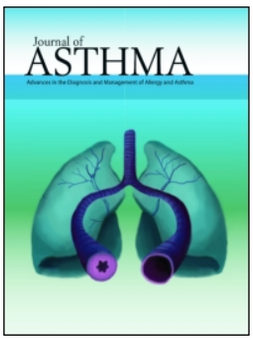

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The current prevalence of asthma, allergic rhinitis, and eczema related symptoms in school-aged children in Costa Rica

M. E. Soto-Martínez, MD, MSc[a,b,c], A. Yock-Corrales, MD, MSc[d,b,c], K. Camacho-Badilla, MD, MSc[e,b,c], S. Abdallah, MD[b], N. Duggan, MPH[c], L. Avila-Benedictis, MD[b], J. J. Romero, MV, MSc, PhD[f], and M. E. Soto-Quirós, MD, PhD[a,b]

[a]Respiratory Department, Hospital Nacional de Niños, Costa Rica; [b]Department of Pediatrics, Hospital Nacional de Niños and University of Costa Rica, San José, Costa Rica; [c]School of Public Health, Tullane University, New Orleans, LA, USA; [d]Emergency Department, Hospital Nacional de Niños, Costa Rica; [e]Department of Infectious Diseases, Hospital Nacional de Niños, San José, Costa Rica; [f]School of Veterinary Medicine, Population Medicine Research Program, National University of Costa Rica, Heredia, Costa Rica

ABSTRACT

Objective: Asthma prevalence in Costa Rica is among the highest worldwide. We aimed to determine the prevalence of asthma among school-age children in the Central Highland Area of Costa Rica. *Methods*: Cross-sectional study using the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire was performed. Parents or guardians of children aged 6–13 years completed written questionnaires. *Results*: Total of 2817 school-aged children returned these questionnaires (74.1% return rate). The prevalence of asthma, rhinitis, and eczema was 21.9%, 42.6%, and 19.2%, respectively. The co-existence of the 3 diseases was seen in 22.6% of children with asthma. Boys had a slightly higher prevalence of these conditions, and younger children had higher prevalence of asthma and eczema, but lower prevalence of rhinitis than older children. The use of acetaminophen and antibiotics in the first 12 months of life showed a significant association with the prevalence of asthma, rhinitis, and eczema. Wheezing with exercise, dry cough at night, and ever rhinitis was highly associated with asthma symptoms in the last 12 months. In contrast, no association was found between children exposed to smoking at home. Frequent traffic next to the house was reported more frequently by the parents of children with asthma, although no significant association was found. *Conclusion*: The prevalence of asthma showed a significant decrease compared to previous studies. However, there was an unexpected high prevalence of rhinitis. Exposure to acetaminophen and antibiotic during the first year of life was highly associated with asthma symptoms.

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Introduction

Globally, asthma is a major public health problem, affecting approximately 300 million people (1,2). Asthma, rhinitis, and other allergic conditions are a group of heterogeneous conditions with complex genetic background (3–6), that interacts with several different risk factors, including allergic sensitization, environment, early respiratory infections, cigarette exposure, diet, changes in the intestinal flora, and other factors infection (7–14). Worldwide, asthma and other allergic conditions such as allergic rhinitis and eczema account for increasing childhood morbidity, placing a burden on the healthcare system and on affected individuals and their families (15). Although data on prevalence of these conditions in our area is scarce, various epidemiological studies have been done through the years as collaboration in the International Study of Asthma and Allergies in Childhood (ISAAC) (16–22). In developing regions such as areas of Africa, Central and South America, Asia and some areas of the Pacific, the prevalence of asthma and allergic rhinitis continues to rise with increasing urbanization and westernization (18,21,23–28). The prevalence of asthma in Costa Rica is among the highest in the world (17,21), showing a steady increase in its prevalence throughout all epidemiological studies (17,29). In a nationwide study of 2682 children aged 5–17 years, the estimated prevalence of physician-diagnosed asthma was 23% in 1989 (29). Among children who participated in phase I of the ISAAC study in 1995, the overall prevalence of asthma was 27.7% (17). Eight years later, approximately 33.2% of children in the same group reported current wheeze in phase III of the ISAAC study (17,21). The causes of this high asthma burden are likely multifactorial and at least partly related of heredity, environmental triggers, and "westernized" lifestyle of contemporary Costa Ricans (11,30).

