infants under 24 months of age who had visited our clinic for allergic diseases such as atopic dermatitis, rhinitis, asthma, recurrent wheezing, and food allergies and who had received an HDM-specific immunoglobulin E (sIgE) test. The infants in the HDM (+) group were defined as those whose *D. farinae* sIgE tests were positive at 0.35 kU/L or higher. The HDM (−) group, as the control group, consisted of infants whose *D. farinae* sIgE tests were negative, with one-on-one matching gender and age to the target group. The reason *D. farinae* was chosen among the HDM allergens is because *D. farinae* is the earliest and most commonly sensitized HDM allergen in Korean children.

Methods

Using retrospective medical records, the data about the types of allergic diseases diagnosed by doctors were collected, and the results of the ImmunoCAP test (ThermoFisher Scientific, Uppsala, Sweden), including *D. farinae* sIgE, egg white sIgE, cow's milk sIgE, and total IgE were analyzed. We calculated the percentage of patients who were positive for *D. farinae* sIgE among all the infants under 24 months of age and under 12 months of age. The types of allergic diseases diagnosed in the HDM (+) group infants were then analyzed. The HDM (−) group was selected as a control group by matching participants 1:1 with the HDM (+) group based on age and sex, allowing for comparative analysis between the two groups. The results of the ImmunoCAP test and clinical manifestations of the HDM (+) and HDM (−) groups were compared.

Statistical Analysis

Categorical variables are presented as n (%) and continuous variables as mean ± SD. The differences in the test results between the two groups were compared using the Wilcoxon signed-rank test. HDM(+) versus HDM(−) infants were compared using McNemar's test. The correlations between the test results were assessed using Spearman's rank correlation test. A *P*-value less than 0.05 was considered statistically significant. P-values were calculated using two-sided tests. All analyses were conducted using R 4.5.0 (R Core Team, 2025), a language and environment for statistical computing distributed by the R Foundation for Statistical Computing, Vienna, Austria (https://www.R-project.org/).

Ethical Considerations

The present study protocol was approved by the Research Ethics Committee of Hallym University Dongtan Sacred Heart Hospital prior to the initiation of the study (approval no. 2021-08-008).

3. Results

Clinical Characteristics of the HDM-Sensitized Infants

Of the 1,793 children under 24 months of age who participated in the study, 96 (5.4%) had HDM sensitization. Of the 739 infants under 12 months of age, 11 (1.5%) were sensitive to HDMs, and 85 (8.1%) of the 1,054 children between 12 and 24 months of age were sensitive to HDMs.

Among infants with HDM sensitization, 74.0% had atopic dermatitis, and 57.3% were diagnosed with food allergies by physicians. Additionally, 45.8% of the subjects were recurrent wheezers (≥ 4 times) at the time of examination. When we did separate analysis of younger infants under 12 months

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old, 90.9% had atopic dermatitis and all the infants had food allergies. Recurrent wheezers accounted for 36.4% (Table 1).

Table 1. Demographic characteristics of infants with house dust mite sensitization.

	N (%) or mean ± SD	
	Infants < 24 months (N=96)	Infants < 12 months (N=11)
Age (months)	**17.2 ± 4.3**	**10.3 ± 0.9**
Male	**63 (64.6%)**	**8 (72.7%)**
Doctor-diagnosed allergic disease		
Atopic dermatitis	**71 (74.0%)**	**10 (90.9%)**
Food allergy	**55 (57.3%)**	**11 (100%)**
Anaphylaxis	**10 (10.4%)**	**2 (18.2%)**
Recurrent wheezing (≥ 4 times)	**31 (32.3%)**	**4 (36.4%)**
Asthma	**23 (24.2%)**	**3 (27.3%)**
Allergic rhinitis	**30 (31.2%)**	**2 (18.2%)**

Categorical variables are presented as n (%) and continuous variables as mean ± SD.

