

# Asthma trend in adolescence in Brazil: results of the National Adolescent School-based Health Survey (PeNSE 2012-2015)

*Tendência da asma na adolescência no Brasil: resultados da Pesquisa Nacional de Saúde do Escolar (PeNSE) 2012 e 2015*

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**ABSTRACT:** *Objective:* To compare the evolution of asthma indicators in the editions of the National School Health Survey (PeNSE 2012 and 2015). *Methods:* Cross-sectional study including Brazilian 9th grade students from public and private schools. Wheezing was assessed through the question: “In the past 12 months, did you have wheezing (or chirping) chest? (yes/no)”, and to assess lifetime presence of asthma, the question was “Have you ever had asthma? (yes/no)”. *Results:* Of the students, 23,52% reported wheezing or chirping chest in the past 12 months, with prevalences ranging from 16,80% (in Salvador, Bahia) to 27,43% (in Porto Alegre, Rio Grande do Sul). Lifetime presence of asthma was reported by 17,92% of the students, ranging from 13,98% (in Campo Grande, Mato Grosso do Sul) to 30,35% (in Porto Alegre, Rio Grande do Sul). There was also a decrease in the prevalence of self-report of wheezing/chirping chest in the last 12 months between the two editions of the survey (2012/2015) in 20 of the 27 Brazilian state capitals, especially in Belo Horizonte, Florianópolis, Cuiabá and Goiânia. However, prevalence of lifetime diagnostic of asthma increased from 2012 to 2015 in 26 of the 27 Brazilian state capitals. *Conclusion:* There was a decrease in the prevalence of self-report of asthma symptoms and an increase of self-reported lifetime presence of asthma. Certainly, monitoring indicators of asthma prevalence is of high importance for health knowledge and the development of public policies.

**Keywords:** Asthma. Respiratory sounds. Prevalence. Adolescents. School health services.

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**RESUMO:** *Objetivo:* Comparar a evolução dos indicadores referentes à asma nas edições da Pesquisa Nacional de Saúde do Escolar (PeNSE) 2012 e 2015. *Métodos:* Estudo transversal em que foram incluídos escolares do nono ano de escolas públicas e privadas das capitais brasileiras. Para saber se o escolar teve chiado no peito nos 12 meses anteriores ao inquérito, foi feita a pergunta: “Nos últimos 12 meses, você teve chiado (ou piado) no peito?” (sim/não). E para saber se teve asma alguma vez na vida foi questionado: “Você teve asma alguma vez na vida?” (sim/não). *Resultados:* Verificou-se que 23,52% dos estudantes relataram chiado ou piado no peito nos últimos 12 meses, variando de 16,80% em Salvador (Bahia) a 27,43% em Porto Alegre (Rio Grande do Sul). Ter asma alguma vez na vida foi relatado por 17,92% dos estudantes, variando de 13,98% em Campo Grande (Mato Grosso do Sul) a 30,35% em Porto Alegre (Rio Grande do Sul). Também foi verificada redução da prevalência de chiado (ou piado) no peito nos últimos 12 meses, entre as duas pesquisas (PeNSE 2012 e 2015) em 20 das 27 capitais do Brasil, com destaque para Belo Horizonte, Florianópolis, Cuiabá e Goiânia. Por outro lado, houve aumento da prevalência daqueles que relataram asma alguma vez na vida em 26 das 27 capitais do país. *Conclusão:* Houve tendência à redução dos sintomas de asma nos últimos 12 meses, enquanto se observa aumento na proporção de adolescentes em que a asma foi referida alguma vez na vida. De certo que o monitoramento da asma ao longo dos anos é imprescindível para gerar conhecimentos e embasar políticas públicas de controle da asma.

*Palavras-chave:* Asma. Sons respiratórios. Prevalência. Adolescentes. Serviços de saúde escolar.

## INTRODUCTION

Asthma is considered one of the most common chronic diseases in the world, affecting about 235 million people<sup>1</sup>. In the last decades, health actions have prioritized improvement in the diagnosis and management of asthma, resulting in a 42% reduction in mortality from this disease between 1990 and 2013<sup>2</sup>. However, despite this reduction in deaths, there is generally no evidence of a decline in the burden of asthma morbidity, but, on the contrary, the prevalence of asthma continues to increase, with a possible increase of more than 100 million cases of asthma until 2025<sup>3</sup>. This increase has been recorded in many regions of the world, such as Asia, North America, Latin America, Oceania, Eastern Mediterranean and Western Europe<sup>4</sup>. On the other hand, there has been a tendency to stabilize or even reduce the prevalence of the disease in some countries, such as France, Spain, and the Scandinavian countries<sup>5</sup>.