CONTACT Manuel Soto-Martínez quiquesoto@gmail.com Respiratory Department, Hospital Nacional de Niños, 957-1100, San José, Costa Rica, PO Box 1654-1000, San José, Costa Rica.

Based on previous epidemiological studies and given the high burden of asthma in Costa Rica, efforts in achieving an adequate control and prevention of the disease has been made in the last 10 years. In 2003, a National Asthma Program (NAP) was implemented in Costa Rica. This program focused in early diagnosis, treatment guidelines (including early use of inhaled corticosteroids), appropriate referral to specialist for asthma care, and avoidance of common allergen (e.g., cockroaches or dust mite) or environmental exposures (e.g., tobacco smoke).

Recently, we showed a significant decrease in the trend in hospitalizations and mortality from asthma in Costa Rica over a 15-year period. The total number of asthma hospitalization in Costa Rica in both children and adults decreased by approximately 53% from 1997 to 2011 (31). In this study, the most substantial changes in absolute terms (given the high baseline rates) occurred in children younger than 10 years old (57% decrease in boys and 54% in girls, in the same period). The most plausible explanation to this decrease in asthma hospitalization was improved asthma management and possibly a decrease in risk factors. However, it was suggested that a decrease in asthma prevalence could also be associated (31).

To date, little is known about the current prevalence of asthma symptoms, related diseases, and prevalence of risk factors in Costa Rica. Given the significant increase in prevalence of the disease in our last study, but also the increasing attention that has been given to environmental and lifestyles factors in low and middle-income countries, we decided to study the current prevalence 12 years later in an inner-city group of children between 6 and 13 years old. Our hypothesis is that similar to other Latin American countries the prevalence of both asthma and allergic rhinitis in Costa Rica has increased.

Methods

During the first semester of 2014, the parents/guardians of school-aged children (6 to 13 years old) attending 8 elementary schools in the Central highland area of Costa Rica were surveyed.The Central highland region known as the Great Metropolitan Area includes those areas situated in the central provinces such as San Jose (capital city), Alajuela, Heredia, and Cartago, all comprising areas of high population density (about 60% of the population). These areas are located on the central plateau of the country, with a temperate climate and an average of 1215 masl. Schools were selected for inclusion in the study by randomly stratifying for geographical location (rural or urban), and also if the school was private or public. All schools selected were highly representative for each province (both in the public and private education system).

Using the previously validated ISAAC questionnaire (32), a history of diagnosed asthma, and presence of wheeze in the previous 12 months, and other allergic conditions such as rhinitis and eczema was obtained. Children were divided in 2 groups: group 1 included all children between 6 and 9 years old; and group 2 included those between 10 and 13 years old. In addition, the environmental questionnaire from ISAAC III was also collected (33). The questionnaire was translated to Spanish as per defined guidelines ISAAC, Manual (ISAAC International Data Centre 1992). This questionnaire was sent home to 3800 school children. Seventy-four percent of children returned these questionnaires completed and were suitable for analysis (2817 children). However, 7 patients (<1%) returned these questionnaires uncompleted, and therefore were excluded.

Case definitions

The diagnosis of asthma was based on a positive answer to the written question: "Have you (has your child) had wheezing or whistling in the chest in the past 12 months?" Similar to asthma, allergic rhinitis was based on a positive answer to the question: "In the past 12 months, have you (your child) had a problem with sneezing or a runny nose or blocked nose when you (he/she) did not have a cold or the flu?" Current eczema was considered in those individuals with positive answer to "Have you (has your child) had this itchy rash at any time in the past 12 months?" This question was preceded by then question: "Have you (has your child) ever had a skin rash which was coming and going for at least 6 months?"

In addition, background characteristics were recorded for each child, including information about sex, age, school, weight, height, parental smoking during first year of life, current parental smoking, some dietary information, traffic next to school or home, use of antibiotics or acetaminophen in the last 12 months, physical activity levels, current ownership of dog or cat and during the first year of life.

Ethics: The study was approved by the local ethics committee of the National Children´s Hospital and by the Ministry of Public Education of Costa Rica.

