

Obesity and the prevalence of allergic diseases in schoolchildren

Kusunoki T, Morimoto T, Nishikomori R, Heike T, Ito M, Hosoi S, Nakahata T. Obesity and the prevalence of allergic diseases in schoolchildren.

Pediatr Allergy Immunol 2008.

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Although the association between obesity and bronchial asthma (BA) has been gaining more attention, few studies have been conducted concerning the relationship between obesity and other allergic diseases. The objective of this study was to determine whether and how childhood obesity is associated with allergic diseases other than BA, such as atopic dermatitis (AD), allergic rhinitis (AR), allergic conjunctivitis (AC), and either AR or AC (AR/AC). A questionnaire was administered to the parents of 50,086 Japanese schoolchildren. Associations between childhood obesity and the various allergic diseases were evaluated by univariate and multivariate logistic models. Significant associations were found between higher body mass index (BMI) and AD ($p = 0.03$), and lower BMI and AC ($p < 0.0001$), and AR/AC ($p < 0.0001$). There was a significantly higher prevalence of BA in girls with obesity ($p = 0.009$) than in those without obesity. Significantly lower prevalence of AC ($p = 0.01$) and AR/AC ($p = 0.002$) among children with obesity, and AR ($p = 0.04$) and AR/AC ($p = 0.0004$) among boys with obesity were observed than those without obesity. Those who were obese and had AD were significantly more likely to have severe symptoms ($p = 0.01$). Overall, childhood obesity has positive associations with BA prevalence and AD severity, whereas it has negative associations with AR and AC prevalence, especially among boys. Changes in the immunologic balance accompanied by obesity might have different effects on each type of allergic disease. Exploring the mechanisms by which childhood obesity affects allergic status should lead to new management options for childhood allergy.

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Key words: allergy; childhood; obesity; bronchial asthma; atopic dermatitis; allergic rhinitis; allergic conjunctivitis; epidemiology

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Accepted 15 October 2007

There have been worldwide trends of increased prevalence of both obesity and allergy, and bronchial asthma (BA) is regarded as one of the most common allergic diseases. Recently, increasing epidemiologic evidence has pointed to obesity as a risk factor for the onset and development of adult BA, especially in females (1). In addition, several reports have shown a link between obesity and BA in children, although the results are less consistent than for adults (2, 3). Decreased lung function and/or modulation of immunologic balance, such as enhancement of proinflammatory cytokines, have been included as possible mechanisms by

which obesity may influence the occurrence of BA (3, 4). If obesity affects BA prevalence only through decreased lung function, it will not affect the prevalence of other allergic diseases. However, if the mechanism is via immunologic modulation, it will influence the prevalence of other allergic diseases as well. In this context, it would be interesting to see whether an association with obesity can be observed in allergic diseases other than BA, such as atopic dermatitis (AD), allergic rhinitis (AR), and allergic conjunctivitis (AC).

To date, few studies have investigated this issue. Von Mutius et al. (5) analyzed 7370

children aged 4–17 yr and found that the prevalence of BA, but not of allergy, as defined by positive skin prick test to any of 10 allergens, was significantly associated with body mass index (BMI). Bråbäck et al. (6) studied 1,247,038 Swedish adults over three decades and found an association between BMI and BA, but not with AR or AC. Meanwhile, several investigations have shown a positive association between BMI and atopy, AR or AC, especially among female young adults and children (7–9). Overall, the data on the relationship between obesity and allergic diseases other than BA among children have not been conclusive.

In this study, we aimed to elucidate the following questions among a childhood population: (i) Is obesity associated with allergic diseases other than BA? (ii) If so, how? (iii) Are there any sex differences in the association, as is seen in BA? Answers to these questions should shed light on the complicated mechanisms of allergic diseases and lead to new management strategies for childhood allergy. For this purpose, we analyzed the data from a questionnaire-based survey on the prevalence of allergic diseases conducted among more than 50,000 schoolchildren between 1996 and 1997 (10), during which body weight and height data were also obtained.

