

The prevalence, severity and seasonal variations of asthma, rhinitis and eczema in Taiwanese schoolchildren

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The prevalence of asthma is increasing in Taiwan but data remain limited. The aim of this study was to determine the prevalence, severity, demographic and seasonal variations of asthma, rhinitis, and eczema in Taiwan. Using a one-stage stratified cluster random sampling, first grade (aged 6–8) and eighth grade (aged 13–15) students from Taoyuan, northern Taiwan, were invited to participate in this survey. The results showed a total of 6190 students, 3079 aged 6–8 and 3111 aged 13–15, completed this survey. In general, children aged 6–8 had significantly higher prevalence rates of diagnosed asthma, rhinitis, and eczema than children aged 13–15 (12.2%, 29.8%, and 10.2% vs. 9.6%, 18.3%, and 4.7%, respectively). Similarly, children aged 6–8 had significantly higher proportions of allergic symptoms, except for exercise-induced wheezing (5.8% vs. 17.8%, $p < 0.0001$). Among those with allergic disorders, children aged 6–8 presented a greater severity of wheezing attacks in the last 12 months. As regards gender, boys aged 6–8 had a significantly higher proportion of asthma or rhinitis symptoms than girls aged 6–8 but not in children aged 13–15. In children aged 6–8, asthma and rhinitis peaked in winter, especially in December. However, children aged 13–15 had two peaks (winter and summer) for asthma or rhinitis.

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Asthma is an important medical problem in many countries and the most common chronic disease among schoolchildren leading to costly treatment, childhood disability, and school absence. There is evidence that the prevalence of asthma and other allergic conditions, such as allergic rhinitis and eczema, is increasing worldwide (1–4).

Many studies have been conducted to explore the risk factors associated with these allergic disorders. However, studies within populations shed little light on why the occurrence of these disorders varies from population to population. Ecological analyses between populations may reveal important risk factors which have not been investigated previously. In order to study the population or trend differences in these disorders, the International Study of Asthma and Allergies in Childhood (ISAAC) has been initiated and has invited many countries to participate, so that

direct comparisons of the prevalence among different countries are allowed (5). Phase 1 used core questionnaires designed to assess the prevalence and severity of asthma and allergic disease in defined populations. Phase 2 focused on etiologic factors suggested by the findings of phase 1. Phase 3 will be a repetition of phase 1 after at least 3 yr to examine time trends in the prevalence and severity of asthma, rhinitis, and eczema in countries that participated in ISAAC phase 1 (6, 7). Countries that did not participate in phase 1 were invited in phase 3 so that the prevalence of the allergic disorders can be available globally.

In Taiwan, there have been limited large-scale studies (8, 9) disclosing the prevalence, severity, and seasonal variations of allergic diseases. The aim of the present study was to use the ISAAC phase 3 protocol to investigate the prevalence, severity, and demographic and seasonal

variations of asthma and other allergic diseases in Taiwanese schoolchildren, who were in the aged range of 6–8 and 13–15.

Materials and methods

Questionnaires

The ISAAC standard questionnaire consist of three main sections, each involving questions relating to the prevalence and severity of wheezing, rhinitis, and eczema. These questionnaires have been validated in previous studies (10, 11). The questions concentrate mainly on past and current wheezing episodes, frequency of wheezing attacks, sleep disturbances during attacks, acute severe wheezing episodes, exercise-induced wheezing, night-time cough unrelated to respiratory infection, and a physician's diagnosis of asthma. The core questionnaires for rhinitis and eczema follow a similar format.

The Chinese version of the questionnaire had been back-translated as a validity check according to defined guidelines (12). We opted to add several questions about seasonal variations of asthma to explore the connection with asthma and hospital admissions. As all the schoolchildren and parents speak Mandarin Chinese fluently in Taiwan, they were given a Chinese version of the questionnaire for completion.

Sampling and data collection

The area studied was Taoyuan County, northern Taiwan. First-grade children (aged 6–8) or eighth-grade (aged 13–15) children were recruited. According to the ISAAC protocols (13, 14), schools were the sampling units. Twenty-five schools were selected from 10 districts in Taoyuan County. In other words, one-stage stratified cluster random sampling was used in this study.

