Pediatr Allergy Immunol 2008: 19: 307–314
DOI: 10.1111/j.1399-3038.2007.00650.x

PEDIATRIC ALLERGY AND IMMUNOLOGY

Prevalence of and factors associated with current asthma symptoms in school children aged 6–7 and 13–14 yr old in Bogotá, Colombia

Garcia E, Aristizabal G, Vasquez C, Rodriguez-Martinez CE, Sarmiento OL, Satizabal CL. Prevalence of and factors associated with current asthma symptoms in school children aged 6–7 and 13–14 yr old in Bogotá, Colombia.
Pediatr Allergy Immunol 2008: 19: 307–314.

This cross-sectional study of children aged 6–7 years and adolescents aged 13–14 years in Bogotá, Colombia, assessed the prevalence of asthma symptoms and their associations with dietary, health, and behavioral habits. This study is part of the International Study of Asthma and Allergies in Childhood (ISAAC)-phase III. Asthma prevalence among the children was assessed using a parental self-administered written questionnaire (WQ), and among adolescents using a WQ together with a video questionnaire (VQ). Associations were estimated with bivariate and multivariate analysis. The study found that the 6–7 year age-group were more likely to report current asthma symptoms than the 13–14 year age-group (10.4% [WQ] vs. 8.6% [WQ] and 8.0% [VQ], respectively). Factors associated with current asthma symptoms among the 6–7 year age-group included higher maternal education (OR = 1.7, [95% CI 1.2–2.6], p = 0.007), a cat in the home during the last year (OR = 1.5, [95% CI 1.0–2.3], p = 0.036), watching TV 1–2 hours/day (OR = 2.1, [95% CI 1.2–3.9], p = 0.013), and medication with acetaminophen in the first and most recent year of life (OR = 1.8, [95% CI 1.3–2.4], p < 0.001; OR = 2.2, [95% CI 1.7–2.8], p < 0.001, respectively) or antibiotics in the first year of life (OR = 1.9, [95% CI 1.4–2.5], p < 0.001). Among the 13–14 year age-group, factors associated with current asthma symptoms included medication with acetaminophen during the last year (OR = 1.8, [95% CI 1.4–2.3], p < 0.001); cereal, milk, and fruit consumption 3 or more times weekly (OR = 1.5, [95% CI 1.1–1.9], p = 0.010; OR = 0.8, [95% CI 0.6–1.0], p = 0.046; OR = 0.6, [95% CI 0.4–1.0], p = 0.031, respectively). Overall, compared with that in other Latin American centers, asthma prevalence in Bogotá is close the lower estimates. However, associations with dietary, health, and behavioral habits need further study to assess their complex relationship with asthma.

Elizabeth Garcia[1], Gustavo Aristizabal[2], Catalina Vasquez[3], Carlos E. Rodriguez-Martinez[4], Olga L. Sarmiento[5] and Claudia L. Satizabal[6]

[1]Division of Pediatric Allergies, Fundación Santa Fe de Bogotá, Bogotá, Colombia, South America, [2]Department of Pediatric Respiratory Medicine, Respiremos; Hospital Simón Bolívar; Universidad El Bosque; and Universidad La Sabana, Bogotá, Colombia, South America, [3]Department of Pediatric Respiratory Medicine, Respiremos and Clínica del Niño J.B., Bogotá, Colombia, South America, [4]Department of Pediatric Respiratory Medicine, Clínica Infantil Colsubsidio and Clínica Colsanitas, Bogotá, Colombia, South America, [5]School of Medicine, Universidad de Los Andes; and Centro de Estudios e Investigación en Salud, Fundación Santa Fe de Bogotá, Bogotá, Colombia, South America, [6]Department of Biological Sciences, Universidad de Los Andes, Bogotá, Colombia, South America

Key words: asthma symptoms; prevalence; 6–7 year age-group; 13–14 year age-group; associated factors; ISSAC phase-III; dietary habits; healthy habits; behavior characteristics; Bogotá, Colombia

Elizabeth García, MD, Av. 9A No. 117-20, office 209, Fundación Santa Fe de Bogotá, Bogotá, Colombia, South America
Tel.: 57 1 2152852 or 57 1 2152300 (ext. 212)
Fax: 57 1 6198079
E-mail: eligarci@cable.net.co

Accepted 16 July 2007

As the most frequent chronic disease in infancy, asthma places a heavy burden on public health. The prevalence of asthma varies among different geographical zones and within the same country (1, 2); additionally comparisons among countries were traditionally difficult by inconsistent diagnostic and methodological criteria. More recently, however, methodological standardization and clear definition of diagnostic criteria by the International

Study of Asthma and Allergies in Childhood (ISAAC) has enabled comparison of prevalence and severity both among different geographical zones and in the same zone across time (3).