Laboratory Data of HDM-Sensitized Infants

Among the children under 24 months of age with HDM sensitization, 71.9% had concomitant egg white sensitization, 56.3% had cow's milk sensitization, and 50% had multiple food sensitization to more than three food allergens. Of the children under 12 months of age with HDM sensitization, 90.9% had concomitant egg white sensitization, 81.8% had cow's milk sensitization and 72.7% had multiple food sensitization (Table 2). Three of the subjects had the maximum *D. farinae* sIgE levels of 100 kU/L. One of these patients was 10 months old, had a family history of allergic diseases, and had all kinds of allergic diseases such as atopic dermatitis, food allergy, infantile asthma, and allergic rhinitis.

Table 2. Allergy test results of infants with house dust mite sensitization.

Characteristics	N (%) or mean ± SD	
	Infants <24 months	Infants <12 months
Total IgE* (kU/L)	**415.0 ± 674.1**	**368.2 ± 718.9**
HDM† sIgE‡ (kU/L)	**12.4 ± 23.6**	**13.3 ± 29.5**
Egg white sensitization	**69 (75.0%)**	**10 (90.9%)**
Cow's milk sIgE sensitization	**54 (62.8%)**	**9 (81.8%)**
Multiple food sensitization (≥ 3 food allergens)	**48 (51.1%)**	**8 (72.7%)**

* HDM, House dust mites; IgE, Immunoglobulin E; sIgE, Specific immunoglobulin E. Categorical variables are presented as n (%) and continuous variables as mean ± SD.

Comparison Between the HDM (+) and HDM (-) Groups

The HDM (+) group had significantly more patients diagnosed with atopic dermatitis (74.0% vs. 21.9%, P<0.001), and food allergies (57.3% vs. 15.6%, P=0.000) compared to the HDM (−) group. However, there was no statistically significant difference in the occurrence of anaphylaxis between the HDM (+) and HDM (+) groups. (10.4% vs. 3.1%, P=0.096). Recurrent wheezing (≥4 episodes) (32.3% vs. 2.1%, P<0.001) and asthma diagnosis (24.2% vs. 1.0%, P<0.001) was significantly higher in the HDM (+) group. Allergic rhinitis diagnosed by a doctor was also significantly higher in the HDM

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(+) group (31.2% vs. 5.2%, *P*<0.001). There was no significant difference in urticaria in the two groups. Egg white sensitization showed a significant difference of 75.0% in the HDM (+) group and 33.0% in the HDM (−) group (*P*<0.001), and cow's milk sensitization also differed (62.8% vs. 38.7%, *P*=0.007). Multiple sensitization cases in three or more foods were significantly higher in the HDM (+) group comparing HDM (−) group (51.1% vs. 8.3%, *P*<0.001) (Table 3).

Table 3. Comparison between the HDM (+) and HDM (−) groups of infants (<24 months).

Variables	HDM (+) group	HDM (−) group	*P*-value
Atopic dermatitis	**71 (74.0)**	**21 (21.9)**	**<0.001*** **
Food allergy	**55 (57.3)**	**15 (15.6)**	**<0.001*** **
Anaphylaxis	**10 (10.4)**	**3 (3.1)**	**0.096**
Recurrent wheezing (≥ 4 times)	**31 (32.3)**	**2 (2.1)**	**<0.001*** **
Asthma	**23 (24.2)**	**1 (1.0)**	**<0.001*** **
Allergic rhinitis	**30 (31.2)**	**5 (5.2)**	**<0.001*** **
Urticaria	**19 (19.8)**	**18 (18.8)**	**1.000**
Egg white sensitization	**69 (75.0)**	**31 (33.0)**	**<0.001*** **
Milk sIgE sensitization	**54 (62.8)**	**36 (38.7)**	**0.007****
Multiple food sensitization (≥ 3 food allergens)	**48 (51.1)**	**8 (8.3)**	**<0.001*** **

* HDM, House dust mites; IgE, Immunoglobulin E; sIgE, Specific immunoglobulin E. HDM(+) versus HDM(−) infants were compared using McNemar's test. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

The Wilcoxon signed-rank test results showed a significant difference between the two groups in the egg white and cow's milk sIgE levels. Total IgE values were log-transformed to approximate a normal distribution, and the paired t-test was performed using the log-transformed data. The total IgE was significantly higher in the HDM (+) group than in the HDM (−) group. In the HDM (+) group, the mean level of egg white sIgE was 16.13 kU/L, whereas in the HDM (−) group, this was 1.15 kU/L. The mean value of cow's milk sIgE in the HDM (+) group was 6.08 kU/L and 0.67 kU/L in the HDM (−) group (Table 4).

