

Original article

Impact of allergic rhinitis on asthma: effects on spirometric parameters

Background: Close association exists between allergic rhinitis and asthma. Moreover, allergic rhinitis is a strong risk factor for the onset of asthma in adults. This study was aimed at evaluating a large group of patients with moderate-to-severe and persistent allergic rhinitis alone for investigating the presence of spirometric abnormalities and possible risk factors related to it.

Methods: A total of 392 patients with persistent allergic rhinitis were prospectively and consecutively evaluated. Clinical examination, skin prick test and spirometry were performed in all patients.

Results: There were 24 (6.1%) patients with forced vital capacity (FVC < 80% of predicted), 50 (12.8%) with forced expiratory volume in the first second (FEV₁ < 80% of predicted and 341 (87.0%) with forced expiratory flow at 25% and 75% of the pulmonary volume (FEF₂₅₋₇₅) < 80% of predicted. The logistic regression analysis evidenced that rhinitis duration (OR_{Adj}: 1.9/year) and sensitization to house dust mites (OR_{Adj}: 8.2) were significantly associated with impaired values of 2 or 3 spirometric parameters.

Conclusion: This study highlights the close link between upper and lower airways and the role of some risk factors, such as duration and mites sensitization, as early prognostic markers of bronchial involvement in patients with moderate-to-severe and persistent allergic rhinitis alone.

G. Ciprandi¹, I. Cirillo², A. Pistorio³

¹Department of Internal Medicine, Azienda Ospedaliera Universitaria San Martino, Genoa;

²Medicine Department, Navy Medical Service, La Spezia; ³Epidemiology and Statistics Unit, IRCCS G. Gaslini, Genoa, Italy

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Giorgio Ciprandi, MD
Department of Internal Medicine
Azienda Ospedaliera Universitaria San Martino
Semeiotica Medica I
Padiglione 3
Largo R. Benzi 10
Genoa 16132
Italy

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Allergic rhinitis is characterized by typical symptoms induced by an IgE-mediated inflammatory response of the nose to allergen exposure (1). Numerous studies have demonstrated a close association between allergic rhinitis and asthma (2–7). In addition, it has been reported that 77% of conscripts with respiratory allergy suffered from asthma associated with allergic rhinitis (8). Allergic rhinitis has been demonstrated to be a strong risk factor for the onset of asthma in adults (9).

Asthma is characterized by a reversible airflow obstruction and forced expiratory volume in the first second (FEV₁) is considered the gold standard to evaluate bronchial obstruction (10, 11). Nevertheless, there is increasing interest to consider the involvement of small airways in the pathogenesis of asthma (12). Even though there is no direct parameter capable of assessing small airways, it has been originally considered that the forced expiratory flow at the 25% and 75% of the pulmonary volume (FEF₂₅₋₇₅) might be more sensitive to obstruction in small airways than FEV₁ (13). It has been demonstrated that FEF₂₅₋₇₅ is useful in predicting the presence of airway responsiveness, may be a more sensitive indicator of chronic airflow obstruction than FEV₁, may be considered as a risk factor for the persistence of respiratory symptoms in allergic asthmatic children, and subjects with mild asthma and normal FEV₁ may show

impaired FEF₂₅₋₇₅ only (14). Concerning this issue, it has been demonstrated that both FEV₁ and mainly FEF₂₅₋₇₅ are impaired in patients with allergic rhinitis and perceiving nasal symptoms alone (15). The FEF₂₅₋₇₅ has been evidenced to be a reliable marker of early bronchial impairment in allergic rhinitis (16). Allergic rhinitis may be considered as the first step of the progression of respiratory allergy towards asthma. Indeed, it has been recently published the WHO document 'the impact of allergic rhinitis on asthma' (ARIA) that clearly underlined the role of allergic rhinitis as risk factor for asthma development (17). This ARIA document revised the classification of allergic rhinitis defining two types: 'intermittent' and 'persistent'; the new classification does not consider the type of allergen, but the duration (days/week and consecutive weeks) and the severity of symptoms (mild or moderate-to-severe).

Nevertheless the possible presence of spirometric abnormalities in patients with allergic rhinitis has been well documented, there are no studies conducted in patients with moderate-to-severe and persistent allergic rhinitis and overall exploring possible associated risk factors. Therefore, a large group of patients with moderate-to-severe and persistent allergic rhinitis alone were evaluated for investigating the presence of spirometric abnormalities and the possible risk factors involved.