Statistical analysis

Descriptive statistics about the general characteristics of the children and their diseases comprised frequencies, measures of central tendency (means, median), and dispersion (standard deviation). Comparison of proportions was done using the Pearson´s chi-squared test. To assess the relationships of independent variables with the diseases, the rate ratio was calculated using Poisson

Table 1. Asthma, rhinitis, and eczema prevalence: comparison of the 2 age groups.

	Group 1 (6–9 years) *n/N* (%)	Group 2 (10–13 years) *n/N* (%)	*p* value	Odds ratio* (95% IC)
Ever wheeze, *n* (%)	498/1417 (35.1)	496/1400 (35.4)	0.87	1.01 (0.87–1.18)
Wheeze last 12 months	357/1417 (23.8)	280/1400 (20.0)	0.01	1.24 (1.03–1.49)
Physician's diagnosis of asthma	318/1417 (23.8)	345/1400 (25.9)	0.19	0.89 (0.74–1.06)
Wheezing chest after exercise	152/1343 (11.3)	198/1333 (14.8)	0.006	0.73 (0.57–0.92)
Dry cough at night in last 12 months	385/1351 (28.5)	331/1354 (24.4)	0.01	1.2 (1.03–1.47)
Ever rhinitis	608/1417 (42.9)	689/1382 (49.8)	0.0002	0.75 (0.64–0.89)
Rhinitis in the last 12 months	559/1413 (39.5)	643/1400 (45.9)	0.0005	0.76 (0.65–0.89)
Rhinoconjuntivitis in the last 12 months	356/1370 (25.9)	428/1284 (33.3)	0.0001	0.70 (0.59–0.83)
Eczema	272/1381 (19.7)	256/1371 (18.6)	0.49	1.06 (0.87–1.29)
Eczema in the last 12 months	222/1381 (16)	203/1371 (14.8)	0.01	0.77 (0.63–0.94)

*p value for OR.
Group 1 is the base for comparison.
$n = 1343$ for group 1 and $n = 1333$ for group 2.

regression. The regression procedure consisted of 2 steps: 1) univariate analysis, 2) multivariable analysis. In the second step, all variables with $p < 0.25$ in the univariate analysis were included. A backward building model was followed based on the likelihood ratio test. The process of exclusion–inclusion of each variable into the multivariable model tested confounding and interaction by comparison of the estimated coefficients in the new model with the estimated coefficients and likelihood ratio of the old model. Confounding was deemed present if at least one coefficient changed more than 10% (if the rate ratio had a value between 0.7 and 1.5) or if at least one coefficient changed more than 25% (if the rate ratio had a value <0.7 or >1.5). Finally, variables that were excluded in the univariable step were checked on collinearity with the variables in the final model to check for potential confounding by calculation of simple correlations. The data were collected using EpiData Software version 2.0 (Odense, Denmark); and analyzed using STATA version 12 (Stata Corp., USA)

Results

General characteristics of study group

A total of 2817 children were included in the initial analysis (1417 children in group 1 and 1400 children in group 2). The mean age for group 1 was 7.41 years (95% CI: 7.35–7.46) and for group 2 was 10.6 years (95% CI: 10.56–10.67), with almost identical numbers of boys and girls in each group.

Asthma

The overall prevalence of wheeze in the past was 35.3%, but just 21.9% of parents reported their children having wheeze during the last 12 months (current asthma). In addition, 24.8% of children had ever been diagnosed with asthma by a physician. As seen in Table 1, the prevalence of current asthma diagnosis (wheeze in the last 12 months) between groups was significantly different, with 23.8% in the younger group and 20.0% in the older group ($p = 0.01$). There was no difference between diagnoses of asthma ever made by a physician (23.8% in group 1 vs. 25.9% in group 2, $p = 0.19$) and ever wheeze (35.1% in group 1 and 35.4 in group 2, $p = 0.87$). In contrast, there was a significant difference between the prevalence of wheezing limiting speech (15.8% in group 1 vs. 22.9% in group 2, $p = 0.02$) and wheezing after exercise (11.3% in group 1 vs. 14.8% in group 2, $p = 0.006$). In addition, the younger group seems to be having more symptoms at night (dry cough at night in the last 12 months) compared to group 2 ($p = 0.01$).

The prevalence of wheeze with exercise was 13.1% (350/2676 responders). As expected, it was more frequent in those asthmatics compared to non-asthmatic children (48.5% vs. 2.6%, <0.0001). In regards to acute attacks, 410 (58.8%) of parents reported between 1 and 3 acute episodes in the last 12 months, 102 (14.6%) reported between 4 and 12, and the remaining 48 (6.9%) more than 12 acute episodes. There was no difference in number of acute episodes between groups.

