

Prevalences of asthma and rhinitis among adolescents in the city of Fortaleza, Brazil: temporal changes*

Comparaç o temporal das preval ncias de asma e rinite em adolescentes em Fortaleza, Brasil

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Abstract

Objective: To describe the prevalences of asthma and rhinitis in adolescents (13-14 years of age) in the city of Fortaleza, Brazil, in 2010, comparing the results with those obtained in a prevalence survey conducted in 2006-2007. **Methods:** This was a cross-sectional study involving probabilistic samples of 3,015 and 3,020 adolescents in surveys conducted in 2006-2007 and 2010, respectively. The International Study of Asthma and Allergies in Childhood protocol was used on both occasions. **Results:** Comparing the two periods, there were no significant differences regarding cumulative wheezing, active asthma, four or more wheezing attacks within the last year, sleep disturbed by wheezing more than one night per week, and speech-limiting wheezing. The prevalences of exercise-induced wheezing, dry cough at night, and physician-diagnosed asthma were significantly higher in 2010 than in the 2006-2007 period ($p < 0.01$ for all). The prevalence of physician-diagnosed rhinitis was significantly lower in 2010 ($p = 0.01$), whereas there were no significant differences between the two periods regarding cumulative rhinitis, current rhinitis, and rhinoconjunctivitis. In both periods, dry cough at night, current rhinitis, and rhinoconjunctivitis were significantly more prevalent in females than in males ($p < 0.01$ for all). Also in both periods, active asthma, current rhinitis, and rhinoconjunctivitis were more prevalent in private school students than in public school students ($p < 0.01$ for all). **Conclusions:** Our data show that the prevalences of asthma and rhinitis symptoms remain high among 13- and 14-year-olds in Fortaleza, predominantly among females and private school students.

Keywords: Asthma/epidemiology; Rhinitis/epidemiology; Adolescent.

Resumo

Objetivo: Descrever as preval ncias de asma e rinite em adolescentes de 13-14 anos de idade em Fortaleza (CE) em 2010 e compar -las com as preval ncias obtidas em um inquerito em 2006-2007. **M todos:** Estudo transversal envolvendo uma amostragem probabil stica de 3.015 e 3.020 adolescentes, respectivamente, em 2006-2007 e 2010, utilizando o protocolo do *International Study of Asthma and Allergies in Childhood*. **Resultados:** Na compara o entre os dois per odos, n o houve diferen as significativas em rela o a sibilos cumulativos, asma ativa, quatro ou mais crises de sibilos no  ltimo ano, preju zo do sono por sibilos > 1 noite/semana e crises limitando a fala. Em 2010, houve um aumento significativo na preval ncia de sibilos ap s exerc cios, tosse seca noturna e asma diagnosticada ($p < 0,01$ para todos). Em 2010, houve uma redu o significativa na preval ncia de rinite diagnosticada ($p = 0,01$), enquanto n o houve diferen as significativas entre os dois per odos nas preval ncias de rinite cumulativa, rinite atual e rinoconjuntivite. Em ambos os per odos, tosse seca noturna, rinite atual e rinoconjuntivite foram significativamente mais prevalentes nas mulheres que nos homens ($p < 0,01$ para todos). Tamb m nos dois per odos, asma ativa, rinite atual e rinoconjuntivite foram significativamente mais prevalentes nos alunos das escolas particulares do que naqueles das escolas p blicas ($p < 0,01$ para todos). **Conclus es:** Nossos dados mostram que as preval ncias de sintomas de asma e rinite continuam altas entre os adolescentes de 13-14 anos em Fortaleza, com predominio no g nero feminino e em alunos de escolas particulares.

Descritores: Asma/epidemiologia; Rinite/epidemiologia; Adolescente.

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Introduction

Asthma and rhinitis are chronic inflammatory airway diseases that affect most of the general population and that, in recent decades, have been increasing in prevalence in various parts of the world.⁽¹⁻³⁾ Although genetic factors are important, they alone cannot explain these increases in prevalence, and it is likely that the environment has greater relevance for the expression of these diseases.^(4,5) In this sense, prevalence comparison across populations and over time can be an important source of new clues to understand these conditions.^(6,7) The definition of asthma remains vague and inaccurate—given that its pathogenesis remains unclear—and this can hinder the identification of cases in epidemiological studies.⁽⁸⁾ Therefore, in 1991, the International Study of Asthma and Allergies in Childhood (ISAAC) protocol was developed with the aim of maximizing the value of research on asthma and allergies in children and adolescents by enabling comparisons of prevalences of these diseases, as well as of their spatial and temporal trends, between populations in different countries and regions.⁽⁷⁾

