

Spirometric criteria for asthma: Adding further evidence to the debate

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Background: Objective assessments of pulmonary function are considered essential for the diagnosis of asthma. The degree of reversibility of FEV₁ considered supportive of asthma varies between international asthma guidelines.

Objective: We sought to compare the relative performance of international guideline reversibility criteria for identifying impairment in persons with a significant bronchodilator response (SBR) without an asthma diagnosis.

Methods: The North West Adelaide Health (Cohort) Study, a population biomedical study of 4060 subjects, conducted spirometry according to American Thoracic Society criteria. SBR was defined as postbronchodilator FEV₁ responses of at least 12% or 15% of baseline values, 9% of predicted values, or 400 mL. A self-completed questionnaire assessed current asthma (CA), respiratory symptoms, and participant demographics.

Results: The prevalence of CA was 9.4% (n = 380), whereas 1.3% (≥ 400 mL) to 4.5% ($\geq 9\%$ of predicted value) of participants demonstrated an SBR in the absence of CA.

With the exception of the 9% predicted criterion, prebronchodilator mean FEV₁ (percent predicted) in those demonstrating an SBR but no CA was significantly worse than that in the CA group. Significantly more respiratory symptoms were experienced by the SBR groups than the group without asthma. Logistic regression analyses identified different characteristics of those classified by the following criteria: 12% and 15%, age of 40 years or greater and household income of less than \$40,000; 9% predicted, household income of less than \$40,000; 400 mL, male sex (odds ratio, 4.5; 95% CI, 2.1-9.3).

Conclusions: Different criteria identify different persons, but SBR by any criteria was associated with significant respiratory impairment, some of which might be attributable to asthma. Postbronchodilator change as a percentage of predicted value was the least biased of the criteria. (*J Allergy Clin Immunol* 2005;116:976-82.)

Key words: Asthma, spirometry, bronchodilator response, asthma epidemiology, asthma diagnosis

Asthma-like symptoms in adults can be explained by differential diagnoses, including cardiac, neurologic, and drug-related causes.¹ The diagnosis of asthma in adults can be difficult and confounded by comorbidities. A gold standard test would simplify the diagnosis of asthma and perhaps reduce the frequency of underdiagnosed asthma²⁻⁵; however, no gold standard exists.⁶ Airway responsiveness is considered a hallmark of asthma.^{7,8} Although it has been suggested that airway hyperresponsiveness testing in primary practice might reduce the problem of delayed diagnosis and inappropriate therapy,⁹ the test is complex, invasive, and conducted by pulmonary function laboratories.¹⁰ Epidemiologic studies have shown that the specificity of the test for an asthma diagnosis (derived by physician or questionnaire) is high; however, the sensitivity is poor,^{11,12} limiting its positive predictive value. Furthermore, there is a continuum of bronchial responsiveness in the normal population that overlaps with that in the asthmatic population, clearly preventing a discriminatory cutoff separating the asthmatic and healthy populations.^{13,14} Patients with airways obstruction also display a broad range of airway responsiveness¹⁵ from normal to asthmatic, which is dependent on baseline lung function^{16,17} and age.¹⁸

The National Asthma Education and Prevention Program¹⁹ identifies the importance of spirometry for the diagnosis of asthma, given that physicians have a limited ability to estimate the degree of obstruction²⁰ or predict reversibility of the obstruction.²¹ The National Asthma Education and Prevention Program report also recommends spirometry over peak expiratory flow measurements because of the wide variability in peak expiratory flow reference values. International asthma guidelines recommend that reversibility of FEV₁ in response to inhalation of short-acting bronchodilators is indicative of asthma; however, the degree of reversibility considered significant varies between guidelines. The British Thoracic Society²² recommends at least 15% of baseline FEV₁, the American Thoracic Society²³ and the Global Initiative for Asthma (GINA)²⁴ recommend at least 12% of baseline FEV₁, and others recommend 9% of the predicted FEV₁²⁵ if the change exceeds 200 mL.

