

Overweight and obesity as risk factors for impaired lung function in patients with asthma: A real-life experience

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ABSTRACT

Several studies have outlined a possible relationship between an increased body mass index (BMI) and asthma. The aim of the study was to investigate in patients with asthma, enrolled in a real-life setting, a possible relationship between BMI and asthma parameters, including lung function markers (i.e., forced vital capacity [FVC], forced expiratory volume in 1 second [FEV₁], FEV₁/FVC ratio, and forced expiratory flow at 25–75%), fractional concentration of exhaled nitric oxide (FeNO), asthma control level, Asthma Control Test (ACT), comorbid allergy, and allergic rhinitis (AR). The study included 286 patients with asthma. All subjects were evaluated performing clinical examination, spirometry, FeNO measurement, and ACT questionnaire. Ninety-six (33.6%) patients were overweight and 45 (14.1%) patients were obese. Lung function was significantly impaired in overweight and obese asthmatic patients in comparison with normal-weight ones. Increased BMI did not affect FeNO values and asthma control level. Overweight patients had double the risk (odds ratio [OR], 1.89) and obese patients had triple the risk (OR, 3.17) of having pathological FEV₁ in comparison with normal-weight patients. Both in overweight (OR, 2.415) and obese patients (OR, 2.126), the risk to have pathological FEV₁/FVC was about two times higher than in normal-weight patients. In overweight and obese asthmatic patients the probability of allergy was, respectively, 3.5 times (OR, 0.285) and 4.5 times (OR, 0.224) lower compared with normal-weight asthmatic patients. The risk of suffering from AR was three times lower in overweight (OR, 0.331) patients and six times lower in obese (OR, 0.163) patients. The present study suggests that BMI assessment should be routinely considered in asthmatic patients to reveal bronchial obstruction, also, in controlled asthma.

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Obesity with associated comorbidities has a dramatically increased prevalence worldwide, taking epidemic proportion¹; obesity prevalence is ranging between 10 and 20% of the general Italian population, depending on age, gender, and geographic area. Obesity is defined as a body mass index (BMI) of ≥ 30 kg/m² and overweight as a BMI between 25 and 29.9 kg/m², in line with the World Health Organization (WHO) recommendation. Asthma prevalence is also significantly raised affecting up to 10% of the Italian general population. Asthma is defined by typical episodic symptoms, bronchial hyperactivity (BHR), and airway inflammation.

Several studies showed a link between obesity and asthma, but the mechanism for this association and the apparent difference between men and women remain unclear.^{2–7} Cross-sectional and case-control surveys reported that obesity and being overweight increased

the odds of asthma incidence. Sin and colleagues analyzed data from the Third National Health and Nutrition Examination Survey and showed a correlation between BMI and self-reported asthma.⁸ In addition, weight loss is associated with asthma improvement in obese subjects.⁹

Because both obesity and asthma are characterized by chronic and systemic inflammation,^{2,4,10} a common inflammatory pathway may be hypothesized for their association.⁵ Adipose tissue is currently considered an active secretory organ involved in modulation of appetite, energy expenditure, insulin sensitivity, endocrine and reproductive systems, bone metabolism, inflammation, and immunity.^{1,6} In addition, adipose tissue produces adipokines concurring to maintain and amplify inflammation.^{1,7} Longitudinal cohort studies allowed a more robust method for assessing the link obesity–asthma. The Coronary Artery Risk Development in Young Adults study, with a 10-year follow-up, showed that epidemic obesity threatens lung health of the general population, because decreased lung function depends on chest adipose compression limiting lung expansion.¹¹ Finally, a more recent meta-analysis showed a positive correlation between BMI and asthma incidence.¹²

The latter literature pointed out a little evidence for any association between obesity and common markers

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of asthma; in particular, obesity is not associated with airway obstruction or increased eosinophilic inflammation.^{3–5} On this regard, Jones and Nzekwu proved a linear relationship between increasing BMI and decline in expiratory reserve volume (ERV), but not with the forced expiratory volume in 1 second/forced vital capacity (FEV₁/FVC) ratio, robust sign of airflow obstruction.¹² Data concerning influence of adiposity on BHR are conflicting.^{5,13} Obesity induces physiological perturbation that might lead to respiratory symptoms, but physiological studies did not confirm that obesity induces airflow obstruction, BHR, or asthma.⁴ This discrepancy may be explained by the fact that most studies were performed on general population models or on trials. An elegant study enrolling normal subjects, nonasthmatic obese patients, nonobese asthmatic patients, and obese asthmatic patients showed significant relationships only between BMI and those parameters depending on thorax volumes (such as FEV₁, FVC, functional residual capacity [FRC], and RV) and no correlations between adiposity degree and airway geometry (specific conductance of airways and forced expiratory flow at 25–75% [FEF_{25–75}]) or bronchial responsiveness to bronchodilators or methacholine, concluding that asthma and obesity seem to influence lung function through different pathways; their coexistence produces an algebraic summation of the individual abnormalities but not synergistic interactions.¹⁴