The objectives of the initial phase of the ISAAC (ISAAC phase I) were to describe the prevalence and severity of asthma, rhinitis, and eczema in children (6-7 years of age) and adolescents (13-14 years of age) living in different locations around the world, as well as to make comparisons within and between various countries and regions; to establish baseline values for the assessment of future trends in the prevalence and severity of these diseases; and to provide structure for future etiological studies on genetics, lifestyle, medical care, and environmental factors related to these diseases. Phase II of the ISAAC was aimed at investigating the relative importance of the hypotheses of interest that were raised in phase I by using objective markers, such as the methacholine challenge test; phase III sought to evaluate the trends in the prevalence of asthma, rhinitis, and eczema at the centers participating in phase I, as well as to include new centers that did not participate in phase I and to identify the possible factors related to these trends.^(6,7)

In ISAAC phase I, the prevalence of asthma symptoms in the last 12 months, considering the two age groups studied, ranged from 1.6% to 36.8%, and the prevalence of allergic rhinitis ranged from 1.4% to 39.7%.⁽⁹⁾ More recently,

the ISAAC phase III findings indicate that the international differences in the prevalence of asthma symptoms have diminished, particularly in the 13-14-year age group, the prevalence decreasing in English-speaking countries, as well as in Western Europe, and increasing in regions where it had previously been low. However, the reported increases in the prevalence of asthma symptoms in Africa, Latin America, and parts of Asia indicate that the global burden of asthma continues to increase.⁽¹⁰⁾ In South America, the mean prevalences of asthma and rhinitis have increased, and there has been a reduction in the differences among centers.⁽¹¹⁾

In Brazil, the results for the participation of various cities in ISAAC phase III have confirmed the previously observed high prevalences of asthma and rhinitis.⁽¹²⁾ In the state of Ceará, Brazil, no studies have yet been conducted in order to evaluate temporal changes in the prevalences of asthma and rhinitis. Therefore, the objective of the present study was to determine the prevalences of asthma and rhinitis in adolescents (13-14 years of age) in the city of Fortaleza, Brazil, in 2010, comparing the results with those obtained in another prevalence survey conducted in 2006-2007.^(13,14)

Methods

This was a cross-sectional population-based descriptive study involving public and private school students (13-14 years of age) that was carried out in the city of Fortaleza, Brazil, and comprised two surveys, one conducted in 2006-2007 and one conducted in 2010. The survey periods were from April to November of each year.

The city of Fortaleza is located on a coastal flat, immediately south of the Equator (between 3°30'S and 4°30'S), at an altitude of 15.49 m above sea level. The city encompasses an area of 4,667.8 km² and has a population of 2,431,415.⁽¹⁵⁾ The annual mean temperature ranges from 26°C to 27°C.⁽¹⁶⁾ The air quality is currently classified as fair, and the relative humidity is approximately 82%.⁽¹⁷⁾ In the 2010 Census, 72.9% of the population had a monthly income of only two times the national minimum wage or less.⁽¹⁵⁾

The city is divided into six administrative regions.⁽¹⁸⁾ Among the schools located in those regions and enrolling 50 or more students in the age group of interest, 29 and 27 were randomly selected for analysis in the 2006-2007 period and

in 2010, respectively. An equal proportion of 13- and 14-year-olds was selected from each region, thereby optimizing the representativeness of a sample drawn from a heterogeneous population.

In both surveys, data were collected with the asthma and rhinitis modules of the ISAAC written questionnaire, which have been validated for use in Brazil by Solé et al.⁽¹⁹⁾ and Vanna et al.,⁽²⁰⁾ respectively. The questionnaires were completed by the adolescents themselves, in the classroom, in the presence of the principal researcher or one of the research assistants, the latter having been duly trained by the former and specifically instructed to avoid offering explanations that could influence the responses. Each research assistant received a copy of the ISAAC manual, which describes the field study process in detail.⁽⁶⁾ Each school was visited at least twice in order to minimize the problems related to absenteeism and to optimize the response rate.

The ISAAC questionnaire consists of three modules—asthma, rhinitis, and eczema—and it is suggested that the sample size should be 3,000 subjects per age group.^(6,7) We chose the 13-14-year age group because it allows greater ease of operation and high questionnaire return.

The ISAAC asthma module contains four questions on the occurrence of asthma symptoms: wheezing ever (cumulative wheezing); wheezing within the last 12 months (current wheezing or active asthma); exercise-induced wheezing; and dry cough at night in the absence of a cold or respiratory infection within the last 12 months. In addition, this module contains three questions on symptom severity within the last 12 months: number of wheezing attacks; sleep disturbed by wheezing; and speech-limiting wheezing. There is also one question on physician-diagnosed asthma (asthma ever). Asthma was defined as presence of wheezing within the last 12 months. Individuals with severe asthma were defined as those who had had “four or more wheezing attacks”, “sleep disturbed by wheezing one or more nights per week”, or “speech-limiting wheezing”, or any combination of the three, within the last 12 months. This last question refers to episodes of severe acute asthma.^(6,7)

The ISAAC rhinitis module, which focuses on eliciting information about symptoms unrelated to influenza or colds, contains six questions related to the following^(6,7): sneezing, rhinorrhea, or nasal obstruction ever (cumulative rhinitis); sneezing,

rhinorrhea, or nasal obstruction within the last 12 months (current rhinitis or active rhinitis), used in order to identify adolescents with rhinitis; sneezing, rhinorrhea, or nasal obstruction accompanied by ocular symptoms (watery or itchy eyes) within the last 12 months, used in order to identify adolescents with rhinoconjunctivitis⁽⁷⁾; month or months in which nasal problems occurred (not analyzed in the present study); rhinitis-related impairment of daily activities (which measures symptom morbidity/symptom severity), used in order to determine the degree of rhinitis—“severe rhinitis” was defined as choosing “severe” as the response to this question; and rhinitis ever, used in order to identify physician-diagnosed rhinitis.

