

Patterns of Psychosocial Adaptation and Allergic Disorders in Korean Schoolchildren

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Key Words

Allergic disorder • Asthma • Child Behavior Checklist • Psychosocial adaptation • Sensitization • Children

Abstract

Background: To date, there is little evidence to support an association between symptoms of pediatric allergic disorders and psychosocial factors in the general population, particularly in Asian countries. The current study aims to investigate the relationship between psychosocial factors and symptoms of allergic disorders and to investigate the association between behavior problems and biomarkers of atopy. **Methods:** A cross-sectional survey of parental responses to the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire and the Korean version of the Child Behavior Checklist (CBCL) was conducted from one elementary school in Seoul, Korea. Skin prick tests for 18 major allergens were also performed. **Results:** A total of 780 children with valid CBCL surveys were included in the study. Externalizing problems were significantly larger in children with asthmatic symptoms, while internalizing problems were significantly larger in children with symptoms of both

asthma and allergic rhinitis. Social adaptations were significantly lower in children with symptoms of allergic rhinitis and atopic dermatitis. Boys with more positive allergens via the skin prick tests showed larger internalizing problems. **Conclusions:** While school children with allergic symptoms have been reported to have more difficulties with psychosocial adaptation, the patterns of psychosocial problems varied somewhat according to the types of atopic disorder. There was a positive relationship between atopy and behavior problems, especially in boys.

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Introduction

Pediatric allergic disorders including asthma, atopic dermatitis and allergic rhinitis, are receiving major attention in current pediatric care, because of their increasing prevalence, their chronic course and the high costs for

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health care [1]. In Korea, asthma-related costs rank number one among childhood illness, and the socioeconomic burden of the disorder is increasing in all age brackets [2].

Like many other chronic pediatric illness, studies have reported increased psychosocial adaptation problems in children with allergic disorders, especially in asthma. A recent meta-analysis of 78 studies found that there was an increase (by approximately one half to two thirds of a standard deviation) in behavioral problems among asthmatic children relative to comparison groups, and that differences are more evident within the domain of internalizing problems [3]. In asthmatic children, clinically significant behavioral problems were associated with a greater frequency of wheezing [4]. Moreover, the results of longitudinal studies and a nationwide mental health survey were consistent with there being a strong association between pediatric asthma and behavioral problems [5, 6]. Children with allergic rhinitis also have been reported to have mental complications, such as sleep disturbances, poor school performance and hyperactivity [7]. Atopic dermatitis has been documented to affect the emotional health of children as well as the social functioning of children and parents [8, 9].

However, there have been a number of pitfalls in the studies of psychosocial adjustment in children with allergic disorders. The sample of convenience and clinical samples in the majority of studies were not methodologically as sound as large population-based samples [10, 11]. Studies did not always control for socioeconomic status or other potentially confounding demographic variables. And valid, objective tools for measuring behavior problems and determining allergic disorders were not always used in large population-based studies. Furthermore, the majority of studies of behavioral adjustment in children with allergic disorders were done in Western countries, including the UK [6] and the United States [12], but studies from Asian countries where we expect many differences in culture and ethnicity are lacking.

Besides the above-mentioned methodological problems, the mechanisms of the association between psychological problems and pediatric allergic disorders are not clear yet [13]. Historically, psychological aspects have been considered as determining factors. For example, asthma has been included in lists of psychosomatic illnesses [14, 15]. However, as it is increasingly clear that the central pathogenesis of allergic disorders lies in interactions between the immune system and environmental exposure to allergens, psychosocial factors have been considered as factors favoring the illness [16] or even more so as a consequence of the illness [17].