School children aged 6–8 yr took the questionnaires home to have it filled out by their parents or guardians, returning it within a week. The age 13–15 schoolchildren completed the questionnaires during class hours under the supervision of their class teacher. For children who missed school attendance during our visit, the questionnaire was administered to them another day. The study protocol, sampling method, and data were submitted to ISAAC, and permission was obtained (area code 113003).

A total of 6771 questionnaires were supposed to be collected between May and June of 2002. The response rate was 95.7% with 6483 questionnaires returned. Excluding 21 children due to

ineligible age (age < 5 or age > 9 for the first-grade children and age < 12 or age > 16 for the eighth-grade children) and 272 due to missing answers in the designated questions on asthma, rhinitis, or eczema, a total of 6190 school children were included for this study.

Consent

Written parental informed consent was obtained individually from children aged 6–8. For children aged 13–15, informed consent was obtained through the schools' administration.

Ethical approval

Permission for visiting schools was obtained from the Taoyuan County Ministry of Education and the Taoyuan County Ministry of Health. The Li-Shin Hospital Ethical Committee also approved the study.

Statistical analysis

Data were tabulated with frequency and percentage by age and gender. Seasonal variations of the three allergic disorders were presented by graphs. A 95% confidence interval (CI) for the response on the three allergic disorders was computed. A chi-square test was used to compare responses of the allergic disorders between boys and girls, or between children aged 6–8 and 13–15. All p-values presented were two-sided, and the significance level was set at 0.05.

Results

The mean age was 6.79 yr (s.d. 0.43) for children aged 6–8 and 13.74 yr (s.d. 0.47) for children aged 13–15. The number of boys and girls were nearly equal in the two age groups.

Responses to the questionnaire on wheezing, rhinitis, and eczema

Children aged 6–8 had significantly higher 'wheeze ever' prevalence than the children aged 13–15 (16.8% vs. 10.8%), more 12-month wheezers (7.5% vs. 4.2%), more physician-diagnosed asthma (12.2% vs. 9.6%), and more reported nocturnal cough (19.2% vs. 11.4%) (Table 1). However, exercise-induced wheezing was more frequent in children aged 13–15 than among children aged 6–8 (17.8% vs. 5.8%).

The diagnosed asthma rate for the age 6–8 boys was 15.14%, significantly higher than that of the same aged girls (9.33%, $p < 0.0001$).

