Prevalence of asthma in children and adolescents in a city in the Brazilian Amazon region*

Prevalência de asma em escolares e adolescentes em um município na região da floresta Amazônica brasileira

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Abstract

Objective: To analyze the prevalence of asthma and asthma symptoms in students of two distinct age brackets residing in the city of Tangará da Serra, Brazil. **Methods:** Cross-sectional, population-based study of the prevalence of asthma in children from 6 to 7 years of age and adolescents from 13 to 14, using the standardized International Study of Asthma and Allergies in Childhood, phase 1 questionnaire, validated for use in Brazil. Students who responded affirmatively to question 2 (presence of wheezing in the preceding 12 months) were classified as suffering from asthma. **Results:** The study comprised 3,362 students, of whom 1,634 (48.6%) were children and 1,728 (51.4%) were adolescents. Of the 1,634 children, 816 (49.9%) were male and 818 (50.1%) were female. Of the 1,728 adolescents, 773 (45.0%) were male and 955 (55.0%) were female. The prevalence of asthma among the children was 25.2%, whereas that among the adolescents was 15.9% (χ^2 = 8.34; p = 0.00). The children presented higher prevalences of the following symptoms of asthma than did the adolescents: wheezing ever (54.3%), nocturnal dry cough (43.9%), wheezing in the preceding 12 months (25.2%), and from 1 to 3 attacks of wheezing in the preceding 12 months (19.1%). There were no differences between the two groups regarding physician-diagnosed asthma (approximately 4.5%). There were no statistical differences regarding the prevalence of asthma by gender in the two groups. **Conclusions:** Tangará da Serra has a high prevalence of asthma in children and adolescents, and this result is compatible with other studies carried out in Brazil and Latin America using the same methodology.

Keywords: Asthma/epidemiology; Child; Adolescent.

Resumo

Objetivo: Analisar a prevalência de asma e seus sintomas em estudantes de duas faixas etárias específicas, residentes no município de Tangará da Serra, Mato Grosso. **Métodos:** Estudo transversal de base populacional da prevalência de asma em escolares de 6-7 anos de idade e em adolescentes de 13-14 anos, utilizando o questionário padronizado e validado para uso no Brasil do *International Study of Asthma and Allergies in Childhood*, fase 1. Foram considerados como asmáticos aqueles estudantes que responderam afirmativamente à questão 2 (presença de sibilância nos últimos 12 meses). **Resultados:** Participaram da pesquisa 3.362 estudantes, dos quais 1.634 (48,6%) eram escolares e 1.728 (51,4%) eram adolescentes. Entre os 1.634 escolares, 816 (49,9%) eram do gênero masculino e 818 (50,1%) do feminino. Entre os 1.728 adolescentes, 773 (45,0%) eram do gênero masculino e 955 (55,0%) do feminino. A prevalência de asma entre os escolares foi de 25,2%, enquanto que entre os adolescentes esta foi de 15,9% (χ^2 = 8,34; p = 0,00). Os escolares apresentaram maiores prevalências dos seguintes sintomas de asma do que os adolescentes: sibilância alguma vez na vida (54,3%), tosse seca noturna (43,9%), sibilância nos últimos 12 meses (25,2%), e de 1 a 3 crises de sibilância nos últimos 12 meses (19,1%). Quanto ao diagnóstico médico de asma, não houve diferença entre os dois grupos (aproximadamente 4,5%). Não foi verificada diferença estatisticamente significante na prevalência de asma entre os gêneros nos dois grupos. **Conclusões:** Tangará da Serra apresenta elevada prevalência de asma entre escolares e adolescentes, resultado compatível com estudos realizados no Brasil e na América Latina utilizando a mesma metodologia.

Descritores: Asma/epidemiologia; Criança; Asma em Adolescente.

