

# Parent-Reported ISAAC Written Questionnaire May Underestimate the Prevalence of Asthma in Children Aged 10–12 Years

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**Summary.** Objectives: The aim of the present study was to compare the validity of the International Study of Asthma and Allergies in Childhood (ISAAC) written (WQ) and audiovisual questionnaires (AVQ 3.0) in two age-groups (10–12 and 13–15 years, respectively). Methods: The 13–15 year olds performed the self-completed the WQ and AVQ on the same day. The 10–12 year olds performed the self-completed the AVQ and the parent-completed WQ was completed by their parents. The methacholine challenge test was conducted in 10–12 year olds from one elementary school. Results: In 10–12 year olds, the AVQ detected a generally higher prevalence of asthma symptoms than WQ. In 13–15 year olds, this was reversed. In 10–12 year olds, poor agreement was found between the parent-completed WQ and the self-reported AVQ. In 13–15 year olds, moderate agreement was found between the self-reported WQ and AVQ. Low sensitivity was found, in predicting bronchial hyper-responsiveness (BHR) for all questions of both WQ and AVQ in 10–12 year olds. However, the AVQ had slightly higher sensitivity than WQ, with the exception of wheeze ever, although it was not statistically significant. Conclusion: The ISAAC AVQ may be another effective instrument for assessing the prevalence of asthma symptoms in children aged 10–12 years, whereas the parent-reported-WQ may underestimate the prevalence of asthma symptoms in this age-group.

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**Key words:** International Study of Asthma and Allergies in Childhood; video questionnaire; validity; written questionnaire; younger children.

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## INTRODUCTION

Asthma is one of the most common chronic disorders of childhood. Its symptoms are recurring in nature and are responsible for significant morbidity and social burden. Epidemiological studies have reported differences in asthma prevalence between countries. Reports of prevalence-trends vary. Some countries indicate an increase and others a decrease in the prevalence of allergic disease.<sup>1–4</sup> Most epidemiological surveys of asthma rely upon self-reported symptoms, with occasional validation by means of biological or physiological assessment. The major difficulties in estimating asthma prevalence are the absence of precise diagnostic criteria and classification, and the fact that there is no single test or standardized method to determine the presence of the disease.

The most common methods of evaluating asthma prevalence are questionnaires and physiological measurements.<sup>5</sup> Self-reported written questionnaires are the most widely used instruments in community surveys of asthma prevalence. Responses to written questionnaires are influenced by the language skills, culture, and perception of the disorder of the respondent.<sup>6</sup> Objective physiological measures such as bronchial provocation tests are an alternative approach, although these are generally used in combination with questionnaires.

The International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire is a standardized instrument for the measurement of the prevalence of childhood asthma and allergic diseases. It was developed to maximize the value of epidemiological studies and to promote international collaboration, and has been translated for use in many countries and cultures. Written (WQ) and video (AVQ 3.0) versions have been established.<sup>7</sup> The AVQ 3.0, which is recommended for use in adolescents, was developed to overcome possible translation bias and provide more reliable comparisons between populations.<sup>8</sup> The ISAAC WQ and AVQ have been used in many epidemiological studies and have been validated using measurements of bronchial hyper-responsiveness (BHR) and doctor-diagnosed asthma. However, most validation studies have focused on children in the age-group 13–14 years since they are able to self-report.<sup>9–16</sup> Few studies have investigated the validity of the ISAAC questionnaire in pre-school or primary school children, and none of these studies have used the AVQ.<sup>17–19</sup>

The Korean ISAAC WQ and AVQ are translations of the international English versions and have been used since 1993. Two validation studies have been performed. Both studies investigated Korean children in the age-group 13–14 years. One study used BHR to hypertonic saline to compare the validity of the AVQ and WQ,<sup>20</sup> and the second study used test–retest.<sup>21</sup> These

studies found no consistent differences between the WQ and AVQ in estimates of asthma prevalence.

The aims of the present study were: (1) to compare asthma prevalence in Korean school children from two age-groups (10–12 and 13–15 years); (2) to investigate the correlation between parent-reported-WQ and self-reported-AVQ in the age group 10–12 years; and (3) to validate the WQ and AVQ in the age-group 10–12 years using the methacholine challenge test as the gold standard.