In Latin America, phase I of the ISAAC included 17 centers in nine countries, phase II included two centers and phase III encompassed 78 centers (4). Additionally, some studies across the world have assessed factors potentially associated with asthma such as diet, allergenic sensitization, respiratory infections, environmental pollution, socioeconomic factors, and medications.

In Colombia there have been two previously published studies that have addressed asthma prevalence. The first study, conducted in Cartagena in 1992, estimated an overall current prevalence of 8.8% (12.3% for the 5–9 age group and 8.3% for the 10–14 age group) (5). The second, conducted in six Colombian cities of different altitudes and climates in 2004, estimated an overall current prevalence of 10.4% (11.6% for the 5–11 age group and 10.3% for the 12–18 age group). This study also showed that prevalence of current asthma between dissimilar cities like Bogotá at 2640 m of altitude (9.4%) and Barranquilla located at sea level (8.1%), did not show significant differences (6).

Even though both studies were population based, neither followed the ISAAC methodology or assessed dietary, health, and behavioral habits.

To fill this research gap, this present study, using protocols designed by ISAAC to enable global comparisons, assessed the prevalence and severity of asthma symptoms and identified the factors associated with asthma symptoms among schoolchildren of 6–7 yr old and 13–14 yr old resident in Bogotá.

Methods

Study setting

The study was conducted between March and September of 2002 in Bogotá, Colombia, the largest urban settlement in the country, with approximately 6,712,247 inhabitants in 2002 (7). Bogotá is located 2640 m above sea level with no seasonal changes other than 2-month long rainy periods. Bogotá neighborhoods are classified into six socioeconomic strata (SES) based on urban characteristics such as population density, quality of public area, and housing characteristics: stratum one corresponds to the lowest SES and stratum six to the highest.

Study design

We conducted a cross-sectional study. Among the 4535 registered educational institutions in Bogotá, we selected schools within neighborhoods SES three and four (42% of the overall) for local security reasons. From these schools, we randomly selected 74 for the 6–7 yr age group, and 48 for the 13–14 yr age group, which were scattered in all regions of the city. All schoolchildren eligible to participate were invited to take part in the study.

Questionnaires

Following the ISAAC methodology described elsewhere (3), two Spanish language questionnaires were administered according to student age. The 6–7 yr age group received written questionnaires (WQ) to be responded by parents or tutors, while the 13–14 yr age group received a self-administered WQ plus a video questionnaire (VQ). No incentives were offered for study participation, and all study procedures were approved by the institutional ethics committee of the Fundación Santa Fe de Bogotá.

Dependent variables

The dependent variables of asthma symptoms were obtained from the core WQ wheezing module of the ISAAC (3). The prevalence of asthma symptoms in the last year for both age groups were obtained from the following question of the WQ, Have you ever had wheezing or whistling in the chest in the last 12 months?

Additionally, we conducted the VQ for measuring asthma symptoms among the 13–14 yr age group, which consisted of five video sequences after each of which respondents were asked the corresponding questions (8).

Independent variables

The following independent variables were taken from the environmental section of the WQ and amended according to age group: demographic characteristics (age, sex); pre- and perinatal characteristics (regular contact of the mother with farm animals, cesarean birth); post-natal characteristics (breast-fed, presence of a cat and/or dog at home during the first year of life, and regular contact with farm animals during the first year of life); dietary habits (meat, seafood, fruits, vegetables, pulses, cereal, pasta, rice, butter, margarine, nuts, potatoes, milk, eggs,

and fast food consumption frequency); behavioral characteristics (exercise and/or watching television time/frequency; exposure to maternal or female guardian smoking, exposure to paternal or male guardian smoking during the first year of life); household and neighborhood characteristics (level of maternal education, traffic frequency around the house, type of cooking fuel, presence of a cat and/or dog at home during the last year, and family size); and medications (acetaminophen during the first and most recent year of life, antibiotics during the first year of life).

