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Asthma, rhinitis and eczema symptoms in Quito, Ecuador: a comparative cross-sectional study 16 years after ISAAC

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ABSTRACT

Background In 2003, the International Study of Asthma and Allergies in Childhood (ISAAC) estimated the prevalence of asthma, rhinitis and eczema symptoms in Quito, Ecuador. Since then, no update of this study has been done in the last years. This study examined changes in the prevalence of asthma–rhinitis–eczema symptoms over a 16 years period in Quito and explored possible risk factors.

Methods We conducted a comparative cross-sectional study in an adolescent population following the Global Asthma Network (GAN) methodology. A written questionnaire was used to explore symptoms of asthma–rhinitis–eczema. We calculated the prevalence and 95% CIs for each of the symptoms and compared them with the ISAAC results. We conducted bivariate and multivariate analysis using logistic regression to identify possible risk factors for recent wheeze, rhinitis and eczema.

Results A total of 2380 adolescents aged between 13 and 14 years were evaluated. The prevalence of doctor diagnosis for asthma, rhinitis and eczema was 3.4%, 8.5% and 2.2%, respectively. Compared with ISAAC results, we found a lower prevalence of wheeze and eczema symptoms: wheeze ever (37.6% vs 12.7%), recent wheeze (17.8% vs 6.5%), asthma ever (6.9% vs 4.6%), recent rush (22.4% vs 13.9%) and eczema ever (11.7% vs 3.6%). The prevalence of rhinitis symptoms in the GAN study was higher than the ISAAC results: nose symptoms in the past 12 months (36.6% vs 45.8%) and nose and eye symptoms in the past 12 months (23.1% vs 27.9). Significant associations were observed between symptoms of asthma–rhinitis–eczema and sex, race/ethnicity, smoking habit, physical exercise and sedentary activities.

Conclusions In the last two decades, the prevalence of asthma and eczema symptoms in adolescent population in the city of Quito has significantly declined; however, the prevalence of rhinitis symptoms has increased. The reduction in asthma symptoms could be related to better managing the disease and changes in local environmental risk factors in the last years. Further studies must be conducted in the country to evaluate the change in trends in asthma and other related allergic diseases.

Key messages

- What is the prevalence of asthma–rhinitis and eczema symptoms in the city of Quito, and to what extent do these estimates vary from the results of the International Study of Asthma and Allergies in Childhood study conducted 16 years earlier?
- Changes in trends of asthma prevalence and other related allergic diseases has been documented in the last decade. Although most of the epidemiological studies shows an increase in the burden of asthma, some evidence suggests that asthma may now be declining in many parts of the world. Comparable studies based on standardised methods are an important epidemiologiacal tools to evaluate these trends.
- This study provides a relevance evidence on changes in asthma–rhinitis–eczema trends in an urban area of Latin America. This data is important for health service planning and also because this offers the possibility of generating and testing new aetiological hypotheses.

INTRODUCTION

For the last four decades, the burden of asthma and other related allergic diseases (RAD) has been increasing worldwide, with substantial variations among countries and regions.[1] Among these disparities, high-income countries (HIC) and urban settings have presented a higher prevalence of asthma compared with low-income and middle-income countries (LMICs) and rural areas.[2 3] However, international studies conducted in the last decades have indicated that the prevalence of asthma may have reached a plateau in HICs, but continues increasing in LMICs, with a high prevalence in urban centres.[4] The factors that underlie such temporal and geographical trends in asthma prevalence are poorly understood, but are likely to reflect a complex interplay of biological, environmental and social factors.[5]

The global prevalence of asthma has been difficult to estimate with precision because of a lack of up-to-date information, methodological limitations and data gaps. The International Study of Asthma and Allergies in Childhood (ISAAC) was set up to overcome

some of these issues using standardised written and video questionnaires to examine variations in time trends of childhood asthma rhinoconjunctivitis and eczema around the world.[6] Since 1991, ISAAC has been the most extensive asthma research programme having a presence in more than 100 countries and evaluating nearly 2 million subjects.[6] However, in 2012, a new research project named the Global Asthma Network (GAN) was established as an evolution of ISAAC to improve asthma care globally, especially with a focus on LMICs.[7]

In Latin America (LA), the first estimation of the prevalence of asthma or asthma symptoms was provided by ISAAC phase I and phase III.[6] These studies showed that children living in cities in several LA countries reported similar or higher rates of asthma symptoms compared with those reported from HICs.[8] Estimations in the region show that the prevalence of childhood asthma ranges widely from 2.6% in Guatemala to 33.1% in Peru,[8] indicating that the burden of asthma in children is highly variable across LA countries. This variability has been associated with important geographical, social, economic, and ethnic differences that characterise this region. Because of the widely contrasts, the study of asthma in LA provides significant research opportunities to identify the social and biological mechanisms that underlie asthma development.[9]

