



Epidemiological trends of allergic diseases in adolescents

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ABSTRACT

Objective: To assess the prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis in adolescents in the city of Belo Horizonte, Brazil, in 2012 by administering the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire, as well as to compare the observed prevalences with those found in studies performed 10 years earlier and employing the same methodology used here.

Methods: This was a cross-sectional study conducted between May and December of 2012 and involving adolescents in the 13- to 14-year age bracket. Participants were randomly selected from among adolescents studying at public schools in Belo Horizonte and completed the ISAAC questionnaire. Proportions were calculated in order to assess the prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis in the sample as a whole, and the chi-square goodness-of-fit test was used in order to compare the prevalences observed in 2012 with those found in 2002. **Results:** The prevalences of symptoms of asthma, allergic rhinitis, and allergic rhinoconjunctivitis in 2012 were 19.8%, 35.3%, and 16.3%, respectively, being significantly higher than those found in 2002 (asthma, $p = 0.006$; allergic rhinitis, $p < 0.01$; and allergic rhinoconjunctivitis, $p = 0.002$).

Conclusions: The prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis among adolescents in 2012 were found to be high, having increased in comparison with those found 10 years earlier, despite efforts in prevention, diagnosis, and treatment.

Keywords: Asthma; Rhinitis, allergic; Prevalence; Adolescent.

INTRODUCTION

Allergic diseases are common in children and adolescents and result in high costs to the health care system, school absenteeism (in the case of the children and adolescents), and work absenteeism (in the case of their parents), as well as having a negative impact on the quality of life of those affected.^(1,2) Despite advances in the understanding of the pathophysiology of allergic diseases and the increasing number of treatment options, a relationship has been established between an increased prevalence of allergic diseases and an interaction between genetic and environmental factors, the latter being the major determinants of this increase.^(3,4)

Epidemiological studies investigating the aforementioned factors have estimated the global and regional prevalences of and risk factors for allergic diseases. One such study is the International Study of Asthma and Allergies in Childhood (ISAAC), aimed at assessing the prevalence and severity of asthma and allergic diseases in children and adolescents in different parts of the world by means of a standardized method⁽⁵⁾ and monitoring them over time.

The prevalence of allergic diseases is higher in Brazil than in other countries in Latin America and the world. The mean prevalence of asthma-related symptoms in Brazil is 20%, varying across regions. The results of phase III of the ISAAC in Brazil revealed asthma prevalence

rates of 11.8-30.5%; in the city of Belo Horizonte, the prevalence of asthma was 17.8%, which is similar to that found in other Brazilian capitals.^(6,7) In a recent study evaluating the prevalence trends of allergic respiratory diseases over a 9-year interval between distinct phases of the ISAAC in seven Brazilian cities, the prevalences of asthma, allergic rhinitis, and atopic dermatitis were found to be variable. Although the prevalences of allergic rhinitis, eczema, and severe asthma increased, the prevalence of active asthma decreased.⁽⁸⁾

The objective of the present study was to assess the prevalences of allergic diseases (asthma, allergic rhinitis, and allergic rhinoconjunctivitis) in adolescents in Belo Horizonte in 2012 by administering the ISAAC questionnaire, as well as to compare our findings with the results of studies conducted 10 years earlier^(6,7) and employing the same methodology used here.

METHODS

This was a cross-sectional study involving adolescent public school students in Belo Horizonte and conducted between May and December of 2012 with the use of the ISAAC questionnaire, which assesses the prevalence and severity of symptoms of asthma and allergic rhinitis.⁽⁵⁾

According to the ISAAC protocol, the study population should comprise at least 3,000 students in the 13- to

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14-year age bracket, randomly selected from at least 14 schools. The Belo Horizonte Municipal Department of Education provided a list of public schools, including the number of students per school and the school year; in accordance with the ISAAC protocol, only schools in which there were at least 200 students in the aforementioned age bracket were considered for participant recruitment. The schools were randomly selected from a list that was randomly generated in the program Epi Info, version 6.04.

Students in the 13- to 14-year age bracket and enrolled in the selected schools were included in the study. The aforementioned age bracket was selected because most such adolescents attend school. This increases the number of respondents and therefore facilitates data collection.