Statistical analysis

The statistical analysis involved several steps. First, the prevalence of asthma symptoms and the 95% confidence intervals were calculated. Second, the agreement between WQ and VQ for the 13–14 yr age group was assessed using the kappa test. Third, the bivariate analysis was conducted to assess the association between current asthma symptoms and independent variables. Fourth, the variables showing stronger associations in the bivariate analysis ($p < 0.25$) were selected for a multivariate analysis. The alpha level of 0.25 was chosen to reduce the likelihood of missing important predictors whose bivariate relationship with the outcome had been confounded by other variables (9). Fifth, the collinearity between independent variables was assessed using regression diagnostic tests. Lastly, a multivariate analysis was conducted. Statistical significance for the multivariate models was defined as $p < 0.05$. All analyses were conducted using SAS version 8.2 Cary, NC, USA: 2001.

Results

Of the selected sample of schools, 86 were contacted for both age groups. The return rate for the 6–7 yr age group was 89.5% and for the 13–14 yr age group, 98.7%. The final sample size included 3256 children for the 6–7 yr age group (43.8% male, 56.2% female) and 3829 adolescents for the 13–14 yr age group (47.3% male, 52.7% female).

Prevalence of asthma symptoms

Parents were more likely to report current asthma symptoms for the 6–7 yr age group than the 13–14 yr age group [10.4% (WQ) vs. 8.6% (WQ) and 8.0% (VQ)] (Table 1). Both age groups reported current asthma attacks more frequently than current asthma symptoms. Of those who reported current asthma attacks, 84.8% of the 6–7 yr age group and 80.9% of the 13–14 yr age group had experienced 1–3 asthma attacks in the previous 12 months. Moreover, 15.2% of these children aged 6–7 yr and 19.1% of these adolescents aged 13–14 yr presented considerable severity, with four or more asthma attacks.

Table 1. Prevalence of asthma symptoms reported in the written questionnaire by age group

	6–7 yr age group (N = 3256)			13–14 yr age group (N = 3829)		
Symptoms	n	%	95% CI	n	%	95% CI
Wheezing ever	1071	33.4	31.7–35.0	673	17.7	16.5–18.9
Wheezing in the last 12 months	327	10.4	9.3–11.4	324	8.6	7.7–9.4
Severity (in the last 12 months)						
Asthma attacks*						
1–3 attacks	296	9.5	8.4–10.5	276	7.3	6.5–8.2
4–12 attacks	36	1.2	0.8–1.5	13	0.3	0.2–0.5
>12 attacks	17	0.5	0.3–0.8	52	1.4	1.0–1.8
Wheezing that disturbs sleep*						
<1 per week	210	6.8	5.9–7.6	173	4.6	3.9–5.3
>1 per week	40	1.3	0.9–1.7	26	0.7	0.4–1.0
Wheezing that limits speech*	60	1.9	1.4–2.4	85	2.3	1.8–2.7
Exercise wheeze (while/after)	204	6.5	5.6–7.3	690	18.6	17.3–19.8
Night cough	797	24.7	23.2–26.2	1035	27.4	26.0–28.8
Asthma ever	175	5.6	4.8–6.4	363	9.7	8.7–10.6

95% CI, 95% confidence interval of the percentage.
*Only asked among those who reported wheezing ever.

Overall, the occurrence of reported asthma symptoms diminished significantly in the VQ compared with the WQ ($p < 0.001$) for the 13–14 yr age group except for the prevalence of current asthma symptoms ($p = 0.352$), which did not show any difference in both questionnaires (data not shown). The degree of agreement between the WQ and VQ corresponding questions were slight, with kappa coefficients below 0.40 (Table 2).

Bivariate analysis

For the 6–7 yr age group, the current asthma symptoms were associated with the intake of pulses and milk three or more times per week, watching television one or more hours per day in a normal week, exposure to maternal or female guardian smoking in the first and most recent year of life; use of acetaminophen in the first and most recent year of life, use of antibiotics in the first year of life, college or higher maternal education, frequent traffic on streets surrounding the household, presence of a cat in the home during the last year, and presence of a dog in home in the first year of life (Table 3).

Table 2. Prevalence of asthma symptoms reported in the video questionnaire for the 13–14 yr age group

	13–14 yr age group (N = 3829)			
Symptoms	n	%	95% CI	Kappa*
Wheezing at rest ever	486	12.7	11.7–13.8	0.342
Wheezing at rest in the last 12 months†	303	8.0	7.1–8.8	0.301
Wheezing at rest one or more times per month†	159	4.3	3.6–4.9	
Wheezing ever after exercise	740	19.6	18.4–20.9	
Wheezing after exercise in the last 12 months‡	513	13.7	12.6–14.8	0.271
Wheezing after exercise one or more times per month‡	311	8.5	7.6–9.4	
Nocturnal wheezing ever	218	5.7	5.0–6.5	
Nocturnal wheezing in the last 12 months§	115	3.0	2.5–3.6	0.259
Nocturnal wheezing one or more times per month§	67	1.8	1.4–2.2	
Nocturnal coughing ever	841	22.2	20.9–23.5	
Nocturnal coughing in the last 12 months¶	529	14.2	13.1–15.3	0.224
Nocturnal coughing one or more times per month¶	287	7.9	7.0–8.7	