Several asthma studies have been conducted in Ecuador in the last two decades, most of them using the ISSAC methodology. These studies have estimated the burden of asthma in different regions of the country and evaluating risk factors for asthma and other RAD.[10–14] According to these studies, the prevalence of asthma in Ecuador varies between 10% and 20%,[7] and factors as helminth infection, atopy, urbanisation and migration have been evaluated. One of these studies was part of ISAAC phase III and was conducted in Quito in 2003.[6] This study showed that the prevalence of wheeze ever, current wheeze and asthma ever was 36.7%; 17.3%; and 6.9%, respectively.[15] Since then, no update of this study has been done in the last years. The objective of this study was to estimate the prevalence of asthma–rhinitis–eczema symptoms in an adolescent population in Quito and compare these estimations with the ISAAC study conducted in 2003. Additionally, we also explored possible risk factors for asthma–rhinitis and eczema.

METHODS

Study design

We performed a comparative cross-sectional survey using the GAN methodology in a school population. The study subjects comprised adolescents between 13 and 14 years old residents in the city of Quito. All the students attending the schools at the time of the survey were eligible for inclusion. Adolescents' legal guardians signed the informed consent, and adolescents signed an assent form. This study is part of the GAN initiative and was conducted between October 2018 to December 2019.

Figure 1 Map of Ecuador and the city of Quito.

Study settings and population

Quito is the capital of Ecuador, a country with approximately 17 267 986 inhabitants (projection for 2019), a Human Development Index of 0.752 (ranked 86th in the world) and a gross national income per capita of $ 11 350 (Purchasing Power Parity).[16] The city of Quito, located at 2850 metres of altitude, is the most populous city in Ecuador, with about 2.9 million inhabitants (projection for 2019) and a population density of 7200 people living per km^2. The city has 156 public schools in the urban area, with approximately 134 000 students. The largest percentage of the population of Quito identifies itself as mestiza (80.6%), 12.8% as white, 3.3% as indigenous and 3.1% as Afro-Ecuadorian. Regarding the level of education, 2.7% of the population are illiterate, 30.9% have primary education, 39.7% have secondary education and 26.7% have a university education.[17]

Sample size

A total sample of 3000 students was selected following the GAN guidelines.[7] A cluster sampling method was used to select schools geographically distributed in the city (figure 1). After this first stage, we selected all the students attending the 9th and 10th grades of each school, which correspond to the student population of 13 and 14 years old. Since the sampling unit was school and the questionnaire was completed by the students, it would likely have a cluster effect. According to the number of male and female students aged 13–14 years old and the required sample size, 12 public and private schools in the three districts of Quito (north, centre and south) were selected by simple random sampling. The eligibility criteria were: (1) children studying in the urban area of the Metropolitan District of Quito and (2) children between 13 and 14 years old.

Data collection

Questionnaires

We used the GAN written questionnaire to collect information on symptoms of asthma, rhinitis and eczema (see table 1).[7] The questionnaire was translated into Spanish and was extensively field-tested. The questionnaire was

Table 1 Sociodemographic, anthropometric and lifestyle indicators of the study population

	(n)	%
Sex		
Male	987	41.5
Female	1393	58.5
Age		
13	1863	78.3
14	517	21.7
Ethnic/race		
Afro-Ecuadorian	49	2.1
White	53	2.2
Indigenous	40	1.7
Mestizo	2238	94
Residence area		
Centre	219	9.2
North	1085	45.6
South	1076	45.2
Overweigh		
No	2226	93.5
Yes	141	5.9
Birth order		
1st–2nd	1679	70.5
3rd–4th	594	25
≥5th	107	4.5
Traffic around the house		
Never	181	7.6
Seldom	924	38.8
Frequently in the day	677	28.4
Day and night	598	25.1
Cat at home		
No	1656	69.6
Yes	724	30.4
Dog at home		
No	699	29.4
Yes	1681	70.6
Smoking habit		
No	2126	89.3
Yes	254	10.7
Physical exercise		
Occasionally	734	30.8
1–2 times by week	1022	42.9
≥3 times by week	624	26.2
Watch television		
<1 hour	573	24.1
1–3 hours	989	41.6
>3 hours	818	34.4
Use of electronics devices*		
<1 hour	224	9.4
1–3 hours	512	21.5
4–5 hours	670	28.2
>5 hours	974	40.9

*Computer, tablet, video games and cell phone.

self-administered by each student, and explanations about the questionnaire were supplied in a standardised manner. The written questionnaire also included questions on age, sex, race/ethnicity, area of residence, height and weight, bird order, traffic pollution, physical exercise, cat and dog at home, smoking habits, time watching television (TV) and use of electronic devices (see table 2).