In Brazil, the prevalence of asthma symptoms among children ranged from 21.3% to 24.4% over a 7-year period (The International Study of Asthma and Allergies in Childhood – ISAAC Phase I and III)<sup>6</sup>. However, it is important to point out that only 5 centers participated in the two phases of ISAAC, and there was a reduction in the prevalence of asthma symptoms in adolescents (27.7 versus 19.9%;  $p < 0.01$ )<sup>7</sup>. The results of the ISAAC phase III study showed a higher prevalence of active asthma in the cities of Salvador, Bahia (24.6%), and Vitória da Conquista, Bahia (30.5%), and lower in Maceió, Alagoas (14.8%), Itajaí, Santa Catarina (12.3%) and Nova Iguaçu, Rio de Janeiro. The average prevalence of active asthma among Brazilian adolescents is close to 20%<sup>8</sup>.

The results of the National Adolescent School-based Health Survey (PeNSE) 2012 indicate a high prevalence of asthma symptoms (23.2%) and asthma reports in the past (12.4%) among the students surveyed<sup>9</sup>. When compared to ISAAC phase I and III, there is an increase in the prevalence of asthma symptoms in the schoolchildren population of some of the country's capitals; with the exception of Recife, whose prevalence remained stable, and Salvador, which presented a significant reduction<sup>9</sup>. These results confirm previous evidence that place Brazil among the countries with the highest prevalence of asthma in the world, and with indications that this prevalence is still growing<sup>6</sup>.

In Brazil, asthma is one of the main causes of hospital admission: in 2011, with more than 175 thousand admissions at all ages registered by the Department of Informatics of the Unified Health System (DATASUS), asthma was the fourth cause of hospitalization<sup>10</sup>. However, this condition is considered sensitive to Primary Health Care (PHC), that is, in which effective and timely outpatient care can prevent hospitalizations, prevent illnesses, treat acute illness early or control chronic illness<sup>11,12</sup>.

With the aim of increasing knowledge on the occurrence of asthma among Brazilian adolescents, PeNSE 2015, performed with students of the 9th grade, has again incorporated questions related to the identification of active asthma. Thus, the current study compares the evolution of asthma indicators in the editions of PeNSE 2012 and 2015, and can thus guide future health policies aiming at the implementation of primary prevention strategies that may contribute to reducing the number of asthma cases in our country.

## METHODS

PeNSE constitutes the most extensive survey on schoolchildren in the country and is currently in its third edition (2009, 2012 and 2015). This cross-sectional study analyzes data from PeNSE 2015, conducted by the Brazilian Institute of Geography and Statistics (IBGE) in partnership with the Brazilian Ministry of Health, to monitor the health conditions of schoolchildren. A total of 102,072 schoolchildren from the 9<sup>th</sup> year of primary school (8<sup>th</sup> grade) of public and private schools from all Brazilian states and the Federal District participated in this study. The PeNSE sample is representative of Brazil, great regions, federation units and capital cities.

For the composition of the sample, public and private schools that reported having classes of the 9th grade of elementary school in the 2013 School Census were selected. Those with less than 15 students enrolled in the 9<sup>th</sup> year in 2013 were excluded from the selection process, because although they represented more of 20% of schools, these establishments comprised little more than 3% of the total students enrolled, with a large contingent of these institutions distributed by the municipalities of the countryside. The night shift students were also excluded, not only for operational reasons, but also for representing only about 3% of the 9<sup>th</sup> grade schoolchildren.

Thus, the schools were the primary sampling units, and the classes were the secondary units. At each school in the sample, the 9<sup>th</sup> grade classes were randomly selected with equal probabilities among those in 2015, as follows: one class at each school that reported having up to two 9<sup>th</sup> grade classes, and two classes at each school with three or more 9<sup>th</sup> grade classes. In each of the selected classes, all students present were invited to answer the survey questionnaire.