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Introduction

Asthma is the most prevalent chronic childhood disease. It generates high health care expenditures, as well as impairing the quality of life of asthma sufferers and increasing absenteeism (from work and school). Asthma can also be fatal if not controlled.[1,2] It is characterized by bronchial inflammation with hyperresponsiveness of the lower airways and variable air flow limitation that is spontaneously reversible or reversible with the use of bronchodilators.[2]

It is diagnosed through clinical evaluation and functional tests, such as spirometry. However, written questionnaires, such as the International Study of Asthma and Allergies in Childhood (ISAAC) phase 1 questionnaire, have shown good sensitivity and specificity in the identification of cases in population-based studies.[3-5] The standardization of this instrument for use with children aged 6 to 7 years and adolescents aged 13 to 14 years, together with its use in many countries, including Brazil, allows a comparative data analysis to be made.[3,6].

The variability in the prevalence of asthma is known worldwide. Phase 1 ISAAC studies showed that the prevalence of asthma among children was 4.2% and 32.1% in Indonesia and Costa Rica, respectively, whereas, among adolescents, it was 2.1% a 35.1% in Indonesia and in the Channel Islands, respectively.[6]

In the comparison of the results observed in phases 1 and 3 of the ISAAC, a trend toward an increase in the prevalence of asthma among children was observed in some regions of the world, including Asia, India, North America, Western Europe and the Eastern Mediterranean. Among adolescents, there is a similar trend in Africa, India, Latin America, North Europe and Eastern Europe. However, there has been a trend toward stabilization or even reduction of the prevalence of the disease in other regions, such as the Oceania, specially in the group of adolescents.[6]

Understanding the factors implied in the different trends in the prevalence of asthma remains a challenge. Suggested explanations for this variability are related to the western life style, to urbanization and to the increase in population density,[7] as well as to the variations in the nature and magnitude of environmental factors at each center.[8]

The prevalence of asthma in Brazil is one of the highest in Latin America and in the world, with mean values of 20%, varying among the regions.[2,4,9] In studies using the ISAAC questionnaire in Brazil, the prevalence of wheezing in the preceding 12 months (active asthma) among children has been shown to range from 16.5% to 31.2%, in the city of Aracaju and the western region of São Paulo, respectively. Among adolescents, the prevalence of wheezing ranges from 11.8% to 30.5%, in the cities of Nova Iguaçu and Vitória da Conquista, respectively.[9]

Little is know about the occurrence of the disease in the Amazon region. The few studies carried out within the Amazon forest biome have shown the prevalence of asthma to be 24.4% among children in the city of Manaus, compared with 18.1% and 23.1% among adolescents in the cities of Manaus and Belém, respectively.[9] However, the Amazon is a geographically extensive region, and its population presents considerable biological and cultural diversity due to the various origins of the migratory flow.[10]

The investigations of the prevalence of asthma carried out to date were conducted in larger cities with greater industrial development than that of the city of Tangará da Serra, which was the focus of the present study. It seems relevant to determine the distribution and behavior of asthma in cities of the Amazon region, thereby allowing future analysis of possible risk factors, as well as establishing a baseline for the identification of tendencies and principally, the foundation of analytical studies on the effects of environmental pollution on human health in the Brazilian Amazon.

This study was developed as a product of the research project: "Evaluation of the effects that biomass burning has on human health in the Legal Amazon", financed by the Foundation for the Support of Research in the State of Mato Grosso, the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq, National Council for Scientific and Technological Development) and by the PAPES IV FIOCRUZ/CNPq project, associated with the Millennium Institutes, as part of the Large-Scale Biosphere-Atmosphere Experiment in Amazonia. The objective was to analyze the prevalence of asthma and asthma symptoms among children and adolescents residing in the city of Tangará da Serra, Brazil.

Methods

Study design

This was a descriptive population-based study of the prevalence of asthma among students of the city of Tangará da Serra, located in the state of Mato Grosso, Brazil. The Municipal Education Department and the Regional Education Coordination Office of the State of Mato Grosso provided the list of schools and the school census counts by grade, which were cross-checked against student enrollment and attendance records.

