폐기능 검사의 해석 및 2021 업데이트

고려대구로병원
김상혁

Table of contents

Table of contents

왜 폐기능 검사를 할까요?

Table 2 Indications for testing Adapted from Cotes

Category	Use
Medical diagnosis	▶ Measure the effects of disease on respiratory function. ▶ Follow the course of a disease affecting respiratory function. ▶ Evaluate signs, symptoms or laboratory findings. ▶ Physical fitness, selection or evaluation in health and disease. ▶ To reassure the patient and/or the physician.
Surgery	▶ Preoperative risk evaluation for anaesthetic and surgery. ▶ Postoperative assessment of surgery, particularly thoracic surgery.
Disability evaluation	▶ Industrial medical. ▶ Government compensation laws. ▶ Personal injury lawsuit. ▶ Other legal purposes e.g, failure to provide a breath test. ▶ Epidemiology.
Research	▶ Clinical trials.

Adapted from Cotes.[174]

Sylvester et al. BMJ Open RR 2020

왜 폐기능 검사를 할까요?

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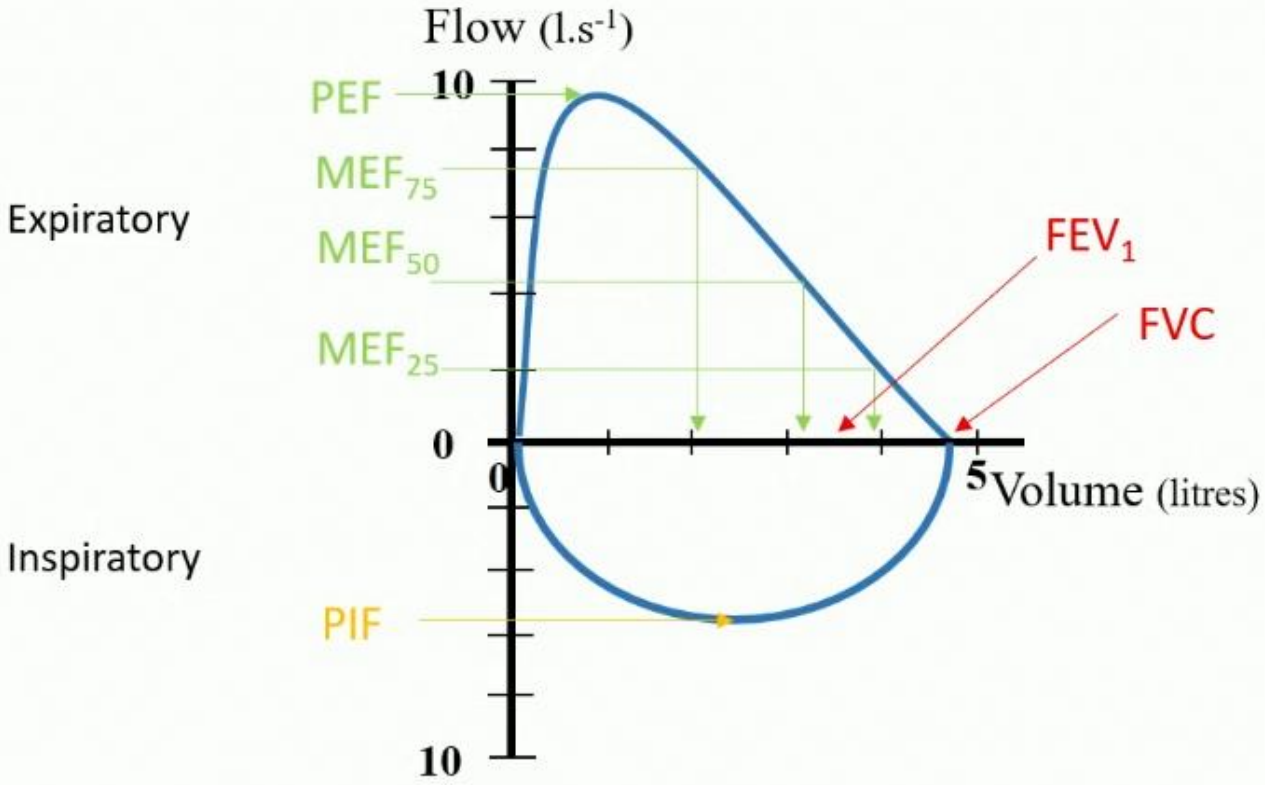
Adapted from Cotes.[174]

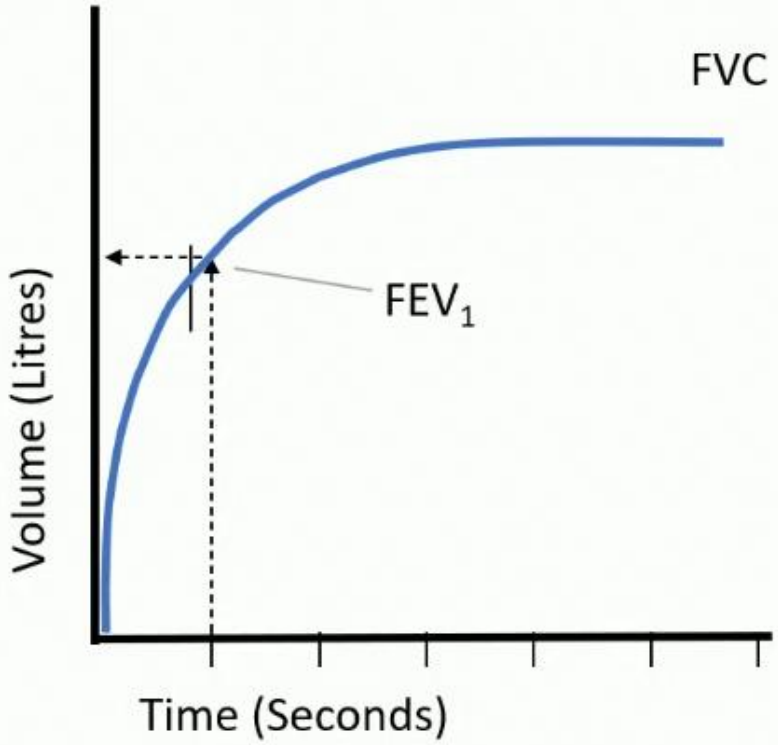
Sylvester et al. BMJ Open RR 2020

정의

- **FEV_1 (Forced Expiratory Volume in 1 second):** Volume of air exhaled in the first second of a forced expiration after full inspiration.
- **FVC (Forced Vital Capacity):** Total volume of air exhaled during a forced expiratory maneuver after full inspiration.
- **FEV_1/FVC**: Ratio expressing the proportion of the lung volume exhaled in the first second; used to detect airflow limitation.
- **M/FEF (Maximal Mid-Expiratory Flow, often $MMEF_{25-75}$):** Average expiratory flow between 25% and 75% of the FVC, reflecting small airway function.
- **PEF (Peak Expiratory Flow):** Maximum flow rate achieved during a forced expiration.

