

## Prevalences of Symptoms of Asthma and Other Allergic Diseases in Korean Children: A Nationwide Questionnaire Survey

The purpose of this study was to estimate the national prevalence of childhood asthma and other allergic diseases in Korea, and to determine potential risk factors for the diseases. Stratified random samples of 42,886 were selected from 34 elementary (6-12 yr olds) and 34 middle schools (12-15 yr olds) nationwide, and 38,955 were in the final analysis. The Korean-translated modified version of the International Study of Asthma and Allergies in Childhood questionnaire was used in this cross-sectional survey. Twelve-month prevalences of the symptoms of asthma, rhinoconjunctivitis, and flexural eczema were 8.7%, 10.5%, 7.3% in 6-12 yr olds, and 8.2%, 10.0%, 3.9% in 12-15 yr olds, respectively. For allergic conjunctivitis, food allergy, and drug allergy, the prevalences in 6-12 yr olds were 11.2%, 6.5%, and 1.5%, respectively. Asthma and flexural eczema decreased significantly with age. Other significant risk factors were also noted. For 6-12 yr-old asthma, adjusted odds ratio (aOR) of body mass index was 1.21 with 95% confidence interval (CI) 1.0-1.48, aOR of passive smoking was 1.37 with 95%CI 1.24-1.51, aOR of carpet use was 1.28 with 95%CI 1.10-1.49. For 6-12 yr-old eczema, aOR of affluence was 1.22 with 95%CI 1.07-1.39. The control of obesity and passive smoking would be the most important preventive measures of allergic diseases.

**Key Words:** Asthma; Allergy; Child; Korea; Prevalence; Risk Factors

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Received: 18 September 2000

Accepted: 26 January 2001

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• This study was supported by the Korean Academy of Pediatric Allergy and Respiratory Disease, the Samsung Medical Center, and the Ministry of Health and Welfare, Republic of Korea.

## INTRODUCTION

The burden of asthma and allergic diseases in Korea has been speculated to be increasing with the nation's industrialization (3.4% in 1964 to 10.1% in 1989), but the evidence was limited to a few studies based on small numbers of subjects (1, 2). Asian countries used to have low rate of allergic diseases compared to Western countries, but increasing prevalences were noted from several countries such as Japan, Hong Kong, and Taiwan, resulting in wide variation within the continent. Since allergic diseases are the commonest illness affecting children worldwide, reliable prevalence of the diseases in Korea needs to be determined.

Comparability has been another issue in prevalence research on allergic diseases. There is no uniform defi-

nition of asthma and other allergic diseases that can be applied to all cases. Symptoms are the most important features for diagnosing asthma, and this makes questionnaire a major tool to survey the prevalence. Various kinds of questionnaires have been used to hundreds of asthma-prevalence studies with different definitions and protocols. To make international or regional comparison possible, International Study of Asthma and Allergies in Childhood (ISAAC) proposed a uniform approach to the prevalence survey through standardized questionnaire (3).

The present study was conducted as the first nationwide survey in Korea using ISAAC written questionnaire to estimate prevalences of the symptoms of asthma, allergic rhinitis (AR), eczema, allergic conjunctivitis (AC), food allergy (FA), and drug allergy (DA) in Korean children aged 6-15. Age, sex, and regional variation of the

prevalences within the nation were investigated as well.

## MATERIAL AND METHODS

### Questionnaire

We developed the Korean version of ISAAC questionnaire for asthma, AR, and eczema, following the guidelines suggested by ISAAC (4). We added similar question modules for AC, FA, and DA into our questionnaire. The questionnaire included questions on demography (age, sex), Body Mass Index (BMI), monthly electricity bill (as a socioeconomic index), passive smoking ("Is there any one who is smoking indoors among people who are living with you?"), potential allergens (carpet use, living with a dog, living with a cat), living environment (rural/plant area/urban), symptoms of each allergic disease including lifetime and last 12-months experiences. For AC, we asked "Have you ever had eye itching other than epidemic conjunctivitis?". For FA, and DA, we simply asked whether they had allergy on food or drugs. Ten pediatricians participated in translation of the original ISAAC questionnaire. Some translational problems were noted during the pilot study. For example, "Have you ever had asthma?" type of questions sometimes received positive answers by self-diagnosed patients with asthma-like symptoms. We changed the question as "Have you ever been diagnosed to have asthma?", and we also asked whether they were treated for the diseases in last 12-months. Video questionnaire was also applied to middle school students, and the results were reported separately.

### Selection of the subjects

We targeted all the age groups between 6 to 12 and 12 to 15 from elementary and middle schools, respectively, while ISAAC proposed to select 6-7 and 13-14 yr olds only. We postulated two centers to make comparison within the nation. One was the Seoul Center, which represented a metropolitan with a large population (over 10 million), polluted air, and high living standards compared to other regions in Korea. The other was the Provincial Center, which includes eight provincial cities, each city from 8 provinces throughout Korea; Suwon, Chungju, Chunju, Changwon, Chunchon, Cheju, Ulsan, and Ansan. The Provincial Center represented relatively rural area with a small population, less pollution (except Ulsan and Ansan, which were industrial cities), and lower living standards compared to Seoul.

We obtained a complete school list from the Ministry of Education, and made 4 sampling frames; Seoul ele-

mentary, Seoul middle, Provincial elementary, and Provincial middle schools. In Seoul, we randomly sampled 10 from 503 elementary and 10 from 347 middle schools. For the other 8 provincial cities, we selected 3 schools from each city summing up to 24 from 253 elementary and 24 from 136 middle schools. Only 1 school refused to participate in the study, and another school that was sampled again in similar manner replaced it. The whole 6 grades in elementary and 3 grades in middle school contained our target age groups. We sampled about 150 children from each grade, and a total of 42,886 children were selected from 68 schools across the nation. Written consent was sought from parents and 40,429 actually participated.

### Data collection

The Korean version of ISAAC written questionnaire was administered to the parents of the children in elementary schools and to the student themselves in middle schools. Response rates for each school were monitored during the study to make it sure that we had response rate over 90%. We trained 18 survey workers in one center, who made rounds across the nation to the selected schools afterwards. Forty one pediatric allergy specialists residing in the target cities also participated in this survey to promote the response rate. The survey was conducted between September 1995 to November 1995.

### Statistical analysis

All data were entered into a computer using a specialized entry program for this particular study. It had special functions to reduce entry error, such as image display of the questionnaire on the screen, mouse-click entry, range check, impossible value check, and automatic skipping of irrelevant questions. Ninety records were sampled for double entry and the result showed little discordance between the two entries.