Table 1. Subject characteristics

	Study population	Total school population
Number	780	1,376
Age, year	9.57 ± 1.74	9.43 ± 1.76
Sex, M/F	408/372	740/636
Body mass index	18.46 ± 7.15	18.57 ± 7.17
Economic state (monthly income)		
Low, ≤2,999 USD	184 (28.0)	362 (31.0)
Middle, 3,000–4,990 USD	409 (62.1)	685 (58.7)
High, ≥5,000 USD	65 (9.9)	120 (10.2)
Asthma history of father	5/515 (1.0)	12/890 (1.3)
Asthma history of mother	0/574 (0.0)	23/969 (2.4)
Asthma history of sibling	63/527 (12.0)	100/930 (10.8)
Environmental tobacco smoking	321/361 (41.2)	587/1,207 (42.7)
Eosinophils, %	3.51 ± 2.63	3.57 ± 2.55
Total IgE, IU/ml ¹	58.45 ± 4.05	58.43 ± 4.01
Atopy ²	283/657 (43.1)	491/1,159 (42.4)

There was no significant difference between the two groups, with the exception of a history of asthma in the mother ($p < 0.001$). Figures in parentheses are percentages.

¹ Geometric mean.

² Positive skin prick test to at least one allergen.

On the other hand, a recent theory of psychoneuroendocrinology emphasizing the importance of interactions among neural, endocrine and immune systems in atopy and allergic disorders [18, 19] has indicated that psychosocial stress plays an important role in increasing morbidity and mortality as well as the susceptibility of allergic disorders [20–22]. Although there are relatively few studies so far, current evidence shows that allergic responses are modulated by mood and psychological stressors [23, 24] or enhanced allergic inflammatory responses by stress [25]. Therefore, there is an increasing need for studies to reveal the patterns of interaction between psychological problems and underlying immunological predispositions of allergic disorder, such as atopy.

The aims of the present study are as follows. First, we tried to reveal the association between the psychosocial adaptation and major symptoms of pediatric allergic disorders, using valid objective measures, in a homogenous community population in Korea. This study design will allow us to minimize other confounding factors and biases caused by sample of convenience and clinical groups. Second, we aimed to observe the pattern of interactions between behavioral problems and biomarkers of atopy in the general population.

Methods

Subjects

All the children who attended one elementary school in Seoul, Korea, were invited to participate in the present study (total 1,376; age 7–12 years; male:female 740:636; table 1). The study design included administering a survey, measuring serum total IgE level and performing skin prick tests for 18 major allergens. We used a modified International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire [26] for determining the prevalence of symptoms and diagnosing allergic diseases, and the Korean version of the Child Behavior Checklist (CBCL) for assessing externalizing/internalizing behavior problems and social adaptation [27]. All questionnaires consisted of parental responses, and were distributed through and collected back from the school. The response rates were 98.6% for the ISAAC questionnaire and 84.0% for CBCL. Of totally 1,376 students, only 780 children whose parents responded to both the ISAAC and CBCL questionnaire completely were included in the present study and the statistical analysis because the rest had CBCL data with more than 4 missing items. According to the K-CBCL manual, data with more than 4 missing items in the K-CBCL questionnaire do not guarantee the validation of the results [27]. There were no significant differences in the prevalence of allergic disorders and socioeconomic status between the study population and the total school population (table 2). The study protocol was approved by the institutional review board of the University of Ulsan College of Medicine. Written consents were obtained from the parents of all participants after they were fully informed of the details of the study.

Questionnaires

ISAAC provides a useful standardized questionnaire for determining the prevalence of allergic diseases [26]. The modified Korean version of ISAAC was previously validated as a tool for assessing allergic symptoms and diagnoses in Korean children [28]. The written questionnaire is largely composed of three parts. The first part consists of general items such as name, year and date of birth, gender, height, and weight. The second part focuses on history of allergic diseases (bronchial asthma, allergic rhinitis, atopic dermatitis, allergic conjunctivitis and food allergy). The third part is about environmental factors pertinent to allergic diseases.

Child Behavior Checklist

Data on the behavior problems and social adaptation of the children was obtained using the modified K-CBCL [27]. The CBCL is a well-known scale that is widely used to assess not only symptoms of behavior problems, but also social adaptation among children. Studies on the reliability and validity of the CBCL have been extensively summarized in the Achenbach manual [29] and the CBCL's multicultural robustness has also been demonstrated [30].