유량-용적 곡선





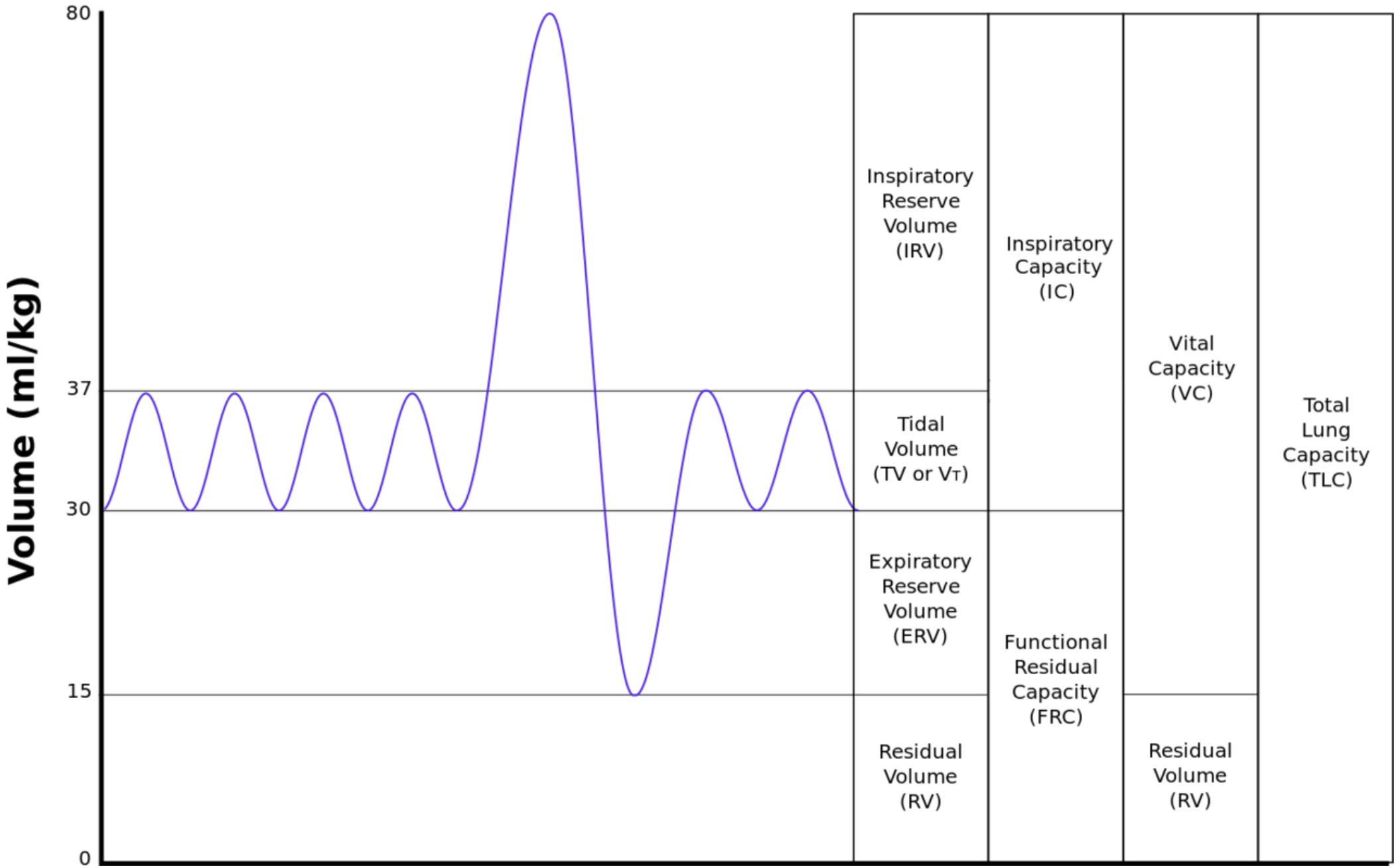
Sylvester et al. ERS CONGRESS 2025

정의

- **TLC (Total Lung Capacity):** Maximum volume of air the lungs can hold after full inspiration.

- **FRC (Functional Residual Capacity):** Volume of air remaining in the lungs after a normal, passive expiration.

- **RV (Residual Volume):** Volume of air remaining in the lungs after maximal exhalation.


Volume (ml/kg)
80
37
30
15
0
Inspiratory Reserve Volume (IRV)
Tidal Volume (TV or VT)
Expiratory Reserve Volume (ERV)
Residual Volume (RV)
Inspiratory Capacity (IC)
Functional Residual Capacity (FRC)
Vital Capacity (VC)
Residual Volume (RV)
Total Lung Capacity (TLC)

Wikipedia

Table of contents

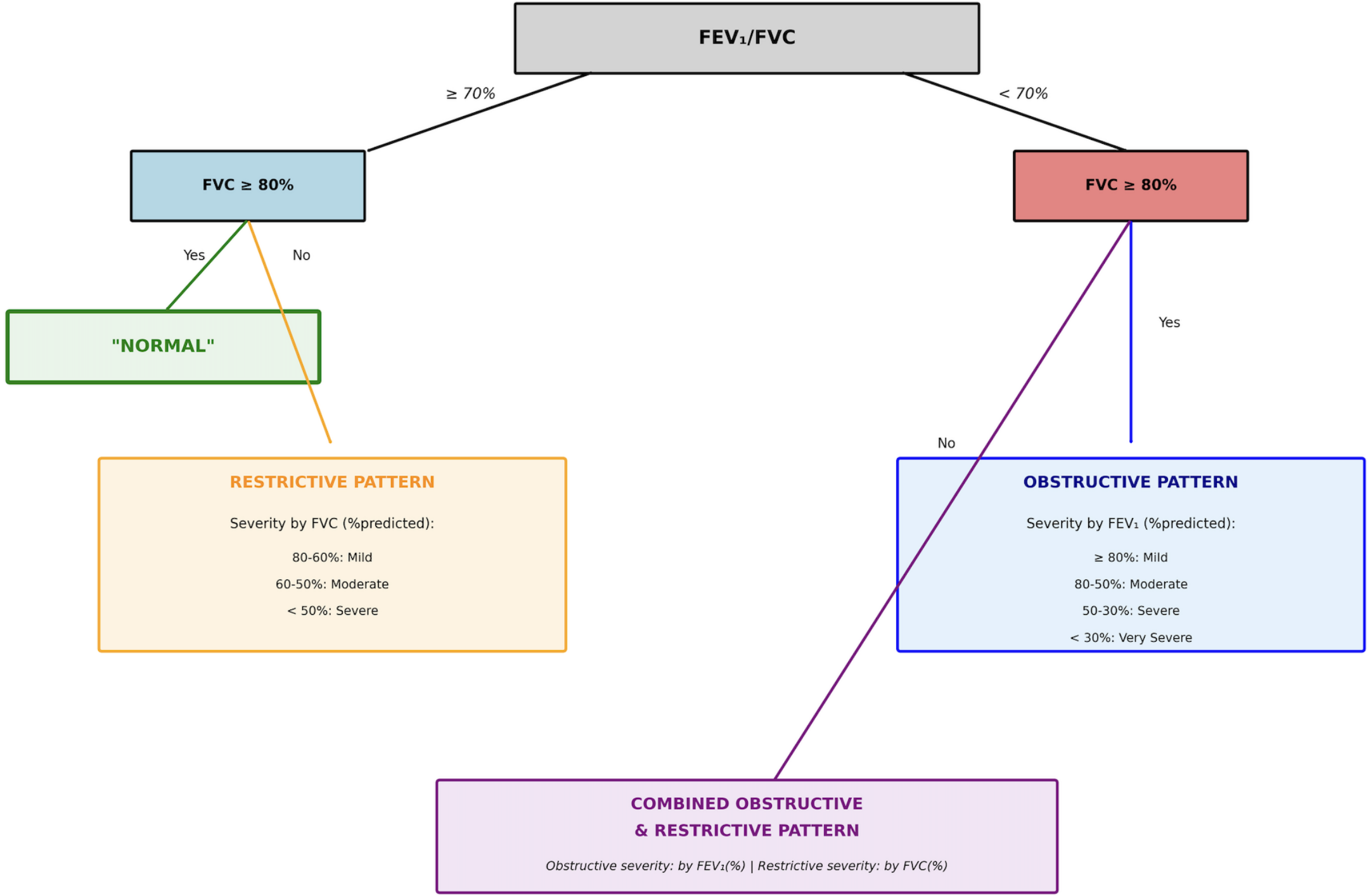
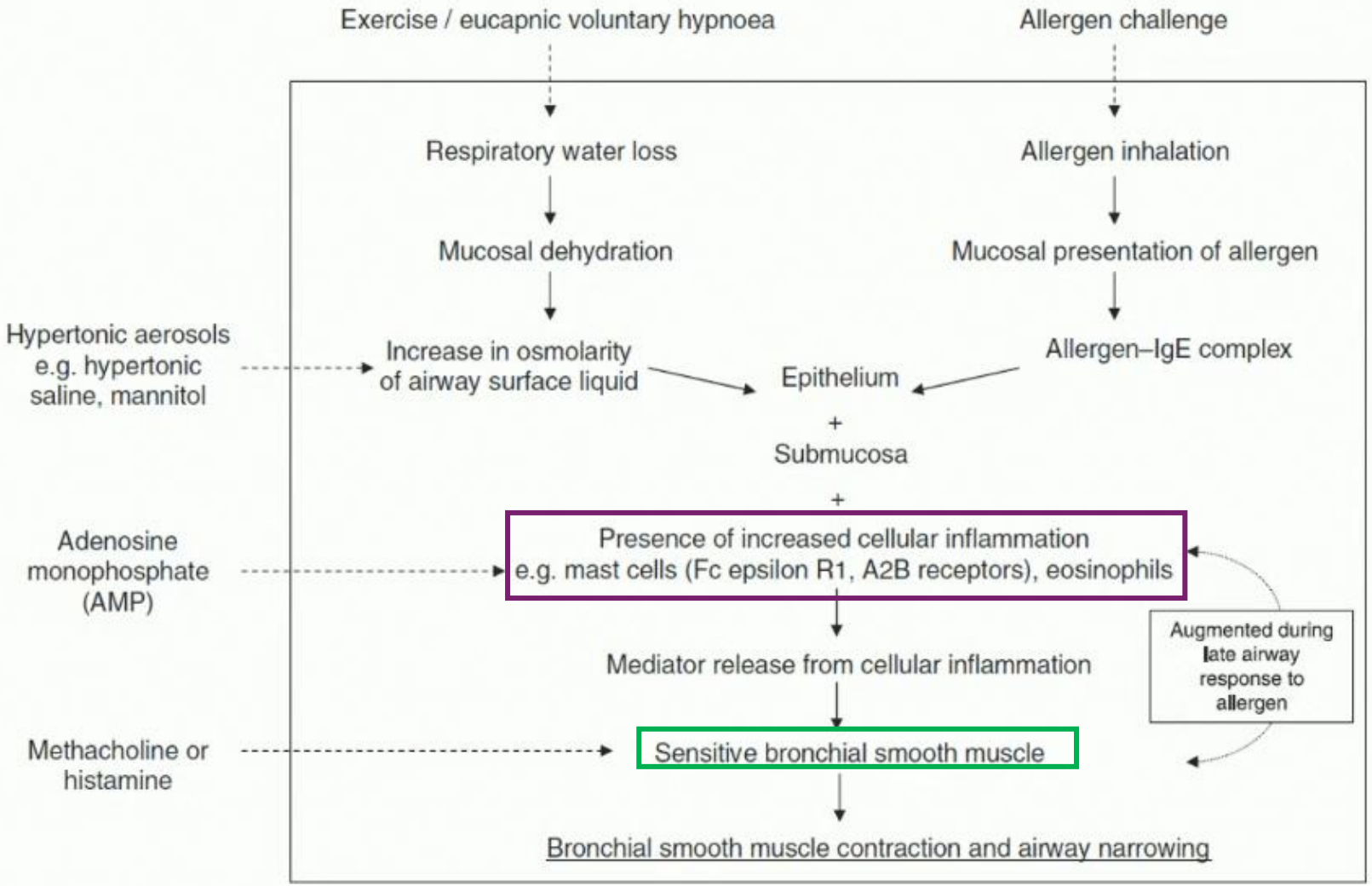