Rhinitis

The overall prevalence of ever rhinitis and rhinitis in the last 12 months was high for all children (46.3% and 42.6%, respectively). Table 1 shows the significant difference in the prevalence of rhinitis ever, rhinitis in the last 12 months and rhinoconjuntivitis between groups, being more prevalent in the older age group. Rhinitis was highly associated with the development of eczema in both groups (OR = 2.5, 95% CI: 2.1–3.1, $p < 0.0001$), being more prevalent in the younger group. In those children with rhinitis, the mean of months with acute rhinitis symptoms was 5.1 months (95% CI: 4.9–5.4). Similar to its prevalence, rhinitis symptoms measured by number of months

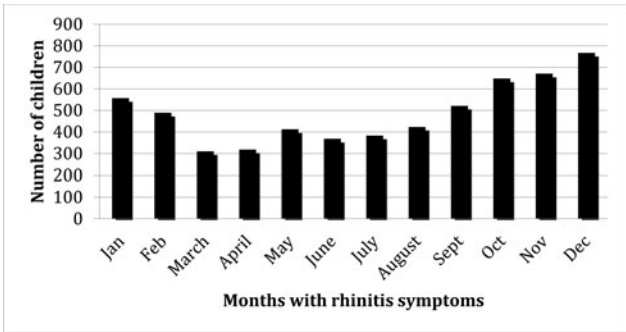

Figure 1. Rhinitis symptoms in children, reported by parents, in the last year.

affected where more common in asthmatic children than in those with no asthma (5.9 vs. 4.6 months, $p < 0.0001$). Figure 1 shows the distribution according to each month, showing a seasonal pattern with a peak between October and February, time of transition between winter and summer months (time of the year with high winds).

Eczema

The overall prevalence of eczema in our study was 19.1%. Although there was a slightly increased prevalence in the younger group, no significant difference between groups was seen (Table 1). Among children with asthma, the prevalence of eczema was 28.2% (see Table 2). There was an increase prevalence of eczema in females compared to males, 269/1362 (19.7%) vs. 259/1390 (18.6%), respectively; however, no significance was seen ($p = 0.45$). There was a significant increased risk of eczema in both groups of children with wheeze in the last 12 months (OR = 1.9, 95% CI: 1.6–2.4, $p < 0.0001$) and rhinitis (OR = 2.4, 95% CI: 1.9–2.9, $p < 0.0001$).

Relationship among prevalence of allergic conditions and risk factors for asthma

A. Allergic conditions

Table 2 shows the percentage of other allergic conditions and associated risk factors with asthmatic and non-asthmatic children. Ever rhinitis was present in 472 (76.8%) of asthmatic children, compared to 811 (37.7%) of children without asthma ($p < 0.0001$). A similar difference was found for rhinitis in the last 12 months, rhinoconjuntivitis and eczema. Nevertheless, some of these conditions were also frequent in the non-asthmatic group, such as rhinitis and rhinitis in the last 12 months with 37.7% and 34.0%, respectively, in the non- asthmatic group. The co-existence of the 3 diseases was seen in 22.6% (140/617) of children with asthma.

B. Acetaminophen and antibiotics in the first 12 months

The use of acetaminophen and antibiotics in the first 12 months of life was also high for both children with asthma and without asthma, however, with a higher prevalence in the asthmatic children than in those without asthma symptoms ($p < 0.0001$). As shown in Table 2, the odds ratio of the use of acetaminophen during the first 12 months of life and asthma was 1.9 (95% CI: 1.5–2.4, $p < 0.0001$). Similarly, the use of antibiotics in the first 12 months was significantly associated with the development of asthma with an OR 2.3 (95% CI: 1.9–2.8, $p < 0.0001$). In this study, 63.9% of asthmatic children reported the use of these medications during the first year of life, compared to 43.5% in the non-asthmatic group ($p < 0.0001$).