Studies of the K-CBCL version showed good validity and reliability [31, 32]. The CBCL includes subscales that assess symptoms of externalizing and internalizing problems, and social adaptation. The externalizing problem scale lists 32 items, including subscales of 'aggression' (e.g. destroys his/her own things) and 'delinquency' (e.g. steals at home), while the internalizing problem scale lists 23 items, including subscales of 'withdrawn' (e.g. would rather be alone than with others) and 'anxious/depressed'

Table 2. Prevalence of diagnosis and symptoms of allergic diseases in the study population versus total population

Symptoms of AD	Study population	Total school population
<i>Asthma</i>		
Wheeze, ever	83/599 (13.9)	134/1,053 (12.7)
Wheeze, last 12 months	44/680 (6.5)	66/1,196 (5.5)
Asthma diagnosis, ever	70/672 (10.4)	114/1,193 (9.6)
Treatment of asthma		
last 12 months	24/619 (3.9)	38/1,101 (3.5)
Current asthma ¹	25/699 (3.6)	34/1,233 (2.8)
<i>AR</i>		
AR Sx, ever	272/635 (42.8)	474/1,116 (42.5)
AR Sx, last 12 months	262/664 (39.5)	453/1,163 (39.0)
AR diagnosis, ever	263/664 (39.6)	446/1,159 (38.5)
Treatment of AR		
last 12 months	193/659 (29.3)	339/1,151 (83.6)
Current AR ¹	177/688 (25.7)	292/1,208 (24.2)
<i>AD</i>		
AD Sx, ever	169/699 (24.2)	306/1,232 (24.8)
AD Sx, last 12 months	116/702 (16.5)	219/1,239 (17.7)
AD diagnosis, ever	215/688 (31.3)	388/1,216 (31.9)
Treatment of AD		
last 12 months	92/684 (13.5)	158/1,210 (13.1)
Current AD ¹	93/699 (13.3)	173/1,058 (14.1)

Figures in parentheses are percentages. The prevalence of symptoms of allergic disease was not significantly different between the study population and total population. AR = Allergic rhinitis; Sx = symptoms; AD = allergic disease.

¹ Current allergic disease: current symptoms plus disease diagnosis ever.

(e.g. unhappy, sad or depressed). The social problem scale consists of 16 items, including subscales of 'activities' (e.g. compared to others of the same age, about how much time does he/she spend in each sports), 'social' (e.g. about how many times a week does your child do things with any friends outside the regular school hours) and 'school' (e.g. performance in academic subjects). The English version of a sample CBCL can be found on <http://www.aseba.org/products/cbcl6-18.html>. Higher scores on the internalizing and externalizing scales indicate that the child has more problems. On the other hand, higher scores on the social problem scale indicate that the children exhibit a higher level of social adaptation.

Serum Total IgE and Skin Prick Tests

The concentration of total serum IgE was measured by fluorescent enzyme immunoassay using the AutoCAP System (Phadia AB, Uppsala, Sweden). Skin prick tests were performed for 18 common Korean inhalant and food allergens with negative and positive controls (Allergopharma, Reinbek, Germany). These included the house dust mites *Dermatophagoides pteronyssinus*,

Table 3. Comparison of externalizing problem scores for children with and without symptoms of allergic disease (mean $\pm$ SD)

