0021-7557/05/81-04/305
Jornal de Pediatria

Prevalence and severity of asthma among adolescents and their relationship with the body mass index

Vitor E. Cassol,[1] Tiago M. Rizzato,[2] Stefania P. Teche,[2] Débora F. Basso,[3] Vânia N. Hirakata,[4] Martín Maldonado,[5] Elisângela Colpo,[6] Dirceu Solé[7]

Abstract

Objective: To investigate the relationship between the increase of body mass index and the prevalence and severity of asthma in adolescents from Santa Maria, in southern Brazil, and surrounding regions.

Method: A cross-sectional, observational, population-based study was carried out with 4,010 schoolchildren aged 13 and 14 years, without any gender restrictions, who answered the written questionnaire of the International Study of Asthma and Allergies in Childhood (ISAAC) phase III. Body mass index was used (kg/m²) as recommended by the World Health Organization for the assessment of nutritional status: below the fifth percentile (underweight), at or above the fifth percentile and below the 85th percentile (normal weight), at or above the 85th percentile and below the 95th percentile (overweight), and at or above the 95th percentile (obesity). The relationship between body mass index and the prevalence and severity of asthma was analyzed using the chi-square test for trend (statistical significance: $p \leq 0.05$).

Results: There was a significant statistical association between the increase in body mass index and the prevalence of "wheezing ever" ($p = 0.036$), and "wheezing with exercise" ($p = 0.008$). When stratified by sex, there was a positive association just for "wheezing ever" ($p = 0.028$) for boys and "wheezing with exercise" ($p = 0.03$) for girls.

Conclusion: The increase in body mass index was associated with the increase in the prevalence of wheezing ever, but not with the increase in the prevalence and gravity of asthma among adolescents.

J Pediatr (Rio J). 2005;81(4):305-9: Asthma, prevalence, adolescent, body mass index.

Introduction

Obesity, defined as excess body fat,[1] is related to chronic degenerative diseases and important metabolic disorders.[2] Asthma is a public health problem, and research studies carried out in different places around the world have shown that its prevalence among children and adolescents has been on the rise.[3-6]

In industrialized countries, this rise has coincided with the increase in obesity or in the body mass index (BMI) in children and adults.[7] Studies suggest that asthmatic children and adults are of above-average weight when compared to control individuals,[8-10] which corroborates an association between the high prevalence of asthma and obesity, more clearly observed among women and adolescent females than among boys, and also with asthma severity.[11,12]

In Brazil, asthma has been considered to be an important public health problem, based on the data obtained through the International Study of Asthma and Allergies in Childhood (ISAAC). The ISAAC was designed to maximize the validity of epidemiological surveys in asthma and allergic diseases by means of a standardized method (sampling, written questionnaire (WQ), and video questionnaire) that facilitates international collaboration and allows for the comparison of the data obtained.[13] Designed to be applied in three consecutive phases, it allowed gathering a representative patient population and getting to know the actual dimension of asthma prevalence in our setting.[14]

In the city of Porto Alegre, in southern Brazil, the highest prevalence of physician-diagnosed asthma and of asthma-

1. Pediatric pulmonologist. Chief of the Pediatric Pulmonology Department, Hospital Universitário de Santa Maria, Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brazil.
2. Undergraduate students, UFSM, Santa Maria, RS, Brazil.
3. MSc, Universidade Federal de Santa Catarina (UFSC), Florianópolis, SC, Brazil.
4. MSc, Universidade Federal de Pelotas (UFPel), Pelotas, RS, Brazil.
5. Specialization student, UFSM, Santa Maria, RS, Brazil.
6. Undergraduate student, Centro Universitário Franciscano (UNIFRA), Santa Maria, RS, Brazil.
7. Full professor, Department of Pediatrics, Universidade Federal de São Paulo/Escola Paulista de Medicina (UNIFESP/EPM), São Paulo, SP, Brazil.

Manuscript received Aug 23 2004, accepted for publication Mar 16 2005.

Suggested citation: Cassol VE, Rizzato TM, Teche SP, Basso DF, Hirakata VN, Maldonado M, et al. Prevalence and severity of asthma among adolescents and their relationship with the body mass index. J Pediatr (Rio J). 2005;81:305-9.

related symptoms has been detected among adolescents.[14,15] With regard to obesity, several Brazilian studies have shown an increase in its prevalence.[16] The frequency of obesity among children and adolescents, diagnosed using BMI, ranged from 4.4 to 15.1% according to the socioeconomic background, in Recife,[17] and amounted to 10.3% among girls and to 9.2% among boys who participated in a large population-based study conducted in the northeast and southeast of Brazil.[18] The south is one of the most developed Brazilian regions, and as indicated by the data, it has a high prevalence of asthma and obesity.

