

ISAAC-based asthma and atopic symptoms among Ha Noi school children

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Childhood asthma and atopy prevalence patterns in the developing world are only beginning to be defined. No such information exists for Vietnam. Estimates would assist in anticipating health service needs as well as add to the growing database on global patterns of atopy. To estimate the prevalence of atopic symptoms in school children in Ha Noi, Vietnam, a cross-sectional survey was conducted of children aged 5- to 11-years-old in two schools using the parent self-administered International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire. The response rate was 66.4% (969 responses). The overall prevalence of selected symptoms were: 'ever wheezed' 24.9%, 'wheezed in past 12 months' 14.9%, 'ever had asthma' 12.1%, 'doctor-diagnosed asthma' 13.9%, 'ever experienced allergic rhinitis (AR) symptoms' 34.9%, 'AR-conjunctivitis symptoms in past 12 months' 10.7%, 'ever had hay fever' 7.8%, 'doctor-diagnosed hay fever' 11.2%, 'ever had eczema' 3.3% and 'doctor-diagnosed eczema' 3.2%. Kappa statistics demonstrated high within symptom category consistency for 'ever had asthma/doctor-diagnosed asthma' (0.728) and 'ever had eczema/doctor-diagnosed eczema' (0.906). Age and gender adjusted odds ratios (OR) were also consistently significant across wheeze and allergic rhinitis symptom categories [highest OR = 10.10 (95% CI 6.23–16.35) between allergic rhinoconjunctivitis and wheeze in past 12 months]. There is a high prevalence of ISAAC-based symptoms in school children in Ha Noi, Vietnam, often above global averages. The high level of association between atopic symptoms suggests some degree of reliability and validity. Childhood atopy symptom prevalence in Vietnam is more similar to that in developed countries rather than developing countries.

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Although there is a large amount of data indicating a rising prevalence of childhood asthma in the developed world, the pattern is not as clear for asthma prevalence patterns in children of developing countries. Generating estimates from the developing world is important in view of current theories about asthma and atopy etiology, which implicate changes in life-style and environment due to modernization. This 'hygiene hypothesis' (1) is consistent with data showing that countries undergoing modernization and economic development have a lower prevalence of asthma and atopy when compared with countries with established market economies (2–5).

This gradient is not so obvious in the Asia-Pacific region. One review of studies done in the region concluded that there was a pattern of increasing atopy prevalence from developing to developed countries (6). This review though was based on a heterogeneous collection of surveys using a variety of instruments. Studies in the region using the standardized questionnaire from the International Study on Asthma and Allergies in Childhood (ISAAC) suggest in part a similar trend. For example in the 6- to 7-year-old age group, Japan and Singapore have higher prevalence estimates of asthma diagnosis and symptoms than Indonesia Malaysia, and Thailand (7). This pattern though is not confirmed in allergic

rhinitis symptoms (8) or eczema (9) or in similar ISAAC data from the 13- to 14-year-old age group (10).

By further defining the differences in prevalence patterns between developed and developing countries, it may be possible to identify factors that either protect from or promote the development of asthma and atopy. In addition, it may help to anticipate health infrastructure needs in the developing world given the potential for similar increases in asthma and atopy prevalence rates as in the developed world.

Ha Noi is the capitol of Vietnam, a developing country undergoing rapid modernization. Since the economic renovation policies of the late 1980s (Doi Moi), the city is being transformed from its post-war state to a modern cosmopolitan center. As a result, the population of Ha Noi is in transition, acquiring modern lifestyle habits superimposed on traditional habits. It is important therefore to estimate the prevalence of asthma and atopic symptoms now in this population both to elucidate the causes of and to cope with prevalence changes in asthma and atopy in the future.

ISAAC has developed a standardized questionnaire survey to help estimate the prevalence of atopic symptoms in children throughout the world (11). The questions in the survey were developed in Europhonic countries and have been translated and implemented in other languages. In the absence of an unbiased, objective measure of asthma or atopy, there is a need to appreciate the subtleties in response patterns to such a questionnaire survey in differing cultural and linguistic circumstances. The ISAAC questionnaire provides an opportunity to conduct this type of analysis. There is an intentional redundancy of symptom questions to help assess reliability. Additionally, the close physiologic associations among asthma, allergic rhinitis and eczema (12) allow for comparison of such symptoms to examine validity.