FEV₁/FVC
≥ 70%
< 70%
FVC ≥ 80%
FVC ≥ 80%
Yes
No
"NORMAL"
Yes
No
RESTRICTIVE PATTERN
Severity by FVC (%predicted):
80-60%: Mild
60-50%: Moderate
< 50%: Severe
OBSTRUCTIVE PATTERN
Severity by FEV₁ (%predicted):
≥ 80%: Mild
80-50%: Moderate
50-30%: Severe
< 30%: Very Severe
COMBINED OBSTRUCTIVE
& RESTRICTIVE PATTERN
Obstructive severity: by FEV₁(%) | Restrictive severity: by FVC(%)

Table of contents

기관지유발검사

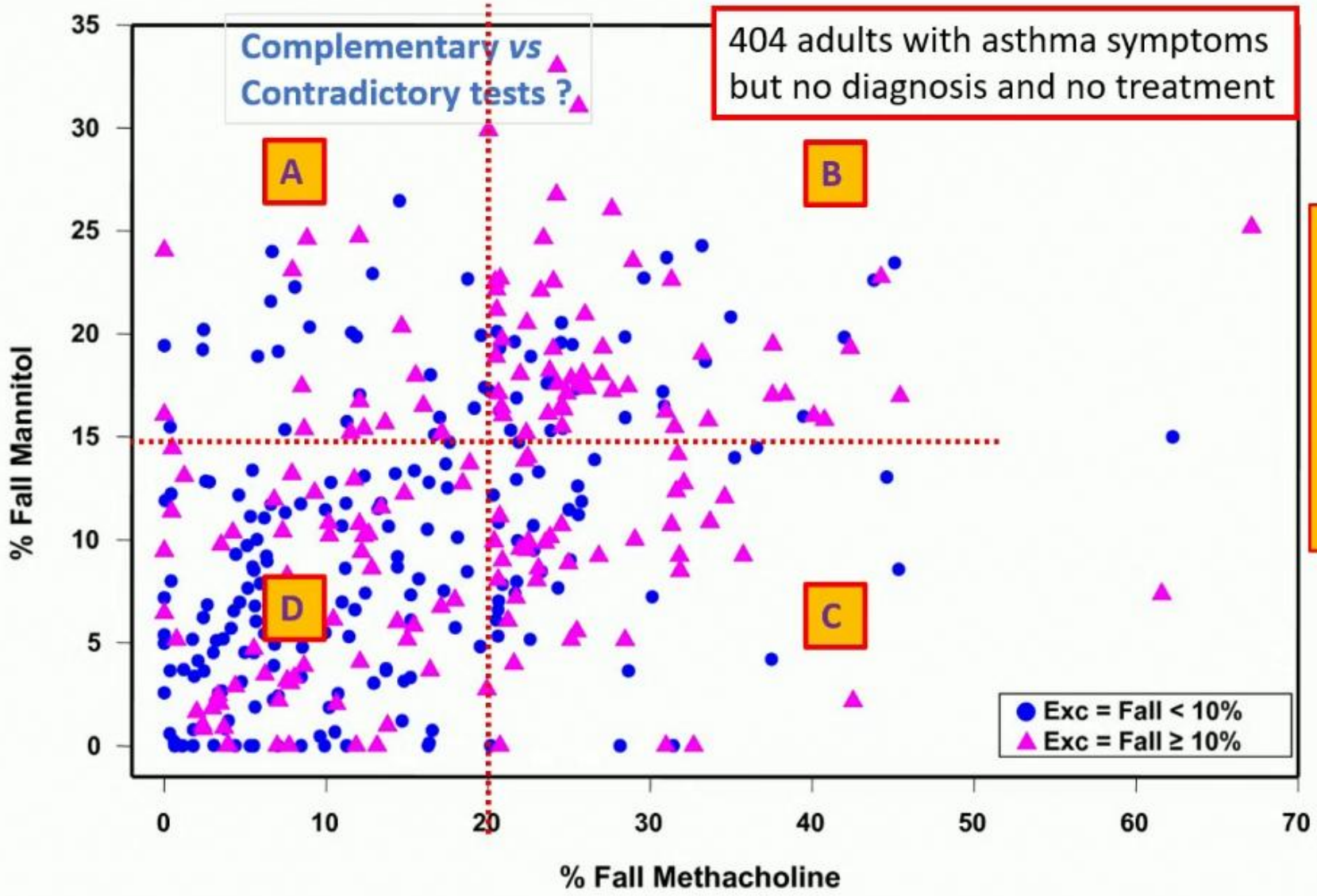


Using different broncho-active stimuli enables to test different components and underlying pathways of AHR

Apart from Allergen Challenge (type2 allergic pathway), there are other Specific Research BPTs, *e.g.*: LPS/ozone and Rhinovirus