95% CI, 95% confidence interval of the percentage.
*Kappa coefficient, to asses the degree of agreement between the corresponding questions of the written and video questionnaires.
†Only asked among those who reported wheezing at rest.
‡Only asked among those who reported wheezing after exercise.
§Only asked among those who reported nocturnal wheezing.
¶Only asked among those who reported nocturnal cough.

For the 13–14 yr age group, associations with current asthma symptoms were found for the intake of meat, butter, and fast food 1–2 times per week; fruit and eggs one or more times per week; and milk and cereal three or more times per week (Table 4). Associations were also found for exposure to maternal or female guardian smoking, use of acetaminophen, and presence of a dog in the home during the last 12 months.

Multivariate analysis

Results from the multivariate analysis are shown in Tables 3 and 4. For the 6–7 yr age group we found positive associations, statistically significant, with the use of acetaminophen during the last 12 months, watching television 1–2 h per day in a normal week, use of antibiotics during the first year of life, use of acetaminophen in the first year of life, college or higher maternal education, and the presence of a cat in the home during the last 12 months. Antibiotic medication in the first year of life was excluded from the final multivariate model because it was correlated with acetaminophen medication in the first year of life for the 6–7 yr age group.

For the 13–14 yr age group we found positive associations, statistically significant, with the use of acetaminophen during the last 12 months and cereal consumption three or more times per week. Additionally we found negative associations, statistically significant, for the consumption of milk three or more times per week and fruits three or more times per week.

Discussion

This study, the first to use the ISAAC methodology to estimate the prevalence of current asthma symptoms in Bogotá, Colombia, employed a standardized version of a Spanish language WQ, together with a supplementary VQ, in schoolchildren aged 6–7 and 13–14 yr old. Prevalence of and factors associated with current asthma symptoms in the Bogotá school population will help plan makers guide health policies on the management of this pathology at the local level.

The WQ results indicate a current asthma symptom prevalence of 10.4% for the 6–7 yr age group and 8.6% for the 13–14 yr age group. A recent report of phase I and III surveys have shown that, for Latin America, the prevalence of asthma symptoms in phase III ranged between 8.4% (Mexico) and 37.6% (Costa Rica) for the 6–7 yr age group, and between 11.6% (Mexico) and 27.3% (Costa Rica) for the 13–14 yr age group (10). According with these results, Bogotá may be among the Latin American cities with the lower prevalence of current asthma symptoms. Moreover, despite the methodological limitations to making accurate comparisons with previous Colombian studies our findings may no differ from those of earlier research (5, 6).

Additionally, among the 13–14 yr age group, the positive responses of the VQ reflected less prevalence of asthma symptoms than the WQ responses, except for the current asthma prevalence, and the level of agreement between questionnaires has been shown to be slight in this study. Differences between the WQ and VQ have been reported by other studies (1), and the most likely explanation is that the VQ looks for more severe asthma symptoms than does the WQ. For example, the first sequence could be understood by adolescents as asthma while being only at rest, excluding other activities open in the corresponding questions of the WQ.

The results from the multivariate analysis indicate that the strongest association for current asthma symptoms for both age groups is the use of acetaminophen during the last 12 months, and for the 6–7 yr age group, also in the first year of life. This finding agrees with previous studies that

Table 3. Associations of current asthma symptoms with independent variables for the 6–7 yr age group*

