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# Prevalence of Asthma, Allergic Rhinitis, and Eczema in Schoolchildren From Huambo, Angola: A Cross-Sectional Study

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## ABSTRACT

**Background and Aims:** Asthma is the most common chronic non-communicable disease in children with a higher prevalence in high-income countries, however, the majority of asthma-related deaths occur in low- and middle-income countries, including Angola. Therefore, we aimed to investigate the prevalence of asthma and allergic diseases among schoolchildren in Huambo, Angola's fourth most populous province.

**Methods:** A cross-sectional study was carried out in April and May 2022 among schoolchildren aged 6–14 using the ISAAC methodology. The questionnaire included questions on asthma, allergic rhinitis, and eczema symptoms, as well as environmental exposure and risk factors. Twenty schools were randomly selected.  $\chi^2$  tests and univariate and multivariate logistic regression analyses examined associations between categorical variables. A *p*-value of < 0.05 was considered significant.

**Results:** The final sample included 1807 schoolchildren, all of whom lived in an urban area, 52.2% were girls, with a mean age of  $11.9 \pm 2.92$  years, and 21.3% of whose parents were illiterate. Current asthma, allergic rhinitis, and eczema prevalence were 7.7%, 23.7%, and 15.8%, respectively, and none of the schoolchildren with asthma were regularly followed up by a physician or were medicated for asthma. The mother's educational level was positively associated with asthma (p = 0.022) and eczema (p = 0.042) prevalence, while having allergic rhinitis was positively associated with older schoolchildren (p < 0.001). Concerning the risk factors studied, schoolchildren with allergic rhinitis [AOR: 3.88 (95%CI 2.67–5.64); p < 0.001] and eczema [AOR: 2.99 (95%CI 2.02–4.41); p < 0.001] had a significant risk of having asthma.

**Conclusion:** Our findings indicate a significant burden of asthma, allergic rhinitis, and eczema among the schoolchildren studied, underscoring the need to address this critical public health issue.

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#### Summary

- Asthma is a significant contributor to disability, diminished quality of life, and premature deaths, and it also represents a major economic burden through both direct and indirect costs, particularly in low- and middleincome countries.
- A high proportion of schoolchildren with asthma studied are frequently symptomatic. None of them were regularly followed up by a physician because of their asthma symptoms, and none of them used or had used inhaled corticosteroids.
- It is essential to develop strategic management and prevention plans to enhance the medical care of asthmatics in Angola, and this approach could also benefit other developing countries.

# 1 | Introduction

Asthma is a chronic respiratory condition that affects individuals of all ages and is the most prevalent noncommunicable disease among children [1]. The Global Asthma Network (GAN) Phase I multicenter study found that approximately one in 10 children and one in 15 adults worldwide experience asthma symptoms, with severe symptoms occurring frequently (around 50%) in children and adolescents [2, 3]. It is a substantial cause of disability, reduced quality of life, and premature deaths, and it also represents a major economic burden through both direct and indirect costs [1]. The Global Burden of Chronic Respiratory Disease study estimated that in 2019, asthma was responsible for 21.6 million disability-adjusted life years (DALYs), with 262.4 million prevalent cases, 37.0 million new cases, and 455,000 deaths worldwide [4, 5]. While asthma is more prevalent in high-income countries, most asthma-related deaths occur in low- and middle-income countries (LMICs) [4]. Other allergic diseases, such as rhinoconjunctivitis and eczema, do not directly cause death but contribute significantly to morbidity [3].

Several factors have been associated with the incidence, prevalence, morbidity, and mortality of asthma and allergic diseases, such as age, gender, socioeconomic determinants, environmental exposure, comorbidities, and genomic and biome influences, some of which have been identified as risk factors and others as protective factors [3, 6]. Some studies carried out in African countries have reported differences between the prevalence of asthma and allergic diseases, as well as differences in risk factors in these regions [7].