The diagnostic value of reversibility to separate asthma from chronic obstructive pulmonary disease (COPD) has been debated for some time.²⁵⁻³² Lack of response to a

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Abbreviations used

BTS/SIGN: British Thoracic Society/Scottish Intercollegiate Guidelines Network
CA: Current confirmed asthma
CLD Index: Chronic Lung Disease Index
COPD: Chronic obstructive pulmonary disease
GINA: Global Initiative for Asthma
NICE: National Institute for Clinical Excellence
SBR: Significant bronchodilator response

single bronchodilator reversibility test is not indicative of long-term response to treatment.²⁶ However, patients with COPD, classified as poorly responsive in single reversibility testing, have demonstrated subsequent responses to long-term therapy for objective and subjective outcomes only half as great as those of patients classified as responders.³³⁻³⁵ This lends some validity to the use of a reversibility test to predict the outcomes of treatment. Recently in the United Kingdom, the National Institute for Clinical Excellence (NICE) guidelines for COPD³⁶ recommended a change of at least 400 mL of FEV₁ in response to an acute bronchodilator test or a short course of oral or inhaled corticosteroids for an increase in FEV₁ to demonstrate asthma. The danger in an older population with an age-related decrease in lung volumes is that the 400 mL reversibility criterion might misclassify persons with significant reversibility that is amenable to treatment. Alternate reversibility criteria might generate false-positive results, but this could be preferable to the alternative of underdiagnosis, given the potential poor health outcomes in older persons.

The aim of this study was to determine the prevalence of asthma according to self-report in the North West Adelaide Health (Cohort) Study, a biomedical population study of 4060 persons. We also sought to determine the prevalence of a significant bronchodilator response (SBR) in those without an asthma diagnosis according to international guideline reversibility criteria. This enabled us to characterize those identified by the criteria in terms of impairment and demographics. To our knowledge, this is the first examination of the performance of the NICE reversibility criterion in a representative population sample.

METHODS

The methods of the North West Adelaide Health (Cohort) Study have been described previously.³⁷ Briefly, all households in the northwest region of Adelaide that were listed in the electronic "White Pages" telephone directory were eligible for selection. A letter of introduction was sent to the household of each randomly selected telephone number. Selected households received a telephone call inviting the person with the most recent birthday and who was at least 18 years of age to participate in the study. Up to 5 callbacks were made to interview the selected person, and there was no replacement for nonresponse. The validity of these methods of selection criteria to achieve an unbiased sample has been described previously.³⁸ Those agreeing to participate were sent an information packet that included a self-administered questionnaire. Self-reported

information on sociodemographic factors was obtained in this questionnaire and the telephone interview. Of the 8213 eligible households contacted, 71.2% (n = 5850) were interviewed. The clinic participation rate as a proportion of eligible selected households was 49.4% (n = 4060). Demographic data on persons who refused participation were also obtained to compare with participants and allow for appropriate weighting in the analyses.

Self-reported current confirmed asthma (CA) was defined as a positive response to all 3 of the following questions: (1) "Have you ever had asthma?," (2) "Was your asthma confirmed by a doctor?," and (3) "Do you still have asthma?" SBR was defined as reversibility according to the criteria in the absence of CA (ie, "yes" or "no" to question 1, but if "yes," then "yes"/"no"/"don't know" in response to question 2 and then "no"/"don't know" in response to question 3. Spirometry was conducted in 2 hospital-based clinics (Microlab 3300 spirometer; Micro Medical LTD, Kent, United Kingdom), according to American Thoracic Society criteria.³⁹ Each subject performed at least 3 acceptable and reproducible forced vital capacity maneuvers. Reversibility of airway obstruction was defined by using several criteria for the increase in FEV₁ after inhalation of 400 μg of salbutamol of at least 12% (American Thoracic Society/GINA)²⁴ or 15% of baseline values (BTS/SIGN)²² or 9% of predicted FEV₁ (assuming the increase exceeded 200 mL) and 400 mL (NICE).³⁶ Reversibility as a volume of FEV₁ (in liters; REVFEV₁) was defined as follows:

$$\text{Postbronchodilator FEV}_1 (L) - \text{Prebronchodilator FEV}_1 (L).$$

Reversibility as a percentage of baseline was calculated as follows:

$$[\text{REVFEV}_1 / \text{Prebronchodilator FEV}_1 (L)] \times 100.$$

If participants' reversibility was equal to or exceeded 12% or 15%, then participants were classified as reversible according to the 12% and 15% criteria, respectively. Nine percent of the predicted prebronchodilator FEV₁ (in liters) was calculated for each participant with the following equation:

$$0.09 \times [\text{Prebronchodilator FEV}_1 (L) / (\text{Prebronchodilator FEV}_1 \% \text{ predicted} / 100)].$$

If the FEV₁ reversibility (L) was equal to or exceeded this volume, then the participant was considered to be reversible according to the 9% predicted criterion. Participants were considered to be reversible according to the 400 mL criterion if the FEV₁ reversibility (L) was equal to or exceeded 0.4 L.