Variables	%	Bivariate analysis			Multivariate analysis		
		OR	95% CI	p-value	OR	95% CI	p-value
Pulse consumption							
Occasionally or 1–2 times/week	9.3	1.0			1.0		
3 or more times/week	11.4	1.3	1.0–1.6	0.052	1.5	1.0–2.2	0.115
Milk intake							
Occasionally or 1–2 times/week	8.5	1.0			1.0		
3 or more times/week	10.7	1.3	0.9–1.8	0.161	1.5	1.0–2.2	0.056
Time watching television							
Less than an hour per day	5.7	1.0			1.0		
1–2 h/day in a normal week	11.4	2.1	1.2–3.6	0.007	2.1	1.2–3.9	0.013
>2 h/day in a normal week	10.4	1.9	1.1–3.3	0.021	1.8	1.0–3.3	0.056
Exposure to maternal or guardian smoking in the last 12 months							
No	9.9	1.0			1.0		
Yes	13.3	1.4	1.0–1.9	0.042	1.1	0.8–1.7	0.502
Exposure to maternal or guardian smoking in the first year of life							
No	10.0	1.0			1.0		
Yes	14.4	1.5	1.0–2.2	0.037	1.2	0.7–1.9	0.549
Use of acetaminophen in the first year of life							
No	6.1	1.0			1.0		
Yes	12.2	2.1	1.6–2.9	<0.001	1.8	1.3–2.4	<0.001
Use of acetaminophen in the last 12 months							
Never or once per year	7.0	1.0			1.0		
Once per month	15.4	2.4	1.9–3.0	<0.001	2.2	1.7–2.8	<0.001
Use of antibiotic in the first year of life†							
No	6.8	1.0			1.0		
Yes	12.9	2.0	1.6–2.6	<0.001	1.9	1.4–2.5	<0.001
Maternal education							
Elementary or less education	8.7	1.0			1.0		
High school education	10.0	1.2	0.8–1.6	0.335	1.2	0.8–1.7	0.444
College or higher education	12.7	1.5	1.1–2.2	0.021	1.7	1.2–2.6	0.007
Traffic on the street of the household							
Never	8.2	1.0			1.0		
Occasionally	9.6	1.2	0.8–1.7	0.352	1.2	0.8–1.8	0.294
Frequently or most of the time	11.9	1.5	1.1–2.1	0.018	1.4	1.0–2.0	0.090
Presence of a cat in home during the last 12 months							
No	10.0	1.0			1.0		
Yes	14.2	1.5	1.0–2.1	0.032	1.5	1.0–2.3	0.036
Presence of a dog in home during the first year of life							
No	9.7	1.0			1.0		
Yes	12.7	1.4	1.0–1.8	0.022	1.3	1.0–1.7	0.076

95% CI, 95% confidence interval.

*Results presented only for those variables that showed stronger association in the bivariate analysis ($p < 0.25$) and that were included in the multivariate model.

†The variable use of antibiotic in the first year of life was omitted from the final multivariate model because it was correlated with acetaminophen consumption in the first year of life.

have reported an association between the use of acetaminophen and asthma symptoms (11–13). Four possible mechanisms may explain this association (14). First, acetaminophen consumption may reduce the pulmonary glutathione, and this depletion may increase the difficulty of mitigating the oxidative stress, increasing the risk of lung inflammation, tissue damage and respiratory disease. Second, acetaminophen interrupts cyclooxygenase-2 suppression, promoting the prostaglandin E_2 production that favors the Th2 response, which results in an allergic tendency to antigenic stimuli. Third, acetaminophen may be an antigenic agent in the proposed immunoglobulin E (IgE)-mediated mechanism. Lastly, a possible selection bias cannot be ruled out because, as the use of non-steroidal anti-inflammatory drugs is contraindicated in asthmatic patients, they are more likely to use acetaminophen to treat fever caused by respiratory infections or headache resulting from asthma treatment.

Another factor associated with asthma symptoms in the 6–7 yr age group was the use of antibiotics in the first year of life. Antibiotics are known to disrupt gastrointestinal flora, thereby altering the protective effect of bacterial infections that promote Th1 responses (15).

Table 4. Association of current asthma symptoms with independent variables for the 13–14 yr age group*

