



Body mass index, asthma, and respiratory symptoms: a population-based study

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ABSTRACT

Objective: To estimate the prevalence of respiratory symptoms and asthma, according to body mass index (BMI), as well as to evaluate factors associated with physician-diagnosed asthma, in individuals ≥ 40 years of age. **Methods:** This was a population-based cross-sectional study conducted in Florianópolis, Brazil, with probability sampling. Data were collected during home visits. Demographic data were collected, as were reports of physician-diagnosed asthma, respiratory symptoms, medications in use, and comorbidities. Anthropometric measurements were taken. Individuals also underwent spirometry before and after bronchodilator administration. Individuals were categorized as being of normal weight (BMI < 25 kg/m²), overweight (25 kg/m² \leq BMI < 30 kg/m²), or obese (BMI \geq 30 kg/m²). **Results:** A total of 1,026 individuals were evaluated, 274 (26.7%) were of normal weight, 436 (42.5%) were overweight, and 316 (30.8%) were obese. The prevalence of physician-diagnosed asthma was 11.0%. The prevalence of obesity was higher in women ($p = 0.03$), as it was in respondents with ≤ 4 years of schooling ($p < 0.001$) or a family income of 3-10 times the national minimum wage. Physician-diagnosed asthma was more common among obese individuals than among those who were overweight and those of normal weight (16.1%, 9.9%, and 8.0%, respectively; $p = 0.04$), as were dyspnea (35.5%, 22.5%, and 17.9%, respectively; $p < 0.001$) and wheezing in the last year (25.6%, 11.9%, and 14.6%, respectively; $p < 0.001$). These results were independent of patient smoking status. In addition, obese individuals were three times more likely to report physician-diagnosed asthma than were those of normal weight ($p = 0.005$). **Conclusions:** A report of physician-diagnosed asthma showed a significant association with being ≥ 40 years of age and with having a BMI ≥ 30 kg/m². Being obese tripled the chance of physician-diagnosed asthma.

Keywords: Obesity; Dyspnea; Cough; Asthma; Smoking.

INTRODUCTION

Asthma and obesity are common conditions that predominantly affect women and can coexist.⁽¹⁾ In recent years, a considerable number of studies have provided evidence that obesity and asthma are linked. Obesity has been reported as a risk factor for asthma in various demographic groups.^(2,3) In addition, results from a meta-analysis involving more than 300,000 adults have shown that obesity nearly doubles the likelihood of incident asthma and that there is a dose-response effect of increasing body mass index (BMI) on asthma incidence.⁽⁴⁾ Furthermore, obesity is associated with increased asthma severity, reduced disease control, and increased risk of exacerbations.^(5,6) Factors contributing to the pathogenesis of asthma in obese individuals include changes in respiratory mechanics and altered inflammatory and immune responses because of obesity.^(1,7)

Obesity has been associated with other chronic respiratory conditions.⁽⁸⁻¹¹⁾ Respiratory symptoms, such as

dyspnea and exercise intolerance, are common in obese individuals^(1,12) and are possibly due to body structure changes resulting from a sedentary lifestyle.⁽¹³⁾ Studies have shown that the prevalence of obesity in Brazil has increased over the years. Malta et al.⁽¹⁴⁾ used data from the Telephone-based System for the Surveillance of Risk and Protective Factors for Chronic Diseases and examined trends in the prevalence of overweight and obesity in adults in 26 Brazilian state capitals and the Federal District of Brasília between 2006 and 2012. The authors reported that the prevalence of obesity increased from 11.6% in 2006 to 17.4% in 2012.

