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Applicability of American and European Spirometry Repeatability Criteria to Korean Adults

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Background: The objective of this study was to evaluate the clinical applicability of the repeatability criteria recommended by the American Thoracic Society/European Respiratory Society (ATS/ERS) spirometry guidelines and to determine which factors affect the repeatability of spirometry in Korean adults.

Methods: We reviewed the spirometry data of 4,663 Korean adults from the Korean National Health and Nutritional Examination Survey (KNHANES) Chronic Obstructive Pulmonary Disease Cohort (COPD cohort) and the Community-based Cohort Study VI-Fishing village/Islands (community cohort). We measured the anthropometric factors and differences between the highest and second-highest FVC (dFVC) and FEV₁ (dFEV₁) from prebronchodilator spirometry. Analyses included the distribution of dFVC and dFEV₁, comparison of the values meeting the 1994 ATS repeatability criteria with the values meeting the 2005 ATS/ERS repeatability criteria, and the performance of linear regression for evaluating the influence of subject characteristics and the change of criteria on the spirometric variability.

Results: About 95% of subjects were able to reproduce FVC and FEV₁ within 150 ml. The KNHANES based on the 1994 ATS guidelines showed poorer repeatability than the COPD cohort and community cohort based on the 2005 ATS/ERS guidelines. Demographic and anthropometric factors had little effect on repeatability, explaining only 0.5 to 3%.

Conclusion: We conclude that the new spirometry repeatability criteria recommended by the 2005 ATS/ERS guidelines is also applicable to Korean adults. The repeatability of spirometry depends little on individual characteristics when an experienced technician performs testing. Therefore, we suggest that sustained efforts for public awareness of new repeatability criteria, quality control of spirograms, and education of personnel are needed for reliable spirometric results. (*Tuberc Respir Dis* 2007;63:405-411)

Key Words: Spirometry, Repeatability, Quality control

서 론

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, FEV₁ FVC (repeatability)

2005 / (American Thoracic Society/European Respiratory Society, ATS/ERS) 1,
 1994 ATS 2
 .
 ATS/ERS

대상 및 방법

1. 연구대상

가 2001
 (Korean National Health and Nutritional Survey, KNHANES)
 (COPD)
 VI- / ()

2. 연구방법

. 2001
 1994 ATS
 , COPD
 2005 ATS/ERS . 2001

Dry rolling seal spirometer (Model 2130, Sensor-Medics, Yorba Linda, CA, USA)
 COPD

가
 가
 3 가
 FVC (dFVC)
 가 FEV₁ FVC (FEV₁)
 (dFEV₁)
 dFVC (dFVC/가 FVC×100, dFVC,%)
 dFEV₁ (dFEV₁/가 FEV₁×100, dFEV₁,%)
 dFVC dFEV₁

, 2001 1994 ATS
 dFVC dFEV₁ 200 ml
 ,
 COPD 2005 ATS/ERS
 dFVC dFEV₁ 150 ml

3. 통계

2001 , COPD
 .
 1994 ATS
 2001 dFVC, dFVC,%,
 dFEV₁, dFEV₁,% 90 95
 , 2005 ATS/ERS
 COPD
 dFVC, dFVC,%, dFEV₁, dFEV₁,% 90
 95 1994 ATS
 2005 ATS/ERS

(multiple regression analysis)

결 과

4,663 46.8
 2,195 (47.1%), 2,468
 (52.9%) 63.9% 2,980
 COPD 11.1% 517
 . 54 COPD
 63 가 (Table 1, 2).
 dFVC dFEV₁ 95
 COPD) dFVC
 (dFEV₁ 95 142 ml 133 ml
 . dFVC,% dFEV₁,% 95
 4.4% 4.9% , COPD
 dFVC,% dFEV₁,% 95 4.5%
 dFVC dFEV₁ . 5.4% (Table 3, 4).

dFVC
dFVC,%
dFEV₁
dFEV₁,%

R² 3%
(0.5~3.0%).

Table 3. Spirometry repeatability (2001 KNHANES)

	Mean	SD	Percentile		
			Median	90th	95th
dFEV ₁ (ml)	53.8	61.7	38.0	113.0	152.0
dFEV ₁ (%)	1.8	2.0	1.2	3.8	4.9
dFVC (ml)	59.3	63.1	42.0	128.0	167.0
dFVC (%)	1.6	1.8	1.1	3.4	4.4

dFVC: the difference between the highest and second-highest FVC; dFEV₁: the difference between the highest and second-highest FEV₁; dFVC (%): dFVC / the highest FVC; dFEV₁ (%): dFEV₁ / the highest dFEV₁.

Table 4. Spirometry repeatability (Community and COPD Cohort)

	Mean	SD	Percentile		
			Median	90th	95th
dFEV ₁ (ml)	49.4	52.7	37	105	133
dFEV ₁ (%)	2.0	2.4	1.4	4.2	5.4
dFVC (ml)	57.4	60.3	43.0	118	142
dFVC (%)	1.7	2.2	1.3	3.6	4.5

dFVC: the difference between the highest and second-highest FVC; dFEV₁: the difference between the highest and second-highest FEV₁; dFVC (%): dFVC / the highest FVC; dFEV₁ (%): dFEV₁ / the highest dFEV₁.

