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Epidemiological profile of allergic respiratory disease in Mexican children

Perfil epidemiológico de la enfermedad respiratoria alérgica en niños mexicanos

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Abstract

Objective: Report the prevalence and severity of the most common allergic diseases in children living in Monterrey, México.

Methods: Cross-sectional multi-center survey on the most common allergic diseases, completed by parents of 6-7-year-old children and by 13-14- year-old adolescents in the Monterrey metropolitan area, between January 2018 and December 2019.

Results: A total of 3,044 questionnaires were eligible for the analysis. Among children between 6-7 years old, 30.2% (n = 143/473) presented wheezing at any time in their life; with a higher prevalence in the male population. In the adolescent group, 26.4% reported having experienced wheezing at some point in their life, with a slight predominance in the female group (54.9%).

Conclusions: Knowing the prevalence of allergic diseases in our population gives us tools to generate strategies that allow us to provide the best quality healthcare to our patients.

Keywords: Asthma; Rhinitis; Eczema; Wheezing; Allergy And Immunology; Child.

Resumen

Objetivo: Reportar la prevalencia y gravedad de las enfermedades alérgicas más comunes en niños residentes en Monterrey, México.

Métodos: Encuesta multicéntrica transversal, acerca de las enfermedades alérgicas más comunes, completada por padres de niños de 6 aa 7 años y por adolescentes de 13 a 14 años del área metropolitana de Monterrey, entre enero de 2018 y diciembre de 2019.

Resultados: Un total de 3044 cuestionarios fueron elegibles para el análisis. Entre los niños de 6-7 años, 30.2% (n = 143/473) manifestaron sibilancias en algún momento de su vida; con mayor prevalencia en la población masculina. En el grupo de adolescentes el 26.4% refirió haber tenido sibilancias alguna vez en su vida, con un ligero predominio en el grupo femenino (54.9%).

Conclusiones: Conocer la prevalencia de las enfermedades alérgicas en la población brinda herramientas para generar estrategias para la mejor calidad asistencial en los pacientes.

Palabras clave: Asma; Rinitis; Eczema; Sibilancias; Alergia E Inmunología; Niño.

INTRODUCTION

Asthma, which is one of the most common chronic diseases, has increased in recent decades. According to the World Health Organization, asthma affects more than 330 million people worldwide.[1] The global prevalence of self-reported asthma in adults is 4.2%, with this figure being higher in industrialized countries. However, the prevalence in developing countries is believed to be underreported because of the difficulty of patient access to health services.[2]

Asthma represents a significant burden for society with a greater impact in developing countries due to the limited access to adequate treatments.[3] Despite the reduction in mortality due to asthma in the last two decades achieved by the development and use of inhaled therapies, especially inhaled corticosteroids (ICS), a large global disparity persists in the years of life lost to the disease.[2,4] This forces us to propose modern and novel treatment strategies to reduce the global mortality and economic and social burden that asthma imposes on the population.

Thus, in recent years, international organizations have made efforts to know the worldwide prevalence of asthma. The International Study of Asthma and Allergies in Childhood (ISAAC) was carried out in three phases (1991-2012) to describe the prevalence and severity of asthma, rhinitis, and eczema in children.[5] According to the results of phase 3 carried out in 237 centers in 98 countries, 17 of which were in Latin America, asthma prevalence varies widely depending on the geographic region. A higher prevalence of asthma symptoms was found above all in low- and middle-income countries. In the Mexican Republic, the prevalence of asthma in 6 cities ranged between 5 and 14%. The self-reported prevalence of current wheezing in children was 3.9% in Mexico City and 3% in Monterrey, Nuevo Leon, increasing to 30.8% in San Salvador, El Salvador. In contrast, in children aged 6 to 7 years, the prevalence in Mexico was 3.6%, increasing in Costa Rica to 37.6%. Furthermore, the prevalence of asthma ranged from 1.2% in Monterrey, Mexico, to 33.1% in Lima, Peru.[6]

Later in 2012, the Global Asthma Network (GAN) was established by scientists from ISAAC and the International Union against Tuberculosis and Lung Diseases to understand the impact of asthma on the population and thus prevent and improve disease care around the world with a special focus on low- and middle-income countries (http://www.globalasthmanetwork.org/). The GAN used the same methodology as ISAAC phases one and three focusing on the three base diseases to evaluate their prevalence, diagnosis, severity, visits to the emergency room for asthma, hospital admissions, management, and drugs used.[7]

Our study's objectives are to report the results of our population that is part of the GAN phase I, with a particular focus on the prevalence and severity of asthma, rhinoconjunctivitis, and eczema in children and adolescents living in the city of Monterrey, Mexico.