If there were missing or impossible values in crucial items, such as birth date, sex, and National Identification Number, we requested them to the schools where the data were originally from. We excluded observations which still had erroneous values after recheck, or had no answers for all symptom questions, or if the respondent was out of the age 6-15. The final number of subjects included in the analysis was 38,955.

Lifetime and last 12-month prevalences were calculated by dividing positive responses to each question by the number of completed questionnaires. 95% confidence intervals (CI) of the prevalences were estimated in individual level.

Twelve-month prevalence of symptoms of AR was defined as the proportion of children having symptoms of allergic rhinitis and eye affection in last 12-months to avoid possible overestimation of symptom prevalence (5). It was defined as the symptom of 'rhinoconjunctivitis'. The definition of 12-month prevalence of symptoms of eczema were also restricted to the proportion of children having atopic dermatitis in last 12-months with the involvement of flexural area only, such as folds of the elbows, behind the knees, in front of the ankles, under the buttocks, or around the neck, ears, or eyes, for the same reason. It was defined as the symptom of 'flexural eczema'. As for other symptom prevalences, we simply calculated the positive rates of the "Have you ever —" and "In last 12-months —" question items in each symptom module. Since the survey methods for elementary (parent administered) and for middle schools (self-administered) were different, we calculated the prevalences separately.

Twelve-month prevalences of symptoms by sex, age, and region were calculated and compared using  $\chi^2$  test and 95% confidence intervals. Confidence intervals were calculated using the normal approximation of the binomial distribution. Logistic regression was used to analyze the effect of several risk factors on 12-month symptom prevalences. Adjusted odds ratio (aOR) and its 95% CI were derived from the asymptotic chi-square distribution of the likelihood ratio test, using age, sex, center, BMI, monthly electricity bill, passive smoking, carpet use, living with dogs, and living environment as covariates. Twelve-month prevalences of each symptom in 6-7 yr

olds and 13-14 yr olds were also calculated for the comparison with other ISAAC studies. The SAS system for Windows V. 6.12 was used for all the analysis (6).

## RESULTS

The total number of respondents were 40,429, of which 25,361 (62.7%) were from elementary schools and 15,068 (37.3%) were from middle schools. The overall response rate was 92.5% in elementary schools and 97.3% in middle schools. Elementary schools in Provincial Center had the lowest response rate (91.6%) and the highest exclusion rate (12.4%) in data analysis. Of the 38,955 children who were included in the final analysis, 12,097 (31.1%) were from Seoul Center and 26,858 (68.9%) were from Provincial Center. The age and sex distribution of the study group is shown in Table 1. The proportion of boys was 51.5% in elementary and 55.1% in middle schools. We had relatively small numbers in two extreme ages; 6 yr olds and 15 yr olds.

### Prevalences of symptoms of asthma

The lifetime prevalences of wheeze were 15.9% (95% CI 15.4-16.3) and 13.4% (95% CI 12.8-13.9) in 6-12 and 12-15 yr olds, respectively, while the 12-month prevalences of wheeze were about half of them (8.7% and 8.2%). Seoul Center had higher prevalences than Provincial Center for all age groups ( $p < 0.01$ ). Severe attack

Table 1. Response rate and age distribution of the subjects

|                                      | Seoul                      |                         | Provincial cities          |                         | Total                      |                         |
|--------------------------------------|----------------------------|-------------------------|----------------------------|-------------------------|----------------------------|-------------------------|
|                                      | Elementary<br>6-12 yr olds | Middle<br>12-15 yr olds | Elementary<br>6-12 yr olds | Middle<br>12-15 yr olds | Elementary<br>6-12 yr olds | Middle<br>12-15 yr olds |
| Survey period                        | 9/1995                     | 9/1995                  | 10-11/1995                 | 10-11/1995              | 9-11/1995                  | 9-11/1995               |
| No. of schools                       | 10                         | 10                      | 24                         | 24                      | 34                         | 34                      |
| No. of subjects surveyed             | 8,483                      | 4,729                   | 18,922                     | 10,752                  | 27,405                     | 15,481                  |
| No. of response (%)                  | 8,025 (94.6)               | 4,439 (93.9)            | 17,336 (91.6)              | 10,629 (98.9)           | 25,361 (92.5)              | 15,068 (97.3)           |
| No. of subjects included<br>analysis | 7,735                      | 4,362                   | 16,439                     | 10,419                  | 24,174                     | 14,781                  |
| Male (%)                             | 3,952 (51.1)               | 2,741 (62.8)            | 8,497 (51.7)               | 5,404 (51.9)            | 12,449 (51.5)              | 8,145 (55.1)            |
| Age (yr) 6 (%)                       | 586 (7.6)                  | -                       | 1,147 (7.0)                | -                       | 1,733 (7.2)                | -                       |
| 7 (%)                                | 1,174 (15.2)               | -                       | 2,587 (15.7)               | -                       | 3,761 (15.6)               | -                       |
| 8 (%)                                | 1,317 (17.0)               | -                       | 2,665 (16.2)               | -                       | 3,982 (16.5)               | -                       |
| 9 (%)                                | 1,344 (17.4)               | -                       | 2,659 (16.2)               | -                       | 4,003 (16.6)               | -                       |
| 10 (%)                               | 1,276 (16.5)               | -                       | 2,807 (17.1)               | -                       | 4,083 (16.9)               | -                       |
| 11 (%)                               | 1,311 (17.0)               | -                       | 2,848 (17.3)               | -                       | 4,159 (17.2)               | -                       |
| 12 (%)                               | 727 (9.4)                  | 623 (14.3)              | 1,726 (10.5)               | 1,471 (14.1)            | 2,453 (10.2)               | 2,094 (14.2)            |
| 13 (%)                               | -                          | 1,407 (32.3)            | -                          | 3,605 (34.6)            | -                          | 5,012 (33.9)            |
| 14 (%)                               | -                          | 1,509 (34.6)            | -                          | 3,494 (33.5)            | -                          | 5,003 (33.9)            |
| 15 (%)                               | -                          | 823 (18.9)              | -                          | 1,849 (17.8)            | -                          | 2,672 (18.1)            |