Data collection was carried out by means of a smartphone, containing a structured and self-administered questionnaire, between April and September 2015.

The questionnaire addresses several aspects of the adolescents' health, such as eating habits, physical activity, substance use, family behavior, self-reported morbidity, violence, among others. More details can be found in other publications<sup>13</sup>.

In order to increase knowledge on the prevalence of asthma symptoms among schoolchildren, the two editions of PeNSE, 2012 and 2015, incorporated questions that were also investigated in ISAAC (phase I and III)<sup>14</sup>. To assess whether the student had wheezing in the 12 months prior to the survey, the following question was asked: "In the last 12 months, did you have wheezing?" (yes/no), and to assess if they ever had asthma, they were asked, "Have you ever had asthma?" (yes/no).

The prevalence of asthma with a 95% confidence interval (95%CI) was estimated according to sex (male/female), school type (public/private schools) and capitals of the Brazilian states. The information collected fed a database and were analyzed with the statistical package Statistical Analysis Software (SAS), version 14.

PeNSE 2015 was approved by the National Commission on Ethics in Research (CONEP) of the National Health Council (CNS), which regulates and approves health research involving human beings.

## RESULTS

In the PENSE survey conducted in 2015, 23.52% (95%CI 22.88 – 24.15) of the 9<sup>th</sup> grade students reported having wheezing or chirping in the last 12 months, ranging from 16.80% (95%CI 15.15 – 18.45) in Salvador, Bahia, to 27.43% (95%CI 24.52 – 30.33) in Porto Alegre, Rio Grande do Sul, with 20.14% (95%CI 19.23 – 21.06) males and 26.75% (95%CI 25.79 – 27.70) females. When the school samples were analyzed separately according to their nature, 24.06% (95%CI 23.31 – 24.81) with asthma symptoms were observed among students in the public school system and 22.06% (95%CI 20.90 – 23.22) of the private network. Having asthma ever in life was reported by 17.92% (95%CI 17.32 – 18.52) of students, ranging from 13.98% (95%CI 12.27 – 15.69) in Campo Grande to 30.35% (95%CI 26.58 – 34.13) in Porto Alegre. A slightly higher prevalence was identified for girls, 18.19% (95%CI 17.41 – 18.6), and among students from private schools, 18.43% (95%CI 17.23 – 19.62), in the total of the capitals of the Brazilian states (Table 1).

There was also a reduction in the prevalence of wheezing in the last 12 months between the two surveys (PeNSE 2012 and 2015) in 20 of the 27 Brazilian capitals, with emphasis

on Belo Horizonte, Florianópolis, Cuiabá and Goiânia. On the other hand, there was an increase in the prevalence of those who reported asthma ever in life in 26 of the country's 27 capitals (Figures 1 and 2).

## DISCUSSION

Asthma is a chronic respiratory disease that affects individuals from childhood to the end of life, has great social and economic impact, and is present in every country in

Table 1. Percentage of schoolchildren in the 9th grade who have had wheezing (or chirping) in the last 12 months and reported asthma ever in life, by sex and school type. Total of the capitals of the Brazilian states. National Adolescent School-based Health Survey, 2015.

Variables	Sex			School type	
	Total	Male	Female	Public	Private
	% 95%CI	% 95%CI	% 95%CI	% 95%CI	% 95%CI
Wheezing in the last 12 months	23.52 22.88 – 24.15	20.14 19.23 – 21.06	26.75 25.79 – 27.70	24.06 23.31 – 24.81	22.06 20.90 – 23.22
Report of asthma ever in life	17.92 17.32 – 18.52	17.64 16.80 – 18.48	18.19 17.41 – 18.96	17.73 17.04 – 18.42	18.43 17.23 – 19.62

