

## Prevalence of asthma among adolescents in the city of Fortaleza, Brazil\*

Prevalência de asma em adolescentes na cidade de Fortaleza, CE

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### Abstract

**Objective:** To determine the prevalence of asthma among adolescents (13-14 years of age) in the city of Fortaleza, Brazil. **Methods:** This was a cross-sectional study involving 3,015 adolescents at public and private schools between 2006 and 2007. The participants completed the International Study of Asthma and Allergies in Childhood questionnaire. **Results:** The prevalences of "wheezing ever", "wheezing within the last 12 months" (active asthma) and "asthma ever" (physician-diagnosed asthma) were 44.1%, 22.6% and 11.6%, respectively. The prevalences of "wheezing ever" ( $p = 0.001$ ), "1-3 wheezing attacks within the last 12 months" ( $p = 0.001$ ), active asthma ( $p = 0.002$ ), "sleep disturbed due to wheezing less than one night per week" ( $p < 0.001$ ) and "dry cough at night" ( $p < 0.001$ ) were higher among girls. Private school students presented higher prevalences of "wheezing ever", active asthma, "1-3 wheezing attacks within the last 12 months", "4-12 wheezing attacks within the last 12 months" and physician-diagnosed asthma ( $p < 0.001$  for all), as well as of "exercise-induced wheezing" ( $p = 0.032$ ). **Conclusions:** The prevalence of asthma and asthma-related symptoms in students aged 13-14 years in the city of Fortaleza, Brazil, was high, predominantly among girls and private school students. The difference between the prevalence of physician-diagnosed asthma and that of active asthma suggests that asthma was underdiagnosed in the population studied.

**Keywords:** Asthma/diagnosis; Asthma/epidemiology; Asthma/prevalence.

### Resumo

**Objetivo:** Avaliar a prevalência de asma em adolescentes (13-14 anos) na cidade de Fortaleza, CE. **Métodos:** Estudo transversal utilizando o questionário do *International Study of Asthma and Allergies in Childhood* e envolvendo 3.015 adolescentes de escolas públicas e privadas entre 2006 e 2007. **Resultados:** As prevalências de "sibilos alguma vez na vida", "sibilos nos últimos doze meses" (asma ativa) e "asma alguma vez na vida" (asma diagnosticada) foram, respectivamente, 44,1%, 22,6% e 11,6%. As prevalências de "sibilos alguma vez na vida" ( $p = 0,001$ ), "1-3 crises de sibilos nos últimos 12 meses" ( $p = 0,001$ ); asma ativa ( $p = 0,002$ ); "sono interrompido por sibilos menos que uma vez por semana" ( $p < 0,001$ ) e "tosse seca noturna" ( $p < 0,001$ ) foram maiores nas adolescentes. Alunos de escolas privadas apresentaram maior prevalência de "sibilos alguma vez na vida", asma ativa, "1-3 crises de sibilos nos últimos 12 meses", "4-12 crises de sibilos nos últimos 12 meses" e asma diagnosticada ( $p < 0,001$  para todos), além de "sibilos após exercícios" ( $p = 0,032$ ). **Conclusões:** A prevalência de asma e de sintomas associados em escolares de 13-14 anos na cidade de Fortaleza mostrou-se elevada, predominando no sexo feminino e no grupo das escolas privadas. A diferença entre as prevalências de asma diagnosticada e a de asma ativa sugere que a asma foi subdiagnosticada na população estudada.

**Descritores:** Asma/diagnóstico; Asma/epidemiologia; Asma/prevalência.

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## Introduction

Asthma is one of the most common chronic diseases during childhood,<sup>(1)</sup> and its prevalence has increased in various parts of the world, principally in developed countries.<sup>(2,3)</sup> Genetic factors, although important, probably do not explain that increase, which has been attributed to the interaction between genetic and environmental factors. Environmental factors seem to have greater relevance in the determination of the symptoms of asthma,<sup>(4,5)</sup> the etiology of which remains poorly understood, despite a considerable amount of research in the area. In this sense, comparisons among the prevalences of asthma in different populations can be an important source of new clues to understand this clinical condition.<sup>(6,7)</sup> However, the absence of a clinical definition for asthma widely accepted in epidemiological studies, together with the lack of an objective measurement of the prevalence with high sensitivity and specificity, as well as the lack of satisfactory standardized tools, have made conducting those studies difficult.<sup>(6-8)</sup>