**Table 2.** Prevalences of symptoms of asthma in Korean children

|  | Seoul                             |                                  | Provincial cities                |                                  | Total                      |                         |
|--|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------|-------------------------|
|  | Elementary<br>6-12 yr olds        | Middle<br>12-15 yr olds          | Elementary<br>6-12 yr olds       | Middle<br>12-15 yr olds          | Elementary<br>6-12 yr olds | Middle<br>12-15 yr olds |
| Wheeze, ever   | 18.0 <sup>†</sup><br>(17.2-18.9)* | 15.5 <sup>†</sup><br>(14.5-16.6) | 14.9 <sup>†</sup><br>(14.3-15.4) | 12.5 <sup>†</sup><br>(11.9-13.2) | 15.9<br>(15.4-16.3)        | 13.4<br>(12.8-13.9)     |
| Wheezing, last 12 months                                     | 9.7 (9.1-10.4)                    | 9.8 (8.9-10.7)                   | 8.3 (7.9-8.7)                    | 7.5 (7.0-8.0)                    | 8.7 (8.4-9.1)              | 8.2 (7.7-8.6)           |
| Attacks of wheezing, last 12 months                          |                                   |                                  |                                  |                                  |                            |                         |
| 1-3  | 4.6                               | 7.0                              | 4.1                              | 5.6                              | 4.2                        | 6.0                     |
| 4-12   | 1.2                               | 1.6                              | 1.1                              | 1.1                              | 1.1                        | 1.2                     |
| >12  | 0.8                               | 0.6                              | 0.8                              | 0.5                              | 0.8                        | 0.5                     |
| Sleep disturbed by wheezing, last 12 months                  | 2.7                               | 1.7                              | 2.5                              | 1.4                              | 2.5                        | 1.5                     |
| Severe attack of wheezing limiting speech,<br>last 12 months | 2.2                               | 3.4                              | 1.8                              | 2.9                              | 1.9                        | 3.0                     |
| Exercise-induced wheeze, last 12 months                      | 5.7                               | 15.6                             | 5.3                              | 12.2                             | 5.4                        | 13.2                    |
| Night cough, last 12 months                                  | 16.7                              | 10.0                             | 15.4                             | 8.7                              | 15.8                       | 9.1                     |
| Diagnosis of asthma, ever                                    | 8.7 (8.1-9.4)                     | 3.3 (2.8-3.9)                    | 7.2 (6.9-7.6)                    | 2.4 (2.1-2.7)                    | 7.7 (7.4-8.1)              | 2.7 (2.4-2.9)           |
| Treatment of asthma, last 12 months                          | 3.4 (3.1-3.9)                     | 1.0 (0.7-1.3)                    | 3.1 (2.8-3.3)                    | 1.0 (0.8-1.2)                    | 3.2 (3.0-3.4)              | 1.0 (0.8-1.1)           |

\* Numbers in parentheses indicate 95% confidence intervals

<sup>†</sup> \* $p < 0.01$  by  $\chi^2$  test (Seoul Center vs. Provincial Center in each age group)**Table 3.** Prevalences of symptoms of other allergic diseases in Korean children

|   | Seoul                      |                         | Provincial cities          |                         | Total                      |                         |
|---|----------------------------|-------------------------|----------------------------|-------------------------|----------------------------|-------------------------|
|   | Elementary<br>6-12 yr olds | Middle<br>12-15 yr olds | Elementary<br>6-12 yr olds | Middle<br>12-15 yr olds | Elementary<br>6-12 yr olds | Middle<br>12-15 yr olds |
| Rhinitis  |                            |                         |                            |                         |                            |                         |
| Symptom, ever                                     | 38.2 (37.1-39.3)           | 40.1 (38.6-41.5)        | 35.2 (34.5-36.0)           | 34.8 (33.9-35.7)        | 36.2 (35.6-36.8)           | 36.3 (35.6-37.1)        |
| Symptom, last 12 months                           | 31.3 (30.3-32.4)           | 32.3 (30.9-33.7)        | 27.7 (27.0-28.3)           | 27.8 (26.9-28.6)        | 28.8 (28.3-29.4)           | 29.1 (28.4-29.8)        |
| Rhinoconjunctivitis <sup>†</sup> , last 12 months | 12.0 (11.3-12.8)           | 11.1 (10.2-12.1)        | 9.8 (9.4-10.3)             | 9.5 (9.0-10.1)          | 10.5 (10.1-10.9)           | 10.0 (9.5-10.5)         |
| Diagnosis of rhinitis, ever                       | 16.9 (16.0-17.7)           | 8.9 (8.1-9.8)           | 14.9 (14.4-15.5)           | 7.0 (6.5-7.5)           | 15.6 (15.1-16.0)           | 7.6 (7.2-8.0)           |
| Treatment, last 12 months                         | 12.7 (12.0-13.5)           | 5.9 (5.2-6.6)           | 11.4 (10.9-11.9)           | 4.5 (4.2-5.0)           | 11.8 (11.4-12.2)           | 4.9 (4.6-5.3)           |
| Eczema  |                            |                         |                            |                         |                            |                         |
| Itchy rash, ever                                  | 18.2 (17.4-19.1)           | 8.7 (7.9-9.6)           | 14.0 (13.5-14.5)           | 6.6 (6.2-7.1)           | 15.3 (14.9-15.8)           | 7.2 (6.8-7.7)           |
| Itchy rash, last 12 months                        | 12.9 (12.2-13.6)           | 6.8 (6.1-7.6)           | 9.8 (9.4-10.3)             | 4.7 (4.4-5.2)           | 10.8 (10.4-11.2)           | 5.4 (5.0-5.7)           |
| Flexural eczema <sup>†</sup>                      | 8.8 (8.2-9.5)              | 4.9 (4.3-5.6)           | 6.6 (6.2-6.9)              | 3.5 (3.2-3.9)           | 7.3 (7.0-7.6)              | 3.9 (3.6-4.3)           |
| Diagnosis of eczema, ever                         | 19.7 (18.8-20.6)           | 7.6 (6.8-8.4)           | 15.2 (14.6-15.7)           | 7.1 (6.7-7.6)           | 16.6 (16.2-17.1)           | 7.3 (6.9-7.7)           |
| Treatment, last 12 months                         | 9.3 (8.7-10.0)             | 4.6 (4.0-5.3)           | 7.7 (7.3-8.1)              | 4.3 (3.9-4.7)           | 8.2 (7.9-8.6)              | 4.4 (4.0-4.7)           |
| Allergic conjunctivitis (AC)                      |                            |                         |                            |                         |                            |                         |
| Eye symptom, ever                                 | 19.2 (18.3-20.0)           | 27.1 (25.8-28.4)        | 15.8 (15.3-16.4)           | 22.2 (21.5-23.1)        | 16.9 (16.4-17.4)           | 23.7 (23.0-24.4)        |
| Eye symptom, last 12 months                       | 12.7 (12.0-13.4)           | 20.3 (19.1-21.5)        | 10.5 (10.0-11.0)           | 16.8 (16.1-17.5)        | 11.2 (10.8-11.6)           | 17.8 (17.2-18.4)        |
| Diagnosis of AC, ever                             | 10.8 (10.2-11.6)           | 6.4 (5.8-7.2)           | 10.0 (9.6-10.5)            | 5.1 (4.7-5.5)           | 10.3 (9.9-10.7)            | 5.5 (5.1-5.9)           |
| Treatment, last 12 months                         | 7.3 (6.8-7.9)              | 4.2 (3.6-4.8)           | 6.8 (6.4-7.2)              | 3.3 (3.0-3.7)           | 7.0 (6.7-7.3)              | 3.6 (3.3-3.9)           |
| Food allergy (FA)                                 |                            |                         |                            |                         |                            |                         |
| Food allergy symptom, ever                        | 12.4 (11.7-13.1)           | 13.0 (12.0-14.0)        | 10.1 (9.7-10.6)            | 10.5 (10.0-11.1)        | 10.9 (10.5-11.2)           | 11.3 (10.8-11.8)        |
| Food allergy symptom, last 12 months              | 7.2 (6.6-7.8)              | 8.9 (8.1-9.8)           | 6.2 (5.8-6.6)              | 6.8 (6.4-7.3)           | 6.5 (6.2-6.8)              | 7.4 (7.0-7.9)           |
| Diagnosis of FA, ever                             | 4.6 (4.1-5.0)              | 4.5 (3.9-5.2)           | 4.1 (3.8-4.4)              | 3.5 (3.1-3.8)           | 4.2 (4.0-4.5)              | 3.8 (3.5-4.1)           |
| Treatment, last 12 months                         | 2.9 (2.5-3.3)              | 2.5 (2.1-3.0)           | 2.7 (2.4-2.9)              | 1.8 (1.5-2.0)           | 2.7 (2.5-2.9)              | 2.0 (1.8-2.2)           |
| Drug allergy (DA)                                 |                            |                         |                            |                         |                            |                         |
| Drug allergy symptom, ever                        | 5.2 (4.7-5.7)              | 3.2 (2.7-3.7)           | 4.0 (3.7-4.3)              | 3.0 (2.6-3.3)           | 4.4 (4.1-4.6)              | 3.0 (2.8-3.3)           |
| Drug allergy symptom, last 12 months              | 1.5 (1.2-1.8)              | 1.7 (1.4-2.1)           | 1.4 (1.3-1.6)              | 1.4 (1.2-1.6)           | 1.5 (1.3-1.6)              | 1.5 (1.3-1.7)           |
| Diagnosis of DA, ever                             | 1.4 (1.2-1.7)              | 1.2 (0.9-1.6)           | 1.0 (0.9-1.2)              | 0.8 (0.7-1.0)           | 1.1 (1.0-1.3)              | 0.9 (0.8-1.1)           |
| Treatment, last 12 months                         | 0.6 (0.5-0.8)              | 0.4 (0.2-0.6)           | 0.5 (0.4-0.6)              | 0.3 (0.2-0.4)           | 0.5 (0.5-0.6)              | 0.3 (0.2-0.4)           |

