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ORIGINAL ARTICLE

Asthma-like symptoms, diagnostic tests, and asthma medication use in children and adolescents: a population-based nationwide survey

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Abstract

Objective: This study aimed to estimate the prevalence of asthma-like symptoms, current asthma (CA), asthma diagnostic tests, and inhaled medication use in a nationwide pediatric population (<18 years). **Methods:** Pediatric-specific data from a cross-sectional, population-based telephone survey (INAsma study) in Portugal were analyzed. CA was defined as lifetime asthma and (1) wheezing, (2) waking with breathlessness, or (3) asthma attack in the previous 12 months, and/or (4) taking asthma medication at the time of the interview. **Results:** In total, 716 children were included. The prevalence of asthma-like symptoms was 39.4% [95% confidence interval (95% CI): 35.7–43.3]. The most common symptoms were waking with cough (30.9%) and wheezing (19.1%). The prevalence of CA was 8.4% (95% CI: 6.6–10.7). Among children with CA, 79.9% and 52.9% reported prior allergy testing and pulmonary function testing (PFT), respectively. Inhaled medication use in the previous 12 months was reported by 67.6% (reliever inhalers, 40.1%; controller inhalers, 41.5%). Those who only used inhaled reliever medications experienced more asthma attacks [odds ratio (OR): 2.69]. Significantly fewer children with CA living in rural areas than those living in urban areas had undergone PFT or used inhaled medication (OR: 0.06 for PFT, 0.20 for medication). **Conclusions:** The prevalence of CA in the Portuguese pediatric population was 8.4%. Only half of children with CA had ever undergone PFT; more than half did not use controller inhalers, and those who only used reliever inhalers reported more asthma attacks. These findings suggest that asthma management has been substandard, mainly in rural areas.

Keywords

Cough, epidemiology, pediatrics, prevalence, respiratory function tests, treatment, wheezing

History

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Introduction

Asthma is one of the most common chronic diseases in children [1]. According to the Global Initiative for Asthma, asthma is a heterogeneous disease characterized by variable symptoms [2]. Composite measures to define asthma are increasingly necessary to obtain more accurate epidemiological prevalence estimates [3], and population-based studies are important for the assessment of these estimates [4].

The results of the 20-year International Study of Asthma and Allergies in Childhood (ISAAC) have changed our

knowledge about the worldwide prevalence of asthma and related symptoms [5]. The ISAAC included some Portuguese cities [6], but neither the ISAAC nor other studies estimated the prevalence of asthma across all pediatric ages (<18 years) or among a representative nationwide sample in Portugal [7–10]. In fact, to the best of our knowledge, very few studies have estimated the prevalence of asthma in this age range using nationwide samples [11–13]. Moreover, different asthma definitions are presented in the literature, making it difficult to accurately compare estimates between studies [3,14]. The patterns of asthma-like symptoms may also differ among various pediatric ages. However, no data have been published on the prevalence of specific asthma symptoms, other than wheezing, in all pediatric ages.

A diagnosis of asthma is based on symptoms and confirmation of variable expiratory flow limitation, making pulmonary function testing (PFT) an important tool. A

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stepwise approach for asthma management takes the previous two features and medication, primarily inhaler use, into account [2]. Epidemiological assessment of asthma should also focus on data from the above-mentioned asthma features closely linked to diagnosis and management.

In 2010, we conducted the First Portuguese National Asthma Survey (INAsma) [15]. In the present paper, we focus on the results obtained from the INAsma pediatric population. Specifically, our primary aim was to estimate the prevalence of asthma-like symptoms and current asthma (CA) in the Portuguese pediatric population (<18 years). Our secondary aims were to describe the differences in CA prevalence estimates according to different definitions to allow for comparisons with other studies and to assess the proportion of the use of diagnostic tests and inhaled medication among children with CA.

Materials and methods

Study design and participants

The INAsma was a population-based, nationwide, cross-sectional survey applied by telephone interview in Portugal in 2010. The study methodology has been previously described [15,16]. The INAsma target population was the Portuguese general population, and the available population included citizens of all ages living in households with a landline telephone. A cluster sampling design was used to obtain a representative sample of the population (detailed in the Supplementary file). Briefly, all municipalities were used as natural strata, and a sample of households was then selected with a probability proportional to the municipality population as estimated in the 2001 National Census. Households were randomly selected from the 2010 residential White Pages telephone directory. Four different lists of telephone numbers were randomly selected for each municipality to allow for substitution of nonresidential telephone numbers. In total, 24 412 telephone numbers were retrieved. One participant (the last person to have had a birthday) was randomly selected from each household. In this study, we considered all included individuals aged <18 years (henceforth referred to as “children” for simplification).