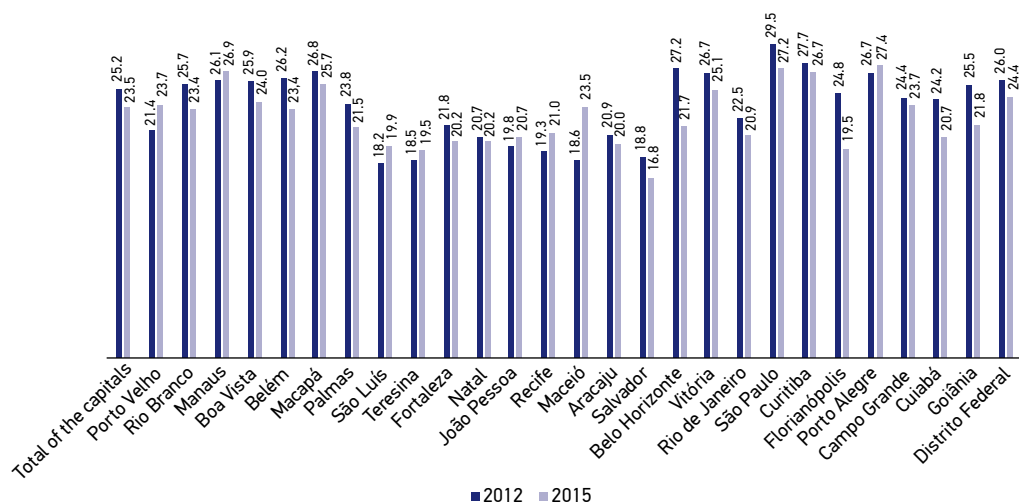


Figure 1. Percentage of schoolchildren in the 9th grade who have had wheezing in the last 12 months. Brazilian capitals (2012–2015).

the world. Asthma continues to challenge researchers seeking to understand its complex causality, as well as health professionals and managers who seek to provide for their prevention or control. Prevalence studies covering varied geographical areas that are repeated over time play an important role in allowing diverse trends to be interpreted in the light of changes observed in each region. The high prevalence of asthma symptoms in the last 12 months (23.52%) and asthma reports in the past (17.92%) among students in the 9<sup>th</sup> grade of primary school confirm the importance of asthma as a health problem among Brazilian adolescents, and highlights Brazil among the countries with the highest prevalence of asthma in the world.

The PeNSE 2015 results, compared to the PeNSE 2012 results, indicate a tendency of reduction in the prevalence of asthma symptoms in the student population of most capitals in the country. On the other hand, it was observed that the prevalence of asthma in the past has increased in all capitals, except in Cuiabá, Mato Grosso. Reducing asthma symptoms — in a context of a higher proportion of individuals that identified asthma in the past — is probably related to increased access to health services and asthma medications in recent years, allowing that a proportion of the individuals with asthma have the disease under control or in temporary remission. In order to reduce the prevalence of asthma symptoms in the year, the increase in the prevalence of asthma in one's lifetime suggests greater access to health services and greater recognition of the disease among health professionals and in the general population. A high prevalence of asthma reported ever in life has been described in developed countries, where populations have greater access to the health system, such as Australia, the Netherlands, France, and the United Kingdom<sup>15</sup>.

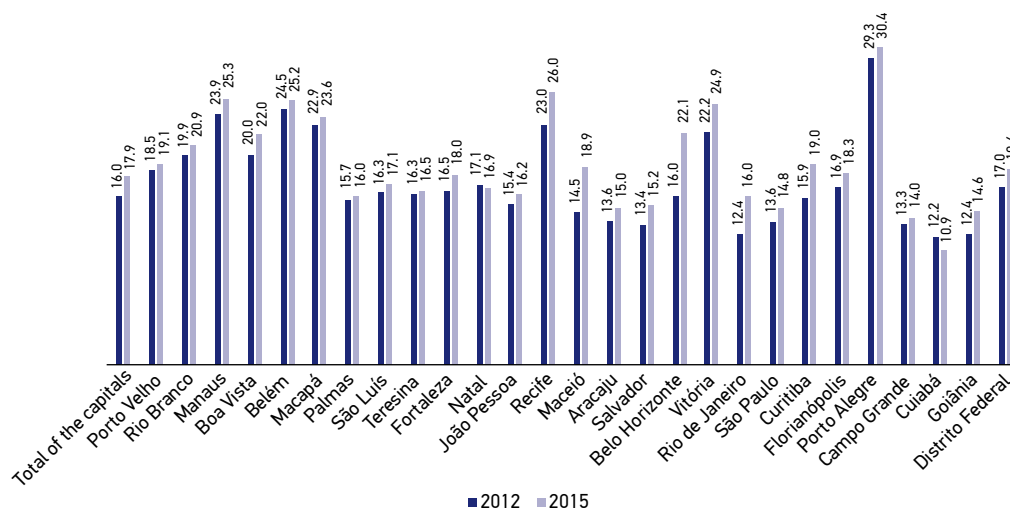


Figure 2. Percentage of schoolchildren in the 9<sup>th</sup> grade who have reported asthma ever in life. Brazilian capitals (2012–2015).