	n	Yes	n	No	p value
Asthma					
Wheeze, ever	83	3.27 $\pm$ 3.94	516	3.53 $\pm$ 4.45	0.604
Wheeze, last 12 months	44	5.52 $\pm$ 5.19	636	3.49 $\pm$ 4.48	0.013
Asthma diagnosis, ever	70	5.07 $\pm$ 5.53	602	3.35 $\pm$ 4.26	0.014
Treatment of asthma, last 12 months	25	3.09 $\pm$ 4.22	594	3.60 $\pm$ 4.45	0.548
Current asthma ¹	25	4.05 $\pm$ 4.54	674	3.55 $\pm$ 4.51	0.615
AR					
AR Sx, ever	272	3.52 $\pm$ 4.16	363	3.60 $\pm$ 4.53	0.827
AR Sx, last 12 months	262	3.79 $\pm$ 4.48	382	3.53 $\pm$ 4.63	0.472
AR diagnosis, ever	263	3.70 $\pm$ 4.18	401	3.42 $\pm$ 4.58	0.420
Treatment of AR, last 12 months	193	3.58 $\pm$ 4.24	466	3.55 $\pm$ 4.51	0.930
Current AR ¹	177	3.64 $\pm$ 4.06	511	3.48 $\pm$ 4.54	0.674
AD					
AD Sx, ever	169	3.73 $\pm$ 4.77	530	3.40 $\pm$ 4.14	0.420
AD Sx, last 12 months	116	4.10 $\pm$ 4.65	586	3.45 $\pm$ 4.46	0.124
AD diagnosis, ever	215	3.84 $\pm$ 4.11	473	3.41 $\pm$ 4.70	0.235
Treatment of AD, last 12 months	92	3.87 $\pm$ 4.17	592	3.53 $\pm$ 4.59	0.482
Current AD ¹	93	3.99 $\pm$ 4.58	606	3.48 $\pm$ 4.47	0.615

AR = Allergic rhinitis; Sx = symptoms; AD = allergic disease.

¹ Current allergic disease: current symptoms plus disease diagnosis ever.

D. farinae, cat, dog, cockroach, the molds *Alternaria alternata* and *Aspergillus fumigatus*, grass, tree mix (I), tree mix (II), oak, alder, mugwort, ragweed, egg, milk, peanut and soybean. A mean wheal diameter of at least 3 mm greater than the negative control was taken as positive. Atopy was defined as a presence of one or more positive allergens via the skin prick test.

Statistical Analysis

Statistical analysis was carried out using SPSS version 12.0. The independent samples t test was used to examine differences in CBCL scores between children with and without symptoms of allergic disorders. χ^2 analysis was used to examine the distribution of demographic data between two groups. The ANOVA test was used to examine differences in CBCL scores according to the degree of sensitization in skin prick test. Logistic regression was used to assess the impact of the number of positive allergens on CBCL scores while controlling for age and gender.

Results

Prevalence of Allergic Disorders

The lifetime and 12-month prevalence of wheezing were 13.9 and 6.5%, respectively. The lifetime prevalence of asthma diagnosis was 10.4%, while the 12-month prevalence of asthma treatment was 3.9% and the prevalence of current asthma was 3.6%. The prevalence of allergic

rhinitis was as follows: lifetime and 12-month prevalence of symptoms were 42.8 and 39.5%, respectively; lifetime prevalence of diagnosis was 39.6%; 12-month prevalence of treatment was 29.3%; prevalence of current allergic rhinitis was 25.7%. With respect to atopic dermatitis, the lifetime and 12-month prevalence of symptoms were 24.2 and 16.5%, respectively, while the lifetime prevalence of diagnosis, the 12-month prevalence of treatment and the prevalence of current atopic dermatitis were 31.3, 13.5 and 13.3%, respectively. There was no significant difference in the prevalence of allergic disorders between the study population and the total population at the school (table 2).

Comparison of Externalizing Problems between Children with and without Symptoms of Allergic Disorders

Children with a recent 12-month history of symptoms of asthma and children with asthma diagnoses exhibited higher externalizing problem scores than children without these symptoms. There were no differences in externalizing problem scores between children with allergic rhinitis or atopic dermatitis and children without these symptoms (table 3).