\* Numbers in parentheses indicate 95% confidence intervals

<sup>†</sup>The proportions of children having symptoms of allergic rhinitis and eye affection in last 12 months<sup>†</sup>The proportions of children having symptoms of eczema in the flexural area. The flexural eczema represents the prevalence of symptoms of eczema

of wheezing in last 12-months were 1.9% and 3.0%. The lifetime prevalences of asthma diagnosis were much lower than the symptom prevalences (7.7% and 2.7% for each age group) ( $p < 0.05$ ). Only 3.2% of children in 6-12 yr olds and 1.0% of children in 12-15 yr olds were treated for asthma in last 12-months (Table 2).

#### Prevalences of symptoms of other allergic diseases

Table 3 shows the prevalences of rhinitis, eczema, AC, FA, and DA. Twelve-month prevalence of the symptoms of rhinoconjunctivitis were about 10% for both age groups. The commonest nose symptom was obstruction (56% of ever had symptom) and itching (26%). Unlike other allergic symptoms, eczema had similar or even higher diagnosis prevalences than symptom prevalences in both centers, especially in 6-12 yr olds (15.3%, 95%CI 14.9%-15.8% for symptom prevalence, and 16.6%, 95%CI 16.2%-17.1% for diagnosis prevalence in 6-12 yr olds, and 7.2% and 7.3% in 12-15 yr olds, for symptom and diagnosis respectively). Twelve-month prevalence of flexural eczema in 6-12 yr olds (7.3%) was about twice as much as in 12-15 yr olds (3.9%). About 80% of the symptom positives had been treated in last 12-months.

Very high prevalence of the symptom of AC was noted among 12-15 yr-old girls. Twelve-month prevalence of itchy eye symptom was 20.3% in 12-15 yr-old girls, while it was between 10.5% and 16.8% in other age-sex group. However, lifetime prevalence of diagnosis of AC

in 12-15 yr-olds was generally much lower than the younger age group. Twelve-month prevalences of FA were 6.5% and 7.4%. The commonest symptoms for FA were urticaria (59% of symptom positives in last 12-months) followed by itching (42%, table not shown). DA had the lowest prevalences among all the allergic diseases considered in this study with little age difference. Twelve-month prevalences of DA were 1.5% for both age groups. The commonest symptom was urticaria (55% of symptom positives in last 12-months, table not shown).

#### Prevalences in the age group of 6-7 and 13-14 (ISAAC age group)

Table 4 presents the prevalences of allergic diseases in the age group of 6-7 and 13-14 to compare with other ISAAC participating countries. In the age group of 13-14, 12-month prevalences of symptoms of asthma, rhinoconjunctivitis, flexural eczema were 7.9%, 10.1%, and 4.0%, respectively. All symptom prevalences fell into the lower 1/3 of prevalences of ISAAC countries (5). Twelve-month symptom prevalences of asthma and flexural eczema in 6-7 yr olds were generally higher than 13-14 yr olds. The prevalences of the other diseases had no age difference. The prevalences were almost always higher in Seoul than in other provincial cities, and the differences were more prominent among girls than boys. Significant differences between Seoul and Provincial