Table 1. Responses for core questions on asthma, rhinitis and eczema

	All (n = 6190)	Aged 6–8			p*	Aged 13–15			p*	p†
		Total (%) (n = 3079)	Boys (%) (n = 1546)	Girls (%) (n = 1533)		Total (%) (n = 3111)	Boys (%) n = 1588	Girls (%) (n = 1523)		
Responses for asthma										
Wheeze ‘ever’	13.7 (12.9–14.6)‡	16.8 (15.4–18.1)	20.0 (18.0–22.0)	13.5 (11.8–15.2)	<0.0001	10.8 (9.7–11.9)	12.3 (10.7–14.0)	9.2 (7.8–10.7)	0.0054	<0.0001
Wheeze in last 12 months	5.8 (5.3–6.4)	7.5 (6.6–8.5)	9.0 (7.5–10.4)	6.1 (4.9–7.3)	0.0034	4.2 (3.5–4.9)	4.3 (3.3–5.3)	4.1 (3.1–5.1)	0.7725	<0.0001
Diagnosed asthma	10.9 (10.1–11.7)	12.2 (11.1–13.4)	15.1 (13.4–16.9)	9.3 (7.9–10.8)	<0.0001	9.6 (8.6–10.6)	10.9 (9.3–12.4)	8.2 (6.8–9.6)	0.0109	0.0008
Exercise-induced wheeze	11.8 (11.0–12.7)	5.8 (5.0–6.6)	6.7 (5.4–7.9)	4.9 (3.9–6.0)	0.0441	17.8 (16.5–19.1)	15.2 (13.5–17.0)	20.5 (18.5–22.5)	0.0001	<0.0001
Nocturnal cough	15.3 (14.4–16.2)	19.3 (17.9–20.7)	19.8 (17.8–21.8)	18.7 (16.8–20.7)	0.4439	11.4 (10.3–12.5)	10.4 (8.9–11.9)	12.5 (10.8–14.1)	0.0706	<0.0001
Responses for rhinitis										
Nasal problem ‘ever’	44.6 (43.4–45.9)	41.3 (39.5–43.0)	45.9 (43.4–48.4)	36.6 (34.2–39.0)	<0.0001	47.9 (46.1–49.6)	49.2 (46.8–51.7)	46.4 (43.8–48.9)	0.1132	<0.0001
Nasal problem last 12 months	37.0 (35.8–38.2)	36.3 (34.6–38.0)	40.5 (38.0–42.9)	32.0 (29.7–34.3)	<0.0001	37.8 (36.1–39.5)	38.4 (36.0–40.8)	37.1 (34.7–39.5)	0.4568	0.2224
Associated itchy eyes	16.9 (15.9–17.8)	19.2 (17.8–20.6)	22.8 (20.7–24.9)	15.8 (14.0–17.7)	<0.0001	14.5 (13.2–15.7)	13.9 (12.2–15.5)	15.1 (13.3–16.9)	0.3396	<0.0001
Diagnosed rhinitis	24.0 (22.9–25.1)	29.8 (28.1–31.4)	34.1 (31.7–36.5)	25.4 (23.2–27.6)	<0.0001	18.3 (16.9–19.7)	18.6 (16.7–20.6)	17.9 (16.0–19.9)	0.6062	<0.0001
Responses for eczema										
Recurrent rash ‘ever’	7.7 (7.0–8.4)	9.7 (8.7–10.8)	9.7 (8.2–11.2)	9.7 (8.2–11.2)	0.9776	5.7 (4.9–6.6)	6.2 (5.0–7.3)	5.3 (4.2–6.4)	0.3103	<0.0001
Recurrent rash last 12 months	6.0 (5.5–6.6)	7.8 (6.8–8.7)	8.0 (6.7–9.4)	7.6 (6.3–8.9)	0.6533	4.3 (3.6–5.1)	4.4 (3.4–5.4)	4.3 (3.3–5.3)	0.9229	<0.0001
Recurrent rash typical eczema distribution	4.8 (4.2–5.0)	6.5 (5.6–7.4)	6.9 (5.6–8.1)	6.1 (4.9–7.3)	0.4154	3.1 (2.5–3.7)	3.4 (2.5–4.3)	2.8 (2.0–3.6)	0.3497	<0.0001
Recover in past 12 months	4.0 (3.5–4.5)	5.3 (4.5–6.1)	5.6 (4.5–6.8)	4.9 (3.9–6.0)	0.3864	2.7 (2.2–3.3)	2.6 (1.8–3.4)	2.9 (2.0–3.7)	0.6680	<0.0001
Diagnosed eczema	7.5 (6.8–8.1)	10.2 (9.2–11.3)	10.7 (9.2–12.3)	9.7 (8.2–11.2)	0.3514	4.7 (4.0–5.4)	4.4 (3.4–5.4)	5.1 (4.0–6.2)	0.3488	<0.0001

*Boys vs. girls.

†Aged 6–8 vs. 13–15.

‡95% CI.

Similarly, the age 13–15 boys had significantly higher diagnosed asthma proportion (10.9%) than girls (8.2%, $p = 0.0008$). In the age 6–8 children, ‘wheeze ever’, 12-month wheezing, physician-diagnosed asthma, and exercise-induced wheezing were more frequent in boys than in girls. Likewise, boys had more ‘wheeze ever’ rates and more physician-diagnosed asthma, but not more exercise-induced wheezing, in children aged 13–15.

Rhinitis problems were more common than asthma problems. The children aged 6–8 also had significantly higher prevalence rates of diagnosed rhinitis (29.8% and 18.3%, respectively) and associated itchy eyes (19.2% and 14.5%, respectively) than children aged 13–15. However, ‘ever’ nasal problem was seen less in children aged 6–8 (41.3%) than in children aged 13–15 (47.9%; $p < 0.0001$). The diagnosed rhinitis rate was higher in aged 6–8 boys (34.1%) than in girls (25.4%; $p < 0.0001$). However, there was no statistical significance in the diagnosed rhinitis rate of the age 13–15 group between boys (18.6%) and girls (17.9%; $p = 0.6062$). Similarly, boys usually had more ‘nasal problem ever’, 12-month nasal problems, and associated itchy eyes

than girls in the aged 6–8. On the other hand, there were no gender differences in the responses for rhinitis in children aged 13–15.

