ORIGINAL ARTICLE

Prevalence and associated factors for asthma in adults in Quito: a cross-sectional study

Prevalencia y factores asociados para asma en adultos en Quito: un estudio transversal

Angelita Cabrera,[1, 2] César Picado,[2,3,4] Sergio Barba,[5] Oscar Fonseca,[6] Eduardo Castro,[1] Luis García-Marcos,[7,8,9] Alejandro Rodríguez[10]
rorodriguezal@uide.edu.ec

1 Universidad Central del Ecuador, Facultad de Ciencias Médicas, Quito, Ecuador. 2 Universitat de Barcelona, Barcelona, España. 3 Institut d'Investigacions Biomèdiques Pi i Sunyer, Barcelona, España. 4 Centro de Investigaciones Biomédicas en Red de Enfermedades Respiratorias (CIBERES). Madrid, España, 5 Centro Médico Axxis, Quito, Ecuador, 6 Ross University School of Medicine, Barbados, 7 University of Murcia, Arrixaca University Children's Hospital, Respiratory and Allergy Units, Murcia, España, 8 Biomedical Research Institute of Murcia (IMIB-Arrixaca), Murcia - Spain, 9 Carlos III Health Institute, Network of Asthma, and Adverse and Allergy Reactions (ARADyAL) Network, Madrid, España, 10 Universidad Internacional del Ecuador, Facultad de Ciencias Médicas de la Salud y la Vida, Quito, Ecuador

Abstract

Background:

Although several epidemiological studies of asthma have been carried out in Ecuador in the last two decades, none of these has estimated the prevalence of asthma in adult populations.

Objective:

To estimate the prevalence of asthma symptoms in adults in the city of Quito and to identify possible associated factors.

Methods:

A cross-sectional study was conducted on subjects older than 18 years residing in the Metropolitan District of Quito. The Global Asthma Network (GAN) questionnaire was applied to collect information on asthma symptoms and sociodemographic and lifestyle data. Bivariate and multivariate analyses with logistic regression were used to identify asthma-related factors.

Results:

2,476 subjects answered the questionnaire (80.9% women, mean age 40 years). The prevalence of wheezing in the last 12 months, asthma ever, and asthma diagnosed by a doctor were 6.3%, 1.9% and 1.6%, respectively. The prevalence of rhinitis ever and eczema ever was 13.7% and 5.5%. The presence of mould at home (OR: 2.13; 95% CI: 1.48 -3.06; p <0.001), cat at home (OR: 1.06; 95% CI: 1.06 -2.13; p <0.022) and rhinitis at some time (OR: 3.65; 95% CI: 2.53 - 5.29; p <0.022) were associated with the presence of wheezing in the last 12 months.

Corresponding author:

Alejandro Rodríguez. **E-mail:** rorodriguezal@uide.edu.ec

Conclusions:

Our study shows that, compared to other cities in Latin America, the prevalence of asthma in adults in Quito is relatively low. Along with the presence of rhinitis, factors related to housing quality are closely linked to the occurrence of asthma in adult populations.

Resumen

Antecedentes:

Aunque en el Ecuador se han realizado varios estudios epidemiológicos de asma en las dos últimas décadas, ninguno de estos ha estimado la prevalencia de asma en poblaciones adultas.

Objetivo:

Estimar la prevalencia de síntomas de asma en adultos en Quito e identificar posibles factores asociados.

Métodos:

Se realizó un estudio transversal en sujetos mayores a 18 años residentes en la ciudad de Quito-Ecuador. Se aplicó el cuestionario Global Asthma Network para recolectar información sobre síntomas de asma y datos sociodemográficas y de estilo de vida. Para la identificación de factores asociados con asma se utilizó análisis bivariados y multivariados con regresión logística.

Resultados:

Un total de 2,476 sujetos respondieron el cuestionario (80.9% mujeres, edad media 40 años). La prevalencia de sibilancias en los últimos 12 meses, asma alguna vez y asma diagnosticado por un médico fue de 6.3%; 1.9% y 1.6%, respectivamente. La prevalencia de rinitis y eczema alguna vez fue de 13.7% y 5.5%. La presencia de moho en el hogar (OR: 2.13; 95% IC: 1.48-3.06; p <0.001), gato en casa (OR: 1.06; 95% IC: 1.06-2.13; p <0.022) y rinitis alguna vez (OR: 3.65; 95% IC: 2.53-5.29; p <0.022) estaban asociados con la presencia de sibilancias en los últimos 12 meses.