BMI is considered a universal indicator of adiposity according to WHO criteria¹⁵ and we showed that BMI was related to BHR to methacholine in patients with asthma or allergic rhinitis (AR).¹⁶ It has been recently reported that BMI of ≥ 25 is a risk factor in patients with AR because of impaired lung function, BHR, and bronchial inflammation.¹⁷

Furthermore, asthma is characterized by bronchial inflammation that may be assessed by measuring the fractional concentration of exhaled nitric oxide (FeNO), a methodology internationally recognized.¹⁸ Asthma is clinically classified as controlled, partly controlled, and uncontrolled for practical purposes¹⁹; the Asthma Control Test (ACT) may be an easy way to assess the patient's perception of asthma control.²⁰

Therefore, the aim of the present study was to investigate in asthmatic patients enrolled in a real-life setting a possible relationship between BMI and asthma parameters, including lung function markers (*i.e.*, FVC, FEV₁, FEV₁/FVC ratio, and FEF_{25–75}), FeNO, asthma control level, ACT, comorbid allergy, and AR.

MATERIALS AND METHODS

Patients

This cross-sectional and prospective study included 286 patients suffering from asthma. They were outpatients who were referred to the asthma or allergy clinic

for a specialist visit and were sequentially recruited. The visit included history and clinical examination, including asthma signs such as whistling, spirometry, FeNO measurement, ACT questionnaire, and asthma control assessment. The Hospital Review Board approved the study procedure and written informed consent was obtained from each subject.

Study Design and Setting

Severity of asthma or a particular set of abnormalities were not selective criteria for inclusion in the study. Asthma diagnosis was previously established and documented as well as AR diagnosis and allergen-specific IgE positivity. After joining the study, all patients prospectively underwent new measurement of BMI, calculated as weight (kg)/height (m²) ratio. Inclusion criterion was documented asthma diagnosis, made by a pulmonary specialist or an allergist and based on a history of intermittent wheezing in combination with reversibility to bronchodilators and/or BHR to methacholine.²¹ Overweight was defined as BMI between 20 and 29.9 kg/m², obesity was defined as BMI of ≥ 30 kg/m², and further obesity was classified in three subgroups as proposed by WHO.¹⁵ Exclusion criteria were history of lung disease other than asthma, coronary artery disease, congestive heart failure, or *cor pulmonale*; recent asthma exacerbation; or presence of acute (in the last 4 weeks) or chronic upper and/or lower respiratory infections. Patients discontinued use of bronchodilators for 12 hours before measurement of lung function. Enrollment was sequential.

Age, gender, FVC, FEV₁, FEV₁/FVC, FEF_{25–75}, FeNO, asthma control level, ACT, presence of allergy, and AR were registered for all patients in the analysis.

Spirometry

Spirometry was performed using a computer-assisted spirometer (predictive values European Community of Coal and Steel 1993; Pulmolab 435-spiro 235; Morgan Medical, Kent, England), with optoelectronic whirl flowmeter. This spirometer fulfills the American Thoracic Society/European Respiratory Society standards according to guidelines.²² It was performed as stated by the European Respiratory Society.²³

NO Measurement

FeNO was measured with a chemoluminescence analyzer (QUARK NO-Breath; COSMED s.r.l., Rome, Italy); the detection limit of the apparatus was 1–5 parts per billion (ppb), as required by American Thoracic Society guidelines, with a resolution of 1 ppb. The analyzer was calibrated daily, using a certified NO mixture. The eNO was recorded with the single-breath method according to published guidelines.¹⁸ Subjects inhaled to total lung capacity from NO-free air and

exhaled a single breath (without nose clip) through a mouthpiece at a mouth pressure of 45 cm of water and at an expiratory flow of 50 mL/s. Mouth pressure was displayed on a computer screen in order for the patients to maintain a steady flow. The measurement was rejected if a stable flow was not maintained for at least 6 seconds of exhalation. NO was measured at the plateau and expressed in ppb.

Asthma Control Level

Asthma control level was assessed according to the Global Initiative for Asthma (GINA) guidelines and patients were classified as having controlled, partly controlled, or uncontrolled asthma.¹⁹

Asthma Control Test

The ACT questionnaire consisted of five questions with five possible responses, exploring the patient's perception of his/her asthma control.²⁰ The result could range between 0 and 25, where 25 was the optimal asthma control.

Allergy

Allergy was considered if there was a documented positivity of allergen-specific IgE, assessed by skin-prick test and/or measurement on serum, and demonstration of a cause/effect relationship between exposure to sensitizing allergen and symptom occurrence.

Rhinitis

Rhinitis was considered if there was a history of typical nasal symptoms, such as itching, sneezing, watery rhinorrhea, and nasal obstruction. If the symptom occurrence was consistent with the exposure to sensitizing allergen the diagnosis of AR was made.

