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Prevalence and factors associated with asthma in students from Montes Claros, Minas Gerais, Brazil

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Abstract *We investigated the prevalence of asthma and factors related to asthma development in schoolchildren aged 6 to 14, living in central and peripheral areas of the city of Montes Claros, Minas Gerais and who were registered with the Family Health Strategy program. Initially, a standard written questionnaire, based on ISAAC (International Study of Asthma and Allergies in Childhood), was administered to collect personal data, information regarding income, asthma prevalence, allergic rhinitis and eczema (N = 1,131). Secondly, a case-control study was performed by grouping the patients as either asthmatic (A; N = 172) or non-asthmatic (NA; N = 379). Potential factors associated with the occurrence of asthma were evaluated using the complementary questionnaire from ISAAC phase II. Skin tests for immediate hypersensitivity (STIH) and parasitological tests were also performed. The odds ratio, estimated by multivariate analysis, indicated that asthma cases were related to kindergarten attendance, household smoking, family history of asthma, rhinitis and positive STIH. It was concluded that, in the studied population, the prevalence of asthma was related to genetic predisposition, in addition to individual history, social demographics, exposure to pollutants such as tobacco smoke and a positive response to allergy testing.*

Key words *Asthma, Allergens, Rhinitis, Eczema*

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Introduction

Allergic diseases are defined as global health problems affecting both developed and non-developed countries, and are responsible for individual suffering and high socioeconomic burden[1]. In particular, asthma is the most common chronic disease of the respiratory tract in children[2], causing morbidity and decreased quality of life for both patients and relatives[1]. There have been many recent advances in the understanding of asthma etiology and the mechanisms involved in asthma pathophysiology, as well as the development of new treatments. However, studies conducted in different countries suggest that asthma prevalence is increasing in children and teenagers[3].

Asthma is a serious public health problem, with both social and economic impacts, since it overloads health services. Recent estimates indicate that asthma affects 334 million people worldwide[4]. In Brazil, asthma is diagnosed in over 20% of children and young people between 7 and 14 years[5]. The age of asthma development can be determined by genetic factors in 34% of cases and by environmental factors in 66%[6]. However, as the innate and adaptive immune responses remain immature in pre and postnatal life, individuals are more susceptible to asthma and similar diseases during childhood[7].

Epidemiological studies are often used to monitor prevalence trends, to determine the associated factors and severity of allergic diseases, especially asthma and allergic rhinitis[8-10]. Classic risk factors for asthma are a family history of allergic diseases, sensitization to environmental allergens (including aeroallergens), exposure to endotoxins, fungal and viral respiratory infections in early life. However, these factors do not fully explain the onset and chronicity of asthma[11]. Other factors that have also been associated with asthma prevalence include male gender, low birth weight, maternal or household smoking and secondary exposure to pollution in urban areas[11]. Moreover, asthma can also be aggravated by climate changes, exposure to irritant chemicals, physical exercise and emotional factors[7]. As a means of verifying and recording trends in the prevalence and severity of asthma and allergic diseases in different countries, ISAAC (International Study of Asthma and Allergies in Childhood) has developed specific research instruments[12]. The use of a standardized ISAAC questionnaire minimizes variations in asthma prevalence estimates, allowing comparison across different locations[12]. In Brazil, this instrument was translated into Portuguese and both reproducibility and validity have been verified[13].

Despite advances in data recording aiding the estimates of asthma prevalence in Brazil, regional data are still scarce. To date there has been limited capacity to identify the magnitude of disease burden within specific populations and compare the results with previously obtained data from other regions of the country[9]. Within this context, the present study utilized ISAAC questionnaires to investigate asthma prevalence and factors related to its development in schoolchildren living in central and peripheral areas of the city of Montes Claros, Minas Gerais.

Methods

A cross-sectional study was performed, carried out in two sequential and dependent stages. Schoolchildren aged from 6 to 14 years old, living in central and peripheral areas of Montes Claros, Minas Gerais, Brazil and who were registered with the Family Health Strategy (FHS) program were eligible to participate in the first stage of the study.

Initially, a standard written questionnaire (WQ) developed by ISAAC was administered in a version validated for use in the Brazilian population[10]. Between the end of 2007 and the beginning of 2008, 1,240 WQs were distributed, with 1,131 of them being considered valid, as they were answered properly (8.8% loss). These questionnaires were forwarded to parents and/or guardians responsible for the students and were administered during FHS medical meetings or by the research team directly at the recipients' homes. Questionnaires were collected after a maximum of five days. Written informed consent on behalf of the student was considered an inclusion criterion.

