



Scientific Letter

Accuracy of PIKO-6® and COPD-6® Devices in COPD Screening

To the Director,

COPD is a prevalent disease for which early diagnosis is essential.¹ The spirometrically determined ratio of the forced expiratory (FS) volume in 1 second (FEV₁) over the forced vital capacity (FVC) is the gold standard (GS) test to confirm the presence of airflow limitation. However, FS is frequently underutilized or unavailable in primary care (PC).^{2–4} Because of easier performance and less variability, several studies have demonstrated that volume at six seconds (FEV₆) could be an acceptable alternative to FVC,^{5,6} and so, the ratio of the FEV₁ over the volume measured at 6 s (FEV₁/FEV₆) could be a valid alternative to the ratio FEV₁/FVC obtained by FS.⁷ Zhou et al.,⁸ in a recent meta-analysis, concluded that micro-spirometers are “user-friendly, patient-friendly, inexpensive, and portable, making them suitable for PC use and providing a feasible pathway for early diagnosis of COPD”; moreover, their use could reduce underdiagnosis of COPD. The European Respiratory Society (ERS) has proposed investigating the role of these devices for early diagnosis.⁹ The aim of our study was to validate COPD-6® and Piko-6®, the most widely studied micro-spirometers, for COPD screening and to determine the most accurate device for this task.

An observational prospective cross sectional study, calculated to require 569 patients (Epidat 4.2 program) to establish the potential differences between the selected micro-spirometers, recruited a total of 689 patients from the pulmonary outpatient departments at the University Hospitals of Salamanca and Zaragoza in Spain. The inclusion criteria were patients of both sexes, older than 35 years, smokers or ex-smokers with a history of more than 10 pack-years, regardless of whether they had respiratory symptoms. Patients who couldn't perform valid and repeatable spirometry or had absolute contraindications for the tests were excluded. The study was approved by the Ethics and Clinical Research Committee of the University Hospital of Salamanca.

All spirometry tests were performed by qualified operators according to the ERS/ATS spirometry standards, and were always carried out in the same order (FS, test with COPD-6®, test with Piko-6®). Variables recruited were: anthropometric data, symptoms, FEV₁, FVC and FEV₁/FVC obtained by FS, used as GS, and FEV₁, FEV₆ and FEV₁/FEV₆ obtained by COPD-6® and Piko-6® devices. Personnel conducting the tests ensured that patients rested between tests. Different statistical tests were used on the basis of the variable in question. A significance level of 0.05 was set in all analyses. The statistical tests used to compare the devices were Pearson correlations, Youden Index (YI), Kappa coefficient and ROC curves, and the analysis was performed with software by IBM SPSS 23 version.

Table 1Percentage and Absolute Measurements of FEV₁, FVC and FEV₆ Obtained by Forced Spirometry (FS), and by the Devices Piko-6® and COPD-6® (Sample Size 664).

Sample Size 664	Data Expressed as Average and Standard Deviation		
	FS	Piko-6®	COPD-6®
FEV ₁ (%)	81.15 (48.52)	71.06 (26.83)	79.9 (30.04)
FEV ₆ or FVC (%)	100.08 (51.60)	81.15 (48.52)	82.5 (24.21)
FEV ₁ (ml)	2303.30 (987.97)	2000.87 (886.98)	2158.71 (969.35)
FEV ₆ or FVC (ml)	3577.03 (1042.26)	2936.43 (998.72)	2800.87 (1025.12)

ml = milliliters.

A total of 664 subjects from the total of 689 recruited (491 males, 173 females) met the criteria for inclusion. Average age 61.5 ± 11 years; 338 ex-smokers (51%) and 326 current smokers (49%); average pack-years 41.2 ± 22. Obstruction was defined as FEV₁/FVC < 70%. FS detected 411 COPD patients (62%), Piko-6® 340 (51%) and COPD-6® 209 (31.5%). Table 1 includes measurements for each variable. Compared to FS, percentages and absolute measurements for FEV₁ and FEV₆ obtained by hand-held expiratory flow meters were lower. Table 2 shows sensitivity, specificity, PPV, NPV and YI of both devices.

The Pearson correlation index of FEV₁ between FS and Piko-6® and between FS and COPD-6® was 0.94 and 0.97 respectively. Correlations of FEV₁/FEV₆ Piko-6® and COPD-6® were 0.79 and 0.73. Using FEV₁/FVC < 70% as a reference, the area under the ROC curve was 0.922 to Piko-6® and 0.913 to COPD-6®. YI of Piko-6® (greater relation between sensitivity and specificity) was higher at cutoff of <73% (YI = 0.74). When using COPD-6®, the sensitivity value was lower, so the cutoff point was 80%. The concordance observed between Piko-6® and FS was 83.9%, with a kappa value 0.67 ± 0.028. Moreover, COPD-6® concordance was 68.7% and the kappa value 0.42 ± 0.02.