This study was reviewed and approved by the Ethics Committee of Centro Hospitalar de São João, Porto, Portugal. Informed consent was obtained from the parent(s) or legal guardian(s) of the children included in this study. We followed the STROBE statement for reporting observational studies [17].

Instruments and data collection

The instrument for data collection was the Portuguese version of the questionnaire used in the GA²LEN survey, which includes the European Community Respiratory Health Survey questions on asthma symptoms [18]. Several questions were added regarding socio-educational variables, medications, and diagnostic test use for asthma. Data were collected by computer-assisted telephone interviews from March to May 2010. Selected participants directly answered the questionnaire. However, in accordance with Portuguese legislation, when the selected individual was younger than 15 years old,

the respondent was the usual and most knowledgeable caregiver. To minimize potential bias in data collection, several quality-assurance measures were followed (Supplementary file) [15].

Variables

Asthma definition variables were defined based on previous studies [3,5]. The outcomes were defined as follows: *Lifetime asthma (LA)*: positive answer to “Have you ever had asthma?”; *CA*: LA plus at least one of the following four features: (1) wheezing, (2) waking with breathlessness, (3) having an asthma attack in the last 12 months, or (4) taking asthma medication at the time of the interview; *Nocturnal symptoms*: at least one of the three symptoms in the last 12 months: waking with breathlessness, waking with chest tightness, or waking with coughing; *Asthma-like symptoms*: at least one of the three symptoms in the last 12 months: wheezing, nocturnal symptoms, or asthma attacks (wheezing was further described as wheezing with breathlessness or wheezing without a cold); *PFT*: positive answer to “Have you ever undergone any test to assess your lung function?”; *Skin prick tests*: positive answer to “Have you ever undergone any skin test to assess your allergies?”; *Blood allergy tests*: positive answer to “Have you ever undergone any blood test to assess your allergies?”; *Any asthma medication at present*: positive answer to “Are you currently taking medication (inhaled, nebulized, or oral) for asthma/breathlessness?”; *Inhaled therapy in the last 12 months*: positive answer to “In the last 12 months, did you take any inhaled medication for asthma/breathlessness?” Further characterization of inhaled treatment was based on auto-reported medication: *Allergic rhinitis*: Positive answer to “Do you have any nasal allergies, including hay fever?”; *Atopic dermatitis/eczema*: Positive answer to “Have you ever had eczema or skin allergy?”; *Food allergy*: Positive answer to “Have you been diagnosed with food allergy by a doctor?”; and *Environmental tobacco smoke*: Positive answer to “Does anyone smoke inside your home?”. *Municipality* was classified as urban if the residence was located in a municipality with at least one city (cities must have at least 8000 citizens), according to Portuguese legislation.

Sample size and statistical analysis

The study sample size was calculated for the total Portuguese population and took into account the two phases of the INAsma project [15]. Thus, for the general all-age population, we estimated an *a priori* asthma prevalence of 6% and a proportion of controlled asthma of 20%. Assuming a 20% loss to follow-up, at least 665 patients with asthma were required. Within these premises, and assuming a margin of error of 0.65%, our study required a sample of at least 6000 persons from the general Portuguese population willing to participate in the first phase of the INAsma. The inclusion of 716 children allowed us to estimate CA prevalence with an error margin of 0.02 and a 95% confidence level.

The sample estimates were weighted according to the 2001 National Census aiming for generalization to the target population [19]. A sequential simple random sampling method without replacement was used to select a random

sample of households with a landline telephone within each stratum (municipality) and then one random eligible household resident. Two types of weights were used: (1) prestratification weights to adjust for the sampling design and (2) poststratification weights to adjust for the true sex and age distribution of the target population, thus partially correcting for nonresponse and noncoverage bias.

Statistical analyses were weighted for the Portuguese pediatric population and performed using the complex samples tool of SPSS version 21 (SPSS IBM, New York, NY, USA), with the exception of the participants' characteristics description, which was performed without weighting procedures. Categorical variables were described using absolute and relative frequencies with 95% confidence intervals (95% CIs); comparisons were performed with Pearson's chi-squared test. Univariate logistic regression models for outcomes were developed using independent variables as risk/predictive factors. Multivariate logistic regression models were developed to adjust for possible confounders. Results of multivariate logistic regression models were presented as odds ratios (ORs) with 95% CIs. A p value of <0.05 was considered statistically significant.