The WQ contains a field requesting a brief description of student personal data and income, in addition to three sections specific to asthma, allergic rhinitis and eczema. With respect to asthma, the evaluated topics were: cumulative prevalence, active asthma condition, medical diagnosis, associated symptoms, severity, and association with other allergic diseases (rhinitis, eczema and rhinitis, or eczema alone). The prevalence of accumulated asthma was evaluated by the percentage of affirmative answers to question 1 of the asthma module: "wheezes at some point in your life?". The prevalence of active asthma

Ciência & Saúde Coletiva, 21(4):1207-1216, 2016

was estimated by the percentage of affirmative responses to question 2: "wheezes in the last 12 months?". The prevalence of asthma as diagnosed by a physician was assessed indirectly by affirmative answers to question 6: "asthma any time in life?". When necessary, the technical terms and any other doubt regarding the questions were explained during the interview.

In accordance with the answers to the WQ, a second stage case control study was performed, where students were divided into asthmatic (A) and non-asthmatic (NA) groups. Students providing positive answers to question 2 of the ISAAC questionnaire, which asked about "the occurrence of wheezes in the last 12 months" were considered asthmatics. Potential factors associated with the occurrence of asthma in the population were investigated, using the complementary questionnaire (CQ) from ISAAC phase II[10] in both groups. The CQ is comprised of 33 questions related to personal data, environmental, dietary and family conditions, diet, infections and immunizations.

Sampling during the second stage was performed with the purpose of keeping the NA/A ratio close to two to one. A 20% in controls prevalence for each factor associated with asthma , 1.5 odds ratio (OR), alpha error of 5% and test power of 85%[5] were assumed. Therefore, all 230 schoolchildren classified as A were included and 460 NA patients were selected by simple random sampling. The final sample, consisting of the selected students whose parents answered the CQ, contained 172 (31.2%) individuals within the A group and 379 (68.8%) within of the NA group. Similarities between the A and NA groups, in terms of distribution of variables such as gender, residential location (peripheral or central area) and maternal education, was confirmed using chi-square tests. P-values < 0.05 were considered significant.

The study also included a skin test for immediate hypersensitivity (STIH) and a parasitological stool test (PST). The STIH included a standard battery of aeroallergens (FDA Allergenic®, Brazil): *Dermatophagoides pteronyssinus* (Dp), *Blomia tropicalis* (Bt), *German cockroach* (Gc), *American cockroach* (Ap), dog epithelium (De), cat epithelium (Ce), pollen mix (Po), fungi mix (Fa), positive control (histamine, 10 mg/mL) and negative control (excipient, salt solution). The test was performed on the anterior surface of the forearm and allergens that induced papule formation with an average diameter equal to or greater than 3 mm were considered positive[14].

The initial parasitological test was carried out by processing the students stool samples using the Hoffmann spontaneous sedimentation technique[15]. The students who tested positive for larvae or eggs of the following helminths were considered to have a parasitic infection: *Strongyloides stercoralis, Ascaris lumbricoides, Ancylostoma duodenale, Necator americanus, Taenia solium* and *Schistosoma mansoni.*

Obtained data were entered into an Excel® spreadsheet and statistical analysis was conducted with SPSS® software (Inc, Chicago, IL). The relative and absolute frequencies of studied variables were determined. The association between asthma prevalence and independent variables (personal characteristics, environmental characteristics, eating habits, and health conditions) were tested by bivariate analysis and multivariate analysis using non-conditional binary logistic regression, with estimated OR and respective 95% confidence intervals (CI 95%) reported. Only variables having p-values < 0.20 in bivariate analysis were included in multivariate analysis, and were assessed using the stepwise backward selection procedure. The final model was comprised of factors associated with asthma occurrence (at 5% level) and/or those kept as control variables. The Hosmer-Lemeshow test was used to determine the quality of the model fit to the observed data[16].

The study was approved by the Ethics Committees of both São Paulo Federal University and Montes Claros State University. All parents and/or guardians provided written informed consent.

Results

The prevalence of asthma, rhinitis and eczema symptoms within the group of 1,131 students answering the WQ during the first stage of the study were assessed according to residential location (center or periphery) and are shown in Table 1. The prevalence of asthma based on symptoms and medical diagnosis, as well as the prevalence of flexural eczema was higher among students from peripheral areas, while cases of rhinitis mainly occurred in individuals from the central area (Table 1).