Data were processed using the Statistical Package for the Social Sciences, version 15.0 (SPSS Inc., Chicago, IL, USA). The frequencies of positive responses to the questions were obtained by considering the proportion of positive responses to each question in relation to the total number of valid questionnaires. The chi-square test was used in order to test the statistical significance of the comparisons between the results of the two surveys, as well as to analyze potential associations between the variables. The level of significance was set at $p < 0.05$ for all tests. The study was approved by the Research Ethics Committee of the Ceará State University (Process no. 09554007-5, FR 31889).

Results

In the first survey, conducted in 2006-2007, a total of 3,078 questionnaires were distributed to the adolescents, with a return rate of 98.9% and a response rate of 97.9%. Therefore, we obtained 3,015 valid questionnaires. In the second survey, conducted in 2010, a total of 3,120 questionnaires were distributed, with a return rate of 100% and a response rate of 96.8%, 3,020 valid questionnaires therefore having been obtained. The characteristics of the adolescents who completed the questionnaires correctly are described in Table 1, which shows that, in both surveys, there was greater participation by females. The proportion of public schools in relation to that of private schools increased in the second survey.

Table 1 shows that the prevalences of exercise-induced wheezing, dry cough at night, and physician-diagnosed asthma were significantly higher in the second survey than in the first survey

($p < 0.01$ for all). However, the prevalences of physician-diagnosed rhinitis and severe rhinitis were significantly lower ($p = 0.01$ for both). There was also a significant difference between the prevalence of active asthma and that of physician-diagnosed asthma, as well as between the prevalence of current rhinitis and that of physician-diagnosed rhinitis.

Table 2 shows that, in both surveys, most symptoms were more prevalent among private school students. The variables for which there were statistically significant differences by type of school (public or private) in the 2006-2007 period, and for which the differences remained statistically significant in 2010, are as follows:

cumulative wheezing; active asthma; one to three wheezing attacks within the last 12 months; four or more wheezing attacks within the last 12 months; dry cough at night; physician-diagnosed asthma; cumulative rhinitis; current rhinitis; rhinoconjunctivitis; no rhinitis-related impairment of daily activities; and physician-diagnosed rhinitis. In both periods, "exercise-induced wheezing" was found to be more common among private school students than among public school students, the difference being statistically significant in the 2006-2007 period ($p = 0.03$) and trending toward statistical significance in 2010 ($p = 0.06$). The variable "sleep disturbed by wheezing one or more nights per week" was more common

Table 1 - Comparison of demographic data and prevalence of asthma and rhinitis symptoms in 13- and 14-year-olds between two surveys conducted in the city of Fortaleza, Brazil. 2006-2007 and 2010.

Variable	Period				p
	2006-2007		2010		
	(n = 3,015)		(n = 3,020)		
	n	%	n	%	
Age					
13 years	1,575	52.2	1,614	53.4	0.34
14 years	1,440	47.8	1,406	46.6	
School					
Public	2,165	71.8	2,559	84.7	< 0.01
Private	850	28.2	461	15.3	
Gender					
Male	1,372	45.5	1,369	45.3	0.89
Female	1,643	54.5	1,651	54.7	
Cumulative wheezing	1,329	44.1	1,326	44.5	0.74
Current wheezing (active asthma)	682	22.6	708	23.4	0.44
Number of attacks within the last 12 months					
1-3	528	17.5	547	18.1	0.54
≥ 4	68	2.3	83	2.7	0.22
Sleep disturbed by wheezing					
< 1 night per week	204	6.8	198	6.6	0.74
≥ 1 night per week	105	3.5	106	3.5	0.95
Speech-limiting wheezing	105	3.5	109	3.6	0.79
Exercise-induced wheezing	759	25.2	855	28.8	< 0.01
Dry cough at night	1,036	34.4	1,136	37.9	< 0.01
Physician-diagnosed asthma	350	11.6	433	14.5	< 0.01
Cumulative rhinitis	1,710	56.7	1,688	57.1	0.78
Current or active rhinitis	1,303	43.2	1,279	42.4	0.49
Rhinoconjunctivitis (allergic rhinitis)	565	18.7	535	17.7	0.30
Rhinitis-related impairment of daily activities					
None	567	18.8	590	19.5	0.47
Mild	581	19.3	582	19.3	0.99
Moderate	81	2.7	81	2.7	0.99
Severe	60	2.0	37	1.2	0.01
Physician-diagnosed rhinitis	609	20.2	520	17.6	0.01

Table 2 – Distribution of the prevalence of asthma and rhinitis symptoms in 13- and 14-year-olds, by type of school, in two surveys conducted in the city of Fortaleza, Brazil. 2006–2007 and 2010.