Eczema problem had the least occurrence in our sample. Again, significantly higher rates of eczema problems were seen in children aged 6–8 than in children aged 13–15. There was no significant difference between boys and girls, regardless of their age. Among children aged 6–8, the diagnosed eczema rates were 10.7% for boys and 9.7% for girls. Among children aged 13–15, the diagnosed eczema rates were 4.4% for boys and 5.1% for girls. There was no gender difference in the responses for eczema in the two age groups.

Severity of asthma, rhinitis and eczema in children being diagnosed with specific allergic disorder

The number of wheezing attacks in the last 12 months was greater in children aged 6–8 than in children aged 13–15 ($p < 0.0001$), but sleep disturbance due to wheezing or severe asthmatic episodes in the last 12 months were similar in the two age groups (Table 2). Gender differences in severity of wheezing were not seen either in children aged 6–8 or in children aged 13–15.

Table 2. Severity of asthma, rhinitis and eczema in children diagnosed with specific allergic disorders

	All	Aged 6–8				Aged 13–15				$p^{\dagger}$
		Total (%)	Boys (%)	Girls (%)	p^*	Total (%)	Boys (%)	Girls (%)	p^*	
Severity of wheezing‡	(n = 675)	(n = 377)	(n = 234)	(n = 143)		(n = 298)	(n = 173)	(n = 125)		
0 wheezing attacks last 12 months‡	63.6	55.6	60.3	48.2	0.1468	73.4	76.0	69.7	0.5696	<0.0001
1–3 wheezing attacks last 12 months	27.9	34.0	31.1	38.7		20.5	18.1	23.8		
4–12 wheezing attacks last 12 months	6.2	7.9	6.4	10.2		4.1	3.5	4.9		
>12 wheezing attacks last 12 months	2.3	2.5	2.3	2.9		2.1	2.3	1.6		
Sleep never disturbed by wheezing§	82.5	80.4	79.2	82.4	0.7545	84.9	85.3	84.3	0.4532	0.2281
Sleep disturbed by wheezing <1 night a week	13.9	16.1	17.1	14.5		11.3	10.0	13.2		
Sleep disturbed by wheezing >1 night a week	3.6	3.5	3.8	3.1		3.8	4.7	2.5		
Severe asthmatic episodes in last 12 months¶	5.0	4.0	5.5	1.5	0.0636	6.2	5.9	6.5	0.8369	0.1977
Severity of rhinitis	(n = 1485)	(n = 916)	(n = 527)	(n = 389)	0.5351	(n = 569)	(n = 296)	(n = 273)	0.3023	0.0016
Did not affect daily activity**	17.8	15.3	14.5	16.4		21.9	24.0	19.6		
Daily activity affected a little	38.4	38.4	37.5	39.7		38.3	40.0	36.6		
Daily activity affected moderately	32.1	35.1	37.1	32.4		27.2	24.7	29.8		
Daily activity affected a lot	11.7	11.2	10.9	11.5		12.6	11.3	14.0		
Severity of itchy rash	(n = 461)	(n = 315)	(n = 166)	(n = 149)	0.4471	(n = 146)	(n = 69)	(n = 77)	0.0153	0.0071
Rash never keeps child awake††	72.4	67.9	68.6	67.2		81.8	78.3	85.1		
Rash keeps child awake <1 night a week	18.2	20.6	22.0	19.0		13.3	20.3	6.8		
Rash keeps child awake >1 night a week	9.3	11.5	9.4	13.9		4.9	1.5	8.1		

*Boys vs. girls.

†Aged 6–8 vs. 13–15.

‡Twenty-one and five missing in the age 6–8 and age 13–15 students, respectively.

§Thirty-five and seven missing in the age 6–8 and age 13–15 students, respectively.