**Table 4.** Twelve-month prevalences of symptoms of asthma and other allergic diseases in the age groups of 6-7 and 13-14

|                         | 6-7 yr olds      |                                |                  | 13-14 yr olds    |                                |                  |
|-------------------------|------------------|--------------------------------|------------------|------------------|--------------------------------|------------------|
|                         | Seoul            | Provincial cities <sup>†</sup> | Total            | Seoul            | Provincial cities <sup>†</sup> | Total            |
| Wheezing                | 15.3 (13.7-17.1) | 12.9 (11.8-14.0)               | 13.6 (12.7-14.6) | 9.6 (8.6-10.8)   | 7.2 (6.7-7.9)                  | 7.9 (7.4-8.5)    |
| Boys                    | 15.4 (13.2-17.9) | 13.1 (11.6-14.6)               | 13.8 (12.6-15.1) | 8.6 (7.4-10.0)   | 7.0 (6.3-7.9)                  | 7.6 (6.9-8.3)    |
| Girls                   | 15.1 (12.9-17.6) | 12.6 (11.2-14.3)               | 13.4 (12.2-14.8) | 11.4 (9.6-13.4)  | 7.5 (6.7-8.4)                  | 8.4 (7.6-9.3)    |
| Rhinoconjunctivitis     | 10.9 (9.5-12.4)  | 9.4 (8.5-10.4)                 | 9.9 (9.1-10.7)   | 11.3 (10.2-12.5) | 9.6 (9.0-10.3)                 | 10.1 (9.5-10.7)  |
| Boys                    | 12.3 (10.3-14.6) | 10.5 (9.2-11.9)                | 11.0 (9.9-12.2)  | 10.3 (9.0-11.7)  | 9.4 (8.5-10.4)                 | 9.7 (9.0-10.5)   |
| Girls                   | 9.3 (7.5-11.4)   | 8.3 (7.1-9.7)                  | 8.6 (7.6-9.8)    | 13.1 (11.2-15.3) | 9.8 (8.9-10.9)                 | 10.6 (9.8-11.6)  |
| Flexural eczema         | 11.4 (10.0-12.9) | 8.1 (7.3-9.1)                  | 9.2 (8.4-10.0)   | 4.8 (4.1-7.8)    | 3.7 (3.3-4.1)                  | 4.0 (3.7-4.4)    |
| Boys                    | 10.9 (9.0-13.1)  | 8.0 (6.9-9.3)                  | 9.0 (8.0-10.1)   | 4.8 (3.9-5.9)    | 3.9 (3.4-4.6)                  | 4.2 (3.7-4.8)    |
| Girls                   | 11.7 (9.7-14.0)  | 8.3 (7.1-9.6)                  | 9.4 (8.3-10.6)   | 4.9 (3.8-6.4)    | 3.3 (2.8-4.1)                  | 3.8 (3.2-4.4)    |
| Allergic conjunctivitis | 9.9 (8.6-11.4)   | 9.7 (8.8-10.7)                 | 9.7 (9.0-10.5)   | 20.3 (18.9-21.8) | 16.4 (15.6-17.3)               | 17.5 (16.8-18.3) |
| Boys                    | 9.9 (8.1-12.0)   | 10.3 (9.0-11.7)                | 10.2 (9.1-11.3)  | 17.0 (15.3-18.7) | 15.2 (14.1-16.4)               | 15.8 (14.8-16.7) |
| Girls                   | 9.7 (7.9-11.9)   | 9.0 (7.7-10.4)                 | 9.2 (8.2-10.4)   | 26.0 (23.4-28.7) | 17.8 (16.5-19.1)               | 19.7 (18.6-20.9) |
| Food allergy            | 7.0 (5.9-8.3)    | 6.4 (5.6-7.2)                  | 6.6 (5.9-7.2)    | 8.2 (7.2-9.2)    | 7.0 (6.4-7.6)                  | 7.3 (6.8-7.9)    |
| Boys                    | 7.1 (5.6-9.0)    | 6.9 (5.9-8.1)                  | 7.0 (6.1-8.0)    | 7.3 (6.2-8.6)    | 6.1 (5.4-6.9)                  | 6.5 (5.9-7.2)    |
| Girls                   | 6.8 (5.3-8.7)    | 5.7 (4.7-6.9)                  | 6.1 (5.2-7.1)    | 9.6 (8.1-11.6)   | 7.9 (7.1-8.9)                  | 8.4 (7.6-9.2)    |
| Drug allergy            | 1.5 (1.1-2.2)    | 1.7 (1.4-2.2)                  | 1.7 (1.4-2.1)    | 1.8 (1.4-2.4)    | 1.4 (1.2-1.7)                  | 1.5 (1.3-1.8)    |
| Boys                    | 1.5 (0.9-2.5)    | 1.6 (1.2-2.3)                  | 1.6 (1.2-2.1)    | 1.4 (1.0-2.1)    | 1.2 (0.9-1.7)                  | 1.3 (1.0-1.6)    |
| Girls                   | 1.6 (1.0-2.7)    | 1.9 (1.3-2.6)                  | 1.8 (1.3-2.4)    | 2.5 (1.7-3.6)    | 1.6 (1.2-2.0)                  | 1.8 (1.4-2.2)    |

\* Numbers in parentheses indicate 95% confidence intervals

<sup>†</sup> Provincial cities include Suwon, Chungju, Chunju, Changwon, Chunchon, Cheju, Ulsan, and Ansan in Korea