Results

Participants

The corrected response rate of the INAsma was 50%. Of the 6003 participants in the INAsma survey, 716 (11.9%) were children. A flowchart of all participants is shown in Figure S1. One-fifth (21.4%) of the children were younger than 6 years of age, and 39% were 13–17 years old; most (80.6%) were from urban areas. The children's characteristics are summarized in Table 1.

Prevalence of asthma-like symptoms

The prevalence of asthma-like symptoms among Portuguese children was 39.4% (95% CI, 35.7–43.3) (Table 2). Asthma-like symptoms were highest in children aged <6 years (47.9%; 95% CI, 40.0–56.0) and lowest in those aged 13–17 years (31.8%; 95% CI, 26.3–37.8; $p=0.005$) (Table S1). Waking during the night with cough was the most prevalent symptom (30.9%; 95% CI, 27.5–34.5), followed by wheezing (19.1%; 95% CI, 16.4–22.1).

The prevalence of nocturnal symptoms was higher in children aged <6 years (39.8%; 95% CI, 32.1–48.1) than in those aged 13–17 years (OR: 0.61; 95% CI, 0.40–0.94), although the prevalence was not significantly different from that of children aged 6–12 years (OR: 0.84; 95% CI: 0.55–1.28). The prevalence of wheezing was highest in children aged <6 years (31.0%; 95% CI: 24.4–38.5) and significantly decreased with age (OR: 0.46; 95% CI: 0.30–0.70 in the 6- to 12-year-old age group; and OR: 0.24; 95% CI: 0.15–0.40 in the 13- to 17-year-old age group) (Figure 1). Among children who reported wheezing in the last 12 months, the symptoms of wheezing without a cold and wheezing with breathlessness were higher in children aged 6–12 years than in those aged <6 years ($p<0.001$) (Figure 2).

The presence of rhinitis and eczema was associated with a higher prevalence of having any asthma-like symptom (OR: 3.67; 95% CI: 2.52–5.39 for rhinitis; and OR: 2.11; 95% CI:

1.51–2.94 for eczema). Supplementary information on asthma-like symptoms is presented in Tables S1 and S2.

Asthma prevalence

The prevalence of LA was 11.2% (95% CI: 9.1–13.7), and that of CA was 8.4% (95% CI: 6.6–10.7). No statistically significant differences were found in the prevalence of CA according to region or other sociodemographic variables (Table 1). A higher risk of CA was found in children with rhinitis and eczema (OR: 5.20; 95% CI: 3.05–8.85 for rhinitis; and OR: 4.17; 95% CI: 2.41–7.19 for eczema). Table 3 shows an overview of different asthma definitions according to the inclusion of different proxies of asthma prevalence.

Diagnostic tests and medication for asthma

PFT and allergy tests (skin prick tests and/or blood allergy tests) were performed in 12.6% (95% CI: 10.3–15.2) and 28.3% (95% CI: 24.9–31.9) of children, respectively. About half of children with CA aged ≥ 6 years had undergone PFT (52.9%; 95% CI: 46.0–59.8), and this prevalence did not change if they had had an asthma attack in the previous 12 months. Children with CA who lived in rural areas were less likely to report diagnostic testing than those from urban areas (OR: 0.06; 95% CI: 0.04–0.09 for PFT; and OR: 0.39; 95% CI: 0.22–0.69 for allergy tests) (Table 4).

Among children with CA, the frequency of any asthma medication at the time of the interview was 76.4% (95% CI: 64.4–85.3). Inhaled reliever and controller therapy were used in the previous 12 months by 40.1% (95% CI: 28.5–53.0) and 41.5% (95% CI: 29.6–54.5) of children with CA, respectively (Table S3). Children who reported using only inhaled reliever medication in the previous year, without any inhaled controllers, were more likely to experience an asthma attack in the same time period (OR: 2.69; 95% CI: 1.24–5.84). Children with CA from rural areas were less likely to report using any inhaled therapy in the previous 12 months (OR: 0.20; 95% CI: 0.09–0.43).