The purpose of this study was to estimate the prevalence of asthmatic and other atopic symptoms in Ha Noi school children and to examine associations between related symptoms and atopic conditions.

Methods

Location and population

The study was conducted in November of 1999 in Ha Noi. The city is situated in the northern inland area of the country and has a population of 2.5 million people, 33% of whom are under

the age of 14. The population of Vietnam is 20% urban and has a literacy rate of 94% (13). The study team at the National Institute of Occupational and Environmental Health (NIOEH) of the Ministry of Health randomly selected two school sites in urban Ha Noi. The schools were public and contained a total of 1460 students, 5–11 years of age all of whom were considered eligible for this study. The age range was derived based on discussions with school personnel and parent focus groups.

Study design and tools

A cross-sectional survey was conducted using the ISAAC parent self-administered questionnaire (11), which was translated from English into Vietnamese and then back translated. Nine Vietnamese colleagues in Ha Noi and 1 in Seattle, USA, were polled for an appropriate phrase for 'wheezing' and 'hay fever' as there are no Vietnamese colloquial translations for these terms. Individuals polled included physicians at the NIOEH (5), lay staff at the NIOEH who were parents (4), and a Vietnamese language instructor in the US. The phrase 'low-pitched or high-pitched sound in the chest' for wheeze and 'summer allergic fever' for hay fever were decided upon by consensus.

To reduce the number of questions in the questionnaire, we used only two questions for atopic eczema from the ISAAC form – 'ever had eczema and doctor-diagnosed eczema'. Additional questions were added regarding demographics, metered dose inhaler (MDI) use accompanied by a picture of an MDI, triggers for wheezing (colds, cold air, pollens, animals, and exercise), and months when allergic rhinitis symptoms occurred. The questionnaire was administered to four NIOEH staff members for testing and comment.

Teachers of all classes within the two schools distributed the questionnaire to students instructing them to give it to their parents and return it to school upon completion. Teachers collected the questionnaires and in turn forwarded them to the headmaster for secure storage until NIOEH staff retrieval.

Analysis

Overall descriptions of asthma, allergic rhinitis, and eczema prevalences were computed. Non-response rates were calculated for those questionnaires that were returned with questions left unanswered. Analysis of variance (ANOVA) was used to compare the average age between 'yes'

and ‘no’ responses for ever wheezed, wheeze in last 12 months, ever had asthma, doctor-diagnosed asthma, ever had allergic rhinitis symptoms, allergic rhinitis/rhinoconjunctivitis symptoms in past 12 months, ever had hay fever, doctor-diagnosed hay fever, ever had eczema, and doctor-diagnosed eczema. Similarly, crude odds ratios were generated for these symptoms to examine associations with gender. A kappa analysis was applied to assess the consistency of responses within each disease category. [Typically, the kappa statistic is used to assess the agreement between the evaluation of two raters as a measure of reproducibility (14).] A kappa value >0.750 was considered excellent agreement, $0.400\text{--}0.750$ good, and $0 \leq 0.400$ poor. Given the well-recognized association between asthma and allergic rhinitis and eczema, age and gender-adjusted odds ratios (OR) examined the risk of wheeze symptoms and asthma given allergic rhinitis, hay fever and eczema as well as the risk of asthma given wheeze symptoms. Entry and analysis of data used SPSS version 7.5 (SPSS Inc., Chicago, IL, USA).

Ethical considerations

The on-site study team reviewed the study protocol with the headmasters, teachers, and a focus group of parents. It was decided in this review that consent would not be obtained for all participants. This protocol then received approval from the chair of the NIOEH Institutional Review Board and the director of the NIOEH and the study proceeded. The researchers at the University of Washington learned of these changes only after they had been implemented. As soon as they were informed of the changes, the implementation of the protocol was halted, and the University of Washington Human Subjects Division (UW-HSD) was notified. After review by the UW-HSD, it was felt that the procedures and safeguards were culturally appropriate and the data could be used and presented.

Results

The overall response rate was 66.4% (969/1460), the average age of the respondent's child was 7.6 years (± 1.4 SD) with an age range of 5–11 years, and 52% were female. 81.9% of respondents who completed the form (794) were either the student's mother, father, grandparent, aunt or uncle, 1.9% (18) was an older sibling, and 16.2% (157) did not respond to this question.