## METHODS

### Materials

The present study is a sub-project of the study “Evaluation of the prevalence and risk factors for atopic asthma and allergic rhinitis in Seoul.” Seoul city is divided into five regions (central, north-east, north-west, south-east, and south-west). One elementary and one middle school were selected randomly from each region. These five elementary schools and five middle schools were involved in the present study. BHR test was performed at one of the five elementary school students.

The ISAAC WQ and AVQ were used to measure the prevalence of asthma symptoms during the school term in June and July 2008. In accordance with the ISAAC protocol, the WQ was completed first, followed by the AVQ. The 13–15 year olds self-completed WQ and AVQ on the same day and the response rate was 94.1% (4,337 out of 4,607). The 10–12 year olds self-completed AVQ and the WQ was completed by their parents. The response rates of WQ and AVQ were 93.8% and 94.3% (2,482 and 2,495 out of 2,646), respectively.

The study protocol was approved by the institutional review boards of the College of Medicine of the University of Ulsan. Written consent was obtained from the parents of all participants following a detailed explanation of the study.

### Study Design

For the 10–12 year olds, two separate data sets were obtained from the same subject on the same day: 2,482 parent-completed WQ and 2,495 self-reported AVQ. Those data sets were merged to measure agreement between the WQ and AVQ by using the following common variables: school-name, grade, class-name, number, and sex. A total of 1,926 observations were attained from the merged set excluding observations that the common variables were not matched exactly. Using merged data ( $n = 1,926$ ), we analyzed asthma prevalence and agreement test for the 10–12 year olds.

For the 13–15 year olds, all data were self-reported and data from all 4,337 children were directly analyzed

for asthma prevalence and agreement between the WQ and AVQ.

Measurement of BHR to methacholine was performed in 10–12 year olds from one of the five elementary schools for use as the gold standard. Diagnostic accuracy was tested in 514 out of 572 respondents (Fig. 1).

### Written Questionnaire (WQ)

The ISAAC WQ includes the following six questions, which correspond to the six questions depicted in the AVQ:

- WQ 1. Have you ever had wheezing or whistling in the chest at any time in the past? (wheeze ever).  
 WQ 2. Have you had wheezing or whistling in the chest in the last 12 months? (current wheeze).  
 WQ 3. In the last 12 months, has your chest sounded wheezy during or after exercise? (wheezing after exercise).  
 WQ 4. In the last 12 months, how often, on average, has your sleep been disturbed due to wheezing? (nocturnal wheeze).  
 WQ 5. In the last 12 months, have you had a dry cough at night, apart from a cough associated with a cold or chest infection? (nocturnal cough).  
 WQ 6. In the last 12 months, has wheezing ever been severe enough to limit your speech to only one or two words at a time between breaths? (severe wheeze).

### Audiovisual Questionnaire (AVQ)

The ISAAC AVQ includes five scenes that demonstrate: (1) wheezing at rest, (2) wheeze after exercise, (3) night awakening with wheeze, (4) night awakening

with cough, and (5) a severe asthma attack. Each scene consists of three questions. WQ 1 and WQ 2 correspond to the first and second question of first scene. WQ 3–WQ 6 correspond to the second question of AVQ 2–AVQ 5, respectively. After watching each scene, the children were asked if they had ever had the same experience. The frequency of these symptoms was documented.

### Bronchial Challenge

The methacholine challenge test was performed using a dosimeter with a concentration range of 0.625–25 mg/ml.<sup>22</sup> A spirometer (Microspiro HI298, Tokyo, Japan) was used to measure the forced expiratory volume in one second (FEV<sub>1</sub>) after each inhalation. Airway responsiveness was expressed as the concentration of methacholine required to provoke a 20% reduction in FEV<sub>1</sub> (PC<sub>20</sub>). BHR to methacholine was defined as a PC<sub>20</sub> ≤ 16 mg/ml.

### Statistical Analysis

All data were analyzed using SAS version 9.2 (SAS Institute Inc., Cary, NC) and R software (version 2.12.1). The prevalence of each symptom and its confidence interval were compared between the two age-groups. This was then shown in the figure. Statistical significance of prevalence differences between the WQ and AVQ was examined for each age-group using McNemar's test.