Definition of outcomes

Outcomes were defined as: recent wheeze—reported wheezing in the last 12 months, recent rhinitis—nasal stuffiness or sneezing without a cold accompanied by itchy eyes in the previous 12 months and recent eczema—reported rash in the past 12 months.

Height and weight measurements

The height of each adolescent was measured and recorded in centimetres. Study subjects had their backs turned to the stadiometer, and their heads were positioned in the Frankfurt horizontal plane. Weight was measured and recorded in kilograms. For both measurements, adolescents were standing upright and barefoot.

Statistical analyses

A descriptive analysis was conducted to obtain frequencies and percentages of demographic, anthropometric and other risk factors variables. Calculation of body mass index (BMI) was done using WHO AnthroPlus V.1.0.4. Nutritional status was defined by z scores of BMI (weight (kg)/height (m^2)) to classify children as overweight (z scores greater than or equal to the 85th centile) or of normal weight. We estimated the prevalence of asthma symptoms, rhinitis and eczema, calculating 95% CIs and compared these estimations with the ISAAC study results using the χ^2 test. Values less than $p<0.05$ were considered significant. ORs were calculated to identify possible risk factors for current wheeze, rhinitis and eczema using logistic regression. In univariate analyses, we associated each variable with the three outcomes using logistic regression and p values less than 0.05 were considered statistically significant. Additionally, multiple regression analysis were used to find the best model. We constructed one model for each outcome introducing all variables. The final models were selected using backwards stepwise regression and were those that explained the most

Table 2 Prevalence of symptoms of asthma, rhinitis and eczema for ISAAC (2003) and GAN (2019) studies with 95% CIs

	ISAAC 2003		GAN 2019		Dif.
Written questionnaire	n	% (95% CI)	n	% (95% CI)	P value
Asthma symptoms					
Wheeze ever	1134	37.6 (35.9 to 9.4)	303	12.7 (11.4 to 14.1)	<0.001
Wheeze in the past 12 months	535	17.8 (16.4 to 9.2)	156	6.5 (5.6 to 7.6)	<0.001
Four or more attacks of wheeze in the past 12 months	76	2.5 (2.0 to 3.1)	19	0.8 (0.4 to 1.1)	<0.001
Sleep disturbance from wheeze, one or more nights a week in the past 12 months	41	1.4 (1.0 to 1.8)	16	0.7 (0.3 to 1.0)	0.017
Speech limited by wheeze in the past 12 months	89	3 (2.4 to 3.6)	60	2.5 (1.8 to 3.2)	0.413
Asthma ever	207	6.9 (6.0 to 7.8)	110	4.6 (3.8 to 5.4)	0.001
Wheeze during or after exercise in the past 12 months	319	10.6 (9.5 to 11.7)	440	18.5 (16.9 to 20.0)	<0.001
Night cough in the past 12 months	233	7.7 (6.8 to 8.7)	670	28.2 (26.3 to 30.0)	<0.001
Doctor diagnosis of asthma			80	3.4 (2.6 to 4.0)	
Rhinitis					
Nose symptoms ever	1446	48 (46.2 to 49.7)	1343	56.4 (54.4 to 58.4)	<0.001
Nose symptoms in the past 12 months	1102	36.6 (34.8 to 38.3)	1091	45.8 (43.8 to 47.8)	<0.001
Nose and eye symptoms in the past 12 months	697	23.1 (21.6 to 24.6)	664	27.9 (26.0 to 29.7)	<0.001
Nose symptoms affecting activities a lot in the past 12 months	26	0.9 (5.9 to 12.6)	100	4.2 (3.3 to 5.0)	<0.001
Rhinitis ever			282	11.8 (10.5 to 13.1)	
Doctor diagnosis of rhinitis			203	8.5 (7.4 to 9.6)	
Eczema					
Rash ever	918	30.5 (28.8 to 32.1)	418	17.6 (16.0 to 19.0)	<0.001
Rash in the past 12 months	675	22.4 (20.9 to 23.9)	330	13.9 (12.4 to 15.2)	<0.001
Flexural symptoms	599	19.9 (18.5 to 21.3)	247	10.4 (9.1 to 12.1)	<0.001
Complete clearance of rash in the past 12 months	356	11.8 (10.7 to 13.0)	259	10.9 (9.6 to 12.1)	0.448
Sleep disturbance from rash, one or more nights a week in the past 12 months	72	2.4 (1.9 to 3.0)	42	1.8 (1.2 to 2.2)	0.144
Eczema ever	354	11.7 (10.6 to 12.9)	85	3.6 (2.8 to 4.3)	<0.001
Doctor diagnosis of eczema			53	2.2 (1.6 to 2.8)	