Symptom	2006–2007						p	2010						p
	Total (n = 3,015)		Public (n = 2,165)		Private (n = 850)			Total (n = 3,020)		Public (n = 2,559)		Private (n = 461)		
	n°	%	n°	%	n°	%		n°	%	n°	%	n°	%	
Cumulative wheezing	1,329	44.1	907	41.9	422	49.6	< 0.01	1,326	44.5	1,071	42.4	255	56.3	< 0.01
Active asthma	682	22.6	442	20.4	240	28.2	< 0.01	708	23.4	548	21.4	160	34.7	< 0.01
Number of attacks within the last 12 months														
1-3	528	17.5	334	15.4	194	22.8	< 0.01	547	18.1	424	16.6	123	26.7	< 0.01
≥ 4	68	2.3	34	1.6	34	4.0	< 0.01	83	2.7	60	2.3	23	5.0	0.01
Sleep disturbed by wheezing														
< 1 night/week	204	6.8	140	6.5	64	7.5	0.29	198	6.6	162	6.3	36	7.8	0.23
≥ 1 night/week	105	3.5	82	3.8	23	2.7	0.14	106	3.5	80	3.1	26	5.6	< 0.01
Speech-limiting wheezing	105	3.5	70	3.2	35	4.1	0.23	109	3.6	87	3.4	22	4.8	0.14
Exercise-induced wheezing	759	25.2	522	24.1	237	27.9	0.03	855	28.8	707	28.1	148	32.4	0.06
Dry cough at night	1,036	34.4	721	33.3	315	37.1	0.05	1,136	37.9	941	37.0	195	42.6	0.02
Physician-diagnosed asthma	350	11.6	220	10.2	130	15.3	< 0.01	433	14.5	353	13.9	80	17.5	0.04
Cumulative rhinitis	1,710	56.7	1,132	52.3	578	68.0	< 0.01	1,688	57.1	1,378	55.1	310	67.8	< 0.01
Current or active rhinitis	1,303	43.2	822	38.0	481	56.6	< 0.01	1,279	42.4	1,021	39.9	258	56.0	< 0.01
Rhinoconjunctivitis	565	18.7	336	15.5	229	26.9	< 0.01	535	17.7	417	16.3	118	25.6	< 0.01
Rhinitis-related impairment of daily activities														
None	567	18.8	314	14.5	253	29.8	< 0.01	590	19.5	454	17.7	136	29.5	< 0.01
Mild	581	19.3	404	18.7	177	20.8	0.17	582	19.3	480	18.8	102	22.1	0.09
Moderate	81	2.7	52	2.4	29	3.4	0.12	81	2.7	65	2.5	16	3.5	0.25
Severe	60	2.0	41	1.9	19	2.2	0.54	37	1.2	29	1.1	8	1.7	0.27
Physician-diagnosed rhinitis	609	20.2	326	15.1	283	33.3	< 0.01	520	17.6	365	14.6	155	33.9	< 0.01

among private school students only in 2010 ($p < 0.01$).

Table 3 shows that, at both types of schools, the proportion of students reporting various asthma-related symptoms increased significantly from the first study period to the second. Among public school students, there was also a temporal increase in the proportion of positive responses to the questions regarding “four or more attacks within the last 12 months” ($p = 0.05$), “exercise-induced wheezing” ($p < 0.01$), and “physician-diagnosed asthma” ($p < 0.01$). Among private school students, there was a significant

increase in the proportion of positive responses to the questions regarding “cumulative wheezing” ($p = 0.02$), “active asthma” ($p = 0.01$), and “sleep disturbed by wheezing one or more nights per week” ($p < 0.01$), as well as an increase trending toward significance in the proportion of positive responses to “exercise-induced wheezing” ($p = 0.08$). For the variable “dry cough at night”, there was a significant increase among public school students and private school students ($p < 0.01$ and $p = 0.05$, respectively).

For rhinitis symptoms, there were significant changes only among public school students.

Table 3 – Comparison, by type of school, of temporal changes in the prevalence of asthma and rhinitis symptoms in 13- and 14-year-olds between two surveys conducted in the city of Fortaleza, Brazil. 2006-2007 and 2010.