Analysis of the performance of the reversibility criteria in terms of identifying impairment was limited to persons who were classified by the reversibility criteria but without a diagnosis of current asthma and therefore were steroid naive. This was to demonstrate unmodified effects on the respiratory health attributable to unrecognized (significant) bronchodilator responsiveness.

The Chronic Lung Disease (CLD) Index⁴⁰ was administered to determine the severity of respiratory symptoms in the population. This is a 6-item questionnaire scored out of 100, with subscales relating to the frequency and intensity of dyspnea and wheezing and frequency of coughing and volume of sputum production. Categories of severity are as follows: mild, 43 or less; moderate, 44 to 62; and severe, 63 or greater. These categories have demonstrated discriminative value between different levels of chronic lung disease that affect quality of life across physical and mental health scales.⁴¹ The CLD Index has been validated in US and Australian population studies.^{40,41} It has shown a high level of agreement with clinical data, including peak flow measurements.⁴⁰

Institutional ethics committee approval was obtained for the conduct of this study.

TABLE I. Population prevalence of significant bronchodilator reversibility according to various FEV₁ reversibility criteria

Reversibility criteria	SBR prevalence, % (n)		
	Overall	No current asthma diagnosis	Current asthma
≥12%	3.8 (153)	2.7 (109)	11.7 (44)
≥15%	2.4 (98)	1.6 (63)	9.0 (35)
≥9% of predicted value	6.2 (251)	4.5 (183)	17.9 (68)
≥400 mL	2.0 (78)	1.3 (53)	6.7 (25)

Data presented here were analyzed with the Statistical Package for Social Sciences (SPSS Inc, Chicago, Ill), version 10.0 for Windows and were weighted to the Australian Bureau of Statistic's 1999 estimated resident population by region (west and north), age groups, sex, and probability of selection in the household. Agreement between the reversibility criteria in the classification of an SBR was determined by using the κ test ratio. Multiple analysis of variance was used to calculate mean prebronchodilator and post-bronchodilator FEV₁ absolute and percent predicted values, adjusting for baseline covariates, including age and sex. Statistically significant differences in proportions were determined by using the χ^2 test (Epi Info Version 6). The Student *t* test was used to determine statistically significant differences in mean values (GraphPad Instat, version 2.02). Odds ratios were calculated with Epi Info version 6. Variables significant in univariate analysis at a *P* value of less than .25⁴² were included in logistic regression analyses (enter method) to determine the best set of explanatory variables to describe those demonstrating an SBR without a diagnosis of CA. Tests for collinearity were conducted before the logistic regression analyses, and none were found.

RESULTS

Complete spirometric and self-reported CA data were available for 4002 (98.5%) participants. Current asthma was reported by 9.4% (*n* = 380) of the study participants. Table I shows that the prevalence of reversibility in the population according to differing criteria ranged from 2.0% for the 400 mL or greater criterion to 6.2% for the 9% of predicted value or greater criterion. The prevalence of significant bronchodilator responsiveness (ie, reversibility without a CA diagnosis) ranged from 1.3% to 4.5%. The proportion of current asthmatic subjects demonstrating SBR was low and ranged from 6.7% (400 mL criterion) to 17.9% (9% of predicted value criterion).

Of those classified as having SBR with no CA, only 19.6% (9% of predicted value) to 26.4% (400 mL criterion) responded that they had ever had physician-confirmed asthma but no longer believed they had asthma. In addition, of those classified as having "no asthma," 9.6% responded they had ever had physician-confirmed asthma.

In the population with no CA and no airways obstruction, the mean bronchodilator response, as an absolute volume, was 0.10 L (95% CI, -0.15 to 0.35). As a percentage of baseline, the mean response was 3.4% (95%

CI, -5.2 to 12.0), and as a percentage of predicted FEV₁, the mean response was 3.2% of predicted value (95% CI, -4.5 to 10.9). In those with SBR and no CA, the median reversibility as a percentage of baseline ranged from 12.8% (9% predicted criterion) to 19.5% (15% criterion). As an absolute volume (in liters), the median reversibility ranged from 0.34 (9% predicted criterion) to 0.48 (400 mL criterion).