Few studies have examined trends in the prevalence of asthma in Brazil.⁽¹⁵⁻¹⁷⁾ In a study conducted in Brazil and examining 2013 Brazilian National Health Survey data for 60,202 adults (in the 18- to 49-year age bracket), the prevalence of physician-diagnosed asthma was found to be 4.4%.⁽¹⁵⁾ In addition, the study examined temporal trends in the prevalence of asthma, which was found

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to have remained stable in 1998, 2003, and 2008. Other studies, however, have shown that trends in the prevalence of asthma vary across Brazilian capitals, the prevalence of asthma increasing considerably each year in some cities, such as Florianópolis,⁽¹⁶⁾ and remaining stable in others, such as Porto Alegre.⁽¹⁷⁾

Data on the prevalence of common chronic diseases such as asthma and obesity play an important role in guiding health policies and providing the basis for the development of educational interventions and preventive measures. Therefore, the objective of the present study was to estimate the prevalence of respiratory symptoms and asthma, according to BMI, as well as to evaluate factors associated with physician-diagnosed asthma, in individuals ≥ 40 years of age.

METHODS

This is a subanalysis of the *Respira Floripa* study, a population-based cross-sectional study conducted in the urban area of Florianópolis, with probability sampling of census tracts and households and data being collected during home visits, as described elsewhere.⁽¹⁸⁾ The present study was approved by the Human Research Ethics Committee of the Federal University of Santa Catarina, in Florianópolis (Protocol 1136; FR: 385174; Certificate no. 766 Dec 31, 2010), and all participants gave written informed consent.

A detailed description of the methods used in the present study can be found elsewhere.^(18,19) In brief, a representative sample of individuals ≥ 40 years of age residing in the greater metropolitan area of Florianópolis was randomly obtained.^(18,19) The study consisted of one or more household visits. Eligible residents who agreed to participate in the study answered questions regarding demographic characteristics, respiratory symptoms, medication use and doses, and physician-diagnosed comorbidities. Spirometry was performed in accordance with American Thoracic Society/European Respiratory Society standards,⁽²⁰⁾ with the use of an American Thoracic Society-certified, portable, ultrasound-based spirometer (EasyOne; ndd Medical Technologies, Inc., Andover, MA, USA). The reference values used were those of Hankinson et al.⁽²¹⁾ Height was measured with a portable stadiometer (Seca®; Hamburg, Germany), and weight was measured with an electronic scale (Tanita Corporation of America, Inc., Arlington Heights, IL, USA). Height and weight were measured with participants barefoot and wearing light clothing.

On the basis of their BMI, participants were stratified into the following categories⁽²²⁾: normal weight ($20 \text{ kg/m}^2 \leq \text{BMI} < 25 \text{ kg/m}^2$), overweight ($25 \text{ kg/m}^2 \leq \text{BMI} < 30 \text{ kg/m}^2$), and obesity ($\text{BMI} \geq 30 \text{ kg/m}^2$). Smoking status was determined in accordance with the criteria established by the Centers for Disease Control and Prevention.⁽²³⁾ Individuals who answered “yes” to the question “Has your doctor ever told you that you have asthma, wheezy bronchitis, or allergic bronchitis?” were considered to have physician-diagnosed asthma. Individuals with chronic airflow limitation (CAL), as

determined by a post-bronchodilator FEV_1/FVC ratio of < 0.7 , were considered to have COPD.⁽²⁴⁾ Individuals who answered “yes” to the question “Are there months in which you cough almost every day?” were considered to have chronic cough. Individuals who answered “yes” to the questions “Do you usually have phlegm in your chest that is difficult to expectorate, even when you do not have a cold?” and “Are there months in which you have this phlegm almost every day?” were considered to have chronic expectoration. Individuals who answered “yes” to the question “Do you have shortness of breath when hurrying on level ground or walking up a slight incline?” were considered to have dyspnea. Individuals who answered “yes” to the question “Have you had wheezing or whistling in the chest in the past 12 months?” were considered to have wheezing in the last year. Individuals who answered “yes” to at least one of the questions regarding respiratory symptoms were considered to have respiratory symptoms. The Brazilian Portuguese version of the Hospital Anxiety and Depression Scale (HADS) was used in order to determine the presence of symptoms of depression and anxiety,⁽²⁵⁾ which were considered to be present when the HADS score was ≥ 8 .⁽²⁶⁾