Studies carried out in Angola, using the ISAAC methodology, reported prevalences of asthma (15.7%), rhinitis (19.0%), rhinoconjunctivitis (10.0%), and eczema (18.4%) in children aged six and seven and asthma (13.4%), rhinitis (26.9%), rhinoconjunctivitis (18.2%) and eczema (20. 2%) in adolescents aged 13 and 14 in Luanda, the capital city of Angola [8, 9], while lower prevalences of asthma (9.3%), rhinoconjunctivitis (6.0%) and eczema (15.9%) were found in children and adolescents

aged 5–14 in Bengo Province [10]. In these studies, some relevant factors were found, such as the type of air-cooling system (AC-split) in the home, excessive paracetamol intake, antibiotic use, and active maternal smoking, which proved to be risk factors, and the use of an electric stove for cooking, which was a protective factor for asthma [8, 9]. We relate this variability in prevalences between the two regions to geographical differences and socioeconomic determinants, as well as the lifestyle of the participants. For this reason, we chose to investigate the prevalence of asthma and allergic diseases among schoolchildren in Angola's fourth most populous province, Huambo.

# 2 | Materials and Methods

#### 2.1 | Study Design, Study Area, and Population

This was a cross-sectional study carried out in April and May 2022 with schoolchildren aged 6–14 in the Huambo municipality, Huambo province, Angola.

Huambo is one of Angola's 18 provinces, located in the central region of the country, 605 km from Luanda, the capital city, with an area of 35,771 km [2] and an estimated population of 2,645,080 inhabitants, of which 598,682 are children aged 5–14 [11]. The climate is tropical, with average temperatures of 19°C and two seasons, one dry and cold and the other rainy [12]. It is located at 1700 m above sea level, and in cold weather, especially at night, the temperature can drop to 4°C [12]. It is the second coldest and the fourth most populous province in Angola, composed of eleven municipalities, of which the municipality of Huambo is the most populated, with about 35% of the population of the province [11, 12].

From a total of 52 public schools in the Huambo municipality, 20 schools (38.5%) were randomly selected. All schoolchildren aged between 6 and 14 were invited to participate in the study through an information letter sent home to their parents. Those whose parents or guardians did not provide consent were excluded from the study. OpenEpi program [13] was used to calculate the sample size. Based on the approximate number of inhabitants in the intended age range (N = 598,682) and the prevalence of asthma, allergic rhinitis, and eczema in the study conducted in Luanda [9], with a margin of error of less than 4% for a 95% confidence interval, the estimated sample size was 1066 participants.

# 2.2 | Questionnaires

Data were collected using the written Portuguese version of the ISAAC questionnaire, which assesses symptoms of asthma, allergic rhinitis, and eczema [14]. The ISAAC questionnaire on environmental exposure and risk factors was also used [14]. The questions and explanations were given by a specially trained team in Portuguese, the national language of the country, to schoolchildren aged 10 and over and to parents or guardians in the presence of schoolchildren under 10.

Based on ISAAC methodology [14], current asthma was defined as an affirmative answer to the question "In the last 12 months have you had wheezing in your chest?/Has your child had wheezing in the chest in the last 12 months?". Questions related to the number of wheezing episodes, whether these interfered with sleep or speech or were related to physical exercise, as well as on episodes of nocturnal cough in the previous 12 months, were also answered. The presence of current rhinitis was based on episodes of sneezing, rhinorrhoea, or nasal congestion in the previous 12 months in the absence of influenza, and the presence of rhinoconjunctivitis was based on the presence of rhinitis symptoms associated with conjunctivitis. Questions related to whether the nasal symptoms interfered with their daily activities and whether they had ever had "hay fever" were also answered. Cutaneous lesions with pruritus that waxed and waned in the previous 12 months were defined as eczema. Additional questions were asked in terms of the location and age of appearance of the lesions and interference with sleep.

All schoolchildren aged 10 and over and the parents or guardians of schoolchildren under 10 who answered yes to the question "In the last 12 months have you had wheezing in your chest?/Has your child had wheezing in the chest in the last 12 months?" were asked whether they were followed up by a physician because of their symptoms, whether they regularly used asthma medication, what type of drug, and what they did when they had an exacerbation.

The environmental exposure questionnaire [14] included questions on the type of fuel used for cooking, type of domestic indoor cooling device, frequency of trucks passing in front of their homes, presence of dogs and cats in the home, exposure to tobacco smoke, use of antibiotics in the first year of life, frequency of paracetamol intake, and number of siblings living in the house.