Materials and methods

Study design

This study included patients with moderate-to-severe and persistent allergic rhinitis. All of them were evaluated by performing skin prick test and spirometry. This study was approved by the Navy Hospital Review Board and an informed consent was obtained from each patient.

Subjects

A total of 392 patients with moderate-to-severe and persistent allergic rhinitis were prospectively and consecutively evaluated. Demographic characteristics, including gender, age and duration of rhinitis (expressed in years), are reported in Table 1. All of them were Navy soldiers who had been referred to Navy Hospital for periodic fitness visit. A detailed clinical history was taken and a complete physical examination was performed. The patients were included in the study on the basis of a clinical history of persistent allergic rhinitis and presence of moderate-to-severe and nasal symptoms according to validated criteria (17). We excluded all the subjects who met the following exclusion criteria: any prior history of asthma or presence of asthmatic symptoms, including cough, wheezing, dyspnoea and shortness of breathing, acute or chronic upper respiratory infections and anatomical nasal disorders (i.e. nasal polyps, septum deviation, etc.), previous or current smoking (screened by expired-CO assessment), previous or current specific immunotherapy, and use of nasal or oral corticosteroids, nasal or oral vasoconstrictors, antileukotrienes and antihistamines during the previous 4 weeks. All patients were treated, only on demand, with drugs (e.g. antihistamines) alone. The diagnosis of persistent allergic rhinitis was made on the basis of a history of nasal symptoms and positive skin prick test according with validated criteria (17).

Skin prick test

The skin prick test was performed as stated by the European Academy of Allergy and Clinical Immunology (18). The panel consisted of: house dust mites (*Dermatophagoides farinae* and *D. pteronyssinus*), cat, dog, grasses mix, *Compositae* mix, *Parietaria officinalis*, birch, hazel, olive tree, *Alternaria tenuis*, *Cladosporium*, *Aspergilli* mix (Stallergenes, Milan, Italy).

Spirometry

The spirometry was performed with a computer-assisted spirometer (Pulmolab 435-spiro 235, Morgan, England) and according to international guidelines (10, 11).

Statistical analysis and data definitions

Descriptive statistics were firstly performed and quantitative spirometric parameters were reported as means and standard deviations (SD), or as medians and minimum and maximum values (or medians and quartiles) in case of skewed distribution. Qualitative data were reported as frequencies and percentages. Comparison of qualitative data among various groups of patients was made by the chi-squared test (or by the Fisher's Exact test in case of expected frequencies < 5). Comparison of quantitative variables among groups of patients was made by means of the ANOVA or by the nonparametric counterpart (Kruskal–Wallis test) whenever the normality assumption was not fulfilled; *post hoc* comparisons were performed using the Scheffé or the nonparametric Dunn's test. Linear correlation between pairs of quantitative variables was evaluated by the Pearson's correlation coefficient (*r*) or the nonparametric Spearman's correlation coefficient (*r_s*).

To evaluate the role of different independent explanatory variables in the relationship with two outcomes (FEV₁ < 80% of predicted or 2 or 3 impaired spirometric parameters) two multiple logistic regression analyses were performed. Variables that were statistically significant in the bivariate analysis or that were considered *a priori* important were entered in the models. The following predictors were evaluated in the first model: gender (female vs male), rhinitis duration (years), sensitization to the following allergens: house dust mites, trees, grass, moulds, dog or cat epithelium and type of sensitization, such as polysensitization vs only house dust mites and house dust mites vs only pollens). The following predictors were evaluated in the second model: gender (female vs male), rhinitis duration (years), sensitization to the following allergens: house dust mites, trees, grass and moulds. The type of allergens did not enter in the second logistic model because of collinearity with sensitization to house dust mites, and age did not enter in both models because of collinearity with rhinitis duration. For the multivariate analysis, the step-down strategy was chosen; the effect was expressed in terms of adjusted odds ratio (OR_{Adj}) and 95% CI and was tested by means of the likelihood ratio test. The area under ROC curve (AUC) of the model was used as an indicator of the model's predictive ability. All tests were two-sided and a *P*-value < 0.05 was considered statistically significant. The package 'STATA release 6' (StatSoft Corp., Tulsa, OK, USA) was used for the bivariate analyses and 'STATA release 7' (Stata Corporation, College Station, TX, USA) for multivariate analyses.