Statistical analysis

Continuous variables are summarized as means and standard deviations, and categorical variables are summarized as absolute and relative frequencies. Differences among groups regarding categorical variables were evaluated by the chi-square test. Comparison of means between two groups was performed with the Student’s t-test. Comparison of means among three or more groups was performed with ANOVA, which was followed by post hoc analysis with the Bonferroni test (when necessary). Factors associated with self-reported physician-diagnosed asthma were analyzed with the use of generalized linear models (Poisson regressions with robust variance estimates). The risk factors examined were age, sex, self-reported race (White or Non-White), BMI (as above), level of education (≤ 4 years of schooling, 5-8 years of schooling, or ≥ 9 years of schooling, in accordance with the educational system in Brazil), smoking status (smokers/former smokers or nonsmokers), socioeconomic class (class A—a family income of > 20 times the Brazilian national minimum wage; class B—a family income of 11-20 times the Brazilian national minimum wage; class C—a family income of 4-10 times the Brazilian national minimum wage; class D—a family income of 2-3 times the Brazilian national minimum wage; and class E—a family income of ≤ 1 time the Brazilian national minimum wage), physician-diagnosed rhinitis, and physician-diagnosed gastritis, ulcer, or gastroesophageal reflux disease (GERD). Prevalence ratios and their 95% confidence intervals were used as a measure of effect size. Smoking, sex, age, level of education, and socioeconomic class were treated as covariates. All statistical tests were two-tailed, and the level of significance was set at $p < 0.05$. All statistical analyses were performed with the IBM

SPSS Statistics software package, version 22.0 (IBM Corporation, Armonk, NY, USA).

RESULTS

A total of 1,059 adults participated in the study. Of those, 33 (3.1%) were excluded from the analysis because they had a BMI of < 20 kg/m². White individuals (85.4%), individuals ≥ 50 years of age (72.9%), females (59.6%), individuals with ≥ 9 years of schooling (57.3%), individuals belonging to socioeconomic class C (75.0%), and nonsmokers (82.7%) predominated. The prevalence of overweight was 42.5%, and the prevalence of obesity was 30.8%. The prevalence of self-reported asthma was 11.3%. Table 1 describes the characteristics of the study population, by BMI.

Prevalence of asthma, respiratory symptoms, and other respiratory diseases in normal-weight, overweight, or obese individuals

As can be seen in Figure 1, physician-diagnosed asthma was more common among obese individuals

than among overweight individuals and those of normal weight (16.1%, 9.9%, and 8.0%, respectively; $p = 0.004$), as were dyspnea (35.5%, 22.5%, and 17.9%, respectively; $p < 0.001$) and wheezing in the last year (25.6%, 11.9%, and 14.6%, respectively; $p < 0.001$). In contrast, the prevalence of rhinitis was significantly higher in normal-weight individuals. There was a trend toward a higher prevalence of COPD among normal-weight individuals than among obese or overweight individuals (11.3%, 6.3%, and 8.3%, respectively; $p = 0.09$). The prevalence of chronic cough was similar among the groups, as was the prevalence of chronic expectoration. As can be seen in Table 2, the prevalence of dyspnea and that of wheezing increased significantly with increasing BMI, regardless of smoking status. In contrast, the prevalence of chronic expectoration was significantly higher in obese nonsmokers than in the remaining subgroups. The prevalence of physician-diagnosed asthma was highest in obese smokers, whereas the prevalence of rhinitis was highest in nonobese nonsmokers. Without considering smoking status, the prevalence of rhinitis

Table 1. Characteristics of the study population (N = 1,026), stratified into normal weight, overweight, and obesity categories on the basis of the body mass index.^a