Table 4. Comparison of internalizing problem scores for children with and without symptoms of allergic disease (mean $\pm$ SD)

	n	Yes	n	No	p value
Asthma					
Wheeze, ever	83	2.27 $\pm$ 3.54	516	2.55 $\pm$ 3.62	0.505
Wheeze, last 12 months	44	4.40 $\pm$ 4.57	636	2.51 $\pm$ 3.55	0.011
Asthma diagnosis, ever	70	3.22 $\pm$ 3.82	602	2.49 $\pm$ 3.56	0.125
Treatment of asthma, last 12 months	25	2.91 $\pm$ 4.19	594	2.53 $\pm$ 3.50	0.616
Current asthma ¹	25	3.84 $\pm$ 4.99	674	2.57 $\pm$ 3.60	0.135
AR					
AR Sx, ever	272	2.46 $\pm$ 3.54	363	2.77 $\pm$ 3.82	0.315
AR Sx, last 12 months	262	3.16 $\pm$ 3.91	382	2.25 $\pm$ 3.45	0.003
AR diagnosis, ever	263	3.01 $\pm$ 3.59	401	2.32 $\pm$ 3.57	0.017
Treatment of AR, last 12 months	193	3.03 $\pm$ 3.74	466	2.41 $\pm$ 3.52	0.041
Current AR ¹	177	3.18 $\pm$ 3.83	511	2.40 $\pm$ 3.56	0.016
AD					
AD Sx, ever	169	2.63 $\pm$ 3.82	530	2.57 $\pm$ 3.65	0.853
AD Sx, last 12 months	116	3.10 $\pm$ 4.34	586	2.48 $\pm$ 3.43	0.074
AD diagnosis, ever	215	2.96 $\pm$ 3.79	473	2.41 $\pm$ 3.58	0.067
Treatment of AD, last 12 months	92	2.64 $\pm$ 3.92	592	2.60 $\pm$ 3.61	0.933
Current AD ¹	93	2.90 $\pm$ 3.97	606	2.54 $\pm$ 3.58	0.135

AR = Allergic rhinitis; Sx = symptoms; AD = allergic disease.

¹ Current allergic disease: current symptoms plus disease diagnosis ever.**Table 5.** Comparison of social problem scores for children with and without symptoms of allergic disease (mean $\pm$ SD)

	n	Yes	n	No	p value
Asthma					
Wheeze, ever	83	10.28 $\pm$ 1.61	516	10.46 $\pm$ 1.63	0.370
Wheeze, last 12 months	44	10.48 $\pm$ 1.54	636	10.43 $\pm$ 1.63	0.861
Asthma diagnosis, ever	70	10.59 $\pm$ 1.41	602	10.46 $\pm$ 1.61	0.522
Treatment of asthma, last 12 months	25	10.92 $\pm$ 1.46	594	10.45 $\pm$ 1.61	0.159
Current asthma ¹	25	10.56 $\pm$ 1.49	674	10.43 $\pm$ 1.63	0.684
AR					
AR Sx, ever	272	10.28 $\pm$ 1.62	363	10.55 $\pm$ 1.65	0.046
AR Sx, last 12 months	262	10.18 $\pm$ 1.53	382	10.35 $\pm$ 1.61	0.399
AR diagnosis, ever	263	10.32 $\pm$ 1.59	401	10.52 $\pm$ 1.65	0.124
Treatment of AR, last 12 months	193	10.23 $\pm$ 1.61	466	10.51 $\pm$ 1.63	0.040
Current AR ¹	177	10.19 $\pm$ 1.58	511	10.51 $\pm$ 1.64	0.026
AD					
AD Sx, ever	169	10.36 $\pm$ 1.73	530	10.46 $\pm$ 1.60	0.473
AD Sx, last 12 months	116	10.20 $\pm$ 1.72	586	10.48 $\pm$ 1.54	0.184
AD diagnosis, ever	215	10.28 $\pm$ 1.67	473	10.50 $\pm$ 1.62	0.106
Treatment of AD, last 12 months	92	10.21 $\pm$ 1.64	592	10.46 $\pm$ 1.63	0.177
Current AD ¹	93	10.03 $\pm$ 1.78	606	10.49 $\pm$ 1.59	0.011

AR = Allergic rhinitis; Sx = symptoms; AD = allergic disease.