Population-based studies have not been undertaken in Brazil as far as the possible association between BMI and the prevalence and severity of asthma is concerned. Thus, the aim of the present study was to assess the relationship between increased BMI and the prevalence and severity of asthma symptoms among adolescent students residing in Santa Maria and in the neighboring region, in southern Brazil.

Patients and methods

Cross-sectional, population-based study with adolescents (13 and 14 years old) selected according to the distribution of schools in Santa Maria (systematic random sampling) obtained from the local Department of Education, after stratification by type of school (public or private) and zone (north, south, east, west and downtown), also including all public and private schools of smaller towns in the vicinity of Santa Maria (n = 152).

Of 15,080 eligible adolescents aged 13 and 14 years, 6,123 participated in the prevalence study of asthma and of asthma-related symptoms as recommended by the ISAAC[13] protocol (number of participating schools = 115). The following parameters were used to establish the size of the sample, i.e., number of participants to be submitted to anthropometric measurements: an 8% obesity prevalence, a 4% difference between groups, an 80% power and an alpha of 5%.[19] Based on these data, the sample would include 600 asthmatic patients. Since asthma prevalence was 16%, 3,750 adolescents should be evaluated. Therefore, 75/115 schools were randomly chosen, from which 4,010 adolescents (1,933 males and 2,077 females) who answered the ISAAC WQ phase III (asthma module) correctly were submitted to anthropometric measurements.

All the students answered the ISAAC WQ in the classroom in order to determine the prevalence and severity of asthma and asthma-related symptoms (at least two affirmative answers to the following: having four or more wheezing episodes in the past 12 months, or speech disorder or sleep disorder or wheezing with exercise). According to the initial validation of the ISAAC WQ the question about wheezing in the past 12 months was the one with the highest sensitivity and specificity for the diagnosis of asthma.[13] The anthropometric measurements consisted of checking the weight and height of the students, who should be barefooted and wearing light clothing. A digital scale with a 180-kg capacity and 100-g sensitivity was used. Height measurement was performed with adolescents standing upright with the bare heels together and with feet parallel using a 6-mm flexible steel anthropometric tape and a headpiece firmly lowered onto the crown of the head. The BMI (kg/m²) was calculated and checked against the NCHS[20] standards, and the nutritional status was assessed by following the World Health Organization (WHO)[21] criteria, according to which individuals with a BMI below the 5th percentile are malnourished (underweight); those at or above the 5th percentile and below the 85th percentile are well-nourished (normal weight); individuals at or above the 85th percentile are overweight; and those at or above the 95th percentile are obese.

The data obtained were stored and analyzed by Epi-Info and SPSS programs. The comparison of asthma prevalence and severity with nutritional status according to BMI percentiles was performed using the chi-square test for linear trend, for which the significance level was set at 5%.

Results

The frequency of adolescents with a BMI above the 95th percentile amounted to 6.4%, with a male predominance (58.5 *versus* 41.5%; Tables 1 and 2).

Table 1 shows the prevalence of asthma and its related symptoms, as well as the prevalence of severe asthma among adolescents as a whole, according to nutritional assessment, using BMI as a parameter. We observe an increase in the prevalence of the WQ parameters with an increase in BMI. However, we found a significant and positive association between a BMI below the 95th percentile and the prevalence of "wheezing ever" (OR = 0.83; 95%CI: 0.61-0.99; $p < 0.05$), and of "wheezing with exercise" (OR = 0.74; 95%CI: 0.55-0.99; $p < 0.05$), compared to a BMI at or above the 95th percentile. After stratification by sex (Table 2), we noted that the significant relationship between BMI and "wheezing ever" was especially perceived among boys (OR = 0.73; 95%CI: 0.52-0.98; $p < 0.05$). With regard to the prevalence of "wheezing with exercise," the increase resulted from the higher prevalence among girls (OR = 0.60; 95%CI: 0.39-0.93; $p < 0.05$).

Discussion

The relationship between the increase in BMI and asthma severity and symptoms among adolescents has not yet been investigated through a population-based study in Brazil. Given that there may probably be differences regarding risk factors for asthma between industrialized and developing countries[22] and that adiposity and its distribution differ across ethnic groups,[10,23] it is important to verify whether the risk factors detected in industrialized countries apply to developing ones in nutritional transition such as Brazil.