C. Pollution

Outdoor AIR pollution included HEAVY traffic reported at home and outside the school area, as backyard TRASH burning FUMES WITHIN 500 meters from home. In the asthma group, 41.7% of parents reported traffic next to the house frequently during the day or all day long, in comparison to 37.5% in the non-asthma group ($p < 0.06$). Although not statistically significant, there was a trend either of more pollution or at least more awareness of pollution near their houses. However, when comparing traffic next to schools, there was no significant difference between groups (69.8% asthma group vs. 70.1% in non-asthma group). Regarding backyard burning, or fires next to the house, 22.5% (137/608) of the asthmatic group

Table 2. Relationship among prevalence of allergic conditions and associated factors for asthma.

	Asthma	No asthma	*p*	Odds ratio (95% IC)
Rhinitis, *n*/*N* (%)	472/614 (76.8)	811/2152 (37.7)	<0.0001	5.49 (4.45–6.80)
Rhinitis within 12 months	458/617 (74.2)	734/2159 (34.0)	<0.0001	5.59 (4.55–6.88)
Rhinoconjuntivitis	338/594 (56.9)	439/2021 (21.7)	<0.0001	4.75 (3.90–5.80)
Eczema	169/600 (28.1)	352/1765 (16.6)	<0.0001	1.57 (1.26–1.95)
Use of acetaminophen in first 12 months life	513/608 (84.3)	1575/2130 (73.9)	<0.0001	1.90 (1.49–2.44)
Use of antibiotics in the first 12 months of life	380/595 (63.9)	910/2094 (43.5)	<0.0001	2.29 (1.89–2.78)
Traffic next to house			0.06	0.84 (0.69–1.01)
None/Infrequent	349/599 (58.3)	1306/2092 (62.4)		
Frequent/all day	250/599 (41.7)	786/2092 (37.6)		
Family member smoking at home	119/605 (19.7)	403/2119 (19.0)	0.72	1.04 (0.82–1.31)

reported fires compared to 17.5% (372/2122) in the non-asthmatic groups ($p = 0.01$).

Indoor pollution encompasses both indoor wood ovens or open fires at home and smoking. In general, 2183 (78.4%) parents reported electricity as their main source for cooking, 573 (20.6%) use gas, and 22 (less 1.0%) indoor wood ovens or open fires at home alone. A total of 147 (5.2%) patients reported a combination of them. Sixty (2.1%) patients reported indoor wood ovens or open fires at home, although there were more patients in the asthma group with indoor pollution, no statistical difference was found between asthmatic and non-asthmatic children (1.9% vs. 1.0%, respectively, $p = 0.08$). In regards to gas cooking, it was more frequent in the non-asthmatics 25.7% (549/2134) versus 23.1% (141/610) in the asthmatic group; however, the difference was not significant ($p = 0.19$).

Other conditions

The environmental questionnaire also included physical activity attitudes. As a group, 26.6% of children engaged in vigorous physical activity more than 3 times per week. Vigorous physical activity more than 3 times per week was more frequent in the non-asthmatic group. In total, 144/612 (23.5%) patients with asthma engaged in vigorous activity compared to 586/1537 (27.7%) children with no-asthma ($p = 0.04$). More importantly, a major finding was that 879/2765 (31.8%) of parents reported that their children had no physical activity. Despite the fact that it was not significant, there were more asthmatic children reporting no physical activity than children without asthma ($p = 0.31$).

Smoking

The prevalence of passive smoking in our group of children was 19.3%. As shown in Table 2, there was no difference between smoking at home in between groups ($p = 0.72$). In addition, no significant difference was found between asthmatics and non-asthmatics in the prevalence of smoking during the first year of life (4.4% vs. 3.5%, respectively, $p = 0.27$). Maternal smoking was very similar in both groups of children with 6.3% in the asthma group and 5.4% in the non-asthma group ($p = 0.40$). In the case of paternal smoking, it was present in 13.3% of the asthma group and 11.8% in the non-asthma group ($p = 0.32$). The amount of cigarettes per day did not show any significance when comparing both groups.

Multivariable logistic regression

After the univariable analyses, 8 variables were identified for inclusion in the multivariable analysis: wheezing chest after exercise, dry cough at night in last 12 months, ever rhinitis, rhinitis in the last 12 months, eczema, acetaminophen in the first 12 months, antibiotics in the first 12 months, and traffic at home. In the multivariable analysis, 5 variables were independently associated with asthma defined by wheeze in the last 12 months (Table 3).

Table 3. Multivariable regression analysis of variables associated with asthma.