Statistical Analysis

The assumption of normality for all analyzed variables was assessed by examining the histograms of frequencies and confirmed with the Kolmogorov-Smirnov test.

Descriptive analysis of demographic and clinical data were given as median with interquartile range (25th–75th) or frequencies (percentages).

Chi-square test and binomial logistic regression was used to find significant associations between weight ranges (BMI categories) and categorical variables (demographic and clinical characteristics). Results were expressed as odds ratio (OR) with 95% confidence interval (CI).

The nonparametric Kruskal–Wallis test was used to determine the significance of the differences in continuous variables among normal, overweight, and obese patients. If necessary, a *post hoc* Conover–Inman test for pairwise comparison of subgroups was performed.

All *p* values were two tailed, with statistical significance set at 0.05. The SPSS (Version 20; IBM Corporation, Armonk, NY), Stata (Version 11; StataCorp., Lakeway, TX), and MedCalc (Version 11.3.0; MedCalc, Ostend, Belgium) were used for computation.

RESULTS

Clinical, Functional, and Demographic Characteristics

Table 1 shows demographic, clinical, functional, and inflammatory characteristics of the study sample (*n* = 286 patients). There was a slight preponderance of male subjects. The distribution of BMI shows that there were 10 patients (3.5%) underweight; 135 (47.2%) had normal weight; 96 (33.6%) were overweight; and 45 (14.1%) were obese, in particular, 31 were grade I obese, 10 were grade II obese, and 4 had morbid obesity.

Spirometric parameters were expressed as relative values (percent of predicted) and categorized as normal or pathological values. In particular, FVC was abnormal in 41 patients (14.3%), FEV₁ was abnormal in 107 patients (37.4%), FEV₁/FVC ratio was abnormal in 117 patients (40.9%), and FEF_{25–75} was abnormal in 152 patients (58.7%).

FeNO values were pathological in 111 patients (43.2%). In addition, allergy was documented in 207 patients (72.4%), 152 of whom were polysensitized. Rhinitis was present in 248 patients (86.7%).

Signs of asthma were detected in 31 patients (10.8%) during the visit. Asthma was controlled in 114 patients (39.9%), partly controlled in 140 patients (49%), and uncontrolled in 27 patients (9.4%).

For practical considerations underweight patients were included in the group of normal-weight patients, and obese patients were globally considered (Tables 2 and 3). A significant difference (*p* < 0.001) was observed in BMI distribution classes based on sex with a higher percentage of normal-weight female patients. Concerning the age, a significant preponderance (*p* < 0.001) of obesity and overweight was found in older patients.

All of the recorded spirometric parameters showed significant differences among the three groups of patients (normal weight, overweight, and obese). In particular, regarding spirometric continuous variables, expressed as percentage of predicted value, a progressive decrement of their value in the overweight and obese patients compared with normal-weight patients was observed. On the contrary, there was no significant difference among groups both concerning FeNO values and ACT data.

Post hoc analysis showed relevant differences only between normal and obese subjects, except for FEV₁/FVC, where not only obese, but also overweight, significantly differed from normal-weight subjects (Table

Table 1 Demographical and clinical characteristics (*n* = 286)

	Age (yr)	48.00 (37.00–63.25)
Male subjects, N (%)		117 (40.9)
BMI		24.80 (22.00–27.84)
BMI (The International Classification of adult, WHO)	<18.50	10 (3.5)
	18.50–24.99	135 (47.2)
	25.00–29.99	96 (33.6)
	30.00–34.99	31 (10.8)
	35.00–39.99	10 (3.5)
	≥40.00	4 (1.4)
FVC % of predicted		99.75 ± 18.74
		98.00 (86.00–111.00)
FVC	≤80%	41 (14.3)
	>80%	245 (85.7)
FEV ₁ % of predicted		85.09 ± 22.32
		88.00 (72.75–103.00)
FEV ₁	≤80%	107 (37.4)
	>80%	179 (62.6)
FEV ₁ /FVC		0.72 ± 0.13
		0.74 (0.63.75–0.81)
FEV ₁ /FVC	≤0.70	117 (40.9)
	>0.70	169 (59.1)
FEF _{25–75} percent of predicted		58.36 ± 30.55
		55.30 (31.75–78.25)
FEF _{25–75}	≤65%	152 (58.7)
	>65%	107 (41.3)
FeNO		30–74 ± 25.50
		21.00 (13.25–39.00)
FeNO	≤25	146 (56.8)
	>25	111 (43.2)
Allergy, positive, <i>n</i> (%)		207 (72.4)
Rhinitis, positive, <i>n</i> (%)		248 (86.7)
Polysensitization, positive, <i>n</i> (%)		152/207 (73.4)
Asthma signs, <i>n</i> (%)		31 (10.8)
ACT		20.24 ± 4.28
		21.00 (17.00–24.00)
Control of the asthma	Uncontrolled	27 (9.4)
	Partly controlled	140 (49.0)
	Controlled	114 (39.9)
Intranasal corticosteroid dosages (μg)		395.68 ± 331.30
		350.00 (200.00–500.00)

Results are expressed as mean ± SD, median (25th–75th), or frequency (%).