# 2.3 | Statistical Analysis

Statistical analysis was performed using SPSS version 29 (IBM SPSS Statistics, USA). Descriptive analyses included the presentation of frequencies and percentages. Normally distributed data were summarized as mean and standard deviation.  $\chi^2$  tests and examined associations between categorical variables. Univariate (OR) and multivariate (AOR) logistic regression with 95% confidence intervals were calculated to assess the strength of these associations. All independent variables with a *p*-value  $\leq 0.25$  in the univariate analysis were included in the final multivariate model. A *p* < 0.05 was deemed significant.

## 3 | Results

Out of the 2132 schoolchildren from 20 selected schools, 325 were excluded due to incomplete or incorrectly filled questionnaires, leaving 1807 valid questionnaires that met all the criteria and were therefore considered for further analyses. There was no clustering of non-responders or invalid questionnaires in any particular school or group of schools. All

participating schoolchildren resided in urban areas, 52.2% were girls, with a mean age of  $11.9 \pm 2.92$  years, and 21.3% of their parents were illiterate (Table 1).

#### 3.1 | Prevalence of Asthma-Like Symptoms

Based on the response to the presence of wheezing in the last 12 months, the prevalence of current asthma was 7.7%, with no significant differences between boys and girls and age, while the prevalence of asthma was significantly lower in schoolchildren with illiterate mothers (p = 0.022) (Table 1). Fifteen percent of schoolchildren reported ever having wheezing episodes, and 16.6% reported having wheezing during or after physical exercise in the last 12 months. Additionally, 36.7% reported episodes of dry nocturnal cough unrelated to respiratory infections in the last 12 months, again with no significant differences between boys and girls (p > 0.05) (Table 2).

#### 3.2 | Prevalence of Allergic Rhinitis

The prevalence of current allergic rhinitis was 23.7%, with no significant differences between boys and girls (p = 0.338), but allergic rhinitis was significantly higher in older schoolchildren (p < 0.001) (Table 1). Nineteen percent of schoolchildren reported that rhinitis symptoms had interfered with their daily activities in the last 12 months, with no significant differences between boys and girls (p = 0.305), and 25.3% reported having ever had hay fever, which was significantly more frequent in girls (p < 0.001) (Table 2).

#### 3.3 | Prevalence of Eczema

The prevalence of current eczema was 15.8% and was significantly lower in schoolchildren with illiterate mothers (p = 0.042) (Table 1). Itch rash, or eczema ever, was reported in 27.7% and 23.0% of the schoolchildren, respectively. The lesions affected specific areas of the body in 15.7%, disappeared at least temporarily in 17.4%, and interfered with their sleep in the last 12 months in 17.0% of the schoolchildren. There were no significant differences in the prevalence of eczema and its symptoms between boys and girls, except eczema ever was significantly more frequent in girls (p = 0.012) (Table 2).

## 3.4 | Respiratory Symptoms in Schoolchildren With Current Asthma

Of the 140 (7.7%) schoolchildren who reported episodes of wheezing in the last 12 months, 77.1% had had 1–3 episodes, 13.6% had had 4–12 episodes and 9.3% had had more than 12 episodes, 42.9% woke up during the night less than once a week, and 14.3% woke up during the night more than once a week, because of wheezing episodes, 32.9% had had episodes of wheezing that interfered with speech, 52.9% of schoolchildren had had wheezing episodes during or after exercise, and 74.3% reported dry nocturnal cough in the last 12 months (Table 3).