Characteristic	Normal weight (n = 274)	Overweight (n = 436)	Obesity (n = 316)	P
Age, years	57.0 ± 11.2	59.6 ± 12.2	57.3 ± 10.8	0.003
Sex				0.04
Female	162 (26.5)	244 (39.9)	206 (33.7)	
Male	112 (27.1)	192 (46.4)	110 (26.6)	
Self-reported race				0.9
White	234 (26.7)	374 (42.7)	268 (30.6)	
Non-White	40 (26.7)	62 (41.3)	48 (32.0)	
Level of education, no. of years of schooling				0.004
0-4	50 (19.5)	118 (45.9)	89 (34.6)	
5-8	41 (22.7)	77 (42.5)	63 (34.8)	
≥ 9	183 (31.1)	241 (41.0)	164 (27.9)	
Socioeconomic class				0.2
A or B	48 (32.4)	65 (43.9)	35 (23.6)	
C	198 (25.7)	326 (42.4)	245 (31.9)	
D or E	28 (36.7)	45 (41.3)	36 (33.0)	
Smoking status				0.04
Nonsmoker	128 (23.5)	239 (43.9)	178 (37.2)	
Smoker/Former smoker	146 (30.0)	197 (41.0)	138 (28.7)	
Anthropometric characteristics				
BMI, kg/m ²	23.1 ± 1.3	27.4 ± 1.4	34.1 ± 3.8	< 0.001*
Neck circumference, cm	35.0 ± 4.4	37.1 ± 3.6	39.8 ± 3.8	< 0.001*
Waist circumference, cm	82.8 ± 8.1	94.1 ± 8.6	107.2 ± 10.4	< 0.001*
Hip circumference, cm	92.2 ± 6.5	102.6 ± 7.5	113.6 ± 9.6	< 0.001*
Nonrespiratory comorbidities				
Systemic arterial hypertension ^b	53 (19.3)	168 (38.5)	179 (56.6)	< 0.001
Heart disease ^b	46 (15.7)	76 (17.4)	73 (23.1)	0.04
Diabetes ^b	24 (8.8)	47 (10.8)	59 (18.7)	< 0.001
Gastritis/ulcer/GERD ^b	90 (32.8)	130 (29.8)	113 (35.8)	0.2
Symptoms of depression ^c	43(15.7)	89 (20.4)	64 (20.3)	0.2

BMI: body mass index; and GERD: gastroesophageal reflux disease. ^aValues expressed as n (%) or mean ± SD. ^bSelf-reported physician-diagnosed disease. ^cHospital Anxiety and Depression Scale score ≥ 8. * $p < 0.001$ for all between-group comparisons.