COPD screening tools are needed to improve disease management. Our study was designed to evaluate the accuracy of Piko-6® and COPD-6® in the diagnosis of airway obstruction and to determine which is more reliable. Jing et al. meta-analyses¹⁰ concluded that FEV₁/FEV₆ has a sensitivity of 89% (IC95%: 83–93%) and specificity of 98% (IC95%: 95–99%) in relation to FEV₁/FVC. Several authors^{11–13} got good results with Piko-6®. In our study, FEV₁ and FEV₆ acquired by COPD-6® and Piko-6®, both in milliliters (ml) and percentage, were smaller than FEV₁ and FVC obtained by FS ($p = 0.001$).

There are two studies with similar objectives and design than ours: Represas et al.¹⁴ with COPD-6® and Hidalgo et al.¹⁵ with Piko-6®. Our COPD-6® results did not substantially differ from those of Represas. In both, FEV₁/FEV₆ was larger than FEV₁/FVC ($p < 0.001$), which was expected because of FEV₆ being lower than FVC. On this basis, the cutoff point for diagnosing obstruction should not be 0.7, since COPD-6® did not detect obstruction in almost half of

<https://doi.org/10.1016/j.arbres.2024.10.002>

0300-2896/© 2024 SEPAR. Published by Elsevier España, S.L.U. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

Table 2

Patients Classified as COPD According to GOLD Criteria With the Three Devices: Forced Spirometry (FS), Piko-6[®] and COPD-6[®]. Sensitivity, Specificity, PPV, NPV and Youden Index (YI) With Piko-6[®] and COPD-6[®], Reference Test Forced Spirometry (FS).

Patients Classified as COPD According to Gold Criteria With the Three Devices: Forced Spirometry (fs), Piko-6 [®] and COPD-6 [®]			
Diagnostic Test FS (Reference Test)	Airway Obstruction (COPD)	No Airway Obstruction (Healthy)	Total
	411	253	664
Diagnostic Test Piko-6 [®]	Airway Obstruction (COPD)	No Airway Obstruction (Healthy)	Total
Positive	322	18	340
Negative	89	235	324
Total	411	253	664
	Value	CI (95%)	
Sensitivity (%)	78.35	74.24–82.45	
Specificity (%)	92.89	89.52–96.25	
Validity index (%)	83.89	81.01–86.76	
PPV (%)	94.71	92.18–97.23	
PNV (%)	72.53	67.52–77.55	
Prevalence (%)	61.9	58.13–65.67	
YI	0.71	0.66–0.76	
Diagnostic Test COPD-6 [®]	Airway Obstruction (COPD)	No Airway Obstruction (Healthy)	Total
Positive	206	3	209
Negative	205	250	455
Total	411	253	664
	Value	CI (95%)	
Sensitivity (%)	50.12	45.17–55.08	
Specificity (%)	98.81	97.28–100	
Validity index (%)	68.67	65.07–72.28	
Predicted value + (%)	98.56	96.71–100	
Predicted value – (%)	54.95	50.26–59.63	
Prevalence (%)	61.9	58.13–65.67	
YI	0.49	0.44–0.54	

Abbreviations: YI, Youden Index; PPV, positive predictive value; NPV, negative predictive value; FS, forced spirometry; Validity index, diagnostic accuracy: (true positives + true negatives)/total × 100.

patients. In our study, we observed smaller differences of FEV₁ with respect to FS than Represas, with an average difference of 144 ml (IC 95%: 126–162) vs 167 ml (IC 95%: 144–190). In contrast, we found a greater difference in FEV₆. Similar to Represas, we found a good correlation between COPD-6[®] and FS, especially for FEV₁ measurement.

In Hidalgo's studio and ours FEV₁ and FEV₆ values with Piko-6[®] were also smaller than FEV₁ and FVC obtained by FS ($p < 0.001$), but there were not significant differences between FEV₁/FEV₆ and FEV₁/FVC. Hidalgo observed a good correlation with FEV₁, FEV₆ and FEV₁/FEV₆. Nevertheless, we noticed the best correlation with FEV₁ ($r = 0.94$ versus $r = 0.87$) and slightly worse with the ratio ($r = 0.79$ versus 0.94). Correlation could be considered excellent by linear regression lines.