BMI is commonly used to measure adiposity in clinical and epidemiological studies and has shown a strong correlation in children and adults.[23] Although BMI does not allow inferring about body composition, it should be considered since it allows easy measurement, by using anthropometric data (weight and height) that are easily

Table 1 - Prevalence of asthma and related symptoms, and asthma severity among adolescents, according to nutritional assessment, using BMI

Questions	Percentile of BMI				*Odds ratio* and (IC 95%)
	< 5	≥ 5 a < 85	≥ 85 a < 95	≥ 95	< 95 x ≥ 95
	n = 167	n = 3.169	n = 416	n = 258	
Wheezing ever	41.3	39.3	44.7	44.7	0.83 (0.61-0.99)*
Wheezing in the last 12 months	12.0	15.9	16.8	18.2	0.84 (0.61-1.17)
Four or more crises	0.6	1.6	1.7	1.9	0.82 (0.33-2.07)
Sleep disorder	4.2	3.8	3.8	5.0	0.75 (0.42-1.34)
Speech disorder	3.6	4.0	3.6	3.9	1.00 (0.52-1.93)
Asthma	13.9	13.6	16.2	15.6	0.88 (0.62-1.25)
Wheezing after exercise	13.9	18.6	20.7	23.7	0.74 (0.55-0.99)*
Nocturnal cough	29.9	31.1	33.7	29.2	1.12 (0.85-1.47)
Severe asthma	4.2	4.7	4.3	7.4	0.61 (0.37-1.01)

* p < 0.05.

Table 2 - Prevalence of asthma and related symptoms, and asthma severity according to nutritional assessment using BMI, and gender

Questions	Percentile of IMC								*Odds ratio* (IC 95%)	
	< 5		≥ 5 a < 85		≥ 85 a < 95		≥ 95		≥ 95 x < 95	
	M	F	M	F	M	F	M	F	M	F
	n= 91	n= 76	n= 1.500	n= 1.669	n= 191	n= 225	n= 151	n= 107		
Wheezing ever	39.6	43.4	35.7	42.5	43.7	45.5	44.0	45.8	0.73 (0.52-0.98)*	0.98 (0.60-1.31)
Wheezing in the last 12 months	13.2	10.5	14.1	17.5	17.3	16.4	16.6	20.6	0.85 (0.54-1.33)	0.80 (0.50-1.30)
Four or more crises	1.1	0.0	1.7	1.6	1.6	1.8	1.3	2.8	1.23 (0.29-5.22)	0.57 (0.17-1.90)
Sleep disorder	5.5	2.6	3.1	4.3	2.1	5.3	5.3	4.7	0.57 (0.27-1.22)	0.94 (0.37-2.37)
Speech disorder	3.3	3.9	3.5	4.5	3.1	4.0	3.3	4.7	1.04 (0.41-2.62)	0.94 (0.37-2.37)
Asthma	10.1	18.4	13.6	13.5	16.9	15.6	14.6	17.0	0.93 (0.58-1.49)	0.81 (0.48-1.36)
Wheezing after exercise	11.1	17.1	17.6	19.4	19.8	21.4	20.7	28.2	0.84 (0.56-1.28)	0.60 (0.39-0.93)*
Nocturnal cough	30.8	28.9	24.3	37.2	27.7	38.7	21.9	39.6	1.19 (0.80-1.78)	0.91 (0.61-1.36)
Severe asthma	4.4	3.9	4.3	5.1	4.2	4.4	6.6	8.4	0.64 (0.32-1.26)	0.58 (0.28-1.17)

* p < 0,05.

obtained and easily reproducible. Studies have confirmed the usefulness of BMI as an indicator of adiposity in children and adolescents, since it is correlated with body fat estimates, assessed by skinfold measurements and bioelectric impedance.[6]

Although this study was conducted with a restricted group of adolescents, it is the first Brazilian research to assess the relationship between BMI and the prevalence and severity of asthma symptoms using the ISAAC WQ. Our data do not allow us to infer that the increase in BMI is accountable for the rise in the prevalence and severity of asthma among adolescent students. According to the ISAAC, "wheezing in the past 12 months" is the question with the highest sensitivity and specificity for the diagnosis of active asthma.[13] On the other hand, albeit the use of the medical diagnosis of asthma ("asthma ever") had high specificity, it revealed low sensitivity and, in our setting, it caused asthma to be underdiagnosed.[14,15]

In this study, we found significant and positive association between the increase in BMI only with the prevalence of "wheezing ever" for boys and "wheezing with exercise" for girls. These results are in agreement with those obtained by

other authors who also evaluated obesity using BMI as a parameter for assessing nutritional status.[24-26] A recent study,[27] which used BMI to verify a possible association between obesity and asthma symptoms through a questionnaire and the presence of obstructive ventilatory defect by spirometry, revealed an increase in the prevalence of asthma symptoms among obese individuals, but not an increase in the prevalence of obstructive defects, suggesting that a possible explanation for the increased prevalence of asthma among obese individuals would be dyspnea and exercise restrictions found in these patients.