Table 1 lists the prevalence rates for each survey question pertaining to wheezing, asthma,

Table 1. Prevalence of atopic symptoms in Ha Noi

	% overall (n)	% no response*
Ever wheezed	24.9 (241)	9.3
Wheezed in the past 12 months	14.9 (144)	
≥ 3 attacks	3.1 (31)	
Wheeze disturbs sleep	1.9 (18)	
Wheeze limits speech	3.6 (35)	
Wheeze after exercise	6.7 (65)	
Night cough	12.8 (124)	
Ever has asthma	12.1 (117)	10.0
Doctor-diagnosed asthma	13.9 (135)	9.8
Ever had allergic rhinitis symptoms	34.9 (338)	10.7
Allergic rhinitis in the past 12 months	27.6 (267)	
Allergic rhinoconjunctivitis symptoms in the past 12 months	10.7 (104)	
Limited activity due to allergic rhinitis symptoms	17 (165)	
Ever had hay fever	7.8 (76)	32.9
Doctor-diagnosed hay fever	11.2 (109)	13.5
Ever had eczema	3.3 (32)	14.8
Doctor-diagnosed eczema	3.2 (31)	15.4

*For questions that were not in a skip pattern, % no response rates based on questionnaires that were returned but with questions left unanswered.

allergic rhinitis, hay fever and eczema. It also depicts the non-response rates for questions that initiated a skip pattern. The mean non-response rate was 14.5% ($\pm 7.8\%$) and was highest for ‘ever had hay fever’ (32.9%). Analysis of non-response patterns from returned questionnaires with unanswered questions found no consistent trend in bias based on age, gender, and parental education or occupation.

The average age for those who ‘ever wheezed’ (7.4 yes, 7.7 no, $p = 0.005$) and ‘wheeze in the past 12 months’ (7.3 yes, 7.7 no, $p = 0.002$) was lower than those without such symptoms (ANOVA). Crude analysis for associations between symptoms and gender found that males were more likely to have ‘doctor-diagnosed asthma’ (OR = 1.52, 95% CI 1.05–2.22) and have ‘allergic rhinoconjunctivitis symptoms in the past 12 months’ (OR = 1.55, 95% CI 1.02–2.35). There were no other significant associations between gender or age with the other symptoms. No significant associations with symptoms were found with regards to the individual completing the questionnaire, whether they were an adult, sibling or unknown.

To examine the amount of agreement between related symptoms within categories (asthma, allergic rhinitis, and eczema), kappa values were generated as shown in Table 2.

We examined the association among wheeze symptoms and asthma as well as among allergic rhinitis symptoms and hay fever. 60.1% of all who ‘ever wheezed’ had ‘wheeze in the past

Table 2. Agreement between symptom questions

Symptoms	Kappa value
Ever wheezed and ever has asthma	0.402
Ever had asthma and doctor-diagnosed asthma	0.728
Ever had allergic rhinitis symptoms and ever had hay fever	0.279
Ever had hay fever and doctor-diagnosed hay fever	0.561
Ever had eczema and doctor-diagnosed eczema	0.906

$\kappa > 0.75$ denotes excellent agreement.

$0.4 \leq \kappa \leq 0.75$ denotes good reproducibility.

$0 \leq \kappa \leq 0.4$ denotes poor reproducibility.

12 months'. The age- and gender-adjusted odds ratio for 'ever had asthma' given 'wheezed in past 12 months' was 13.81 (95% CI 8.47–22.52). The adjusted odds ratio for 'doctor-diagnosed asthma' given 'wheezed in past 12 months' was 10.48 (95% CI 6.56–16.76). Meanwhile, 32.9% of all those who had 'ever had allergic rhinitis symptoms' had 'allergic rhinoconjunctivitis symptoms in the past 12 months'. The adjusted odds ratio for 'ever had hay fever' given 'allergic rhinoconjunctivitis symptoms in the past 12 months' was 11.82 (95% CI 6.56–21.30) while for 'doctor-diagnosed hay fever' given 'allergic rhinoconjunctivitis in the past 12 months' was 2.31 (95% CI 1.27–4.20).

Age- and gender-adjusted odds ratios for wheeze symptoms and asthma given allergic rhinitis symptoms, hay fever, and eczema are shown in Table 3. There is a consistent increase in odds ratio from 'ever wheezed' to 'wheeze in the past 12 months' given allergic rhinitis symptoms. The patterns in the odds ratios demonstrate an internal consistency of responses within atopic symptom categories.