¶Twenty-three and six missing in the age 6–8 and age 13–15 students, respectively.

**Thirty-one and 29 missing in the age 6–8 and age 13–15 students, respectively.

††Nineteen and three missing in the age 6–8 and age 13–15 students, respectively.

Similarly, the severity of rhinitis was higher in children aged 6–8 than in children aged 13–15 ($p = 0.0016$). There were no gender differences between the two age groups in severity of rhinitis symptoms.

Children aged 6–8 showed greater severity of eczema symptoms than children aged 13–15 ($p = 0.0071$). Among the children aged 13–15, itchy rash kept 20.3% boys awake <1 night a week and 1.5% boys awake >1 night a week. However, only 6.8% of the same age girls were kept awake <1 night a week due to itchy rash and 8.1% were kept awake >1 night a week ($p = 0.0153$). No gender difference in terms of severity of itchy rash was seen in children aged 6–8.

Seasonal variations of asthma and rhinitis symptoms in children being diagnosed with specific allergic disorder

Among the children aged 6–8, asthma and rhinitis revealed similar pattern, which peak in winter (November, December, and January), but more especially in December. However, children aged 13–15 had two peaks, winter and summer, for the occurrence of asthma or rhinitis. Gender difference in seasonal variations was not seen in the two age groups (Figs 1 and 2).

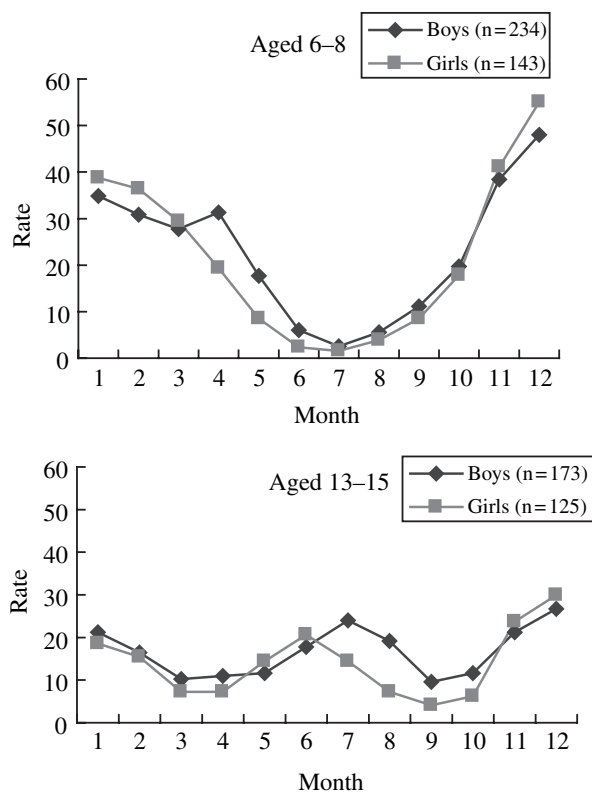


Fig. 1. Seasonal variations of asthma symptoms.

