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Rhinoconjunctivitis prevalence and associated factors in school children aged 6–7 and 13–14 years old in Bogota, Colombia

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ABSTRACT

Objective: Allergic rhinitis is one of the most frequent chronic diseases among children. The objective of the study was to assess the prevalence of rhinoconjunctivitis and determine clinical, social and environmental associated factors, among school children aged 6–7 years and adolescents aged 13–14 years in Bogotá, Colombia.

Methods: We used ISAAC (International Study of Asthma and Allergies in Childhood) phase III study methodology and questionnaire for design and data collection, and we did a secondary analysis of these data. The sample consisted of 3830 registers from adolescents between 13 and 14 years old and 3256 registers from children between 6 and 7 years.

Results: The prevalence of rhinoconjunctivitis symptoms in the last year was 17.2% (95% CI, 15.9–18.5) in children vs. 24.9% (95% CI, 23.6–26.3) in adolescents. In both groups there was a female predominance in children (17.8% vs. 16.5%), and in the teenagers group (28.0% vs. 21.4%), though the differences were not statistically significant.

The factors associated with rhinoconjunctivitis in the group of 6–7 years were: asthma [OR 3.9; (95% CI, 2.8–5.4)], atopic dermatitis [OR 2.3; (95% CI, 1.7–3.1)], use of acetaminophen in the last year [OR 2.6; (95% CI, 1.4–4.9)], use of antibiotics in the first year of live [OR 1.7; (95% CI, 1.3–2.3)], higher maternal education [OR 1.5; (95% CI, 1.0–2.3)] and cesarean delivery [OR 1.6; (95% CI, 1.2–2.1)].

Among the 13–14 year age-group, factors associated with rhinoconjunctivitis included: asthma [OR 2.6; (95% CI, 2.0–3.4)], atopic dermatitis [OR 1.8; (95% CI, 1.4–2.3)], use of acetaminophen in the last year [OR 1.8; (95% CI, 1.4–2.4)], consumption of fast-food three times or more per week [OR 1.5; (95% CI, 1.2–2.0)], ever smoked [OR 1.4; (95% CI, 1.2–1.7)] and meat consumption was protective factor [OR 0.7; (95% CI, 0.5–0.9)].

Conclusion: In both studied groups, the estimated prevalence of rhinoconjunctivitis symptoms was relatively high. Future in-depth research is needed to assess the complex interactions between allergic rhinoconjunctivitis symptoms and social and environmental factors.

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1. Introduction

During most of the previous century, studies estimating the prevalence of asthma and other allergic diseases such as rhinitis and dermatitis have shown an important increase in several countries where such studies were conducted [1]. In Colombia, a previous study conducted in six cities [2] showed that the

prevalence, severity and social consequences of these allergic diseases were worrisome.

There is recent evidence from epidemiological studies, mostly from middle and high income societies, that the disease burden due to asthma may have stabilized or even decreased [3,4]. In such countries, this trend has been more marked in the last 10–15 years. However, it is not clear whether this trend will be observed in low- to middle-income countries, as well as for rhinoconjunctivitis and atopic dermatitis [5–7]. Additionally, new potentially causal associations have been proposed to help to explain these trends, such as changes in the frequency of

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atopy, active and passive smoking, obesity, and interactions between gender, tobacco smoking, and weight, as well as dietary and socio-economical factors [8–13]. Even exposures to antibiotics and analgesics drugs, may need further exploration [14,15].

Unfortunately, given the difficulty and potential for bias when extrapolating research results from other countries, especially on allergic conditions where the risk factors may be substantially different, even varying dramatically from region to region within a given country [16], there seems to be a need for more regional and national research on trends in these conditions, especially in Latin America [17].

In Colombia, due to long standing opinion at many levels that these conditions were not public health issues, the lack of reliable registries and low number of research studies hampered comparisons with other countries for many years, and also made it impossible to evaluate trends within the country during different time periods. Previous studies on allergic diseases conducted in the last decade in Colombia [2,18,19] should provide a good base where new studies will allow not only comparisons of trends over time, but also to inform national policy makers about the health status of these highly prevalent conditions. However, to the best of our knowledge, no research has been conducted so far on the frequency of rhinoconjunctivitis in Bogotá, Colombia; and no information is available either on the medical and social factors associated with this disease in our setting. This information is of interest in order to direct future research and manage patients according to our own context. Therefore, the objective of this study was to assess the prevalence of rhinoconjunctivitis and to determine the clinical, social and environmental associated factors among school children aged 6–7 years and adolescents aged 13–14 years in Bogotá, Colombia.