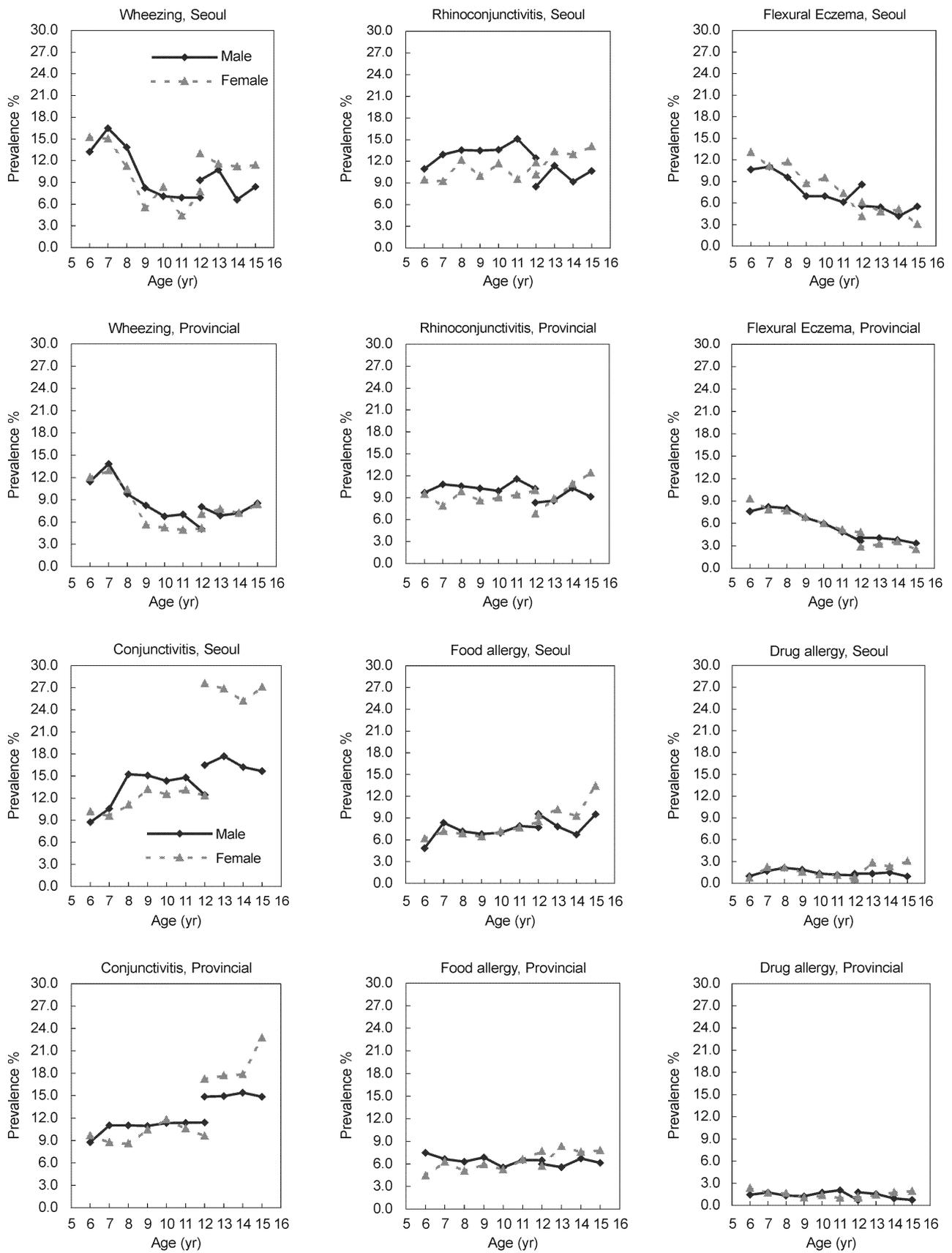


Fig. 1. Age-sex specific 12-month prevalences of wheezing and other allergic symptoms by region.

Cities in the prevalences for wheezing, rhinoconjunctivitis, and allergic conjunctivitis were noted in 13-14 yr-old girls, while for flexural eczema the difference was significant in 6-7 yr-old girls.

### Effect of age, sex, and region

Age and sex variations of 12-month prevalences of all the allergic diseases by center were plotted in Fig 1. The prevalences decreased with age in asthma and flexural eczema, but such tendency was not distinguished in rhinoconjunctivitis, AC, FA, and DA. Boys tend to have higher prevalences in 6-12 yr-olds, while girls tend to have higher prevalences in 12-15 yr olds. Seoul Center always had higher prevalences than Provincial Center, but wide variation in prevalences among cities was noted when individual cities were compared. Twelve-month prevalences for symptoms of allergic diseases were consistently high in Cheju (a southern island city) and low in Chunchon, although air pollution indexes were very low in both cities (Table 5).

### Effect of other covariates on the prevalences

Table 6 shows the result of multivariate logistic regression. Younger children who had BMI ( $\text{kg}/\text{m}^2$ ) higher than the median had 1.15 (95%CI 1.03-1.28) times higher risk of wheeze than those who had not. In older children, the aOR of BMI on wheeze was 1.13 (95%CI 0.99-1.28). Similarly, BMI increased the risk of eczema in both 6-12 yr olds (aOR 1.29, 95%CI 1.15-1.44) and 12-15 yr olds (aOR 1.26, 95%CI 1.05-1.50). For rhinoconjunctivitis, both 6-12 yr olds and 12-15 yr olds had not significant risk increase by BMI.

Monthly electricity bill showed significant risk increase for 12-month symptom prevalence of rhinoconjunctivitis and flexural eczema in all ages (for rhinoconjunctivitis

aOR 1.12, 95%CI 1.01-1.25 in 6-12 yr olds, aOR 1.21, 95% CI 1.06-1.38 for 12-15 yr olds, for flexural eczema aOR 1.22, 95%CI 1.07-1.33 for 6-12 yr olds, aOR 1.29, 95%CI 1.05-1.56 for 12-15 yr olds). Passive smoking increased the risk for all three allergic symptoms in 6-12 yr olds (aOR 1.37, 95%CI 1.24-1.51 for asthma, aOR 1.18, 95%CI 1.08-1.29 for rhinoconjunctivitis, and aOR 1.19, 95%CI 1.07-1.33 for flexural eczema), but only for rhinoconjunctivitis in 12-15 yr olds (aOR 1.22, 95%CI 1.09-1.37). Carpet use were related to asthma and rhinoconjunctivitis only in 6-12 yr olds (aOR 1.28, 95%CI 1.10-1.49 for asthma, and aOR 1.21, 95%CI 1.06-1.39 for rhinoconjunctivitis). Living with a dog showed borderline risk increase for asthma in 6-12 yr olds (aOR 1.17, 95%CI 1.00-1.37), but living with a cat did not show significant association (result not shown in the table). Living in industrial area showed significantly higher risk than living in rural area in middle school eczema (aOR 2.04, 95%CI 1.07-3.60).

## DISCUSSION

This study was the first nationwide questionnaire survey to assess the prevalence of allergic diseases in Korean children. The lifetime prevalence of wheeze were 15.9% and 13.4% in 6-12 yr olds and 12-15 yr olds, respectively. However children who had been ever diagnosed as having asthma were only 7.7% and 2.7%, which were only 48% and 20% of ever-wheezed for each age group. The diagnosis rates among symptom positives were apparently lower than Western countries (57-68% of symptom ever positives) (7, 8), but it was also possible that symptom prevalences were overestimated in this study. Twelve-month symptom prevalence of asthma in this study were 8.2-8.7%, which were very close to the result from a previous study in Korea, 1994 (9). Twelve-