Conclusiones:

Nuestro estudio muestra que, en comparación con otras ciudades de América Latina, la prevalencia de asma en adultos en Quito es relativamente baja. Junto con la presencia de rinitis, factores relacionados con la calidad de la vivienda están estrechamente ligados con la ocurrencia de asma en poblaciones adultas.

Remark

1) Why was this study conducted?

In Ecuador, since 2003, the only study that has estimated the prevalence of asthma in adults was the World Health Survey. Since then, no study has updated the prevalence of asthma in the adult population in the country.

2) What were the most relevant results of the study?

Compared to other cities in Latin America, the prevalence of asthma in adults in Quito is relatively low. Factors related to housing quality are associated with the occurrence of asthma in adult populations.

3) What do these results contribute?

Our results allow comparing the prevalence of asthma in adults with previous studies conducted in the country and other countries in Latin America, as well as monitoring future trends in the prevalence of asthma.

Introduction

In the last decades, asthma has emerged as a significant challenge for health systems worldwide, affecting individuals of all ages [1]. While the global prevalence of asthma is difficult to estimate because of a lack of up-to-date information and data gaps, the most recent global estimates suggest that 339 million people worldwide have asthma [2]. Among those with asthma, children are most affected, and asthma is now the most common chronic disease of childhood [3]. However, although asthma prevalence in adults is relatively lower compared to children and adolescents, significant direct and indirect costs are associated with this condition through emergency visits, physician visits, diagnostic tests, among other social costs [4].

Three major international studies (The European Community Respiratory Health Survey, The World Health Survey and The Global Allergy and Asthma Network of Excellence) have provided data on asthma prevalence in adults for comparisons between countries and regions [1]. These studies have estimated that the overall prevalence of asthma in young adults (18-45 years old) is 4.3% but with vast differences between countries [5]. However, very little is known about the prevalence of asthma in middle-aged people and older adults, including the elderly [2], mainly because of the greater difficulty in distinguishing asthma from other respiratory conditions such as chronic obstruction from lung disease or chronic sinusitis [2,6].

In Latin America (LA), the prevalence of asthma in adult populations has been rarely investigated [7-9]. However, estimations from countries that were part of The World Health Study (WHS) [10] showed that the prevalence of recent wheeze in adults ranged from 3.83% in Ecuador to 22.6% in Brazil. The prevalence of doctor diagnoses for asthma in these countries ranged from 2.0% in Ecuador to 12.0% in Brazil [5]. Since the WHS was conducted in 2003, few studies have estimated the prevalence of asthma in adults in LA. The objective of the present study was to estimate the prevalence of asthma symptoms in people over 18 years of age in the city of Quito and to evaluate possible associated factors.

Materials and Methods

Study Design

A cross-sectional study was conducted to estimate the prevalence of asthma symptoms in subjects over 18 years old in Quito, Ecuador. This study is part of the GAN initiative, and It was done between October 2018 to December 2019.

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 11,350.00 PPP dollars. Quito, located at 2850 metres altitude, is the most populous city in Ecuador, with about 2.9 million inhabitants (projection for 2019) and a population density of 7,200 people living per km². 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. In the study area, the sex ratio is estimated at 100 women by 95 men [11].

This study is part of the project "Study of the prevalence of asthma and other allergic diseases in adolescents in Quito", and it is described elsewhere [12]. The present study used information from the parents of adolescents who attended different educational units (public and private) of the Metropolitan District of Quito (MDQ).