2. Methods

2.1. 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 [20]. The estimated coverage of education enrollment was about 90.4% for primary school and 78.1% for secondary school in 2002 [21]. 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 1 corresponds to the lowest SES and stratum 6 to the highest.

2.2. Study design

We conducted a cross-sectional study following the International Study of Asthma and Allergies in Childhood (ISAAC) methodology. The ISAAC study is a multicenter project designed to assess the prevalence of and factors associated with asthma, rhinitis and eczema in children from different regions, allowing comparisons worldwide and the assessment of prevalence time trends [22–24].

Among the 4535 registered educational institutions in Bogotá, we selected schools within neighborhoods SES 3 and 4 (42% of the overall) for local security reasons. From these schools, we randomly selected 74 for the 6–7 year age-group, and 48 for the 13–14 year age-group. All school children eligible to participate were invited to take part in the study.

2.3. Questionnaires

Two Spanish-language questionnaires were administered according to student age. The 6–7 year age-group received written questionnaires (WQ) to be responded by parents or tutors, while the 13–14 year age-group received a self-administered WQ. 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.

2.4. Dependent variables

The dependent variables of rhinoconjunctivitis symptoms in the last year, were obtained from the core rhinitis symptoms questionnaire of the ISAAC, based on the following questions (worded age appropriately for the parent vs. the student questionnaires): (1) In the past 12 months, have you (has your child) had a problem with sneezing, or a runny or blocked nose when you (he or she) DID NOT have a cold or the flu? (2) In the past 12 months, has this nose problem been accompanied by itchy-watery eyes? [22–24]. This questionnaire has been externally validated [25,26].

2.5. 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 delivery); postnatal characteristics (breast-fed, presence of a cat and/or dog at home during the first year of life, 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 TV 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 medications (acetaminophen during the first and most recent year of life, antibiotics during the first year of life) [22–24].

2.6. Statistical analysis

The statistical analysis involved several steps. First, the prevalence of rhinoconjunctivitis symptoms and the 95% confidence intervals (95% CI) using a binomial distribution were calculated. Second, several bivariate logistic regression models were used to assess the association between current rhinoconjunctivitis symptoms and each single independent variable. Third, variables showing the stronger associations in the bivariate analysis (p -value < 0.10) were selected to be included in a multivariable logistic regression model. The 10% alpha level was chosen to reduce the likelihood of missing important predictors whose bivariate relationship with the outcome had been confounded by other variables. Fourth, collinearity among selected independent variables was assessed through regression diagnostic tests. Lastly, a multivariable analysis was conducted. We repeated multivariate models excluding current asthma and atopic dermatitis symptoms but the results were unchanged, therefore we report full models. Statistical significance for multivariable models was set at $p < 0.05$. All analyses were conducted using STATA version 8.0.

Table 1

Prevalence of rhinoconjunctivitis symptoms in the last 12 months by sex for school children of Bogotá, Colombia.

Variable	Children aged 6–7 years				Adolescents aged 13–14 years			
	n	Yes	%	95% CI ^a	n	Yes	%	95% CI ^a
Male	1386	229	16.5	14.6–18.6	1772	380	21.4	19.5–23.4
Female	1794	319	17.8	16.0–19.3	1993	559	28.0	26.1–30.0
Overall	3180	548	17.2	15.9–18.5	3765	939	24.9	23.6–26.3

^a CI: confidence interval.**Table 2**

Prevalence of allergic diseases together with rhinoconjunctivitis in the last 12 months for school children from Bogotá, Colombia.

Variable	Children aged 6–7 years				Adolescents aged 13–14 years			
	n	Yes	%	95% CI ^a	n	Yes	%	95% CI ^a
Rhinoconjunctivitis and asthma in the last 12 months	3090	153	4.9	4.2–5.7	3721	148	4.0	3.3–4.6
Rhinoconjunctivitis and atopic dermatitis in the last 12 months	3112	147	4.7	4.0–5.5	3711	181	4.9	4.2–5.6
Rhinoconjunctivitis, asthma and atopic dermatitis in the last 12 months	3031	42	1.4	1.0–1.8	3679	48	1.1	0.7–1.4

^a CI: confidence interval.