Table 4. Laboratory findings in the HDM (+) and HDM (−) groups of infants (<24 months).

Variables	HDM (+) group (mean ± SD)	HDM (−) group (mean ± SD)	*P*-value
Log(total IgE +1)	**2.17 ± 0.64**	**1.57 ± 0.66**	**≤ 0.001**
Egg white sIgE (kU/L)	**16.13 ± 29.65**	**1.15 ± 3.30**	**≤0.001**
Cow's milk sIgE (kU/L)	**6.08 ± 16.20**	**0.67 ± 1.36**	**0.001**

* HDM, House dust mites; IgE, Immunoglobulin E; sIgE, Specific immunoglobulin E. Values are expressed as mean ± SD. *P*-values for log-transformed total IgE were calculated using the paired t- test, whereas *P*-values for the remaining variables were calculated using the Wilcoxon signed-rank test.

In the HDM (+) group, the *D. farinae* sIgE and total IgE levels and *D. farinae* sIgE and egg white sIgE levels showed statistically significant moderate correlations (coefficient 0.326, *P*=0.002; coefficient 0.312, *P*=0.002, respectively), *D. farinae* sIgE and cow's milk sIgE levels showed a statistically significant weak correlation with a coefficient of 0.215 (p = 0.047). (Table 5).

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Table 5. Factors that are correlated with HDM levels.

	Total IgE coefficient (*P*-value)	Egg white sIgE coefficient (*P*-value)	Cow's milk sIgE coefficient (*P*-value)
HDM sIgE	**0.326 (0.002)**	**0.312 (0.002)**	**0.215 (0.047)**

* HDM, House dust mites; IgE, Immunoglobulin E; sIgE, Specific immunoglobulin E. Because the variables were not normally distributed, Spearman's rank correlation test was used to assess relationships between HDM sIgE and total IgE, egg white sIgE, and cow's milk sIgE. Correlation coefficients (ϱ) and corresponding p-values are presented in this table.