Discussion

A high prevalence of asthma-like symptoms was found in the Portuguese pediatric population (39.4%; 95% CI: 35.7–43.3), and the prevalence of CA was 8.4% (95% CI: 6.6–10.7). This study showed that less than half of children with CA had been on inhaled controller medication in the previous 12 months and that only 52.9% of those aged ≥ 6 years had undergone PFT.

This study was the first population-based nationwide epidemiological study aiming to estimate the asthma prevalence in Portugal among all municipalities and pediatric ages. It included a large representative sample of the Portuguese population, allowing us to estimate the prevalence of asthma-like symptoms, CA, diagnostic tests, and medication use in asthmatic children. Nationwide studies on the prevalence of asthma across the entire pediatric population have only been previously performed in Germany and the United States [11–13]; no previous study has reported the prevalence of asthma-like symptoms across all pediatric ages. A multinational study of children aged 1–5 years showed that

Table 1. Participants' characteristics in a pediatric sample.

	Total participants, <i>n</i> (%)	Current asthma % (95% CI)	Odds ratio ^a (95% CI)
All pediatric Population	716 (100.0)	8.4 (6.6–10.7)	
Gender			
Female	270 (37.7)	6.7 (4.3–10.1)	1.00 (Ref)
Male	446 (62.3)	10.1 (7.5–13.4)	1.59 (0.92–2.75)
Age groups			
0–5 years	153 (21.4)	6.5 (3.5–11.6)	1.00 (Ref)
6–12 years	284 (39.7)	9.7 (6.8–13.8)	1.53 (0.73–3.23)
13–17 years	279 (39.0)	8.7 (5.9–12.5)	1.36 (0.64–2.90)
National region			
North	284 (39.7)	7.2 (4.6–11.1)	1.00 (Ref)
Centre and Islands	179 (25.0)	9.7 (6.3–14.7)	1.35 (0.67–2.74)
South	253 (35.3)	8.7 (5.7–12.9)	1.21 (0.61–2.38)
Municipality			
Urban	577 (80.6)	8.0 (5.9–10.8)	1.00 (Ref)
Rural	139 (19.4)	9.8 (6.6–14.3)	1.12 (0.59–2.11)
ETS ^b			
No	454 (63.4)	8.2 (5.9–11.3)	1.00 (Ref)
Yes	262 (36.6)	8.8 (6.1–12.6)	1.06 (0.61–1.84)
Allergic rhinitis			
No	558 (77.9)	5.0 (3.4–7.4)	1.00 (Ref)
Yes	158 (22.1)	22.3 (16.6–29.2)	5.15 (3.02–8.78)*
Eczema			
No	517 (72.2)	5.0 (3.4–7.4)	1.00 (Ref)
Yes	199 (27.8)	18.3 (13.6–24.2)	4.08 (2.35–7.08)*
Food allergy			
No	676 (94.4)	8.3 (6.4–10.8)	1.00 (Ref)
Yes	40 (5.6)	9.6 (5.4–16.4)	0.94 (0.45–1.95)

Weighted proportion and odds ratio (95% confidence intervals) of current asthma according to sociodemographic and clinical variables.

^aAdjusted odds ratio for gender, age, region, municipality, and ETS.

^bEnvironmental tobacco smoke.

*Statistically significant.

Table 2. Weighted prevalence of asthma-like symptoms in the previous 12 months in the Portuguese pediatric population.

	Total population % (95% CI)	Current asthma	
		Yes % (<i>n</i> = 66)	No % (<i>n</i> = 750)
Any symptom ^a	39.4 (35.7–43.3)	91.4 (82.4–96.1)	34.7 (30.9–38.6)
Wheezing	19.1 (16.4–22.1)	76.5 (65.4–84.9)	13.8 (11.4–16.6)
Wheeze w/o cold	8.2 (6.5–10.4)	49.2 (37.2–61.3)	4.5 (3.1–6.3)
Nocturnal symptoms	34.7 (31.1–38.5)	79.2 (68.0–87.3)	30.7 (27.0–34.6)
Waking with breathlessness	5.0 (3.6–7.1)	24.7 (16.1–35.9)	3.2 (2.0–5.3)
Waking with chest tightness	6.7 (5.1–8.8)	27.4 (17.8–39.6)	4.8 (3.4–6.8)
Waking with cough	30.9 (27.5–34.5)	68.7 (56.6–78.7)	27.4 (24.0–31.2)
Asthma attack	3.7 (2.6–5.4)	44.4 (32.6–56.9)	0.0 (0.0–0.0)