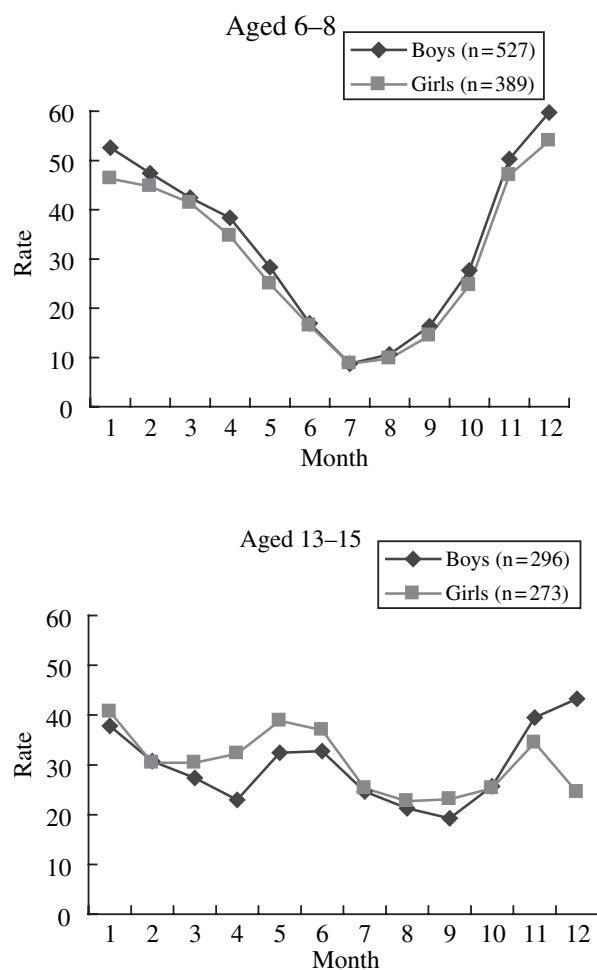


Fig. 2. Seasonal variations of rhinitis symptoms.

Combination of the three diagnosed allergic disorders

The age 6–8 boys were more likely to have diagnosed rhinitis alone, and two or three diagnosed allergic disorders combined, than the age 6–8 girls ($p < 0.0001$; Table 3). In children aged 13–15, there was no significant difference in combination of the three allergic disorders between boys and girls ($p = 0.1616$). The majority of the children (67.2%) did not have any of these three diagnosed allergic disorders, and about 16.1% had rhinitis alone. Approximately 1.6% of the children had all of these three diagnosed allergic disorders combined.

Discussion

Our results clearly demonstrate that allergic diseases are common problems in Taiwanese schoolchildren. Our high response rate (>90%) and randomness of sample adds strength to the result obtained. Considerable variation in the prevalence of childhood asthma has been shown

Table 3. Combination of the three diagnosed allergic disorders

	All	Aged 6–8				Aged 13–15			
		Total n = 3079	Boys (%) n = 1546	Girls (%) n = 1533	p	Total n = 3111	Boys (%) n = 1588	Girls (%) n = 1523	p
None	4159	1859	858 (55.5)	1001 (65.3)	<0.0001	2300	1161 (73.1)	1139 (74.8)	0.1616
Asthma only	299	146	84 (5.4)	62 (4.0)		153	93 (5.9)	60 (3.9)	
Rhinitis only	995	600	333 (21.5)	267 (17.4)		395	200 (12.6)	195 (12.8)	
Eczema only	225	143	68 (4.4)	75 (4.9)		82	34 (2.1)	48 (3.2)	
Asthma and rhinitis	276	159	105 (6.8)	54 (3.5)		117	65 (4.1)	52 (3.4)	
Asthma and eczema	22	15	9 (0.6)	6 (0.4)		7	4 (0.3)	3 (0.2)	
Rhinitis and eczema	136	100	53 (3.4)	47 (3.1)		36	20 (1.3)	16 (1.1)	
Asthma and rhinitis and eczema	78	57	36 (2.3)	21 (1.4)		21	11 (0.7)	10 (0.7)	

in different studies and regions (5, 15, 16). These differences may be attributable to variable diagnostic criteria, methodologies used, problems in defining childhood asthma, and confusion as to the interpretation of symptoms like coughing and wheezing, mainly in early childhood (17, 18). Data from recent international comparisons of childhood asthma and respiratory-related symptoms, using identical study instruments, as in ISAAC, show a real variation in the worldwide prevalence of the disease from many countries. The prevalence of childhood asthma for Asian populations has also been reported from Taiwan and Hong Kong (8, 15, 19).

The results in this survey indicate that 13.7% of all participating children were reported to have wheezed at some time in their life. However, only 5.8% of all respondents were reported to still be wheezing in the previous year. Moreover, 10.9% of all respondents who were aware that they were diagnosed as having asthma lagged well behind the cumulative prevalence of wheezing. Although this might be partly explained by other causes of wheezing apart from asthma, the most likely explanation for most is the under-diagnosis of the condition or the failure to apply the diagnosis of asthma. In addition, the prevalence of reported nocturnal cough was higher than the cumulative wheezing rate and the rate of diagnosed asthma. This might also be explained by the under-diagnosis of asthma or the over-reporting of nocturnal cough attributable to the fact that this symptom can also be a consequence of other diseases such as pneumonia or bronchitis.