**Table 5.** Twelve-month prevalences of the symptoms of allergic diseases by cities

| Allergic diseases  |   | Seoul | Suwon | Ansan | Ulsan | Chunju | Cheju | Changwon | Chungju | Chunchon | p-value |
|--------------------|---|-------|-------|-------|-------|--------|-------|----------|---------|----------|---------|
| 6-12 yr olds       | Asthma  | 9.71  | 6.28  | 6.30  | 9.91  | 10.65  | 10.46 | 8.71     | 8.46    | 5.17     | <0.01   |
|                    | Rhinoconjunctivitis                                       | 12.01 | 9.82  | 10.38 | 10.15 | 9.16   | 10.80 | 10.61    | 8.95    | 7.80     | <0.01   |
|                    | Flexural eczema   | 8.82  | 6.24  | 7.11  | 5.80  | 7.05   | 7.90  | 5.63     | 6.07    | 6.72     | <0.01   |
| 12-15 yr olds      | Asthma  | 9.77  | 9.43  | 8.55  | 6.27  | 6.18   | 9.25  | 8.33     | 6.61    | 4.95     | <0.01   |
|                    | Rhinoconjunctivitis                                       | 11.12 | 9.21  | 10.42 | 10.42 | 8.46   | 12.45 | 10.42    | 7.30    | 7.34     | <0.01   |
|                    | Flexural eczema   | 4.93  | 4.64  | 4.31  | 2.71  | 2.35   | 3.73  | 4.17     | 2.31    | 3.79     | <0.01   |
| Pollution in 1995* | SO <sub>2</sub> (ppm)                                     | 0.017 | 0.028 | 0.024 | 0.028 | 0.012  | 0.008 | 0.014    | 0.018   | 0.015    |         |
|                    | Total suspended particulates ( $\mu\text{g}/\text{m}^3$ ) | 85    | 86    | 78    | 97    | 39     | -     | 37       | -       | 31       |         |
|                    | NO <sub>2</sub> (ppm)                                     | 0.032 | 0.026 | 0.032 | 0.023 | 0.018  | 0.015 | 0.021    | 0.023   | 0.015    |         |
|                    | CO (ppm)  | 1.3   | 1.2   | 1.0   | 1.3   | 0.9    | 0.4   | 0.9      | 1.1     | 1.3      |         |

\*Source: Ministry of environment Republic of Korea, 1997 Environmental Statistics Yearbook Vol. 10

**Table 6.** Adjusted odds ratio (aOR) and its 95% confidence interval (CI) of potential risk factors for 12-month symptom prevalence of asthma, rhinoconjunctivitis, and eczema

|  | Asthma                                    |  | Rhinoconjunctivitis                       |  | Eczema                                    |  |
|--|---|--|---|--|---|--|
|  | Elementary<br>6-12 yr olds<br>aOR (95%CI) | Middle<br>12-15 yr olds<br>aOR (95%CI) | Elementary<br>6-12 yr olds<br>aOR (95%CI) | Middle<br>12-15 yr olds<br>aOR (95%CI) | Elementary<br>6-12 yr olds<br>aOR (95%CI) | Middle<br>12-15 yr olds<br>aOR (95%CI) |
| Age <sup>§</sup>                       | 0.81 (0.78-0.83)                          | 1.00 (0.93-1.07)                       | 1.00 (0.97-1.03)                          | 1.11 (1.05-1.18)                       | 0.86 (0.84-0.89)                          | 0.91 (0.83-0.99)                       |
| Sex                                    |   |  |   |  |   |  |
| Male                                   | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   |
| Female                                 | 0.89 (0.80-0.98)                          | 1.10 (0.97-1.24)                       | 0.80 (0.73-0.87)                          | 1.13 (1.00-1.26)                       | 1.09 (0.97-1.21)                          | 0.82 (0.68-0.97)                       |
| Center                                 |   |  |   |  |   |  |
| Provincial                             | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   |
| Seoul                                  | 1.21 (1.08-1.35)                          | 1.34 (1.17-1.53)                       | 1.27 (1.15-1.39)                          | 1.16 (1.02-1.31)                       | 1.34 (1.20-1.50)                          | 1.38 (1.15-1.66)                       |
| Body mass index                        |   |  |   |  |   |  |
| <16.9 <sup>†</sup> (19 <sup>†</sup> )  | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   |
| 16.9 <sup>†</sup> (19 <sup>†</sup> ) ≤ | 1.15 (1.03-1.28)                          | 1.13 (0.99-1.28)                       | 1.03 (0.94-1.13)                          | 1.04 (0.92-1.17)                       | 1.29 (1.15-1.44)                          | 1.26 (1.05-1.50)                       |
| Electricity bill                       |   |  |   |  |   |  |
| <30,000 won/month                      | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   |
| 30,000 ≤                               | 1.07 (0.95-1.22)                          | 1.06 (0.92-1.23)                       | 1.12 (1.01-1.25)                          | 1.21 (1.06-1.38)                       | 1.22 (1.07-1.39)                          | 1.29 (1.05-1.56)                       |
| Passive smoking                        |   |  |   |  |   |  |
| No                                     | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   |
| Yes                                    | 1.37 (1.24-1.51)                          | 0.99 (0.87-1.13)                       | 1.18 (1.08-1.29)                          | 1.22 (1.09-1.37)                       | 1.19 (1.07-1.33)                          | 0.88 (0.74-1.05)                       |
| Carpet use                             |   |  |   |  |   |  |
| No                                     | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   |
| Yes                                    | 1.28 (1.10-1.49)                          | 1.03 (0.84-1.25)                       | 1.21 (1.06-1.39)                          | 1.08 (0.90-1.28)                       | 1.04 (0.87-1.23)                          | 1.02 (0.77-1.33)                       |
| Living with a dog                      |   |  |   |  |   |  |
| No                                     | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   |
| Yes                                    | 1.17 (1.00-1.37)                          | 1.07 (0.90-1.29)                       | 0.91 (0.78-1.05)                          | 0.94 (0.80-1.12)                       | 1.11 (0.93-1.32)                          | 1.08 (0.83-1.37)                       |
| Living environment                     |   |  |   |  |   |  |
| Rural                                  | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   | 1.00                                      | 1.00                                   |
| Industrial area                        | 1.27 (0.92-1.71)                          | 1.17 (0.72-1.92)                       | 1.29 (0.96-1.69)                          | 1.42 (0.90-2.16)                       | 1.23 (0.84-1.74)                          | 2.04 (1.07-3.60)                       |
| Urban                                  | 0.84 (0.75-0.94)                          | 1.00 (0.85-1.17)                       | 0.93 (0.84-1.03)                          | 1.13 (0.97-1.32)                       | 1.03 (0.91-1.17)                          | 1.26 (0.99-1.60)                       |

\* Adjusted ORs (aOR) are adjusted for the variables in Table 6 simultaneously

<sup>§</sup>aOR for 1 yr-old increment of age; <sup>†</sup>Median BMI in 6-12 yr olds; <sup>‡</sup>Median BMI in 12-15 yr olds

month symptom prevalence of wheeze in that study was 8.2% (95%CI 7.3-9.1). However, when they included bronchial hyperresponsiveness to methacholine into the diagnosis criteria, the prevalence reduced to 4.6%. Therefore the validity of the ISAAC questionnaire in Korea should be confirmed by provocation tests to know the real prevalence of asthma, although the validation studies were conducted several times in English speaking countries (10-12). However, symptom prevalences reported in this study have good comparability because they were measured under a standardized data collection program adopted by 155 collaborating centers in 56 countries (5).