¹ Current allergic disease: current symptoms plus disease diagnosis ever.

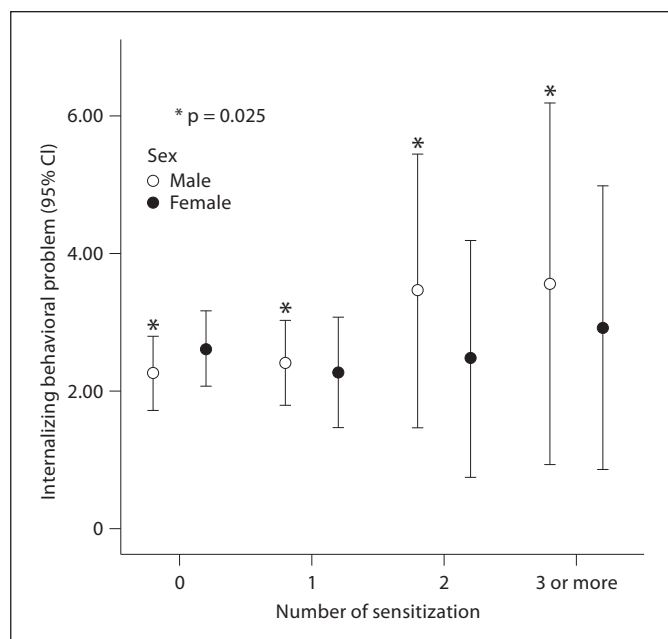


Fig. 1. Internalizing behavior problems according to the number of positive allergens in boys and girls. Controlling for age, internalizing behavior problems increased significantly with increasing number of positive allergens in boys. Girls showed a similar trend, but it was not statistically significant.

Comparison of Internalizing Problems between Children with and without Symptoms of Allergic Disorders

Children with a recent 12-month history of asthma symptoms exhibited more internalizing problems. Children with a recent 12-month history of allergic rhinitis, those with a diagnosis or treatment of allergic rhinitis, and those with current allergic rhinitis also exhibited higher internalizing problem scores (table 4). There was a tendency of children with a recent 12-month history or a diagnosis of atopic dermatitis to have more internalizing problems, but the difference did not reach the level of statistical significance (table 4).

Comparison of Social Problem Scores between Children with and without Symptoms of Allergic Disorders

Children with lifetime symptoms with treatment of allergic rhinitis, and those with current allergic rhinitis showed lower social problem scores compared to children without symptoms of allergic rhinitis. Children with current atopic dermatitis showed lower social problem scores as well (table 5).

Relationship between Sensitization and CBCL Scores

Children were assigned to 4 groups based on skin prick test results. The nonatopic group was negative for all allergens via the skin prick test. Atopic children were classified into 3 groups based on the number of positive allergens (one, two and three or more positive allergens). As the number of positive allergens increased, the scores for internalizing and externalizing problems also increased (table 6). When compared with nonatopic children, children with 3 or more positive allergens exhibited significantly higher internalizing problem scores, based on univariate analysis (2.44 ± 3.56 as compared to 3.64 ± 4.37). The similar trend was observed with externalizing problems, but the difference did not reach statistical significance. After controlling for age and sex, the association between degree of sensitization and behavioral problems was no longer significant. However, after adjusting only for age, increased sensitization to allergens significantly associated with increased internalizing problems in boys, but not in girls (fig. 1). There was no significant association between the number of positive allergens and social problem score. We also found that increased sensitization to allergens is a risk factor for asthma (table 6). The prevalence of wheezing within the past 12 months was increased in children who were more sensitive to allergens. Current asthma and current allergic rhinitis exhibited the same pattern (data not shown).

Discussion

The aim of the current study was to investigate the relationship between psychosocial adaptation and symptoms of allergic disorders and biomarkers of atopy in Korean elementary schoolchildren.