A written questionnaire, the ISAAC phase 1 questionnaire, which is internationally standardized and has been validated for use in Brazil,[3-5] was used for the identification of asthma in children and adolescents.

Area of study and population

Tangará da Serra is located 240 km from the state capital of Cuiabá, at 423 m above sea level and a latitude of 14°04'38"S. In 2000, the Human Development Index was 0.780. In 2007, there were 76,657 inhabitants, more than 90.0% of whom were residents of the urban area.[11] The main economic activities are agriculture and livestock production.

The city lies between the plateaus of Chapada dos Parecis and Serra Tapirapuã, with a mean temperature of 25°C and relative humidity of approximately 80%, reaching 25% or less in the period of extreme drought, from the end of July through August.[12] It is within the Amazon forest biome, with typical wet and dry cycles that alter the levels of air pollution, with possible effects on human health.

The city is located in the trajectory of the dispersion of the pollutants generated from burn-offs in the region of the arc of deforestation and has a growing area of sugar cane culture on its outskirts. In the 2006/2007 harvest season, sugar cane occupied 53.7% of the cultivated area in the state.[13]

Of the 66 schools in the municipal school district, 35 were eligible for inclusion in the study. Of those, 30 were in the urban area and 5 were in the rural area. Students from 14 municipal schools, 15 state schools and 6 private schools participated in the study. Students enrolled in the *Associação de Pais e Amigos dos Excepcionais* (Association of Parents and Friends of Exceptional Children) and in the 17 Indian schools were excluded, in addition to 15 students enrolled in schools located more than 100 km from the urban area, due to the specificities of this population and the difficulty in travelling on rural roads during the rainy season. Eleven schools had no students in the age bracket defined for the study. All children from 6 to 7 years of age and all adolescents from 13 to 14 years of age were considered eligible, assuming that they were duly enrolled and attending classes regularly. For the purpose of this study, the children and adolescents were, as a group, considered students.

Data were collected between March and April of 2007 after meetings with teachers of the local education network for the presentation of the study proposal. The children and the adolescents were informed of the objectives of the study and were asked to request that their parents or legal guardians complete the questionnaires and to then return them to the school. Students who were absent when the questionnaire was applied were offered another opportunity.

The overall questionnaire return rate was 68.3% (3,362/4,922): 67.6% (3,074/4,548) in the public schools and 42.8% (160/374) in the private schools. Among the returned questionnaires, there were 128 (3.8%) in which the school of origin was not identified.

The city neighborhoods were grouped, according to a geographical criterion, as belonging to the urban area (central region) or the suburban area (neighborhoods on the outskirts of the city), thereby stratifying the analysis according to urban, suburban and rural residence.

The study was approved by the Ethics in Research Committee of the Júlio Muller University Hospital, according to ruling no. 290/07. A parent or legal guardian of each of the students evaluated gave written informed consent using a form provided as part of the questionnaire.

Data analysis

The data obtained were analyzed using the Epi Info program, version 3.2. The prevalence of asthma and asthma symptoms was calculated according to gender and age group. The chi-square (χ^2) test was used to compare the

Table 1 - Prevalence, in percentage, of asthma symptoms by gender and age group. Tangará da Serra, Brazil, 2007.

Question	6-7 years			13-14 years			Total	95% CI
	M	F	Subtotal	M	F	Subtotal		
Wheezing ever	58.1*	50.6	54.3**	44.9	41.4	42.9	48.5	46.8-50.2
Wheezing within the preceding 12 months	25.9	24.6	25.2**	17.1	15.0	15.9	20.4	19.1-21.8
Frequency of wheezing attacks							-	-
1-3 within the preceding 12 months	19.9	18.3	19.1**	12.8	10.9	11.8	15.3	14.1-16.6
≥ 4 within the preceding 12 months	5.3	4.2	4.7	3.4	3.2	3.3	4.0	3.4-4.7
Frequency of wheezing that disturbs sleep							-	-
< 1 per week	11.9	11.2	11.6	6.7	5.0	5.8	8.6	7.7-9.6
≥ 1 per week	7.8	6.5	7.1	5.3	4.9	5.1	6.1	5.3-7.0
Wheezing that impairs speech	4.5	4.9	4.7	3.6	2.4	3.0	3.8	3.2-4.5
Asthma ever	4.9	4.2	4.5	5.2	5.7	5.4	5.0	4.3-5.8
Wheezing after physical exercise	6.4	6.4	6.4	13.1	10.2	11.5	9.0	8.0-10.0
Dry nocturnal cough	45.2	43.8	43.9**	33.6	34.5	34.1	38.8	37.2-40.5