The kappa statistic is widely used to evaluate the repeatability of survey questions.<sup>23</sup> In the present study, this was used to measure agreement between the ISAAC WQ and AVQ for six asthma symptoms in two age-groups. Agreement was rated as follows: strong (kappa ≥ 0.75), moderate (kappa 0.4–0.75), and weak

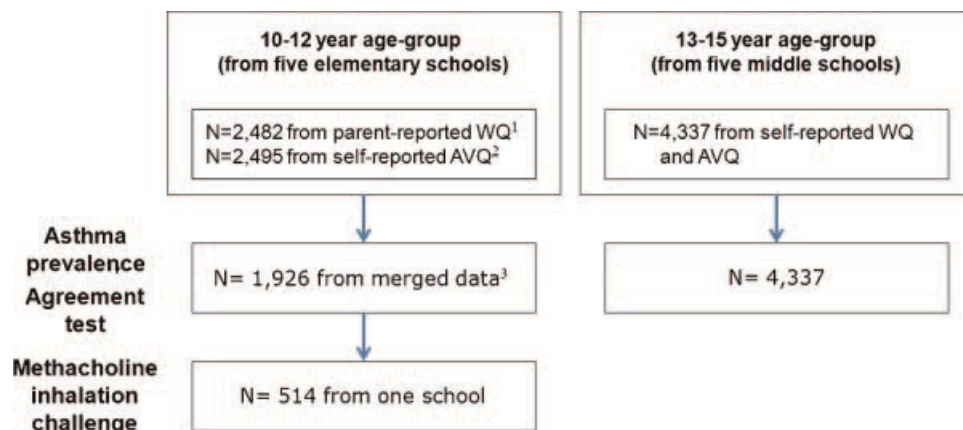


Fig 1. Flow diagram of the study: sampling scheme and grouping of the children in analysis steps. 1 and 2 were obtained from the same subject on the same day. 3 excluding observations that the common variables were not matched exactly. WQ, written questionnaires; AVQ, audiovisual questionnaires.

**TABLE 1—Prevalence of All Six Asthma Symptoms According to the Written and Video Questionnaires in 10–12 Year Olds and 13–15 Year Olds**

| Asthma symptoms         | Written questionnaire |                       | Video questionnaire |                       |
|-------------------------|-----------------------|-----------------------|---------------------|-----------------------|
|                         | n                     | Prevalence % (95% CI) | n                   | Prevalence % (95% CI) |
| 10–12 year olds         |                       |                       |                     |                       |
| Wz_ever                 | 157/1,657             | 9.47 (8.06–10.88)     | 184/1,848           | 9.96 (8.59–11.33)     |
| Current_wz              | 39/1,656              | 2.36 (1.63–3.09)      | 93/1,448            | 6.42 (5.16–7.68)      |
| Wheezing after exercise | 32/1,734              | 1.85 (1.22–2.48)      | 99/1,399            | 7.08 (5.74–8.42)      |
| Nocturnal wheeze        | 17/1,559              | 1.09 (0.57–1.61)      | 22/1,360            | 1.62 (0.95–2.29)      |
| Nocturnal cough         | 151/1,745             | 8.65 (7.33–9.97)      | 97/1,390            | 6.98 (5.64–8.32)      |
| Severe wheeze           | 9/1,560               | 0.58 (0.2–0.96)       | 53/1,338            | 3.96 (2.91–5.01)      |
| 13–15 year olds         |                       |                       |                     |                       |
| Wz_ever                 | 481/3,489             | 13.79 (12.65–14.93)   | 510/3,876           | 13.16 (12.1–14.22)    |
| Current_wz              | 350/3,985             | 8.78 (7.9–9.66)       | 212/3,056           | 6.94 (6.04–7.84)      |
| Wheezing after exercise | 387/3,675             | 10.53 (9.54–11.52)    | 356/3,075           | 11.58 (10.45–12.71)   |
| Nocturnal wheeze        | 110/3,496             | 3.15 (2.57–3.73)      | 56/2,953            | 1.9 (1.41–2.39)       |
| Nocturnal cough         | 483/3,694             | 13.08 (11.99–14.17)   | 241/2,982           | 8.08 (7.1–9.06)       |
| Severe wheeze           | 148/3,487             | 4.24 (3.57–4.91)      | 105/2,918           | 3.6 (2.92–4.28)       |

CI, confidence interval.

Number of observations for 10–12 year olds: 1,926.

Number of observations for 13–15 year olds: 4,337.