It is worth noting that in December 2010, the rules for financing and implementing the basic component of pharmaceutical assistance were approved, which allocated medicines of the national reference list of the basic component of pharmaceutical care to the asthma and rhinitis program<sup>16</sup>. In 2012, the Brazil Carinhoso program was launched, with actions aimed at reducing poverty in childhood. Among the measures envisaged is the free distribution of three drugs for the treatment of asthma (ipratropium bromide, beclomethasone, and salbutamol) through the Saúde Não Tem Preço program<sup>17</sup>. Such initiatives have contributed to the reduction of asthma morbidity and mortality indicators recorded by DATASUS in recent years.<sup>18,19</sup>

Probably, the multimedia information campaigns carried out by the Global Initiative against Asthma in Brazil (GINA) (<http://www.ginanobrasil.org.br/mortes-por-asma-2016/teste-figuras/>) have contributed to increase the recognition of asthma among health professionals and the population in general in recent years.

In the present study, the prevalence of asthma symptoms was higher among female schoolchildren. These results are consistent with those of several studies in which asthma is more prevalent in boys during childhood and in girls during adolescence<sup>20,21</sup>. This difference could be due to hormonal and behavioral changes in young females, genetic polymorphisms, among other factors not yet clearly identified.<sup>22</sup>

Despite the accumulation of information about the magnitude of the asthma problem, its risk factors and treatment options, its causes remain poorly understood, and the explanations for the development and manifestations of asthma point to a complex interaction between multiple genetic factors and environmental impacts<sup>23,24</sup>. In addition, most studies have ignored the distinction between disease phenotypes, particularly between atopic and non-atopic asthma, although these phenotypes probably present distinct causal mechanisms<sup>24</sup>. There are reports that a high proportion of asthma cases in Latin America are not attributable exclusively to atopy<sup>25</sup>. Many factors have been proposed to explain the high prevalence of non-atopic asthma, including home humidity and respiratory infections in childhood<sup>26</sup>, aspects that indicate poverty (such as low maternal schooling and filth in the household)<sup>27</sup> and, more generally, low socioeconomic conditions<sup>28</sup>, nutritional<sup>29,30</sup> and psychosocial aspects<sup>31,32</sup>. Certainly, the identification of the most relevant risk factors will be crucial to subsidize the development of interventions that aim at the prevention and control of asthma.

One of the limitations of this study may have been memory bias. Additionally, there is a concern regarding the ability of the population studied to understand the issues and provide adequate responses. However, the ISAAC written questionnaire consists of clear and easy-to-understand questions. It has been validated and applied worldwide, proving useful in the evaluation and comparison of the prevalence of asthma and allergies between different regions<sup>33</sup>.

## CONCLUSION

Several aspects of the present study give robustness to its results: the use of a standardized methodology in the two periods of the research; high response rate; rigorous checking of the data obtained and the methodology of its acquisition. The findings reported here confirm the high prevalence of asthma among Brazilian adolescents, which places it as one of the main public health problems in Brazil, especially in the adolescent population. There has been a tendency to reduce asthma symptoms in the last 12 months, while an increase in the proportion of adolescents in whom asthma has been diagnosed ever in life is observed. It is possible that a greater proportion of individuals with access to health services for diagnosis and treatment of asthma in the Unified Health System, as well as the dissemination of large national campaigns to raise awareness on the disease, are associated with this favorable trend, indicating that the control of the disease may be sensitive to simple interventions, based on population awareness, access to primary health services and, where necessary, treatment with essential medications. Therefore, actions focused on primary care may result in a significant reduction in the number of cases of the disease in our country. Of course, monitoring over the years is essential to generate knowledge and support public policies for asthma control.