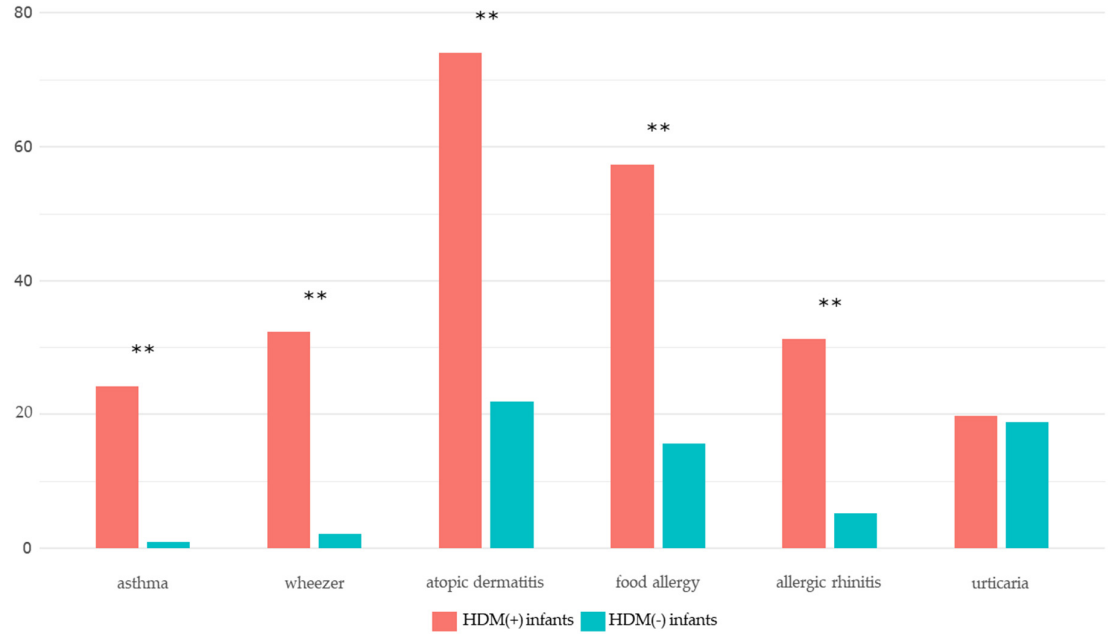

Figure 1. Comparison of allergic diseases between the HDM(+) and HDM(−) groups (**$P < 0.01$, ***$P < 0.001$).

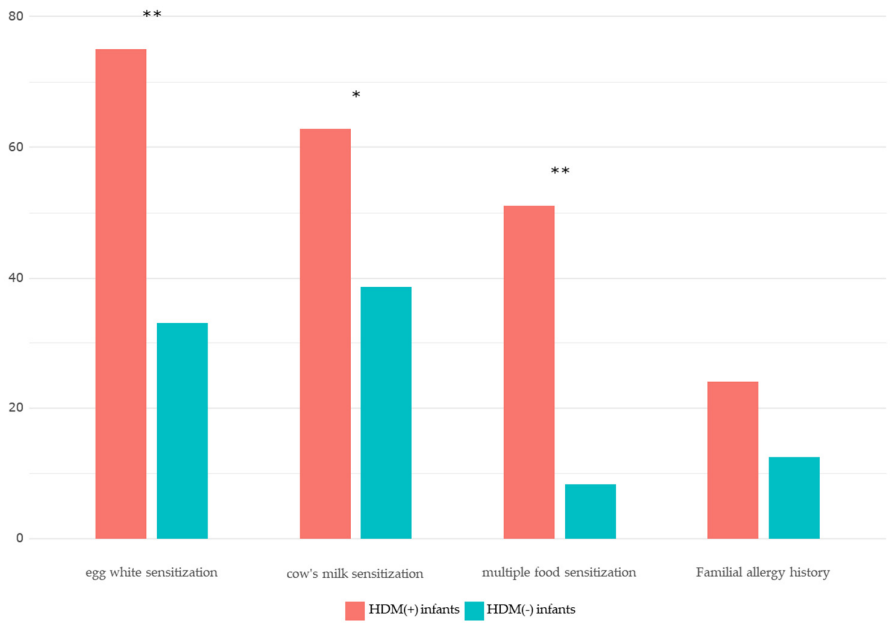

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Figure 2. Comparison of allergy test results and family history of allergic diseases between the HDM(+) and HDM(−) groups (**$P < 0.01$, ***$P < 0.001$).

3. Discussion

In this study, the HDM sensitization rate for the infants under 2 years of age who visited the allergy clinic in our hospital was 5.4%. Sensitization to house dust mites (HDM) is generally considered uncommon in infants. However, a study from Belgium reported that up to 28% of infants under the age of two who visited an asthma clinic were sensitized to aeroallergens, with the majority being sensitized to HDM [17]. In a cohort study from Thailand, approximately 30% of children aged 1.5 to 2 years were found to be sensitized to HDM, although two-thirds of them were asymptomatic. The study attributed this high rate of asymptomatic HDM sensitization to the region's humid climate [15]. Korea has a unique heating system called Ondol and has an environment with less carpeting than in foreign countries, so it is believed that the HDM sensitization in Korea differs from that in other countries. However, as the environment and lifestyles in Korea have become more Westernized, the rate of HDM sensitization has increased [5]. According to domestic data released in 2010, 32.4% of elementary school students, 42.7% of middle school students, and 57.2% of children living in metropolitan cities were sensitized to HDMs [4].