(kappa  $\leq$  0.4). Sensitivity, specificity, and their 95% confidence interval (CI) were calculated using the methacholine challenge test as the gold standard. To evaluate significant difference between WQ and AVQ for sensitivity and specificity, the McNemar's test was used.

## RESULTS

### Prevalence of Asthma Symptoms According to the WQ and AVQ

Table 1 shows the prevalence of asthma symptoms and 95% confidence intervals according to the WQ and AVQ in the two age-groups. For the WQ, the prevalence of the six asthma symptoms was higher in 13–15

year olds than in 10–12 year olds. This difference was particularly pronounced for wheezing after exercise and severe wheeze: the prevalence of this symptom was about 6 and 7 times higher in 13–15 year olds than in 10–12 year olds, respectively. For the AVQ, the prevalence of most asthma symptoms was also higher in 13–15 year olds than in 10–12 year olds.

To help direct comparison between WQ and AVQ for the two age-groups, Table 1 was graphically displayed with statistical significance. Figure 2 shows the prevalence of asthma symptoms and 95% confidence intervals according to the WQ and AVQ for 10–12 year age-group. In 10–12 year olds, the prevalence of each symptom was higher in AVQ than WQ, with the

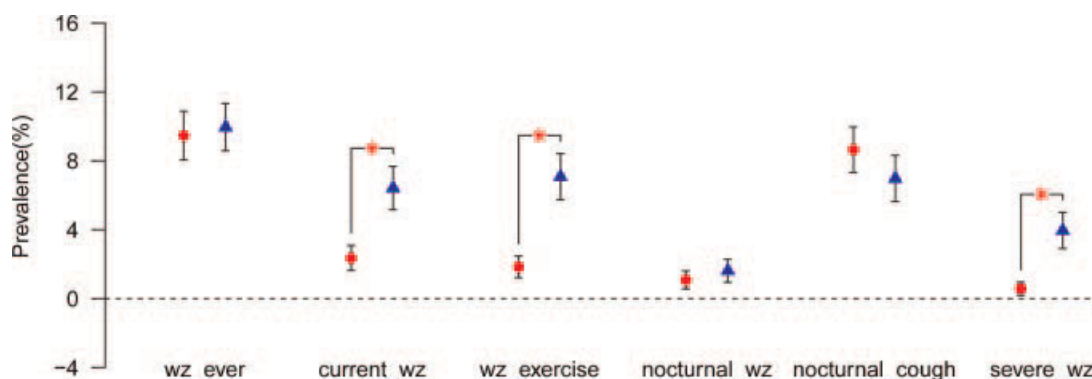


**Fig 2.** Prevalence and 95% confidence intervals of asthma symptoms according to the written (WQ) and audiovisual questionnaires (AVQ) in the 10–12 age group (circle, WQ; triangle, AVQ; \* $P < 0.05$  for significance difference). wz\_ever, wheeze ever at rest (lifetime wheeze); current\_wz, wheeze in the last 12 months; wz\_exercise, wheezing after exercise in the last 12 months; nocturnal\_wz, nocturnal wheeze in the last 12 months; nocturnal\_cough, nocturnal cough in the last 12 months; severe\_wz, severe wheeze in the last 12 months.