O'Byrne PM, et al, CEA 2009; Hallstrand TS et al, ERJ 2018

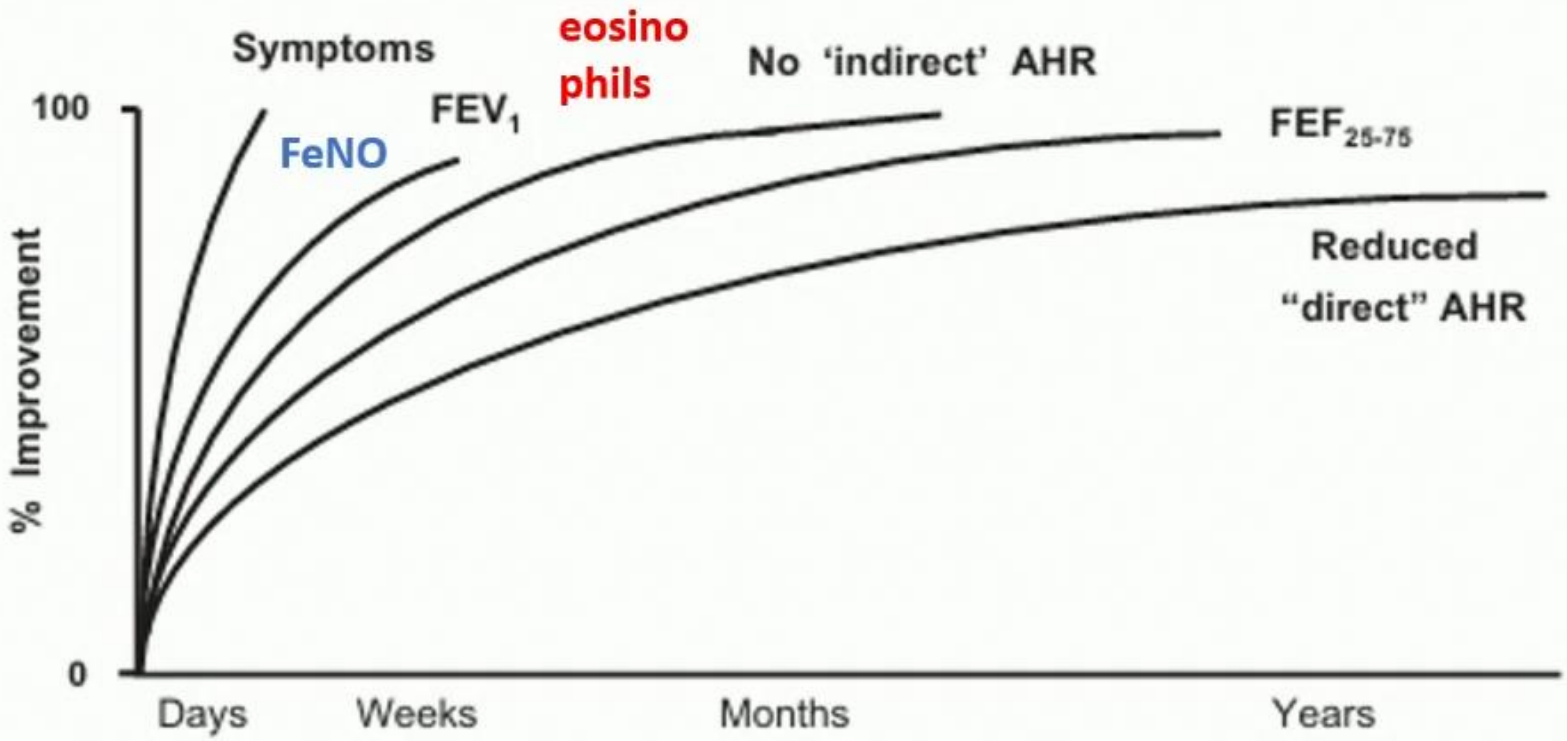
기관지유발검사



Symptomatic subjects with positive or negative EIB test can have:
A: positive mannitol; negative Meth
B: positive mannitol/positive Meth
C: negative mannitol/positive Meth
D: negative mannitol/Meth

Anderson SD, et al, Respir Res 2009

기관지유발검사



Indirect tests of AHR:
- Indicative of airway inflammation
- Useful for monitoring of anti-inflammatory Rx

Direct tests of AHR:
- Indicative of ''long-standing'' inflammation+remodeling
- Useful for monitoring of disease modifying Rx

AHR: airway hyperresponsiveness

Brannan J, et al, Respir Res 2009

Table of contents

EUROPEAN RESPIRATORY JOURNAL
ERS OFFICIAL DOCUMENTS
S. STANOJEVIC ET AL.

ERS/ATS technical standard on interpretive strategies for routine lung function tests

Sanja Stanojevic[1], David A. Kaminsky[2], Martin R. Miller[3], Bruce Thompson[4], Andrea Aliverti[5], Igor Barjaktarevic[6], Brendan G. Cooper[7], Bruce Culver[8], Eric Derom[9], Graham L. Hall[10], Teal S. Hallstrand[8], Joerg D. Leuppi[11,12], Neil MacIntyre[13], Meredith McCormack[14], Margaret Rosenfeld[15] and Erik R. Swenson[8,16]

TABLE 1 Summary of differences between the American Thoracic Society (ATS) and European Respiratory Society (ERS) 2005 [3] and 2021 interpretation standards

	2005 ATS/ERS statement	2021 ATS/ERS technical standard
General comments	• Using PFT interpretation to aid in clinical diagnosis and decision making	• More emphasis on using PFTs to classify physiology, not make a clinical diagnosis • Emphasis on uncertainty of interpretation, especially near LLN
Reference equations	• Use of race/ethnic-specific equations preferred over using adjustment factors • Spirometry: In USA: NHANES III recommended In Europe: no specific equations recommended • Lung volumes and D_{LCO}: In USA and Europe: no specific equations recommended	• Recommendation to use GLI reference equations for spirometry, lung volumes and D_{LCO} • More emphasis on incomplete understanding of role of race/ethnicity on lung function • Clarify that biological sex, not gender be used to interpret lung function
Defining normal range	• General use of LLN=5th percentile • Use of fixed ratio FEV_1/FVC <0.7 not recommended • Use of 80% predicted to define normal not recommended	• General use of LLN=5th percentile and ULN=95th percentile • Use of fixed ratio FEV_1/FVC <0.7 not recommended • Use of 80% predicted to define normal not recommended
Bronchodilator response	• ⩾12% and 200 mL in FEV_1 or FVC from baseline • 4 doses of 100 µg salbutamol; wait 15 min	• >10% of predicted value in FEV_1 or FVC • Choice of protocol for administering bronchodilator not specified

Interpretation of change over time	• Variable changes over time depending on normal *versus* COPD and time period (within a day, week to week, year to year)	• Conditional change score in children • FEV_1Q in adults
Severity of lung function impairment	• Using FEV_1 (includes obstruction or restriction): Mild: FEV_1 >70% predicted Moderate: 60–69% predicted Moderate-to-severe: 50–59% predicted Severe: 35–49% predicted Very severe: <35% predicted • D_{LCO}: Mild: >60% predicted and <LLN Moderate: 40–60% predicted Severe: <40% predicted	• For all measures use z-score: Mild: −1.65 to −2.5 Moderate: −2.51 to −4.0 Severe: <−4.1
Classification of physiological impairments	• Airflow obstruction: FEV_1/FVC <5th percentile, using largest VC; lung volumes to detect hyperinflation or air trapping; elevated airway resistance; central/upper airway obstruction • Restriction: TLC <5th percentile and normal FEV_1/VC Mixed: FEV_1/VC and TLC <5th percentile • Gas transfer impairment: D_{LCO}, K_{CO} <5th percentile Importance of adjustments for Hb, COHb	• Airflow obstruction: FEV_1/FVC <5th percentile, using FVC; lung volumes to detect hyperinflation or air trapping; dysanapsis; non-specific pattern and PRISm; central/upper airway obstruction • Restriction: TLC <5th percentile Simple *versus* complex restriction Hyperinflation Mixed • Gas transfer impairment: D_{LCO} <5th percentile Using V_A, K_{CO} to classify low D_{LCO}

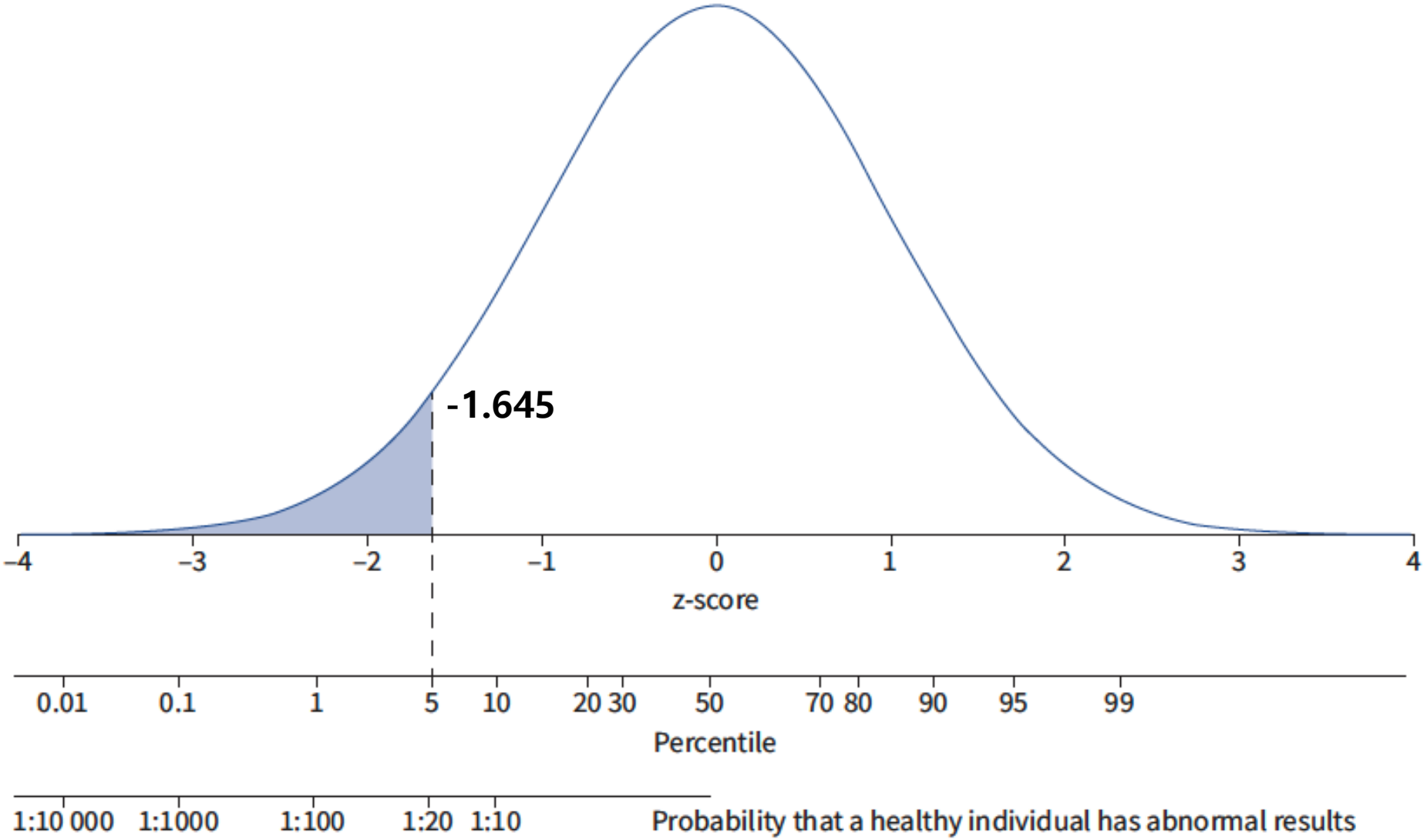


FIGURE 2 The normal distribution with z-scores and percentiles displayed. Percentile can be interpreted as the probability that a healthy individual has results inside the normal range (*i.e.* the false-positive rate).

