

## Comparison of the "Fixed thresholds" and the "Z-Score" for Spirometric diagnosis of Asthma

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### Abstract

**Introduction and objective:** The use of z-score to interpret lung function has been recommended by GLI 2012 [1] and ATS/ERS 2022 [2], with evidence of false positives in the diagnosis of asthma when using fixed thresholds of FEV1/FVC. The aim of our study is to analyze the pulmonary function tests (PFTs) of patients admitted to our explorations for suspected asthma according to the z-score and the fixed thresholds, with a comparison of the two methods.

**Methods:** Our study is retrospective, carried out over a one-year period, from February 2022 to February 2023.

**Results:** We collected 292 cases. The average age of patients was 30 years, with a clear predominance of women (65%).

A similarity of results according to the fixed thresholds and z-score was found in 235 cases (182 had a normal PFT and 53 had an OVD). An OVD was found in 39 cases according to the fixed thresholds, whereas PFT was normal according to the z-score. A reduction of FVC according to the z-score, while the PFT was normal to the fixed thresholds, was noted in 18 cases. It was related to a hyperinflation

In our study, using the z-score, we found 39 cases of false-positive spirometric diagnosis of asthma and under-diagnosis of reduction of FVC in 18 cases.

**Conclusion:** The prevalence of asthma based on spirometry is higher when using the fixed thresholds than when using the z-score, hence the need for standardization of interpretation methods, notably by GINA 2024.

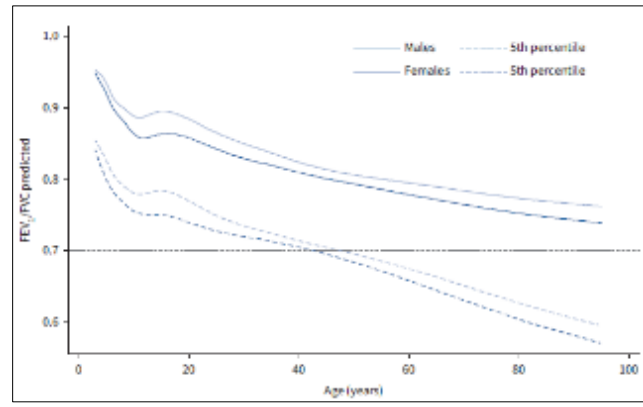
**Keywords:** Pulmonary Function Tests; Z-Score; Asthma; Spirometry; Airway Obstruction

### 1. Introduction

The use of z-score to interpret lung function has been recommended by GLI 2012 [1] and ATS/ERS 2022 [2], with evidence of false positives in the diagnosis of asthma when using fixed thresholds of FEV1/FVC (figure1).

The aim of our study is to analyze the pulmonary function tests (PFTs) of patients admitted to our explorations for suspected asthma according to the z-score and the fixed thresholds, with a comparison of the two methods.

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**Figure 1** FEV1/FVC predicted and lower limits of normal (5th percentile) compared with the fixed cut-off of 0.7 [2]

## 2. Methods

Our study is retrospective, carried out over a one-year period, from February 2022 to February 2023

An analysis of PFTs of patients admitted to our explorations for suspected asthma was carried out according to the z-score and fixed thresholds, with a comparison of the two methods.

An airflow obstruction was defined as a FEV1/FVC ratio less than 75% or a z-score less than -1.64, and a volume reduction was defined by a percent predicted less than 80% or a z-score less than -1.64.

## 3. Results

We collected 292 cases. The average age of patients was 30 years, with a clear predominance of women (65%).

A similarity of results according to the fixed thresholds and z-score was found in 235 cases (182 had a normal PFT (figure2) and 53 had an OVD (figure3)).

Paramètre	Unité	LLN	Ref	ULN	Pre	%Ref	ZScor...	Post	%Ref	ZScor...
VEMS	l	1,92	2,55	3,17	2,16	85	-1,01	2,37	93	-0,46
CVFex	l	2,27	2,98	3,68	2,73	92	-0,57	2,83	95	-0,35
VEMS/CVF	%	69	80	91	79		-0,16	84		0,56
DEP	l/s	4,80	6,28	7,76	4,71	75	-1,73	5,04	80	-1,38
DEM25	l/s	0,48	1,62	2,75	0,84	52	-1,12	1,22	76	-0,57
DEM50	l/s	2,10	3,91	5,71	2,88	61	-1,38	3,00	77	-0,82
DEM75	l/s	3,36	5,58	7,80	3,72	67	-1,37	4,82	86	-0,56
DEM 25-75	l/s	1,92	3,32	4,72	2,01	61	-1,53	2,64	79	-0,80