Results

Three hundred and ninety-two patients (306 males and 86 females) were included in the study. The mean age was

Table 1. Demographic and clinical parameters of the patients divided into two groups according to their spirometric findings

	FVC % of predicted			FEV ₁ % of predicted			FEF _{25–75} % of predicted		
	≥80 (n = 368)	<80 (n = 24)	<i>P</i> -value	≥80 (n = 342)	<80 (n = 50)	<i>P</i> -value	≥80 (n = 51)	<80 (n = 341)	<i>P</i> -value
Gender: males, n (%)	285 (77.5)	21 (87.5)	0.25	258 (75.4)	48 (96.0)	0.001	43 (84.3)	263 (77.1)	0.25
Age (years): median	23 [21–24]	49 [49–49]	<0.0001*	23 [21–24]	43.5 [20–49]	<0.0001*	21 [20–22]	23 [22–25]	<0.0001*
Rhinitis duration (years): median	3 [2–5]	11 [9–12]	<0.0001*	2 [2–5]	10 [10–11]	<0.0001*	2 [2–3]	3 [2–8]	<0.0001*

All percentages in round brackets are calculated over the total number of subjects reported at top of the column. All numbers in square brackets represent first to third quartiles. All *P*-values refer to the chi-squared test, unless otherwise specified.

FVC, forced vital capacity; FEV₁, forced expiratory volume in the first second; FEF, forced expiratory flow at the 25% and 75% of the pulmonary volume.

*Mann–Whitney *U*-test.

25.2 years (SD: 7.6) with a minimum age of 18 and a maximum of 49 years. Two hundred and sixty-eight patients had a diagnosis of rhinitis and 124 had a diagnosis of rhinoconjunctivitis. Patients were studied on the basis of their spirometric parameters [forced vital capacity (FVC), FEV₁ and FEF₂₅₋₇₅]; there were 24 (6.1%) patients with FVC < 80% of predicted, 50 (12.8%) with FEV₁ < 80% of predicted and 341 (87.0%) with FEF₂₅₋₇₅ < 80% of predicted. In Table 1, demographic and clinical parameters of the patients, divided into two groups according to their spirometric findings are presented. There were no difference between patients with FEV₁, FEF₂₅₋₇₅ or with FVC impaired in the distribution of patients with a positive familiar anamnesis or in the distribution of allergy diagnosis (rhinitis vs rhinoconjunctivitis); there was a greater percentages of males in patients with FEV₁ < 80% of predicted. Rhinitis duration is significantly higher in patients with impaired spirometric parameters (Table 1), and this result is confirmed by an evident correlation between FEV₁ values and rhinitis duration ($r = 0.66$) (Fig. 1, panel A) and between FEF₂₅₋₇₅ values and rhinitis duration ($r = 0.67$) (Fig. 1, panel B). Patients with one impaired parameter (and that is always FEF₂₅₋₇₅) have a median age rhinitis duration of 2 years; patients with two impaired spirometric parameters (FEV₁ and FEF₂₅₋₇₅ in most cases, 29/32, 90.6%) have a median rhinitis duration of 10 years; patients with three impaired spirometric parameters have a median rhinitis duration of 11 years; the difference in rhinitis duration among these groups of patients is statistically different, and in particular, there is a difference between patients with all the three parameters normal and patients with two or three impaired parameters and between patients with one impaired parameter with respect to patients with two or three impaired parameters (Fig. 2).

The description of sensitizations in the two groups of patients (with each of the three spirometric parameters <80% of predicted) is shown in Table 2. Patients with FEV₁ < 80% of predicted have the greatest number of statistically significant differences; they have a higher percentage of positive patients to house dust mites, and a lower percentage of positive patients to grass, trees, moulds and dog or cat. Patients with impaired FEV₁ and FVC were more frequently polysensitized ($P = 0.0004$ and $P < 0.001$, respectively) (Table 2).

All patients were then divided into four groups according to their spirometric findings: patients that had all three spirometric parameters $\geq 80\%$ of predicted ($n = 51$, 13%), patients with only one spirometric parameter <80% of predicted ($n = 288$, 73.5%; in this case it was always FEF₂₅₋₇₅), patients with two spirometric parameters <80% of predicted ($n = 32$, 8.2%) and finally patients with all three spirometric parameters <80% of predicted ($n = 21$, 5.3%). Patients with two impaired parameters were in the large majority of cases FEV₁ and FEF₂₅₋₇₅ (29/32, 91%) and only in very few cases were FVC and FEF₂₅₋₇₅ (3/32, 9%).