Sample size

A total sample of 3,000 students was selected following the GAN guidelines [13]. A cluster sampling method was used to select 12 academic units (public and private) geographically distributed in the city. After this first stage, we selected all the students attending each school's ninth and tenth grades, which correspond to the student population of 13 and 14 years old. The eligibility criteria were: (i) children studying in the urban area of the MDQ and (ii) children between 13 and 14 years old. Each student was given an adult GAN questionnaire, which was to be filled out at home only by one representative of each adolescent (mother or father)

Data Collection

Questionnaires. The adult GAN questionnaire had a total of 42 self-administered questions. We evaluated demographic information such as sex, age, race/ethnicity and education. Several questions on asthma symptoms included breathing problems, wheezing in the past 12 months, wheeze attacks, speech problems, sleep problems, problems exercising, asthma ever, and asthma diagnosed by a doctor. Additionally, the instrument included questions on care for asthma as medical care during asthma attacks and medication for asthma. Lifestyle and home environment variables also were evaluated as moisture inside the house, mould inside the house, presence of large stains of moisture or mould inside the house, cat at home, dog at home, traffic around the house, smoking habits, smoking in the past, smoking habit in the present. The presence of allergic diseases (rhinitis ever and eczema ever) was included in the questionnaire. The outcome was defined as wheeze in the last 12 months (current wheeze).

Statistical analyses

A descriptive analysis was conducted to obtain frequencies and percentages of demographic, lifestyle, and asthma symptoms variables. Odds ratios (OR) were calculated using logistic regression to identify possible risk factors for current wheeze. In bivariate analyses, we associated each variable with current wheeze using logistic regression and p values <0.05 were considered statistically significant. Additionally, multiple regression analysis was used to find

Table 1. Sociodemographic and lifestyle indicators of the study population

Variables	Categories	n	%
Sex	Men	472	19.1
	Women	2,004	80.9
Age group (years)	21-30	136	5.6
	31-40	1,293	53.7
	41-50	750	31.1
	≥51	229	9.5
Ethnic group	Mestizo	2,299	92.9
	Others	177	7.1
Education	Primary	349	14.1
	Incomplete Secondary	419	16.9
	Completed Secondary	1,189	48
	University	517	20.9
Humidity at house	No	1,746	70.5
	Yes	730	29.5
Mould at house	No	1,985	80.2
	Yes	491	19.8
Smoking habit in the past	Never	1,917	77.4
	Seldom	453	18.3
	Daily	106	4.3
Smoking habit in the present	Never	2,179	88
	Seldon	248	10
	Daily	49	2
Traffic around the house	Never	201	8.2
	Seldom	962	39.2
	Frequently in the day	666	27.1
	Day and night	627	25.5
Cat at home	No	1,697	69.1
	Yes	759	30.9
Dog at home	No	726	29.6
	Yes	1,730	70.4
Rhinitis ever	No	2,138	86.3
	Yes	338	13.7
Eczema ever	No	2,340	94.5
	Yes	136	5.5

Table 2. Asthma symptoms

Symptoms	Categories	n	%
Do you ever have trouble with your breathing?	Never	1,740	70.3
	Only rarely	550	22.2
	Repeatedly, but it always gets completely better	163	6.6
	Continuously, so that your breathing is never quite right	23	0.9
Have you had wheezing or whistling in your chest at any time in the past 12 months? (current wheeze)	No	2,320	93.7
	Yes	156	6.3
Have you had wheezing or whistling in your chest at any time in the past 12 months?	None	2,312	93.7
	1 a 3	126	5.1
	4 a 12	19	0.8
	More than 12	11	0.4
In the past 12 months, how often, on average, has your sleep been disturbed due to wheezing?	Never woken with wheezing	73	2.9
	Less than one night per week	56	2.3
	One or more nights per week	27	1.1
Have you ever been breathless when the wheezing noise was present?	No	66	2.7
	Yes	90	3.6
In the past 12 months, how often, on average, has your sleep been disturbed due to shortness of breath?	Never woken with wheezing	73	2.9
	Less than one night per week	60	2.4
	One or more nights per week	23	0.9
In the past 12 months, how often, on average, has your sleep been disturbed due to coughing?	Never woken with wheezing	51	2.1
	Less than one night per week	60	2.4
	One or more nights per week	45	1.8
Have you ever had asthma? (Asthma ever)	No	2,428	98.1
	Yes	48	1.9
Was your asthma confirmed by a doctor? (Doctor diagnosis of asthma)	No	2,437	98.4
	Yes	39	1.6

Table 3. Bivariate and multiple regression analyses between recent wheeze and sociodemographic and lifestyle variables