BMI = body mass index; WHO = World Health Organization; FVC = forced vital capacity; FEV₁ = forced expiratory volume in 1 s; FEF_{25–75} = forced expiratory flow at 25–75%; FeNO = fractional exhaled nitric oxide; ACT = Asthma Control Test.

2). Furthermore, FEV₁/FVC, unlike the others, was lower in overweight patients compared both with obese and normal-weight patients (Fig. 1).

Table 3 shows frequencies and OR with 95% CIs related to the pathological spirometric values in different classes of BMI.

The probability for having pathological FVC (OR, 2.476; 95% CI, 1.024–5.987; *p* = 0.044) or FEF_{25–75} (OR,

2.53; 95% CI, 1.171–5.464; *p* = 0.018) was more than twofold higher in obese patients compared with normal-weight patients.

In overweight patients compared with normal-weight patients the probability to have a pathological FEV₁ was almost twice as high (OR, 1.891; 95% CI, 1.099–3.253; *p* = 0.021), and it was tripled if the patient was obese (OR, 3.171; 95% CI, 1.590–6.323; *p* = 0.001).

Table 2 Differences in demographic and clinical characteristics among normal, overweight, and obese patients

	Normal Weight (<i>n</i> = 145)	Overweight (<i>n</i> = 96)	Obese (<i>n</i> = 45)	<i>p</i> Value	<i>Post hoc</i>
Gender					
Female patients	102 (70.3)	44 (45.8)	23 (51.1)	<0.001*	
Males patients	43 (29.7)	52 (54.2)	22 (48.9)	<0.001*	
Age (yr)	41.00 (30.00–52.50)	58.00 (42.25–67.00)	62.00 (48.50–69.00)	<0.001*	
FVC percent of predicted	102.00 (89.50–111.80)	99.00 (87.25–114.25)	90.00 (82.50–104.50)	0.022*	Normal vs obese (0.005*)
FEV ₁ percent of predicted	90.00 (78.00–103.50)	86.00 (70.25–107.25)	79.00 (64.00–90.75)	0.014*	Normal vs obese (0.003*)
FEV ₁ /FVC	77.00 (66.50–83.00)	70.00 (61.50–79.00)	71.00 (64.50–77.00)	0.001*	Normal vs obese (0.002*) Normal vs overweight (0.003*)
FEF _{25–75} percent of predicted	62.00 (39.00–82.50)	51.10 (28.50–80.75)	45.00 (24.65–70.30)	0.035*	Normal vs obese (0.016*)
FeNO	23.90 (16.00–41.75)	20.00 (12.80–33.75)	19.10 (10.00–38.00)	0.195	
ACT	22.00 (18.00–25.00)	21.00 (16.75–23.00)	20.00 (16.50–23.00)	0.096	
Intranasal corticosteroid dosages (μg)	300.00 (100.00–500.00)	250.00 (200.00–600.00)	400.00 (200.00–400.00)	0.924	

Results are expressed as median (25th–75th) or frequency (%). *significant finding.

FVC = forced vital capacity; FEV₁ = forced expiratory volume in 1 s; FEF_{25–75} = forced expiratory flow at 25–75%; FeNO = fractional exhaled nitric oxide; ACT = Asthma Control Test.

Both in overweight patients (OR, 2.415; 95% CI, 1.417–4.116; *p* = 0.001) and in obese patients (OR, 2.126; 95% CI, 1.074–4.205; *p* = 0.030), the risk to have a pathological FEV₁/FVC was about two times higher in comparison with normal-weight patients.

Figure 2 shows the distribution of both normal and pathological spirometric values among BMI groups.

In overweight and obese patients the probability of being allergic was, respectively, ~3.5 times (OR, 0.285; 95% CI, 0.155–0.526; *p* < 0.001) and 4.5 times (OR, 0.224; 95% CI, 0.106–0.470; *p* < 0.001) lower compared with normal-weight patients. Similarly, the risk of AR diagnosis was about three times lower in overweight patients (OR, 0.331; 95% CI, 0.140–0.784; *p* = 0.012), and six times lower in obese patients (OR, 0.163; 95% CI, 0.064–0.414; *p* < 0.001) compared with normal-weight patients (Fig. 3).

On the contrary, no significant risk was observed concerning presence of asthma signs at visit, level of asthma control, and FeNO values.

DISCUSSION

We performed a study based on real life, adapted to the common clinical practice, in a way that each physician may gain the same experience, visiting patients

with asthma. Along the recruitment period we included all of the consecutive patients with asthma without selecting any specific type of clinical characteristic.