	OR (95% IC)	*p*
Wheezing chest after exercise	3.23 (2.67–3.90)	<0.0001
Dry cough at night in the last 12 months	2.20 (1.80–2.69)	<0.0001
Ever rhinitis	2.02 (1.63–2.51)	<0.0001
Use of antibiotics in the first 12 months of life	1.2 (1.01–1.43)	0.04
Use of acetaminophen in first 12 months life	1.27 (1.01–1.62)	0.04

Discussion

Epidemiological data from 4 different studies indicate a very high prevalence of asthma and related allergic conditions in school-aged children in Costa Rica, and this prevalence had been increasing from study I (1989) to study IV (2002) (17). Asthma diagnosis by a physician increased significantly from the first study (23.0%) and second study (23.1%) to 27.1% and 25.9%, in the third and fourth study (17,21,29). Asthma diagnosis using ISAAC's definition of wheeze in the last 12 months also showed a significant increase from ISAAC I (27.7%) to ISAAC III (33.2%). This increment could be A real increase in asthma prevalence or due to better awareness about asthma following information campaign. However, a similar trend has been reported for other countries such as United Kingdom, Australia, New Zealand, and United States (16,21). We undertook this study to follow asthma and other allergic conditions' prevalence, which had increased significantly in the previous epidemiological studies.

The prevalence of asthma symptoms in children in the central area of Costa Rica remains very high. At present, 21.9% of children between 6 and 13 years old reported wheeze in the last 12 months. Asthma ever diagnosed by a doctor was slightly higher with a prevalence of 24.8%. Although not significant, the prevalence of asthma was higher in boys and younger children. In addition, we found that the prevalence of rhinitis in the past year was extremely high in our group, especially among children with asthma. Moreover, rhinitis was also more prevalent in boys, but different to asthma in older children. These findings are similar to other studies, showing that asthma in early childhood is predominantly a male disease (34,35); however, there was no statistical significance in our study.

It is well known that there is a close association between asthma and other allergic diseases (36–38). In our study, 74.2% of asthmatic children suffered allergic rhinitis, while 22.6% suffered both allergic rhinitis and eczema. As shown in our study, allergic rhinitis and eczema were associated with asthma in children, with ORs of 5.6 and 1.6, respectively. Our findings remain similar to previous studies, where a strong association among allergy markers and asthma, allergic rhinitis and eczema in Costa Rican children was shown (11,30,39). This pattern has been identified in industrialized countries, where a linear relationship between positive skin test to allergens, prevalence of asthma and allergic rhinitis has been described (16,21,40).

Another factor to consider when analyzing prevalence of allergic disease is age. Generally, the prevalence of asthma and other allergic diseases is more frequent during childhood and decreases with age. Song and colleagues (41) studied a group of 10,338 children, aged 6–18 years from a province in China. They stratified children into 3 age groups: 6–8 years, 8–13 years, and 13–18 years. Asthma symptoms decreased 48% from the younger group to the oldest one (7.1% to 3.7%). In our study, even though it was not that large, there was a decrease in asthma symptoms of approximately 15.9% between the younger and the older groups (23.8% to 20.0%, respectively). When analyzing the prevalence of rhinitis, our group showed similar findings to other studies where the prevalence increases with age (41). In our group, ever rhinitis increased from 42.9% in the 6–9 years age group to 49.8% in children 10–13 years of age (13.8% increase). A similar trend was found in rhinitis during the last 12 months (39.5% to 45.9%, 13.9% increase). Eczema on the other hand showed a slight decrease from 19.7% in the younger group to 18.6% in the oldest group. Thus, in our study, the prevalence of eczema symptoms was lower in the younger group; whereas asthma symptom in the last 12 months, ever rhinitis, and rhinitis symptoms in the last 12 months was higher in the older group. Similar trend was reported in our previous studies (17,29).