Overall, 15.9% of all respondents had used an MDI, pill or syrup for breathing problems in the past 12 months, with 44.9% of these having 'wheezing in past 12 months'. Of all those with 'wheezing in past 12 months', 53.7% had used an MDI, pill or syrup. Overall, 3.6% of all respondents had used an MDI in the past 12 months, with 41.2% of them having 'wheezing in the past 12 months'. Of all those with 'wheezing in the past 12 months', 12.6% had used an MDI in the past 12 months. Meanwhile 14.3% of all respondents indicated that they had used a pill or syrup in the past 12 months to help with breathing, with 48.1% of them having 'wheezing in the past 12 months'. Of all those with 'wheeze in the past 12 months', 43.8% had used a pill or syrup.

'Colds' and 'cold air' were the most frequently noted triggers for 'wheezing in the past 12 months' (31.3% and 40.3%, respectively). Age stratification of trigger prevalence did not reveal any significant pattern. 58.4% of all of those with 'allergic rhinitis symptoms in the past 12 months' indicated a monthly variability to symptoms. The most frequent months in which allergic rhinitis symptoms occurred were in October and November (22.5% and 16.9%, respectively, of all respondents with 'allergic rhinitis symptoms in the past 12 months').

Discussion

This questionnaire survey using ISAAC protocols reveals a high prevalence of atopic symptoms in a sample of school children from Ha Noi, Vietnam. There were significant age- and gender-adjusted associations within and between

Table 3. Age- and gender-adjusted odds ratios for asthma and wheeze symptoms given allergic rhinitis symptoms and eczema

Exposure	Outcome	OR	95% CI
Ever had allergic rhinitis symptoms	Ever wheezed	4.38	3.10–6.19
	Wheezed in the past 12 months	7.51	4.70–12.02
Allergic rhinitis symptoms in the past 12 months	Ever wheezed	4.91	3.43–7.03
	Wheezed in the past 12 months	10.10	6.23–16.35
Allergic rhinoconjunctivitis symptoms in the past 12 months	Ever wheezed	7.19	4.35–11.87
	Wheezed in the past 12 months	9.94	5.88–16.80
	Ever had asthma	5.08	2.97–8.69
	Doctor-diagnosed asthma	3.94	2.35–6.60
Ever had hay fever	Ever had asthma	3.90	2.14–7.11
	Doctor-diagnosed asthma	3.22	1.77–5.85
Doctor-diagnosed hay fever	Ever had asthma	2.40	1.39–4.15
	Doctor-diagnosed asthma	2.42	1.42–4.11
Ever had Eczema	Wheezed in the past 12 months	3.20	1.34–7.66
	Ever had asthma	2.76	1.06–7.22
	Doctor-diagnosed asthma	3.61	1.49–8.77
Doctor-diagnosed eczema	Wheezed in the past 12 months	2.07	0.80–5.37
	Ever had asthma	2.28	0.88–5.92
	Doctor-diagnosed asthma	2.29	0.87–6.01

categories of asthma, allergic rhinitis and eczema questions as well as noteworthy patterns in medication use, monthly variability in allergic rhinoconjunctivitis symptoms, and specific triggers. Males more than females tended to have 'doctor-diagnosed asthma' as well as 'allergic rhinoconjunctivitis symptoms in the past 12 months' and children who 'ever wheezed' or had 'wheezing in the past 12 months' tended to be younger. The associations and correlations between symptoms support the idea that these responses reflect a high prevalence of atopy among Vietnamese children.

The intention of the survey was to estimate the current prevalence of atopic symptoms in Ha Noi, Vietnam at a stage of accelerated economic development and modernization. The ISAAC questionnaire has been validated primarily in Europhonic countries using objective measures, other standardized surveys and the ISAAC video questionnaire. Most of these investigations have demonstrated a significant degree of both validity and reliability (15–19).

It is difficult to determine the true validity of the ISAAC questionnaire in a country such as Vietnam due to cultural and linguistic differences, particularly in the absence of objective physiologic measures. In addition, local medical providers including traditional healers and pharmacists may be using diagnostic rubrics different from those assumed in ISAAC. Finally, the Vietnamese colloquial has no single term for wheezing or for hay fever. The ISAAC protocols' video questionnaire was designed to help in the situation with the wheeze term but only for the self-administered > 12-years-old age group. The logistics to show it to parents in our study was prohibitive. Instead, we used two expressions that describe wheezing. For hay fever we used 'pollen fever', a familiar term to medical providers but not in the Vietnamese colloquial.