METHODS

This was a comparative cross-sectional study following the official Global Asthma Network (GAN) methodology.

Data collection

Data was collected from January 2018 up to December 2019 in the Monterrey metropolitan area. Elementary and secondary schools were randomly selected from a list of public institutions that meaningfully represent the metropolitan population. Subjects were selected following the same methodology as ISAAC phase III. The same age groups were used: adolescents aged 13 to 14 years (self-reported questionnaires) and children aged 6 to 7 years (questionnaires filled out by their parents). Students in both age groups were selected by grade/level/year or age group. The study was approved by the Human Research Ethics Committee of "Dr. José Eleuterio González" University Hospital of the Autonomous University of Nuevo León (AL17-00004/AL17-00006). Inform consents/assents were obtained by the participants, and their parents or guardians.

GAN questionnaire

The same standardized GAN questionnaire was used, similar to that used in ISAAC phase III, with the addition of a physician-confirmed diagnosis of asthma, rhinitis and/or eczema.

The GAN questionnaire's main questions are sensitive and specific, with good content, construct, concurrent, and predictive validity.[7] The questionnaire contained basic participant demographic data such as age, date of birth, gender, education, etc., and questions regarding the prevalence and severity of the evaluated allergic diseases. The questionnaires are available for consultation online at http://www.globalasthmanetwork.org/surveillance/manual/manual.php.

Statistical analysis

Descriptive statistics were used to analyze continuous and categorical variables. The Kolmogorov-Smirnov test was used to determine normality. Continuous variables with a normal distribution are shown as mean ± standard deviation (SD) and non-normal distribution median and interquartile range (IQR). Student's t-test or Mann-Whitney U test, accordingly. The Chi-square (χ^2) test and Fisher's exact test were used to compare categorical variables. Current asthma symptoms (WHEZ12) was the dependent variable in the analyses examining the risk factors for asthma. All possible factors which were likely to influence the prevalence of current wheeze were identified ($p < 0.05$) by the Fisher and Chi-square tests. These factors were further analysed by backward conditional logistic regression to create models to predict current wheeze.The statistical analysis was performed using SPSS statistical software v.25.0 (IBM Corp., Armonk, NY, USA).

RESULTS

The prevalence and severity of asthma symptoms in children and adolescents are presented in **Table 1**. It is important to mention that 29.4% (n = 143/486) of

Table 1. Prevalence and severity of asthma symptoms in children and adolescents in Monterrey according to the Global Asthma Network.

Variable	Children 6-7 years		Teenagers 12-14 years	
	n	Frequency %	n	Frequency %
Have you had a wheezing or wheezing in your chest at any time in your life?				
Males	85/235	36.2%	306/1239	24.7%
Females	58/238	24.4%	373/1333	28.0%
Total	143/473	30.2%	679/2572	26.4%
How old was the child when the whistle started? <1 year old				
Males	28/82	34.1%	NA	
Females	19/55	34.5%	NA	
Total	47/137	34.3%	NA	
How old was the child when the whistle started? 1-2 years old				
Males	18/82	22.0%	NA	
Females	20/55	36.4%	NA	
Total	38/137	27.7%	NA	
How old was the child when the whistle started? 3-4 years old				
Males	17/82	20.7%	NA	
Females	12/55	21.8%	NA	
Total	29/137	21.2%	NA	
How old was the child when the whistle started? 5-6 years old				
Males	17/82	20.7%	NA	
Females	3/55	5.5%	NA	
Total	20/137	14.6%	NA	