## REFERENCES

1. Organização Mundial da Saúde. Fact sheet nº 307: Asthma [Internet]. 2017 [citado em 13 set. 2017]. Disponível em: <http://www.who.int/mediacentre/factsheets/fs307/en/>
2. GBD 2013 Mortality, Causes of Death. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2015; 385(9963): 117-71. [https://doi.org/10.1016/S0140-6736\(14\)61682-2](https://doi.org/10.1016/S0140-6736(14)61682-2)
3. Masoli M, Fabian D, Holt S, Beasley R, Global Initiative for Asthma P. The global burden of asthma: executive summary of the GINA Dissemination Committee report. *Allergy*. 2004; 59(5): 469-78. <https://doi.org/10.1111/j.1398-9995.2004.00526.x>
4. 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. <https://doi.org/10.4168/aair.2012.4.2.62>
5. Anandan C, Nurmatov U, van Schayck OC, Sheikh A. Is the prevalence of asthma declining? Systematic review of epidemiological studies. *Allergy*. 2010; 65(2): 152-67. <https://doi.org/10.1111/j.1398-9995.2009.02244.x>
6. 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. <https://doi.org/10.1136/thx.2006.070169>



7. Solé D, Melo KC, Camelo-Nunes IC, Freitas LS, Britto M, Rosário NA, et al. Changes in the prevalence of asthma and allergic diseases among Brazilian schoolchildren (13-14 years old): comparison between ISAAC Phases One and Three. *J Trop Pediatr*. 2007; 53(1): 13-21. <https://doi.org/10.1093/tropej/fml094>
8. Solé D, Wandalsen GF, Camelo-Nunes IC, Naspitz CK, ISAAC. Prevalência de sintomas de asma, rinite e eczema atópico entre crianças e adolescentes brasileiros identificados pelo International Study of Asthma and Allergies (ISAAC): fase 3. *J Pediatr*. 2006; 82: 341-6. <http://dx.doi.org/10.1590/S0021-75572006000600006>
9. Barreto ML, Ribeiro-Silva RC, Malta DC, Oliveira-Campos M, Andreazzi MA, Cruz AA. Prevalence of asthma symptoms among adolescents in Brazil: National Adolescent School-based Health Survey (PeNSE 2012). *Rev Bras Epidemiol*. 2014; 17: 106-15.
10. Diretrizes da Sociedade Brasileira de Pneumologia e Tisiologia para o Manejo da Asma. *J Bras Pneumol*. 2012; 38: S1-46.
11. Lenz MLM, Flores R, Pires NBV, Stein AT. Hospitalizações entre crianças e adolescentes no território de abrangência de um serviço de atenção primária. *Rev Bras Saúde Família*. 2008; 3(12): 271-81. [https://doi.org/10.5712/rbmf3\(12\)363](https://doi.org/10.5712/rbmf3(12)363)
12. Lenz MLM, Silva DDF, Camillo EG, Pires NBV, Flores R. Atendimento sequencial multiprofissional de crianças e adolescentes com asma em um serviço de atenção primária à saúde. *Rev APS*. 2014; 17(4): 438-49.
13. Brasil. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Saúde do Escolar (PeNSE), 2015 [Internet]. Rio de Janeiro: IBGE; 2015 [citado em 13 set. 2017]. Disponível em: <http://biblioteca.ibge.gov.br/visualizacao/livros/liv97870.pdf>
14. Solé D, Wandalsen GF, Camelo-Nunes IC, Naspitz CK, ISAAC Grupo Brasileiro. 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*. 2006; 82(5): 341-6. <http://dx.doi.org/10.1590/S0021-75572006000600006>
15. To T, Stanojevic S, Moores G, Gershon AS, Bateman ED, Cruz AA, et al. Global asthma prevalence in adults: findings from the cross-sectional world health survey. *BMC Public Health*. 2012; 12: 204. <https://doi.org/10.1186/1471-2458-12-204>
16. Brasil. Ministério da Saúde. Portaria nº 4.217, 28 de dezembro de 2010. *Diário Oficial da União*. 2010 dez 29; 249; Seção 1: 72-4.
17. Amaral LM, Palma PV, Leite ICG. Evolução das políticas públicas e programas de controle da asma no Brasil sob a perspectiva dos consensos. *J Bras Pneumol*. 2012; 38: 518-25. <http://dx.doi.org/10.1590/S1806-37132012000400015>
18. Souza-Machado C, Souza-Machado A, Cruz AA. Asthma mortality inequalities in Brazil: tolerating the unbearable. *ScientificWorldJournal*. 2012; 2012: 625829. <https://doi.org/10.1100/2012/625829>
19. Cardoso TA, Roncada C, Silva ERD, Pinto LA, Jones MH, Stein RT, et al. The impact of asthma in Brazil: a longitudinal analysis of data from a Brazilian national database system. *J Bras Pneumol*. 2017; 43(3): 163-8. <https://doi.org/10.1590/S1806-37562016000000352>
20. 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. <https://doi.org/10.1164/rccm.200412-1738OC>
21. Subbarao P, Mandhane PJ, Sears MR. Asthma: epidemiology, etiology and risk factors. *Can Med Assoc J*. 2009; 181(9): E181-90. <https://dx.doi.org/10.1503/cmaj.080612>
22. Anthracopoulos MB, Pandiora A, Fouzas S, Panagiotopoulou E, Liolios E, Priftis KN. Sex-specific trends in prevalence of childhood asthma over 30 years in Patras, Greece. *Acta Paediatrica*. 2011; 100(7): 1000-5. <https://doi.org/10.1111/j.1651-2227.2011.02255.x>
23. Beasley R, Semprini A, Mitchell EA. Risk factors for asthma: is prevention possible? *Lancet*. 2015; 386(9998): 1075-85. [https://doi.org/10.1016/S0140-6736\(15\)00156-7](https://doi.org/10.1016/S0140-6736(15)00156-7)
24. Pavord ID, Beasley R, Agusti A, Anderson GP, Bel E, Brusselle G, et al. After asthma: redefining airways diseases. *Lancet*. 2017.
25. Souza da Cunha S, Barreto ML, Fiaccone RL, Cooper PJ, Alcantara-Neves NM, Simões SM, et al. Asthma cases in childhood attributed to atopy in tropical area in Brazil. *Rev Panam Salud Publica*. 2010; 28(6): 405-11.
26. Strina A, Barreto ML, Cooper PJ, Rodrigues LC. Risk factors for non-atopic asthma/wheeze in children and adolescents: a systematic review. *Emerging Themes Epidemiol*. 2014; 11: 5. <https://doi.org/10.1186/1742-7622-11-5>
27. Barreto ML, Cunha SS, Fiaccone R, Esquivel R, Amorim LD, Alvim S, et al. Poverty, dirt, infections and non-atopic wheezing in children from a Brazilian urban center. *Respirat Res*. 2010; 11: 167. <https://doi.org/10.1186/1465-9921-11-167>
28. Cooper PJ, Rodrigues LC, Barreto ML. Influence of poverty and infection on asthma in Latin America. *Current Opinion Allergy Clin Immunol*. 2012; 12(2): 171-8. <https://doi.org/10.1097/ACI.0b013e3283510967>