Subjects and methods

Epidemiologic studies on the prevalence of allergic diseases in schoolchildren

A questionnaire survey on the prevalence of four allergic diseases, BA, AD, AR, and AC, was administered to the parents of schoolchildren aged 7–15 yr. The questionnaire was based on and comparable with the one used by the International Collaborative Study of Asthma and Allergies in Childhood (ISAAC) (11) and was prepared and validated (12) by the Study Group of Epidemiology of Allergic Diseases founded by the Japanese Ministry of Public Health and Welfare in 1993 (10). Details of the questionnaire, as well as definition of the diseases and their severity, are shown in the Appendix in Tables 1–4.

Briefly, BA was defined as repeated episodes of wheezing with dyspnea during the preceding 2 yr. AD was defined as chronic eczema with more than three of the symptoms typical of AD, which are listed in the appendix in Table 2. AR was defined as the presence of at least three of four chronic nasal symptoms: sneezing, rhinorrhea, scratching around the nose, and nasal obstruction. AC was defined as the presence of itchy-

Table 1. Comparison of participant characteristics with or without BMI data

	With BMI data	Without BMI data	p-Value
Number	45,727	3661	
Male	22,906	1814	
Female	22,614	1815	
No sex data	207	32	
Age (mean $\pm$ s.d.)	10.8754 $\pm$ 0.0117	11.0503 $\pm$ 0.04137	
Prevalence of the disease (%)			
BA	2227 (4.87)	179 (4.89)	0.96
AD	2782 (6.08)	232 (6.34)	0.54
AR	9898 (21.65)	717 (19.58)	0.003
AC	8159 (17.84)	622 (16.99)	0.2
AR/AC	13,814 (30.21)	1032 (28.19)	0.01

BMI, body mass index; BA, bronchial asthma; AD, atopic dermatitis; AR, allergic rhinitis; AC, allergic conjunctivitis; s.d., standard deviation.

Table 2. Relationships between BMI and allergic diseases in schoolchildren

Disease	BMI (mean $\pm$ s.d.)					
	Patients	Controls	p-Value (univariate)	p-Value (multivariate)†	Adjusted OR	95% CI
BA	17.5 $\pm$ 2.7	17.3 $\pm$ 2.8	0.004	0.64	1	0.99–1.02
AD	17.4 $\pm$ 2.7	17.5 $\pm$ 2.7	0.24	0.03	1.02	1.00–1.04
AR	17.5 $\pm$ 2.7	17.4 $\pm$ 2.7	0.01	0.14	0.99	0.98–1.00
AC	17.6 $\pm$ 2.7	17.4 $\pm$ 2.8	0.0002	< 0.0001	0.98	0.97–0.99
AR/AC	17.5 $\pm$ 2.7	17.4 $\pm$ 2.8	0.02	< 0.0001	0.98	0.97–0.99

BMI, body mass index; CI, confidence interval; s.d., standard deviation; OR, odds ratio; BA, bronchial asthma; AD, atopic dermatitis; AR, allergic rhinitis; AC, allergic conjunctivitis.

†Adjusted for age, sex, birth order, and other allergic diseases.

watery sensation in both eyes. AR/AC was defined as the presence of either AR or AC. BA severity was defined as mild, moderate, or severe, according to the number of days absent from school because of asthmatic symptoms, i.e., 3 days or less, 4–6 days, or more than 7 days, respectively. AD severity was defined as mild, moderate, or severe, according to the sum of symptom scores listed in the appendix in Table 2, i.e., four or less, five to seven, or more than eight, respectively. AR severity was defined as mild, moderate, or severe, when nasal symptoms were experienced sometimes, often, or so often as to disturb quality of life, respectively. AC severity was defined as mild, moderate, or severe, when itchy eyes were experienced sometimes, always, or always in combination with sleep disturbance because of the symptom, respectively.