Questionnaires have been the most widely used tools in epidemiological investigations, due to their ease of use, low cost and good acceptability, as well as because they can be self-administered and are considered relatively independent of climatic factors. In 1991, the International Study of Asthma and Allergies in Childhood (ISAAC) protocol was developed, aiming to maximize the value of research in asthma, rhinitis and eczema in children and adolescents by promoting a standardized methodology in order to facilitate international collaborative studies.<sup>(6-8)</sup>

The first phase of the ISAAC had the following objectives: to describe the prevalence and the severity of asthma, rhinitis and eczema in children and adolescents living in different localities of the world; to make comparisons inside and among the various countries and regions; to obtain baseline values for the evaluation of future tendencies in the prevalence and in the severity of those diseases; and to provide structure for future etiological studies on genetics, lifestyle, medical care and environmental factors related to those diseases. In its second phase, the ISAAC sought to analyze objective measurements of asthma and allergies, comparing those measurements among the different centers involved, in addition to exploring new hypotheses related

to the development of those diseases. The third phase was designed to evaluate the tendencies of the prevalence of asthma, rhinitis and eczema in the centers participating in the first phase, insert new centers that did not participate in that phase and identify factors potentially related to those tendencies.<sup>(6,7)</sup>

The phase I ISAAC results showed a wide variation in the prevalence of asthma and asthma-related symptoms among different countries and among regions within the same country.<sup>(9)</sup>

In Brazil, the ISAAC studies revealed that asthma is highly prevalent, in addition to being underdiagnosed, and placed Brazil in eighth place among the countries with the highest rates, with notable variation among the various regions of Brazil. Adolescents presented a greater degree of variation in the prevalence rates of "wheezing within the last 12 months", in relation to children in the 6-7 year age bracket, the cities of Itabira and Salvador presenting the lowest and the highest rates, respectively.<sup>(10)</sup> More recently, the results referring to the participation of various cities in phase III of the ISAAC study have confirmed the high prevalences of asthma among Brazilian children and adolescents.<sup>(11)</sup> However, in some Brazilian regions, asthma studies using that standardized methodology are still scarce. In Fortaleza, Brazil, a population-based study on the prevalence of asthma and rhinitis among students aged 12-14 years was conducted in 1998.<sup>(12)</sup> More recently, the ISAAC questionnaire was used in a study in which 301 children treated at a public hospital were interviewed about asthma.<sup>(13)</sup> However, there have been no population-based studies of asthma prevalence using the ISAAC methodology in the state of Ceará, Brazil. In the present study, we attempted to evaluate the prevalence of asthma and its symptoms in a representative sample of students aged 13-14 years residing in the city of Fortaleza, in the state of Ceará, Brazil, using the standardized ISAAC questionnaire.

## Methods

Between April of 2006 and November of 2007, we conducted a descriptive population-based cross-sectional study involving adolescents in public and private schools in the city of Fortaleza, Brazil.

Fortaleza is located on a coastal flat, immediately below the equator, between latitude 3°30' and latitude 4°30', at an altitude of 15.49 m above sea level. It has an area of 4,667.8 km<sup>2</sup> and had a population of 2,431,415 inhabitants in 2000.<sup>(14)</sup> The annual mean temperature ranges from 26 to 27°C, and the relative humidity is approximately 82%.<sup>(15)</sup> The air quality has been monitored by the measurement of the levels of sulfur dioxide, particulate matter and smoke, and is currently classified as fair.<sup>(16)</sup> In the year 2000, 71.9% of the population earned less than or equal to 2 times the national minimum wage, according to the census.<sup>(14)</sup>

The city is administratively divided into six regions, and the schools are aggregated by region. In 2006, the Planning and Educational Policy Committee of the Ceará State Department of Education<sup>(17)</sup> reported that there were 85,261 adolescents in the 13-14 year age bracket, with a proportion between public and private schools students of 2.6:1. Among the schools which presented in their records a number equal to or higher than 50 students in the age bracket of the study, 29 were randomly selected, and those were distributed among the six administrative regions, respecting the proportion of students aged 13-14 years in each region, as well as the proportion of those adolescents in the public and private schools, thus assuring the heterogeneity of the sample.