3. Results

We obtained information on 3256 children aged 6–7 years (girls 56.2%; boys 42.8%) and 3829 adolescents aged 13–14 years (52.7% girls; 47.3% boys). The participation rate for the children was 89.5% and for the adolescents, 98.7%. The current prevalence of rhinoconjunctivitis was higher for the adolescents (24.9%) than for the children (17.2%). In both groups there was a slight female predominance in children (17.8% vs. 16.5%), and in the teenagers group (28.0% vs. 21.4%), though the differences were not statistically significant (Table 1). The prevalence of rhinoconjunctivitis and concomitant asthma in the last 12 months was higher for the children (4.9%) than for the adolescents (4.0%); concomitant atopic dermatitis was similar in both groups, and having both, asthma and atopic dermatitis with rhinoconjunctivitis, was underneath 2%, both in children and adolescents (Table 2).

3.1. Children aged 6–7 years

In the bivariate analysis, factors associated with current rhinoconjunctivitis symptoms in the group of children were: prevalence of asthma symptoms in the last 12 months, prevalence

of atopic dermatitis in the last 12 months, acetaminophen and antibiotic use, maternal higher education, exposure to dogs at home, cesarean delivery, and maternal or guardian smoking (Table 3).

In the multivariable analysis, factors that remained associated with rhinoconjunctivitis symptoms in the last 12 months in the group of children were: prevalence of asthma symptoms in the last 12 months, prevalence of atopic dermatitis in the last 12 months, use of acetaminophen in the last 12 months once per year, antibiotic use in the first year of life, higher maternal education, and cesarean delivery (Table 3).

3.2. Adolescents aged 13–14 years

In the bivariate analysis, factors associated with current rhinoconjunctivitis symptoms in the group of adolescents were: gender, asthma symptoms in the last 12 months, atopic dermatitis symptoms in the last 12 months, acetaminophen use, smoking ever, and consumption of fast-food three or more times per week (Table 4).

In the multivariable analysis, factors that remained associated with rhinoconjunctivitis symptoms in the last 12 months in the

Table 3

Association between the most common symptoms of rhinoconjunctivitis and the independent variables for the group of children aged 6–7 years.

Variables	Bivariate analysis		Multivariable analysis	
	OR	95% CI ^a	OR	95% CI ^a
Prevalence of asthma symptoms in the last 12 months				
No	1.0		1.0	
Yes	6.1	4.8–7.8	3.9	2.8–5.4
Prevalence of atopic dermatitis symptoms in the last 12 months				
No	1.0		1.0	
Yes	2.9	2.3–3.6	2.3	1.7–3.1
Use of acetaminophen in the last 12 months				
No	1.0		1.0	
Once per month	1.5	0.9–2.4	1.5	0.8–2.9
Once per year	3.2	2.1–5.1	2.6	1.4–4.9
Use of antibiotics in the first year of life				
No	1.0		1.0	
Yes	2.3	1.9–2.9	1.7	1.3–2.3
Maternal educational level				
Primary school	1.0		1.0	
University	1.3	1.0–1.8	1.5	1.0–2.3
Cesarean delivery				
No	1.0		1.0	
Yes	1.3	1.1–1.6	1.6	1.2–2.1

^a Results presented for significant variables in the multivariable analysis with $p < 0.05$.^a CI: confidence interval.

Table 4Association between the most common symptoms of rhinoconjunctivitis and the independent variables for the group of adolescents aged 13–14 years.^{*}