We attempted to assess the validity and reliability of ISAAC in Vietnam using the kappa statistic within and adjusted odds ratios between symptom categories. The kappa analysis was done assuming that certain questions were 'testing' for the same clinical disorder and in some cases were redundant to a degree. The results from this analysis demonstrate the varying levels of comprehension of terminology by parents. The high kappa values for 'ever had asthma' and 'doctor-diagnosed asthma' (0.728) and 'ever had eczema' and 'doctor-diagnosed eczema' (0.906) suggests that such terminology is acquired from medical provider encounters and not through lay contacts. The relatively low kappa between 'ever wheezed' and 'ever had asthma' (0.402) and 'ever

had allergic rhinitis symptoms' and 'ever had hay fever' (0.279) may be due to either the poor validity of our translations or the unfamiliarity in terminology.

Parents were more apt to acknowledge hay fever in the context of a doctor diagnosis (32.9% non-response rate for 'ever had hay fever' but 13.5% for 'doctor-diagnosed hay fever' and a non-response kappa of 0.083 for the two questions). In addition, they appeared to associate allergic rhinitis symptoms with hay fever less than expected (kappa for 'ever had allergic rhinitis symptoms' with 'ever had hay fever' of 0.279).

The rationale for examining associations between allergic rhinitis and eczema symptoms with wheeze symptoms using adjusted odds ratios is based on the established close relations among these atopic disorders (12, 20). This link between asthma and atopy, however, is refutable particularly in the developing world and more so in adults than in children, as the association becomes weaker with increasing age (21). The ISAAC survey may be eliciting non-specific symptoms in the Vietnamese colloquial. The association between allergic rhinitis and wheeze may be a result of recurrent infectious etiologies such as sinusitis and acute bronchitis and other recurrent respiratory infections. However, this interpretation does not explain the high odds ratios between eczema and wheeze symptoms. Also, the high odds ratio for 'doctor-diagnosed asthma' given 'wheeze in past 12 months' [OR = 10.48 (95% CI 6.56–16.76)] supports the notion that those with more recent wheeze symptoms were more likely to have been diagnosed as asthmatic and may reflect persistent wheezing. The higher odds for males for 'doctor-diagnosed asthma and allergic rhinoconjunctivitis in the past 12 months' is consistent with the trend for a higher atopy rate in males (22). In contrast, the lower average age for 'ever wheezed and wheezing in past 12 months' is not consistent with patterns of asthma diagnosis wherein children tend to acquire the label as they become older (22).

Parents' confusion with the term eczema may explain the low prevalence estimate for eczema (relative to asthma and allergic rhinoconjunctivitis symptoms estimates). The Vietnamese translation of eczema is a non-specific term describing a variety of rashes. This non-specificity and confusion could have also contributed to the weaker association of eczema with wheeze symptoms as compared with allergic rhinitis and wheeze symptoms, and the high non-responder kappa statistic for 'ever had eczema' and

‘doctor-diagnosed eczema’. In an effort to limit the length of the questionnaire, we omitted the other, more specific ISAAC eczema questions, imposing further limitations on our analysis of the eczema response pattern.

The pattern of medication usage suggests some variability in diagnosis and treatment of respiratory illnesses in this population. Less than half (41.2%) of those who used an MDI in the past 12 months had ‘wheezing in the past 12 months’ suggesting that providers or parents themselves are treating non-wheeze illnesses such as upper respiratory tract infections, tuberculosis, or pneumonia with MDIs. There is also a large financial incentive in the Vietnamese health care system for medical providers to prescribe pharmaceuticals with each patient encounter (23). The 87.4% of those who ‘wheezed in the past 12 months’ who did not use an MDI and the higher prevalence of treating wheezing with pills and syrup (43.8%) as opposed to MDIs (12.6%) may reflect inadequate supplies for or knowledge of appropriate treatment of asthma (24). There may also be cultural perceptions and preferences that may be an obstacle to this type of treatment. Clearly, better education of providers and the public is needed to promote appropriate use of such medication.