		Bivariate analysis			Multivariate analysis		
Variables	%	OR	95% CI	p-value	OR	95% CI	p-value
Meat consumption							
Occasionally	9.3	1.0			1.0		
1–2 times/week	7.0	0.7	0.5–1.1	0.135	0.7	0.4–1.0	0.073
3 or more times/week	9.9	1.1	0.7–1.6	0.745	0.9	0.6–1.5	0.793
Fruit consumption							
Occasionally	12.6	1.0			1.0		
1–2 times/week	8.5	0.6	0.4–1.0	0.060	0.6	0.4–1.1	0.077
3 or more times/week	8.3	0.6	0.4–1.0	0.035	0.6	0.4–1.0	0.031
Cereal consumption							
Occasionally or 1–2 times/week	7.1	1.0			1.0		
3 or more times/week	9.4	1.4	1.0–1.7	0.020	1.5	1.1–1.9	0.010
Butter consumption							
Occasionally	7.7	1.0			1.0		
1–2 times/week	9.5	1.3	1.0–1.6	0.065	1.2	0.9–1.6	0.204
3 or more times/week	8.9	1.2	0.8–1.7	0.339	1.1	0.8–1.6	0.654
Milk intake							
Occasionally or 1–2 times/week	9.9	1.0			1.0		
3 or more times/week	8.2	0.8	0.6–1.0	0.086	0.8	0.6–1.0	0.046
Egg consumption							
Occasionally	10.6	1.0			1.0		
1–2 times/week	8.6	0.8	0.6–1.1	0.176	0.8	0.5–1.1	0.190
3 or more times/week	8.1	0.7	0.5–1.1	0.104	0.7	0.5–1.0	0.071
Fast food consumption							
Occasionally	8.1	1.0			1.0		
1–2 times/week	9.4	1.2	0.9–1.5	0.205	1.1	0.9–1.5	0.339
3 or more times/week	8.2	1.0	0.7–1.5	0.962	1.0	0.7–1.6	0.833
Exposure to maternal or guardian smoking in the last 12 months							
No	8.3	1.0			1.0		
Yes	10.0	1.22	0.9–1.6	0.153	1.2	0.9–1.6	0.178
Use of acetaminophen in the last 12 months							
Never or once/year	6.4	1.0			1.0		
Once/month	10.3	1.7	1.3–2.1	<0.001	1.8	1.4–2.3	<0.001
Presence of a dog in home in the last 12 months							
No	7.5	1.0			1.0		
Yes	9.5	1.3	1.0–1.6	0.038	1.2	0.9–1.5	0.242

95% CI, 95% confidence interval.

*Results presented only for those variables that showed stronger association in the bivariate analysis ($p < 0.25$) and that were included in the multivariate model.

Nevertheless, despite diverse research approaches, findings on this association between antibiotic use early in life and the risk of asthma have been controversial. Some studies have shown evidence of positive associations between the use of antibiotics in infancy and the subsequent development of asthma (11, 16), while others have not only failed to show any association (17) but have even suggested a reverse causation in which children with atopy tend to present more respiratory symptoms that can be confused with or pre-dispose to infections, which then leads to more frequent use of antibiotics (18).

Also strongly associated with asthma symptoms for the 6–7 yr age group was 1–2 h each day spent watching television, which is an indicator of a sedentary lifestyle. As in a comparative study of urban schoolchildren from Baltimore that found asthmatic children to be less active than their controls (19), we observed that children with respiratory symptoms tended to be more sedentary than those who did not experience the symptoms. This association may occur because, first, the severity of the disease and exacerbation of its symptoms can manifest during or after exercise and, second, parents may fear that the children will fall sick from strenuous activity.

Another positive association for the 6–7 yr age group was the presence of a cat in the home during the last year. The effect of such pet exposure on the development of asthma and allergies currently remains unclear. Whereas, some studies have suggested that pet contact in early life is a protective factor for subsequent allergic sensitivity because of the favored Th1 response to environmental endotoxins (20)

others have found that pet exposure in later life promotes IgE sensitization, leading to the development of respiratory symptoms and asthma (12, 21). Nevertheless, our findings suggest that late exposure to cats could be an aggravating factor for the development of asthma symptoms. Therefore, future studies are needed on our population to elucidate the role of time position to pets and the association with asthma symptoms.

The final positive association for the 6–7 yr age group was a higher maternal educational level, a characteristic encompassed by the multidimensional construct of SES, which also covers income, residential characteristics, and quality of healthcare. Consistent with our findings, one study of children in Munich found that asthma symptoms were more frequent in higher SES, although severe asthma was significantly more prevalent in lower compared with higher SES (22). Other studies have shown that asthma symptoms were more prevalent among low SES children (23) or no association (24) with asthma symptoms.

Among the 13–14 yr age group, cereal consumption three or more times per week was an aggravating factor for the development of asthma symptoms, an aspect addressed in a previous ecological analysis of asthma prevalence and per capita food intake in 53 countries that have participated in phase-I of the ISAAC (25). This prior analysis provided evidence that, for the 13–14 yr age group, the percentage of current wheeze decreased as the consumption of cereal and rice calories augmented. The authors thus hypothesized that antioxidants in cereals and a plant-based carbohydrate-rich diet could add a protective effect. However, this study followed a different methodological approach some years ago. Similarly, an ISAAC phase-II Dutch study of diet and asthma observed an inverse association between the intake of whole grain products and current asthma (26). Explaining our findings would require further studies on the relation between dietary habits and the development of asthma symptoms.