When we compare 12-month prevalence of wheeze in 13-14 yr olds with that of other ISAAC countries, the prevalence was below the lower 1/3 of the total countries and about middle among Asian countries. Japan, Thailand, Hong Kong, Singapore, and Malaysia reported higher prevalences of wheeze than Korea, and Taiwan and China reported lower (5). For rhinoconjunctivitis

symptoms, the prevalence was 6.8% (95%CI 6.3-7.3) in 13-14 yr olds, which was also below the lower 1/3 of the total ISAAC countries and also of Asian countries. Only China reported lower prevalence than Korea. So rhinoconjunctivitis had wider variation of prevalences than asthma within Asian countries (about 20%). Like asthma, the symptom prevalence of atopic eczema fell into the lower 1/3 of all the ISAAC countries, and about middle among Asian countries. Japan, Thailand, Malaysia, and Singapore had higher prevalences than Korea, and Hong Kong, Taiwan, and China reported lower prevalences. The higher prevalences of asthma and atopic eczema in 6-7 yr olds than 13-14 yr olds in our data was consistent with several other studies (8, 13, 14). It is hard to compare the exact levels of prevalences with those reported in the other Asian countries due to the disparity of the age group and survey method, but at least we observe higher prevalences of wheeze in younger age group almost invariably. The result that Seoul-

Provincial differences were more prominent among 13-14 girls is something we need to study further to distinguish any real biological difference from other confounding factors, such as the attitude toward the questionnaire.

The interrelationship between allergic symptoms showed interesting features. Children who had wheeze had more than 3 times higher risk of having rhinoconjunctivitis than who had not. In 6-12 yr olds, the proportion of having rhinoconjunctivitis in last 12-months among those who had wheeze in last 12-months were 29.8%, while it was 8.7% among those who had not. Children who had wheeze or rhinoconjunctivitis also had 2.5 times higher risk of having flexural eczema. In 6-12 yr olds, the proportion of flexural eczema in last 12-months among those who had wheeze in last 12-months were 16.3%, while it was 6.4% among those who had not. The proportion of flexural eczema in last 12-months among those who had rhinoconjunctivitis in last 12-months were 16.9%, while it was 6.2% among those who had not. These results suggested that once a child has an allergic disease, the risk of having other allergic diseases increase 2.5 to 3 times, and this magnitude is also true for the 12-15 yr-old group as well. The affinity was stronger between asthma and rhinoconjunctivitis than with eczema.

Both lifetime and 12-month prevalences of wheeze decreased with age (Fig. 1). Although it is difficult to explain why lifetime prevalences is decreasing with age, such trend has been documented in other studies also. The most probable reason for this feature could be incomplete recalls from the respondents (8). Prevalences of symptoms of asthma, rhinoconjunctivitis, flexural eczema, and conjunctivitis were significantly different between sexes (Fig. 1, Table 6). For all allergic symptoms except eczema, boys had higher prevalences in 6-12 yr olds and girls had higher prevalences in 12-15 yr olds. Younger children's male preponderance and older children's female preponderance of asthma were noted in several articles (8, 15, 16), but there could be some contribution of an artifact caused by differential reporting, i.e., by parental reporting or self reporting.

Although Seoul Center had higher prevalences than Provincial Center for all allergic diseases, regional variation was noted in individual city comparison (Table 5). Again, Seoul had higher prevalences than most of the other regions for all the allergic diseases, but not always the highest. The level of pollution indices did not explain the regional variation within Korea. Cheju, a city in the Cheju island in the southernmost part of Korea, generally showed high prevalences of allergic diseases, and Chunchon, a rural city in the eastern part, generally showed low prevalences, while both cities are known as one of the least polluted cities in Korea. Furthermore, in risk

factor analysis, living environment (rural vs. urban or industrial area) was not related to the prevalences of allergic symptoms, except for flexural eczema in 12-15 yr olds. Lack of association between allergic diseases and pollution of the region or the child's living environment suggests personal characteristics are far more important factors than environmental pollution when we are to prevent allergic diseases.

Body mass index (BMI) increased the risk of asthma and eczema. Recently several studies reported the possible effect of BMI on asthma and atopy (17, 18). Female had stronger relationship between BMI and asthma, and the stricter the definitions for asthma, the stronger the relationship. In our study, the effect of BMI on wheeze or on eczema were indeed stronger in girls in younger age group, but boys had stronger effect in older age group. For eczema, the girls in older age group had aORs greater than 1 suggesting the increase of risk by BMI but they were statistically not significant. If we could apply stricter criteria of the diagnosis of eczema, it might be possible to observe stronger relationship in this age-sex group. This should be tested in the validation study for the questionnaire in the future.

There has been a lot of debate over the effect of socioeconomic class. Studies in Western countries reported higher risk of asthma symptom and its severity in less privileged social classes (8, 19), whereas the studies in Asia reported higher risk of wheeze in higher socioeconomic group (13, 20). In our study, rhinoconjunctivitis and flexural eczema were more prevalent in more affluent families. This result, along with the risk increase in Seoul, which has the highest average income, suggests the positive risk increase by the level of socioeconomic status is the common trend among Asian countries.

Passive smoking was one of the most important factors affecting children's health. Smoking is a major public health problem in Korea, as reflected by both the high rate of smoking among adult male (60%) and the high prevalence of passive smoking among children in our study (44.6%). The increase of risk of the allergic diseases by passive smoking was more apparent in younger age group. Risk increase by passive smoking reported in the other study was also higher in children under the age of 2, and was less strong in mid-childhood (21). It is important to prevent the exposure to the passive smoking especially in the early life.

In conclusion, The prevalences of allergic disease in Korea are still low compared to Western and other Asian countries except for China and Taiwan. Socioeconomic and personal factors play more important role in developing allergic diseases in Korea than environmental pollution. The control of obesity in younger girls and older boys, and prevention of the exposure to the passive

smoking in younger children, is very important in the prevention of allergic diseases. Further studies should be followed to assess the validity of symptom positives in Korea, such as provocation tests or pulmonary function tests.

## ACKNOWLEDGEMENT

The authors thank the devotion and help of the pediatricians, who were the members of Korean Academy of Pediatric Allergy and Respiratory Disease, and participated in the survey.

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