Dif, Difference; GAN, Global Asthma Network; ISAAC, International Study of Asthma and Allergies in Childhood.

variation in wheeze, eczema and rhinitis prevalence, those with the smallest mean square error and the highest value of adjusted R^2. Associations with $p<0.05$ were considered statistically significant. Data were analysed using the Software Package for Social Sciences V.24.0.

Patient and public involvement

This research was done without patient involvement. Patients were not invited to comment on the study design and were not consulted to develop patient relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy.

RESULTS

We evaluated a total of 3000 schoolchildren in the city of Quito, of whom 2380 were included in the analysis, which means a response rate of 79%. We excluded 620 adolescents because they were out of the age range. Sociodemographic indicators and other variables of interest are shown in table 1. Of the 2380 subjects in the analysis, 58.5% were women, 94% were mestizo, 45.3% lived in the south of the city, 25% lived in an area with traffic day and night. Almost 6% of the subjects presented overweight, 10.7% had the smoke habit, 30.8% did exercise occasionally and 34.4% watched TV more than 4 hours a day.

Table 3 Associations between current wheeze/asthma and symptoms of rhinitis and eczema

		Current wheeze			Asthma ever		
Symptoms	Categories	OR	95% CI	P value	OR	95% CI	P value
Current rhinitis	Yes vs No	3.5	2.5 to 4.8	<0.001	2.7	1.8 to 4.0	<0.001
Rhinitis ever	Yes vs No	3.2	2.2 to 4.6	<0.001	5.5	3.6 to 8.1	<0.001
Current eczema	Yes vs No	2.7	1.8 to 3.8	<0.001	2.5	1.6 to 3.8	<0.001
Eczema ever	Yes vs No	3.0	1.9 to 4.9	<0.001	5.9	3.3 to 10.4	<0.001

Symptoms of asthma, rhinitis, and eczema

The prevalence of symptoms of asthma, rhinitis and eczema for the ISAAC and GAN studies are shown in table 1. The prevalence of doctor diagnosis of asthma, rhinitis and eczema in the GAN study was 3.4%, 8.5% and 2.2%, respectively. The occurrence of asthma symptoms as wheeze ever, recent wheeze, four or more attacks of wheeze, sleep disturbance for wheeze and asthma ever was less common in the GAN study than in the ISAAC results. Contrary, symptoms as current wheezing during or after exercise and current night cough were higher in the GAN study. The prevalence of rhinitis symptoms as nose symptoms ever, nose symptoms in the past 12 months, nose and eye symptoms in the past 12 months and nose symptoms affecting activities a lot in the past 12 months were higher in the GAN study than the ISAAC data. The prevalence of eczema symptoms as rash ever, recent rash, flexural rush and eczema ever were lower in the GAN study than the ISAAC data.

Associations between asthma and symptoms of rhinitis and eczema

Positive associations between asthma and rhinitis and eczema symptoms were found (see table 3). Adolescents with current rhinitis presented 3.5-fold greater odds of wheeze compared with those without rhinitis (OR: 3.5; 95% CI: 2.5 to 4.8; p<0.001), and adolescents with recent eczema had 2.7-folds greater odds of wheeze compared with those without eczema (OR: 2.7; 95% CI: 1.8 to 3.8; p<0.001).