Of the 551 students participating in the second stage of the study, 48.8% were male and 51.2% female, 46.6% lived in peripheral areas and 53.4% in the central city area. Table 2 shows the results of bivariate analysis assessing relationships between personal, environmental, eating

Table 1. Prevalence of asthma, rhinitis and eczema symptoms in students from Montes Claros, Minas Gerais, according to residential location.

Disease / symptoms	All places (n = 1131)		Periphery (n = 361)	Central (n = 770)	OR (CI95%)	p-value
	n (%)	CI95%	n (%)	n (%)		
Asthma						
Wheezes any time	587 (51.9)	49.0-54.8	195 (54.0)	392 (50.9)	0.9 (0.7-1.1)	0.330
Wheezes last year	230 (20.3)	18.0-22.7	88 (24.4)	142 (18.4)	0.7 (0.5-0.9)	0.012*
More than 4 episodes last year	56 (4.8)	3.2-5.6	20 (4.7)	36 (4.7)	0.9 (0.5-1.5)	0.580
Sleep compromise ≥ 1x/without	104 (9.2)	7.5-10.9	34 (9.4)	70 (9.1)	0.9 (0.6-1.2)	0.722
Speech limitation	52 (4.6)	3.4-5.8	21 (5.8)	31 (4.0)	0.7 (0.4 -1.2)	0.180
Medical diagnosis of asthma	47 (4.2)	3.0-5.3	24 (6.6)	23 (3.0)	0.4 (0.2-0.8)	0.004*
Rhinitis						
Wheeze during exercises	80 (7.1)	5.6-8.6	33 (9.1)	47 (6.1)	0.6 (0.4-1.0)	0.063
Nocturnal cough	478 (42.3)	39.4-45.1	148 (41.0)	330 (42.9)	1.1 (0.8-1.4)	0.555
Nasal symptoms last year	414 (36.6)	33.8-39.4	116 (32.1)	298 (38.7)	1.2 (1.01-1.4)	0.036*
Rhinoconjunctivitis	205 (18.1)	15.9-20.4	61 (16.9)	144 (18.7)	1.1 (0.8-1.6)	0.463
Eczema						
Flexural eczema	104 (9.2)	7.5-10.9	44 (12.2)	60 (7.8)	0.6 (0.4-0.9)	0.017*
Skin lesions disappear	90 (8.0)	6.4-9.5	37 (10.2)	53 (6.9)	0.6 (0.4-1.0)	0.051

OR: odds ratio; CI95%: 95% confidence interval; * $p < 0.05$. ** Category of reference for the calculation of OR is the "Central" place of residence.

Table 2. Bivariate analysis of risk factors for asthma based on asthma status.

Variables	Asthmatics		Non-asthmatics		Total		OR_b (CI-95%)	p-value
	n	%	n	%	n	%		
Personal characteristics								
Gender								
Female	80	46.5	202	53.3	282	51.2	1.00	0.140*
Male	92	53.5	177	46.7	269	48.8	1.31 (0.92-1.88)	
Has younger brothers								
No	70	40.7	168	44.3	238	43.2	1.00	0.426
Yes	102	59.3	211	55.7	313	56.8	1.16 (0.81-1.67)	
Has older brothers								
No	69	40.1	157	41.4	226	41.0	1.00	0.772
Yes	103	59.9	222	58.6	325	59.0	1.1 (0.73-1.52)	
Exclusive breastfeeding up to six months								
Yes	33	19.2	63	16.6	96	17.4	1.00	0.463
No	139	80.8	316	83.4	455	82.4	0.84 (0.53-1.34)	
Prematurity								
No	149	88.2	343	93.0	492	91.4	1.00	0.065*
Yes	20	11.8	26	7.0	46	8.6	1.77 (0.96-3.27)	
Low birth-weight								
No	135	86.5	300	88.2	435	87.7	1.00	0.593
Yes	21	13.5	40	11.8	61	12.3	1.17 (0.66-2.06)	
Attended daycare or nursery								
No	142	82.6	329	86.8	471	85.5	1.00	0.190*
Yes	30	17.4	50	13.2	80	14.5	1.39 (0.85-2.28)	
Attended kindergarten								
No	46	26.7	146	38.5	192	34.8	1.00	0.007**
Yes	126	73.3	233	61.5	359	65.2	1.72 (1.16-255)	