*χ^2 test for difference between genders ($p < 0.05$). **χ^2 test for difference between age groups ($p < 0.05$).

differences in proportion, at a level of significance of 5%.

The ISAAC asthma module consists of eight questions related to the symptoms of the disease. Children and adolescents who gave an affirmative response to question 2 (presence of wheezing in the preceding 12 months) were classified as asthma patients. Those giving an affirmative response to question 5 (presence of severe wheezing preventing the student from speaking two words consecutively) were classified as having severe asthma.[4,5,14]

Results

Of the 3,362 students participating in the study, 1,589 (47.3%) were male and 1,773 (52.7%) were female. Of those 3,362, 1,664 (49.5%) attended municipal schools, 1,409 (41.9%) attended state schools, and 158 (4.7%) attended private schools. As for the location of the school, 2,908 (86.5%) and 326 (9.7%) studied in urban and rural areas, respectively. In relation to the location of residence, 1,449 (44.6%) resided in an urban area, 1,449 (44.6%) in a suburban area and 245 (7.3%) in a rural area.

Of the 3,362 participants, 1,634 (48.6%) were children, of whom 816 (49.9%) were male and 818 (50.1%) were female, and 1,728 (51.4%) were adolescents, of whom 773 (45.0%) were male and 955 (55.0%) were female.

The prevalence of asthma among children was 25.2%, compared with 15.9% among adolescents ($\chi^2 = 8.34$; $p = 0.00$). The most prevalent symptoms among the children were as follows: wheezing ever; wheezing within the preceding 12 months; 1 to 3 wheezing attacks within the preceding 12 months; and dry nocturnal cough. All of these differences were statistically significant ($p < 0.05$)

Table 1 shows that the prevalence of asthma among male and female children was 25.9% and 24.6%, respectively ($\chi^2 = 0.16$; $p = 0.69$), compared with 17.1% and 15.0%, respectively, among the male and female adolescents ($\chi^2 = 0.38$; $p = 0.53$). Therefore, there were no statistically significant gender-based differences. Except for question 1 (wheezing ever), no gender-based differences in the proportion of symptoms of asthma were observed among the children. Among the adolescents, no gender-based differences were observed for any of the symptoms. The prevalence of severe asthma was 4.7% and 3.0% among the children and the adolescents, respectively, without differences among the age groups.

Considering the analyzed groups, students from private schools presented a proportion of asthma 6.4% higher than that observed for those from public schools, a difference that was not statistically significant ($\chi^2 = 0.15$; $p = 0.70$). No differences were observed between residents of urban areas and residents of rural areas in terms of the prevalence of asthma. However, when comparing the urban and suburban areas, students residing in the central areas of the city presented a higher proportion of asthma than did those in the suburban area ($\chi^2 = 6.61$; $p = 0.01$).

Discussion

In the present study, a higher prevalence of asthma and asthma-related symptoms was observed among the children, a finding that is in agreement with those of other studies,[4,9] in which it has been shown that the prevalence of asthma cases tends to decrease during adolescence.[15,16]

The prevalence of asthma in both groups was within the limits of variation observed in the Brazilian and international literature.[6,9,17,18] In the only study carried out in the state of Mato Grosso using the ISAAC questionnaire, the prevalence of asthma in the city of Cuiabá was found to be 28.2% among children and 26.4% among adolescents.[19] However, the authors classified as cases of asthma those students who gave a affirmative response to the question "Have you ever had asthma or bronchitis?", which limits the comparability with the present study, in a different criterion was used in order to define a case. In addition, according to the authors themselves, the use of the term bronchitis as a synonym of asthma can result in an overestimation of the prevalence of asthma.