Symptom	Public				p	Private				p
	2006-2007		2010			2006-2007		2010		
	n°	%	n°	%		n°	%	n°	%	
Cumulative wheezing	907	41.9	1,071	42.4	0.73	422	49.6	255	56.3	0.02
Active asthma	442	20.4	548	21.4	0.40	240	28.2	160	34.7	0.01
Number of attacks within the last 12 months										
1-3	334	15.4	424	16.6	0.28	194	22.8	123	26.7	0.11
≥ 4	34	1.6	60	2.3	0.05	34	4.0	23	5.0	0.40
Sleep disturbed by wheezing										
< 1 night/week	140	6.5	162	6.3	0.84	64	7.5	36	7.8	0.85
≥ 1 night/week	82	3.8	80	3.1	0.21	23	2.7	26	5.6	< 0.01
Speech-limiting wheezing	70	3.2	87	3.4	0.75	35	4.1	22	4.8	0.57
Exercise-induced wheezing	522	24.1	707	28.1	< 0.01	237	27.9	148	32.4	0.08
Dry cough at night	721	33.3	941	37.0	< 0.01	315	37.1	195	42.6	0.05
Physician diagnosed asthma	220	10.2	353	13.9	< 0.01	130	15.3	80	17.5	0.29
Cumulative rhinitis	1,132	52.3	1,378	55.1	0.05	578	68.0	310	67.8	0.95
Current or active rhinitis	822	38.0	1,021	39.9	0.17	481	56.6	258	56.0	0.82
Rhinoconjunctivitis	336	15.5	417	16.3	0.46	229	26.9	118	25.6	0.59
Rhinitis-related impairment of daily activities										
None	314	14.5	454	17.7	< 0.01	253	29.8	136	29.5	0.92
Mild	404	18.7	480	18.8	0.93	177	20.8	102	22.1	0.58
Moderate	52	2.4	65	2.5	0.76	29	3.4	16	3.5	0.95
Severe	41	1.9	29	1.1	0.03	19	2.2	8	1.7	0.54
Physician-diagnosed rhinitis	326	15.1	365	14.6	0.66	283	33.3	155	33.9	0.82

Among these students, there were increases in the prevalence of cumulative rhinitis ($p = 0.05$) and in the proportion of the response “no rhinitis-related impairment of daily activities” ($p < 0.01$), whereas there was a significant decrease in the prevalence of severe rhinitis ($p = 0.03$). There was no significant reduction in the prevalence of physician-diagnosed rhinitis at either type of school (Table 3).

In both surveys, various asthma and rhinitis symptoms were found to be more common among females than among males (Table 4). The variables for which gender-related differences were statistically significant in the two surveys were as follows: cumulative wheezing; sleep disturbed by wheezing less than one night per week; dry cough at night; cumulative rhinitis; current rhinitis; rhinoconjunctivitis; mild rhinitis-related impairment of daily activities; and physician-diagnosed rhinitis. The variables “active asthma”, “one to three wheezing attacks within the last 12 months”, and “no or moderate rhinitis-related

impairment of daily activities” were found to be more common among females only in the 2006-2007 period ($p < 0.01$ for all), whereas the variable “exercise-induced wheezing” ($p = 0.01$) was found to be more common among females only in 2010.

Discussion

Questionnaires have been the most widely used instruments in epidemiological surveys, because of their ease of use, low cost, and good acceptability, as well as because they can be self-administered, eliminating interviewer bias, and are considered to be relatively independent of climatic factors. In the ISAAC questionnaire, most questions limit the investigation to the last 12 months in order to reduce memory errors and not to interfere with the month of the study. However, a concern that arises in questionnaire-based surveys is whether the study population is able to understand the questions and provide appropriate responses. To facilitate this process,

Table 4 - Distribution of the prevalence of asthma and rhinitis symptoms in 13- and 14-year-olds, by gender, in two surveys conducted in the city of Fortaleza, Brazil. 2006-2007 and 2010.