While controversy exists over how early exposure to HDMs affects respiratory allergies [12,18], several reports have shown that HDM sensitization at an early age affects lung function after childhood. In a birth cohort study, even the asymptomatic toddlers with early HDM sensitization had a higher rate of asthma, allergic rhinitis at age 7 years, higher exhaled nitric oxide levels, and a higher prevalence of airway hyperresponsiveness [15,19]. Since this was a retrospective study, it was not possible to analyze the children's prognoses, such as the severity of respiratory allergic disease, or to conduct lung function tests in the early HDM sensitization groups. However, 32.3% of the infants with HDM sensitization had recurrent wheezing at the time of the survey, and 22.9% had already been diagnosed with infantile asthma.

In the first year of life, IgE antibody responses are initially directed toward food allergens and, later, indoor and outdoor allergens. Early onset of sensitization means longer sensitization [20]. The harmful effects of indoor allergen exposure interacting with sensitization to allergens are most pronounced during the first 3 years of life. Children's adaptive immunity is mature over 6 years of age, but the most important step to developing mature systemic immune responses takes place at 1–2 years of age [21].

There is growing evidence that people can be sensitized to allergens through an impaired skin barrier. It is thought that infants with skin barriers damaged by atopic dermatitis are sensitized to food allergens and that this causes the allergic march to begin [22–24]. It has also been reported that people can be sensitized to HDMs through an impaired skin barrier. A study from France reported a high rate of delayed sensitization to inhalant allergens in infants with atopic dermatitis, and found that higher transepidermal water loss was associated with an increased rate of inhalant allergen sensitization [25]. In the current study, 74% of the infants under 2 years of age and 90.9% of the infants under 1 years of age with HDM sensitization had atopic dermatitis. Infants with severe atopic dermatitis should be suspected of having aeroallergen sensitization through skin.

Among the children under 24 months of age with HDM sensitization in our study, 71.9% had concomitant egg white sensitization, 56.3% had cow's milk sensitization, and 50% had multiple food sensitization to more than three food allergens. Infants under 12 months of age showed a greater food allergen sensitization rate if they had HDM sensitization (egg white sensitization 90.9%, cow's milk sensitization 81.8%, multiple food sensitization 72.7%). Infants with HDM sensitization exhibited significantly higher levels of egg white–specific IgE, cow's milk–specific IgE, and total IgE compared to those without HDM sensitization. These findings suggest that infants with atopic dermatitis who are sensitized to egg, milk, or multiple foods may be at increased risk for HDM sensitization. Clinicians should therefore consider evaluating HDM sensitization in such infants.

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One study reported a close positive correlation between egg white- and HDM-specific immune responses in infants with atopic dermatitis. The authors explained that these results may support the hypothesis that both food and indoor allergens sensitize infants concurrently via the skin [26]. A Danish birth cohort reported that early life sensitization to hens' eggs was associated with asthma and rhinoconjunctivitis at 14 years. In the same study, the authors established that transient early life sensitization to HDMs produced an increased risk of asthma (adjusted odds ratio 3.80) at 14 years [27]. In our study, infants with HDM sensitization had a significantly higher rate of egg white sensitization compared to those without HDM sensitization, and HDM-specific IgE levels showed a significant correlation with egg white–specific IgE levels within the HDM-sensitized group.

In high-risk infants, HDM sensitization seems to have a negative effect on respiratory outcomes, so environmental management to reduce HDM sensitization from an early age is necessary to prevent HDM sensitization [28,29].

A limitation of this study is that a retrospective data analysis rather than a prospective study was conducted, and we thus failed to compare the long-term outcomes of respiratory allergies in early life HDM-sensitized infants to those who are not HDM-sensitized. However, this study employed a matched case-control design with 1:1 matching for age and sex, which offers several advantages, including control of confounding variables, improved statistical precision, high efficiency even in small sample sizes, and greater clarity in interpretation. Furthermore, by analyzing the characteristics of infants with early sensitization to HDMs, this study contributes to a better understanding of and heightened alertness toward a population potentially at risk for adverse respiratory outcomes.

In conclusion, early-life HDM sensitization in infants was frequently accompanied by multiple food sensitizations, particularly to egg white, and was commonly associated with atopic dermatitis. Given these associations, early HDM sensitization should be carefully evaluated, especially in infants presenting with atopic dermatitis, food allergies, or elevated levels of total IgE and egg white–specific IgE.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

HDM	house dust mites

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