The study sample was only selected from one community school in Seoul, Korea, reflecting a highly homogenous, upper middle socioeconomic state group with minimal psychosocial risk factors as shown in demographic data. Although the present study design of using a very selective population will limit our ability to generalize the results, one of the advantages of the current study sample was that it minimized the influence of different confounding factors, including poverty, family violence and physical environmental factors, thus enabling us to investigate clear correlations between behavior problems and pediatric allergic symptoms and atopic tendency.

Our findings that symptoms of childhood allergic disorders are closely linked to psychosocial adaptation in

Table 6. CBCL scores and the risk of 12-month wheeze prevalence by number of positive allergens

Number of sensitization	Wheeze in last 12 months				Behavioral problem, mean $\pm$ SD		
	case/total number	percent	adjusted odds ratio ¹	p value	internalizing	externalizing	social adaptation
0	17/349	4.9%	–	–	2.44 $\pm$ 3.56	3.57 $\pm$ 4.35	10.51 $\pm$ 1.58
1	13/174	7.5%	1.49 (0.69–3.21)	0.313	2.34 $\pm$ 3.27	2.92 $\pm$ 4.12	10.37 $\pm$ 1.75
2	3/40	7.5%	2.14 (0.57–8.11)	0.263	3.04 $\pm$ 4.19	3.90 $\pm$ 4.57	10.50 $\pm$ 1.50
≥ 3	6/43	14.0%	4.22 (1.44–12.34)	0.009	3.64 $\pm$ 4.37*	4.88 $\pm$ 5.95**	10.32 $\pm$ 1.64

* $p = 0.035$ compared with nonatopic group, by univariate analysis, $p = 0.109$ by ANCOVA (age and sex as covariates); ** $p = 0.137$ compared with nonatopic group, by univariate analysis, $p = 0.249$ by ANCOVA (age and sex as covariates).

¹ Adjusted by age and sex.

Korea are similar to those of previous studies conducted in other countries [3–6]. In particular, the finding that asthmatic children, the most frequently studied sample, exhibited higher levels of externalizing and internalizing behavior problems than control children is consistent with previous reports [3, 5, 6, 33].

There was a somewhat different pattern of psychosocial problems in children with atopic dermatitis and allergic rhinitis compared to asthmatic children. Children experiencing symptoms of allergic rhinitis were scored by their parents as having higher rates of internalizing problems and social adaptation problems than unaffected children. This observation is a novel finding, and extends previous studies of reporting increased mental complications of sleep disturbance, poor school performance and hyperactivity in children with allergic rhinitis [34–36]. Children with symptoms of atopic dermatitis showed only low social adaptation in the present study. Their internalizing problems were somewhat higher than controls but only below the level of statistical significance. Our results showing that patterns of psychosocial adaptation are different in asthma, allergic rhinitis and atopic dermatitis, which are derived from a common allergic diathesis, imply that psychosocial adaptation may differ with respect to symptoms of allergic disorders.

Asthmatic children who experienced frequent wheezing and breathlessness were not only passive and withdrawn, but also defiant and aggressive, which are manifestations of externalizing problems. These results suggest that their symptoms provoke parental anxiety or depression and might lead to overprotective, overly controlling parenting [37–39]. On the other hand, children with allergic rhinitis and atopic dermatitis were withdrawn and timid, with internalizing problems, or exhibited impaired social adaptation. This might be due to the

fact that symptoms of these disorders mainly affect physical appearance and attract the attention of others, with less associated functional impairment [8, 40, 41].

We identified different patterns of psychosocial adaptation in children with different allergic symptoms. For these results to be generalized, these have to be replicated in other large population-based studies, then, these data would suggest that children with different allergic disorders require different psychosocial interventions to improve adaptation. This is the first finding in Asian children of the association between allergic disorders and behavior adaptation in the general population. Compared to previous studies in Western countries, Asian children with allergic symptoms seem to have much more difficulty with social adaptation.