TABLE 3 The 5th percentile values (lower limit of normal (LLN)) for various lung function indices expressed as percent predicted for six individuals

	Male (age 10 years; height 137 cm)	Female (age 15 years; height 162 cm)	Male (age 25 years; height 175 cm)	Female (age 25 years; height 165 cm)	Male (age 80 years; height 175 cm)	Female (age 80 years; height 165 cm)
FEV_1	81.3	80.5	80.5	80.2	69.4	70.0
FVC	81.2	80.4	80.9	79.9	72.0	70.0
FEV_1/FVC	87.4	87.8	86.9	87.2	80.0	80.5
TLC	78.0	79.8	80.0	80.4	77.8	77.6
FRC	70.9	69.9	69.6	72.5	69.8	70.7
RV	40.6	40.9	49.1	52.5	55.7	57.7
D_{LCO}	75.4	77.5	79.0	77.8	72.4	74.5

BOX 1 Determination of a bronchodilator response

$$\text{Bronchodilator response} = \frac{(\text{post-bronchodilator value (L)} - \text{pre-bronchodilator value (L)}) \times 100}{\text{predicted value (L)}^{\#}}$$

A change of >10% is considered a significant bronchodilator response.

#: predicted value should be determined using the appropriate Global Lung Function Initiative (GLI) spirometry equation.

For example, a 50-year-old male, height 170 cm, has a pre-bronchodilator forced expiratory volume in 1 s (FEV_1) of 2.0 L and a post-bronchodilator FEV_1 of 2.4 L. The predicted FEV_1 is 3.32 L (GLI 2012 "other" equation).

$$\text{Bronchodilator response} = \frac{(2.4 - 2.0) \times 100}{3.32} = 12.1\%$$

Therefore, their bronchodilator response is reported as an increase of 12.1% of their predicted FEV_1 and classified as a significant response.

Table of contents

예측치의 계산

	모리스식	최정근식
FVC		
Male	Ht x 0.148 x 0.3937 – age x 0.025 -4.241	0.05292 x Ht + 0.010947 x Wt – 0.00008633 x age^2 -4.8434
Female	Ht x 0.115 x 0.3937 – age x 0.032 -2.852	0.03951 x Ht + 0.006892 x Wt – 0.00012728 x age^2 -3.00068434
FEV_1		
Male	Ht x 0.092 x 0.3937 – age x 0.032 -1.260	0.04578 x Ht – 0.0002484 x age^2 -3.4132
Female	Ht x 0.089 x 0.3937 – age x 0.025 -1.932	0.03558 x Ht – 0.0001920 x age^2 -2.4114

Global Lung Function Initiative (GLI)

GLI

Global Lung Function Initiative

What is the Global Lung Function Initiative Network?

Established in 2008, the GLI Network aims to standardize how pulmonary function test results are interpreted around the world.

Quanjer PH, Stanojevic S, Cole TJ, *et al.* Multi-ethnic reference values for spirometry for the 3–95-yr age range: the global lung function 2012 equations. *Eur Respir J* 2012; 40: 1324–1343.

Stanojevic S, Graham BL, Cooper BG, *et al.* Official ERS technical standards: Global Lung Function Initiative reference values for the carbon monoxide transfer factor for Caucasians. *Eur Respir J* 2017; 50: 1700010.

Hall GL, Filipow N, Ruppel G, *et al.* Official ERS technical standard: Global Lung Function Initiative reference values for static lung volumes in individuals of European ancestry. *Eur Respir J* 2020; 57: 2000289.

Global Lung Function Initiative (GLI)

TABLE 1 Summary of datasets included in the initial analysis[#]

Group	Countries	Males		Females	
		N	Age range yrs	N	Age range yrs
African–American	1	1529	6–85	2029	6.1–87
India and Pakistan	2	2837	4–86	3003	3–79
Latin America	5	2337	6.7–89.4	2578	7.4–89.7
Mexican–American	1	1622	6.2–86	2282	6.5–87
Iran	1	3398	5–85	2739	5–80
Oman	1	638	6–65	618	6–65
North East Asia	2	2176	15.3–91	4526	15.5–90
South East Asia	4	4187	3.3–88	6371	3.1–92
North Africa	2	541	6–78	602	6–90
Caucasian	14	24229	2.5–95	28844	2.5–95
Other		199	6.2–93	474	5.8–91
Total	33	43693	2.5–95	54066	2.5–95

[#]: total sample included 97,759 subjects.

GLI reference population	GLI data sources	Population/ancestral origin
White	Europe, Israel, Australia, USA, Canada, Brazil, Chile, Mexico, Uruguay, Venezuela, Algeria, Tunisia	White (European); Hispanic (European)
Black	African American	Black (North America)
South East Asian	Thailand, Taiwan, China (including Hong Kong)	Asian
North East Asian	Japan, Korea	
Multi-ethnic	Average of the other four GLI groups	Multiracial; Black South Africa [177]; India [178]; unknown

Shin, 2024 update of PFT

Global Lung Function Initiative (GLI)

32-year-old
Korean
Female
156cm

Spirometry (BTPS)

		PRED	PRE-RX BEST	%PRED
FVC	Liters	3.41	2.87	84
FEV.5	Liters	2.16	1.93	90
FEV.5/FVC	%	68	67	
FEV1	Liters	2.94	2.46	84
FEV1/FVC	%	86	86	
FEF25-75%	L/sec	3.27	2.71	83
FEF50%	L/sec	3.80	3.44	90
FEF200-1200	L/sec	5.22	5.43	104
PEF	L/sec	6.10	6.58	108
FET100%	Sec		8.17	
FVL ECode			111000	

Shin, 2024 update of PFT

Global Lung Function Initiative

32-year-old
North East Asian
Female
156cm

GLI calculator

The Global Lung Function Initiative (GLI) has collected respiratory function outcomes from researchers and health care professionals from around the world. To date, the GLI Network has produced reference equations for Spirometry and Transfer Factor for Carbon Monoxide. Current projects include reference equations for lung volumes.