The questionnaire was distributed between 1996 and 1997 through schoolteachers to the parents of all 56,108 Japanese schoolchildren aged 7–15 yr in 133 randomly selected schools in the suburban areas of Kyoto, Japan. Basically, the targeted area includes residents who have a

Table 3. Prevalence of allergic diseases in schoolchildren with or without either (a) obesity or (b) overweight

(a)	Prevalence (%)		p-Value (univariate)	p-Value (multivariate)†	Adjusted OR	95% CI
	Obese	Non-obese				
BA	5.4	4.8	0.24	0.08	1.19	0.98–1.44
AD	6.5	6.1	0.6	0.26	1.11	0.93–1.32
AR	20.0	21.7	0.05	0.28	0.94	0.84–1.05
AC	15.6	18.0	0.003	0.01	0.85	0.75–0.96
AR/AC	27.5	30.4	0.003	0.002	0.86	0.78–0.94

(b)	Prevalence (%)		p-Value (univariate)	p-Value (multivariate)†	Adjusted OR	95% CI
	Overweight	Non-overweight				
BA	5.1	4.8	0.33	0.21	1.08	0.96–1.22
AD	6.4	6.0	0.26	0.15	1.08	0.97–1.21
AR	21.2	21.7	0.36	0.96	1.00	0.94–1.07
AC	16.3	18.1	0.0004	0.0004	0.87	0.81–0.94
AR/AC	28.9	30.5	0.01	0.004	0.92	0.86–0.97

OR, odds ratio; CI, confidence interval; BA, bronchial asthma; AD, atopic dermatitis; AR, allergic rhinitis; AC, allergic conjunctivitis.

†Adjusted for age, sex, birth order, and other allergic diseases.

Table 4. Sex differences in the prevalence of allergic diseases in schoolchildren with or without obesity

	Prevalence (%)		p-Value (univariate)	p-Value (multivariate)†	Adjusted OR	95% CI
	Obese	Non-obese				
(a) Boys						
BA	5.7	6.0	0.67	0.93	1.01	0.78–1.32
AD	6.1	5.7	0.57	0.33	1.14	0.88–1.46
AR	21.7	25.4	0.004	0.04	0.85	0.73–0.99
AC	15.0	18.0	0.009	0.09	0.86	0.72–1.02
AR/AC	28.1	33.2	0.0003	0.0004	0.78	0.68–0.90
(b) Girls						
BA	5.1	3.7	0.02	0.009	1.46	1.10–1.93
AD	6.9	6.5	0.55	0.52	1.08	0.85–1.38
AR	18.4	18.0	0.75	0.47	1.06	0.90–1.36
AC	17.9	16.1	0.12	0.04	0.83	0.69–0.99
AR/AC	26.8	27.5	0.13	0.38	0.94	0.82–1.08

OR, odds ratio; CI, confidence interval; BA, bronchial asthma; AD, atopic dermatitis; AR, allergic rhinitis; AC, allergic conjunctivitis.

†Adjusted for age, sex, birth order, and other allergic diseases.

modern urban lifestyle. The questionnaires were answered by the parents and collected at school. A total of 50,086 questionnaires, which covers approximately 17% of all schoolchildren in the area, were collected (response rate, 89.3%).

Definition of obesity and overweight

In Japanese schools, physical examination is conducted at least once every 4 months, during which specially trained school nurses measure the height and weight of the children according to a standard technique. The results are reported to the parents in writing. In the questionnaire, parents were asked to report height and weight

of their children according to the record of the latest physical examination. Based on these data, BMI was calculated and its distribution was stratified by age and sex. Obesity was defined as a BMI above the 95th percentile in each stratum (13). Overweight was defined as BMI of more than the 85th percentile in each stratum (13).

Statistical analysis

Univariate associations between BMI values and allergic diseases were assessed using the *t*-test based on the central-limit theorem. Adjusted odds ratios (ORs) for allergic disease and their *p*-values were assessed using logistic regression models with covariates of BMI, age, sex, birth order, and other allergic diseases. This model provides OR for one increment of BMI.

To evaluate the effects of obesity and overweight on allergic diseases, univariate and multivariate logistic regression models were used. The dependent variables included BA, AD, AR, AC, and AC/AR. The independent variables for multivariate models were the same as the BMI models. These analyses were also conducted without sex covariate for boys and girls separately.

Associations between obesity and symptom severity were assessed by chi-square tests for univariate analyses for those with each allergic disease. Because we wanted to retain the ordinal nature of this measure of symptom severity of allergic disease, we treated symptom severity as a linear variable and constructed the multivariate linear models. The dependent variables included symptom severity of BA, AD, AR, and AC, and

the independent variables were the same as the BMI models. $p < 0.05$ was considered statistically significant and $p < 0.1$ was considered a tendency. All statistical analyses were carried out using SAS software (Version 9.1; SAS Institute Inc., Cary, NC, USA).