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Table 2. continuation

Variables	Asthmatics		Non-asthmatics		Total		OR_b (CI-95%)	p-value
	n	%	n	%	n	%		
Environmental characteristics								
Lives in central area								
No	77	44.8	180	47.5	257	46.6	1.00	
Yes	95	55.2	199	52.5	294	53.4	1.12(0.78-1.60)	0.552
Intradomiciliary dog								
No	44	25.6	132	34.8	176	31.9	1.00	
Yes	128	74.4	247	65.2	375	68.1	1.56(1.04-2.33)	0.031**
Intradomiciliary cat								
No	136	79.1	280	73.9	416	75.5	1.00	
Yes	36	20.9	99	26.1	135	24.51	0.75(0.49-1.15)	0.189*
Intradomiciliary bird								
No	125	72.7	290	76.5	415	75.3	1.00	
Yes	47	27.3	89	23.5	136	24.7	1.23(0.1-1.85)	0.332
Any other intradomiciliary furry animal								
No	161	93.6	356	93.9	517	93.8	100	
Yes	11	6.4	23	6.1	34	6.2	1.06(0.50-2.22)	0.883
Other intradomiciliary animals								
No	161	93.6	365	96.3	526	95.5	1.00	
Yes	11	6.4	14	3.7	25	4.5	1.78(0.79-4.00)	0.158*
Shared bedroom								
No	36	20.9	75	19.8	111	20.1	1.00	
Yes	139	79.1	304	80.2	440	79.9	0.3(0.60-1.46)	0.757
Uses foam pillow								
No	42	24.4	80	21.1	122	22.1	1.00	
Yes	130	75.6	299	78.9	429	77.9	0.83(0.54-1.27)	0.386
Visible mold on wall or ceiling								
No	102	59.6	222	58.6	324	58.9	1.00	
Yes	69	40.4	157	41.4	226	41.1	0.96(0.66-1.38)	0.813
Maternal smoking during the first year								
No	144	83.7	326	86.0	470	85.3	1.00	
Yes	28	16.3	53	14.0	81	14.7	1.20(0.73-1.97)	0.481
Maternal smoking during pregnancy								
No	145	84.3	330	87.1	475	86.2	1.00	
Yes	27	15.7	49	12.9	76	13.8	1.25(0.75-2.08)	0.382
Smoking in the house								
No	103	59.9	258	68.1	361	65.5	1.00	
Yes	69	40.1	121	3.19	190	34.5	1.43(0.98-2.08)	0.061*

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and health characteristic of evaluated schoolchildren based on the presence or absence of asthma. Variables with p-values below 0.20 were chosen for integration into the multivariate model.

In the multivariate analysis (Table 3), attendance at kindergarten (OR = 1.67), household smoking (OR = 1.53), occurrence of rhinitis (OR = 3.35), family history of asthma (OR = 3.02) and positive STIH (OR = 2.48) remained significantly associated with the prevalence of asthma.

Table 2. continuation

Variables	Asthmatics n	Asthmatics %	Non-asthmatics n	Non-asthmatics %	Total n	Total %	OR_b (CI-95%)	p-value
Eating habits								
Consumption of raw vegetables								
Yes	96	55.8	215	56.7	311	56.4	1.00	
No	76	44.2	164	43.3	240	43.6	1.04(0.72-1.49)	0.841
Consumption of cooked								
vegetables	134	77.9	270	71.2	404	73.3	1.00	
Yes	38	22.1	109	28.8	147	26.7	0.70(0.46-1.08)	0.101*
No								
Consumption of red meat	156	90.7	332	87.6	488	88.6	1.00	
Yes	16	6.3	47	12.4	63	11.1	0.72(0.39-1.32)	0.290
No								
Consumption of fresh fruits	139	80.8	303	79.9	442	80.2	1.00	
Yes	33	19.2	76	20.1	109	19.8	0.95(0.60-1.49)	0.813
No								
Consumption of fruit juice	165	95.9	364	96.0	529	96.0	1.00	
Yes	07	4.1	15	4.0	22	4.0	1.03(0.41-2.57)	0.950
No								
Consumption of soft drinks	161	93.6	357	94.2	518	94.0	1.00	
Yes	11	6.4	22	5.8	33	6.0	0.90(0.43-1.90)	0.787
No								
Consumption of fish	14	8.1	16	4.2	30	5.4	1.00	
Yes	158	91.9	363	95.8	521	94.6	0.50(0.24-1.04)	0.060*
No								
Health Conditions								
Verminosis history	102	59.3	240	63.3	342	62.1	1.00	
No	70	40.7	139	36.7	209	37.9	1.19(0.82-1.71)	0.367
Yes								
Occurrence of rhinitis	64	37.2	262	69.1	326	59.1	1.00	
No	108	62.8	117	30.9	225	40.8	3.78(2.59-5.52)	0.000**
Yes								
Occurrence of eczema	145	84.3	343	90.5	488	88.6	1.00	
No	27	15.7	36	9.5	63	11.4	1.77(1.04-3.03)	0.034**
Yes								
Family history of asthma	154	89.5	366	96.6	520	94.4	1.00	
No	18	10.5	13	3.4	31	5.6	3.30(1.57-6.88)	0.001**
Yes								
Family history of rhinitis	132	76.7	325	85.8	457	82.9	1.00	
No	40	23.3	54	14.2	94	17.1	1.82(1.15-2.88)	0.010**
Yes								
Family history of eczema	158	91.9	359	94.7	517	93.8	1.00	
No	14	8.1	20	5.3	34	6.2	1.59(0.79-3.23)	0.196*
Yes								
Parasitological test* (n = 280)	70	80.5	162	83.9	232	82.9	1.00	
Negative	17	19.5	31	16.1	48	17.1	1.27(0.66-2.44)	0.475
Positive								
STIH	43	25.0	166	43.8	209	37.9	1.00	
Negative	129	75.0	213	56.2	342	62.1	2.34(1.57-3.49)	0.000**
Positive								