Access the calculator ›

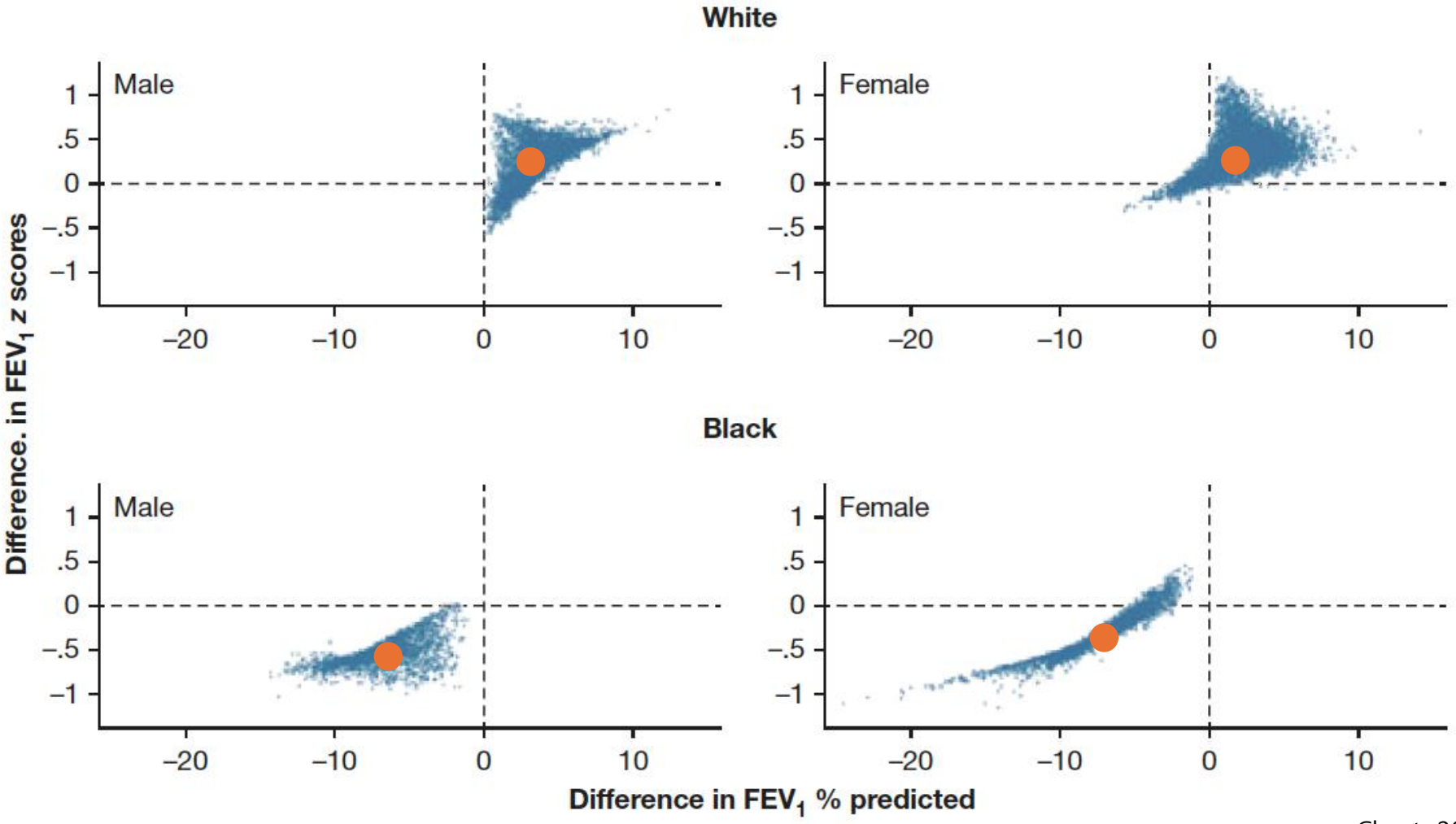
GLI Lung Function Calculator

Calculator	Index	Measured	Predicted	Z-Score	LLN	ULN	% Predicted
Spirometry - pre-BD	FEV1	2.46	2.873	-1.213	2.311	3.418	85.631
	FVC	2.87	3.361	-1.430	2.797	3.941	85.402
	FEV1/FVC	0.857	0.856	0.023	0.760	0.935	100.139
	FEF25-75	2.71	3.051	-0.485	1.961	4.326	88.814
	FEV0.75		0.000		0.000	0.000	
	FEF75		1.441		0.818	2.364	
	FEV0.75/FVC	0.000	0.000	0.000	0.000	0.000	0.000

Shin, 2024 update of PFT

FEV1 %pred and Z-scores

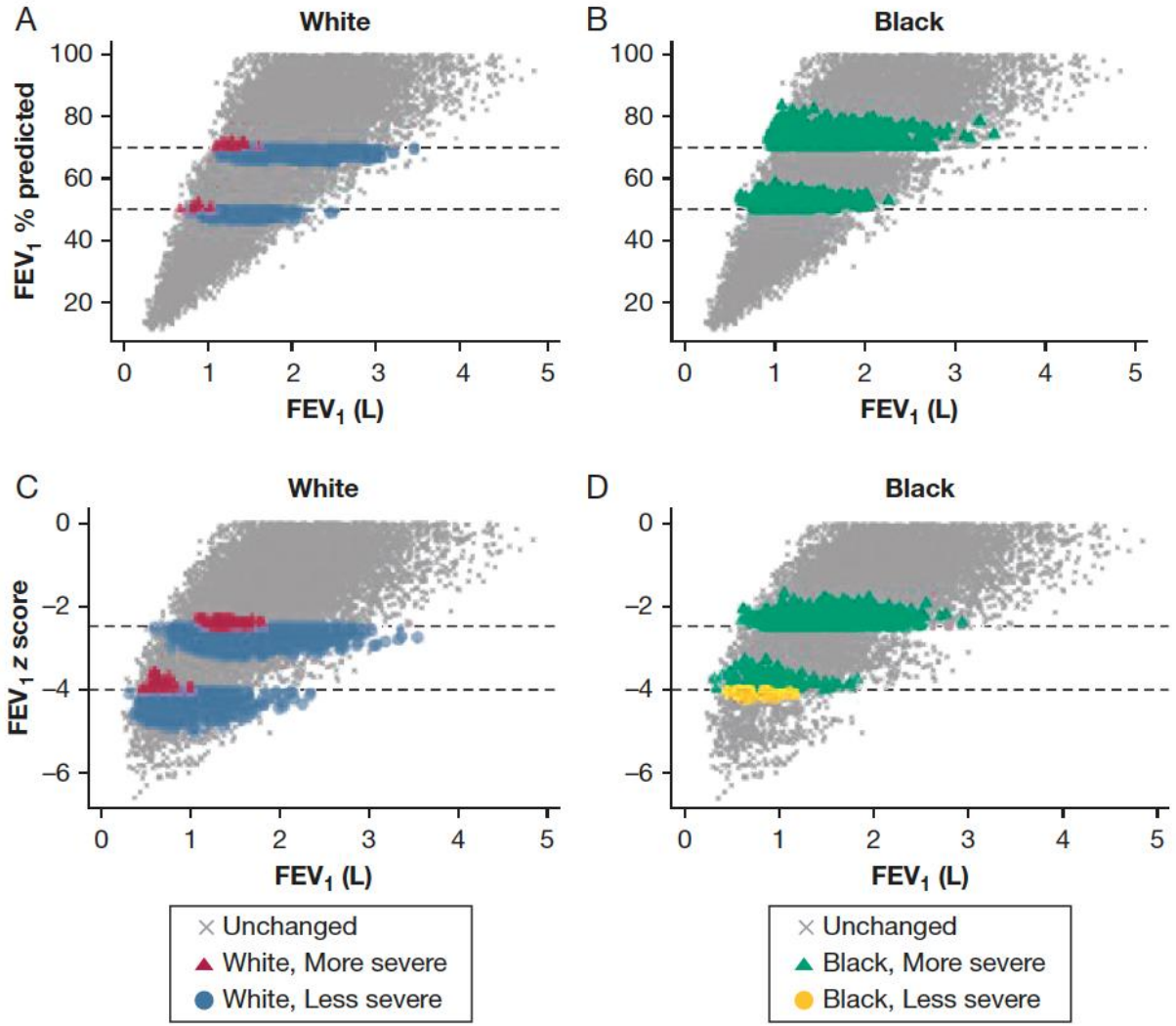
Difference: race-neutral vs. race-specific



Chest. 2024 Aug;166(2):294-303.