When compared with the global prevalence rate (20), all of the prevalence rates of asthmatic symptoms were below the worldwide average mean for both age groups. When we made comparisons with previous studies for children aged 13–15 in the same county in 1996 (8), the prevalence rate of diagnosed asthma (9.6%) was higher than that of the previous study by Lin

et al. (8.0%). This is in agreement with other past studies in Taiwan (19) and other countries (10, 20). Comparisons between the two age groups in asthma and asthma symptoms show that younger children and male children have more asthma and asthma symptoms than older and female children. This observation might be due to a methodological bias from the different subjects for the questionnaire and age grouping.

However, wheezing after exercise was more prevalent among the age 13–15 children when compared with age 6–8 children. This difference could be due to the fact that age 13–15 children exercise more, because their asthma worsens, or because parents under-evaluate the presence of exercise-induced asthma in age 6–8 children. Conversely, children aged 6–8 spent more time at home than children aged 13–15, probably related to indoor exposure to allergens. Our results are consistent with other studies (5, 21, 22). Furthermore, children aged 6–8 presented a higher severity in asthma and asthma symptoms than children aged 13–15, irrespective of gender.

Seasonal variations of asthma and asthma symptoms in this survey were similar to our previous study (23), which revealed significantly increasing asthma admission rates during winter season, especially in December. This might be due to the subtropical climate with high humidity in Taiwan and a high house dust mite concentration in December (24). This may provide us with prevention strategies for asthma and allergies, such as environmental control, allergen avoidance, and warm-up exercise, especially during seasonal changes. Furthermore, this survey may help in establishing the prevalence of asthma in Taiwan and also in developing avoidance strategies. Asthma symptoms peaked in summer in children aged 13–15, which may be related to exercise-induced wheezing.

Rhinitis seems to be an even more common problem than wheezing in our school children. Again, younger and male children presented

more severe rhinitis symptoms than older and female children, except with cumulative nasal problems. Interestingly, seasonal variations of rhinitis and rhinitis symptoms were also similar to those of asthma and asthma symptoms in both age groups. The seasonal patterns are very supportive of an allergic cause to most of these asthma and rhinitis symptoms, and are probably due to a combination of the prevailing weather conditions of high humidity and increased house dust mite concentration.

An itchy rash, intermittent for at least 6 months, which is suggestive of eczema, was the least common of the three allergic diseases investigated in this study. The Taiwan cumulative and current prevalence rates are less than that of the global mean (25). It was again the children aged 6–8 who had more eczema and eczema symptoms than the children aged 13–15, as well as the severity of eczema, except in age 13–15 girls, who presented a greater severity in eczema. Approximately 30% of all diagnosed eczema children kept awake at night because of itchy rash.

In terms of a combination of the three diagnosed allergic disorders, boys were more likely to present more than one allergic disorder than girls, especially in asthma and rhinitis combined. This observation might reflect that boys present greater severity in asthma than girls with concomitant with allergic rhinitis (26).

In conclusion, the prevalence of asthma has increased more than before in Taiwan (9.6% vs. 8.0%, respectively). The overall picture in this study shows that age 6–8 children and male Taiwanese schoolchildren have more asthma and allergies than older and female children. This observation may be explained by methodological bias, with younger children having more upper respiratory infections (27) and more indoor exposure to allergens triggering wheezing episodes. In this study, male children proved to be at greater risk for asthma and other allergies, even after adjustment for age. This association of asthma and sex has been studied extensively.

Some published studies that used the same ISAAC protocol did not show consistent results for the relationship between sex and asthma (21, 28, 29). This could be related to biologic and physiologic differences, such as hormones or social influences, which may lead to over- or under-reporting of symptoms in either sex. Seasonal variations of asthma and rhinitis are related to those of house dust mite concentrations, which may provide us with several prevention strategies for asthma and allergies, such as environmental control, allergen avoidance, and

warm-up exercise, especially during seasonal changes. This survey may help in establishing the prevalence of asthma in Taiwan and also in developing avoidance strategies. However, there is a need for further studies in the evaluation of the risk factors associated with the development of asthma.

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