We set out to determine the best FEV₁/FEV₆ cutoff point in terms of sensitivity and specificity to detect obstruction. However, FEV₁/FEV₆ acquired by micro-spirometers was greater than FEV₁/FVC, and so, a higher cutoff should be considered. To this aim, we used YI. The Piko-6[®] cutoff point of FEV₁/FEV₆ was 0.73 while with COPD-6[®] was 0.8 (considerably lower sensitivity). The cutoff point in the Represas,¹⁵ Fritz,¹¹ Hidalgo,¹⁴ and Van de Bemt¹¹ studies varied between 0.70 and 0.78. Represas concluded that when using COPD-6[®], a cutoff point of 0.7 was not valid for COPD screening, and that a cutoff point of 0.75–0.80 was needed, in accordance with our results.

ROC curves were performed using FEV₁/FVC < 70% as a reference. For FEV₁/FEV₆ we noticed AUC 0.91 and 0.92 with COPD-6[®] and Piko-6[®], respectively showing an excellent correlation with FS. Both devices showed an odds ratio higher than 20, the minimum needed to validate a test.

Chen et al.¹⁶ stated that micro-spirometry was accurate and had clinical utility. In our research, Piko-6[®] showed a better concordance than COPD-6[®] classifying individuals as having COPD or healthy (COPD diagnosis excluded), although a possible limitation

of our study is the fact that the tests were always performed in the same order and were not randomized. This study provides real-world evidence to identify best practices when screening for COPD using hand-held devices.

In conclusion, although FEV₁ and FEV₆ measurements undertaken with hand-held expiratory flow meters were lower than FEV₁ and FVC performed with FS, Piko-6[®] and COPD-6[®] are useful for COPD screening because correlation with FS is good. A FEV₁/FEV₆ cutoff point of 0.7 obtained by hand-held expiratory flow meters as COPD screening had false negative results, so, with portable devices, this cut-off point for detecting obstruction must be increased. The usefulness of hand-held expiratory flow meters for COPD screening could help reduce underdiagnoses of COPD and minimize workloads in lung function laboratories. We found Piko-6[®] to be the device of choice given that it achieves the best correlation with FS. Nevertheless, the exact role of micro-spirometers in the diagnosis process isn't yet fully established.

Contributing Authors

Miguel Ángel Hernández Mezquita and Alfonso Pérez Trullen: Study design, case inclusion, analysis of results and supervision of the final manuscript. Idania de Los Santos Ventura, Vanessa Hidalgo Sierra and Enrique Barrueco Otero: case inclusion and initial writing of the manuscript.

Statement of Ethics

This research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki and approved by the ethics committee at Salamanca University Hospital on October 2, 2014. Approval code: PI 2014 10 01.

Funding

This work was supported by a research grant from the Spanish Society of Pneumology (SEPAR) – grant code 091/2014.

Conflict of Interests

The authors have no conflicts of interest to declare.

Data Availability

No restrictions on data availability. Data statement: the data is available at: <https://scholar.archive.org/work/ng6ecpnosrftzpkzvkyjhjrhtu>.

Acknowledgements

Thanks to the team at the pulmonary function laboratory at the University Hospital of Salamanca, Jacinto Ramos, head of the unit, and the nurses José Miguel Hernández, Begoña González and Florinda Pérez for his advice.