Variables	Categories	Prevalence	Bivariate			Multivariate		
		(%)	OR	95% CI	p	OR	95% CI	p
Sex	Men	3.8	1					
	Women	6.9	1.86	(1.13-3.08)	0.015	1.57	(0.92-2.68)	0.096
Age group (years)	21-30	4.4	1					
	31-40	7.3	1.7	(0.73-3.95)	0.219			
	41-50	4.9	1.12	(0.47-2.71)	0.795			
	≥51	6.6	1.51	(0.58-4.01)	0.399			
Ethnic group	Mestizo	6.4	1					
	Other	4.5	0.69	(0.33-1.42)	0.314			
Education	Primary	5.4	1					
	Incomplete Secondary	6.7	1.24	(0.68-2.26)	0.477	1.19	(0.63-2.24)	0.579
	Completed Secondary	5.5	1	(0.59-1.69)	0.987	0.95	(0.54-1.66)	0.867
	University	8.5	1.61	(0.92-2.81)	0.092	1.46	(0.81-2.65)	0.203
Humidity at house	No	5.0	1					
	Yes	9.5	1.99	(1.43-2.76)	<0.001			
Mould at house	No	5.0	1			1		
	Yes	11.4	2.42	(1.72-3.42)	<0.001	2.13	(1.48-3.06)	<0.001
Smoking habit in the past	Never	5.9	1			1		
	Seldom	6.2	1.04	(0.68-1.60)	0.85	0.99	(0.63-1.57)	0.993
	Daily	13.2	2.4	(1.33-4.35)	0.004	1.86	(0.93-3.70)	0.076
Smoking habit in the present	Never	6.1	1					
	Seldom	6.5	1.06	(0.62-1.81)	0.829			
	Daily	14.3	2.56	(1.13-5.8)	0.024			
Traffic around the house	Never	6	1					
	Seldom	5.9	0.99	(0.52-1.88)	0.98			
	Frequently in the day	5.7	0.95	(0.48-1.86)	0.888			
	Day and night	7.7	1.31	(0.67-2.51)	0.424			
Cat at home	No	5.6	1			1		
	Yes	7.9	1.48	(1.04-2.02)	0.031	1.51	(1.06-2.13)	0.022
Dog at home	No	6.7	1					
	Yes	6.1	0.9	(0.63-1.28)	0.563			
Rhinitis ever	No	4.6	1			1		
	Yes	17.2	4.31	(3.04-6.10)	<0.001	3.65	(2.53-5.29)	<0.001
Eczema ever	No	5.9	1					
	Yes	14.0	2.61	(1.56-4.36)	<0.001			

the best model. The final model was selected using back-wards step-wise regression and was that which explained the most variation in current wheeze prevalence, that 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 (SPSS) version 24.0.

Ethics approval

This study was approved by the Ethics Committees of the Hospital Clinic de Barcelona (Reg. HCB/2016/0822) and by the Ethics Committees of the Hospital Carlos Andrade Marín in Quito. Additionally, the project was approved by the Ministry of Health and Education of Ecuador and the Directors of the 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.

Results

Of a total of 3,000 questionnaires sent to parents or representatives, 2,476 were returned with the requested information, which means coverage of 82.5%. Table 1 shows the characteristics of the study population based on demographic and quality of life indicators. Around 81.0% of the study population were female, 60% had less than 40 years old, 92.9% were mestizo, and 60.9% of the population had secondary education. Rhinitis and eczema ever were reported by 13.7% and 5.5% of participants, respectively. Prevalence of wheeze in the last 12 months, asthma ever, and doctor diagnoses for asthma were 6.3%, 1.9%, and 1.6%, respectively (Table 2).

Table 3 shows the bivariate and multivariate analysis between wheeze in the last 12 months and demographic and lifestyle variables. Our results showed that women had 1.86 times more

chance of wheeze compared to men (OR: 1.86; CI 95%: 1.13-3.08; *p*: 0.015), people who lived in homes with humidity had 1.99 times more chance of wheeze compared to those who lived in homes without humidity (OR: 1.99; CI 95%: 1.43-2.76; *p*: <0.001), people who lived in mold homes had 2.42 times more chance of wheeze compared to those who lived in mold-free homes (OR: 2.42; CI 95%: 1.72-3.42; *p*: <0.001), people who smoked daily in the past had 2.4 times more chance of wheeze than those who never smoked (OR: 2.4; CI 95%: 1.33-4.35; *p*: 0.004), people who smoke daily had 2.56 times more chance of wheeze than those who never smoked (OR: 2.56; CI 95%: 1.13-5.88; *p*: 0.024), people with a cat at home had 1.48 times more chance of wheeze than those without a cat at home (OR: 1.48; CI 95%: 1.04-2.02; *p*: 0.031), people with rhinitis and eczema ever had 4.31 and 2.61 times more chances of wheeze, respectively, than those without rhinitis and eczema (OR: 4.31; CI 95%: 3.04-6.10; *p*: <0.001) (OR: 2.61; CI 95%: 1.56-4.36; *p*: <0.001).