Two protective factors were established for the 13–14 yr age group: the consumption of fruits and the intake of milk three or more times per week. Fruit and vegetable consumption has been shown by several studies to be protective against asthma symptoms, mainly because vitamins and minerals found in fruits and vegetables are beneficial for lung function (27, 28). Thus, the fruit antioxidant activity may protect the airways, which are particularly susceptible to oxidative damage. As regards the milk intake, the PIAMA birth cohort study found similar results in preschool children whose regular consumption of products containing milk fat was associated with a reduced risk of asthma symptoms (29) It has been hypothesized that increased asthma prevalence could be associated with minor consumption of saturated fat and an increase in n-6 polyunsaturated fatty acids, like linoleic acid which may cause increased synthesis of prostaglandin E_2 and subsequent formation of IgE (30).

The inference of our results to the total population is limited by inclusion of SES three and four in the sample. Nevertheless, not only were the schools randomly selected but these SES are known to represent 42% of the total population in Bogotá. In addition, the use of questionnaires for data collection could include a recall bias of symptoms, diet and behaviors, which may have affected the report of asthma symptoms, that is the parents of children diagnosed with asthma and the adolescents that have had or are still experiencing asthma, may remember and report symptoms and exposure differently. And finally, the cross-sectional approach of this study does not allow assessing the direction, causality and time relationship between the asthma symptoms and factors associated.

Conclusions

Our estimates of the prevalence and severity of asthma symptoms in schoolchildren aged 6–7 and 13–14 yr old from Bogotá, fall within the lower estimates described for Latin American studies for both age groups. Schoolchildren of both age groups presented similar estimates of current asthma symptoms, as other studies conducted previously in Colombia, with children presenting a higher prevalence than adolescents. The associations with current asthma symptoms established for each age group included a set of alimentary and behavioral habits, some demonstrated in other global studies, others not. This lack of finding consistency demonstrates the complex relationships among asthma symptoms, pre-disposition, and environmental lifestyles. Therefore, future in-depth research is needed to assess the interactions between asthma symptoms and current lifestyles in both the Colombian population and around the world.

Acknowledgments

The authors wish to thank the children, the adolescents, and their parents for their participation and the participating educational institutions for their cooperation. We also

appreciate the collaboration of Ofelia Aristizabal, who coordinated the field survey and the methodological support from the Centro de Estudios e Investigación en Salud-CEIS of the Fundación Santa Fe de Bogotá.

Funding

This study was founded in part by GlaxoSmithKline, Astra Zeneca, and Boehringer Ingelheim. Dr. Sarmiento received funding from the Research Fund for Assistant Professors of the Universidad de Los Andes (Grant no. 1808) and from Colciencias (Grant no. 468-2005).