Associations between several exposures and recent wheeze, rhinitis, and eczema

Table 4 presents univariate and multiple regression analyses for wheeze, rhinitis and eczema in the last 12 months with several exposures. For recent wheeze, multiple regression analyses showed significant associations with sex, race/ethnicity, smoking habit, physical exercise and time watching TV. Girls showed two times more chance of wheeze compared with boys (OR: 2.0; 95% CI: 1.4 to 2.9; p<0.001), Afro-Ecuadorian showed 2.7 times more chance of wheeze compared with mestizos (OR: 2.7; 95% CI: 1.2 to 6.2; p<0.022), adolescents with smoking habit showed 1.7 times more chance of wheeze (OR: 1.7; 95% CI: 1.1 to 2.6; p:0.021) compared with those no smoking, adolescents doing exercise 1–2 times by week and ≥3 times by week presented 1.8 and 2.9 times more chance of wheeze compared with those doing exercise occasionally (OR: 1.8; 95% CI: 1.1 to 2.7; p:0.021) (OR: 2.9; 95% CI: 1.8 to 4.7; p<0.001) and adolescents watching TV more than 3 hours had 1.9 times more chance of wheeze compared with those watching <1 hour (OR: 1.9; 95% CI: 1.1 to 3.2; p:0.011). Fo recent rhinitis, multiple regression analyses showed associations with sex, area of residence, smoking habit, physical exercise, time watching TV and use of electronic devices. Girls showed two times more chance of rhinitis compared with boys (OR: 2.0; 95% CI: 1.7 to 2.5; p<0.001), adolescent residing in the centre area of the city showed 1.6 times more chance of rhinitis compared with those living in the south area (OR: 1.6; 95% CI: 1.1 to 2.1; p<0.008), adolescents with smoking habit showed 1.7 times more chance of rhinitis (OR: 1.7; 95% CI: 1.3 to 2.2; p<0.001) compared with those no smoking, adolescents doing exercise 1–2 times by week and ≥3 times by week presented 1.8 and 2.3 times more chance of rhinitis compared with those doing exercise occasionally (OR: 1.8; 95% CI: 1.4 to 2.3; p<0.001) and (OR: 2.3; 95% CI: 1.8 to 3.0; p<0.001), adolescents watching TV more than 3 hours had 1.5 times more chance of rhinitis compared with those watching <1 hour (OR: 1.5; 95% CI: 1.2 to 1.9; p:0.001) and adolescents using electronics for more than 5 hours had 1.7 times more chance of rhinitis compared with those using less than 1 hour (OR: 1.7; 95% CI: 1.2 to 2.5; p:0.003). For recent eczema, multiple regression analyses showed associations with sex, area of residence, smoking habit, physical exercise and use of electronics. Girls showed 2.3 times more chance of eczema compared with boys (OR: 2.3; 95% CI: 1.8 to 3.0; p<0.001), adolescent residing in the centre area of the city showed 1.5 times more chance of eczema compared with those living in the south area (OR: 1.5; 95% CI: 1.0 to 2.3; p<0.033), adolescents with smoking habit showed two times more chance of eczema (OR: 2; 95% CI: 1.4 to 2.8; p<0.001) compared with those no smoking, adolescents doing exercise 1–2 times by week and ≥3 times by week presented 1.7 and 2.8 times more chance of eczema compared with those doing exercise occasionally (OR: 1.7; 95% CI: 1.3 to 2.3; p<0.001) and (OR: 1.8; 95% CI: 1.3 to 2.5; p<0.001) and adolescents using electronics for more than 5 hours had two times more chance of eczema compared with those using less than 1 hour (OR: 2; 95% CI: 1.2 to 3.3; p:0.007).

Table 4 Bivariate and multiple regression analyses between recent wheeze, rhinitis and eczema and interest variables