The multivariate analysis showed that people living in mould homes had 2.13 times more chance of wheeze compared to those living in mould-free homes (OR: 2.13; CI 95%: 1.48-3.06; *p*: <0.001), people with a cat at home had 1.51 times more chance of wheeze than those without a cat at home (OR: 1.51; CI 95%: 1.06-2.13; *p*: 0.022), and people with rhinitis ever had 3.65 times more chance of wheeze than those without rhinitis (OR: 3.65; CI 95%: 2.53-5.29; *p*: <0.001).

Discussion

The present study conducted a cross-sectional analysis to evaluate the prevalence of asthma symptoms in an adult population in Quito. Based on the GAN questionnaire, we estimated the prevalence of wheeze in the past 12 months, asthma ever, and doctor diagnosis of asthma for an adult population. Our results allow comparisons of the prevalence of asthma in adults with previous studies conducted in the country and other countries in the region and monitor future trends in asthma prevalence. Additionally, this study identified associated factors such as the presence of mould at home, pets at home (cat) and the presence of rhinitis, all of which are potentially modifiable.

In the last two decades, several studies have been conducted in Ecuador to estimate the prevalence of asthma and other allergic diseases [14-18]. However, all these studies have been conducted in child or adolescent populations. These studies have shown that the prevalence of asthma in the country varies between 10% and 20% [2]. In the case of asthma studies in the adult population, the only study conducted in the country was the World health survey in 2003 [5]. This study showed that the prevalence of asthma diagnosed by a doctor for people over 18 years old was 2.03%, and the prevalence of wheeze symptoms was 3.8%. Our results showed that the prevalence of asthma diagnosed by a doctor is slightly lower (1.6%) than that reported by the WHS, and the prevalence of asthma measured by wheeze in the last 12 months was higher than that reported in the WHS. However, it is essential to emphasise that the definition of asthma symptoms in the WHS was based on the medical diagnosis of asthma, clinical asthma, and/or reported wheezing in the last 12 months, and our definition is based solely on those who presented wheeze in the last 12 months.

Few studies in LA have evaluated the prevalence of asthma in the adult population [5,8,9]. In Argentina, a study conducted in 2018 in subjects aged 20-44 years showed that the prevalence of asthma (defining asthma as the presence of exacerbations in the last year plus the use of medications), doctor diagnosed of asthma, and current wheeze was 5.9%, 9.5%, and 13.9%, respectively [19]. A study conducted in Brazil on patients older than 18 years showed that the prevalence of doctor diagnosis of asthma was 4.4% [20]. In Mexico, a study in patients older than 40 years old showed that the prevalence of doctor diagnosis of asthma was 5% [21]. Another study conducted in Bogotá - Colombia, published in 2012, showed that the prevalence of doctor diagnosis of asthma in people aged 18 to 59 years was 6.3%, and the prevalence of current wheeze was 9.68% [22]. Comparing our results with the studies conducted in LA, we can observe that the prevalence of doctor diagnoses for asthma in Quito - Ecuador is relatively low.

Our study's relatively low prevalence of asthma could be related to several factors. First, active and passive smoking are known to be risk factors for asthma [23]. However, an important positive environmental change experienced in Ecuador in the last years has been a decrease in the prevalence of cigarette smokers [24]. According to the National Institute of Statistical and Census (INEC), cigarette consumption has gradually reduced in the country. In 1998, 9.5% of the Ecuadorians smoked daily; in 1999, 8.2%; in 2006, 5.0% and in 2014, 2.8% [24]. There is also a much greater public awareness of cigarette smoke-related morbidities. Second, the low prevalence 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 [25]. These changes can be seen in the decrease in hospitalisations and mortality from asthma in Ecuador in the last two decades [26]. Age-adjusted hospitalization rates decreased by 54.% from 2000-to 2018, from 278 to 129 per million population, and age-adjusted mortality rates decreased by 68% in the same period, from 11.1 to 3.5 deaths per million population. 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 the population [27]. Finally, the low asthma prevalence could be related to new medications and medical care access and effectiveness. The latter is mainly represented by an increase in physicians in the country from 10808 in 2003 to 37293 in 2017 [28].