Variable	Bivariate analysis		Multivariable analysis	
	OR	95% CI ^a	OR	95% CI ^a
Gender				
Female	1.0		1.0	
Male	0.7	0.6–0.8	0.8	0.6–0.9
Prevalence of asthma in the last 12 months				
No	1.0			
Yes	2.9	2.3–3.6	2.6	2.0–3.4
Prevalence of atopic dermatitis in the last 12 months				
No	1.0			
Yes	2.2	1.8–2.7	1.8	1.4–2.3
Use of acetaminophen in the last 12 months				
No	1.0			
Once per month	1.0	0.8–1.3	1.2	0.9–1.6
Once per year	1.8	1.4–2.3	1.8	1.4–2.4
Consumption of fast-food				
Never or occasionally	1.0			
Once or twice per week	1.1	0.9–1.3	0.04	0.9–1.3
Three or more times per week	1.5	1.2–1.9	1.5	1.2–2.0
Exposure to cats at home in the last 12 months				
No	1.0			
Yes	1.2	1.0–1.5	1.3	1.0–1.7
Ever smoked				
No	1.0			
Yes	1.4	1.2–1.7	1.4	1.2–1.7
Consumption of meat				
No	1.0			
Yes	0.7	0.5–0.9	0.7	0.5–0.9

^{*} Results presented for significant variables in the multivariable analysis with $p < 0.05$.^a CI: confidence interval.

group of adolescents were: gender, asthma symptoms in the last 12 months, atopic dermatitis symptoms in the last 12 months, use of acetaminophen once per year in the last 12 months, ever smoked, consumption of fast-food three or more times per week, and exposure to cats at home in the last 12 months. Interestingly, the consumption of meat was associated as a protective factor (Table 4).

4. Discussion

In this study, the authors used the results of the ISAAC-phase III, conducted in the biggest settlement of Colombia, to estimate the prevalence of rhinoconjunctivitis symptoms among children and adolescents from Bogotá. The results may serve as basis for planning public health policies for the management of this pathology in the studied region.

Using the protocol of the ISACC phase-III [22–24], we have found differences within Bogotá city for the studied age groups. The prevalence of rhinoconjunctivitis symptoms in the last 12 months was found to be high, with 17.2% in children and 24.9% in the adolescents. A higher frequency in the adolescents than in children may be due to a real increase in the prevalence of symptoms in the period of adolescence, or to a better perception of the problem in adolescents than in the parents of the group of children.

After seven years, ISAAC worldwide results show an increasing trend on the prevalence of rhinoconjunctivitis symptoms, ranging between 2.2% and 45.1% in the participating centers [5]. However, the increase in prevalence was more common in the group aged 6–7 years than in the group of adolescents aged 13–14 years. Although the centers report a wide variety of results for both age groups, most of the centers reported an increase in the prevalence of the three allergic diseases (asthma, allergic rhinitis, atopic dermatitis) as reported in Hong Kong [27], Turkey [28], and the comparative studies between phase I and III in Germany [29], Brazil [30], and Poland [31]; while others reported a decrease [5].

Not only important differences in prevalence rates were found among countries, but also inside the same country as for example in Spain [32].

In general, the natural history of the disease shows a higher frequency in boys during childhood and then a change toward higher frequencies in females during the adolescence and adulthood [33]. This is in agreement with a consensus showing a higher frequency of boys presenting symptoms in infancy, tending to disappear in adolescence [34]. However, in this study we found a higher frequency of rhinoconjunctivitis in girls than in boys, both in childhood and adolescence. Our results are in line with those from the German study that compared ISAAC phases I (1995) and III (2000), which found that girls had a higher prevalence of rhinoconjunctivitis compared to boys in both periods, and increasing trends in the prevalence for girls in phase-III [27–32]. The same was found in Estonia [35], Finland [36] and United Kingdom [37]. Similar results are also found for a study in Norway, although it used different questionnaires than those of the ISAAC. In contrast, Taiwan reported higher prevalence in males [38].

Results in Bogotá show a positive association of current rhinoconjunctivitis symptoms with asthma and atopic dermatitis symptoms in the last 12 months in both groups. This association between allergic diseases is in agreement with international and Colombian reports following the ISAAC methodology [18].

Another association found with the disease was the use of acetaminophen in the first year of life for children and in the last 12 months for both children and adolescents. This finding is in agreement with other reports, showing that acetaminophen use in the first years of life may constitute a risk factor for rhinoconjunctivitis and asthma [14,39–41]. The proposed explanation for the association between acetaminophen use and allergic diseases lies in the ability of acetaminophen to diminish antioxidants and promote the Th2 response [41].

In the group of adolescents aged 13–14 years it was evidenced a positive association with the consumption of fast-food three or

more times per week as a risk factor. This is in agreement with the ecological analysis of diet under the ISAAC methodology, which found that a western-type diet rich in margarine, trans-fatty acids, animal fats and fast-foods to be a risk factor; whereas a diet based in vegetables, cereals, fruits, seafood, peanuts and olive oil was considered as protective factor [11,12].