The study comprised a probabilistic sample of 3,015 adolescents. For the ISAAC protocol, which contemplates the 6-7 and the 13-14 year age brackets, for reflecting, respectively, those with the greatest prevalence of asthma and those with the greatest mortality due to the disease,<sup>(7)</sup> it is suggested that the sample comprise 3,000 subjects for each age bracket chosen. With that sample size, considering prevalences of wheezing of 30% and 25% in two different centers, the power of the study to detect that difference was 99%, with a level of significance of 1%. In order to analyze asthma severity,

considering a prevalence of severe asthma of 5% in a given center and of 3% in another, the power of the study to detect that difference is 90%, with a level of significance of 1%.<sup>(6)</sup>

The data were obtained with the application of the standardized ISAAC questionnaire, asthma module, validated in São Paulo, Brazil, by Solé et al.<sup>(18)</sup> In relation to the translation of the term “wheezing” into Portuguese—*chiado* (*sibilo*, *piado*)—the word *cansaço* (fatigue) was also added to *sibilo* and *piado*, in parenthesis, since this is a term frequently used by the population in Brazil to refer to asthma attacks. In this study, however, the word *sibilo* was used.

The asthma module questionnaire comprises the following: four questions referring to the occurrence of symptoms of the disease—wheezing ever (cumulative wheezing), wheezing within the last 12 months (active asthma), exercise-induced wheezing and dry cough at night in the absence of common cold or respiratory infection; three questions about severity/morbidity—number of wheezing attacks within the last 12 months, sleep disturbed due to wheezing and speech-limiting wheezing; and one question about physician-diagnosed asthma—asthma ever. Most questions limit the investigation to the preceding year in order to minimize memory errors.<sup>(6)</sup>

The prevalence of asthma was estimated by the percentage of positive responses to the question about wheezing within the last 12 months (active asthma). The difference between the positive responses for “wheezing within the last 12 months” and the positive responses for “asthma ever” was considered underdiagnosis of asthma. Asthma was classified as severe in adolescents who gave positive responses to the question about “speech-limiting wheezing attacks”.<sup>(6,19)</sup>

The questionnaires were completed by the students themselves, in the classroom and in the presence of the principal researcher or one of the research assistants, duly trained by the former—they received a manual developed by the ISAAC

**Table 1** – Characteristics of the sample of adolescent students evaluated in Fortaleza, Brazil, 2006-2007.

Category	All, n (%)	Males, n (%)	Females, n (%)
Age, 13 years	1,575 (52.2)	690 (50.3)	885 (53.9)
Age, 14 years	1,440 (47.8)	682 (49.7)	758 (46.1)
Public school	2,165 (71.8)	971 (70.8)	1,194 (72.7)
Private school	850 (28.2)	401 (29.2)	449 (27.3)
Total	3,015 (100)	1,372 (100.0)	1,643 (100.0)

**Table 2** – Distribution of the prevalence of asthma and asthma-related symptoms, by gender, in a sample of 3,015 adolescent students aged 13-14 years in Fortaleza, Brazil, 2006-2007.