	Recent wheeze						Recent rhinitis						Recent eczema					
	Bivariate			Multiple regression			Bivariate			Multiple regression			Bivariate			Multiple regression		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
Sex																		
Female vs Male	1.9	1.3 to 2.6	<0.001	2.0	1.4 to 2.9	<0.001	1.8	1.5 to 2.2	<0.001	2.0	1.7 to 2.5	<0.001	2.1	1.6 to 2.7	<0.001	2.3	1.8 to 3.0	<0.001
Race/ethnic																		
Afro vs Mestizo	2.5	1.1 to 5.6	0.030	2.7	1.2 to 6.2	0.022	0.8	0.4 to 1.6	0.573				0.5	0.2 to 1.5	0.253			
White vs Mestizo	1.5	0.6 to 3.9	0.360	1.6	0.6 to 4.2	0.334	1.0	0.5 to 1.8	0.981				0.9	0.4 to 2.1	0.879			
Indigene vs Mestizo	1.2	0.3 to 3.9	0.758	1.6	0.5 to 5.3	0.466	0.5	0.2 to 1.2	0.143				1.3	0.6 to 2.9	0.522			
Residence area																		
Centre vs south	1.5	0.9 to 2.6	0.121				1.4	1.0 to 1.9	0.025	1.6	1.1 to 2.1	0.008	1.5	1.0 to 2.1	0.048	1.5	1.0 to 2.3	0.033
North vs south	1.8	0.8 to 1.7	0.358				0.9	0.8 to 1.2	0.648	0.9	0.8 to 1.2	0.883	0.9	0.7 to 1.2	0.404	0.9	0.7 to 1.2	0.445
Overweight																		
Yes vs no	1.9	1.1 to 3.3	0.021	1.6	0.9 to 2.8	0.104	1.4	0.9 to 1.9	0.094				1.2	0.7 to 1.9	0.394			
Birth order																		
1st–2nd vs 5th	1.1	0.5 to 2.3	0.903				1.0	0.7 to 1.6	0.934				0.9	0.5 to 1.5	0.715			
3rd–4th vs 5th	0.9	0.4 to 2.0	0.740				0.9	0.6 to 1.5	0.729				0.9	0.5 to 1.7	0.825			
Traffic around the house																		
Seldom vs never	1.3	0.6 to 2.9	0.488				1.1	0.7 to 1.5	0.793				1.0	0.6 to 1.6	0.978			
Frequently/day vs never	2.1	0.9 to 4.6	0.078				1.4	0.9 to 2.0	0.109				1.2	0.7 to 2.0	0.397			
Day and night vs never	2.3	1.0 to 5.1	0.047				1.5	1.0 to 2.2	0.036				1.4	0.8 to 2.3	0.201			
Cat at home																		
Yes vs no	1.3	0.9 to 1.9	0.087				1.0	0.8 to 1.2	0.922				1.2	0.9 to 1.5	0.216			
Dog at home																		
Yes vs no	1.4	0.9 to 2.1	0.075				1.2	0.9 to 1.5	0.071				1.2	0.9 to 1.6	0.155			
Smoking habit																		
Yes vs no	1.9	1.3 to 3.0	0.003	1.7	1.1 to 2.6	0.021	1.9	1.4 to 2.4	<0.001	1.7	1.3 to 2.2	<0.001	2.2	1.6 to 3.0	<0.001	2.0	1.4 to 2.8	<0.001
Physical exercise																		
1–2 times/ vs occasionally	1.8	1.2 to 2.9	0.009	1.8	1.1 to 2.7	0.013	1.8	1.5 to 2.3	<0.001	1.8	1.4 to 2.3	<0.001	1.7	1.3 to 2.4	<0.001	1.7	1.3 to 2.3	<0.001
≥3 times/ vs occasionally	2.9	1.8 to 4.6	<0.001	2.9	1.8 to 4.7	<0.001	2.3	1.8 to 2.9	<0.001	2.3	1.8 to 3.0	<0.001	1.8	1.3 to 2.5	<0.001	1.8	1.3 to 2.5	0.001
Time watching television																		
1–3 hours vs <1 hour	1.2	0.7 to 1.9	0.469	1.2	0.7 to 1.9	0.478	1.0	0.8 to 1.3	0.678	1.0	0.8 to 1.3	0.896	0.9	0.7 to 1.3	0.816			
>3 hours<1 hour	2.0	1.2 to 3.1	0.003	1.9	1.1 to 3.2	0.011	1.7	1.3 to 2.1	<0.001	1.5	1.2 to 1.9	0.001	1.3	1.0 to 1.8	0.053			
Electronics devices																		
1–3 hours vs <1 hour	1.1	0.6 to 2.1	0.816				1.3	0.9 to 1.9	0.135	1.3	0.9 to 2.0	0.138	1.3	0.7 to 2.1	0.370	1.3	0.7 to 2.2	0.362
4–5 hours vs <1 hour	1.1	0.6 to 2.0	0.864				1.5	0.9 to 2.1	0.050	1.4	1.0 to 2.1	0.063	1.4	0.8 to 2.3	0.239	1.4	0.8 to 2.3	0.230
>5 hours vs <1 hour	1.3	0.7 to 2.3	0.463				2.1	1.5 to 3.0	<0.001	1.7	1.2 to 2.5	0.003	2.2	1.7 to 3.6	0.001	2.0	1.2 to 3.3	0.007

DISCUSSION

In the present study, we conducted a cross-sectional analysis to estimate the symptoms of asthma, rhinitis and eczema in an adolescent population in the city of Quito. Using a GAN methodology, we were able to show that the burden of wheeze, rhinitis and eczema (in the last 12 months) was 6.5%, 27.9% and 13.9%, respectively. This GAN study enables us to compare results with the ISAAC study conducted in 2003 and other studies in the regions to monitor trends in asthma prevalence and other RAD. Our results show significant variation in the prevalence of symptoms of asthma rhinitis and eczema between the GAN and the ISAAC study. Additionally, we identified several risk factors for wheeze, rhinitis and eczema, which are potentially modifiable.