^aWheezing or waking with breathlessness or waking with chest tightness or waking with cough or asthma attacks.

approximately one-third had wheezing, coughing, or breathlessness [20], which is lower than our observation in children aged <6 years (47.9%). However, the time period considered in that study was only 6 months, while the time period in our study was 12 months. Two recent Portuguese studies reported estimates of wheezing in preschoolers (24.5% and 27.5%) [21,22], similar to our results. Mvula et al. [23] found that 27.3% of children aged 5–18 years had cough at night, apart from cold or chest infection. Our question did not distinguish different causes of cough and association to colds; however, our prevalence among children aged 0–17 years (30.9%) is similar to that reported by Mvula et al. [23].

The United States National Center for Health Statistics reported a 5.4% prevalence of asthma attacks among children

aged 0–17 years [24]. The slightly lower prevalence among Portuguese children (3.7%) may be related to differences in the definition of asthma attacks in the two populations.

Differences in asthma-like symptom patterns in various age subgroups

The prevalence of wheezing and nocturnal symptoms decreased with age (Figure 1). However, after the age of 5 years, most children with wheezing exhibited wheezing without a cold and wheezing with breathlessness (Figure 2). These results suggest that age influences asthma-like symptom patterns. These findings are in agreement with previous studies suggesting that wheezing

Figure 1. Weighted prevalence of asthma-like symptoms within the previous 12 months, according to age group (%; 95% CI). Symbols represent prevalence of: ○ nocturnal symptoms (waking with breathlessness or waking with chest tightness or waking with cough); ■ wheezing; ▲ asthma attack. *Difference between age groups with $p < 0.001$; †Difference between age groups with $p < 0.001$.

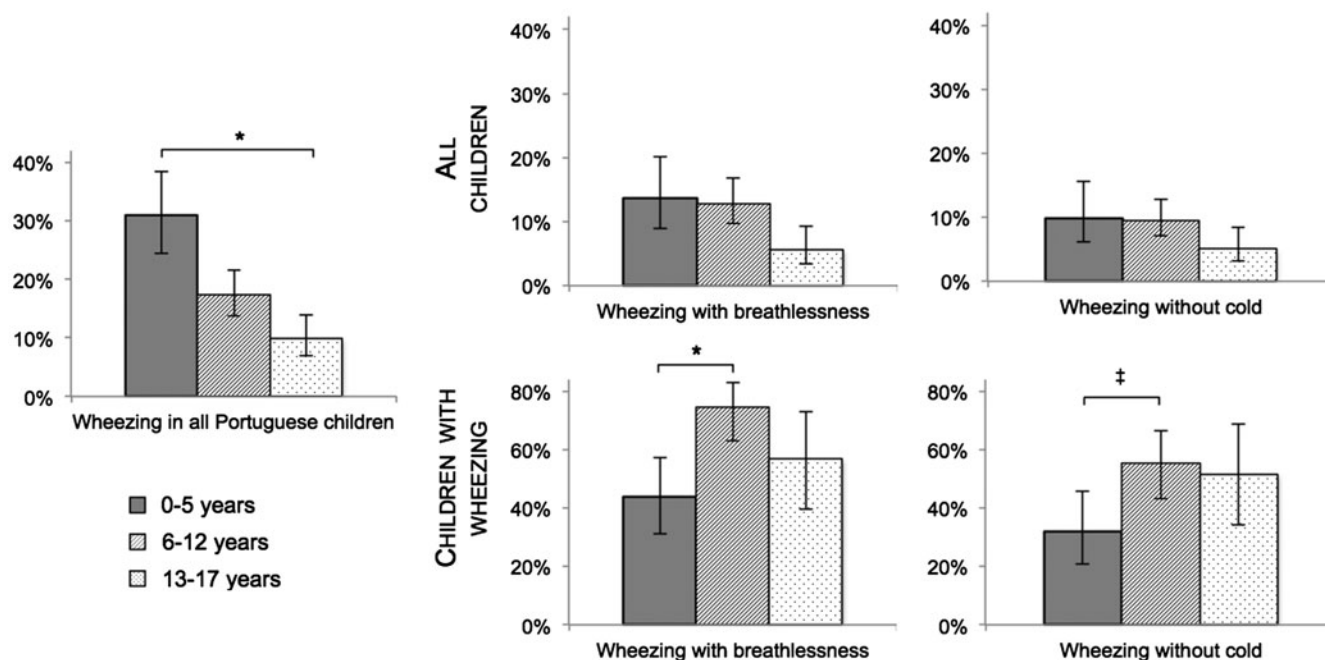
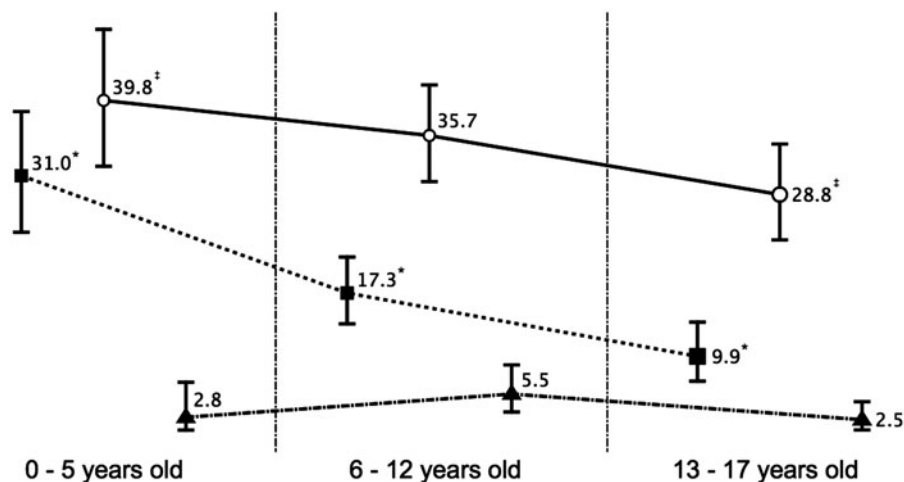