As evident from Table II, there was considerable disparity in the performance of the criteria to identify reversibility, which was related to the number identified by each criterion. For example, of the 153 participants with FEV₁ reversibility of at least 12% of baseline value, 97% were also reversible according to the 9% of predicted value criterion (κ = 0.73). Conversely, of the 248 reversible according to the 9% of predicted value criterion, only 59% were reversible according to the 12% criterion. The κ values show the highest agreement between the 12% and 15% criteria (κ = 0.77) and the 12% and 9% of predicted value criteria (κ = 0.73). The lowest agreement occurred between the 400 mL criterion and the other standard criteria, reflecting the large lung volumes in this group of predominantly young male subjects identified by the 400 mL criterion. Importantly, the 9% of predicted value criterion identified nearly all patients who were classified by the standard criteria (≥12%, ≥15%) and the 400 mL criterion.

Respiratory function for those with CA or a SBR with no CA is shown in Table III. The mean age- and sex-adjusted prebronchodilator and postbronchodilator FEV₁ of the CA group was significantly worse than that of the group without asthma; however, postbronchodilator values (percent predicted) returned to near-normal levels. Mean prebronchodilator and postbronchodilator FEV₁ (absolute and percent predicted) of those classified by the 12% and 15% reversibility criteria were significantly worse than the values for the CA group and the group without asthma. The exception to this was that the post-bronchodilator values of those classified by the 12% criterion were similar to the values for the CA group. Those classified by the 9% of predicted value criterion also demonstrated significantly worse respiratory function than the group without asthma, and the postbronchodilator FEV₁ returned to normal values with significantly less impairment than that seen in the subjects with current asthma.

Compared with the other criteria, the FEV₁ values of those classified by the 400 mL criterion showed a different pattern. Unlike the other criteria, the unadjusted prebronchodilator absolute FEV₁ of this group (3.14 L) was not significantly different from that of the group without asthma; however, this value equated to 84% of predicted value. After adjustment for age and sex, prebronchodilator values were significantly worse than those in the CA group and the group without asthma. Postbronchodilator values returned to near normal and were similar to those in the CA group and the group classified by the 9% of predicted value criterion.

Mean CLD Index scores for respiratory symptoms in the population are also shown in Table III, indicating that

TABLE II. Ability of FEV₁ reversibility criteria to capture cases of significant bronchodilator reversibility and agreement according to κ ratio

Reversibility criteria (n)	≥12%, % (n)	≥15%, % (n)	≥400 mL, % (n)	≥9% of predicted value, % (n)
≥12% (153)		64 (98), κ = 0.77	43 (64), κ = 0.55	97 (149), κ = 0.73
≥15% (98)	100 (98)		53 (50), κ = 0.57	99 (97), κ = 0.54
≥400 mL (78)	82 (64)	63 (50)		94 (73), κ = 0.43
≥9% of predicted value (248)	59 (149)	39 (97)	29 (73)	

TABLE III. Mean FEV₁ (absolute and percent predicted) and CLD Index scores according to significant bronchodilator reversibility or CA

Asthma diagnosis (n)	Prebronchodilator FEV ₁			Postbronchodilator FEV ₁			CLD Index* score		
	SBR (no CA) by reversibility criteria	L	SD	% Predicted	L	SD	% Predicted	Mean	SD
≥12% (109)		2.32†‡	0.77	76.5†‡	2.69‡	0.86	89.4‡	29.4†‡	16.9
≥15% (63)		2.15†‡	0.69	69.9†‡	2.56‡§	0.81	83.7†‡	31.9†‡	16.8
≥9% of predicted value (183)		2.56‡	0.88	86.0‡	2.91†‡	0.93	98.0†‡	27.1†‡	15.5
≥400 mL (53)		2.38‡§	1.03	80.6‡§	2.88	1.02	94.7‡	29.4†‡	18.2
Current asthma (380)		2.58‡	0.98	85.9‡	2.74‡	1.00	91.4‡	39.2‡	16.4
No asthma		2.94	0.92	99	3.02	0.95	102	22.7	13

NB, No asthma: n range, 3458 (≥9% of predicted value and 200 mL criteria) to 3481 (≥400 mL criterion).