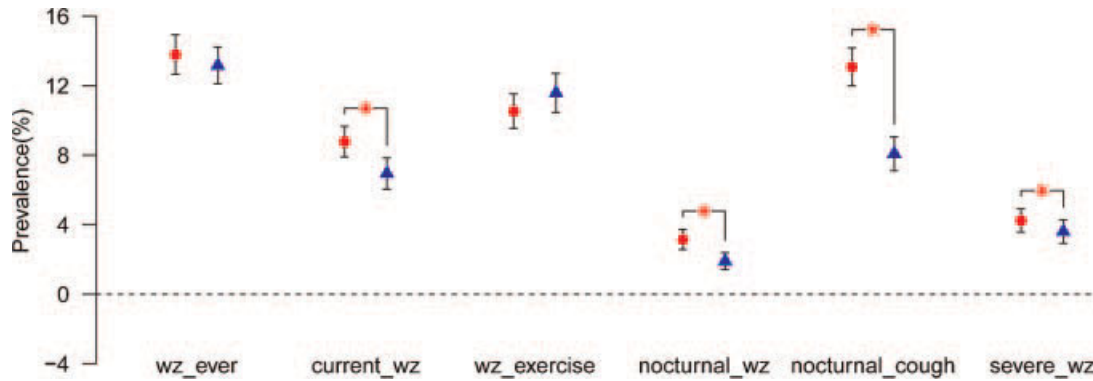


**Fig 3.** Prevalence and 95% confidence intervals of asthma symptoms according to the written (WQ) and audiovisual questionnaires (AVQ) in the 13–15 age-group (circle, WQ; triangle, AVQ; \* $P < 0.05$  for significance difference). wz\_ever, wheeze ever at rest (lifetime wheeze); current\_wz, wheeze in the last 12 months; wz\_exercise, wheezing after exercise in the last 12 months; nocturnal\_wz, nocturnal wheeze in the last 12 months; nocturnal\_cough, nocturnal cough in the last 12 months; severe\_wz, severe wheeze in the last 12 months.

exception of nocturnal cough. Pronounced differences between WQ and AVQ were observed for the following symptoms with statistical significance: current wheeze, wheezing after exercise, and severe wheeze. The prevalence of nocturnal cough tended to be higher in WQ than AVQ. However, the difference was not statistically significant (Fig. 2).

In 13–15 year olds, the prevalence of reported asthma symptoms was generally higher in the WQ than in the AVQ, with the exception of wheezing after exercise. There was a significant difference between the WQ and AVQ in the prevalence of current wheeze, nocturnal wheeze, nocturnal cough, and severe wheeze (Fig. 3).

In 10–12 year olds, the AVQ detected a generally higher prevalence of asthma symptoms than the WQ. In 13–15 year olds, this was reversed.

### Correlation Between the WQ and AVQ

In 10–12 year olds, there was weak agreement between the WQ and AVQ. Best agreement was found for current wheeze (Kappa, 0.20; 95% CI, 0.09–0.31). Weak agreement was found for nocturnal wheeze and nocturnal cough that had Kappa values of 0.05 and 0.06, respectively. Weak agreement was found for wheezing after exercise (Kappa, 0.07; 95% CI, –0.00–0.15).

In 13–15 year olds, there was moderate agreement between the WQ and the AVQ for all six asthma symptoms. All kappa indices were statistically significant (range 0.24–0.44) (Table 2). The kappa indices of all six asthma symptoms were generally higher in 13–15 year olds than in 10–12 year olds.

### Validation of the WQ and AVQ

Table 3 shows the results of validation of the WQ and AVQ with BHR to methacholine challenge in

10–12 year olds from one elementary school ( $n = 514$ ; mean age  $10.9 \pm 0.86$  years; male 50.87%). The prevalence of BHR was 20.1%.

The AVQ had a slightly higher sensitivity than the WQ, except for the symptom wheeze ever. However, the values of sensitivity of both questionnaires were low. The AVQ showed the highest sensitivity for wheezing after exercise (sensitivity, 0.13; 95% CI, 0.07–0.21), and the smallest  $P$ -value was gained by testing the difference between WQ and AVQ sensitivity using McNemar's test for wheezing after exercise ( $P = 0.065$ ). Specificity was generally higher than sensitivity for all six asthma symptoms (range 0.89–1.00). We tested methacholine  $PC_{20} \leq 8$  mg/ml and  $PC_{20} \leq 25$  mg/ml, respectively. The results and trends were similar to those of  $PC_{20} \leq 16$  mg/ml (data not shown).

### DISCUSSION

The validity of the ISAAC WQ has been conclusively established in various age groups and in many

**TABLE 2—Agreement Between the ISAAC WQ and AVQ for all Six Asthma Symptoms in 10–12 Year Olds and 13–15 Year Olds**

| Asthma symptoms         | Kappa index (CI)                   |                                    |
|-------------------------|------------------------------------|------------------------------------|
|                         | 10–12 year olds<br>( $n = 1,926$ ) | 13–15 year olds<br>( $n = 4,337$ ) |
| Wheeze ever             | 0.15 (0.08–0.21)                   | 0.44 (0.40–0.49)                   |
| Current wheeze          | 0.20 (0.09–0.31)                   | 0.44 (0.38–0.50)                   |
| Wheezing after exercise | 0.07 (–0.00–0.15)                  | 0.44 (0.39–0.49)                   |
| Nocturnal wheeze        | 0.05 (–0.07–0.17)                  | 0.27 (0.17–0.37)                   |
| Nocturnal cough         | 0.06 (–0.01–0.13)                  | 0.24 (0.19–0.29)                   |
| Severe wheeze           | –0.01 (–0.01–0.00)                 | 0.34 (0.26–0.42)                   |

WQ, written questionnaires; AVQ, audiovisual questionnaires; CI, confidence interval.