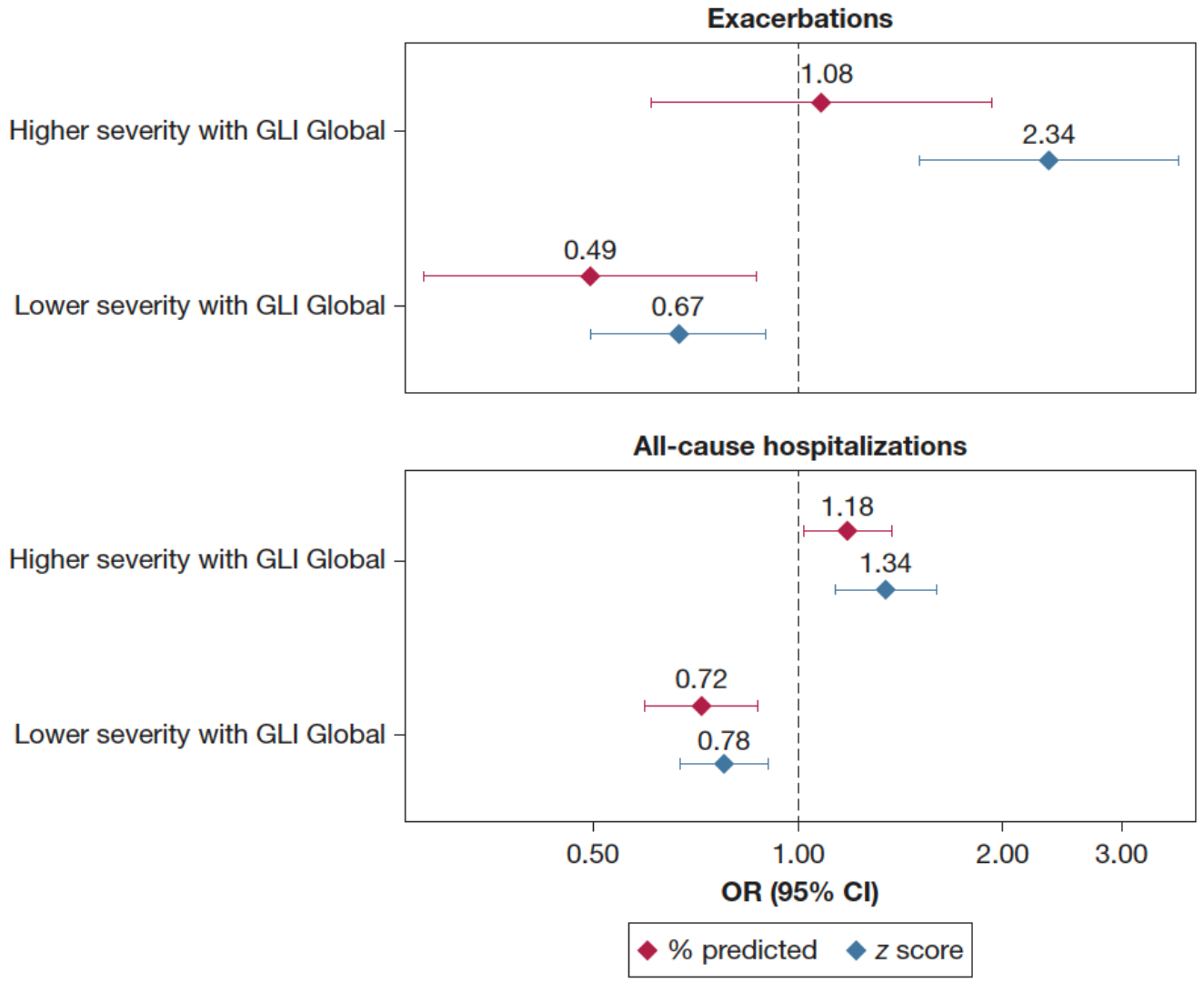
FEV1 %pred and Z-scores

Difference: race-neutral vs. race-specific



Chest. 2024 Aug;166(2):294-303.

FEV1 %pred and Z-scores



Chest. 2024 Aug;166(2):294-303.

Table of contents

Bronchodilator response

Conference Abstract Free

What adds the new definition of bronchodilator responsiveness in asthmatic adults?

Hela Fakhfakh | Rim Kammoun | Emna Eleuch | Asma Haddar | Molk Maalej | Ines Kammoun | Kawthar Masmoudi See Less

European Respiratory Journal 2023 62(suppl 67): PA4735; DOI: https://doi.org/10.1183/13993003.congress-2023.PA4735

Abstract

Introduction: The ATS/ERS 2021 (AE21) proposed a new definition of the bronchodilator (BD) responsiveness (BDR) basing on the increase of the forced expiratory volume in 1 second (FEV 1) or the forced vital capacity over 10 % of the predicted value.

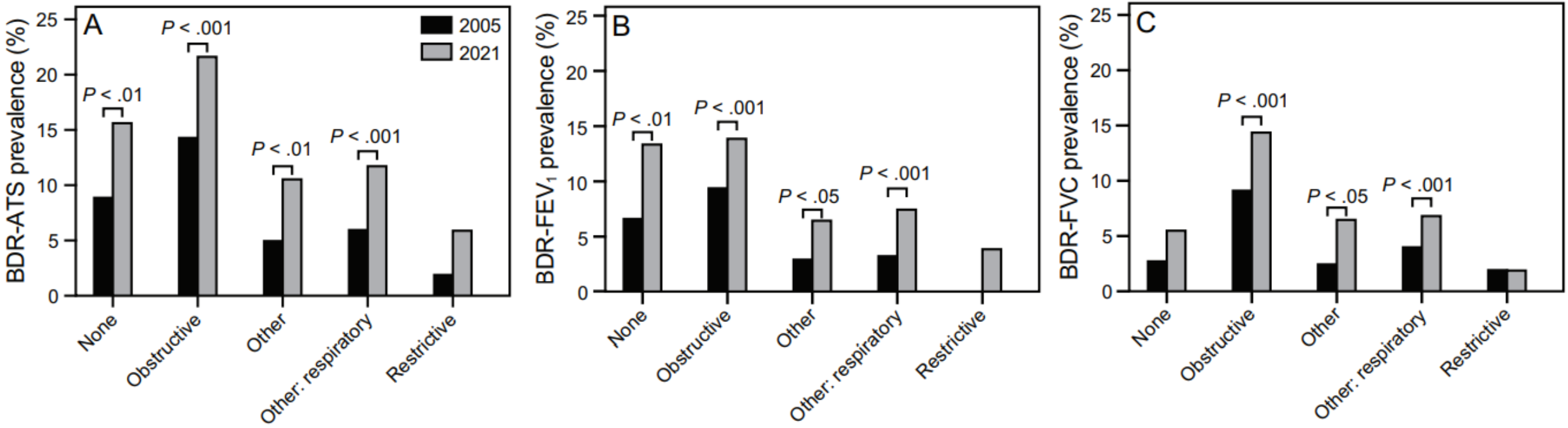
Objectives: To assess whether the AE21 BD definition is valid or not in asthmatic adults.

Methods: We have conducted a retrospective study, involving asthmatic adults in the Physiology and functional exploration department of Habib Bourguiba hospital of Sfax. Spirometry was performed before and after BD. Significant BDR was established according three definitions the AE21, the ATS/ERS 2005 (AE05) (increase of FEV1 or FVC by 200 ml and 12 % of the initial value) and the GINA 2022 (G21) (increase of FEV1 by 12 % and 200 ml). For statistical purpose, we have used the SPSS 20. A $p < 0.05$ was significant.

Results: Among 100 included adults, 69.3% were females The mean age was of 52.1±13.61 years old. The percentage of BDR by AE21 was 42.6 % significantly higher than those of AE05 (22.8%) and G21 (18.8%) ($p<0.05$). These percentages were higher among mans with respectively 50% by AE21, 30 % by AE05 and 26.7 % by G21 ($P<0.05$). In patients with BMI > 25 kg/m² the percentages were respectively 45.3% by AE21, 22.7 % by AE05 and 18.7 % by G21 higher than those with BMI<25 kg/m² (respectively 36% by AE21, 24 % by AE05 and 20 % by G21)

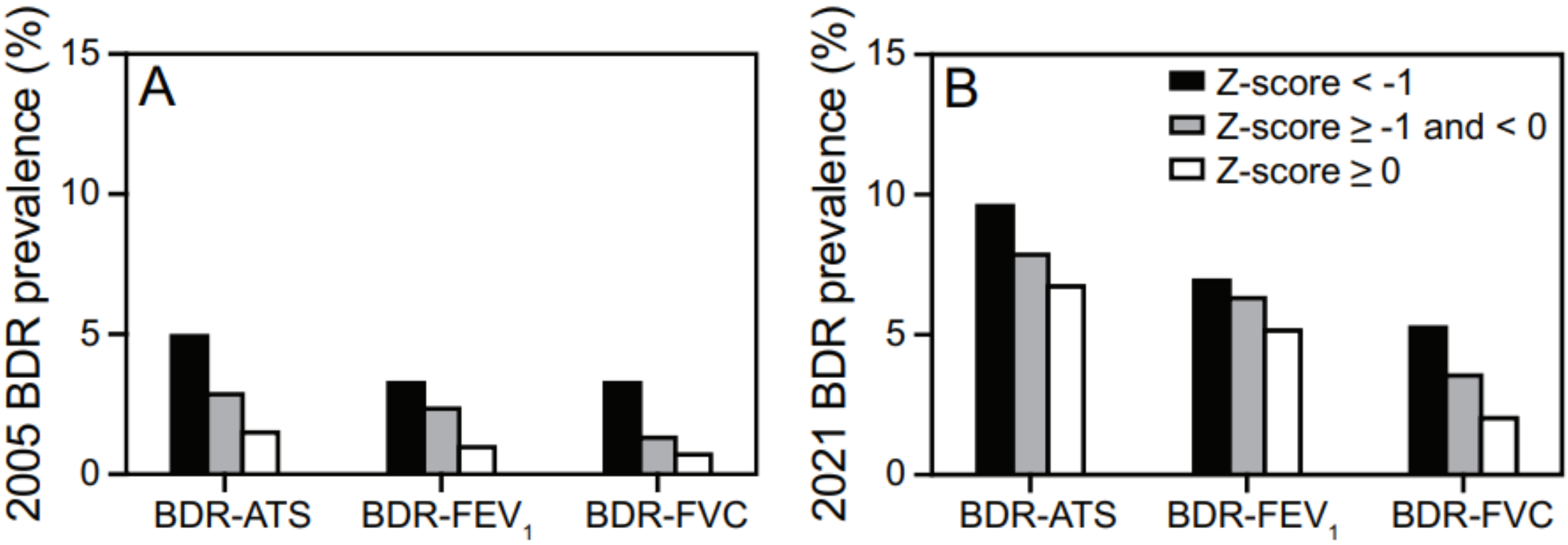
Conclusion: The BR assessment depends on the scholarly society. The ATS/ERS 2021 definition provides a significantly higher BR rate than ATS/ERS 2005 and GINA 21 ones and seems more suitable for mans that women. Prospective randomized studies would help standardize the interpretation of BR in asthmatic adults.