In order to assess the prevalence of symptoms of asthma, allergic rhinitis, and allergic rhinoconjunctivitis in the study population, we used a questionnaire that has been translated to Portuguese and validated for use in Brazil by Solé et al.⁽⁹⁾ Chart 1 shows the questions aimed at determining the prevalence of symptoms of asthma, allergic rhinitis, and allergic rhinoconjunctivitis. The questions regarding "the last 12 months" were aimed at limiting the time between the presence or absence of symptoms and the administration of the questionnaire, thus reducing recall bias and increasing the sensitivity and specificity of the questions.⁽⁵⁾ In addition, the seasonal distribution of symptoms of asthma, allergic rhinitis, and allergic rhinoconjunctivitis can be controlled for by limiting the data collection period to 12 months. The question "have you ever had asthma?" was included in order to determine whether or not participants had ever been diagnosed with asthma.

At the selected schools, the questionnaire was administered to all eighth and ninth graders in the 13- to 14-year age bracket. Each school was visited at least twice in order to avoid losses resulting from school absenteeism. The questionnaire was completed by the adolescents themselves in the classroom, under the supervision of one of the researchers, who had been trained and instructed not to interfere with the process.

Data analysis was performed with the Statistical Package for the Social Sciences, version 14.0 (SPSS Inc., Chicago, IL, USA). Proportions were calculated in order to assess the prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis in the sample as a whole. The chi-square goodness-of-fit test, which is used in order to test whether the observed frequency distribution fits a specific distribution, was used in order to compare the prevalences of the

aforementioned allergic diseases in 2012 with those found in 2002 (in studies conducted in the same city by practically the same group of researchers using the same methodology used here).^(6,7)

The study project was approved by the Research Ethics Committee of the Federal University of Minas Gerais (on August 31, 2011; Protocol no. 237) and by the Belo Horizonte Municipal Department of Education. After permission was granted by all 14 school boards, written informed consent was obtained from all participating adolescents and their parents or legal guardians.

RESULTS

The study sample consisted of 3,325 adolescents, 1,825 (54.9%) of whom were 13 years old. Most of the participants were female (n = 1,858; 56.1%).

The prevalence of asthma symptoms in the sample as a whole was 19.8% (651/3,282). There was a statistically significant difference between genders regarding the prevalence of asthma (p = 0.014), which was 21.4% (391/1,827) and 18.0% (259/1,442) in females and males, respectively.

The prevalence of allergic rhinitis symptoms was 35.3% (1,140/3,225). The prevalence of allergic rhinitis symptoms was higher among females (40.8%; 738/1,810) than among males (28.4%; 398/1,403), the difference being significant (p < 0.001).

The prevalence of symptoms of allergic rhinoconjunctivitis was 16.3%. The prevalence of symptoms of allergic rhinoconjunctivitis was higher among females (19.3%) than among males (12.5%), the difference being significant (p < 0.001).

In order to compare the prevalences observed in 2012 with those found in 2002, we used the results of previously published studies showing data for 2002^(6,7): among 3,088 adolescents in the 13- to 14-year age bracket, the prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis were 17.8%, 26.1%, and 14.5%, respectively (Table 1).

After statistical sample adjustment, the prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis were found to have been significantly higher in 2012 than in 2002.

DISCUSSION

The present study showed high prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis among adolescents in Belo Horizonte in 2012. These results are consistent with those obtained in several other cities in

Chart 1. Questions regarding the prevalence of symptoms of asthma, allergic rhinitis, and allergic rhinoconjunctivitis.^a

Question	Disease
"Have you had wheezing or whistling in the chest in the past 12 months?"	Asthma
"In the past 12 months, have you had a problem with sneezing, or a runny, or blocked nose when you DID NOT have a cold or the flu?"	Allergic rhinitis
"In the past 12 months, has this nose problem been accompanied by itchy-watery eyes?"	Allergic rhinoconjunctivitis

^aBased on Solé et al.⁽⁹⁾

Table 1. Prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis in the general populations in the city of Belo Horizonte, Brazil, by year in which the questionnaire was administered.^a

Prevalence	Year		p
	2002	2012	
Asthma	550 (17.8) [16.5-19.1]	641 (19.8) [18.4-21.2]	0.006
Allergic rhinitis	806 (26.1) [24.6-27.6]	1.103 (35.3) [33.7-36.9]	< 0.001
Allergic rhinoconjunctivitis	448 (14.5) [13.3-15.7]	505 (16.3) [5.0-17.6]	0.002
Asthma diagnosis ("Have you ever had asthma?")	303 (9.8) [8.8-10.9]	572 (17.6) [16.3-18.9]	< 0.001

^aValues expressed as n (%) [95% CI].