*CLD Index⁴⁰ is a 6-item questionnaire with subscales of dyspnea, wheezing, and cough-sputum and scored out of 100 as follows: mild, 43 or less; moderate, 44 to 62; severe, 63 or greater.

†Significantly different from CA, *P* < .001.

‡Significantly different from no asthma, *P* < .001.

§Significantly different from CA, *P* < .05.

the SBR groups experienced significantly less respiratory symptoms than the CA group but significantly worse symptoms than the group without asthma after adjustment for age and sex.

Among those with CA, 14% demonstrated airways obstruction, whereas among those with SBR and no CA, the prevalence ranged between 7% (400 mL criterion) and 21% (15% criterion). Less than 2% of the group without asthma demonstrated obstruction.

The best sets of sociodemographic variables to describe the various SBR (no CA) groups as determined by logistic regression are presented in Table IV. The 12% and the 15% reversibility criteria consistently identified individuals who were likely to be older than age 40 years with lower levels of income. The 9% of predicted value and 400 mL criteria were not age specific; however, the 400 mL criterion was selective in its identification of men.

DISCUSSION

It is clear from this study that the 4 reversibility criteria classify quite different persons, which, although intuitive, has not been previously demonstrated in a large representative population sample. This has considerable implications for clinical practice and for the interpretation of epidemiologic studies examining asthma prevalence. Consistent with previous studies in COPD,^{25,30} bronchodilator reversibility was normally distributed in the population. Consequently, there is likely to be a large

discordance between different criteria. Both the frequency and the characteristics of individuals classified with an SBR but without a diagnosis of CA varied. The logistic regression analyses identified a significant sex bias in the ability of the NICE criterion to detect SBR, which might be asthma. This criterion was established to avoid the misclassification of persons with COPD who have reversibility of their airway obstruction as having asthma. However, women with airways obstruction with a large reversible component but less than 400 mL are more likely to be classified as having COPD by using this criterion. Given the possible diverging therapeutic strategies for asthma and COPD and the associated long-term outcomes, this has implications for such patients if inhaled steroid therapy is withheld.

However, all criteria have the potential to misclassify patients. In our study the GINA and BTS/SIGN criteria missed patients with an SBR who were identified by the NICE criterion of 400 mL or greater reversibility. These subjects were almost exclusively young male subjects aged less than 35 years with large lung volumes such that reversibility of 400 mL was less than 12% of their prebronchodilator FEV₁. The standard criteria (≥12% and ≥15%) appear biased in their ability to detect cases among younger persons, indicating a potential need for age-specific cutoffs. This might be achieved by using reversibility as a percentage of predicted FEV₁, as recommended by Quanjer et al.⁴³ However, the 9% predicted criterion also missed 6% of cases (n = 5) among those identified as having at least 400 mL of FEV₁ reversibility.

TABLE IV. Logistic regression analysis of factors associated with significant bronchodilator responsiveness in the absence of CA, as classified by FEV₁ reversibility criteria

Reversibility criteria	Variable*	Odds ratio	P value
≥12%	Age ≥40 y	2.24 (1.33-3.75)	<.01
	Government benefit	1.52 (1.01-2.30)	.04
	Income <\$40,000	1.91 (1.18-3.08)	<.01
≥15%	Age ≥40 y	2.27 (1.10-4.69)	.03
	Income <\$40,000	2.70 (1.38-5.29)	<.01
≥9% of predicted value	Income <\$40,000	1.51 (1.06-2.15)	.02
≥400 mL	Male sex	4.45 (2.14-9.26)	<.01

*Reference categories: age less than 40 years, not receiving a government benefit, annual household income of \$40,000 or greater, and female sex.

There is a substantial burden of unidentified disease in the community. Regardless of the criteria used, the frequency of persons with significant reversibility and impairment without a diagnosis of asthma or COPD is considerable. Among these individuals, lung function and respiratory symptoms were significantly worse than in persons without asthma. However, in terms of symptoms experienced, these persons are not as burdened as those with current asthma. Therefore the potential exists for gains to be made through identification and treatment of many of these individuals. This is particularly important when it is considered that by most of the criteria, such persons will tend to be older, where gains in quality of life can be made with effective treatment. It is also of note that although lung function was worse in the SBR groups compared with the group with current asthma, this was not reflected in the level of symptoms experienced. This might reflect the poorer perception of bronchoconstriction that has been observed in older persons.⁴⁴ Detection of possible asthma by means of screening with spirometry might need to be considered in older persons or in younger persons with any respiratory symptoms.