Figure 2. Weighted prevalence of wheezing with breathlessness and wheezing without a cold in the Portuguese pediatric population. * $p < 0.001$, † $p = 0.03$. Prevalence of wheezing in all Portuguese children: 31.0% in 0- to 5-year age group (OR: 1.00); 17.3% in 6- to 12-year age group (OR: 0.46; 95% CI: 0.30–0.72); 9.9% in 13- to 17-year age group (OR: 0.25; 95% CI: 0.15–0.41). Prevalence of wheezing with breathlessness in all Portuguese children: 13.6% in 0- to 5-year age group; 12.8% in 6- to 12-year age group; 5.7% in 13- to 17-year age group. Prevalence of wheezing without a cold in all Portuguese children: 9.9% in 0- to 5-year age group; 9.5% in 6- to 12-year age group; 5.1% in 13- to 17-year age group. Prevalence of wheezing with breathlessness among all children who wheezed: 43.7% in 0- to 5-year age group (OR: 1.00); 74.4% in 6- to 12-year age group (OR: 3.73; 95% CI: 1.79–7.78); 57.0% in 13- to 17-year age group (OR: 1.71; 95% CI: 0.83–3.50). Prevalence of wheezing without a cold among all children who wheezed: 31.9% in 0- to 5-year age group (OR: 1.00); 55.2% in 6- to 12-year age group (OR: 2.64; 95% CI: 1.27–5.48); 51.7% in 13- to 17-year age group (OR: 2.28; 95% CI: 0.96–5.43).

in younger children is more closely related to immature airways and viral respiratory illnesses [25], whereas older children tend to exhibit wheezing even without respiratory infections.

Asthma prevalence

There is no consensus on the epidemiologic definition of CA, which leads to hardly comparable differences in reported prevalence estimates, depending on the definition used [3,14]. Therefore, we presented estimates using different combinations of asthma proxies (Table 3). The definition we chose

includes the less frequent nocturnal symptom, waking with breathlessness; the term asthma attack to improve specificity; and asthma medication, because children with asthma may not experience symptoms when controlled with medication, and medication is a known valid proxy for asthma prevalence [26,27]. By using definitions of prevalence used in different studies, our prevalence estimates varied from 6.3% (LA plus wheezing in the last year) and 9.1% (LA plus any asthma-like symptom in the last year or CA medication). These differences highlight the importance of setting standardized definitions to allow for comparisons between studies.

Table 3. Weighted Asthma prevalence in the Portuguese pediatric population, using different asthma proxies.