29. de Cássia Ribeiro Silva R, Assis AM, Cruz AA, Fiaccone RL, Dinnocenzo S, Barreto ML, et al. Dietary Patterns and Wheezing in the Midst of Nutritional Transition: A Study in Brazil. *Pediatr Allergy Immunol Pulmonol*. 2013; 26(1): 18-24. <https://doi.org/10.1089/ped.2012.0182>
30. Silva RC, Assis AM, Gonçalves MS, Fiaccone RL, Matos SM, Barreto ML, et al. The prevalence of wheezing and its association with body mass index and abdominal obesity in children. *J Asthma*. 2013; 50(3): 267-73. <https://doi.org/10.3109/02770903.2012.757774>
31. Feitosa CA, Santos DN, Barreto do Carmo MB, Santos LM, Teles CA, Rodrigues LC, et al. Behavior problems and prevalence of asthma symptoms among Brazilian children. *J Psychosomatic Res*. 2011; 71(3): 160-5. <https://doi.org/10.1016/j.jpsychores.2011.02.004>
32. Alves GC, Santos DN, Feitosa CA, Barreto ML. Community violence and childhood asthma prevalence in peripheral neighborhoods in Salvador, Bahia State, Brazil. *Cad Saúde Pública*. 2012; 28(1): 86-94. <http://dx.doi.org/10.1590/S0102-311X2012000100009>
33. 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: 483-91.

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