References

1. Asher MI, Montefort S, Bjorksten B, et al. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema: ISAAC. The International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. Lancet 1998: 351: 1225–32.
2. Beasley R, Ellwood P, Asher I. International patterns of the prevalence of pediatric asthma the ISAAC program. Pediatr Clin North Am 2003: 50: 539–53.
3. Ellwood P, Asher MI, Beasley R, Clayton TO, Stewart AW. The international study of asthma and allergies in childhood (ISAAC): phase three rationale and methods. Int J Tuberc Lung Dis 2005: 9: 10–6.
4. Mallol J. Satellite symposium: Asthma in the World. Asthma among children in Latin America (in Spanish). Allergol Immunopathol (Madr) 2004: 32: 100–3.
5. Caraballo L, Cadavid A, Mendoza J. Prevalence of asthma in a tropical city of Colombia. Ann Allergy 1992: 68: 525–9.
6. Dennis R, Caraballo L, Garcia E, et al. Asthma and other allergic conditions in Colombia: a study in 6 cities. Ann Allergy Asthma Immunol 2004: 93: 568–74.
7. National Administrative Department of Statistics (Departamento Administrativo Nacional de Estadística DANE). Population Series and Projections. http://www.dane.gov.co/files/investigaciones/poblacion/series_proyecciones/Dptos/bogota.xls (accessed June 11, 2006), 2005.
8. Wellington Asthma Research Group – WARG. Video Questionnaire. http://www.wnmeds.ac.nz/academic/Med/warg/ADV.html (accessed March 1, 2007), 2002.
9. Sun GW, Shook TL, Kay GL. Inappropriate use of bivariable analysis to screen risk factors for use in multivariable analysis. J Clin Epidemiol 1996: 49: 907–16.
10. Asher MI, Montefort S, Bjorksten B, et al. Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC phases one and three repeat multicountry cross-sectional surveys. Lancet 2006: 368: 733–43.
11. Del-Rio-Navarro B, Berber A, Blandon-Vijil V, et al. Identification of asthma risk factors in Mexico City in an International Study of Asthma and Allergy in Childhood survey. Allergy Asthma Proc 2006: 27: 325–33.
12. Kuschnir FC, ves da Cunha AJ. Environmental and socio-demographic factors associated to asthma in adolescents in Rio de Janeiro, Brazil. Pediatr Allergy Immunol 2007: 18: 142–8.
13. Davey G, Berhane Y, Duncan P, ref-Adib G, Britton J, Venn A. Use of acetaminophen and the risk of self-reported allergic symptoms and skin sensitization in Butajira, Ethiopia. J Allergy Clin Immunol 2005: 116: 863–8.
14. Eneli I, Sadri K, Camargo C Jr, Barr RG. Acetaminophen and the risk of asthma: the epidemiologic and pathophysiologic evidence. Chest 2005: 127: 604–12.
15. Levy J. The effects of antibiotic use on gastrointestinal function. Am J Gastroenterol 2000: 95: S8–10.
16. Cohet C, Cheng S, MacDonald C, et al. Infections, medication use, and the prevalence of symptoms of asthma, rhinitis, and eczema in childhood. J Epidemiol Community Health 2004: 58: 852–7.
17. Celedon JC, Litonjua AA, Ryan L, Weiss ST, Gold DR. Lack of association between antibiotic use in the first year of life and asthma, allergic rhinitis, or eczema at age 5 years. Am J Respir Crit Care Med 2002: 166: 72–5.
18. Wjst M, Hoelscher B, Frye C, Wichmann HE, Dold S, Heinrich J. Early antibiotic treatment and later asthma. Eur J Med Res 2001: 6: 263–71.
19. Lang DM, Butz AM, Duggan AK, Serwint JR. Physical activity in urban school-aged children with asthma. Pediatrics 2004: 113: e341–6.
20. Ownby DR, Johnson CC, Peterson EL. Exposure to dogs and cats in the first year of life and risk of allergic sensitization at 6 to 7 years of age. JAMA 2002: 288: 963–72.
21. Lau S, Illi S, Platts-Mills TA, et al. Longitudinal study on the relationship between cat allergen and endotoxin exposure, sensitization, cat-specific IgG and development of asthma in childhood – report of the German Multicentre Allergy Study (MAS 90). Allergy 2005: 60: 766–73.
22. Mielck A, Reitmeir P, Wjst M. Severity of childhood asthma by socioeconomic status. Int J Epidemiol 1996: 25: 388–93.
23. Cesaroni G, Farchi S, Davoli M, Forastiere F, Perucci CA. Individual and area-based indicators of socioeconomic status and childhood asthma. Eur Respir J 2003: 22: 619–24.
24. Hancox RJ, Milne BJ, Taylor DR, et al. Relationship between socioeconomic status and asthma: a longitudinal cohort study. Thorax 2004: 59: 376–80.
25. Ellwood P, Asher MI, Bjorksten B, Burr M, Pearce N, Robertson CF. Diet and asthma, allergic rhinoconjunctivitis and atopic eczema symptom prevalence: an ecological analysis of the International Study of Asthma and Allergies in Childhood (ISAAC) data. ISAAC Phase One Study Group. Eur Respir J 2001: 17: 436–43.
26. Tabak C, Wijga AH, de MG, Janssen NA, Brunekreef B, Smit HA. Diet and asthma in Dutch school children (ISAAC-2). Thorax 2006: 61: 1048–53.
27. Pastorino AC, Rimazza RD, Leone C, Castro AP, Sole D, Jacob CM. Risk factors for asthma in adolescents in a large urban region of Brazil. J Asthma 2006: 43: 695–700.
28. Farchi S, Forastiere F, Agabiti N, et al. Dietary factors associated with wheezing and allergic rhinitis in children. Eur Respir J 2003: 22: 772–80.
29. Wijga AH, Smit HA, Kerkhof M, et al. Association of consumption of products containing milk fat with reduced asthma risk in pre-school children: the PIAMA birth cohort study. Thorax 2003: 58: 567–72.
30. Black PN, Sharpe S. Dietary fat and asthma: is there a connection? Eur Respir J 1997: 10: 6–12.