		Astl	ıma		Rhin	nitis		Ecze	ima	
Demographic characteristics	N (%)	No	Yes	<i>p</i> -value	No	Yes	<i>p</i> -value	No	Yes	<i>p</i> -value
Overall	1807 (100)	1667 (92.3)	140 (7.70)		1379 (76.3)	428 (23.7)		1521 (84.2)	286 (15.8)	
Age, years mean ±SD	$11.9 \pm 2.92$	$11.9 \pm 2.93$	$12.2 \pm 2.71$	0.239	$11.7 \pm 3.02$	$12.5 \pm 2.48$	< 0.001	$11.9 \pm 2.88$	$11.7 \pm 3.19$	0.176
Sex										
Female	943 (52.2)	868 (52.1)	75 (53.6)	0.733	711 (51.6)	232 (54.2)	0.338	781 (51.3)	162 (56.6)	0.100
Male	864 (47.8)	799 (47.9)	65 (46.4)		668 (48.4)	196 (45.8)		740 (48.7)	124 (43.4)	
Parental schooling										
Father										
Illiterate	388 (21.5)	368 (22.1)	20 (14.3)	0.058	307 (22.3)	81 (18.9)	0.284	336 (22.1)	52 (18.2)	0.521
Basic	$195\ (10.8)$	$183\ (11.0)$	12 (8.60)		141 (10.2)	54 (12.6)		$164\ (10.8)$	31 (10.8)	
Medium	544 (30.1)	501(30.1)	43 (30.7)		418 (30.3)	126 (29.4)		453 (29.8)	91 (31.8)	
High	680 (37.6)	615 (36.9)	65 (46.4)		513 (37.2)	167 (39.0)		568 (37.3)	112 (39.2)	
Mother										
Illiterate	383 (21.2)	367 (22.0)	16(11.4)	0.022	303 (22.0)	80 (18.7)	0.231	340 (22.4)	43~(15.0)	0.042
Basic	327 (18.1)	302~(18.1)	25 (17.9)		256 (18.6)	71 (16.6)		274 (18.0)	53~(18.5)	
Medium	659 (36.5)	602 (36.1)	57 (40.7)		488 (35.4)	171 (40.0)		542 (35.6)	117 (40.9)	
High	438 (24.2)	396 (23.8)	42 (30.0)		332 (24.1)	106 (24.8)		365 (24.0)	73 (25.5)	
Note: Bold means that results were statistical	ly significant for th	e independent-samp	les <i>t</i> -test or $\chi^2$ ( $p <$	0.05).						

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 TABLE 2
 Prevalence of asthma, rhinitis, and eczema in schoolchildren from Huambo (N = 1807).

Clinical characteristics	N (%)	Female	Male	<i>p</i> -value
Asthma				
Wheezing ever	271 (15.0)	139 (14.7)	132 (15.3)	0.749
Wheezing in the last 12 months	140 (7.70)	75 (8.00)	65 (7.50)	0.733
Asthma ever	149 (8.20)	83 (8.80)	66 (7.60)	0.369
Exercise-induced wheezing in the last 12 months	300 (16.6)	169 (17.9)	131 (15.2)	0.115
Nocturnal cough last 12 months	663 (36.7)	353 (37.4)	310 (35.9)	0.494
Rhinitis				
Sneezing, runny or blocked nose ever	683 (37.8)	372 (39.4)	311 (36.0)	0.130
Sneezing, runny or blocked nose in last 12 months	428 (23.7)	232 (24.6)	196 (22.7)	0.338
Rhinoconjuctivitis in the last 12 months	507 (28.1)	277 (29.4)	230 (26.6)	0.193
Interference with activities in the last 12 months	342 (18.9)	187 (19.8)	155 (17.9)	0.305
Hay fever ever	457 (25.3)	269 (28.5)	188 (21.8)	< 0.001
Eczema				
Itchy rash ever	500 (27.7)	272 (28.8)	228 (26.4)	0.244
Itchy rash in last 12 months	286 (15.8)	162 (17.2)	124 (14.4)	0.100
Itchy flexural areas	283 (15.7)	155 (16.4)	128 (14.8)	0.343
Clearance of rash in last 12 months	314 (17.4)	158 (16.8)	156 (18.1)	0.466
Interference with sleep in the last 12 months	307 (17.0)	161 (17.1)	146 (16.9)	0.921
Eczema ever	415 (23.0)	239 (25.3)	176 (20.4)	0.012

*Note:* Bold means that results were statistically significant for the  $\chi^2$  (p < 0.05).