Results

Profile of the participants

Among 50,082 participants, BMI was available for 45,520 children (22,906 males, 22,614 females). BMI data was missing in 4562 participants (9.1%). As there was no difference in characteristics, including sex, age distribution, or prevalence of allergic diseases among those with and without BMI other than AR (Table 1), we used the data from those with BMI for the subsequent analysis. The number of patients with each allergic disease and the severity rate (mild, moderate, severe) were as follows: 2279 (56.4%, 23.3%, 20.4%) with BA; 3014 (58.5%, 29.4%, 12.1%) with AD; 10,615 (13.9%, 36.4%, 49.6%) with AR; and 8781 (73.1%, 5.2%, 21.8%) with AC. The prevalence of allergic diseases obtained here were comparable to other epidemiologic surveys conducted in Japan (12).

BMI distribution with and without allergic diseases

Mean BMI and standard deviation (s.d.) according to the presence of each allergic disease are shown in Table 2. Univariate analyses showed a significantly smaller BMI among those with BA ($p = 0.004$), and a significantly greater BMI among those with AR ($p = 0.01$), AC ($p = 0.0002$), and AR/AC ($p = 0.02$). Multivariate analyses resulted in a significantly greater BMI among those with AD ($p = 0.03$) and a significantly smaller BMI among those with AC ($p < 0.0001$), and AR/AC ($p < 0.0001$). No association was observed between BMI and either BA or AR in multivariate analyses.

Obesity, overweight and prevalence of allergic diseases

The prevalence of each allergic disease based on obesity status is shown in Table 3a. In univariate analyses, there was a tendency for a lower prevalence of AR ($p = 0.05$) and a significantly lower prevalence of AC ($p = 0.003$) and AR/AC ($p = 0.003$) among obese children. In multivariate analyses, a significantly lower prevalence of AC ($p = 0.01$) and AR/AC ($p = 0.002$) were observed. Furthermore, there was a tendency for a higher prevalence of BA among obese children

($p = 0.08$). Similarly, there was a significantly lower prevalence of AC ($p = 0.0004$) and AR/AC ($p = 0.004$) among overweight compared with the non-overweight population (Table 3b).

Sex difference in the relationship between obesity and prevalence of allergic diseases

We looked into the associations of obesity and allergic diseases by sex. In univariate analyses, there was a significantly lower prevalence of AR ($p = 0.004$), AC ($p = 0.009$), and AR/AC ($p = 0.0003$) in obese boys compared with non-obese boys (Table 4a). The same significance and tendency were also seen for AR ($p = 0.04$), AC ($p = 0.09$), and AR/AC ($p = 0.0004$) in multivariate analyses (Table 4a). In girls, there was no association between obesity and the prevalence of any of the diseases by univariate analysis (Table 4b). On the other hand, by multivariate analysis, there was a significantly higher prevalence of BA ($p = 0.009$), which is consistent with previous data (14), and a significantly lower prevalence of AC ($p = 0.04$) in obese girls compared with non-obese girls (Table 4b).

Obesity and severity of allergic diseases

Finally, we determined the effect of obesity on symptom severity among those with each allergic disease (Fig. 1). No association between obesity and disease severity was seen for BA, AR, or AC. However, among those with AD, the presence of obesity significantly shifted the distribution of symptom severity towards the more severe end ($p = 0.01$).

Discussion

This is, to our knowledge, the first report of the relationship between obesity and not only BA, but also other allergic diseases, including AD, AR, and AC, among children, using data from a large questionnaire-based survey. The data was collected from almost 90% of total subjects, which indicates that the analysis was reliable, although it is not known how the missing 10% of the population would have affected the analysis. We showed that, consistent with previous reports, there is a significantly greater prevalence of BA among obese girls. In addition, we found a significantly lower prevalence of AR and AR/AC among obese boys, and a significantly lower prevalence of AC and AR/AC among obese children. We also found that, although there is no difference in AD prevalence between obese