Variable	All		Males	Females	p
	(n = 3,015)		(n = 1,372)	(n = 1,643)	
	n (%)	95% CI	n (%)	n (%)	
Cumulative wheezing	1,329 (44.1)	42.3-45.8	561 (40.9)	768 (46.7)	0.001
Active asthma	682 (22.6)	21.1-24.0	275 (20.1)	407 (24.8)	0.002
Attacks within the last 12 months, n					
1-3	528 (17.5)	16.1-18.8	206 (15.0)	322 (19.6)	0.001
4-12	54 (1.8)	1.6-1.9	22 (1.6)	32 (1.9)	0.478
> 12	14 (0.5)	0.4-0.6	07 (0.5)	07 (0.4)	0.735
Sleep disturbed due to wheezing					
< 1 night/week	204 (6.8)	5.9-7.6	58 (4.2)	146 (8.9)	< 0.001
≥ 1 night/week	105 (3.5)	2.8-4.1	39 (2.8)	66 (4.0)	0.080
Speech-limiting wheezing	105 (3.5)	2.8-4.1	40 (2.9)	65 (4.0)	0.122
Exercise-induced wheezing	759 (25.2)	23.6-26.7	343 (25.0)	416 (25.3)	0.840
Dry cough at night	1,036 (34.4)	32.7-36.1	376 (27.4)	660 (40.2)	< 0.001
Physician-diagnosed asthma	350 (11.6)	10.4-12.7	168 (12.2)	182 (11.1)	0.319

group, containing the details of the field study process.<sup>(6)</sup>

The relevance of asthma and asthma-related symptoms were analyzed using the z test for proportions. Values of  $p < 0.05$  were considered statistically significant. Data were processed using the Statistical Package for the Social Sciences, version 15.0 (SPSS Inc., Chicago, IL, USA).

The study was approved by the Research Ethics Committee of Ceará State University (Process no 06193215-9, FR 93004).

## Results

We distributed 3,078 questionnaires among the students aged 13-14 years, with a return rate of 98.9%. Of those 3,078 questionnaires, 29 were

excluded due to incomplete or inconsistent responses. Therefore, the true response rate was 97.9%. The characteristics of the 3,015 students whose questionnaires were properly completed are shown in Table 1, in which it is observed that females predominated and that the proportion between the number of adolescents of the public and private schools was 2.55:1.

Table 2 shows that females predominated for cumulative wheezing ( $p = 0.001$ ), active asthma ( $p = 0.002$ ), “1-3 wheezing attacks within the last 12 months” ( $p = 0.001$ ), “sleep disturbed due to wheezing less than a night per week” ( $p < 0.001$ ) and “dry cough at night” ( $p < 0.001$ ). For the symptoms related to morbidity/severity—“4-12 wheezing attacks within the last 12 months”, “more than 12 wheezing attacks

**Table 3** – Distribution of the prevalence of physician-diagnosed asthma, according to morbidity, in a sample of 3,015 adolescents aged 13-14 years in Fortaleza, Brazil, 2006-2007.

Symptom	Total, n	Physician-diagnosed asthma		p
		Yes, n (%)	No, n (%)	
Current wheezing (active asthma), n	682	179 (26.2)	503 (73.8)	< 0.001
1-3 Attacks within the last 12 months	528	140 (26.5)	388 (73.5)	< 0.001
4-12 Attacks within the last 12 months	54	21 (38.9)	33 (61.1)	< 0.001
> 12 Attacks within the last 12 months	14	6 (42.9)	8 (57.1)	< 0.001
Speech-limiting wheezing	105	40 (38.1)	65 (61.9)	0.003
Sleep disturbed due to wheezing				
Never	375	67 (17.9)	308 (82.1)	< 0.001
< 1 night/week	204	63 (30.9)	141 (69.1)	< 0.001
≥ 1 night/week	105	45 (42.9)	60 (57.1)	< 0.001

**Table 4** – Distribution of the prevalence of asthma and of asthma-related symptoms, by school type, in a sample of 3,015 adolescents aged 13-14 years in Fortaleza, Brazil, 2006-2007.