**TABLE 3** | Clinical characteristics of schoolchildren with current asthma (N = 140).

Signs and symptoms	N (%)	Female	Male	<i>p</i> -value
Wheezing episodes in the last 12 months				
1–3	108 (77.1)	55 (73.3)	53 (81.5)	0.663
4–12	19 (13.6)	12 (16.0)	7 (10.8)	
>12	13 (9.3)	8 (10.7)	5 (7.7)	
Sleep disturbance episodes in the last 12 months				
None	60 (42.9)	37 (49.4)	23 (35.4)	0.269
< one/week	60 (42.9)	28 (37.3)	32 (49.2)	
≥ one/week	20 (14.3)	10 (13.3)	10 (15.4)	
Speech affected in last 12 months				
No	94 (67.1)	47 (62.7)	47 (72.3)	0.280
Yes	46 (32.9)	28 (37.3)	18 (27.7)	
Asthma ever				
No	93 (66.4)	47 (62.7)	46 (70.8)	0.203
Yes	47 (33.6)	28 (37.3)	19 (29.2)	
Exercise-induced wheezing in the last 12 months				
No	66 (47.1)	32 (42.7)	34 (52.3)	0.166
Yes	74 (52.9)	43 (57.3)	31 (47.7)	
Nocturnal cough in the last 12 months				
No	36 (25.7)	20 (26.7)	16 (24.6)	0.468
Yes	104 (74.3)	55 (75.3)	49 (75.4)	

We observed that none of the schoolchildren with current asthma were regularly followed up by a physician because of their asthma symptoms. They were occasionally seen in the emergency room when they had asthma attacks, where they were prescribed short-acting beta 2 agonists to relieve symptoms. None of them used or had used inhaled corticosteroids.

# 3.5 | Putative Risk Factors Associated With Asthma

Of the known factors studied, we found that allergic rhinitis [AOR: 3.88 (95%CI 2.67–5.64); p < 0.001] and eczema (itch rash) [AOR: 2.99 (95%CI 2.02–4.41); p < 0.001] in the last 12 months were risk factors associated with asthma increasing the chance of having asthma by more than three times for allergic rhinitis and more than two times for eczema. Interestingly, high levels of education, whether of the father [OR: 1.95 (95%CI 1.16–3.26); p = 0.012] or mother [OR: 2.43 (95%CI 1.34–4.40); p = 0.003] were important risk factors for schoolchildren having asthma, although multivariate analysis did not characterize these variables with significance (Table 4).

# 4 | Discussion

This study of schoolchildren in the Huambo province, Angola, followed the ISAAC methodology and showed a prevalence of current asthma of 7.7%, with no significant differences between age and sex, a prevalence of allergic rhinitis of 23.7%, with no significant differences between sex and a prevalence of eczema of 15.8%, also with no significant differences between age and sex. However, the prevalence of asthma and eczema was significantly lower in schoolchildren with illiterate mothers, while having allergic rhinitis was associated with older schoolchildren. Concerning the risk factors studied, schoolchildren with allergic rhinitis and eczema had a four and threefold risk of having asthma, respectively. A worrying finding was that none of the schoolchildren with current asthma, despite being symptomatic, were regularly medicated for asthma and only occasionally received medication to relieve symptoms in the emergency room.

The GAN Phase I study [3] which will be conducted between 2015 and 2020 in various centers around the world, will enroll 101,777 children aged 6 and 7 from 44 centers in 16 countries and 157,784 adolescents aged 13 and 14 from 63 centers in 25 countries, reported a prevalence of current asthma in children and adolescents of 9.1% and 11.0% respectively. Although our prevalence is lower than the GAN Phase I study [3], other studies have shown that asthma has a higher prevalence among schoolage children and adolescents in several African countries. A recent meta-analysis of ten African studies on the prevalence of asthma and/or wheezing in preschool and school-aged children found asthma prevalence ranging from 1.70% to 20.85%, with a population-weighted average of 4.41% [15]. The historical prevalence of wheezing varied between 4.71% and 67.72%, with a population-weighted average of 22.91% [15].

Although the prevalence of asthma in the schoolchildren studied is lower than that found in children [8] and

adolescents [9] in Luanda, the capital city of Angola, symptoms such as the number of wheeze episodes, their impact on sleep, speech, and exercise due to wheeze episodes, and the frequency of dry nocturnal cough in the last 12 months, were relatively similar. This highlights the persistent lack of asthma control among children and adolescents in our study population.

We found no significant differences between prevalence and symptoms of current asthma between sex and age, unlike the GAN Phase I study [3] where among children, boys, and among adolescents, girls had a higher prevalence, except for asthma ever, where adolescent girls had a lower prevalence than boys. In the Luanda studies [8, 9], we also found no significant differences in these parameters in the children, but the prevalence of current asthma was significantly higher in adolescent girls, similar to the GAN Phase I study [3].