First, the present study showed that 33.6% of patients were overweight and 15.7% were obese showing that the prevalence of obesity in an unselected cohort of patients with asthma is higher than in the reference general population: 3.6% of northwestern Italian people are underweight, 53.5% are normal weight, 33.9% are overweight, and 9.0% are obese. There is impressive evidence that asthma prevalence, as well as allergic disorders, had increased worldwide in developed countries. Dietary aspects, alcohol consumption, physical inactivity, and adiposity have been recently considered the main lifestyle factors. Indeed, the increase in affluence, typical of the western society, may result in increased availability of food and decreased physical activity, both contributing to promote overweight and obesity. In addition, there is evidence that obesity and overweightness are associated with an increased risk of asthma, probably because of the immune activity exerted by the adipose tissue producing adipokines, both in children and adults.²⁴ However, the real association between obesity and asthma is still unclear.

Table 3 Associations between clinical characteristics expressed as “normal or pathological values” and BMI subgroups

	Normal Weight (<i>n</i> = 145)	Overweight (<i>n</i> = 96)	Obese (<i>n</i> = 45)
FVC cat			
Normal	130 (89.7)	80 (83.3)	
Pathological	15 (10.3)	16 (16.7)	
OR (95% CI); <i>p</i> value	1.000	/	2.476 (1.024–5.987); <i>p</i> = 0.044
FEV ₁ cat			
Normal	104 (71.7)	55 (57.3)	20 (44.4)
Pathological	41 (28.3)	41 (42.7)	25 (55.6)
OR (95%); <i>p</i> value	1.000	1.891 (1.099–3.253); <i>p</i> = 0.021	3.171 (1.590–6.323); <i>p</i> = 0.001
FEV ₁ /FVC cat			
Normal	100 (69.0)	46 (47.9)	23 (51.1)
Pathological	45 (31.0)	50 (52.1)	22 (48.9)
OR (95% IC); <i>p</i> value	1.000	2.415 (1.417–4.116); <i>p</i> = 0.001	2.126 (1.074–4.205); <i>p</i> = 0.030
FEF _{25–75} cat			
Normal	64 (59.8)	32 (29.9)	11 (10.3)
Pathological	69 (45.4)	53 (34.9)	30 (19.7)
OR (95% CI); <i>p</i> value	1.000	/	2.530 (1.171–5.464); <i>p</i> = 0.018
FeNO cat			
≤25	71 (53.4)	49 (60.5)	26 (60.5)
>25	62 (46.6)	32 (39.5)	17 (39.5)
Asthma signs		NS	
Negative	55 (37.9)	45 (46.9)	22 (48.9)
Positive		90 (62.1)	
Asthma control			
Uncontrolled	13 (9.2)	10 (10.6)	4 (8.9)
Partly controlled	70 (49.3)	43 (45.7)	27 (60.0)
Controlled	59 (41.5)	41 (43.6)	14 (31.1)
Allergy			
No		22 (15.2)	
Yes	123 (84.8)	59 (61.5)	25 (55.6)
OR (95% CI); <i>p</i> value	1.000	0.285 (0.155–0.526); <i>p</i> < 0.001	0.224 (0.106–0.470); <i>p</i> < 0.001
Rhinitis			
No	9 (6.2)	16 (16.7)	24 (28.9)
Yes	136 (93.8)	80 (83.3)	32 (71.1)
OR (95% CI); <i>p</i> value	1.000	0.331 (0.140–0.784); <i>p</i> = 0.012	0.163 (0.064–0.414); <i>p</i> < 0.001

Results are expressed as frequency (%).

NS = not significant; OR = odds ratio; CI = confidence interval; FVC = forced vital capacity; FEV₁ = forced expiratory volume in 1 s; FEF_{25–75} = forced expiratory flow at 25–75%; FeNO = fractional exhaled nitric oxide.

In this study about one-half of patients had airway obstruction, as detected by lung function assessment, and ~10% of them had overt clinical obstruction. The most relevant finding is that obesity and overweight, although to a small extent, were important risk factors for airflow obstruction in patients with asthma. In fact, obesity constituted a more than two times higher risk of having impaired FEV₁, FEV₁/FVC, and FEF_{25–75} in comparison with normal-weight asthmatic patients. In addition, overweightness doubled the risk of reduced FEV₁ and FEV₁/FVC ratio in comparison with patients

with normal-weight asthmatic patients. Therefore, these findings are clearly impressive and suggest that adiposity really affects lung function, being an important factor able of sustaining airflow obstruction. The most commonly recognized change in lung function is a reduction in FRC consequent to a reduction of the ERV.^{3,4,6} Although an inverse association was reported between BMI and FEV₁/FVC ratio,²⁵ obesity is considered as not inducing any significant airway obstruction.^{3,4,25,26} In fact, the most cited study by Jones and Nzekwu showed that increasing BMI significantly af-