Healthcare-utilizing adults ≥18 years



Serna et al. Respiratory Care 2024

Healthcare-utilizing adults ≥18 years



Serna et al. Respiratory Care 2024

COPD patients

		2005 ATS/ERS		2021 ATS/ERS	
	Overall (*n* = 3,339)	ATS-BDR+ (*n* = 1,084)	ATS-BDR− (*n* = 2,255)	GLI-BDR+ (*n* = 1,489)	GLI-BDR− (*n* = 1,850)
Age, yr	63.5 (8.6)	63.7 (8.8)	63.5 (8.4)	63.9 (8.8)	63.3 (8.4)
F, *n* (%)	1,374 (41.2%)	452 (41.7%)	922 (40.9%)	475 (41.8%)	899 (40.8%)
Non-Hispanic White, *n* (%)	2,699 (80.8%)	887 (81.8%)	1,812 (80.4%)	943 (83.0%)	1,756 (79.7%)
Non-Hispanic Black, *n* (%)	640 (19.2%)	197 (18.2%)	443 (19.6%)	193 (17.0%)	447 (20.3%)
Body mass index, kg/m^2	27.6 (5.9)	27.6 (5.7)	27.6 (6.0)	27.7 (5.8)	27.6 (5.9)
Active smoker, *n* (%)	1,872 (56.1%)	611 (56.4%)	1,261 (55.9%)	694 (61.1%)	1,178 (53.5%)
Pack-years of smoking	52.7 (27.0)	52.9 (27.0)	52.7 (27.0)	52.8 (27.2)	52.7 (26.9)
GOLD Stage, *n* (%)					
1	660 (19.8%)	167 (15.4%)	493 (21.9%)	132 (11.6%)	528 (24.0%)
2	1,439 (43.1%)	483 (44.6%)	956 (42.4%)	485 (42.7%)	954 (43.3%)
3	828 (24.8%)	296 (27.3%)	532 (23.6%)	362 (31.9%)	466 (21.2%)
4	412 (12.3%)	138 (12.7%)	274 (12.2%)	157 (13.8%)	255 (11.6%)
FEV_1	1.7 (0.8)	1.6 (0.7)	1.8 (0.8)	1.6 (0.7)	1.8 (0.8)
FEV_1 %predicted	59.1 (23.1)	57.0 (22.0)	60.1 (23.5)	55.3 (22.2)	62.2 (23.3)
FVC	3.2 (1.0)	3.2 (0.9)	3.2 (1.1)	3.1 (1.0)	3.3 (1.1)
FVC %predicted	109.8 (26.4)	111.2 (25.6)	109.1 (26.8)	108.5 (26.3)	110.9 (26.5)
FEV_1/FVC	0.53 (0.13)	0.50 (0.13)	0.54 (0.13)	0.50 (0.13)	0.55 (0.13)
Total exacerbations (per 100 person-years)	45.9	50.1	43.9	50.4	42.3
Severe exacerbations (per 100 person-years)	16.4	18.2	15.5	18.7	14.5
Deaths, *n* (%)	1,142 (34.2%)	373 (34.4%)	769 (34.1%)	426 (37.5%)	716 (32.5%)

Bhatt et al. AJRCCM 2024

Table of contents

PERSPECTIVE

Translating Pulmonary Function Test Results into Practical Clinical Interpretations

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Table 1. Spirometry phraseology

Code	FEV_1*	FVC*	FEV_1/FVC Ratio*	FVL†	Suggested phraseology	Optional Add-on	Add-on when No Lung Volumes Available	Caveats
S1	WNL	WNL	WNL	–	Normal spirometry	No obstructive impairment demonstrated	FVC is WNL, arguing against restrictive impairment	–
S10	WNL	WNL	WNL	Concavity	Spirometric indices are WNL but concavity of FVL could suggest mild obstructive impairment at low lung volumes or loss of elastic recoil	–	FVC is WNL, arguing against restrictive impairment	Loss of elastic recoil may result from emphysema or aging
S11	WNL/ borderline	WNL/ borderline	WNL/ borderline	–	Spirometric values are borderline low and significance is uncertain	This may represent a very mild ventilatory impairment‡ or be a normal variant	–	One or more spirometric values is borderline low
S21	Mild/WNL	WNL	Low	–	Spirometric pattern demonstrates mild obstructive impairment	–	FVC is WNL, arguing against restrictive impairment	–
S22	Moderate	WNL	Low	–	Spirometric pattern demonstrates moderate obstructive impairment	–	FVC is WNL, arguing against restrictive impairment	–
S23	Severe	WNL	Low	–	Spirometric pattern demonstrates severe obstructive impairment	–	FVC is WNL, arguing against restrictive impairment	–
S31	Low	Low	WNL	–	Spirometric pattern demonstrates nonspecific ventilatory impairment	–	May reflect mild obstructive impairment with air trapping or mild restrictive impairment	–
S32	Low	Low	Low	–	Spirometric pattern demonstrates obstructive impairment with air trapping or coexisting restrictive impairment	–	–	–

Code	FEV_1*	FVC*	FEV_1/FVC Ratio*	FVL†	Suggested phraseology	Optional Add-on	Add-on when No Lung Volumes Available	Caveats
S33	Low	Low	Low	–	Submaximal effort (or muscle weakness) likely explanation for reduced spirometric values	–	–	Use in patients with muscle weakness or poor effort with reduced PEF
S34	WNL/ high	High	Low	–	Spirometric pattern suggests a possible obstructive impairment, although a normal variant or dysanaptic lung growth should be considered	–	–	–
S41	Mild	WNL	WNL	–	Spirometric pattern shows an isolated mild reduction in FEV_1	–	This may represent an early ventilatory impairment‡	–
S42	WNL	Mild	WNL	–	Spirometric pattern shows isolated mild reduction in FVC	–	May represent early ventilatory impairment‡	–
S51	Any	Any	Any	Expiratory limb flat	Reproducible flattening on expiratory limb of FVL is suggestive of intrathoracic upper/central airway obstruction	–	–	–
S52	Any	Any	Any	Inspiratory limb flat	Reproducible flattening of inspiratory limb of FVL is suggestive of extrathoracic upper/central airway obstruction	–	–	–
S53	Any	Any	Any	Both limbs flat	Reproducible flattening of inspiratory and expiratory limbs of FVL suggestive of fixed upper/central airway obstruction	–	–	–
S61	No change	No change	–	–	No spirometric improvement after BD administration	BD therapy may still be useful	–	No spirometric parameter improves per ERS/ATS criteria. Use add-on If BD improvement is borderline in subjects with known airway disease

Code	TLC†	RV/TLC†	FEV_1/FVC Ratio†	Suggested Phraseology	Optional Add-ons	Caveats
V1	WNL	WNL	–	Normal static lung volumes	No restrictive impairment demonstrated	–
V10	Borderline	WNL	–	Static lung volumes borderline low, significance uncertain	May represent very mild ventilatory impairment* or be a normal variant	–
V11	Mild	WNL	–	Static lung volumes demonstrate mild restrictive impairment	Obesity may contribute to restrictive pattern	Use add-on when high BMI present
V12	Mild	High (often with reduced FVC or SVC)	WNL	Static lung volumes demonstrate mild complex restrictive impairment	Obesity may contribute to restrictive pattern	Use add-on when high BMI present
V13	Mild	High (often with reduced FVC or SVC)	Low	Static lung volumes demonstrate mild mixed obstructive and restrictive disorder	Obesity may contribute to restrictive pattern	Use add-on when high BMI present
V14	Moderate	WNL	–	Static lung volumes demonstrate moderate restrictive impairment	Obesity may contribute to restrictive pattern	Use add-on when high BMI present
V15	Moderate	High (often with reduced FVC or SVC)	WNL	Static lung volumes demonstrate moderate complex restrictive impairment	Obesity may contribute to restrictive pattern	Use add-on when high BMI present
V16	Moderate	High (often with reduced FVC or SVC)	Low	Static lung volumes demonstrate moderate mixed obstructive and restrictive disorder	Obesity may contribute to restrictive pattern	Use add-on when high BMI present
V17	Severe	WNL	–	Static lung volumes demonstrate severe restrictive impairment	Obesity may contribute to restrictive pattern	Use add-on when high BMI present
V18	Severe	High (often with reduced FVC or SVC)	WNL	Static lung volumes demonstrate severe complex restrictive impairment	Obesity may contribute to restrictive pattern	Use add-on when high BMI present
V19	Severe	High (often with reduced FVC or SVC)	Low	Static lung volumes demonstrate severe mixed obstructive and restrictive disorder	Obesity may contribute to restrictive pattern	Use add-on when high BMI present
V20	WNL	High	–	Static lung volumes demonstrate air trapping	–	–

Summary

- Introduction: 폐기능 건강 검진 도입
- Basic interpretation: FEV1/FVC, FEV1, FVC
- Provocation test: Direct, Indirect
- 2021 updates: Reference equation, FEV1Q, Z-score, BDR
- Reference equations: race-neutral
- BDR: pro and cons
- Phaseology