How old was the child when the whistle started? >6 years old				
Males	2/82	2.4%	NA	
Females	1/55	1.8%	NA	
Total	3/137	2.2%	NA	
Have you had wheezing or wheezing in the past 12 months?				
Males	30/106	28.3%	145/508	28.5%
Females	9/80	11.3%	183/550	33.3%
Total	39/186	21.0%	328/1058	31.0%
How many whistling attacks have you had in the last 12 months? None				
Males	31/59	52.5%	182/309	58.9%
Females	18/26	69.2%	168/343	49.0%
Total	49/85	57.6%	350/652	53.7%
How many whistling attacks have you had in the last 12 months? 1 - 3				
Males	21/59	35.6%	103/309	33.3%
Females	6/26	23.1%	143/343	41.7%
Total	27/85	31.8%	246/652	37.7%
Wheeze attacks in past 12 months none				
Males	31/59	52.5%	182/309	58.9%
Females	18/26	69.2%	168/343	49.0%
Total	49/85	57.6%	350/652	53.7%
Wheeze attacks in past 12 months 1-3				
Males	21/59	35.6%	103/309	33.3%
Females	6/26	23.1%	143/343	41.7%
Total	27/85	31.8%	246/652	37.7%
Wheeze attacks in past 12 months 4-12				
Males	7/59	11.9%	16/309	5.2%
Females	0/26	0.0%	26/343	7.6%
Total	7/85	8.2%	42/652	6.4%
Wheeze attacks in past 12 months >12				
Males	0/59	0.0%	8/309	2.6%
Females	2/26	7.7%	6/343	1.7%
Total	2/85	2.4%	14/652	2.1%
In the past 12 months, how many times, on average, has the child's sleep been disturbed due to hissing or whistling? 1 per night				
Males	13/53	24.5	33/276	12.0%
Females	3/29	10.3%	53/313	16.9%
Total	16/82	19.5%	86/589	14.6%
In the past 12 months, how many times, on average, has the child's sleep been disturbed due to hissing or whistling? >1 per night				
Males	6/53	11.3%	9/276	3.3%
Females	0/29	0.0%	18/313	5.8%
Total	6/82	7.3%	27/589	4.6%

In the past 12 months, has whistling or whistling ever been serious enough to limit the way you speak (says only one or two words at a time between breaths)?				
Males	5/68	7.4%	39/313	12.5%
Females	4/40	10.0%	73/332	22.0%
Total	9/108	8.3%	112/645	17.4%
Has the child ever had asthma?				
Males	26/242	10.7%	133/1224	10.9%
Females	11/244	4.5%	162/1322	12.3%
Total	37/486	7.6%	295/2546	11.6%
Did a doctor confirm the child's asthma?				
Males	24/44	54.5%	119/295	40.3%
Females	11/26	42.3%	120/276	43.5%
Total	35/70	50.0%	239/571	41.9%
Does the child have a written plan that tells you/he/she how to take care of his/her asthma?				
Males	16/43	37.2%	66/272	24.3%
Females	7/27	25.9%	83/276	30.1%
Total	23/70	32.9%	149/548	27.2%

children in the 6 to 7-year-old range presented wheezing at any time in their life; the majority were boys. The age at which most of the children presented wheezing for the first time was before their first year of life; however, in girls, it occurred mostly between the first and second year of age. Of these patients, 8% (n = 39/486) had some wheezing episodes in the last 12 months; the majority were boys . Most of these patients had had 1 to 3 attacks of wheezing in the past year, and only 2 girls had more than 12 attacks. Regarding the number of nocturnal awakenings due to asthma symptoms in the last 12 months, 3.3% (n = 16/486) of the children woke up only once at night while 1.2% (n = 6/486) woke more than once. It is important to mention that among the patients who ever had asthma symptoms, only 50% (n = 35/70) had a diagnosis of asthma confirmed by a physician. Of these, only 32.9% (n = 23/70) had a plan for managing their illness.

We describe the prevalence and severity of rhinitis symptoms in children and adolescents in **Table 2**. In this same group of children, 29.5% (n = 143/485) presented allergic rhinitis symptoms such as sneezing, rhinorrhea, or nasal congestion without presenting an upper airway infection. When stratifying by age group, we found that most of the children started with these problems between 5 and 6 years of age, while >50% of the children started with these symptoms between 3 and 6 years of age. Allergic rhinitis symptoms were present in 23.7% (n = 115/485) at some point in the last 12 months. The symptom that most frequently affected this group was nasal itching in 15.2% (n = 74/485) in the last 12 months, followed by ocular itching and epiphora in 11.1% (n=54/485). In 8.4% (n = 41/115) of the children, these symptoms only mildly interfered with their daily activities, and only 0.6% were frequently affected.