The study conducted by ISAAC in 2003 has been the only survey that provides a general estimation of the prevalence of asthma, rhinitis and eczema in an adolescent population in Quito.[6] This study showed that the prevalence of wheeze ever, current wheeze and asthma ever was 37.6%, 17.8% and 6.9%, respectively.[6] Compared with the results in 2003, our data showed a significant decrease in the prevalence of asthma symptoms, except with those related to severe asthma. Likewise, the prevalence of eczema symptoms shows a marked decrease compared with the ISAAC study. Nonetheless, the prevalence of symptoms of rhinitis has increased in the last 16 years after ISAAC. According to our results, several studies conducted after ISAAC phase III have found that the prevalence of asthma and other RAD have decreased in some countries of Europe and Asia.[18] For example, repeated studies in the Netherlands showed a decreasing trend in asthma symptoms from 13.4% in 1989 to 6.2% in 2010; however, this trend was contrary to rhinitis symptoms.[19] Similarly, a study conducted in southern Taiwan showed a decline in the prevalence of asthma symptoms as doctor diagnosis, exercise-induced wheeze and nocturnal cough.[20] However, contrary to our results, many studies suggest a continued increase in asthma prevalence, especially in LMICs.[21]

In Ecuador, several studies conducted in different cities have estimated the prevalence of asthma and other RAD. For example, in 2002, an ISAAC study conducted in Guayaquil evaluated 3176 adolescents between 13 and 14 years old.[6] This study showed that the prevalence of wheeze, rhinitis and eczema in the last 12 months was 15.5%, 24.1% and 17.9%, respectively.[15] In 2003, a cross-sectional study conducted in rural areas of the Pichincha province evaluated 4433 children and adolescents between 5 and 19 years.[22] The study reported that the prevalence of wheeze, rhinitis and eczema in the last 12 months was 2.1%, 2.7% and 0.7, respectively.[22] In 2013, a study conducted in Esmeraldas evaluated 2526 subjects aged between 5 and 16 years old.[23] The study showed that the prevalence of wheeze, rhinitis and eczema in the last 12 months was 9.4%, 8.1% and 5.9%, respectively.[23] A cohort study conducted in Quininde showed that the prevalence of current wheeze and asthma at 5 years of the following was 12.6% and 5.7%.[24] In 2020, a study conducted in the city of Cuenca showed that asthma symptoms (defined as parental reported wheezing in the last 12 months, plus at least one of the following: (i) asthma diagnosis ever, (ii) wheezing during/after physical exercise in the last 12 months and (iii) sleep interruption due to wheezing in the last 12 months) was presented in 18% of the participants.[14] Comparing our results with the studies conducted in different cities of Ecuador, the prevalence of asthma symptoms found in the GAN study is relatively low. However, a recent study conducted in the north of Quito in 2019 showed that the prevalence of current wheeze and wheeze ever in a school population was 8% and 18%, respectively,[25] results that are relatively similar to our study.

In LA, the prevalence of asthma varies widely between countries and between different localities within countries. Based on the ISAAC phase III data, most of the cities included in the study presented an asthma prevalence >15%.[26] Comparing our results with those centres included in the ISAAC, the prevalence of asthma in Quito is relatively low. However, some studies conducted in the region have shown a similar prevalence of asthma. For example, a study published in 2020 in the city of Mexico showed that the prevalence of current wheeze was 8.8%,[27] a study conducted in Punta Arenas—Chile reported a prevalence of current wheeze was 6.8%,[9 15] a study in Bogota—Colombia reported a prevalence was 8.5% and a study conducted in Monterrey—Mexico reported a prevalence of 6%.[26] The significant variation observed in LA and other world regions have been attributed to several factors: geography and climate, air pollution, diet, sensitisation of allergens, socioeconomic factors, ethnicity, and others.[26]