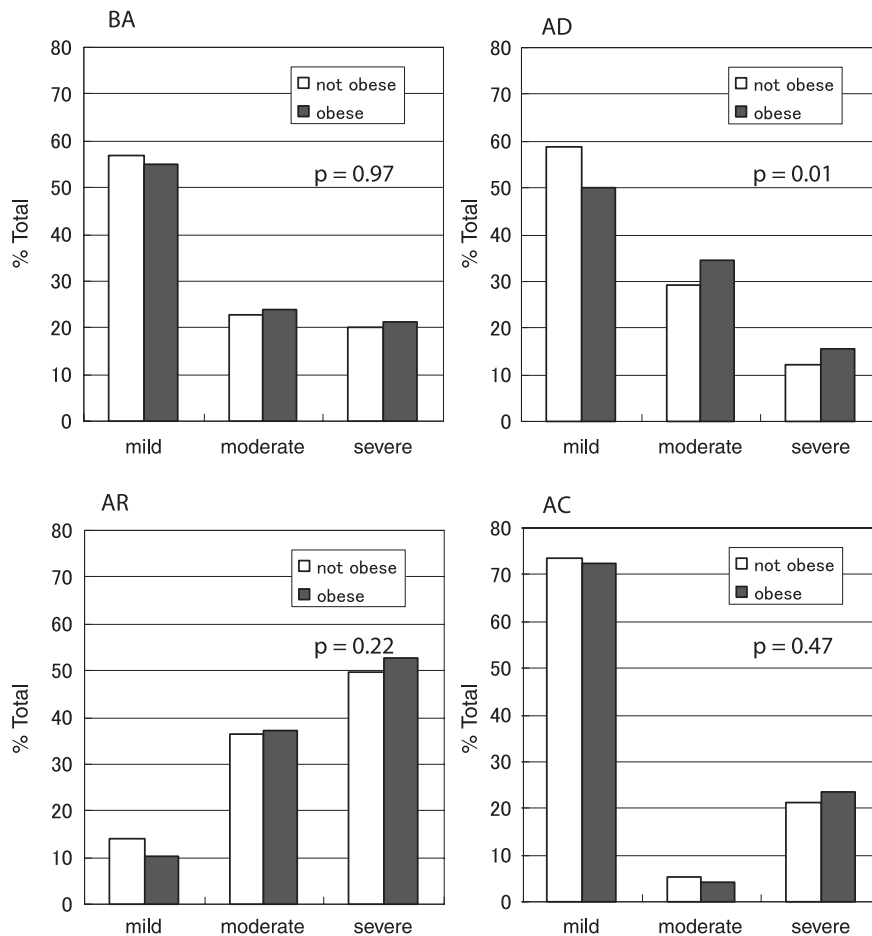


Fig. 1. Association between obesity and disease severity among those with allergic diseases. p-Values were adjusted for age, sex, birth order, and other allergic diseases.

and non-obese children, obese children with AD have significantly more severe symptoms than non-obese children with AD. Overall, on the basis of our findings, it is conceivable that childhood obesity is positively associated with BA prevalence in girls and AD severity in boys and girls, whereas it is negatively associated with AR and AC prevalence, especially in boys. What is the cause of this difference among allergic diseases?

Recent studies on the effect of obesity on the immune system have revealed that adipocytokines, such as adiponectin and leptin, have various immunomodulatory effects (15). Leptin, which is significantly increased in obese subjects, has been shown to be pro-inflammatory and to enhance Th1 response while inhibiting Th2 response (15). On the other hand, adiponectin, which is another major adipocytokine and is decreased in obese subjects, is anti-inflammatory (15). Thus, overall, it seems that the net effect of the quantitative changes of these adipocytokines in obese subjects skews the Th1/Th2 balance toward Th1 and enhances Th1-mediated inflam-

mation (15). As AR and AC are presumed to be relatively pure Th2 type diseases, it can be argued that obesity works through inhibition of the Th2 response. In contrast, BA and AD have more complicated etiologies and cannot simply be explained by a Th2-deviated immune mechanism. For example, Th1-type cytokines, such as interferon- γ and tumor necrosis factor- α , have been shown to aggravate BA (16, 17). Similarly, it has been demonstrated that a Th1 response is induced in the chronic phase of AD inflammation (18, 19).