**TABLE 3—Sensitivity, Specificity, and Their 95% Confidence Intervals for BHR to Methacholine for All Six Asthma Symptoms in 10–12 Year Olds**

| Asthma symptoms         | Sensitivity      |                  |                              | Specificity      |                  |                              |
|-------------------------|------------------|------------------|------------------------------|------------------|------------------|------------------------------|
|                         | WQ (95% CI)      | AVQ (95% CI)     | <i>P</i> -value <sup>1</sup> | WQ (95% CI)      | AVQ (95% CI)     | <i>P</i> -value <sup>1</sup> |
| Wheeze ever             | 0.14 (0.08–0.23) | 0.11 (0.06–0.18) | 0.388                        | 0.89 (0.86–0.92) | 0.89 (0.86–0.92) | 0.904                        |
| Current wheeze          | 0.06 (0.02–0.13) | 0.07 (0.03–0.14) | 1.000                        | 0.98 (0.96–0.99) | 0.95 (0.93–0.97) | 0.167                        |
| Wheezing after exercise | 0.04 (0.01–0.10) | 0.13 (0.07–0.21) | 0.065                        | 0.98 (0.96–0.99) | 0.93 (0.91–0.96) | 0.005                        |
| Nocturnal wheeze        | 0.02 (0.00–0.08) | 0.03 (0.01–0.08) | 1.000                        | 0.99 (0.97–1.00) | 0.99 (0.97–0.99) | 0.607                        |
| Nocturnal cough         | 0.07 (0.03–0.13) | 0.09 (0.04–0.16) | 0.508                        | 0.91 (0.88–0.94) | 0.95 (0.93–0.97) | 0.044                        |
| Severe wheeze           | 0.02 (0.00–0.08) | 0.08 (0.04–0.15) | 0.125                        | 1.00 (0.99–1.00) | 0.97 (0.95–0.98) | 0.006                        |

BHR, bronchial hyper-responsiveness; WQ, written questionnaires; AVQ, audiovisual questionnaires; CI, confidence interval.

Number of observations in one elementary school: 514 (58 missing out of 572).

Positive BHR is defined by PC<sub>20</sub> < 16 mg/ml.

<sup>1</sup>The *P*-value is taken from the corresponding McNemar's chi-square test.

countries. Although the ISAAC AVQ has been used in adolescents, there are no recommendations regarding its use in younger children. The present study is the first to have validated the ISAAC WQ/AVQ and to investigate the correlation between parent-reported WQ and self-reported AVQ in the age group 10–12 years.

The present study found a higher prevalence of asthma symptoms in children aged 13–15 years than in those aged 10–12 years. In 13–15 year olds, the WQ detected a higher prevalence than the AVQ. Whereas this was reversed in 10–12 year olds. Assessment of the degree of agreement between the WQ and AVQ revealed that the kappa index of each asthma symptom was higher in children aged 13–15 years than in children aged 10–12 years. When compared with the gold standard methacholine challenge test, the AVQ had a slightly higher sensitivity than the WQ, although the sensitivity of both questionnaires was low.

Most epidemiological studies to have used the ISAAC questionnaire have reported that the WQ detected a higher prevalence of asthma symptoms than the AVQ.<sup>11,14,16,24,25</sup> This corresponds to the findings of the present study for children aged 13–15 years. Proposed explanations for this include: (1) the fact that it is difficult to directly translate the word “wheezing”;<sup>14</sup> and (2) that the AVQ may underestimate the prevalence of milder asthma since it demonstrates more severe wheezing.<sup>16,25</sup>