OR: odds ratio; CI95%: 95% confidence interval. STIH: Skin tests for immediate hypersensitivity. * $p < 0.20$; ** $p < 0.05$

Ciência & Saúde Coletiva, 21(4):1207-1216, 2016

Table 3. Factors associated with the prevalence of asthma (multivariate analysis – logistic regression model).

Variables	Gross Analysis		Adjusted Analysis	
	OR_b (CI95%)	p-value	OR_b (CI95%)	p-value
Prematurity				
No	1.00		1.00	
Yes	1.77(0.96-3.27)	0.065	1.86(0.93-3.72)	0.080
Attended kindergarten				
No	1.00		1.00	
Yes	1.72(1.16-2.55)	0.007	1.67(1.10-2.66)	0.024
Smoking in the house				
No	1.00		1.00	
Yes	1.43(0.98-2.08)	0.061	1.53(1.01-2.33)	0.047
Intradomiciliary dog				
No	1.00		1.00	
Yes	1.56(1.04-2.33)	0.031	1.51(0.97-2.34)	0.070
Fish consumption				
No	1.00		1.00	
Yes	0.50(0.24-1.04)	0.060	0.45(0.21-1.02)	0.057
Occurrence of rhinitis				
No	1.00		1.00	
Yes	3.78(2.59-5.52)	0.000	3.35(2.24-5.01)	0.000
Family history of asthma				
No	1.00		1.00	
Yes	3.30(1.57-6.88)	0.001	3.02(1.35-6.76)	0.000
STIH				
Negative	1.00		1.00	
Positive	2.34(1.57-3.49)	0.000	2.48(1.60-3.85)	0.000

OR: odds ratio; CI95%: 95% confidence interval. STIH: Skin tests for immediate hypersensitivity. Hosmer & Lemeshow Test: $\chi^2 = 0.224$ (p-value = 0.224); - 2log likelihood = 579.03; Pseudo $R^2_{Nagelkerke} = 0.212$.

Discussion

The development of asthma is multifactorial in nature and is associated with both genetic and phenotypic heterogeneity, making it challenging to compare the results from different asthma studies[17]. Asthma presents as a complex interaction between environmental stimuli and immunological responses[17]. In this study, the application of an ISAAC standard questionnaire aided the identification of factors associated with asthma prevalence, including attendance at kindergarten, household smoking, family history and factors linked to the immunological system, such as rhinitis and positive responses to STIH. Although the data were collected in 2007-2008, it should be taken into account that the prevalence of asthma in Brazil has been a significant health problem for many years[5,18,19]. The results from this study are therefore likely to have current relevance. In addition, this work addresses a gap in knowledge regarding asthma epidemiology in Montes Claros, and in future will serve as a reference for the adoption of control measures for asthma in this region.