The irritating effect that air pollutants, as well as environment pollutants in the home or elsewhere, compounded by low relative humidity, have on the respiratory tract in some periods of the year can cause varying degrees of wheezing. However, in periods of high humidity, characteristic of the Amazon region, the growth of fungi in the environment and the fact that individuals spend longer periods of time in the home can influence the occurrence of the disease. It has been shown that there is a seasonal variation in the number of emergency room visits due to asthma, which peaks during the rainy months of March and October.[20] However, it is impossible to determine whether this variation influences the prevalence of the disease or causes greater severity, thereby resulting in an increase in the number of emergency room visits.

Certain characteristics of the city of Tangará da Serra and of the region, such as the cotton culture, which induces pollination, as well as air pollution, whose dispersion is possibly restricted due to the barrier formed by the , might have contributed to the prevalence of asthma observed. The microregion of Tangará da Serra has an extensive area of sugar cane cultivation, and sugar cane field burn-offs release pollutants that are hazardous to human health. The region also receives emissions from other burn-offs in the arc of deforestation. Pollution is possibly associated with an increase in the prevalence of asthma and with the exacerbation of symptoms in children with asthma, as well as with a higher number of emergency room visits and hospitalizations due to asthma.[21,22] The increase in the levels of air pollution seems to have a different effect on children with asthma than on those without, causing greater damage to the former.[23]

It is known that wheezing attacks are twice as common as attacks of asthma per se, since other factors, such as viral infections, especially those caused by respiratory syncytial virus, as well as eosinophilic syndromes and parasitic infections, can cause transient wheezing.[16,24] These factors can explain the high prevalence of wheezing in the studied groups.

In other studies, the prevalence of physician-diagnosed asthma was found to be lower than that of wheezing within the preceding 12 months, with relevant variability among regions of the world and in Brazil.[4,6,9,17] This difference was also observed in the present study.

In other cities within the Amazon forest biome, the prevalence of physician-diagnosed asthma in adolescents is higher than the national mean, possibly due to, among other factors, the hot, humid climate. For example, in the cities of Manaus and Belém, the prevalence is 19.7% and 32.8%, respectively.[9] However, the question with greatest sensitivity for the identification of cases of asthma is the one related to wheezing within the preceding 12 months.[3] Therefore, the similarity of the findings for this item, when our findings are compared with the diagnoses made in the ISAAC, suggests the occurrence of underdiagnosis of asthma in both groups.

The underdiagnosis of asthma and regional differences in asthma prevalence in Brazil are probably attributable to a number of factors: diagnostic criteria; cultural issues (such as the acceptance of the disease by the family); the perception of the severity of the symptoms by the caregivers; the quality of the health care services/records; the level of access to health care services; and the degree of awareness on the part of professionals regarding the identification of the cases.

It has been reported that males are at a higher risk for developing asthma.[1,2] However,

in the present study, the prevalence of asthma was similar for both genders. There appears to be an inverse relationship between age group and the prevalence of asthma by gender. Various studies have shown that the prevalence of the disease is higher among boys in childhood and among girls in adolescence.[9,25,26] This difference might be due to hormonal factors.

Severe asthma accounts for 5% to 10% of all cases of asthma.[2] In Brazil, the prevalence of severe asthma ranges from 2.9% to 8.5% among children, compared with 2.6% to 9.1% among adolescents.[9] In the present study, the prevalence of severe asthma was within these limits.

In a study conducted in the in the Federal District of Brasília, the prevalence of severe asthma in adolescence was found to be higher among females than among males.[27] However, in two urban centers in Chile,[7] this situation was found to be more common among children. In Tangará da Serra, this was not found to be true among the children or the adolescents.

A similarity between the prevalence of severe asthma and that of physician-diagnosed asthma was observed in the present study. This probably indicates that only the most severe cases are being diagnosed.