Variable	Public school	Private school	p
	(n = 2,165)	(n = 850)	
	n (%)	n (%)	
Cumulative wheezing	907 (41.9)	422 (49.6)	< 0.001
Active asthma	442 (20.4)	240 (28.2)	< 0.001
Attacks within the last 12 months, n			
1-3	334 (15.4)	194 (22.8)	< 0.001
4-12	23 (1.1)	31 (3.6)	< 0.001
> 12	11 (0.5)	03 (0.4)	0.573
Sleep disturbed due to wheezing			
< 1 night/week	140 (6.5)	64 (7.5)	0.296
≥ 1 night/week	82 (3.8)	23 (2.7)	0.145
Speech-limiting wheezing	70 (3.2)	35 (4.1)	0.234
Exercise-induced wheezing	522 (24.1)	237 (27.9)	0.032
Dry cough at night	721 (33.3)	315 (37.1)	0.051
Physician-diagnosed asthma	220 (10.3)	130 (15.4)	< 0.001

within the last 12 months”, “sleep disturbed due to wheezing one or more nights per week” and “speech-limiting wheezing attacks”—there were no statistically significant differences between the genders ( $p = 0.478$ ,  $p = 0.735$ ,  $p = 0.080$  and  $p = 0.122$ , respectively). A relevant difference was also observed between the prevalence of active asthma (22.6%) and that of physician-diagnosed asthma (11.6%), which is suggestive of underdiagnosis of the disease.

It is of note that the underdiagnosis of asthma was inversely proportional to its morbidity (Table 3).

In relation to the prevalence by type of school—public or private—a predominance among the adolescents of the latter was observed, with statistical significance, for cumulative wheezing ( $p < 0.001$ ), active asthma ( $p < 0.001$ ), “1-3 wheezing attacks within the last 12 months” ( $p < 0.001$ ), “4-12 wheezing attacks within the last 12 months” ( $p < 0.001$ ), physician-diagnosed asthma ( $p < 0.001$ ) and “exercise-induced wheezing” ( $p = 0.032$ ). There were no statistical significant differences between the two groups for “sleep disturbed due to wheezing” or for the symptoms related to asthma severity (Table 4).

## Discussion

Self-report questionnaires, which have been employed with increasing frequency, offer various advantages, among which is the elimi-

nation of interviewer bias.<sup>(10)</sup> However, one concern that arises in studies based on questionnaires is whether the population studied is able to understand the questions and provide appropriate responses. To facilitate that process, the ISAAC questionnaire presents objective, well-defined, easily understandable questions. The ISAAC questionnaire has been validated in various countries and has been applied worldwide, allowing valid comparisons among the prevalence of asthma and allergies in different cities and countries.<sup>(7,9)</sup>

In the 13-14 year age bracket, it becomes easier to reach the necessary sample due to the fact that the completed questionnaire is obtained immediately after being handed out in the classroom. That decreased the losses, allowing a return rate of 98.9%, which is considered adequate in the ISAAC method.<sup>(6,7)</sup>

The present study revealed high rates of current and cumulative asthma symptoms. The rate of cumulative wheezing (44.1%) was similar to that found for the cities of Salvador (44.3%) and São Paulo (45.4%). Excluding the rate found for Lima, Peru (48.6%), this represents the highest rate of cumulative wheezing reported in Latin America in the first phase of the ISAAC.<sup>(9)</sup> The rate of cumulative wheezing observed in the present study suggests that there is, in Brazil, a high index of respiratory diseases accompanied by wheezing.

The prevalence of active asthma was slightly higher than the mean found in phase III of the ISAAC in Brazilian cities (19.0%), being higher than that found for the cities of Manaus (18.1%) and Natal (18.9%), which are at latitudes similar to that of Fortaleza, and similar to the rates obtained for the western zone of the city of São Paulo (21.9%) and for the city of Santo André (23.2%), despite the differences in latitude. In relation to the international centers, it was near those found for Saskatoon, Canada (24.0%) and in Sidney, Australia (24.7%), and similar to those in Costa Rica (23.7%), which was one of the highest in Latin America.<sup>(9,11)</sup>

Wide variations in the prevalences of asthma and allergies were registered in the studies using the ISAAC protocol, even in genetically similar groups, suggesting that the environmental factors are determining those variations.<sup>(20)</sup> Aspects of the environment associated with the lifestyle of the populations and families—such as the socioeconomic status, exposure to allergens, size of the family, early exposure to infections, eating habits and place of residence (urban or rural area)—have been reported as being of great relevance for the explanation of those differences<sup>(4,5)</sup> and certainly offer great opportunities for prevention.