The prevalence and severity of atopic dermatitis in presented in **Table 3**. In this same age group, 9.2% (n = 44/479) had an intermittent itchy skin rash for at least 6 months at some point in their life. Of these, 6.7% (n = 32/479) presented this symptom in the last 12 months. The risk factors associated with suffering from an atopic disease (asthma, rhinitis and/or atopic dermatitis) that were found in this group of children was having had wheezing in the last 12 months (OR: 1.21; CI: 1.12-1.31; p = <0.001) and presenting a rash in the last 12 months (OR: 1.22; CI: 1.11-1.35; p = <0.001).

In the group of adolescents between 12 and 14 years of age (n = 2557), 26.5% reported having experienced wheezing at some point in their life, with a slight pre-

Table 2. Prevalence and severity of rhinitis symptoms in children and adolescents in Monterrey according to the Global Asthma Network.

Variable	Children 6-7 years		Teenagers 12-14 years	
	n	Frequency %	n	Frequency %
Has the child had a problem with sneezing or a runny or stuffy nose when he/she doesn't have a cold or flu?				
Males	71/230	30.9%	554/1239	44.7%
Females	72/242	29.8%	687/1336	51.4%
Total	143/472	30.3%	1241/2575	48.2%
How old was the child when the problem in the nose started? <1 year				
Males	10/70	14.3%	NA	
Females	8/69	11.6%	NA	
Total	18/139	12.9%	NA	
How old was the child when the problem in the nose started? 1-2 years				
Males	9/70	12.9%	NA	
Females	10/69	14.5%	NA	
Total	19/139	13.7%	NA	
How old was the child when the problem in the nose started? 3-4 years				
Males	15/70	21.4%	NA	
Females	20/69	29.0%	NA	
Total	35/139	25.2%	NA	
How old was the child when the problem in the nose started? 5-6 years				
Males	28/70	40.0%	NA	
Females	22/69	31.9%	NA	
Total	50/139	36.0%	NA	
How old was the child when the problem in the nose started? >6 years				
Males	8/70	11.4%	NA	
Females	9/69	13.0%	NA	
Total	17/139	12.2%	NA	
In the past 12 months, has the child had a problem with sneezing or a runny or stuffy nose when he/she did not have a cold or flu?				
Males	63/78	80.8%	420/807	52.0%
Females	52/72	72.2%	572/917	62.4%
Total	115/150	76.7%	992/1724	57.5%
In the past 12 months, has the child had nose problems accompanied by an itchy nose?				
Males	38/62	61.3%	227/532	42.7%
Females	36/53	67.9%	393/660	59.5%
Total	74/115	64.3%	620/1192	52.0%
In the past 12 months, has the child had nose problems accompanied by an itchy nose and watery eyes?				
Males	29/62	46.8%	221/536	41.2%
Females	25/54	46.3%	343/667	51.4%
Total	54/116	46.6%	564/1203	46.9%

In the past 12 months, how much did the problem in the child's nose interfere/affect the child's daily activities? Not at all				
Males	29/61	47.5%	220/515	42.7%
Females	23/54	42.6%	231/652	35.4%
Total	52/115	45.2%	451/11167	38.6%
In the past 12 months, how much did the problem in the child's nose interfere/affect the child's daily activities? Slightly				
Males	23/61	37.7%	234/515	45.4%
Females	18/54	33.3%	317/652	48.6%
Total	41/115	35.7%	551/1167	47.2%
In the past 12 months, how much did the problem in the child's nose interfere/affect the child's daily activities? Moderately				
Males	7/61	11.5%	40/515	7.8%
Females	12/54	22.2%	83/652	12.7%
Total	19/115	16.5%	123/1167	10.5%
In the past 12 months, how much did the problem in the child's nose interfere/affect the child's daily activities? Very frequently				
Males	2/61	3.3%	21/515	4.1%
Females	1/54	1.9%	21/652	3.2%
Total	3/115	2.6%	42/1167	3.6%
Has the child ever had allergic rhinitis?				
Males	26/238	11.8%	248/1138	21.8%
Females	27/247	10.9%	330/1215	27.2%
Total	55/485	11.3%	578/2353	24.6%
Did a doctor confirm the child's allergic rhinitis?				
Males	23/46	50.0%	106/1265	8.4%
Females	24/41	58.5%	108/1359	7.9%
Total	47/87	54.0%	214/2624	8.2%