	Population % (95% CI)	Total weighted population (2,066,953)
Lifetime asthma	11.2 (9.1–13.7)	230,886
Current asthma (with symptoms in the previous 12 months)		
Wheezing w/o cold	8.2 (6.5–10.4)	169,991
Lifetime asthma + wheezing	6.4 (4.8–8.6)	132,848
Lifetime asthma + wheezing OR waking with breathlessness	7.0 (5.3–9.1)	143,958
Lifetime asthma + wheezing OR asthma attack OR waking with breathlessness	7.2 (5.5–9.4)	149,199
Lifetime asthma + wheezing OR waking with breathlessness OR waking chest tightness OR waking cough	8.3 (6.5–10.6)	171,829
Lifetime asthma + wheezing OR asthma attack OR waking with breathlessness OR current asthma medication ^a	8.4 (6.6–10.7)	173,681
Lifetime asthma + wheezing OR asthma attack OR waking with breathlessness/chest tightness/cough	8.4 (6.6–10.7)	173,963
Lifetime asthma + wheezing OR asthma attack OR current asthma medication OR waking with breathlessness/chest tightness/cough	9.1 (7.2–11.5)	188,819

^aDefinition used as *current asthma*.

Table 4. Weighted proportions (95% confidence interval) of pulmonary function tests, allergy tests (skin or blood), and inhaled medication use in Portuguese children with current asthma.

	PFT ^a ever % (95% CI)	Allergy tests ^b ever % (95% CI)	Inhaled meds ^c in the last 12 months % (95% CI)
All	45.7 (33.8–58.1)	79.9 (67.9–88.2)	67.6 (58.4–75.7)
Gender			
Female	36.9 (26.0–49.3)	87.0 (67.5–95.5)	74.9 (70.7–79.3)
Male	51.4 (41.3–61.4)	75.3 (70.2–79.8)	62.9 (49.1–74.9)
Age groups			
0–5 years old	21.9 (13.5–33.6)	48.4 (27.1–70.3)	72.1 (38.7–91.4)
6–12 years old	46.4 (40.2–52.7)	97.1 (96.8–97.5)	72.5 (64.8–79.1)
13–17 years old	61.5 (47.4–73.9)	79.4 (69.0–87.0)	58.1 (47.4–68.1)
National region			
North	44.0 (29.6–59.4)	93.3 (82.4–97.7)	57.9 (36.5–76.8)
Centre and Islands	38.6 (29.5–48.5)	75.6 (75.2–75.9)	69.8 (69.3–70.2)
South	53.9 (41.0–66.2)	71.3 (56.2–82.7)	74.7 (61.2–84.7)
Municipality			
Urban	57.6 (46.9–67.7)	83.9 (74.8–90.1)	76.4 (63.4–85.9)
Rural	7.3 (7.2–7.3)	67.0 (66.6–67.5)	39.2 (29.5–49.9)
Allergic rhinitis			
No	43.8 (33.8–54.4)	71.4 (59.5–81.0)	67.6 (51.8–80.1)
Yes	47.4 (38.9–56.1)	87.7 (84.0–90.7)	67.7 (59.5–74.9)
Food allergy			
No	46.2 (38.4–54.2)	78.6 (72.0–84.0)	67.6 (57.8–76.1)
Yes	37.6 (37.6–37.6)	100.0 (n/a)	67.8 (67.8–67.8)

^aPFT, pulmonary function tests. ^bAllergy tests: blood and/or skin tests. ^cInhaled medications: inhaled medication use. n/a: not applicable. Bold values are statistically significant differences between row subgroups.

Our estimate of LA is based on the same question of ISAAC. The estimate in the 6- to 12-year-old age group (12.3%) was higher than that in the 6- to 7-year-old age group in the Portuguese ISAAC survey (9.8%) [6], while our estimate for the 13- to 17-year-old age group (13.9%) was similar to that in the 13- to 14-year-old age group in the ISAAC survey (13.8%). In preschoolers, two recent Portuguese studies had also reported estimates of physician asthma diagnosis similar to ours: 4.6% in both studies [21,22].

Schmitz et al. [11] reported a 4.7% prevalence of a doctor diagnose LA in the Germany population of 0- to 17-year-old using data from the 2003–2006 German Health Interview and Examination Survey for Children and Adolescents (KiGGS). This prevalence was much lower than ours and is in agreement with the estimated prevalence of LA among

German children reported in the ISAAC, which was also much lower than that in Portugal (in Germany, 4.3% in 6- to 7-year-old children and 7.5% in 13- to 14-year-old children) [5]. Data from the 2010 United States National Health Interview Survey for children aged <18 years reported an estimated doctor diagnosed LA prevalence of 13.6% and CA prevalence of 9.5% [12,13], which are similar to our estimations.