In the population studied here, asthma morbidity was relatively low, despite the high prevalence of wheezing. The rate of 4 or more wheezing attacks within the last 12 months was lower than that found for three Brazilian cities—Recife (3.8%), São Paulo (4.4%) and Salvador (6.0%)—and for the city of Saskatoon, Canada (7.7%), as well as for Costa Rica as a whole (5.3%), for Brazil as a whole (4.4%) and worldwide (3.7%), although it was slightly higher than that found for the cities of Santiago, Chile (1.2%) and Cuernavaca, Mexico (1.5%).<sup>(9,11)</sup> The rate of “sleep disturbed due to wheezing one or more nights per week” (3.5%) was similar to the Brazilian mean (3.7%). In Latin America, that rate has been reported to be as low as 0.8% (in Punta Arenas, Chile) and as high as 4.6% (in Salvador, Brazil).<sup>(9,11)</sup> In a previous study,<sup>(12)</sup> in which a high prevalence of wheezing episodes within the last 12 months (35.4%) was also reported in students aged 12–14 years in the city of Fortaleza, only 2.4% of the students reported “4–12 wheezing attacks within the last 12 months”.

The question about “speech-limiting wheezing” shows severe acute asthma, and is of direct relevance to international comparisons of hospital admissions and mortality statistics.<sup>(6)</sup> In Brazil, the prevalence of positive responses to that question ranged from 2.6% to 9.1% among the adolescents. The data for Fortaleza are similar to those obtained for the other Brazilian cities of Curitiba (3.1%), Nova Iguaçu (3.3%) and Santa Maria (3.8%).<sup>(11)</sup>

The predominance of females among adolescents with asthma symptoms has been reported by other authors.<sup>(12,21)</sup> The prevalence of wheezing is generally higher in males in the first decade of life—when the caliber of their airways is smaller than is that of the females—and the opposite is observed from puberty onward.<sup>(22)</sup> Studies have also indicated the influence of the female sex hormones in the expression of asthma, and some of that epidemiological evidence has emerged from natural models, that is, menstrual cycles, pregnancy and menopause.<sup>(23–25)</sup> In addition, greater contact with the medical professional due to gynecological problems or prenatal care would increase the opportunity to report other conditions—including asthma and allergies—among female adolescents, who are also subject to gender-specific environmental exposure, such as exposure to cosmetic products.<sup>(26)</sup>

The underdiagnosis of asthma has also been observed in other studies.<sup>(9,12,21)</sup> The question “have you ever had asthma?” does not have a high sensitivity for identifying asthma cases.<sup>(19)</sup> In addition to the level of patient access to the health care system and the perception of the attending physician, other factors—such as acceptance of the disease, the perception of patients or their relatives and the use of synonyms for the term “asthma”—as well as the degree of morbidity, interfere with the response to that question.<sup>(8)</sup> As observed in the present study, the number of adolescents who did not perceive themselves as having asthma increased as the degree of morbidity decreased.

Studies of the association between social class and asthma, conducted in Brazil or internationally, have produced conflicting results.<sup>(21,27–30)</sup> The results obtained in the present study are in accordance with those obtained in epidemiological studies conducted in other cities in the northeastern region of Brazil<sup>(27,30)</sup> and give support to the hygiene hypothesis, in which

the variation in the risks for allergic diseases is interpreted as reflecting the level of exposure to various infectious agents in the early phase of life.<sup>(4)</sup> However, our results might, to some extent, indicate the different levels of access to health care or the cultural aspects which would furnish greater understanding and perception of the disease among adolescents at higher socio-economic levels.

In conclusion, the present study showed that the prevalence of asthma and asthma-related symptoms, among adolescent students aged 13-14 years in the city of Fortaleza, Brazil is among the highest in Brazil and in world, and that the prevalence is highest among female adolescents and among students attending private schools. The low rate of physician-diagnosed asthma in relation to that of active asthma suggests that asthma is underdiagnosed in the studied population. Our results serve as a warning to health administrators and planners, indicating the need to invest in the quality of the primary care geared toward the prevention and control of asthma.

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