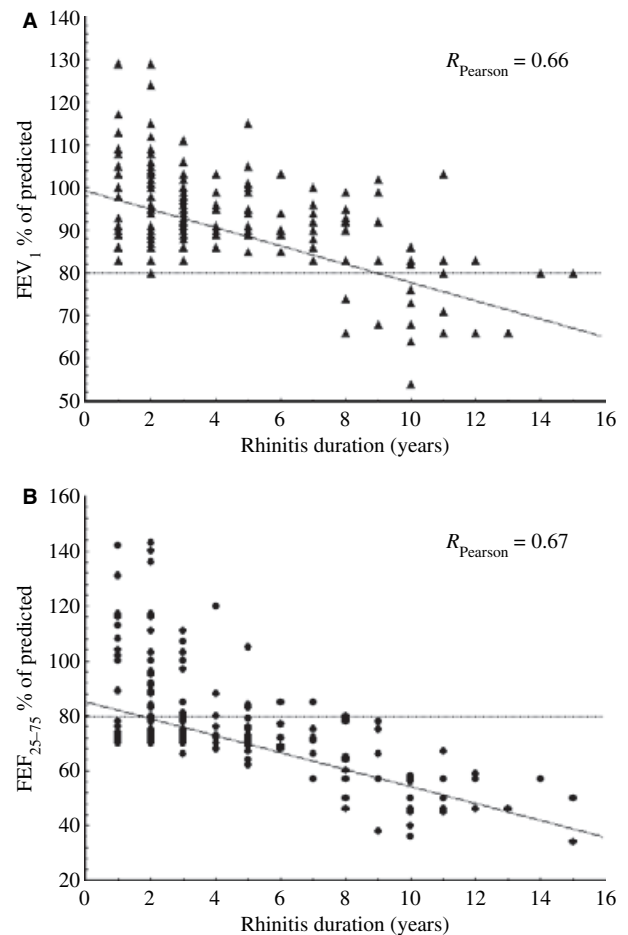


Figure 1. Relationship between rhinitis duration (years) and FEV₁ (panel A) and FEF₂₅₋₇₅ (panel B).

Demographic and clinical parameters of the patients, divided into four groups according to their spirometric findings are shown in Table 3. Patients with all the three spirometric parameters <80% of predicted were more frequently males, were significantly older and had a rhinitis duration significantly longer as compared with the other groups of patients.

Description of allergen sensitization in the patients divided into four groups according to their spirometric findings, is shown in Table 4. The percentage of patients sensitized to house dust mites, was higher in the group of patients presenting with all the three spirometric parameters impaired or in the group of patients with two impaired spirometric findings with respect to normal patients and to patients with only one impaired function. The percentage of patients sensitized to *Parietaria*, was higher in the group of patients presenting all the three spirometric parameters as compared with the other three groups. The patients with all the three functions impaired presented on the contrary a significantly lower percentage of sensitization to trees, grasses and moulds. Moreover, patients with all the three impaired parameters were more frequently polysensitized than the other groups of patients.

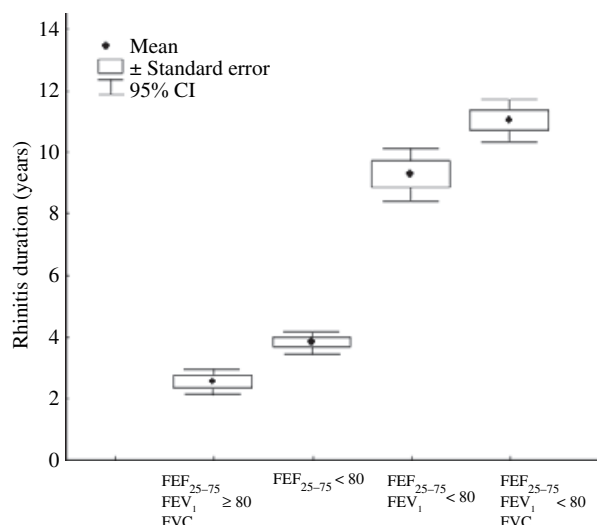


Figure 2. Mean rhinitis duration (years) in the four group of patients: patients with all three spirometric parameters with normal values ($\geq 80\%$ of predicted), with one (FEF_{25-75}) impaired ($< 80\%$ of predicted), with two parameters impaired (FEV_1 and FEF_{25-75}) and with all the three spirometric parameters (FEV_1 , FEF_{25-75} and FVC) impaired.