The report of nocturnal cough in the last 12 months among the schoolchildren studied (36.7%) was considerable. Other studies have also reported the frequency of this symptom [16–18]. Although coughing may not be associated with asthma, it should be borne in mind as it may also be related to rhinitis [3].

Also, according to Phase I of the GAN study, the rhinoconjunctivitis, hay fever, and eczema prevalence in children was 7.7%, 11.1%, and 5.9%, respectively, and in adolescents 13.3%, 15.2%, and 6.4 respectively [3]. The low-income countries (LICs) and LMICs centers had a lower prevalence of these conditions, with the exception of hay fever [3]. The prevalence of rhinoconjunctivitis was higher among children boys, whereas the trend reversed in adolescence, with higher prevalence among girls, and for eczema, while adolescent girls had twice the prevalence compared to boys, no significant sex differences were observed among children [3]. Our prevalence rates for current rhinitis (23.7%), rhinoconjunctivitis (28.1%), hay fever (25.3%), and eczema (15.8%) were much higher, placing our schoolchildren among those with the highest prevalence rates for these symptoms, given that several studies have reported much lower prevalence rates [19, 20], although others have reported even higher prevalence rates than ours [18, 21]. Our results showed no significant differences between boys and girls, and prevalences of allergic rhinitis, rhinoconjunctivitis, and eczema were similar to the results for children in Luanda [8], although in adolescents, these prevalences were significantly higher in girls [9]. Hay fever and eczema were significantly higher in girls than in boys, also similar to the results for adolescents in Luanda [9], but this may indicate an overestimation of symptoms, as the term "hay fever" can be difficult to interpret in regions like Huambo province, where there is no distinct pollen season, although other factors may also contribute to this discrepancy [3]. These differences found between the age groups of boys and girls are not well understood but may be related to hormonal influences [22, 23].

The burden of asthma, rhinoconjunctivitis, and eczema varies between countries and even between regions in the same country, according to the GAN Phase I study, as we can see in our study. In LMICs such as Angola, the burden is considerable

		Wheezing in the	last 12 months	Univariate analysis		Multivariate analysis	
Independent variables	N (%)	No	Yes	OR (95%CI)	<i>p</i> -value	AOR (95%CI)	<i>p</i> -value
Overall	1807~(100)	1667 (92.3)	140 (7.7)				
Rhinitis in the last 12 months							
No	1379 (76.3)	1318 (79.1)	61 (43.6)	1.00		1.00	
Yes	428 (23.7)	349 (20.9)	79 (56.4)	4.89 (3.43–6.97)	< 0.001	3.88 (2.67–5.64)	< 0.001
Itchy rash in the last 12 months							
No	1521 (84.2)	1437 (86.2)	84 (60.0)	1.00		1.00	
Yes	286 (15.8)	230 (13.8)	56 (40.0)	4.17 (2.89–6.00)	< 0.001	2.99 (2.02-4.41)	< 0.001
Cooking fuel used at home							
Electricity							
No	900 (49.8)	839 (50.3)	61 (43.6)	1.00		1.00	
Yes	907 (50.2)	828 (49.7)	79 (56.4)	1.31(0.93 - 1.86)	0.125	1.26(0.87 - 1.83)	0.228
Gas							
No	358 (19.8)	333 (20.0)	25 (17.9)	1.00		Ι	I
Yes	1449~(80.2)	1334~(80.0)	115(82.1)	1.15(0.73 - 1.80)	0.546	I	Ι
Coal							
No	1199 (66.4)	1106 (66.3)	93 (66.4)	1.00		I	I
Yes	608 (33.6)	561 (33.7)	47 (33.6)	0.99 (0.69 - 1.44)	0.984	I	Ι
Firewood							
No	1781 (98.6)	1641 (98.4)	140(100)	1.00		I	I
Yes	26 (1.40)	26 (1.60)	0 (000)	0.00(0.00-0.00)	0.998	I	Ι
Indoor home cooling system							
Split air conditioner							
No	1710 (94.6)	1581 (94.8)	129(92.1)	1.00		1.00	
Yes	97 (5.40)	86 (5.20)	11 (7.90)	1.57 (0.82 - 3.01)	0.177	1.17 (0.55 - 2.51)	0.683
Window air conditioner							
No	662 (36.6)	601 (36.1)	61 (43.6)	1.00		1.00	
Yes	1145 (63.4)	1066 (63.9)	79 (56.4)	0.73 (0.52–1.04)	0.077	0.80 (0.53–1.21)	0.281
Fan							
							(Continues)