Symptom	2006/2007						p	2010						p
	Total		Male		Female			Total		Male		Female		
	(n = 3,015)		(n = 1,372)		(n = 1,643)			(n = 3,020)		(n = 1,369)		(n = 1,651)		
	n°	%	n°	%	n°	%		n°	%	n°	%	n°	%	
Cumulative wheezing	1,329	44.1	561	40.9	768	46.7	< 0.01	1,326	44.5	554	41.1	772	47.3	< 0.01
Active asthma	682	22.6	275	20.0	407	24.8	< 0.01	708	23.4	303	22.1	405	24.5	0.48
Number of attacks within the last 12 months														
1-3	528	17.5	206	15.0	322	19.6	< 0.01	547	18.1	235	17.2	312	18.9	0.21
≥ 4	68	2.3	29	2.1	39	2.4	0.63	83	2.7	31	2.3	52	3.1	0.13
Sleep disturbed by wheezing														
< 1 night/week	204	6.8	58	4.2	146	8.9	< 0.01	198	6.6	74	5.4	124	7.5	0.02
≥ 1 night/week	105	3.5	39	2.8	66	4.0	0.08	106	3.5	39	2.8	67	4.1	0.07
Speech-limiting wheezing	105	3.5	40	2.9	65	4.0	0.12	109	3.6	46	3.4	63	3.8	0.50
Exercise-induced wheezing	759	25.2	343	25.0	416	25.3	0.84	855	28.8	357	26.1	498	30.2	0.01
Dry cough at night	1,036	34.4	376	27.4	660	40.2	< 0.01	1,136	37.9	424	31.0	712	43.1	< 0.01
Physician-diagnosed asthma	350	11.6	168	12.2	182	11.1	0.31	433	14.5	199	14.5	234	14.2	0.77
Cumulative rhinitis	1,710	56.7	676	49.3	1,034	62.9	< 0.01	1,688	57.1	678	49.5	1,010	61.2	< 0.01
Current or active rhinitis	1,303	43.2	494	36.0	809	49.2	< 0.01	1,279	42.4	498	36.4	781	47.3	< 0.01
Rhinoconjunctivitis	565	18.7	193	14.1	372	22.6	< 0.01	535	17.7	185	13.5	350	21.2	< 0.01
Rhinitis-related impairment of daily activities														
None	567	18.8	48	3.5	93	5.7	< 0.01	590	19.5	253	18.5	337	20.4	0.18
Mild	581	19.3	223	16.3	358	21.8	< 0.01	582	19.3	201	14.7	381	23.1	< 0.01
Moderate	81	2.7	25	1.8	56	3.4	< 0.01	81	2.7	39	2.8	42	2.5	0.60
Severe	60	2.0	23	1.7	37	2.3	0.26	37	1.2	13	0.9	24	1.5	0.21
Physician-diagnosed rhinitis	609	20.2	241	17.6	368	22.4	< 0.01	520	17.6	214	15.6	306	18.5	0.03

the ISAAC questionnaire consists of objective, well-defined, and easy-to-understand questions. The ISAAC questionnaire has been validated for use in several countries and is used worldwide, allowing valid comparisons among different cities and countries in terms of the prevalences of asthma and allergies.^(6,7,21,22)

The prevalences of asthma symptoms and rhinitis symptoms were high in both of our surveys. Although there was an increase in the proportion of public school students who had lower frequencies of asthma symptoms in both surveys, there was a clear increase in the frequencies of exercise-induced wheezing and dry cough at night in the study population as a whole. A

comparison of the two survey results by type of school, indicating an increase in the frequencies of some symptoms in one group but not in the other, showed that the frequencies of dry cough at night and exercise-induced wheezing increased in the two groups. It is of note that the lower proportional representation of private school students might have decreased the statistical power of our study to demonstrate an increase in the frequency of exercise-induced wheezing in this group, an increase that trended toward statistical significance.

The frequencies of exercise-induced wheezing and dry cough at night also increased in a similar comparative study conducted in the city of Recife,

Brazil.⁽²²⁾ The findings of the present study are also in accordance with those of the ISAAC phase III, in which the most significant changes were in the mean frequencies of exercise-induced wheezing (an increase of 0.15% per year) and dry cough at night (an increase of 0.51% per year). In that phase, there were small mixed changes in the prevalence of asthma symptoms, but, at most centers, increases were twice as common as were decreases. For instance, the rates of exercise-induced wheezing decreased in the eastern Mediterranean region, on the Indian subcontinent, and in Oceania, whereas they increased in the other regions of the world.⁽¹⁰⁾

The factors involved in the differences in these asthma prevalence trends have yet to be fully elucidated. Environmental aspects associated with the lifestyle of populations and families, such as exposure to allergens, family density, sedentary habits, obesity, socioeconomic status, eating habits, early exposure to infections, etc., have been reported to be highly relevant for explaining these differences and can offer interesting opportunities for prevention.^(4,5,23)

Underdiagnosis of asthma and rhinitis, which was observed in the two surveys, has also been reported in other studies.⁽²⁴⁻²⁶⁾ The responses to the questions “Have you ever had asthma?” and “Have you ever had rhinitis?” depend on whether teenagers recognize these diseases, which, in turn, depends on how their symptoms are perceived by their families, their level of access to the health care system, the perception of the attending physician in their case, and their level of disease-related morbidity.⁽²²⁾ A previous study found that, as the degree of morbidity decreased, the number of adolescents who did not categorize themselves as having asthma increased.⁽¹⁴⁾ In contrast, the increase in physician-diagnosed asthma observed in our second survey indicates better recognition of the problem by this population or even increased acceptance of the term “asthma”, which contributes to more cases being treated. Corroborating this possibility, our more recent survey showed that the prevalences of the various degrees of asthma severity remained stable, although the prevalences of other symptoms increased.