This study identified associated factors for asthma. Our results showed that people living in mouldy homes have more wheeze. The relationship between household environmental factors and asthma has been well documented [29,30]. Among the most important characteristics of the house related to asthma are the excessive humidity of the dwelling and the presence of mould [30]. For example, a recent study conducted on the adult population in Sweden showed that people who lived in houses with mould and humidity had 5.72 times more asthma [31]. In our study, a part of the participants resided in the city centre, an area known for a high presence of old houses and colonial constructions. The age of the houses and their building materials could intensify the presence of allergic triggers such as mould, mites, cockroaches and others, increasing the prevalence of asthma. Likewise, our study showed that having a cat at home was associated with the presence of wheeze. It is well known that pets are an important source of household endotoxin. One study found that households with pets had an average of 1.4 times higher endotoxins concentrations in dust sedimented than households without pets [32]. Rhinitis was strongly associated with the presence of wheeze in our study population. It is widely known that rhinitis, sinusitis, and respiratory tract infections are frequently associated with asthma, regardless of the age of onset of the disease [33].

Approximately 81% of the study population was female, a factor associated with a higher prevalence of asthma in bivariate and multivariate analyses. The high presence of female participants in our study was because, in our environment, children's education falls on the mothers, so mothers generally filled out the questionnaires. The prevalence of asthma in women was double compared of men. This difference could be related to a higher representation of female participants in our study. However, several studies have shown that the prevalence, severity, rate of exacerbations, hospitalisations and mortality of asthma are higher among women than men populations [34]. These differences could be related to sociocultural factors. For example, in our society, men are less likely to visit health services than women, increasing hospitalisation for asthma in women.

The main methodological limitation of our study is the non-random selection of the population. We worked with a convenience sample from another study. Other limitations of the study include its cross-sectional design and possible memory bias when using questionnaire data. Additionally, we could not evaluate the presence of atopy in the study population, so we could not estimate the associations between asthma symptoms and atopy, a relevant fact because non-atopic asthma is the most common form of childhood asthma in LA [35,36].

Conclusions

The present study is one of the first investigations estimating the prevalence of asthma in adults in Quito. Our study shows that, compared to other cities in Latin America, the prevalence of asthma in adults in Quito is relatively low. Along with the presence of rhinitis, factors related to housing quality are closely associated with the occurrence of asthma in adult populations. Our results provide substantial evidence on the factors associated with the prevalence of wheeze symptoms in urban populations in LA.

References

1. Agache I, Akdis CA. Global Atlas of Asthma. European Academy of Allergy and Clinical Immunology; 2021. Available from: http://www.eaaci.org/resources/global-atlas-of-allergy.html.

2. Global Initiative for Asthma. Global strategy for asthma management and prevention; 2020. Available from: https://ginasthma.org/wp-content/uploads/2020/04/GINA-2020-full-report_-final-_wms.pdf.

3. Asher I, Pearce N. Global burden of asthma among children. Int J Tuberc Lung Dis. 2014;18(11):1269-78. doi: 10.5588/ijtld.14.0170

4. Nunes C, Pereira AM, Morais-Almeida M. Asthma costs and social impact. Asthma Res Pract. 2017; 3: 1. doi: 10.1186/s40733-016-0029-3

5. To T, Stanojevic S, Moores G, Gershon AS, Bateman ED, Cruz AA, et al. Global asthma prevalence in adults: Findings from the cross-sectional world health survey. BMC Public Health. 2012;12(1):204. doi:10.1186/1471-2458-12-204

6. Promsopa C, Kansara S, Citardi MJ, Fakhri S, Porter P, Luong A. Prevalence of confirmed asthma varies in chronic rhinosinusitis subtypes. Int Forum Allergy Rhinol. 2016; 6(4): 373-7. doi: 10.1002/alr.21674

7. Solé D, Aranda CS, Wandalsen GF. Asthma: epidemiology of disease control in Latin America - short review. Asthma Res Pract. 2017; 3: 4. doi:10.1186/s40733-017-0032-3

8. Cooper PJ, Rodrigues LC, Cruz AA, Barreto ML. Asthma in Latin America: A public health challenge and research opportunity. Allergy Eur J Allergy Clin Immunol. 2009;64(1):5-17. doi: 10.1111/j.1398-9995.2008.01902.x.