The questionnaire was implemented in November, a month of weather transition from the dry to the wet season when it is commonly perceived that children are more prone to respiratory illnesses (the temperature in Ha Noi during the months of November–February can drop as low as 10°C). Moreover, parents most frequently indicated October and November as when allergic rhinitis symptoms occurred. They may be more alert to respiratory symptoms during these months and may have likewise biased their responses. There was also a higher frequency of colds and cold air as triggers of ‘wheezing in the past 12 months’ when compared with pollens, animals and exercise. This predominance either suggests a more pervasive role for infectious exacerbators of wheezing in this population or supports a season of response effect. With regards to the later, Stewart et al. in their analysis of ISAAC in New Zealand found a statistically significant trend of decreased symptoms for winter respondents. These respondents may have tended to be asymptomatic due to absence of seasonal allergens (25). Our survey was conducted within one season and thus does not provide the opportunity to make such an analysis.

Several issues with this ISAAC survey limit its generalizability to the entire population of Hanoi

and comparisons with previously published ISAAC surveys (7–10). We were unable to adhere to ISAAC guidelines regarding sample size and response rates. Our sample size and response rates were below the targets of 3000 and 80%, respectively. Nonetheless, aggregated ISAAC data demonstrated no response bias when they analyzed data both with and without centers with less than 80% response rates (10). The sampling frame in our study involved two school sites only. The ISAAC study group recommended a minimum of 10 schools. The age range of our population was broader when compared with other ISAAC studies. Our sample ranged from 5 to 11 years of age whereas other ISAAC’s parent-administered questionnaire responders were 6 to 7 years old. The age range in this study was decided upon based on parental and school administration input during discussion with collaborators. In addition, Vietnam was not included in the original aggregation of ISAAC data due to timing of the study, which was after other sites had submitted the results of their surveys.

Despite these limitations, the prevalence estimates obtained in this study were similar to or greater than global averages (7–9). Greater prevalence estimates were noted for the following items: ‘ever wheezed’ (24.9% vs. 22.6%), ‘wheezed in the past 12 months’ (14.9% vs. 11.7%), ‘wheeze limits speech’ (3.6% vs. 2.3%), ‘wheeze after exercise’ (6.7% vs. 6.6%), ‘ever had asthma’ (12.1% vs. 11.0%), ‘ever had allergic rhinitis symptoms’ (34.9% vs. 21.5%), ‘allergic rhinitis symptoms in the past 12 months’ (27.6% vs. 18.0%), ‘allergic rhinoconjunctivitis symptoms in the last 12 months’ (10.7% vs. 7.2%), and ‘limited activity due to allergic rhinitis symptoms’ (17.0% vs. 12.1%). If these estimates reflect true atopy and asthma prevalences, the question then is why are these estimates from Ha Noi so high?

It is unclear whether Asian populations have a higher prevalence of asthma or atopic symptoms compared with the rest of the world. Immigrant studies of Asians who reside in Europe and Australia (26, 27) are inconclusive in this regard. They demonstrate a trend of increasing risk with earlier arrival and longer duration of residence in the adopted country, suggesting the importance of environmental factors rather than genetic influences. Previous ISAAC survey results do not reveal any marked difference in prevalence patterns between Asian and non-Asian countries with regard to asthma or atopic symptoms (7–9). However, other investigations have found that Asians have a higher risk of atopic eczema (28) compared with European white populations, contrary to our results.

It is possible that a 'threshold' of affluence has been achieved in Ha Noi whereby the population has acquired risk factors that predispose to asthma and atopy or lost the protective factors that reduce the risk. This possibility is conceivable given Ha Noi's rapid economic development since the late 1980s when the economic renovation policies of Doi Moi were implemented. For example, changes in enteral environmental exposures may have occurred as a result of reduced contact with farm animals, improved hygiene and sanitation, or changes in dietary habits and food processing. As a result, children may have reduced exposure to endotoxin or helminth antigens, or increased exposure to antibiotic animal feed supplementation, thereby increasing the risk of atopy. With economic development, lifestyle patterns change as well. Individuals acquire more sedentary lifestyles, employing motorized transportation methods and spending more time indoors. Such alterations have been implicated in the development of atopy (29, 30).

Based on the results of our ISAAC survey, Vietnam appears to have a high prevalence of asthma and atopic symptoms. Future studies should be directed at verifying the atopic nature of these symptoms using more objective outcome measures, such as skin prick testing for allergen sensitization, and establishing the cause of these conditions. In addition, given the seemingly high prevalence of asthma and atopy-related symptoms, health care systems in Vietnam should consider culturally specific screening for and early management of childhood asthma. An improved understanding of asthma and atopic symptoms in children in the developing world may provide further insight into the nature of these diseases as well as help cope with their potentially rising prevalence.

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