dominance of the female gender (28%). In the previous 12 months, 9.6% had 1 to 3 episodes of wheezing, and only 0.5% suffered more than 12 attacks. Regarding nocturnal awakenings due to asthma symptoms in the previous 12 months, 14.6% of adolescents woke up once, while only 1% woke up more than once. Even though 679 of the adolescents have ever presented asthma symptoms, only 239 (35.2%) were confirmed by a specialist, and 149 (22%) claim to have a written action plan in case of presenting asthma symptoms.

About half of the adolescent group (48.2%) had allergic rhinitis symptoms such as sneezing, rhinorrhea, or nasal congestion without a cold or influenza. The most reported symptom in the last 12 months was nasal itching (38.5%), followed by ocular itching and epiphora in 21.9% of adolescents.

In this same group of adolescents, 20.% had an itchy skin rash intermittently for at least 6 months at some point in their life, and 14.9% of these had been present in the last 12 months. The risk factors associated with suffering from an atopic disease in adolescents 12-14 years of age were having wheezing during the last 12 months (OR: 1.13; CI: 1.09-1.16; p = <0.001) or the presence of wheezing during exercise or immediately after (OR: 1.21; CI: 1.05-1.40; p = 0.007). Similarly, an association was found, although less clearly, if the child had nasal problems with nasal pruritus in the last 12 months (OR: 1.08; CI: 1.00-1.16; p = 0.039) or if

Table 3. Prevalence and severity of rhinitis symptoms in children and adolescents in Monterrey according to the Global Asthma Network.

Variable	Children 6-7 years		Teenagers 12-14 years	
	n	Frequency %	n	Frequency %
Has your child ever had an itchy skin rash that has been back and forth for at least six months?				
Males	22/229	9.6%	178/1211	14.7%
Females	22/243	9.1%	329/1316	25.0%
Total	44/472	9.3%	507/2527	20.1%
Has this child had this itchy rash at any time in the last 12 months?				
Males	13/26	50.0%	125/488	25.6%
Females	19/25	76.0%	251/591	42.5%
Total	32/51	62.7%	376/1079	34.8%
Has your child's itchy rash ever affected any of the following places: the creases of the elbows, behind the knees, in front of the ankles, under the buttocks, or around the neck, ears or eyes?				
Males	7/13	53.8%	86/248	34.7%
Females	13/19	68.4%	180/352	51.1%
Total	20/32	62.5%	266/600	44.3%
At what age was the child's first itchy skin rash? <2 years				
Males	3/13	23.1%	NA	
Females	2/19	10.5%	NA	
Total	5/32	15.6%	NA	
At what age was the child's first itchy skin rash? 2-4 years				
Males	1/13	7.7%	NA	
Females	5/19	26.3%	NA	
Total	6/32	18.8%	NA	
At what age was the child's first itchy skin rash? 5 or more years				
Males	9/13	69.2%	NA	
Females	12/19	63.2%	NA	
Total	21/32	65.6%	NA	
Has this child's rash completely disappeared at any time over the past 12 months?				
Males	6/13	46.2%	NA	
Females	14/19	73.7%	NA	
Total	20/32	62.5%	NA	
In the last 12 months, how many times, on average, have you been kept awake at night from this itchy skin rash? Never				
Males	9/14	64.3%	164/213	77.0%
Females	12/18	66.7%	224/329	68.1%
Total	21/32	65.6%	388/542	71.6%
In the last 12 months, in the last 12 months, how many times, on average, have you been kept awake at night from this itchy skin rash? <1 night/week				

Males	4/14	28.6%	31/213	14.6%
Females	6/18	33.3%	79/329	24.0%
Total	10/32	31.3%	110/542	20.3%
In the last 12 months, how many times, on average, have you been kept awake at night from this itchy skin rash? >1 night/week				
Males	1/14	7.1%	18/213	8.5%
Females	0/18	0.0%	26/329	7.9%
Total	1/32	3.1%	44/542	8.1%
Has the child had atopic dermatitis?				
Males	15/234	6.4%	95/1208	7.9%
Females	13/245	5.3%	165/1314	12.6%
Total	28/479	5.8%	260/2522	10.3%
Did a doctor confirm the child's atopic dermatitis?				
Males	13/33	39.4%	53/242	21.9%
Females	12/26	46.2%	72/300	24.0%
Total	25/59	42.4%	125/542	23.1%

the rash that occurred in the last 12 months completely disappeared in the same period (OR: 1.07; CI: 1.03-1.11; p = <0.001).