In addition, previous studies have shown that exposure to acetaminophen during the first year of life and during childhood were associated with the risk of asthma, rhinoconjuntivitis, and eczema at school age (42–46). Similar to these studies, we found a significant association between the use of acetaminophen during the first 12 months of life and prevalence of asthma, allergic rhinitis and eczema. Although this relationship is still in debate, the ISAAC phase III Study showed a significant association between paracetamol use for fever in the first year of life and symptoms of asthma at age 6–7 years of age (adjusted OR = 1.76, 95% CI: 1.68–1.85). This significant association was found worldwide. In addition, there was also a strong dose-dependent association with a threefold increased risk with frequent use (at least once per month) 42). Despite the fact that there is a strong relationship, one should keep in mind that this association might be confounded by several factors, including respiratory tract infections in infancy, such as respiratory syncytial virus and rhinovirus infections that are associated with an increased risk of wheezing and asthma in later childhood (47–52). Nevertheless, the dose-dependent association seems to be suggestive of a cause–effect relationship.

In this study, children who lived in areas of high risk of pollution (either by traffic density or garbage burning) had an increase in disease prevalence, severity, and probably poorer control. Exposure of children to harmful environmental factors such as smoking or outdoor pollution could be major factors in allergic disease development (12–14,53,54). In our study, some risk factors that where included during ISAAC III environmental questionnaire where considered. Initially, bivariate analyses showed that traffic next to the house frequently during the day was higher in the asthma group. Further, parents of asthmatic children reported a significant higher prevalence of backyard burning or trash burns 500 m from their houses than non-asthmatic children (22.5% vs. 17.5%, respectively). However, after a multivariable logistic regression looking at the relationship between lifestyle and disease prevalence, no association was found for pollution variables. Interestingly, one can think that in families where a child suffers from allergic diseases (mainly asthma or allergic rhinitis), unhealthy lifestyle changes should be lower than in healthy individuals. However, in our study, the prevalence of smoking in a family member living at home was not different between asthmatics and non-asthmatics. Nowadays, parents know that smoking is not good for their children's disease; therefore, those having a child with asthma should tend to quit. Fortunately, in contrast to our previous study 25 years ago (29), the prevalence of smoking at home by a family member in the asthmatic children group decreased 35.4% (from 30.5% to 19.7%). Even though it was associated with asthma in our previous studies, in our current one there was no association found (OR 1.04, 95% CI: 0.82–1.3). This finding may reflect the effect of a smoke-free law that was approved in 2008 by the Costa Rican Government, that prohibits smoking in public places like parks, beach, bars, and restaurants. Other lifestyle modifications include better home ventilation, cleaning frequency of homes, bedding changes, and sometimes diet limitations.

Several limitations where found in this study, mainly those related to surveys. First, parent-report surveys that assess the prevalence of asthma in terms of physician diagnoses may exclude undiagnosed children who suffer

asthma-related symptoms such as excessive coughing and wheezing, or whose parents do not want their children diagnosed with a chronic disease. Second, our study was limited to a specific population of the Central Highland Area of Costa Rica. Although it is the most populated area, it excludes the coastal region. Nevertheless, no difference was found in the prevalence of ever wheeze, wheeze in the last 12 months, and physician´s diagnosis of asthma between the Central Highland area, Pacific or Atlantic coast in our previous studies (17). A third, limitation of the study is the lack of a clear explanation of disease development and other factors including: child´s characteristics, genetics, concomitant exposures, living environments, diet, and socioeconomic factors. As expected, the cross-sectional design of the study would not provide a cause–effect relation. Still, previous studies have shown how environmental factors, home environment, allergic sensitization, and infection have a large effect on disease development and exacerbation. Fourth, as stated in other ISAAC reports, several potential biases that might confound any given association are present, including recall bias and misclassification bias.

Conclusions

The present cross-sectional epidemiologic study has shown that although the prevalence of asthma and asthma-related symptoms in Costa Rican school-aged children is still high, it has decreased nearly by half in the last 12 years. This decrease might be attributable to protective lifestyle changes such as decrease in outdoor pollution (e.g., air-pollution monitoring and traffic control), reduction of exposure to mites and other bed allergens, and the elimination of tobacco smoke from public places. However, other lifestyle changes such as the use of acetaminophen and antibiotics in the first year of life continue to be associated with asthma later in childhood. There is still a high association between asthma, allergic rhinitis, and eczema in children. Although it was not investigated for asthma and eczema, there was clear seasonal pattern in the prevalence of rhinitis throughout the year, likely associated with increased upper airway infections, allergen particulate in the environment, and coexistence of high prevalence of acute asthma symptoms. The prevalence of rhinitis was very high in our study, suggesting the need of intervention strategies to control rhinitis.

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Declaration of interest

All authors have no conflict of interest to report.

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