Obesity-related psychologic factors (20) may also promote BA and AD. Life events that may cause psychologic stress are known to promote BA and AD, but not AR and AC, even before their eventual manifestation (21). Also, obesity has been shown to affect smooth muscle and airway hyper-responsiveness, which may lead to asthmatic symptoms (22). These various obesity-associated aggravating effects on BA and AD may ultimately promote allergic diseases, despite Th2 inhibition. In line with these observations, the association between obesity and BA has been

shown to be stronger in non-allergic than allergic adults (23, 24), suggesting that the mechanisms underlying the effect of obesity on BA are not simply related to the allergic reaction.

A limitation of this study is that it is a questionnaire-based survey of parents and there was no diagnosis by a physician. Also, recall bias with respect to the prevalence of the diseases is possible. However, the data are adequate and reliable, as the questionnaire was comparable with that of ISAAC, and was prepared and validated by authorized Japanese experts from different specialties, including pediatrics, dermatology, otolaryngology, and ophthalmology, who were selected by the Japanese Ministry of Public Health and Welfare. Also, the weight and height data are reliable because the parents' responses in the questionnaire were taken from written reports from school nurses. In addition, although BMI data was missing in about 9% of the participants, we assessed the potential bias and found no statistical difference in sex, age distribution, or disease prevalence between those with and without BMI other than AR.

Another limitation of this study is that it is cross-sectional, and it is not clear whether obesity is the cause or the result of the diseases. Several previous reports have shown that obesity in children predisposes to the occurrence of BA (13, 14), suggesting that obesity is a contributing factor to BA. However, a British study concluded that trends in overweight and obesity did not explain the increase in the incidence of asthma from 1982 to 1994 (25), suggesting that recent changes in lifestyle and diet are associated with both asthma and overweight. If we assume that obesity is a result of the diseases, it can be speculated that enhanced appetite because of the stress of disease, less physical activity possibly because of concern for disease aggravation in BA (26), and hesitation to go outside in AD, may lead to weight gain and obesity. On the contrary, increased physical fitness has been shown to be associated with a decrease in the incidence of asthma in schoolchildren (27). There may exist a potential spiral of disadvantage for children with BA and AD, whereby obesity increases the risk of the diseases, and the diseases exacerbate obesity. A prospective longitudinal study is necessary to clarify the issue.

Assuming that obesity is the contributing factor to either an increased prevalence of BA or aggravation of AD, strategies for preventing obesity, such as daily exercise and reduced calorie and fat intake, should be encouraged to inhibit the occurrence or aggravation of BA and AD.

Another interesting and unexpected finding of this study is that obesity has negative associations with AR and AC prevalence, particularly among boys. Several investigations have already shown that the relationship between obesity and BA is more likely to be observed among girls, which is consistent with our present finding. It has been speculated that female sex hormones may contribute to the increased risk of asthma in obesity, although the precise mechanisms remain to be elucidated (28). Similarly, in the case of AR and AC, female sex hormones may inhibit, or alternatively, male sex hormones may enhance, the disease-inhibiting effects of obesity. It is tempting to speculate that the supposed Th2-inhibitory effect of adipocytokines could be counteracted by a possible Th2-promoting effect of estrogen (29) in females. Several groups have shown the positive relationships between BMI and either allergy, AR or AC (7–9), which are apparently contrary to our findings. However, in these studies, the relationships were observed only in females, again suggesting that the effect of obesity on allergy differs depending on sex. Further clinical and laboratory investigations are required to determine the mechanisms. Regardless, it is obviously improper to argue that one should become obese to improve the symptoms of AR and AC, and alternatives should be pursued. In this respect, it may be useful to examine the possible mechanisms by which obesity inhibits the occurrence of AR and AC. As we discussed earlier, the role of adipocytokines on the Th2 reaction might be worth pursuing as a key to new treatment strategies for allergic diseases.

In summary, we analyzed a large data set from a questionnaire-based survey of more than 45,000 schoolchildren and found positive associations between obesity and BA prevalence and AD severity, and negative associations between obesity and AR and AC prevalence. Further study of the relationship between childhood obesity and allergic diseases should shed light on the complex etiologies of the diseases, and lead to new management options for childhood allergy.