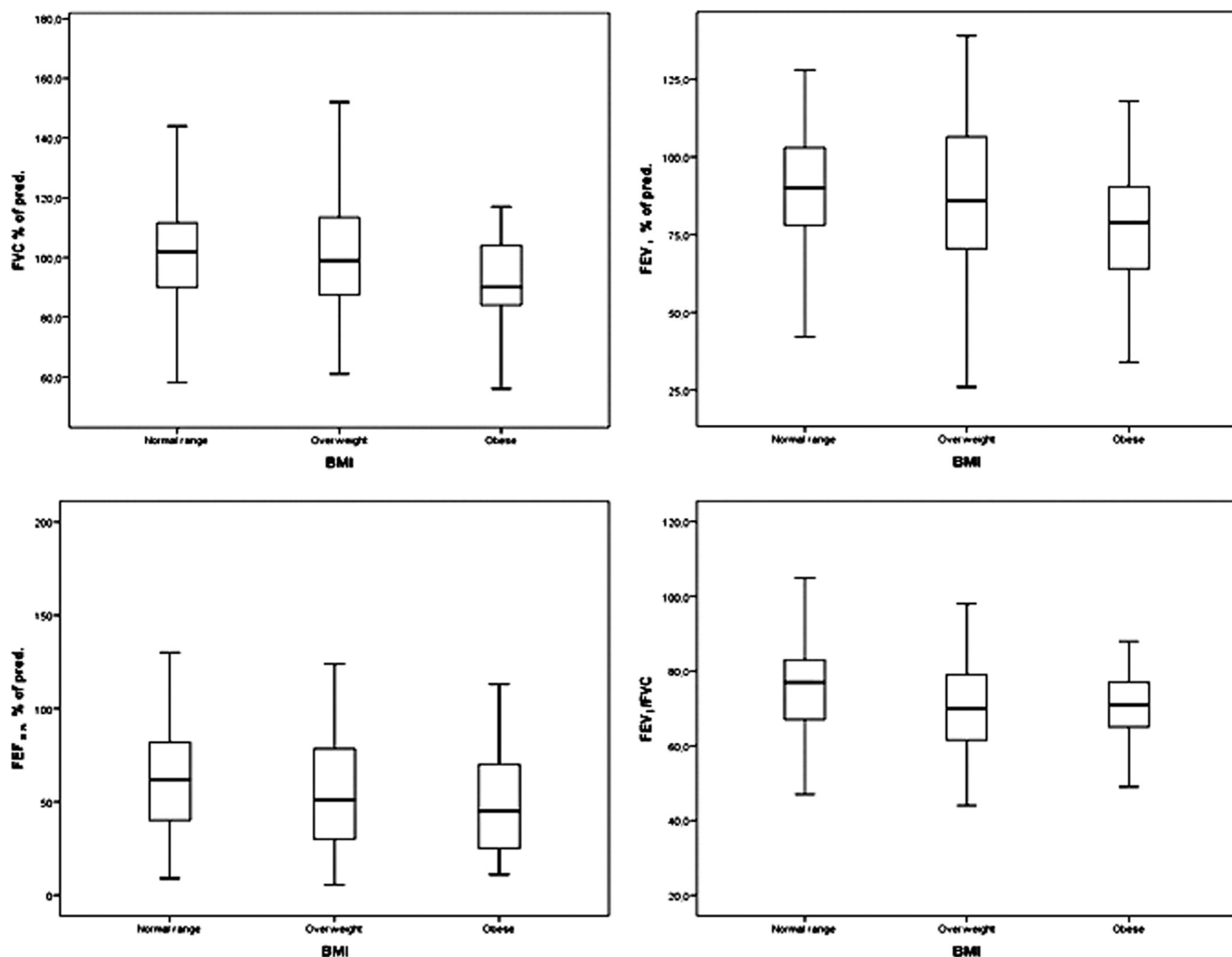


Figure 1. Median values of spirometric parameters for groups of patients.

affected ERV and partially affected FRC, but did not affect FEV₁/FVC ratio.¹³ However, it has to be noted that this study was performed in individuals without lung disease. A conceivable criticism to this concept is that most of these studies were performed on nonasthmatic patients. A more convincing study was performed by Nicolacakis and colleagues who compared patients with asthma alone, obesity alone, or both, including also healthy subjects.¹⁴ A moderate and negative relationship was reported between BMI and FVC; a weak and negative relationship reported between FEV₁ and BMI was also shown in patients with asthma or asthma associated with obesity. On the contrary, there was no relationship between BMI and FEF₂₅₋₇₅ as well as between BMI and PC₂₀ to methacholine or the Δ FEV₁ after β 2-adrenergic agent in the same groups of patients. Therefore, the authors concluded that asthma and obesity affect lung function through different processes. Unfortunately, this study has many methodological biases; many obese patients had a BMI

of >40; obese and asthmatic patients were compared only with normal subjects (asthmatic patients were not compared with patients with both asthma and obesity). Surprisingly, the FEV₁/FVC ratio was not considered and OR was not calculated. Thus, conclusive remarks could not be drawn from this experience.