Asthma symptoms other than wheezing

In children, epidemiological asthma definitions and clinical asthma phenotypes are primarily based upon wheezing [28]. However, Skytt et al. [29], based on data from the Copenhagen Prospective Study on Asthma in Childhood,

addressed the lack of validity of wheezing for asthma diagnosis in children aged 0–3 years. They argued for a global description of asthma symptoms to reduce the risk of misclassification of asthma in children. Wheezing-based asthma definitions are also limited by differences in the concept and perception of wheezing. Fernandes et al. [30] reported a lack of perception of the term “wheezing” among Portuguese parents and health professionals. To account for this problem, we used several synonyms of wheezing in Portuguese in wheezing-related questions. Additionally, the presence of wheezing was not mandatory in our definition of CA.

We suggest that questionnaires directed at children and adolescents should include different measures to comprehensively assess asthma characteristics (previous diagnosis, several symptoms, and medication), thus aiming to obtain precise estimates of asthma prevalence, especially in younger children. In any case, standardization of epidemiologic asthma definitions and their clinical validation are needed [3].

Diagnostic tests and medication for asthma

In spite of the recommendations to perform spirometry as part of asthma management [2], only about half of the Portuguese children with CA aged ≥ 6 years had undergone PFT. Similarly, fewer than half of Portuguese children with CA had used inhaled controller medications within the previous 12 months, even considering a CA definition based on several symptoms occurring in the last 12 months, like the one used in our study. Moreover, those who only used reliever inhaled medication in the previous year, without any controller inhalers, were twice as likely to have experienced an asthma attack in the same time period.

No differences in the prevalence of asthma or asthma-like symptoms were found between urban and rural municipalities; however, children living in rural areas were much less likely to have undergone PFT or allergy tests or used inhaled medication. In agreement with our data, a Greek study with school-aged children also showed that the prevalence of asthma diagnosis was the same between rural and urban areas despite findings on the narrowing of small airways in urban environments [31]. Disparities in health care for rural-dwelling patients with asthma have been reported, indicating that those with asthma who live in rural areas receive substandard care for asthma; however, there are limited direct data on these findings [32]. Taken together, our results and those of previous studies on diagnostic tests and medication use may be related to differences in health-care access and may suggest substandard asthma care in Portuguese children, especially in less urbanized areas.

Limitations

This study has several limitations. The survey was designed for the overall Portuguese population; however, the questions included in the questionnaire and the definitions used are similar to others used in international and Portuguese pediatric studies [33–35]. The use of the 2001 National Census for sampling could not account for the reduction in the number of births that occurred in the last decade; however, it was the most recently available data at the time of data

collection. Also, the study's pediatric sample follows the characteristics of the Portuguese pediatric population characteristics [19]. The use of landline telephones excludes households without residential telephones; nevertheless, it allowed us to guarantee a stratified cluster sample by region. Answers were given by the main caregiver for participants <15 years old and by the adolescent when the participant was ≥ 15 years old. This may limit comparisons between these age groups; however, changes of parent-reported to auto-reported outcomes are recommended between school age and adolescence [23], and other studies on asthma prevalence in pediatric ages had similar methodology [11]. Finally, we could not obtain a clinical confirmation of the diagnosis; therefore, participants' misclassification can be expected, as in any similar survey.

Conclusion

Asthma-like symptoms were present in more than one-third of Portuguese children, and the prevalence of CA was 8.4%. Age influenced asthma-like symptoms patterns, and asthma prevalence varied according to different definitions. Therefore, using composite measures and reporting different operational estimates is advisable. Fewer than half of the children with CA had used inhaled controller medications in the previous year, and those who used inhaled relievers alone had experienced twice more asthma attacks. PFT were underused among asthmatic children. Also, the findings on low inhaled controller medication and PFT use were more prevalent in children living in rural areas.

Declaration of interest

The authors report no conflicts of interest. None of the authors received any honorarium, grant, or other form of payment to produce the manuscript. The authors alone are responsible for the content and writing of the paper.

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Supplementary material available online
Supplementary Tables S1 and S2