A remarkable finding that emerged from the current study was that children's behavior/emotional problems were associated with the number of positive allergens in skin prick tests. This positive association was statistically significant only in boys, although girls showed a similar trend. The fact that the increase in internalizing behavior problems in boys reached statistical significance might reflect a general vulnerability among boys that could have biological as well as cultural roots [42]. Culturally, the Korean society is generally more accepting shy and withdrawn behavior in girls, and parents might react more intensely when boys exhibit internalizing behavior problems. Biologically, boys may be more vulnerable to disorders that affect the interactions between neuronal, hormonal and immune systems. These explanations are theoretical at this point, and further studies are needed to clarify the underlying mechanism involved.

Until recently, the psychobiological relationship between allergic disorders and behavioral problems has not been clearly understood. However, several possible mech-

anisms have been suggested. The brain and the immune system are linked through the autonomic nervous system and the hypothalamic-pituitary-adrenal axis [43]. Psychological factors such as emotion and stress can influence asthma through the autonomic nervous system/vagal mechanism [44, 45] and neuroendocrine hormones can induce a shift in the type 1 and type 2 cytokine balance of peripheral blood mononuclear cells towards a predominantly type 2 response [46]. Through the dysregulation of neuroendocrine hormones, psychological factors can enhance the Th2 response, and thus amplify IL-4 and IgE synthesis [47]. These results might provide an explanation of the association between a positive skin prick test and behavioral problems, although, in children with a greater number of positive allergens, there was also an increased prevalence of allergic diseases, which is related to behavioral problems. Clearly, the precise cause and effect relationship between allergen sensitivity and behavioral problems is not yet fully elucidated. However, the novel findings here suggest that there is a positive relationship between atopy and behavioral problems in children.

There are several limitations to the current study that are worth noting. Poor behavior problems and the status of allergic disease were based on parental reporting. Although parents can observe and report a child's specific behavior problems as primary caregivers, reporting from teachers or friends are also needed to objectively evaluate the child's behavior problems. The Korean version of the ISAAC questionnaire [26] and the CBCL [27, 31] are well-known tools for evaluating the prevalence of allergic diseases and behavior problems in children, and have been validated in Korea. We also need to consider that of the 1,376 students with complete ISAAC questionnaire, only 780 with valid K-CBCL data were included in the present study. To get a valid statistical analysis of K-CBCL, students with more than 4 missing items in K-CBCL out of a total of 113 were excluded. Because there were no significant differences between participants and the total population of 1,376 students in terms of basic demographic data and prevalence of allergy symptoms, we could assume that the high attrition rate for valid K-CBCL surveys would not affect the overall interpretation of data. However, we suppose the following causes of the high attrition rate of K-CBCL. First, Korean mothers might be uncomfortable to assess and report their children's behavior problems in social contexts. Second, completing the whole 113 items of K-CBCL might be too much for some of the mothers, so they could miss more than 4 items unintentionally. We also compared the incidence of allergic disorders and important variables be-

tween all school children and the 780 study participants and could not find any differences. Thus, we can assume the high attrition rate of the present study does not affect the interpretation of our data. Therefore, future population-based studies of this kind should make every effort to enhance the complete response rate of K-CBCL surveys. In addition, because this was a cross-sectional survey, it was not possible to assess any cause and effect relationship between poor behavior and allergic diseases.

To the best of our knowledge, the current study represents one of the largest population-based studies investigating the relationship between allergic diseases and behavior problems in children in Asia, using objective and well-validated measures of both asthma and behavior problems in children. The results of the current study open the door to future longitudinal studies focused on elucidating the causal relationships between allergic diseases and psychosocial problems in children.

In conclusion, children with allergic disorders had more difficulty with psychosocial adaptation, and the pattern of psychosocial behavior differed according to type of allergic symptoms and degree of atopic tendency. The results underscore that comprehensive but specific approaches to the treatment of pediatric allergic disorders are needed, both in terms of medical and psychosocial intervention. In addition, the results of the current study indicate a positive relationship between atopy and behavioral problems in boys.

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