Bronchial inflammation, as documented by high FeNO values, was present in ~40% of patients. Interestingly, BMI was not associated with eosinophilic bronchial inflammation. This outcome is consistent with a previous study performed by Todd and colleagues who evaluated induced sputum in subjects with or without asthma: BMI was not significantly associated with increased inflammation.²⁷ Also, McLachlan showed that there was a significant relationship between BMI and eNO levels.²⁸ Probably, these concordant data are consistent with the concept that comorbid asthma and obesity represent a phenotype different from the classic allergic one characterized by prevalence of eosinophil in the

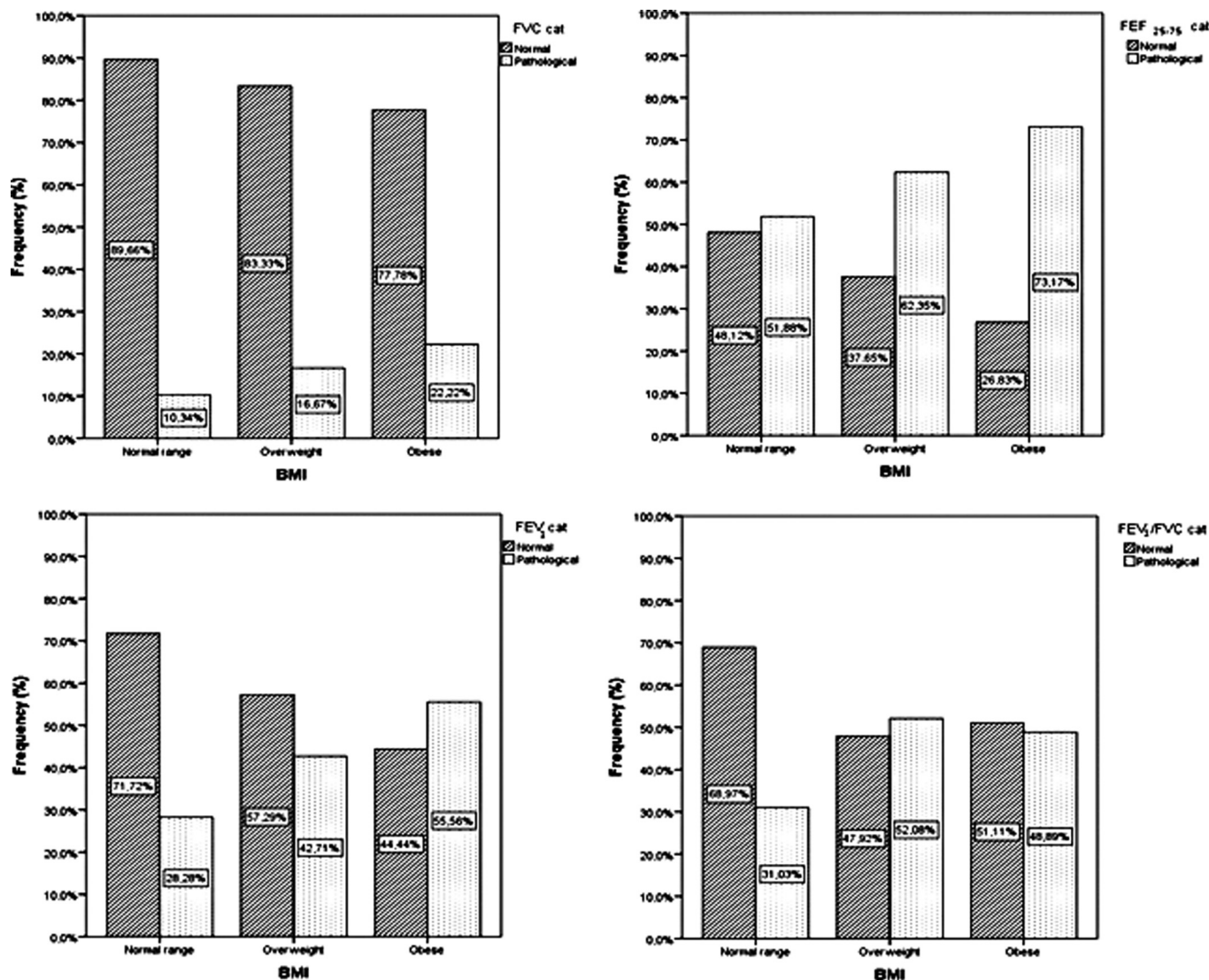


Figure 2. Distribution of spirometric values (normal or pathological) among body mass index (BMI) groups of subjects.

bronchial wall. To support this theory, our data evidenced that allergy and AR were two protective factors for having increased BMI.