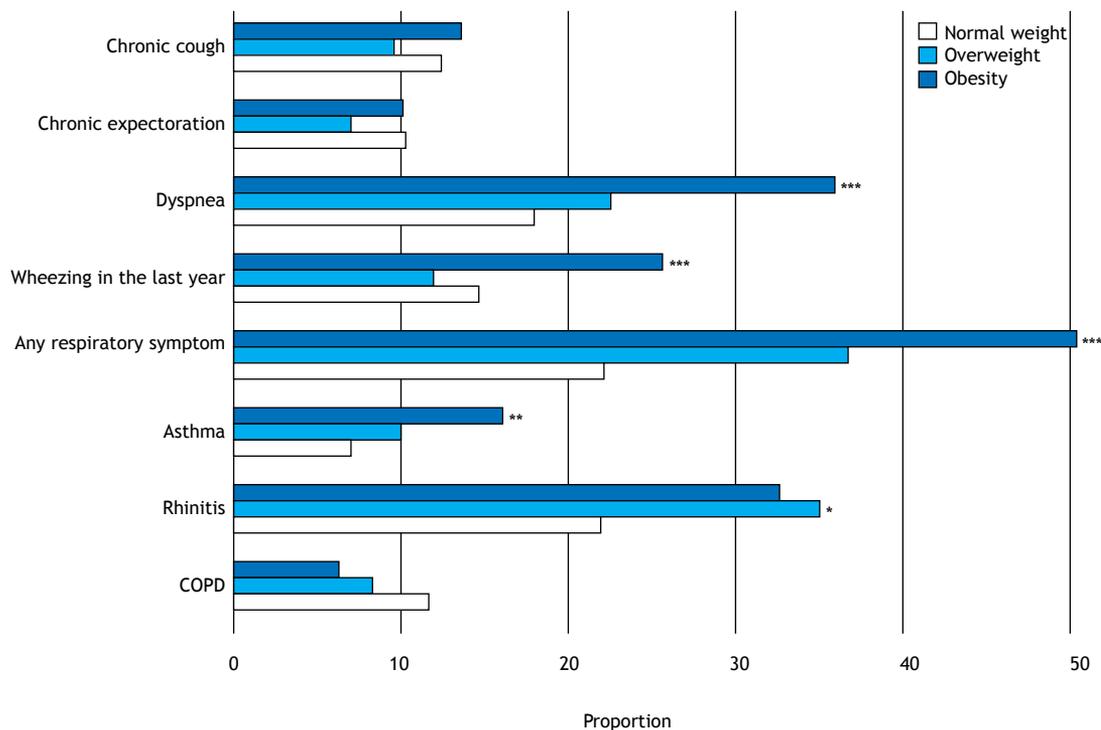


Figure 1. Prevalence of respiratory symptoms, asthma, rhinitis, and COPD in normal weight, overweight, and obesity groups. *p = 0.05; **p = 0.001; ***p < 0.001.

Table 2. Prevalence of respiratory symptoms, asthma, and respiratory disease in individuals of normal weight, overweight individuals, and obese individuals, by smoking status.

Prevalence	Normal weight (n = 274)	Overweight (n = 436)	Obesity (n = 316)	p*
Chronic cough, n (%)	34 (12.4)	42 (9.6)	43 (13.6)	0.2
Nonsmokers	6 (4.7)	16 (6.7)	18 (10.1)	0.1
Smokers/Former smokers	28 (19.2)	26 (13.2)	25 (18.1)	0.2
Chronic expectoration, n (%)	28 (10.2)	31 (7.1)	32 (10.1)	0.2
Nonsmokers	2 (1.6)	9 (3.8)	14 (7.9)	0.02
Smokers/Former smokers	26 (17.8)	22 (11.2)	18 (13.0)	0.2
Dyspnea, n (%)	48 (17.9)	98 (22.5)	113 (35.5)	< 0.001
Nonsmokers	13 (10.2)	44 (18.4)	56 (31.5)	< 0.001
Smokers/Former smokers	35 (24.0)	53 (26.9)	59 (42.8)	< 0.001
Wheezing in the last year, n (%)	40 (14.6)	52 (11.9)	81 (25.6)	< 0.001
Nonsmokers	10 (7.8)	15 (6.3)	38 (21.3)	< 0.001
Smokers/Former smokers	30 (20.5)	37 (18.8)	43 (31.2)	< 0.001
Any respiratory symptom, n (%) ^a	90 (22.0)	162 (37.2)	158 (50.0)	< 0.001
Nonsmokers	24 (18.8)	70 (29.3)	77 (43.3)	< 0.001
Smokers/Former smokers	66 (45.2)	92 (46.7)	81 (58.7)	0.04
Asthma, n (%)	22 (8.0)	43 (9.9)	51 (16.1)	0.004
Nonsmokers	9 (7.0)	20 (8.4)	25 (14.0)	0.07
Smokers/Former smokers	13 (8.9)	23 (11.7)	26 (18.8)	0.04
Rhinitis, n (%)	60 (21.9)	64 (34.8)	60 (32.6)	0.04
Nonsmokers	35 (27.3)	31 (13.0)	29 (16.3)	0.002
Smokers/Former smokers	25 (17.1)	33 (16.8)	31 (22.5)	0.4
COPD, n (%)	31 (11.3)	36 (8.3)	20 (6.3)	0.09
Nonsmokers	2 (1.6)	11 (4.6)	6 (3.4)	0.3
Smokers/Former smokers	29 (19.9)	25 (12.7)	14 (10.1)	0.04

^aAny respiratory symptom: dyspnea, wheezing in the last year, chronic cough, or chronic expectoration.

was highest in overweight individuals. In contrast, the prevalence of COPD was significantly higher in smokers/former smokers of normal weight than in the remaining subgroups.