Brazil and the world.^(6,10) The prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis were found to have significantly increased over the course of 10 years—from 17.8% in 2002 to 19.8% in 2012; from 26.1% in 2002 to 35.3% in 2012; and from 14.5% in 2002 to 16.3% in 2012, respectively—suggesting that allergic diseases are on the rise in Belo Horizonte and other large Brazilian cities.⁽¹¹⁾

Despite evidence of increased prevalences of asthma and allergic diseases in developed countries, little is known about the trends in the prevalences of these diseases in developing countries.⁽¹²⁻¹⁵⁾ In a study conducted in Brazil and comparing phases I and III of the ISAAC in terms of the prevalences of asthma and allergic diseases in adolescents in Brazil, the mean prevalence of wheezing in the last 12 months was found to have decreased, from 27.7% in phase I to 19.9% in phase III ($p < 0.01$). However, an analysis of the prevalence of asthma-related symptoms in each of the five centers participating in phases I and III of the ISAAC revealed differences in the magnitude and direction of the changes in prevalence, with no uniform trend for an increase. The results for symptoms of rhinitis and atopic dermatitis were similar to those for asthma symptoms.⁽¹⁶⁾

Recent studies conducted in other cities in Brazil and employing the same methodology used here have shown the same trend as that observed in Belo Horizonte; that is, the prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis are still high. In the city of Fortaleza, the prevalences of asthma, allergic rhinitis, and allergic rhinoconjunctivitis were 22.6%, 43.2%, and 18.7%, respectively; in the city of Londrina, they were 22.0%, 27.3%, and 13.6%, respectively; and in the city of Taubaté, they were 15.3%, 36.6%, and 17.7%, respectively.⁽¹⁷⁻¹⁹⁾ It is of note that the aforementioned cities are located in very different geographic regions of Brazil.

In a recently published study of allergic respiratory diseases in Brazil,⁽⁸⁾ the objective of which was to assess the trends in the prevalence of allergic respiratory diseases in the 9-year interval between distinct phases of the ISAAC, the overall prevalences of asthma, allergic rhinitis, and atopic dermatitis were found to be variable, being high (particularly those of asthma and atopic dermatitis) in areas near the equator. In Belo Horizonte, annual percent changes in the prevalences of wheezing in the last 12 months, asthma diagnosis, and nasal symptoms in the last 12 months were 21%,

83%, and 89%, respectively. According to the authors of that study, this might be due to environmental pollution.⁽⁸⁾ In a recently published study conducted in the United Kingdom⁽²⁰⁾ and employing the ISAAC questionnaire to compare the prevalences of allergic rhinitis and asthma between two cohorts approximately 12 years apart, the prevalence of rhinitis was found to have increased, from 22.6% to 28.1% ($p = 0.004$), whereas the prevalence of asthma was found to have decreased, from 18.9% to 15.0% ($p = 0.02$). The authors hypothesized that the aforementioned findings were due to changes in the prevalence of aeroallergen sensitization and to cigarette smoke exposure.⁽²⁰⁾

For comparative epidemiological studies, questionnaires previously adapted and validated for use in the country where they are to be administered constitute the ideal tools because they are simple, easily applicable, and inexpensive, as well as having good acceptability, having good reproducibility, and allowing comparisons within and between populations.⁽²¹⁾ Therefore, the ISAAC questionnaire is a valid method for understanding variations in the prevalence of asthma and allergic diseases; however, it is subject to criticism. The main concern when conducting questionnaire-based studies is whether the study population is able to understand the questions and provide appropriate responses.⁽⁵⁾ Therefore, because the perception that adolescents have of their own symptoms is better than the perception that parents have of the symptoms of their younger children (preschoolers, for example), adolescents constitute an age group in which the use of questionnaires is an appropriate method for assessing disease trends. According to the literature, the fact that the prevalence of allergic diseases is higher in adolescents than in younger children might be due to an actual increase in the prevalence of symptoms during adolescence.⁽²²⁾

With regard to the use of the phrase "presence of wheezing in the last 12 months" in order to assess the prevalence of asthma symptoms, it should be noted that some studies have included the term "bronchitis", which resulted in an increase in the reported prevalence of asthma symptoms. In Brazil, the fact that asthma is commonly referred to as "bronchitis" and that the two terms are mistakenly used as synonyms by physicians themselves makes it difficult to establish an accurate diagnosis of asthma.^(21,23) In a study conducted in the city of São Luís, different prevalences were found for ISAAC questionnaire items "wheezing in the last 12 months" (12.7%) and "asthma/bronchitis ever" (19.1%).⁽²⁴⁾ In

the present study, similar prevalences were found for ISAAC questionnaire items "wheezing in the last 12 months" (19.8%) and "have you ever had asthma?" (17.6%), allowing us to infer that, on the basis of data from a study conducted 10 years earlier, the prevalence of asthma diagnosis is on the rise. It is possible that the results of the present study were influenced by the fact that health professionals and the population have gained a deeper understanding of asthma over this period.