9. Forno E, Gogna M, Cepeda A, Yañez A, Solé D, Cooper P, et al. Asthma in Latin America. Thorax. 2015;70(9):898-905. Doi: 10.1136/thoraxjnl-2015-207199

10. Sembajwe G, Cifuentes M, Tak SW, Kriebel D, Gore R, Punnett L. National income, self-reported wheezing and asthma diagnosis from the World Health Survey. Eur Respir J. 2010;35(2):279-86. doi: 10.1183/09031936.00027509.

11. INEC. Instituto Nacional de Estadística y Censos. 2020. Cited: 2020 Apr 26. Available from: http://www.ecuadorencifras.gob.ec

12. Cabrera A, Picado C, Rodriguez A, Garcia-Marcos L. Asthma, rhinitis and eczema symptoms in Quito, Ecuador: A comparative cross-sectional study 16 years after ISAAC. BMJ Open Respir Res. 2021;8(1):1-9. doi: 10.1136/bmjresp-2021-001004.

13. Ellwood P, Asher MI, Billo NE, Bissell K, Chiang C-Y, Ellwood EM, et al. The Global Asthma Network rationale and methods for Phase I global surveillance: prevalence, severity, management and risk factors. Eur Respir J. 2017; 49(1): 1601605. doi: 10.1183/13993003.01605-2016.

14. Cooper PJ, Chico ME, Rodrigues LC, Strachan DP, Anderson HR, Rodriguez EA, et al. Risk factors for atopy among school children in a rural area of Latin America. Clin Exp Allergy. 2004;34(6):845-52. doi: 10.1111/j.1365-2222.2004.01958.x

15. Cooper PJ, Chico ME, Vaca MG, Rodriguez A, Alcântara-Neves NM, Genser B, et al. Risk factors for asthma and allergy associated with urban migration: background and methodology of a cross-sectional study in Afro-Ecuadorian school children in Northeastern Ecuador (Esmeraldas-SCAALA Study). BMC Pulm Med. 2006;6(1):24. Doi: 10.1186/1471-2466-6-24

16. Chico ME, Vaca MG, Rodriguez A, Cooper PJ. Soil-transmitted helminth parasites and allergy: Observations from Ecuador. Parasite Immunol. 2019; 41(6):e12590. doi: 10.1111/pim.12590.

17. Cooper PJ, Chico ME, Platts-Mills TAE, Rodrigues LC, Strachan DP, Barreto ML. Cohort Profile: The Ecuador Life (ECUAVIDA) study in Esmeraldas Province, Ecuador. Int J Epidemiol. 2015;44(5):1517-27. doi: 10.1093/ije/dyu128.

18. Ochoa-Avilés C, Morillo D, Rodriguez A, Cooper PJ, Andrade S, Molina M, et al. Prevalence and risk factors for asthma, rhinitis, eczema, and atopy among preschool children in an Andean city. PLoS One. 2020;15(7):e0234633. Doi:10.1371/journal.pone.0234633

19. Arias SJ, Neffen H, Bossio JC, Calabrese CA, Videla AJ, Armando GA, et al. Prevalence and Features of Asthma in Young Adults in Urban Areas of Argentina. Arch Bronconeumol. 2018;54(3):134-9. doi:10.1016/j.arbres.2017.08.021.

20. Menezes AMB, Wehrmeister FC, Horta B, Szwarcwald CL, Vieira ML, Malta DC. Prevalence of asthma medical diagnosis among Brazilian adults: National Health Survey, 2013. Rev Bras Epidemiol. 2015;18(Suppl 2):204-13. doi: 10.1590/1980-5497201500060018.

21. García-Sancho C, Fernández-Plata R, Martínez-Briseño D, Franco-Marina F, Pérez-Padilla JR. Prevalencia y riesgos asociados con pacientes adultos con asma de 40 años o más de la Ciudad de México: estudio de base poblacional. Salud Publica Mex. 2012; 54 (4): 425-32. doi: 10.1590/s0036-36342012000400013.