An important finding of the present study is that the AVQ detected a generally higher prevalence of asthma symptoms than the WQ in the age group 10–12 years, in sharp contrast to findings in the age group 13–15 years. This suggests that the parent-reported WQ may underestimate the prevalence of asthma symptoms in this age-group. This hypothesis is supported by other findings of the present study. Firstly, kappa values showed poorer agreement in 10–12 year olds than in 13–15 year olds, which may demonstrate a significant difference between the responses of parents and

children. Parents may be unaware that their child has asthma symptoms. Two studies of the prevalence of asthma symptoms found that the responses of children appeared to be more valid than those of parents.<sup>26,27</sup> This was further demonstrated by the findings for wheezing after exercise. Since exercise-induced symptoms usually occur in the daytime and outdoors, many parents do not observe them. In the present study, the AVQ detected a 3.8-fold higher prevalence of wheezing after exercise than the WQ. In contrast, no significant difference was found between the AVQ and WQ for nocturnal wheeze or nocturnal cough, symptoms that are likely to be observed by parents.

Secondly, the present study validated the ISAAC WQ and AVQ in 10–12 year olds using BHR to methacholine challenge, and showed that the AVQ has a higher sensitivity than the WQ in this age-group. For wheezing after exercise, it is notable that the smallest *P*-value was founded by testing the difference between WQ and AVQ sensitivity, although *P*-value did not reach statistical significance (*P* = 0.065).

We used PC<sub>20</sub>, which is generally accepted as an AHR index and a cut-off level of 16 mg/ml, suggested by American Thoracic Society (ATS) guidelines.<sup>28</sup> Two previous studies have used methacholine to validate written and video questionnaires. Lai et al.<sup>29</sup> demonstrated the validity of the ISAAC AVQ and found that it was as effective as the ISAAC WQ in predicting BHR. Shaw et al.<sup>30</sup> found that a video questionnaire was a valid and reliable instrument for estimating asthma prevalence, although this study did not use the ISAAC AVQ. Both studies, however, investigated the age group 13–14 years.

In the present study, validation scores for the WQ and AVQ were poor. BHR to exogenous stimuli is a characteristic feature of asthma,<sup>31</sup> and methacholine challenge is a highly sensitive test for the presence of asthma symptoms.<sup>28</sup> Since high sensitivity is correlated with a high negative predictive value, negative

methacholine challenge is useful in excluding a diagnosis of asthma. However, owing to the relatively low specificity of a direct test, positive methacholine challenge does not establish a diagnosis of asthma.<sup>32</sup> Careful interpretation of BHR test results is required in epidemiological studies. Although BHR is a useful marker of asthma-associated airway abnormality, it may not indicate asthma severity. A study of school-children in Hong Kong and Guangzhou found that WQ-reported symptoms may not correlate with pulmonary function, and that an objective parameter may be required to assess asthma severity.<sup>33</sup> Remes et al. investigated the correlation between the WQ and methacholine-induced BHR in the age-group 7–12 years. They reported that BHR alone was a very insensitive indicator of asthma, and stressed the validity of the WQ.<sup>18</sup> A Korean study that used hypertonic saline challenge in 13–14 year olds found no differences between the WQ and AVQ in the prediction of BHR.<sup>20</sup>

The present study had several limitations. Although the sample size of our study is not small, generalization should be made carefully because it is not nationally representative. The measurement of BHR was performed soon after the questionnaire survey, not to make a discrepancy between the test and questionnaire. We had some limitation in the interpretation of methacholine challenge testing because we did not get the answer of a question about the drug usage for the treatment of asthma such as using inhaled corticosteroids when the survey was performed. Also, the discrepancy rate of common variables for data merging was about 20%. Full student-name or social security number would be a more accurate common variable for merging. However, due to ethical considerations regarding subject identity we could only have part of the personal information in our data. So we merged those two separate data sets by creating a new id with the following five common variables: school-name, grade, class-name, number, and sex. Finally, self-reported WQ for 10–12 years old children would be more helpful to demonstrate the relationship and the difference of validity between WQ and AVQ, as well as the relationship between self-reported WQ and parent-reported WQ in the younger age group.

In conclusion, the present study revealed pronounced differences between the ISAAC WQ and AVQ in the estimation of the prevalence of asthma symptoms in children aged 10–12 years, and demonstrated that the AVQ may be at least as effective as WQ in detecting asthma symptoms in this age-group. Future studies of larger and representative samples are required to replicate these findings, which suggest that the parent-reported ISAAC WQ underestimates the true prevalence of asthma symptoms in children of elementary-school-age.

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