DISCUSSION

As the most common chronic respiratory disease, asthma affects approximately 300 million people worldwide.[8] Although its prevalence fluctuates in different regions of the world, in Latin America, an average of 17% is estimated.[9] In Mexico, according to the World Health Organization, 7% of the population has asthma, which represents about 8.5 million Mexicans with this condition.[8]

ISAAC phase three included a total of 1,059,053 children in 236 centers in 98 countries around the world. In this study, a prevalence of asthma symptoms of 13.7% in the 13 to 14-year-old group and 11.6% in the 6 to 7-year-old group was reported.10 According to the data obtained from the ISAAC phase three in our regional center for allergy and clinical immunology in the city of Monterrey, Nuevo Leon, a general prevalence of 26.5% of asthma (wheezing at some time) was reported in the 13 to 14-years group, and 29.4% in the 6 to 7 years group. In recent years, the prevalence of allergic diseases has increased due to multiple environmental factors such as urbanization and rapid population growth, which has favored lifestyle changes and greater exposure to environmental pollutants.[11] This increase is evidenced in a recent study where 15 centers that participated in GAN phase I in the Mexican Republic were analyzed. In this study, a prevalence of asthma of 23.9% was reported in adolescents, while in children aged 6 to 7 years, it was 26.2%.[12] These data differ to those obtained in our study population, where the prevalence of asthma was 7.6% and 11.6% in the children and adolescent groups, respectively.When we compared our results with those obtained by Chinratanapisit et al. as part of the GAN phase I in Thailand, an important similarity was observed in the frequency of asthma symptoms, 26% in the group aged 6 to 7 years and 22.9% in the group of adolescents 13 to 14 years.[13] Similar to the findings in Mexico, a significant increase occurred in the frequency of asthma symptoms when comparing the previous results with the ISAAC phase III in the population of Bangkok, a prevalence of asthma of 14.6% *vs*. 15.0% was reported in the groups of children and adolescents, respectively.[14] In recent years, multiple studies have been carried out to determine the prevalence of allergic diseases worldwide. A significant increase has been seen due to the increasing urbanization of developing countries, such as Mexico or Thailand, in addition to multiple factors, such as the increase in population density, the increase in environmental pollution, and epigenetic alterations that affect this vulnerable population.[15] In the information obtained from our population, we noticed that the wheezing attacks in the last year (before the survey applica-