22. Dennis RJ, Caraballo L, García E, Rojas MX, Rondon MA, Pérez A, et al. Prevalence of asthma and other allergic conditions in Colombia 2009-2010: a cross-sectional study. BMC Pulm Med. 2012;12(1):1-9. Doi: 10.1186/1471-2466-12-17

23. Polosa R, Thomson NC. Smoking and asthma: dangerous liaisons. Eur Respir J. 2013; 41(3):716-26. doi: 10.1183/09031936.00073312.

24. Ministerio de Salud Pública; Instituto Nacional de Estadística y Censos. Indicadores de Salud del Ecuador-2012. Indicadores Bàsicos. https://www3.paho.org/ecu/index.php?option=com_docman&view=download&category_slug=documentos-2014&alias=471-indicadores-basicos-de-salud-ecuador-2012&Itemid=599.

25. Chang Campos CJ. Evolución del sistema de salud de Ecuador: Buenas prácticas y desafíos en su construcción en la última década 2005-2014. An Fac Med. 2017; 78(4):452-60. DOI: 10.15381/anales.v78i4.14270.

26. Cabrera A, Rodriguez A, Romero-Sandoval N, Barba S, Cooper PJ. Trends in hospital admissions and mortality rates for asthma in Ecuador: a joinpoint regression analysis of data from 2000 to 2018. BMJ Open Respir Res. 2021;8(1):e000773. doi: 10.1136/bmjresp-2020-000773.

27. Estrella B, Sempértegui F, Franco OH, Cepeda M, Naumova EN. Air pollution control and the occurrence of acute respiratory illness in school children of Quito, Ecuador. J Public Health Policy. 2019;40(1):17-34. Doi: 10.1057/s41271-018-0148-6

28. Rodriguez A, Romero-Sandoval A, Sandoval BA, Romero N. Medical specialist distributions in Ecuador: a geographical and temporal analysis of data from 2000 to 2017. BMC Health Serv Res. 2022;5:1-12. Doi: 10.1186/s12913-022-08056-5/

29. Maziak, W. The asthma epidemic and our artificial habitats. BMC Pulm Med. 2005; 5: 5. Doi: 10.1186/1471-2466-5-5

30. Krieger J. Home is Where the Triggers Are: Increasing Asthma Control by Improving the Home Environment. Pediatr Allergy Immunol Pulmonol. 2010;23(2):139-45. Doi: 10.1089/ped.2010.0022

31. Wang J, Engvall K, Smedje G, Norbäck D. Exacerbation of asthma among adults in relation to the home environment in multi-family buildings in Sweden. Int J Tuberc Lung Dis. 2017;21(2):223-9. doi: 10.5588/ijtld.16.0307

32. Chen CM, Thiering E, Doekes G, Zock JP, Bakolis I, Norbäck D, et al. Geographical variation and the determinants of domestic endotoxin levels in mattress dust in Europe. Indoor Air. 2012;22(1):24-32. doi: 10.1111/j.1600-0668.2011.00740.x

33. Ilmarinen P, Tuomisto LE, Kankaanranta H. Phenotypes, risk factors, and mechanisms of adult-onset asthma. Mediators of Inflammation. Mediators Inflamm. 2015;2015:514868. doi: 10.1155/2015/514868..

34. Zein JG, Erzurum SC. Asthma is Different in Women. Curr Allergy Asthma Rep. 2015; 15(6):28. doi: 10.1007/s11882-015-0528-y.

35. Moncayo AL, Vaca M, Oviedo G, Erazo S, Quinzo I, Fiaccone RL, Chico ME, Barreto ML, Cooper PJ. Risk factors for atopic and non-atopic asthma in a rural area of Ecuador. Thorax. 2010; 65(5):409-16. doi: 10.1136/thx.2009.126490.

36. Souza da Cunha S, Barreto ML, Fiaccone RL, Cooper PJ, Alcantara-Neves NM, Simões Sde M, Cruz AA, Rodrigues LC. Asthma cases in childhood attributed to atopy in tropical area in Brazil. Rev Panam Salud Publica. 2010; 28(6): 405-11. doi: 10.1590/s1020-49892010001200001.