Multivariate logistic analysis

Two logistic regression models were performed: first was performed to evaluate the role of possible predictors for impaired FEV_1 and secondly to evaluate the role of possible predictors for being a patient with two or three impaired spirometric parameters.

In the first model, three predictors turned out to be significantly associated with impaired values of FEV_1 : male gender (OR_{Adj} : 21.6), sensitization to house dust mites (OR_{Adj} : 11.7) and rhinitis duration (OR_{Adj} : 2.3); for the variable rhinitis duration, the OR was calculated for a 1-year increase (i.e. the variable was evaluated as continuous) and therefore a value of 2.3 is a steep increase, as it represents the increase of the risk for every 1 year change in rhinitis duration. Sensitization to trees was on the contrary inversely associated with the outcome (Table 5). The model's discriminative ability is very satisfactory ($AUC = 0.98$).

In the second model, sensitization to house dust mites (OR_{Adj} : 8.2) and rhinitis duration (OR_{Adj} : 1.9) were significantly associated with impaired values of two or three spirometric parameters: sensitization to trees was again inversely associated with the outcome (Table 5).

Table 2. Description of allergen sensitization in the patients divided into two groups according to their spirometric findings

	FVC % of predicted			FEV ₁ % of predicted			FEF ₂₅₋₇₅ % of predicted		
	≥ 80 (n = 368)	< 80 (n = 24)	P-value	≥ 80 (n = 342)	< 80 (n = 50)	P-value	≥ 80 (n = 51)	< 80 (n = 341)	P-value
HDM, n (%)	225 (61.1)	24 (100.0)	0.0001	206 (60.2)	43 (86.0)	0.0004	32 (62.7)	217 (63.6)	0.90
Trees, n (%)	125 (34.0)	1 (4.2)	0.0025	125 (36.5)	1 (2.0)	< 0.0001	16 (31.4)	110 (32.3)	0.90
Parietaria, n (%)	214 (58.2)	20 (83.3)	0.015	200 (58.5)	34 (68.0)	0.20	32 (62.7)	202 (59.2)	0.63
Grass, n (%)	139 (37.8)	0 (0.0)	0.0002	139 (40.6)	0 (0.0)	< 0.0001	29 (56.9)	110 (32.3)	0.0006
Moulds, n (%)	70 (19.0)	0 (0.0)	0.01*	70 (20.5)	0 (0.0)	0.0004	11 (21.6)	59 (17.3)	0.46
Dog or cat n (%)	32 (8.7)	3 (12.5)	0.46*	35 (10.2)	0 (0.0)	0.014*	7 (13.7)	28 (8.2)	0.19*
Compositae, n (%)	11 (3.0)	0 (0.0)	1.00*	11 (3.2)	0 (0.0)	0.37*	0 (0.0)	11 (3.2)	0.37*
Polysensitization	157 (42.6)	23 (95.8)	$< 0.001^*$	153 (44.7)	27 (54.0)	0.0004	22 (43.1)	158 (46.3)	0.89
Sensitization only to HDM	68 (18.5)	1 (4.2)		53 (15.5)	16 (32.0)		10 (19.6)	59 (17.3)	
Sensitization only to pollens	143 (38.9)	0 (0.0)		136 (39.8)	7 (14.0)		19 (37.3)	124 (36.4)	

All percentages in round brackets are calculated over the total number of subjects reported at top of the column. All P-values refer to the chi-squared test, unless otherwise specified.

FVC, forced vital capacity; FEV_1 , forced expiratory volume in the first second; FEF, forced expiratory flow at the 25% and 75% of the pulmonary volume; HDM, house dust mite.

*Fisher's Exact test.