**TABLE 4** | Risk factors associated with asthma in schoolchildren from Huambo (N = 1807).

		Wheezing in the	last 12 months	Univariate analvsis		Multivariate analvsis	
Independent variables	N (%)	No	Yes	OR (95%CI)	<i>p</i> -value	AOR (95%CI)	<i>p</i> -value
No	1513 (83.7)	$1404 \ (84.2)$	109 (77.9)	1.00		1.00	
Yes	294 (16.3)	263 (15.8)	31 (22.1)	1.52(0.99-2.31)	0.05	1.28 (0.79–2.08)	0.317
Frequency of paracetamol intake							
Never	464 (25.7)	434 (26.0)	30 (21.4)	1.00		1.00	
$\geq$ once/month	480 (26.6)	436 (26.2)	44 (31.4)	1.46(0.90-2.37)	0.124	1.17(0.70-1.97)	0.550
≥ once/year	863 (47.8)	797 (47.8)	66 (47.1)	1.20(0.77 - 1.87)	0.428	1.04(0.64-1.67)	0.888
Antibiotic intake							
No	1468 (81.2)	1353 (81.2)	115 (82.1)	1.00		I	I
Yes	339 (18.8)	314 (18.8)	25 (17.9)	$0.94 \ (0.60 - 1.47)$	0.776	I	I
Pets at home							
Cat							
No	1365 (75.5)	1268 (76.1)	97 (69.3)	1.00		1.00	
Yes	442 (24.5)	399 (23.9)	43 (30.7)	1.41 (0.97–2.05)	0.074	$1.14 \ (0.76 - 1.70)$	0.539
Dog							
No	687 (38.0)	644 (38.6)	43 (30.7)	1.00		1.00	
Yes	1120 (62.0)	1023 (61.4)	97 (69.3)	1.42(0.98-2.06)	0.065	1.31 (0.88 - 1.95)	0.185
Frequency of passage of trucks in front of home							
Never	255 (14.1)	239 (14.3)	16 (11.4)	1.00		1.00	
Seldom	643 (35.6)	604 (36.2)	39 (27.9)	0.97 (0.53–1.76)	0.965	0.99 (0.53–1.86)	0.977
Frequently during the day	600 (33.2)	537 (32.2)	63 (45.0)	1.75(0.99 - 3.10)	0.054	1.38 (0.76–2.51)	0.297
Almost the whole day	309 (17.1)	287 (17.2)	22 (15.7)	1.15 (0.59–2.23)	0.690	0.83(0.41 - 1.68)	0.599
Smoking at home							
Mother							
No	1802 (99.7)	1662 (99.7)	140(100)	1.00		Ι	I
Yes	5 (0.30)	5 (0.30)	0 (000)	0(0.00-0.00)	0.999	I	Ι
Father							
No	1753~(97.0)	1617 (97.0)	136 (97.1)	1.00		I	I
Yes	54 (3.00)	50 (3.00)	4 (2.90)	0.95 (0.34–2.67)	0.924	I	I
							Continues)