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Appendix

Table 1. Core questionnaire for bronchial asthma

1. Has your child ever had wheezing or whistling in the chest at any time in the past?
Yes () No ()
2. Has your child had wheezing or whistling in the chest two times or more in the last 24 months?
Yes () No ()
3. Has your child had dyspnea with wheezing or whistling in the chest at any time in the past?
Yes () No ()
4. Has your child had dyspnea with wheezing or whistling in the chest in the last 24 months?
Yes () No ()
5. How many days in the last year has your child been absent from school due to dyspnea?
(1) 0 days (2) 1–3 days (3) 4–6 days (4) 7 days or more

BA is defined if the answers to questions 1 and 3 are 'yes,' and the answer to questions 2 or 4 is 'yes.' BA severity is defined as mild, moderate, or severe, when the answer to question 5 is 1 or 2, 3, or 4, respectively.

Table 2. Core questionnaire for atopic dermatitis

1. Has your child ever had an itchy rash that has come and gone repeatedly?
Yes () No ()

2. Has your child had any of these symptoms in the past and/or at present?

Symptom	Score
1. Eczema around the mouth	1
2. Eczema on the face	1
3. Eczema on the neck	1
4. Eczema under the ear	1
5. Dry skin on the face	1
6. Red papules on the trunk	2
7. Red papules on the extremities	2
8. Dry skin on the trunk	1
9. Moist eczema on the flexor side of elbow joint	1
10. Lichenification on the flexor side of elbow joint	2
11. Moist eczema on the flexor side of knee joint	1
12. Lichenification on the flexor side of knee joint	2
13. Eczema on the finger	1
14. Eczema on the foot	1
15. Nummular eczema distributed over the body	2
16. Solid eczematous lesion over the body	2
17. Erythematous lesion over the face	3
18. Dirty neck	3
19. Erythematous lesion over the trunk	3
20. Lichenification on the forehead	2
21. Eczema on the scalp	1

AD is defined if the answer to question 1 is 'yes' and any three of the symptoms typical of AD exist at present or existed in the past, plus the sum of symptom scores at present is 3 or more. AD severity is defined as mild, moderate, or severe, if the sum of symptom scores at present is 4 or less, 5–7, or 8 or more, respectively.

Table 3. Core questionnaire for allergic rhinitis

- Has your child has nasal symptoms in the past?
- Has your child had a problem with sneezing when the child DID NOT have a cold or the flu?
(1) No (2) Sometimes (3) Often (4) So often as to disturb quality of life
- Has your child had a problem with a runny nose when the child DID NOT have a cold or the flu?
(1) No (2) Sometimes (3) Often (4) So often as to disturb quality of life
- Has your child had a problem with scratching the nose when the child DID NOT have a cold or the flu?

(1) No (2) Sometimes (3) Often (4) So often as to disturb quality of life

- Has your child had a problem with a blocked nose when the child DID NOT have a cold or the flu?

(1) No (2) Sometimes (3) Often (4) So often as to disturb quality of life

- In the past 24 months, has your child had a problem with the above-mentioned sneezing, runny nose, blocked nose, or scratching the nose when the child DID NOT have a cold or the flu?

Yes () No ()

AR is defined if the answer to question 1 is 'yes,' three or more answers to questions 2 through 5 are (2) to (4), and the answer to question 6 is 'yes.' AR severity is defined as mild, moderate, or severe, if the answers to questions 2 through 5 are all (1) or (2), all (1) to (3), and at least one of the answers is (3), or all (1) to (4) and at least one of the answers is (4), respectively.

Table 4. Core questionnaire for allergic conjunctivitis

- Has your child ever had eye symptoms?
Yes () No ()
- Has your child ever had itchy-watery eyes?
Yes () No ()
- In which eye your child has had the symptom?
Right () Left () Both ()
- How often does your child experience the symptom?
(1) Sometimes (2) Always (3) Always with disturbance of sleep due to the symptom
- Does your child have the symptom at present?
Yes () No ()

AC is defined if the answers to questions 1 and 2 are both 'yes,' the answer to question 3 is 'both,' and the answer to question 5 is 'yes.' AC severity is defined as mild, moderate, or severe, if the answer to question 4 is (1), (2), or (3), respectively.