The fact that the prevalence of asthma among students was higher in the urban area than in the suburban area shows the need for future investigations into the relationship between asthma and the characteristics of these populations.

Although the questionnaire used is internationally standardized and validated for use in Brazil, as well as being a safe, inexpensive and noninvasive method for the identification of asthma in children and adolescents,[3,4,5] minor episodes of wheezing might not be recalled by the parents or legal guardians. Snoring or rales can be confused with wheezing, and individuals with lower levels of education might find it difficult to understand the questions posed.

It is likely that many students with asthma and their relatives did not have adequate information to comprehend the importance of the measures to control and manage attacks, especially if the peculiar phase of development of the children and adolescents, as well as the effect that asthma has on their activities of daily living, is taken into account.[1,2] Asthma, when not properly controlled, can increase susceptibility to bronchial remodeling and loss of pulmonary function, as well as to worsening of quality of life.[28]

Discussion and implementation of local public policies, coordinated with the national policy, have been proposed, considering the promotion of health and prevention of the disease for all individuals, as well as the adequate treatment and follow-up evaluation of asthma patients, with community support groups and guidance provided to the affected families. In addition, the incorporation of a model of care for chronic conditions, as suggested by the World Health Organization,[29] seems relevant. It proposes the establishment of a favorable political environment, with community partnerships and strengthening of the links among patients, teams and the families.

In conclusion, the prevalence of asthma among children and adolescents in Tangará da Serra is high, a finding consistent with those of other studies carried out in Brazil and in Latin America using the ISAAC questionnaire.

References

1. Global Initiative for Asthma (GINA) [homepage on the Internet]. Bethesda: National Heart, Lung and Blood Institute. National Institutes of Health, US Department of Health and Human Services; c2000 [cited 2007 Aug 17]. Available from: http://www.ginasthma.org/
2. Sociedade Brasileira de Pneumologia e Tisiologia. IV Diretrizes Brasileiras para o Manejo da Asma. J Bras Pneumol. 2006;32(Supl 7):S447-S474.
3. 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.
4. Worldwide variations in the prevalence of asthma symptoms: the International Study of Asthma and Allergies in Childhood (ISAAC). Eur Respir J. 1998;12(2):315-35.
5. International Study of Asthma and Allergies in Childhood - ISAAC [homepage on the Internet]. New Zealand: International Study of Asthma and Allergies in Childhood. [cited 2007 Apr 20]. Available from: http://isaac.auckland.ac.nz/
6. Asher MI, Montefort S, Björkstén B, Lai CK, Strachan DP, Weiland SK, et al. Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC Phases One and Three repeat multicountry cross-sectional surveys. Lancet. 2006;368(9537):733-43. Erratum in: Lancet. 2007;370(9593):1128.
7. Mallol J, Aguirre V, Aguilar P, Calvo M, Amarales L, Arellano P, et al. Cambios en la prevalencia de asma en escolares chilenos entre 1994 y 2002. Rev Méd Chile. 2007;135(5):580-6.
8. Pearce N, Douwes J. The Latin American exception: why is childhood asthma so prevalent in Brazil? J Pediatr (Rio J). 2006;82(5):319-21.