Table 3. Demographic and clinical parameters of the patients divided into four groups according to their spirometric findings expressed as % of predicted

	FEF ₂₅₋₇₅ , FEV ₁ and FVC ≥ 80 , (n = 51)	FEF ₂₅₋₇₅ < 80 , FEV ₁ and FVC ≥ 80 , (n = 288)	FEF ₂₅₋₇₅ and FEV ₁ < 80 , FVC ≥ 80 , (n = 32)	FEF ₂₅₋₇₅ , FEV ₁ and FVC < 80 , (n = 21)	P-value
Gender: males, n (%)	43 (84.3)	215 (74.6)	27 (84.4)	21 (100.0)	0.011*
Age (years): median	21 [18–38]	23 [18–48]	22 [20–49]	49 [20–49]	$< 0.0001^\dagger$
Rhinitis duration (years): median	2 [1–8]	2 [1–15]	10 [2–13]	11 [8–13]	$< 0.0001^\dagger$

All percentages in round brackets are calculated over the total number of subjects reported at top of the column. All numbers in square brackets represent minimum and maximum values.

FVC, forced vital capacity; FEV_1 , forced expiratory volume in the first second; FEF, forced expiratory flow at the 25% and 75% of the pulmonary volume.

*Fisher's Exact test.

† Kruskal–Wallis test.

Table 4. Description of allergen sensitization in the patients divided into two groups according to their spirometric findings expressed as % of predicted

	FEF ₂₅₋₇₅ , FEV ₁ and FVC ≥ 80, (n = 51)	FEF ₂₅₋₇₅ < 80, FEV ₁ and FVC ≥ 80, (n = 288)	FEF ₂₅₋₇₅ , FEV ₁ < 80 and FVC ≥ 80, (n = 32)	FEF ₂₅₋₇₅ , FEV ₁ , and FVC < 80, (n = 21)	P-value
HDM, n (%)	32 (62.7)	171 (59.4)	25 (78.1)	21 (100.0)	0.0007
Trees, n (%)	16 (31.4)	109 (37.8)	0 (0.0)	1 (4.76)	<0.0001
Parietaria, n (%)	32 (62.7)	168 (58.3)	14 (43.7)	20 (95.2)	0.002
Graminae, n (%)	29 (56.8)	110 (38.2)	0 (0.0)	0 (0.0)	<0.0001
Moulds (<i>Aspergilli</i>), n (%)	11 (21.6)	59 (20.5)	0 (0.0)	0 (0.0)	0.001*
Dog or cat, n (%)	7 (13.7)	25 (8.7)	3 (9.4)	0 (0.0)	0.33*
Compositae, n (%)	0 (0.0)	11 (3.8)	0 (0.0)	0 (0.0)	0.49*
Polysensitization	22 (43.1)	128 (44.5)	10 (31.2)	20 (95.2)	<0.0001
Sensitization only to HDM	10 (19.6)	43 (14.9)	15 (46.9)	1 (4.8)	
Sensitization only to pollens	19 (37.3)	117 (40.6)	7 (21.9)	0 (0.0)	

All percentages in round brackets are calculated over the total number of subjects reported at top of the column. All *P*-values refer to the chi-squared test, unless otherwise specified.

FVC, forced vital capacity; FEV₁, forced expiratory volume in the first second; FEF, forced expiratory flow at the 25% and 75% of the pulmonary volume; HDM, house dust mites.

*Fisher's Exact test.

Table 5. Best fitting logistic regression models for independent predictors of the presence of impaired spirometric findings (n = 392)

Explanatory variables	Odds ratio _{Adj} 95% CI	P-value*
First model: outcome variable: FEV ₁ < 80% of predicted		
Rhinitis duration (years)	2.3 (1.8–3.0)	<0.0001
Sensitization to HDM (reference category: negative)	11.7 (3.1–44.7)	0.0001
Gender: male (reference category: female)	21.6 (2.9–158.3)	0.0003
Sensitization to trees (reference category: negative)	0.01 (0.001–0.09)	<0.0001
AUC of the model: 0.98		
Second model: outcome variable: 2 or 3 impaired spirometric parameters		
Rhinitis duration (years)	1.9 (1.6–2.2)	<0.0001
Sensitization to HDM (reference category: negative)	8.2 (2.5–26.5)	0.0001
Sensitization to trees (reference category: negative)	0.02 (0.002–0.15)	<0.0001
AUC of the model: 0.96		

CI, confidence interval; HDM, house dust mite; AUC, area under ROC curve.

*Likelihood ratio test.

The model's discriminative ability of the second model is appreciably satisfactory (AUC = 0.96).