Some of the impairment associated with bronchodilator responsiveness seen in this study is likely to be due to COPD. According to the GOLD criteria, COPD requires the presence of airflow limitation on postbronchodilator spirometry measurement.⁴⁵ However, the prevalence of obstruction was low in the SBR groups. Therefore it is unlikely that COPD is a dominant influence on our results.

Our study is limited by the use of self-report for a diagnosis of asthma. However, it is unlikely that participants self-reporting CA do not actually have the condition because it is used widely and has been shown to be a valid measure of asthma.⁴⁶

Second, it is also important to acknowledge that given the controversy surrounding the diagnostic utility of bronchodilator reversibility test, this analysis was based on a single reversibility test. Calverley et al²⁵ have recently demonstrated that in a group of patients with COPD meeting the European Respiratory Society criteria for irreversibility, 52% changed their responder status using the 12% and 200 mL criteria. Quanjer et al⁴³ stated

that “an unambiguous bronchodilator response should exceed spontaneous variability and the response observed in healthy individuals.” The upper 95% CI of short-term variability in persons with stable obstructive and restrictive defects has been shown to be less than or equal to 0.19 L.^{47,48} The NICE criteria of an increase of at least 400 mL in FEV₁ being necessary to demonstrate asthma appears to be derived from evidence from the ISOLDE study, in which 95% of nonasthmatic, nonbronchodilator-responsive (<10% of predicted value) ex-smokers with COPD demonstrated an FEV₁ response to prednisolone of up to 412 mL.⁴⁹ Two large North American population samples, by Lorber et al⁵⁰ and Dales et al,⁵¹ have demonstrated upper 95th percentile of FEV₁ bronchodilator response in healthy subjects in the range of 7.7% to 9% respectively. Dales et al⁵¹ recommended the use of at least 9% of predicted value given its stability across sex-age-height groups. The criteria specified by the BTS/SIGN and GINA guidelines are derived from these early studies of the bronchodilator response.^{47,48,50,51} Importantly, the SBR groups in the present study demonstrated median bronchodilator reversibility far exceeding the spontaneous variability of the test and that seen in our group without asthma. The North West Adelaide Health (Cohort) Study cohort is currently undergoing clinic reassessment, and a proportion of the asthmatic subjects are undergoing saline bronchial challenge testing, induced sputum analysis, and measurements of exhaled nitric oxide. This will permit validation of the original asthma diagnosis and responder status to the extent that the technology allows.

Third, our survey was limited to households with telephones. However, because 97% of the households in the region have telephones³⁸ and the demographic characteristics were representative of the population of profile of Adelaide overall,⁵² the extent of any bias is likely to be small.

This study suggests that spirometry and, in particular, the bronchodilator response is not a very sensitive tool for the confirmation of current asthma, as shown by the 82% to 93% of subjects with CA not demonstrating an SBR, depending on the criterion used. It is arguable, however, that asthma is well controlled and managed in these participants, given that moderate-to-severe respiratory symptoms (CLD Index) were reported by 29%. It is also possible that the group classified as having no asthma also contained individuals with nondiagnostic spirometry (ie, bronchodilator nonresponsive). However, given that 94% of this group had respiratory symptoms rated as none to mild, a level significantly lower than that seen in the SBR group, this seems unlikely. The lack of a demonstrable SBR does not exclude asthma, however, and the bronchodilator reversibility test is therefore an imperfect tool for screening the general population. Although it is difficult to conjecture about the specificity of the bronchodilator response in the absence of a gold standard, this does not detract from the central message of this study that an SBR, however classified, in the absence of a diagnosis of asthma was associated with significant avoidable morbidity.

In summary, this study has shown that given asthma guideline recommendations for demonstration of reversible airflow obstruction, misclassification of asthma can occur depending on the reversibility criteria used. Depending on the criteria used, 1% to nearly 5% of the population had an SBR and were symptomatic yet unrecognized and unmanaged, which has considerable consequences for their respiratory health, particularly for older persons. Evidence-based international consensus on this issue is clearly required to avoid preventable adverse asthma outcomes. Spirometric criteria using change in predicted values appear less likely to bias against certain age and sex groups and in this study captured almost all of the cases identified by means of the other criteria. We would suggest serious consideration for its use as a criterion standard in guidelines.

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