9. 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.
10. Adital [homepage on the Internet]. Fortaleza: Agência de Informação Frei Tito para América Latina. [cited 2008 Apr 13] Silva JK, Nascimento JA. Amazônia: uma análise das migrações com base no censo demográfico 2000. Available from: http://www.adital.com.br/site/noticia.asp?lang=PT&cod=26357
11. Instituto Brasileiro de Geografia e Estatística - IBGE [homepage on the Internet]. Brasília: Ministério do Planajamento, Orçamento e Gestão. [cited 2007 May 20]. Available from: www.ibge.gov.br
12. Instituto Nacional de Meteorologia - INMET [homepage on the Internet]. Brasília: Ministério da Agricultura, Pecuária e Abastecimento; c2006 [cited 2007 May 20]. Available from: www.inmet.gov.br
13. Canasat - Mapeamento da área plantada de cana-de-açúcar no Brasil [homepage on the Internet]. São Jose dos Campos: Instituto Nacional de Pesquisas Espaciais, Divisão de Sensoriamento Remoto. [cited 2007 Nov 26]. Available from: http://www.dsr.inpe.br/mapdsr
14. 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.
15. Kamoi TO, Rosario Filho NA, Farias L. História natural da asma em crianças: há remissão na adolescência? Pediatria. 1998;20(4):310-5.
16. Taussig LM, Wright AL, Holberg CJ, Halonen M, Morgan WJ, Martinez FD. Tucson Children's Respiratory Study: 1980 to present. J Allergy Clin Immunol. 2003;111(4):661-75; quiz 676.
17. Cassol VE, Solé D, Menna-Barreto SS, Teche SP, Rizzato TM, Maldonado M, et al. Prevalence of asthma among adolescents in the city of Santa Maria, in the state of Rio Grande do Sul, Brazil: International Study of Asthma and Allergies in Childhood (ISAAC) project. J Bras Pneumol. 2005;31(3):191-6.
18. Maia JG, Marcopito LF, Amaral NA, Tavares BF, Santos FA. Prevalência de asma e sintomas asmáticos em escolares de 13 e 14 anos de idade. Rev Saúde Pública. 2004;38(2):292-9
19. Amorim AJ, Daneluzzi JC. Prevalência de asma em escolares. J Pediatr (Rio J). 2001;77(3):197-202.
20. Valença LM, Restivo PC, Nunes MS. Seasonal variations in emergency room visits for asthma attacks in Gama, Brazil. J Bras Pneumol. 2006;32(4):284-9.
21. Solé D, Camelo-Nunes IC, Wandalsen GF, Pastorino AC, Jacob CM, Gonzalez C, et al. Prevalence of symptoms of asthma, rhinitis, and atopic eczema in Brazilian adolescents related to exposure to gaseous air pollutants and socioeconomic status. J Investig Allergol Clin Immunol. 2007;17(1):6-13.
22. Chew FT, Goh DY, Ooi BC, Saharom R, Hui JK, Lee BW. Association of ambient air-pollution levels with acute asthma exacerbation among children in Singapore. Allergy. 1999;54(4):320-9.
23. Vedal S, Petkau J, White R, Blair J. Acute effects of ambient inhalable particles in asthmatic and nonasthmatic children. Am J Respir Crit Care Med. 1998;157(4 Pt 1):1034-43.
24. Martinez FD. Development of wheezing disorders and asthma in preschool children. Pediatrics. 2002;109(2 Suppl):362-7.
25. Siroux V, Curt F, Oryszczyn MP, Maccario J, Kauffmann F. Role of gender and hormone-related events on IgE, atopy, and eosinophils in the Epidemiological Study on the Genetics and Environment of Asthma, bronchial hyperresponsiveness and atopy. J Allergy Clin Immunol. 2004;114(3):491-8.
26. Mandhane PJ, Greene JM, Cowan JO, Taylor DR, Sears MR. Sex differences in factors associated with childhood- and adolescent-onset wheeze. Am J Respir Crit Care Med. 2005;172(1):45-54.
27. Felizola ML, Viegas CA, Almeida M, Ferreira F, Santos MC. Prevalence of bronchial asthma and related symptoms in schoolchildren in the Federal District of Brazil: correlations with socioeconomic levels. J Bras Pneumol. 2005;31(6):486-91.
28. Morgan WJ, Stern DA, Sherrill DL, Guerra S, Holberg CJ, Guilbert TW, et al. Outcome of asthma and wheezing in the first 6 years of life: follow-up through adolescence. Am J Respir Crit Care Med. 2005;172(10):1253-8.
29. Organização Mundial de Saúde. Cuidados inovadores para condições crônicas Componentes estruturais de ação - relatório mundial. Brasília: OMS; 2002.

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