Discussion

Allergic rhinitis and asthma should be considered as a single syndrome involving two parts of the respiratory tract (19). Patients with allergic rhinitis may quite frequently present asthmatic symptoms and/or spirometric impairment. Indeed, it has been very recently demonstrated that patients with allergic rhinitis alone may show impaired FEF₂₅₋₇₅ values (16). Thus, this finding underlines the link between upper and lower airways.

The present study investigated the possible presence of spirometric impairment in a large cohort of patients with moderate-to-severe and persistent allergic rhinitis alone,

such as perceiving only nasal symptoms. First, this study confirms previous studies as a high percentage of these patients show spirometric abnormalities, mainly concerning FEF₂₅₋₇₅, but also FEV₁ (50 subjects) and FVC (24 subjects). This finding highlights the concept that a bronchial involvement is frequent in allergic rhinitis, also in the absence of overt asthmatic symptoms. Therefore, the recommendation, suggested by ARIA document, of considering this issue in each patient with allergic rhinitis has to be strongly supported.

Secondly, several risk factors, concerning a bronchial involvement, may be defined. Male gender may have an important role, even though the multivariate analysis does not confirm it if two or more spirometric parameters are impaired. The duration of allergic rhinitis appears to be more relevant: it is to note that the observed OR_{Adj} is particularly high and overall it has to be calculated per year of allergic rhinitis duration. The other important risk factor of bronchial impairment in allergic rhinitis is the sensitization to house dust mites. This finding highlights the role of the minimal persistent inflammation that allows the development of structural bronchial remodeling. Indeed, continuous exposure to mite allergen induces the persistence of inflammatory phenomena that induce a worsening of respiratory function (20).

Thirdly, a progression of bronchial function impairment appears evident as the early spirometric parameters that is involved is FEF₂₅₋₇₅. Further, FEV₁ may be impaired and successively FVC. This chronological sequence is not random, but expresses a diverse severity of bronchial function worsening. Indeed, a reduced value of FEV₁, such as <80% of predicted, shows an overt asthma. Moreover, a patients with reduced values of both FEV₁ and FVC presents a more chronic and severe bronchial impairment than a patient with reduced value of FEV₁ alone.

Fourthly, the type and the number of sensitizations exert an important effect on bronchial airflow limitation in allergic rhinitis. In particular, mite sensitization represents the most impressive risk factor as well as the presence of

polysensitization. Unexpectedly, tree sensitization is characterized by a low OR. This fact might be however because of the relatively low number of patients belonging to the subgroups with reduced values of both FEV₁ and FVC. On the other hand, we have to consider that this study has restricted to enrol patients with moderate-to-severe and persistent allergic rhinitis alone and without asthmatic symptoms. Therefore, it was difficult to reach a large adequacy of patients with those characteristics.

This study confirms and increases the strength of the role of FEF₂₅₋₇₅ as a marker of early bronchial involvement in patients suffering from isolated persistent allergic rhinitis. Moreover, other spirometric parameters may be impaired in allergic rhinitis, mainly when allergen exposure persists (typically for mites), this issue supports the concept that airway allergic inflammation and airflow impairment are closely associated as well as upper and lower airways.

Lastly, the most clinically relevant finding of this study is represented by carefully considering the duration of allergic rhinitis. This factor may be considered as the most important risk factor for a possible bronchial involvement in allergic rhinitis. Therefore, from a clinical point of view it appears to be beneficial to evaluate in

each patients with moderate-to-severe and persistent allergic rhinitis the type of sensitization and the duration of nasal symptoms. Thus, as suggested by ARIA document, a spirometry should be performed, also in absence of overt asthmatic symptoms, in patients with moderate-to-severe and persistent allergic rhinitis with sensitization to mites and long duration of the disease to prematurely detect the possible onset of asthma. Another important aspect is represented by the fact that an inadequate treatment of allergic rhinitis is characterized by a progressive decline of respiratory function. Indeed, all studied patients were treated only on demand and with pharmacological therapies. It is well known that drug therapy of allergy does not modify the natural history of allergy. As medical treatment of rhinitis may impact on any lower airway measurement, these findings could establish the link in a stronger manner and reinforce that adequate treatment of upper airway disease is important.

In conclusion, this study highlights the close link between upper and lower airways and the role of some risk factors, such as duration and mites sensitization, as early prognostic marker of bronchial involvement in patients with moderate-to-severe and persistent allergic rhinitis alone.

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