According to Chinn & Rona,[24] the associations detected between obesity and asthma are quite recent, since only with the sufficient increase in the prevalence of obesity or the possibility of investigation of large population samples, it was possible to establish statistically significant associations between them. These associations admittedly result from the different lifestyles of obese and nonobese individuals, because according to some authors, obese individuals are more frequently exposed to tobacco and household allergens, due to the fact that they stay indoors for a longer period of time,[9,24] in addition to differences in their eating habits. The detection of positive association between BMI and the prevalence of wheezing with exercise among the adolescents evaluated here may be explained by the fact that obesity is associated with dyspnea on exertion, a symptom that may mimic asthma.[28] Data from studies with adults allow us to infer that the association between obesity and asthma symptoms may also be explained by the fact that obese adolescents have some characteristics that may mimic asthma: dyspnea on exertion, increase in respiratory effort, reduced pulmonary function, hypoventilation, sleep apnea and gastroesophageal reflux.[28,29] For Schacther et al., obese individuals with symptoms of dyspnea and wheezing are often diagnosed as asthmatic, even though no evidence of airway obstruction, reduced flow rates or airway hyperresponsiveness was detected.[3] In epidemiological studies, such as the present one, which use only the WQ, the consistency of the answers allows partially controlling these possible biases.[13] None of the WQ was refused because of that.

Another explanation for the association between obesity and asthma symptoms is the fact that overweight or obese children have a higher frequency of acute respiratory infections than those with normal weight, especially boys.[29] This fact may explain the higher frequency of "wheezing ever" associated with obesity observed herein.

Studies with asthmatic adolescents and adults show significant association between obesity and a higher prevalence of asthma symptoms among women.[29] In our study, both males and females showed an association between obesity and one asthma-related symptom. Chinn, in a recent article, states that despite the limitations of the studies there may be an association between the prevalence of asthma and BMI, at least in white children, showing scant evidence of differences between boys and girls.[30]

Asthma is a multifactorial disease in which genetic and environmental factors play a crucial role for its expression.[1] Thus, by analyzing the potential risk factors involved, the investigation should be as comprehensive as possible. The ISAAC protocol used herein restricts the identification of these factors.[13] In the present study, we could not confirm whether asthma and its severity are associated with obesity. Given the fact that obesity would result in a more frequent sedentary lifestyle for most patients, with consequent reduction in physical activity, poorer physical ability, longer time periods spent indoors and higher exposure to environmental inhalant allergens, especially to household dust, we expected to find some association, but we did not find any.

In conclusion, in this study, the increase in the BMI of Brazilian adolescents residing in Santa Maria and in the neighboring region was only associated with the increase in the prevalence of asthma-related symptoms and not with an increase in the prevalence of asthma severity. In spite of this, special attention should be given to the clinical diagnosis of asthma in obese individuals, since wheezing and dyspnea, especially during physical activity, may exacerbate its diagnosis or the assessment of its severity. Further studies are necessary to clarify this association.

References

1. World Health Organization. Physical Status: the use and interpretation of anthropometry – Report of a WHO Expert Committee. Geneva; 1995. p. 263-305.
2. Guedes DP, Guedes JP. Controle do peso corporal – composição corporal, atividade física e nutrição. Londrina: Midiograf; 1998.
3. Schachter LM, Salome CM, Peat JK, Woolcock AJ. Obesity is a risk for asthma and wheeze but not airway hyperresponsiveness. Thorax. 2001;56:4-8.
4. Seidell JC, de Groot LC, Van Sonsbeek JL, van Sonsbeek JL, Deurenberg P, Hautvast JG. Associations of moderate and severe overweight with self-reported illness and medical care in Dutch adults. Am F Public Health. 1986;76:264-9.
5. Shaheen SO, Sterne JA, Montgotery SM, Azima H. Birth weight, body mass index and asthma in young adults. Thorax. 1999;54:396-402.
6. Huang SL, Shiao GM, Chou P. Association between body mass index and allergy in teenage girls in Taiwan. Clin Exp Allergy. 1999;29:232-9.
7. Xu BX, Jarvelin MR, Pekkanen J. Body build and atopy. J Allergy Clin Immunol. 2000;105(2 Pt 1):393-4.
8. Del-Rio-Navarro BE, Fanghanel G, Berber A, Sanchez-Reyes L, Estrada-Reyes E, Sienra-Monge JJ. The relationship between asthma symptoms and anthropometric markers of overweight in a Hispanic population. J Invest Allergol Clin Immunol. 2003;13:118-23.
9. Camargo CA Jr, Weiss ST, Zhang S, Willett WC, Speizer FE. Prospective study of body mass index, weight change, and risk of adult-onset asthma in women. Arch Intern Med. 1999;159:2582-8.
10. Figueroa-Muñoz JI, Chinn S, Rona RJ. Association between obesity and asthma in 4-11 year old children in the UK. Thorax. 2001;56:133-7.
11. Martinez F J, Stanopoulos I, Acero R, Becker FS, Pickering R, Beamis JF. Graded comprehensive cardiopulmonary exercise testing in the evaluation of dyspnea unexplained by routine evaluation. Chest. 1994;105:168-74.
12. Gold DR, Rotnitzky R, Damokosh AI, Dockery DW, Berkey CS. Race and gender differences in respiratory illness prevalence and their relationship to environmental exposures in children aged 7 to 14 years of age. Am Rev Respir Dis. 1993;148:10-18.
13. 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.