Reports of inhaled corticosteroid use or asthma medication use were more common among participants with physician-diagnosed asthma than among those without (18.8% vs. 0.6%, $p < 0.001$, and 34.2% vs. 1.3%, $p < 0.001$, respectively). In addition, post-bronchodilator percent predicted FEV₁, post-bronchodilator percent predicted FVC, and the FEV₁/FVC ratio were significantly lower in participants with physician-diagnosed asthma than in those without (79.9% \pm 23.3% vs. 92.9% \pm 18.0%, $p < 0.001$; 81.5% \pm 15.2% vs. 89.2% \pm 15.2%, $p < 0.001$; and 0.75 \pm 0.10 vs. 0.80 \pm 0.07, $p < 0.001$, respectively). However, 48 (41.4%) of all participants with physician-diagnosed asthma had normal spirometry results. Of those who had abnormal spirometry results (airflow limitation), 38.2% had a significant bronchodilator response (≥ 200 mL and $\geq 12\%$).

Relationship among physician-diagnosed asthma, smoking, and CAL

The relationship among physician-diagnosed asthma, smoking, and CAL is shown in Figure 2. Of the individuals with self-reported physician-diagnosed asthma, 24 (20.7%) had CAL, as determined by spirometry. Of the never smokers, 8 (14.8%) had CAL. Among smokers/former smokers with a smoking history of < 10 pack-years, the prevalence of CAL was 35.5%. Among those with a smoking history of 10-20 pack-years, the prevalence of CAL was 11.1%, whereas, among those with a smoking history ≥ 20 pack-years, the prevalence of CAL was 24.2%.

Prevalence of physician-diagnosed asthma and associated demographic and clinical variables

The prevalence of physician-diagnosed asthma was significantly higher in women, in individuals with

5-8 years of schooling, in individuals belonging to socioeconomic class C, and in obese individuals. Being obese tripled the chance of physician-diagnosed asthma (Table 3). In addition, the prevalence of physician-diagnosed asthma was significantly higher in individuals with COPD and in those with physician-diagnosed gastritis, ulcer, or GERD (Table 3). Multivariate analysis adjusted for age, sex, level of education, socioeconomic class, smoking, and the remaining variables showed that self-reported physician-diagnosed rhinitis, overweight, and obesity (BMI ≥ 30 kg/m²) were independently associated with self-reported physician-diagnosed asthma (Table 4).

DISCUSSION

The results of the present study show that the prevalence of asthma and that of obesity are high in individuals ≥ 40 years of age, and that respiratory symptoms and asthma are significantly more common in obese individuals. The results also show that being obese tripled the chance of physician-diagnosed asthma.

The association between asthma and BMI is complex and has been widely studied. The findings of the present study are consistent with those of epidemiological studies showing that being obese doubles the risk of incident asthma.⁽⁴⁾ Population-based studies evaluating the association between asthma and obesity are scarce, particularly in Brazil. To our knowledge, this is the first population-based study in Brazil involving adults ≥ 40 years of age and investigating the association among obesity, asthma, and respiratory symptoms. In the present study, the prevalence of respiratory symptoms such as dyspnea and wheezing in the last year was significantly more common in obese individuals than in nonobese individuals regardless of smoking status, constituting further evidence for the association between obesity and physician-diagnosed asthma. This association is further supported by the fact that the probability of physician-diagnosed asthma was 2.5 times higher in individuals with physician-diagnosed