The frequencies of most rhinitis symptoms remained similar or identical to those previously recorded, suggesting that the prevalence of this disease has reached its peak among these adolescents living in the city of Fortaleza. Some

studies have demonstrated a parallel increase in the prevalences of asthma and rhinitis, whereas others have not.⁽²⁵⁾ In the ISAAC phase III, no consistent global temporal trend was identified in the prevalence of rhinoconjunctivitis among children.^(26,27)

The reduction in the frequency of physician-diagnosed rhinitis can be attributed to the increase in the proportion of public school students in the second survey, given that, in both surveys, the frequency of this variable was more than twice as high among private school students as among public school students. Corroborating this finding, there was no significant variation in the frequency of physician-diagnosed rhinitis among students attending the same type of school. These data are in accordance with those found for the city of Recife, Brazil, where the prevalence of asthma observed in 2002 was lower than was that reported in a study conducted in 1994-1995, a reduction that was also attributed to an increase in the proportion of public school students in the second survey.⁽²²⁾

Regarding the reduction in the frequency of severe rhinitis, it is supposed that if more cases of asthma are being treated, as presumed on the basis of the increase in the frequency of physician-diagnosed asthma, this could, to some extent, cause a reduction in rhinitis severity, given that patients might be receiving concomitant treatment for rhinitis and given the fact that, by treating asthma, it is possible to relieve rhinitis symptoms. These diseases have similar inflammatory mechanisms and often coexist in the same patient. There are similarities between the nasal and bronchial mucosa, and one of the most important concepts about nose-lung interactions is that there is a functional systemic link between the upper and lower airways.⁽²⁵⁾ In addition, among public school students, there was an improvement in the perception of milder symptoms of the disease—represented by the increase in the frequency of the response “no rhinitis-related impairment of daily activities”—and this might be contributing to more cases being treated and to a consequent decrease in the frequency of severe cases, a decrease that was found to be significant in this particular group.

The predominance of asthma and rhinitis symptoms among females and private school students that was observed in the second survey

confirms the findings of the first survey and has been previously discussed.⁽²⁸⁾

In conclusion, the results of our second survey, conducted in 2010, confirm the high prevalences of asthma, rhinitis, and symptoms previously observed in this age group, revealing an increase in the frequency of exercise-induced wheezing and dry cough at night. Underdiagnosis of asthma and rhinitis remains evident, although there was an increase in the frequency of physician-diagnosed asthma and a reduction in the frequency of severe rhinitis. In addition, the present study confirms the predominance of females and private school students among the adolescents reporting symptoms of these diseases. Finally, the present study shows, for the first time, a comparison of the prevalences of asthma and rhinitis between two different periods in the city of Fortaleza, reporting current and relevant data that serve to alert health administrators and planners of the essential need to invest in the quality of primary care focused on the prevention and control of these diseases.