References

1. Lin CH, Cheng SL, Chen CZ, Chen CH, Lin SH, Wang HC. Current progress of COPD early detection: key points and novel strategies. *Int J Chron Obstruct Pulmon Dis*. 2023;18:1511–24. <http://dx.doi.org/10.2147/COPD.S413969>.
2. Baldomero AK, Kunisaki KM, Bangerter A, Nelson DB, Wendt CH, Fortis S, et al. Beyond access: factors associated with spirometry underutilization among patients with a diagnosis of COPD in urban tertiary care centers. *Chronic Obstr Pulm Dis*. 2022;9(4):538–48. <http://dx.doi.org/10.15326/jcopdf.2022.0303>.
3. Derom E, van Weel C, Liistro G, Buffels J, Schermer T, Lammers E, et al. Primary care spirometry. *Eur Respir J*. 2008;31:197–203. <http://dx.doi.org/10.1183/09031936.00066607>.
4. Fukahori S, Matsuse H, Takamura N, Hirose H, Tsuchida T, Kawano T, et al. Prevalence of chronic obstructive pulmonary diseases in general clinics in terms of FEV₁/FVC. *Int J Clin Pract*. 2009;63:269–74. <http://dx.doi.org/10.1111/j.1742-1241.2008.01873.x>.
5. Venkatachalam P, Dwivedi DP, Govindraj V. FEV₁/FEV₆ is effective as a surrogate for FEV₁/FVC in the diagnosis of chronic obstructive pulmonary disease. *Indian J Tubercul*. 2021;68(2):230–5. <http://dx.doi.org/10.1016/j.ijtb.2020.09.002>.
6. Wang S, Gong W, Tian Y, Zhou J. FEV₁/FEV₆ in primary care is a reliable and easy method for the diagnosis of COPD. *Respir Care*. 2016;61:349–53. <http://dx.doi.org/10.4187/respcare.04348>.
7. Swanney MP, Jensen RL, Crichton DA, Beckert LE, Cardno LA, Crapo RO. FEV₆ is an acceptable surrogate for FVC in the spirometric diagnosis of airway obstruction and restriction. *Am J Respir Crit Care Med*. 2000;162:917–9. <http://dx.doi.org/10.1164/ajrccm.162.3.9907115>.
8. Zhou J, Li X, Wang X, Yu N, Wang W. Accuracy of portable spirometers in the diagnosis of chronic obstructive pulmonary disease. A meta-analysis. *NPJ Prim Care Respir Med*. 2022;32:2–15. <http://dx.doi.org/10.1038/s41533-022-00275-x>.
9. Celli BR, Decramer M, Wedzicha JA, Wilson KC, Agusti A, Criner GJ, et al. An official Am Thoracic Society/Eu Resp Society statement: research questions in COPD. *Eur Respir J*. 2015;45:879–905. <http://dx.doi.org/10.1183/09031936.00009015>.
10. Jing JY, Huang TC, Cui W, Xu F, Shen HH. Should FEV₁/FEV₆ replace FEV₁/FVC ratio to detect airway obstruction? A metaanalysis. *Chest*. 2009;135:991–8. <http://dx.doi.org/10.1378/chest.08-0723>.
11. Frith P, Crockett A, Beilby J, Marshall D, Attewell R, Ratnanesan A, et al. Simplified COPD screening: validation of the Piko-6® in primary care. *Primary Care Respir J*. 2011;20:190–8. <http://dx.doi.org/10.4104/pcrj.2011.00040>.
12. Van den Bemt L, Wouters BC, Grootens J, Denis J, Poels PJ, Schermer TR. Diagnostic accuracy of pre-bronchodilator FEV₁/FEV₆ from microspirometry to detect airflow obstruction in primary care: a randomised cross-sectional study. *NPJ Prim Care Respir Med*. 2014;24:14033. <http://dx.doi.org/10.1038/nnpjrcm.2014.33>.
13. Kaufmann M, Hartl S, Geyer K, Breyer MK, Burghuber OC. Measuring FEV(6) for detecting early airway obstruction in the primary care setting. Quality and utility of the new Piko-6® device. *Respiration*. 2009;78:161–7. <http://dx.doi.org/10.1159/000197466>.
14. Represas C, Botana Rial M, Leiro Fernandez V, Gonzalez Silva AI, del Campo Perez V, Fernandez-Villar A, et al. Assessment of the portable COPD-6® device for detecting obstructive airway diseases. *Arch Bronconeumol*. 2010;46:426–32. <http://dx.doi.org/10.1016/j.arbres.2010.04.008>.
15. Hidalgo Sierra V, Hernández Mezquita MA, Palomo Cobos L, García Sánchez M, Castellanos RD, Jodra Sanchez S, et al. Usefulness of The Piko-6® portable device for early COPD detection in primary care. *Arch Bronconeumol*. 2018;54:445–54. <http://dx.doi.org/10.1016/j.arbres.2018.04.015>.
16. Chen CZ, Sheu CC, Cheng SL, Wang HC, Lin MC, Hsu WH, et al. Performance and clinical utility of various chronic obstructive pulmonary disease case-finding tools. *Int J Chron Obstruct Pulmon Dis*. 2021;16:3405–15. <http://dx.doi.org/10.2147/COPD.S339340>.

Miguel A. Hernández-Mezquita^{a,b,*},
Idania de los Santos-Ventura^a, Vanesa Hidalgo-Sierra^c,
Alfonso Pérez-Trullen^d, Enrique Barrueco-Otero^e

^a Pneumology Department, University Hospital, Salamanca, Spain

^b Department of Medicine, University of Salamanca, IBSAL, Spain

^c Primary and Community Care, Tejares, Salamanca, Spain

^d Pneumology Service, University Hospital of Zaragoza, Spain

^e Primary and Community Care, Ciudad Rodrigo, Salamanca, Spain

Corresponding author.

E-mail address: mhmezquita@gmail.com

(M.A. Hernández-Mezquita).