Very interestingly, according to GINA guidelines, uncontrolled and partly controlled asthma were diagnosed in 9.4 and 49% of the sample, respectively, whereas asthma was controlled in ~40% of patients. Most of our patients were on inhaled corticosteroid treatment and the percentage of uncontrolled asthma was dramatically less than in a previous study on a European asthmatic population including Italian subjects.²⁹ Our results concerning asthma control could depend on the high level of implementation of the GINA guidelines adopted in our clinics since the first visit. A surprising outcome was the absence of association between BMI and asthma control grade by means of ACT. Inconsistently with our data, a previous study showed that asthmatic patients on inhaled corticosteroid who were overweight were

more likely to have uncontrolled or partly controlled asthma.²⁶ We might postulate that in our population the whole group of asthmatic patients was clinically followed with short-term intervals, thus reducing the risk of loss of control.

In this study most of the patients were allergic and AR was a very frequent comorbidity. Few studies investigated the effects of obesity on AR. A study, conducted on a large cohort of Swedish military conscripts, reported that obesity was not associated with AR in patients with nasal symptoms only.³⁰ Another study evidenced that the risk of AR increased with increasing BMI among women but not among men.³¹ On the contrary, our group showed that there was a significant relationship between BMI and AR and between BMI and BHR, also in patients with asthma.¹⁶ A more recent study reported that BMI values were significantly higher in AR patients than in control subjects.¹⁷ Overweight/obese AR patients had more al-

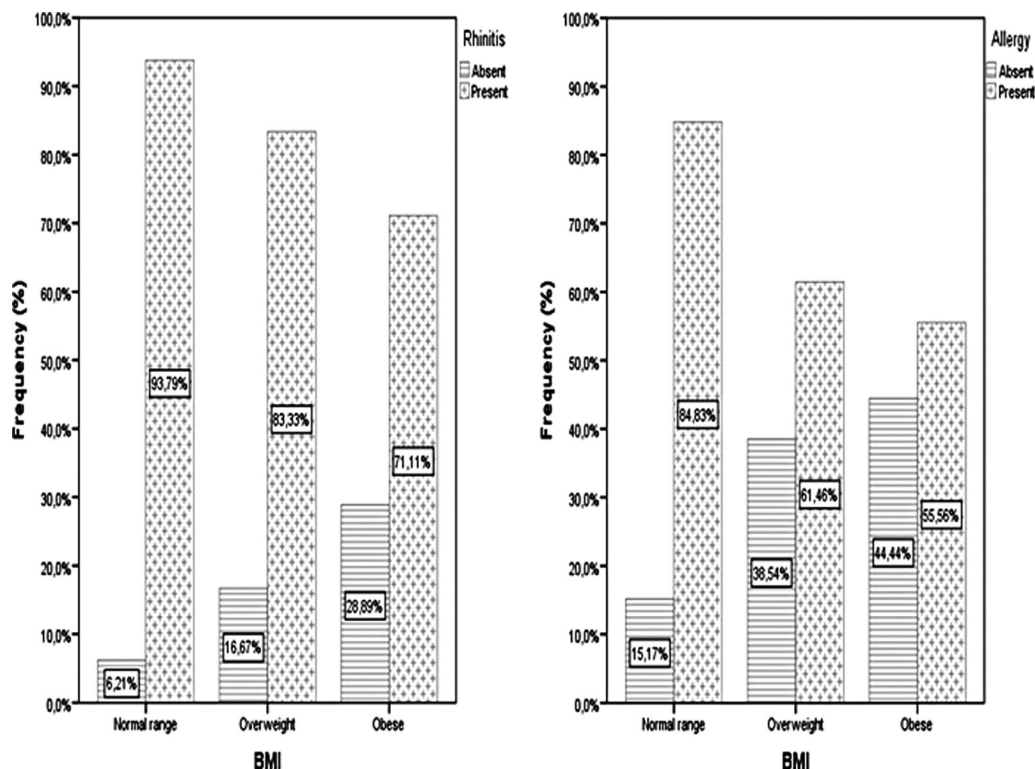


Figure 3. Presence of allergy and rhinitis among body mass index (BMI) groups of subjects.

tered functional and inflammatory parameters than normal-weight ones, and a BMI of >25 was a risk factor for bronchial airflow limitation and inflammation and BHR.

In addition, obese asthmatics have less frequently allergy and rhinitis in comparison with non-obese ones. This finding is consistent with the obese phenotype defined by the cluster analysis.³² In fact, Haldar and colleagues reported that the cluster analysis identified an obese phenotype, characterized by non-allergic inflammation.

In addition, finally, the relationship between body weight and asthma, mainly concerning its control, is well recognized also in childhood and adolescence.^{33–35}

CONCLUSIONS

The present study gives relevant information from a practical clinical point of view: BMI should be considered in all patients with asthma and attempts should be performed for weight loss in overweight and obese subjects.

However, this study may have some limitation: it has been conducted on a relatively limited cohort of patients, BMI may be a simplistic tool for measuring overweight/obesity, and the methodology was principally based on clinical ground and was cross-sectional. On the other hand, all patients were carefully examined and full functional parameters were performed.

Therefore, the present study may suggest that BMI assessment should be routinely considered in asthmatic patients for individuating bronchial obstruction, also in controlled asthma.

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