**TABLE 4** | (Continued)

TABLE 4   (Continued)							
		Wheezing in the	e last 12 months	Univariate analysis		Multivariate analysis	
Independent variables	N (%)	No	Yes	OR (95%CI)	<i>p</i> -value	AOR (95%CI)	<i>p</i> -valu
Parenteral schooling							
Father							
Illiterate	388 (21.5)	368 (22.1)	20 (14.3)	1.00		1.00	
Basic	195 (10.8)	183(11.0)	12 (8.60)	1.21 (0.58–2.52)	0.618	0.83 (0.35–1.96)	0.673
Medium	544 (30.1)	501 (30.1)	43 (30.7)	1.58 (0.92–2.73)	0.102	1.20 (0.61–2.35)	0.595
High	680 (37.6)	615 (36.9)	65 (46.4)	1.95(1.16 - 3.26)	0.012	1.36 (0.71–2.60)	0.360
Mother							
Illiterate	383 (21.2)	367 (22.0)	16 (11.4)	1.00		1.00	
Basic	327 (18.1)	302 (18.1)	25 (17.9)	1.90 (0.99–3.62)	0.052	1.90(0.88-4.09)	0.101
Medium	659 (36.5)	602 (36.1)	57 (40.7)	2.17 (1.23–3.84)	0.008	1.65(0.81 - 3.36)	0.170
High	438 (24.2)	396 (23.8)	42 (30.0)	2.43(1.34 - 4.40)	0.003	1.75(0.83 - 3.66)	0.139

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not only because of the prevalence and severity of symptoms but above all because of limitations in access to healthcare, including essential drugs [24]. As we reported, in addition to the high prevalence of asthma and allergic diseases, a high number of our schoolchildren with current asthma were frequently symptomatic however, none of them were regularly medicated, they only used medication to relieve exacerbations, prescribed in the emergency room.

Finally, we evaluated which of the known risk factors such as rhinitis and eczema, as well as the fuel used to cook food at home. the air-cooling system at home, the passage of trucks in front of the house, the frequency of intake paracetamol, intake antibiotics, the presence of cats and/or dogs at home, smoking, and parental education level would be associated with asthma in our schoolchildren. We observed that, as also reported by several studies [17, 19, 20] and also in the studies in Luanda [8, 9], rhinitis and eczema were risk factors associated with asthma. This association is attributed to the close link between allergic diseases and the concept of allergy as a systemic condition that primarily affects the nasal mucosa, respiratory tract, and skin [25].

This study had some limitations. The study relied on selfreported symptoms and is therefore subject to various types of bias however, the ISAAC approach guarantees that the reported symptoms rare a meaningful reflection of the clinical reality [26]. Some adolescents and parents/guardians of the children were unfamiliar with certain specific terms used in the questionnaire, a challenge that has also been noted in other ISAAC studies. The fact that all the schoolchildren came from urban areas in Huambo Province may have introduced another source of bias. The study did not include certain key risk factors, such as the family history of asthma and allergies, testing for sensitization to aeroallergens, and lung function assessment, which may have hindered comparison with similar studies in other populations. Finally, since this is a cross-sectional study, its design does not allow for a detailed examination of the interrelationships between the different diseases, particularly in the context of complex patterns of multimorbidity [27]. However, we followed a complete and validated approach concerning asthma and allergic diseases, and the results obtained provide useful data on these aspects in Angola.

#### | Conclusion 5

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio

*Note:* Bold means that results were statistically significant (p < 0.05).

Our results reveal that the burden of asthma, allergic rhinitis, and eczema in this population is significant and that schoolchildren with asthma, despite frequently experiencing symptoms, were not followed by a physician and were not regularly medicated for asthma, highlighting the need to address this critical public health issue

It is crucial to implement strategies for a better approach to asthma and for asthma patients to have access to basic health services and essential drugs for asthma control at a national level.

More comprehensive and localized studies in other regions of Angola are needed to better clarify various aspects, especially those related to factors associated with asthma.

#### **Author Contributions**

Elias José Gonçalves: conceptualization, data curation, investigation, writing – original draft. Crícia do Espírito Santo Nunda: conceptualization, data curation, investigation. Cruz dos Santos Sebastião: formal analysis, methodology, writing – original draft. Margarete Lopes Teixeira Arrais: conceptualization, data curation, investigation, methodology, supervision, writing – original draft, writing – review and editing. All authors have read and agreed to the published version of the manuscript.

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#### **Ethics Statement**

This study was approved by the Ethics Committee of the Angolan Ministry of Health (Number 30/C.E./2021). It was also approved by the Provincial Board of Education, Huambo, Angola, and by the directors of the selected schools. All parents/guardians were informed about the study in a face-to-face session as well as via a leaflet, and those who agreed to participate signed a written consent form.

#### **Conflicts of Interest**

The authors declare no conflicts of interest.

#### Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

#### **Transparency Statement**

The lead author Margarete Lopes Teixeira Arrais affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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