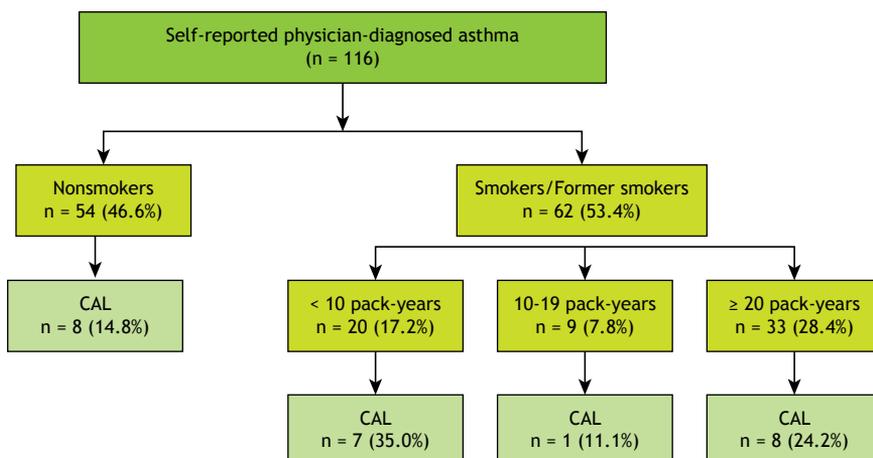


Figure 2. Prevalence of chronic airflow limitation (CAL) in nonsmokers and smokers/former smokers with physician-diagnosed asthma.

Table 3. Self-reported physician-diagnosed asthma, by demographic and clinical variables (and their respective prevalence ratios).

Variable	n/N	%	Crude analysis		Adjusted analysis		
			PR (95% CI)	p	PR (95% CI)	p	
Sex							
Female	83/612	13.6	1	0.007	1	< 0.001*	
Male	33/414	8.0	1.7 (1.1-2.5)		1.6 (1.3-2.2)		
Age bracket, years							
40-49	39/278	14.0	1	0.2	1	0.1**	
50-59	29/313	9.3	1.2 (0.8-1.8)		1.3 (0.9-2.1)		
≥ 60	48/435	11.0	0.8 (0.5-1.3)		0.8 (0.5-1.4)		
Self-reported race							
White	94/976	10.7	1	0.1	1	0.1**	
Non-White	22/150	14.7	1.4 (0.9-2.1)		1.4 (0.9-2.2)		
Level of education, no. of years of schooling							
0-4	26/257	10.1	0.8 (0.7-1.6)	0.8	1.1 (0.7-1.8)	0.8**	
5-8	28/181	15.5	1.5 (0.9-2.5)		1.4 (0.8-2.4)		
≥ 9	62/588	10.5	1		1		
Socioeconomic class							
A or B	8/148	5.4	1	0.01	1	0.01**	
C	100/769	13.0	2.4 (1.2-4.8)		2.4 (1.2-4.9)		
D or E	8/109	7.3	1.3 (0.5-3.5)		1.3 (0.5-3.5)		
BMI, kg/m²							
< 25	22/274	8.0	1	0.004	1	0.002**	
25-29	43/436	9.9	1.2 (0.7-2.0)		1.1 (0.7-1.9)		
≥ 30	51/316	16.1	2.0 (1.2-3.2)		2.1 (1.3-3.4)		
Smoking status							
Nonsmokers	54/545	9.9	1	0.1	1	0.5**	
Smokers/former smokers	62/481	12.9	1.3 (0.9-1.9)		1.3 (0.8-2.2)		
Rhinitis^a							
No	70/842	8.3	1	< 0.001	1	< 0.001**	
Yes	46/184	25.0	3.0 (2.1-4.2)		2.1 (1.4-3.1)		
Gastritis/ulcer/GERD^a							
No	59/693	8.5	1	< 0.001	1	0.001**	
Yes	57/333	17.1	2.0 (1.4-2.8)		1.9 (1.3-2.7)		

PR: prevalence ratio; BMI: body mass index; and GERD: gastroesophageal reflux disease. ^aSelf-reported physician-diagnosed disease. *Adjusted for BMI, smoking, and age. **Adjusted for sex, BMI, smoking, and age.

rhinitis and 1.5 times higher in individuals with physician-diagnosed gastritis, ulcer, or GERD. This is not unexpected, given that these comorbidities are commonly associated with asthma.⁽²⁷⁾

In the present study, asthma treatment was more common in individuals with physician-diagnosed asthma than in those without, the former showing functional changes consistent with asthma. Taken together, these findings add robustness to the results of the present study. However, our results should be interpreted with caution because the presence of asthma in our cohort was determined by self-reports of physician-diagnosed asthma rather than by objective measures, meaning that there is a risk of overdiagnosis or underdiagnosis.⁽²⁸⁾