Table 5. Numbers of subjects meeting different repeatability criteria

Repeatability criteria	KNHANES* 3,021 (100%)	Community cohort [†] 1,543 (100%)	COPD cohort [‡] 99 (100%)
dFVC			
< 200 ml	2,933 (97.1%)	1,512 (98.0%)	97 (98.0%)
≥ 200 ml	88 (2.9%)	31 (2.0%)	2 (2.0%)
dFVC			
< 150 ml	2,818 (93.8%)	1,476 (95.7%)	96 (97.0%)
≥ 150 ml	203 (6.7%)	67 (4.3%)	3 (3.0%)

dFVC: the difference between the highest and second-highest FVC.

*Korean National Health and Nutritional Examination Survey,

[†]A Community-based Cohort Study VI-Fishing village/Islands,

[‡]Chronic Obstructive Pulmonary Disease Cohort.

Table 6. Numbers of subjects meeting different repeatability criteria

Repeatability criteria	KNHANES* 3,021 (100%)	Kangwha 1,543 (100%)	COPD cohort [†] 99 (100%)
dFEV ₁			
< 200 ml	2,948 (97.6%)	1,513 (98.1%)	499 (100.0%)
≥ 200 ml	73 (2.4%)	30 (1.9%)	0 (0.0%)
dFEV ₁			
< 150 ml	2,861 (94.7%)	1,490 (96.6%)	99 (100.0%)
≥ 150 ml	160 (5.3%)	53 (3.4%)	0 (0.0%)

dFEV₁: the difference between the highest and second-highest FEV₁.

*Korean National Health and Nutritional Examination Survey,

[†]Chronic Obstructive Pulmonary Disease Cohort.

Table 7. Linear regression models predicting higher spirometry variability

	Male	Height* (cm)	Age [†] (years)	Weight [‡] (kg)	Smoker	Edu.1 [§]	Edu.2	FEV ₁ /FVC < 0.7	1994 ATS criteria	R ² (%) [¶]
dFVC (ml)	NS	NS	0.18	0.28	NS	NS	NS	17.62	5.16	1.6%
dFVC (%)	NS	-0.02	0.01	0.008	NS	NS	NS	0.55	0.13	2.9%
dFEV ₁ (ml)	NS	NS	-0.27	NS	NS	NS	NS	NS	NS	0.54%
dFEV ₁ (%)	NS	-0.02	NS	NS	NS	NS	NS	0.51	NS	1.6%

dFVC: the difference between the highest and second-highest FVC; dFEV₁: the difference between the highest and second-highest FEV₁; dFVC (%): dFVC / the highest FVC; dFEV₁ (%): dFEV₁ / the highest dFEV₁; NS: not a statistically significant factor.

*1 cm increase in height, [†]1 year increase in age, [‡]1 kg increase in weight, [§]10 years ≤ educational period ≤ 12 years, ^{||}educational period ≥ 13 years, [¶]the total variance explained by the model.

(Table 7).

고찰	ATS	가	dFVC	dFEV ₁	가
1994 ATS ² dFVC가 200 ml ml	dFEV ₁ , 200	Enright ³	20	90	18,000
2005 ATS/ERS dFVC가 150 ml	dFEV ₁ 1.	1994	dFVC	dFEV ₁	가
ATS ²	가	dFEV ₁	가	2005 ATS/ERS	150 ml
2005 ATS/ERS	가	dFVC	dFEV ₁	가	가
4,663 ERS	2005 ATS/ dFVC 95	5-7	가	ATS/ERS	가
COPD 가 142 ml 가 152 ml, 133 ml . 2005	ATS/ERS	가 167 ml, dFEV ₁ 95 COPD 가	COPD	가	가
dFVC dFEV ₁ 1994	ATS	COPD	dFVC	dFEV ₁	COPD
1994 ATS dFVC 95 150 ml	Enright ³ 180 ml, dFEV ₁ 95	Humerfelt ⁸	30	46	45,000 9.5%
dFVC dFEV ₁ 95	COPD	864 6.8%(59)가	가	Enright ³	Neale ⁹
가 COPD	FVC FEV ₁ Hankinson ⁴ 6,500	가	가	Enright ³	가

Enright¹⁰ 65 85 5,201 ATS/ERS (Table 3, 4, 7), 1994 ATS 2005

가 , 6% , 3% , FEV₁ , FVC

65 497 가 Bellia⁶ 65 FVC³ . Enright

638 , 2005 ATS/ERS

, 6 가 , FEV₁ 가 , 요 약

, FVC 가 연구배경: 2005 ATS/ERS

가 . Enright³ , 방 법: , COPD ,

dFVC dFEV₁ 4,663 , 1994

ATS 2005 ATS/ERS

가 , 가

3.0% , R² 0.5~ , dFVC dFEV₁ 결 과: 95% 150

, 가 ml . 1994 ATS

dFVC dFEV₁ , 가 가

3,4,8 , , , , ,

가 dFVC가 가 , , , , ,

. FEV₁ FVC 6 (0.5~3.0%).

가 , 가 결 론: 2005 ATS/ERS

가 ,

Enright³ FEV₁ , 가

FEV₁ COPD FEV₁ ,

감사의 글

(A040153).

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