So why we did observe such differences in the present study? The low prevalence of asthma in our study could be related to several factors. First, active and passive smoking are known to be risk factors for asthma.[28] However, an important positive environmental change experienced in Ecuador in the last years has been a decrease in the prevalence of cigarette smokers. According to the National Institute of Statistical and Census (INEC), cigarette consumption has gradually reduced in the country.[29] In 1998, 9.5% of the Ecuadorians smoked daily; in 1999, 8.2%; in 2006, 5.0%; and in 2014, 2.8%.[29] There is also a much greater public awareness of cigarette smoke-related morbidities. Second, this decrease could be related to improvements and access to appropriate medical care. In the last two decades, a series of reform policies and processes increased the coverage of the population to social and health security.[30] These changes can be observed in the decrease of hospitalisations and mortality by asthma in Ecuador in the last 20 years.[31] Age-adjusted hospitalisation rates decreased 54% over the period 2000–2018 from 278 to 129 per million, and mortality rates declined by 68% in the same period, from 11.1 to 3.5 deaths per million.[31] Third, in the last two decades, policies and regulations have been

implemented in Quito to improve air quality. Because of air quality management and control, traffic-related air pollution has declined in Quito, a decrease that has been associated with a lower incidence of respiratory illness in schoolchildren.[32] Finally, the reduction in asthma symptoms could be related to the access and effectiveness of new medications and medical care, the latter mainly represented by an increase in physicians in the country from 10 808 in 2003 to 37 293 in 2017.[33]

We also identified possible risk factors for current asthma, rhinitis and eczema. Our results showed that girls had two times more chance of wheeze, rhinitis and eczema compared with boys. It is well established that sex-related differences in asthma prevalence change through the reproductive phases of life. As children, boys have an increased prevalence of asthma compared with girls; however, as adults, women have an increased prevalence of asthma compared with men.[34] Afro-Ecuadorian students showed 2.7 times more wheeze compared with mestizos. The relationship between asthma and race/ethnicity have been well documented in different studies of the world.[35] Several studies have shown that the prevalence, morbidity and severity of asthma is higher in children who belong to certain ethnic minorities.[36 37] Ethnicity is strongly correlated with socioeconomic status (SES) in Ecuador, and most of the Afro-Ecuadorian members belong to low SES.[38] Poverty has been associated with increased asthma morbidity, it has been postulated that SES is solely responsible for ethnic differences in asthma and asthma morbidity.[39] The prevalence of rhinitis and eczema was higher in those students residing in the city centre. This area of the city is known for a high presence of old colonial houses and buildings. The age of the houses and buildings materials could foster the presence of allergic triggers like moulds, dust mite, cockroaches and others, increasing the prevalence of rhinitis and eczema in this area. Adolescents with smoking habit reported more wheeze, rhinitis and eczema. Our results are in concordance with studies showing that regular smoking is associated with a substantial risk for developing asthma and other RAD.[28] We found that adolescents with sedentary behaviours were associated with a higher prevalence of asthma and rhinitis. These findings support the evidence from other studies that contend that sedentary activities are substantially associated with asthma symptoms.[40] However, our study showed a higher prevalence of asthma in those who practice exercise, contrary to other studies that contend that regular exercise and physical fitness are possible protective factors for asthma.[41] Several factors could be related with this results. It is probable that students conduct their exercise outdoors, were the level of pollution is higher. Additionally, the presence of traffic around the house was associated with wheeze and rhinitis in the univariate analyses. This suggest that the area where the adolescents live and study present higher level of air pollution. Although we mention that the quality off the air has improved in Quito in the last years, the number and the locations of the measuring stations could influence in the relation between pollution and asthma.

The methodological limitations of our study include its cross-sectional design and the potential recall bias using questionnaire data. Additionally, we could not evaluate the presence of atopy in the study population and their associations with asthma symptoms and atopy. This fact becomes relevant because non-atopic wheeze is the most common form of childhood asthma in LA. We did not include other relevant risk factors in the analysis, such as the family history of asthma or other related allergic diseases. This issue partially impaired full comparison with other studies. Although we evaluated 3000 students attending 9th and 10th grade, we only include in the analysis 2380 students (79%). Most of the subjects not included in the analysis did not meet the required age. However, our response rate is higher compared with other studies of the GAN initiative.[42] Finally, our study did not include the 6–7 years population as the GAN methodology recommends due to the limited budget to carry out the study and bureaucratic problems to access the child population.

CONCLUSIONS

The present study represents the most exhaustive effort to investigate the epidemiology of asthma and other RAD in the city of Quito in the last two decades. Although this study cannot answer the question of why trends change, it provides a comprehensive picture and some insights into the complexity of asthma prevalence in an LMICs. Our data shows a decrease in the prevalence of asthma and eczema symptoms compared with the ISAAC study conducted in 2003 and an increase in rhinitis symptoms in 13–14 population. The association with some preventable predisposing factors supports the need to design preventive and control measures. Further studies must be conducted to evaluate the trends of asthma and other RAD in the country.

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selected schools. All parents/guardians were informed about the study in a face-to-face session, and those who agreed to participate signed a written consent form.

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