Physician-diagnosed asthma is commonly used in order to define the presence of asthma in epidemiological studies.^(14,15,29,30) In the present study, all participants underwent spirometry. Of those who reported having physician-diagnosed asthma, 58.6% had

airflow limitation. Of those, 39.2% had a significant bronchodilator response. However, a significant proportion (41.4%) had normal spirometry. The presence of normal spirometry and absence of significant bronchodilator response do not rule out asthma.⁽³¹⁾ Because this was a population-based study, it would have been impracticable to use additional methods to confirm the presence of asthma. In addition, there is sufficient evidence that a negative challenge test result rules out asthma as a cause of current respiratory symptoms but does not rule out a previous diagnosis of asthma. Because airway hyperresponsiveness varies as does asthma, prevalence estimates based on challenge test results are not adequate to rule out a previous diagnosis of asthma.⁽³¹⁾ In summary, the definition of asthma in the present study is perfectly adequate for the objectives and design of the study.

Asthma and smoking are common conditions that can coexist in patients, and the prevalence of smoking

Table 4. Multivariate analysis of factors associated with self-reported physician-diagnosed asthma in individuals ≥ 40 years of age.

Factor	PR	95% CI	p*
Overweight	2.3	1.2-4.5	0.01
Obesity	3.1	1.6-6.0	0.001
Self-reported physician-diagnosed rhinitis	2.6	1.7-3.7	< 0.001

PR: prevalence ratio. *Adjusted for age, sex, level of education, socioeconomic class, and smoking.

in asthma patients has been reported to be similar to the prevalence of smoking in the general population.⁽³²⁾ Smoking has a negative impact on asthma, interfering with the response to corticosteroids and being associated with accelerated decline in lung function and increased exacerbations.⁽³²⁻³⁴⁾ Although only a minority of the participants with physician-diagnosed asthma were current smokers, more than half had experimented with smoking. Because asthma is associated with accelerated decline in lung function regardless of smoking status, asthma patients with CAL were evaluated in the present study. Of those, one third had never smoked, and one third had a smoking history of < 20 pack-years. However, the presence of CAL in smokers/former smokers (13.3%) is suggestive of asthma-COPD overlap syndrome. This prevalence is higher than that reported in a recent study conducted in low-income countries.⁽²⁹⁾ However, differences between studies in populations and definitions of CAL might explain these discrepancies.

The prevalence of obesity in the present study was higher than the national prevalence reported in 2017.⁽¹⁴⁾ Our results are similar to those reported in a study conducted in the city of São Paulo, Brazil,⁽³⁵⁾ where the prevalence of overweight and obesity was higher than the national prevalence. Methodological differences can explain the discrepancy. Malta et al.⁽¹⁴⁾ assessed the prevalence of obesity in 26 Brazilian state capitals and in the Federal District of Brasília on the basis of data on height and weight collected via telephone interviews, whereas, in the present study

and in the study conducted in São Paulo,⁽³⁵⁾ height and weight were objectively measured.

Our study has limitations, some of which are due to its design. As is the case with all studies in which a cross-sectional design is used, it is impossible to infer causality. Another limitation is the use of self-reports of physician-diagnosed asthma to define the presence of asthma in the present study. However, as discussed earlier, self-reported physician-diagnosed asthma is commonly used in order to define asthma in epidemiological studies. In addition, our definition of asthma was validated, at least in part, by our findings of differences in lung function between individuals with asthma and those without. Despite these limitations, the study methods and random selection of a representative sample add robustness to the results.

Respiratory symptoms in obese individuals should be objectively investigated in order to confirm or rule out asthma as a cause. If the presence of asthma is confirmed, personalized asthma treatment can provide better symptom control. Despite the role of genetic factors in these diseases, obesity prevention and treatment can minimize complications. Government policies and public health policies should work in concert to encourage lifestyle changes and healthy behaviors.

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