tion) were similar in both boys and girls (12.8 *vs*. 7.4%). Still, when making a global comparison for asthma diagnosis, we found that in the 6 to 7-year group, the male gender predominated (54.5% *vs*. 42.3%); in the adolescent group, there was a female gender predominance (43.5 *vs*. 40.3%). This predominance of female gender over male gender at puberty could be due to the predisposition that adolescent girls have to present symptoms and exacerbations of asthma during puberty and close to the menstrual cycle.16 When stratifying by age, we found that most children begin with wheezing episodes before the first year of life (34.3%), and about 80% present them before 6 years of age. Our results are similar to those reported by Del-Río-Navarro et al,[12] with an onset before 6 years of age in 87% of cases. These data show and corroborate the greater presentation of asthma symptoms in early childhood, a period when a diagnosis can be difficult due to the greater frequency of cases of wheezing due to viral infections.[17] It is vitally important to sensitize primary health service providers and the general population about clinical data suggestive of asthma to provide timely detection and treatment. Children and adolescents in our city had a lowe number of nocturnal awakenings due to asthma symptoms (3.3 *vs*. 3.4%) compared to children in Thailand (5.4 *vs*. 4.2%) and a different prevalence of nocturnal awakenings compared to the rest of the Mexican population (12.2 *vs*. 8.2%). Nighttime awakenings are an important variable to consider as part of the control of a disease as heterogeneous as asthma since this variable not only affects the lung function of patients but also sleep quality and school performance, which have a direct impact on their quality of life. Despite the efforts made by international organizations to raise awareness of asthma around the world, only slightly more than half of the patients diagnosed with asthma by a doctor have an effective treatment plan and adequate adherence. Similar data have been reported in other Latin American countries, where only 40% of patients comply with their long-term treatment.[18] This leads us to conclude that specialist physicians must generate strategies in our population to educate patients and improve their adherence to long-term treatment. As is well known, viral and bacterial infections play a very important role in the pathogenesis of asthma. The viruses most commonly involved in lower respiratory tract infections and the development of wheezing and asthma have been rhinovirus (RV) and respiratory syncytial virus (RSV), with rhinovirus being the main trigger for asthma attacks.[19] There is strong evidence that shows that children having wheezing episodes at 3 years of age, wheezing due to RSV (OR 2.6), RV (OR 9.8), or both RSV and RV (OR 10.0), have a higher risk of developing asthma at 6 years of age.[20] On the other hand, in a study by García-Marcos et al. of more than 28,000 subjects in Latin America, it was reported that the main risk factors for developing asthma were attending daycare and having an upper respiratory infection in the first 3 months of life, as well as maternal smoking during pregnancy. The same authors identified maternal breast milk ingestion for more than 3 months and maternal education higher than high school as protective factors.[21] Ojwang et al., in a prospective study conducted in Finland, studied the relationship of early exposure to dogs, cats, and farm animals and its relationship with the development of asthma. They found that having a dog at home was associated with a 40%, 28%, and 23% reduction in the risk of developing asthma, allergic rhinitis, and atopic sensitization by the age of 5, respectively. Contrary to what was found in our population, exposure to farm animals during the first year of life was not associated with these results. However, in a recent study by Levin et al. conducted in South Africa where environmental factors associated with allergic diseases were analyzed, it was found that exposure to farm animals in childhood and maternal exposure during pregnancy were a protective effect for developing allergic diseases in rural areas.[22,23,24] The results of this variable in multiple studies have been heterogeneous. Other factors specific to the farm environment must be taken into account to establish an adequate recommendation depending on our population.[24] The GAN phase I has been a very important project since it offers a global perspective of the frequency of the main allergic diseases that affect the population. Regarding the symptoms of allergic rhinitis in our population of children between 6 to 7 years of age, the prevalence was lower than that reported in the Bangkok population of the same age (29.5 *vs*. 47.3%). However, when comparing this finding with data from ISAAC phase III, we found that the prevalence of these symptoms has not significantly changed in recent years in our population (29.5 *vs*. 31.8%).10 In the same way, allergic rhinitis symptoms were lower in our population when compared with the GAN phase I results from Bangkok (11.3 *vs*. 24.5%), and they were significantly higher when com-

pared to those reported in the ISAAC phase III (4.6%). In the last 12 months, school children from Monterrey presented a lower prevalence of nasal pruritus (15.2 *vs*. 38.2) and ocular pruritus (11.1 *vs*. 15%) than children from Bangkok. Likewise, in the adolescent population, in the last 12 months, nasal pruritus appeared less frequently in the Mexican population than in the Thai population (24.1 *vs*. 48.8%), in contrast eye symptoms were more prevalent (21.9 *vs*. 18.0%). When comparing GAN phase I atopic dermatitis data with ISAAC phase III in our center, we noticed a very significant increase in both age groups. In children aged 6 to 7 years, the presence of eczema at some point in life was higher in GAN phase I children compared to those of ISAAC phase III (9.3 *vs*. 2.9%); also in the adolescent group (20.1 *vs*. 1.5%). Regarding the presence of eczema in the last 12 months, the GAN phase I showed a frequency of 6.7% and 14.9% in children and adolescents, respectively. Similarly, this shows significantly higher figures than those obtained in ISAAC phase I in both groups (4.1 and 4%).

CONCLUSION

In this study, the results obtained using the GAN phase I material showed the increasing appearance of allergic diseases throughout the world over time, without forgetting the Mexican population. Although allergic diseases have a very important genetic component, environmental and social factors play a significant role in their development. Therefore, the results of studies like this will give us a complete perspective of the current burden of allergic diseases in our population to generate strategies that allow us to provide our patients with better comprehensive, and timely care.

Declaration of conflicts of interest

The authors declare no conflicts of interest.

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