14. Solé D, Vanna AT, Yamada E, Werneck G, Freitas LS, Sologuren MJ, et al. International Study of Asthma and Allergies in Childhood (ISAAC): Prevalence of asthma and asthma-related symptoms among Brazilian school chidren. J Invest Allergol clin Immunol. 2001;11:123-8.
15. Camelo-Nunes IC, Wandalsen GF, Solé D. Asma em escolares brasileiros: problema de saúde pública? J Pediatr (Rio J). 2003;79:472-3.
16. Mello ED, Luft VC, Meyer F. Obesidade infantil: como podemos ser eficazes? J Pediatr (Rio J). 2004;80:173-82.
17. Balaban G, Silva GA. Prevalência de sobrepeso e obesidade em crianças e adolescentes de uma escola da rede privada de Recife. J Pediatr (Rio J). 2003;77:96-100.
18. Abrantes MM, Lamounier JA, Colosimo EA. Prevalência de sobrepeso e obesidade em crianças e adolescentes das regiões Sudeste Nordeste. J Pediatr (Rio J). 2002;78:335-40.
19. Fletcher RH, Fletcher SW, Wagner EH. Epidemiologia clínica: elementos essenciais. 3ª ed. Porto Alegre: Artmed; 1996.
20. NCHS, National Center for Health Statistics/National Center for Chronic Disease Prevention and Health Promotion (2000), http://www,cdc,gov/growthcharts,
21. World Health Organization, WHO, Physical Status: the use and interpretation of anthropometry – Report of a WHO Expert Committee. Geneve; 1995. p. 263-305.
22. Mallol J, Solé D, Asher I, Clayton T, Stein R, Soto-Quiroz M. Prevalence of Asthma Symptoms in Latin America: The International Study of Asthma and Allergies in Childhood (ISAAC). Pediatr Pulmonol. 2000;30:439-44.
23. Must A, Dalla GE, Dietz WH. Reference data for obesity: 85th and 95th percentiles of body mass index (Wh/Ht²) and triceps skin fold thickness. Am J Clin Nutr. 1991;53:839-56.
24. Chinn S, Rona RJ. Can the increase in body mass index explain the rising trend in asthma in children? Thorax. 2001;56:845-50.
25. Kaplan TA, Montana E. Exercise Induced bronchospasm in non-asthmatic. Obese Children. Clin Pediatr. 1993;32:220-5.
26. Somerville SM, Rona RJ, Chinn S. Obesity and respiratory symptoms in primary school. Arch Dis Child.1984;59:940-4.
27. Sin DD, Jones RL, Man SF. Obesity is risk factor for dyspnea but not for airflow obstruction. Arch Intern Med. 2002;162:1477-81.
28. Chen Y, Dales R, Tang M, Krewski D. Obesity may increase the incidence of asthma in women but not in men; longitudinal observations from the Canadian National Population Health Surveys. Am J Epidemiol. 2002;155:191-8.
29. von Kries R, Hermann M, Grunert VP, von Mutius E. Is obesity a risk factor for childhood asthma? Allergy. 2001;56:318-22.
30. Chinn S. Obesity and asthma: evidence for and against a causal relation. J Asthma. 2003;40:1-10.

Correspondence:
Tiago Moraes Rizzato
Rua Luiz Antônio Maffini, 45/3, Centro
CEP 97060-420 – Santa Maria, RS, Brazil
Tel.: + 55 (55) 221.3377
Fax: +55 (55) 221.7712
E-mail: tiagorizzato@yahoo.com.br