The prevalences of asthma and allergic diseases have varied widely across phases of the ISAAC, and environmental and lifestyle factors, including socioeconomic status, exposure to allergens, active and passive smoking, eating habits, and early exposure to infections, have been reported to play a major role in the observed differences,⁽²⁵⁻²⁷⁾ providing an excellent opportunity for prevention.

In Belo Horizonte, the reported prevalence of smoking in individuals in the 15- to 24-year age bracket in 2002 and 2003 was 11.7% (95% CI: 9.1-14.4%).⁽²⁸⁾ The 2012 Brazilian National School Health Survey⁽²⁹⁾ evaluated adolescents in 26 Brazilian capitals and the Federal District of Brasília and showed that the prevalence of smoking was 6.1% (95% CI: 5.6-6.6%). However, no data were found on Belo Horizonte alone in order to make a temporal comparison. Nevertheless, the prevalence of smoking in Belo Horizonte has probably decreased, given the national trend toward reduced smoking as a result of antismoking public policies. Therefore, although the design of the present study precludes an analysis of the relationship between smoking and an increased prevalence of allergic diseases, such a relationship seems unlikely in the study population.

The observed changes in the prevalences of asthma and allergic rhinitis in Belo Horizonte might be due to an increased prevalence of obesity and overweight and reduced air quality in the city in recent years. In Belo Horizonte, the prevalences of obesity and overweight in 2006 were 3.1% and 8.4%, respectively.⁽³⁰⁾ On the basis of the findings of a study conducted 5 years earlier by the same research group using the same methodology, the authors found that there was a 13% increase in the prevalences of obesity and overweight in Belo Horizonte.⁽³⁰⁾

In Belo Horizonte, as in other large cities, air pollutant emissions have increased as a result of a significant and uncontrolled increase in the number of motor vehicles in recent years. However, there are currently no data

correlating increased air pollutant emissions with the prevalences of the diseases investigated in the present study. Environmental monitoring of air pollutants in the greater metropolitan area of Belo Horizonte has shown that, during the winter and spring months, air pollutant levels exceed the limits established by law.⁽³¹⁾

The impact of fossil fuel pollution has been shown in a recently published study in which the ISAAC questionnaire was administered to 1,039 adolescents in the 13- to 14-year age bracket enrolled in public or private schools in the city of Taubaté; the study showed that approximately 20% of those living near Presidente Dutra Highway (a heavily traveled highway) had symptoms of asthma and allergic rhinitis, which were absent in 85% of those living far from Presidente Dutra Highway.⁽³²⁾

The impact of genetic factors was not investigated in the present study, because the interval between the two evaluation time points was short. In a recent study conducted in Thailand and employing the ISAAC questionnaire, the prevalence of asthma and allergic rhinitis in combination was 52.7%, directly and significantly affecting the quality of life of Thai adolescents.⁽³³⁾ In contrast, in the city of Aracaju, Brazil, the prevalence of asthma was found to be lower in 2012 than in 2003 (12.8% vs. 18.7%; $p < 0.001$).⁽³⁴⁾ This was due to improved quality of life and increased investment in public health policies (as evidenced by increased proportions of schools and Family Health Program teams), as well as to better education resulting in improved health indicators, such as reduced smoking.⁽³⁴⁾

We believe that the present study contributes to improving the prevention and treatment of allergic respiratory diseases. Government efforts to provide effective public policies and access to asthma treatment can contribute to reducing asthma morbidity and mortality, given that there is currently no nationwide asthma management program aimed at controlling the disease in Brazil.⁽³⁵⁾

In conclusion, the present study showed high rates of asthma, allergic rhinitis, and allergic rhinoconjunctivitis among adolescents living in Belo Horizonte, as well as showing that, despite public sector efforts to prevent and treat the aforementioned diseases, their prevalences increased significantly over a 10-year period. For effective prevention, further studies are needed in order to determine the causes of increased prevalences of allergic diseases in Belo Horizonte.

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