References

- Wehrmeister FC, Menezes AM, Cascaes AM, Martínez-Mesa J, Barros AJ. Time trend of asthma in children and adolescents in Brazil, 1998-2008. *Rev Saude Publica*. 2012;46(2):242-50.
- Ninan TK, Russell G. Respiratory symptoms and atopy in Aberdeen schoolchildren: evidence from two surveys 25 years apart. *BMJ*. 1992;304(6831):873-5. Erratum in: *BMJ* 1992;304(6835):1157.
- Venn A, Lewis S, Cooper M, Hill J, Britton J. Increasing prevalence of wheeze and asthma in Nottingham primary schoolchildren 1988-1995. *Eur Respir J*. 1998;11(6):1324-8.
- Strachan DP. Family size, infection and atopy: the first decade of the "hygiene hypothesis". *Thorax*. 2000;55 Suppl 1:S2-10.
- von Mutius E. The environmental predictors of allergic disease. *J Allergy Clin Immunol*. 2000;105(1 Pt 1):9-19.
- International Study of Asthma and Allergies in Childhood - ISAAC [homepage on the Internet]. Auckland: International Study of Asthma and Allergies in Childhood. [cited 2009 Jun 10]. International Study of Asthma and Allergies in Childhood - Manual. [Adobe Acrobat document, 58p.]. Available from: <http://isaac.auckland.ac.nz/phases/phaseone/phaseonemanual.pdf>
- Asher MI, Keil U, Anderson HR, Beasley R, Crane J, Martinez F, et al. International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. *Eur Respir J*. 1995;8(3):483-91.
- Bateman ED, Hurd SS, Barnes PJ, Bousquet J, Drazen JM, FitzGerald M, et al. Global strategy for asthma management and prevention: GINA executive summary. *Eur Respir J*. 2008;31(1):143-78.
- Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema: ISAAC. The International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. *Lancet*. 1998;351(9111):1225-32.
- Pearce N, Ait-Khaled N, Beasley R, Mallol J, Keil U, Mitchell E, et al. Worldwide trends in the prevalence of asthma symptoms: phase III of the International Study of Asthma and Allergies in Childhood (ISAAC). *Thorax*. 2007;62(9):758-66.
- Chong Neto HJ, Rosário NA, Solé D; Latin American ISAAC Group. Asthma and Rhinitis in South America: How Different They are From Other Parts of the World. *Allergy Asthma Immunol Res*. 2012;4(2):62-7.
- Solé D, Wandalsen GF, Camelo-Nunes IC, Naspitz CK; ISAAC - Brazilian Group. Prevalence of symptoms of asthma, rhinitis, and atopic eczema among Brazilian children and adolescents identified by the International Study of Asthma and Allergies in Childhood (ISAAC) - Phase 3. *J Pediatr (Rio J)*. 2006;82(5):341-6.
- Luna MF, Almeida PC, Silva MG. Prevalência de sintomas de rinite em adolescentes de 13 e 14 anos avaliada pelo método ISAAC, na cidade de Fortaleza. *Rev Bras Alergia Imunopatol*. 2009;32(3):106-11.
- de Luna Mde F, Almeida PC, Silva MG. Prevalence of asthma among adolescents in the city of Fortaleza, Brazil. *J Bras Pneumol*. 2009;35(11):1060-7.
- Instituto Brasileiro de Geografia e Estatística. [homepage on the Internet]. Brasília: Ministério do Planejamento, Orçamento e Gestão [cited 2011 Jan 11]. Censo 2010. Available from: <http://www.censo2010.ibge.gov.br>
- Fundação Cearense de Meteorologia e Recursos Hídricos. [homepage on the Internet]. Fortaleza: Governo do Estado do Ceará. [cited 2011 Apr 17]. Available from: <http://www.funceme.br>
- Superintendência Estadual do Meio Ambiente - SEMACE [homepage on the Internet]. Fortaleza: Governo do Estado do Ceará. [cited 2011 Apr 17]. Available from: <http://www.semace.ce.gov.br/>
- Prefeitura de Fortaleza. [homepage on the Internet]. Fortaleza: Prefeitura de Fortaleza. [cited 2010 Mar 02]. Available from: <http://www.fortaleza.ce.gov.br>
- Solé D, Vanna AT, Yamada E, Rizzo MC, Naspitz CK. International Study of Asthma and Allergies in Childhood (ISAAC) written questionnaire: validation of the asthma component among Brazilian children. *J Investig Allergol Clin Immunol*. 1998;8(6):376-82.
- Vanna AT, Yamada E, Arruda LK, Naspitz CK, Solé D. International Study of Asthma and Allergies in Childhood: validation of the rhinitis symptom questionnaire and prevalence of rhinitis in schoolchildren in São Paulo, Brazil. *Pediatr Allergy Immunol*. 2001;12(2):95-101.
- Solé D. The International Study of Asthma and Allergies in Childhood (ISAAC): what have we learned? *J Bras Pneumol*. 2005;31(2):93-4.
- Pizzichini MM. Defining asthma for epidemiologic studies: can this objective be attained? *J Bras Pneumol*. 2005;31(6):vi-viii.
- Mitchell EA, Beasley R, Björkstén B, Crane J, Garcia-Marcos L, Keil U, et al. The association between BMI, vigorous physical activity and television viewing and the risk of symptoms of asthma, rhinoconjunctivitis and eczema in children and adolescents: ISAAC Phase Three. *Clin Exp Allergy*. 2013;43(1):73-84.
- Britto MC, Bezerra PG, Brito RC, Rego JC, Burity EF, Alves JG. Asthma in schoolchildren from Recife, Brazil. Prevalence comparison: 1994-95 and 2002 [Article in Portuguese]. *J Pediatr (Rio J)*. 2004;80(5):391-400.

25. Jucá SC, Takano OA, Moraes LS, Guimarães LV. Asthma prevalence and risk factors in adolescents 13 to 14 years of age in Cuiabá, Mato Grosso State, Brazil [Article in Portuguese]. *Cad Saude Publica*. 2012;28(4):689-97.
26. Toledo MF, Rozov T, Leone C. Prevalence of asthma and allergies in 13- to 14-year-old adolescents and the frequency of risk factors in carriers of current asthma in Taubaté, São Paulo, Brazil. *Allergol Immunopathol (Madr)*. 2011;39(5):284-90.
27. Bousquet J, Khaltaev N, Cruz AA, Denburg J, Fokkens WJ, Togias A, et al. Allergic Rhinitis and its Impact on Asthma (ARIA) 2008 update (in collaboration with the World Health Organization, GA(2)LEN and AllerGen). *Allergy*. 2008;63 Suppl 86:8-160.
28. Björkstén B, Clayton T, Ellwood P, Stewart A, Strachan D; ISAAC Phase III Study Group. Worldwide time trends for symptoms of rhinitis and conjunctivitis: Phase III of the International Study of Asthma and Allergies in Childhood. *Pediatr Allergy Immunol*. 2008;19(2):110-24.
29. Ait-Khaled N, Pearce N, Anderson HR, Ellwood P, Montefort S, Shah J, et al. Global map of the prevalence of symptoms of rhinoconjunctivitis in children: The International Study of Asthma and Allergies in Childhood (ISAAC) Phase Three. *Allergy*. 2009;64(1):123-48.
30. Luna Mde F, Almeida PC, Silva MG. Asthma and rhinitis prevalence and co-morbidity in 13-14-year-old schoolchildren in the city of Fortaleza, Ceará State, Brazil [Article in Portuguese]. *Cad Saude Publica*. 2011;27(1):103-12.

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