Epidemiological data shows that children born and raised in rural environments are exposed to a wider diversity of microorganisms such as fungi and bacteria. This results in the development of stronger innate and adaptive immunity, including increased activity of regulatory T cells, which act as mediators of such protection[20,21]. In this study however, children from peripheral areas, who may be comparable to children from rural areas, presented with higher incidence of asthma and eczema. Usually, socioeconomic conditions in these areas, such as poor sanitation, substandard living conditions and large reservoirs of inhalant allergens contribute to disease development[22]. Despite the urbanization of rural and remote areas in Brazil and other places in Latin America, with the aid of social and health programs and broadening of infrastructure services[23,24], there are still discrepancies in healthcare and disease prevalence, as disclosed by this study.

Kindergarten attendance was a personal characteristic assessed as a possible factor associated with the incidence of asthma in the investigated population. Other studies report that kindergarten attendance may contribute to development of the immune system and, therefore, can act as a protective factor against the development of childhood asthma. It is likely that kindergarten attendance promotes interactions between children of different ages in an environment with a high diversity of microorganisms[25]. In this study however, the chance of asthma development in children who attended kindergarten was 1.67 times higher compared with those who did not. This suggests that attending kindergarten is not a factor able to solely explain the emergence of childhood asthma. Further investigations will be necessary to ascertain what conditions are associated with the development of asthma in children attending kindergarten.

Among the environmental factors studied, the only factor associated with higher prevalence of asthma was the presence of household smokers, which increased disease prevalence by 1.53-fold. Tobacco smoke is an environmental pollutant of high impact since it is composed of several toxic, carcinogenic and mutagenic substances, which negatively affect the health of both active and passive smokers[26]. There are controversies regarding the association of age with vulnerability to tobacco smoke, however some studies indicate that maternal or familial smoking causes the development and/or exacerbation of asthma[10,27]. In the pre and postnatal phases, it is known that tobacco smoke leads to the development of asthma through induction of interleukin (IL)-13, which stimulates immunoglobulin E (IgE) production, infiltration of inflammatory cells and bronchial hyper-reactivity[27]. This knowledge reinforces the necessity of compliance with the World Health Organization recommendations to utilize legislation and public education to ensure completely tobacco free environments. Such actions would assist in reducing the negative impact of smoking on children's and young people's health[26].

The development of asthma is frequently associated with atopic sensitization, which can also contribute to rhinitis and eczema development[28]. In this study, asthma was positively associated with the occurrence of allergic rhinitis, as previously reported in other epidemiological studies[29,30]. In our work, prevalence of allergic rhinitis increased the chance of asthma development by 3.35-fold, which is consistent with previous literature[31]. Furthermore, the chance of asthma development was 2.48 times higher in children with positive STIH results, which is the most popular method for the diagnosis of allergic diseases, particularly those caused by aeroallergens[17,32].

Allergies occur most frequently after children reach the age of two years[28]. Among the major sensitizing agents are mites within house dust, fungi, cockroaches and animal epithelial allergens[28]. Such agents, as well as the immunological responses they initiate, are important risk factors for asthma development, and sensitized children have higher chances of developing new or more severe allergic conditions when constantly exposed to specific allergens[33].

Genetic factors may also be related to asthma, since the prevalence of allergy in relatives, especially first-degree relatives, is considered an important risk factor for asthma development[34]. Confirming this , our results showed that children whose parents, particularly mothers, reported asthma, rhinitis or eczema had a 3.02 times higher chance of developing asthma. However, genetic factors alone cannot explain the prevalence of asthma, and the involvement of geographic and environmental factors should be considered[6,35]. Therefore, the higher association of maternal allergies with asthma development may also involve immunologic factors during pregnancy, genetic polymorphisms, interactions with oxidative stress genes, maternal exposure to environmental factors both inside and outside the home, exposure to tobacco smoke and occurrence of maternal atopy[11,36].

In conclusion, asthma prevalence in schoolchildren in Montes Claros was not only related to genetic predisposition, but was also associated with individual history, social demographics, exposure to pollutants such as tobacco smoke and positive responses to allergens. These results obtained can be compared to those from other studies, since they were obtained using a standardized ISAAC protocol. A limitation to this study was the cross-sectional design, limiting our ability to identify the time sequences between exposure to risk factors and development of allergic diseases. However, the data are useful for highlighting the role of residential location in increasing the risk of asthma development, and demonstrate a need for planning specific strategies to prevent and control asthma.

Collaborators

MAQ Coelho and D Solé participated in project preparation, data collection, data assembly, analysis, and article writing. PQ Marques participated in data collection and article writing. L Pinho and MF Silveira participated in data analysis, writing and revision of the manuscript.

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