In the group of children aged 6–7 years, university maternal education was found to be a risk factor. One possible explanation could be that a higher educational level is related to a better socioeconomic status, better awareness of symptoms and understanding of questions, and more reliable responses in this group of mothers, in addition to better opportunity of diagnosis and medical treatment.

Also for this group of children we found a positive association between rhinoconjunctivitis symptoms in the last 12 month and cesarean delivery. So far in our knowledge, this is the first time that this association is reported under the ISAAC [42]. The existing literature is contradictory regarding this finding. A retrospective cohort study conducted in Norway showed an association between cesarean delivery and food allergy among susceptible children [43]. Other cohort studies in Finland and United Kingdom showed contradictory results because of heterogeneous measurements [44,45]. Finally a recent meta-analysis found that cesarean delivery was associated with a moderate risk of allergic rhinitis OR 1.2 [(95% CI, 1.1–1.3)] [46]. Several studies have shown that the intestinal flora of children born by cesarean section is different from those born vaginally. There is consistent evidence of different studies showing a high colonization of *Clostridium difficile* and low counts of *Bifidobacterium* spp. and *Lactobacillus* spp. in children born by cesarean section, having a western life-style, experiencing food allergies or presenting positive prick test reactions, compared to non-allergic children [42,47,48]. But as mentioned by one of the authors of those studies, the differences may be due to other specific factors of the mucous related with atopia.

It was also found that a high proportion of adolescents admitted to having ever smoked in their lives (37.3%), and constituted an aggravating factor for rhinoconjunctivitis symptoms in the group aged 13–14 years. This is a high frequency for the adolescent group and the finding agrees with the hypothesis of association between the habit of smoking and allergic diseases [49–51]. It has been demonstrated that smoking cigarette increases the permeability of the respiratory mucous, the total IgE and the IgE in the umbilical cord blood, and the number of Th2 lymphocytes involved on the allergic response. However, it is not yet demonstrated that it increases allergic sensitization [49–51]. In households with smoking parents there is an increased risk that their children will develop bronchial asthma; nevertheless, this fact has not been demonstrated for rhinoconjunctivitis.

The exposure to domestic animals, like dogs (children group), and cats (adolescents group), was positively associated with rhinoconjunctivitis symptoms. Similarly, the exposure of the mother during pregnancy to different domestic animals was positively associated for the children group, although the association was not longer significant after controlling for other variables in the multivariable analysis. The association between the exposure to a cat in the infancy and the subsequent sensitization and allergy is controversial. Some cohort studies support the protective effect of this association [52], whereas other studies show an increase in the risk for the sensitization associated with the exposure to pets [28,53,54]. One of the hypothesis states that having a cat at home provides an exposure with high doses of allergens and could increase the risk of sensitization to cats in susceptible children. Another hypothesis states that some endotoxins may be more abundant in the dust of homes with cats and dogs, and this may protect against future allergenic sensitization by the stimulating the Th1 system [53,54].

The strengths of this study include the design, which uses an international and controlled methodology with a validated questionnaire; our sample size; and a high participation rate. Limitations in our study are that we could not have access to all SES in Bogotá, therefore we could not take into account possible variations in our population of children and adolescents; the fact that participants did not follow a clinical examination to control for misclassification; and possible recall bias when answering questionnaires.

5. Conclusions

The results from our study indicate a high prevalence of rhinoconjunctivitis symptoms in the group of children aged 6–7 years (17.2%) and in the adolescents aged 13–14 years (24.9%) of SES 3 and 4 in Bogotá, Colombia.

A high significant association with other allergic diseases like asthma and atopic dermatitis was confirmed, and with other frequent independent factors like the use of antibiotics and acetaminophen in the first year of life and in the past 12 months, social and environmental factors like the habit of smoking, consumption of fast-food, exposure to domestic animals, cesarean delivery and maternal higher education.

The application of a rigorous multicentric methodology and a representative sample of SES 3 and 4 in the study, allow us to present representative data that could serve as the basis for future research and comparisons at local and international levels.

Conflict of interest statement

None of the authors declare any conflict of interest related with this manuscript.

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