**Figure 2** Example of normal spirometry according to the fixed thresholds and z-score

Paramètre	Unité	LLN	Ref	ULN	Pre	%Ref	ZScor...	Post	%Ref	ZScor...
VEMS	l	2,29	2,91	3,54	2,03	70	-2,31	2,48	85	-1,13
CVFex	l	2,64	3,34	4,05	3,22	96	0,29	3,30	99	0,11
VEMS/CVF	%	73	84	95	61		-3,22	75		-1,32
DEP	l/s	5,21	6,69	8,17	4,06	61	-2,92	4,79	72	-2,10
DEM25	l/s	0,96	2,10	3,23	0,50	24	-2,30	0,90	43	-1,73
DEM50	l/s	2,52	4,33	6,14	1,45	34	-2,61	2,44	56	-1,72
DEM75	l/s	3,75	5,97	8,19	2,82	47	-2,33	4,45	75	-1,12
DEM 25-75	l/s	2,59	3,99	5,38	1,18	30	-3,29	2,04	51	-2,28

**Figure 3** Example of spirometry with OVD according to the fixed thresholds and z-score

An OVD was found in 39 cases according to the fixed thresholds, whereas PFT was normal according to the z-score (figure 4).

Paramètre	Unité	LLN	Ref	ULN	Pré	%Ref	ZScor...	ZScore
VEMS	l	1,04	1,66	2,29	1,53	92	-0,33	
CVFex	l	1,34	2,04	2,75	2,11	103	0,16	
VEMS/ CVF	%	64	75	85	73		-0,31	
DEP	l/s	3,71	5,19	6,67	3,67	71	-1,69	
DEM25	l/s	0,29	0,85	1,98	0,37	44		
DEM50	l/s	1,27	3,08	4,89	1,39	45	-1,53	
DEM75	l/s	2,50	4,72	6,94	3,34	71	-1,02	
DEM 25-75	l/s	0,89	2,29	3,68	1,09	48	-1,41	

**Figure 4** Example of spirometry with OVD according to the fixed thresholds whereas PFT was normal according to the z-score

A reduction of FVC according to the z-score, while the PFT was normal to the fixed thresholds, was noted in 18 cases. It was related to a hyperinflation (figure5).

Paramètre	Unité	LLN	Ref	ULN	Pré	%Ref	ZScor...	ZScore
VEMS	l	3,92	4,76	5,59	2,14	45	-5,12	
CVFex	l	4,69	5,70	6,70	4,53	80	-1,91	
VEMS/ CVF	%	71	83	94	47		-4,91	
DEP	l/s	8,46	10,45	12,44	3,65	35	-5,60	
DEM25	l/s	1,56	2,84	4,12	0,39	14	-3,14	
DEM50	l/s	3,72	5,89	8,06	1,04	18	-3,67	
DEM75	l/s	6,12	8,93	11,74	2,29	26	-3,87	
DEM 25-75	l/s	3,48	5,19	6,90	0,89	17	-4,12	
tex	s				13,2			
Paramètre	Unité	LLN	Ref	ULN	Pré	%Ref	ZScor...	ZScore
CV	l	5,05	5,97	6,89	4,53	76	-2,56	
CI			4,28		1,90	44		
VC					0,75			
VRE			1,72		2,57	149		
VGT		1,87	3,50	5,12	6,98	200	3,51	
CPT		6,53	7,78	8,93	8,85	114	1,53	
VR		1,10	1,78	2,45	4,49	252	5,59	
VR/ CPT	%	15	24	33	51	210	4,86	

**Figure 5** Example of PFT with reduction of FVC related to hyperinflation according to the z-score, while the PFT was normal to the fixed thresholds

#### 4. Discussion

The simplicity of the fixed thresholds and percent predicted has resulted in their use across the age spectrum, leading to systematic misinterpretation of results [5, 6].

They don't take into account the observed age-related changes in measurement variability [2]

For example, the LLN for FEV1 varies from 81% predicted at the age of 10 years to 68% predicted at the age of 85 years [2] (table 1).

**Table 1** The 5th percentile values (lower limit of normal (LLN)) for various lung function indices expressed as percent predicted for six individuals [2]

	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 <sub>1</sub>	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 <sub>1</sub> /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 <sub>LCO</sub>	75.4	77.5	79.0	77.8	72.4	74.5

In our study, using the z-score, we found 39 cases of false-positive spirometric diagnosis of asthma and under-diagnosis of reduction of FVC in 18 cases (table 2).

**Table 2** Discordance in Diagnosis of Obstruction Using Different Methods

	Number of cases	Percentage
Total	292	100%
Concordance between z-score and fixed thresholds:	235	81%
Normal spirometry	182	62%
OVD	53	19%
Disconcordance between z-score and fixed thresholds:	57	19%
Normal spirometry (z-score) Vs OVD (fixed thresholds)	39	13%
Hyperinflation (z-score) Vs normal spirometry (fixed thresholds)	18	6%

### Abbreviations

- ATS American Thoracic Society;
- ERS European Respiratory Society;
- PFT pulmonary function test;
- GLI Global Lung Function Initiative;
- FVC Forced vital capacity;
- FEV1 Forced expiratory volume in one second;
- OVD obstructive ventilatory defect.

## 5. Conclusion

The prevalence of asthma based on spirometry is higher when using the fixed thresholds than when using the z-score, hence the need for standardization of interpretation methods, notably by GINA 2024.

## Compliance with ethical standards

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### Disclosure of conflict of interest

No conflict of interest to disclosed.

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