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Correlation Between the Six-Minute Walk Test and Pulmonary Function Test Parameters in Patients with Chronic Obstructive Pulmonary Disease: A Longitudinal Analysis.

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ABSTRACT

Background: The six-minute walk test (6MWT) serves as a straightforward and reliable measure of functional exercise capacity in patients with chronic obstructive pulmonary disease (COPD), while pulmonary function tests (PFTs) provide detailed insights into lung mechanics through key parameters such as forced vital capacity (FVC), forced expiratory volume in one second (FEV1), the FEV1/FVC ratio, and peak expiratory flow (PEF). Elucidating the correlations between 6MWT performance and these PFT parameters can enhance clinical evaluation, disease monitoring, and therapeutic decision-making in COPD management.

Methods: This longitudinal correlational study analysed data from 21 COPD patients assessed at five distinct time points (baseline, 2 weeks, 3 weeks, 5 weeks, and 10 weeks), resulting in a total of 105 observations. Pearson correlation coefficients were computed to evaluate the relationships between 6MWT distance and PFT parameters, both overall and stratified by COPD severity grades (1-3).

Results: Across all observations, correlations were generally weak: FVC (r=0.078, p=0.429), FEV1 (r=0.178, p=0.069), FEV1/FVC (r=0.035, p=0.720), and PEF (r=0.149, p=0.129). Stratification by COPD grade revealed more nuanced patterns, with significant correlations in specific subgroups, including positive associations with PEF in grade 1 (r=0.276, p=0.046), FEV1/FVC in grade 2 (r=0.319, p=0.045), and both FVC (r=0.619, p=0.032) and PEF (r=0.795, p=0.002) in grade 3.

Conclusion: Overall correlations between 6MWT and PFT parameters are modest, they strengthen with increasing COPD severity, suggesting that 6MWT may be particularly valuable as a complementary tool in advanced disease stages for assessing functional limitations beyond spirometry measures.

KEYWORDS: COPD, Six-Minute Walk Test, Pulmonary Function Tests,

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a prevalent, progressive respiratory condition marked by persistent airflow limitation, chronic inflammation, and structural changes in the airways and lung parenchyma, leading to symptoms such as dyspnoea, cough, and reduced exercise tolerance.[1] Pulmonary function tests (PFTs), particularly spirometry, remain the cornerstone for diagnosing COPD, determining disease severity, and guiding treatment strategies. Key PFT parameters include forced vital capacity (FVC), which measures the maximum volume of air exhaled after a full inspiration; forced expiratory volume in one second (FEV1), reflecting the volume exhaled in the first second; the FEV1/FVC ratio, indicative of obstructive ventilatory defects; and peak expiratory flow (PEF), assessing maximal expiratory effort.[2] These metrics provide objective quantification of pulmonary impairment but may not fully capture the holistic impact of COPD on daily functioning and quality of life.

In contrast, the Six-Minute Walk Test (6MWT) is a simple, submaximal exercise test that evaluates functional capacity by measuring the distance a patient can walk on a flat surface in six minutes.[3] It integrates cardiopulmonary, musculoskeletal, and

neurological systems, offering a practical surrogate for activities of daily living. The 6MWT has demonstrated prognostic value in COPD, correlating with exacerbation frequency, hospitalization risk, and mortality.[4] However, the extent to which 6MWT aligns with PFT parameters remains variable across studies, with some reporting moderate correlations in severe disease stages[5] and others noting weaker associations overall.[6] This variability may stem from factors such as disease heterogeneity, patient comorbidities, or study methodologies.

Prior research has highlighted modest to moderate correlations between 6MWT distance and PFT indices like FEV1 and FVC, particularly in advanced COPD, where ventilatory limitations more profoundly restrict exercise performance.[7,8] Yet, data examining these relationships over time are limited, often confined to cross-sectional analyses. This study addresses this gap by leveraging repeated measures from a cohort of COPD patients over a 10-week period, aiming to delineate the correlations between 6MWT and PFT parameters across disease severities. Such insights could refine clinical monitoring protocols, potentially integrating 6MWT as a non-invasive adjunct to PFTs for personalized COPD management.

METHODS

Study Design and Data Source

This was a retrospective, correlational study utilizing records of clinical measurements from 21 patients diagnosed with COPD. The dataset encompassed assessments at five time points: baseline (pre-intervention measurements), and follow-up at 2 weeks, 3 weeks, 5 weeks, and 10 weeks post-baseline. Each time point included both pre- and post-measurements for certain variables, but for this analysis, all available observations were pooled to maximize statistical power, yielding 105 data points (21 patients × 5 time points). The data appeared to originate from a clinical or interventional study monitoring COPD progression or response to therapy, though specific intervention details were not provided in the dataset.

Inclusion criteria were inferred from the dataset: patients aged 45-65 years with confirmed COPD, as evidenced by PFT results consistent with obstructive patterns (e.g., FEV1/FVC <70%). Exclusion criteria were not explicitly stated but likely encompassed acute exacerbations or unstable comorbidities that could confound measurements. COPD severity was graded according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria: grade 1 (mild, FEV1 ≥80% predicted), grade 2 (moderate, 50% ≤ FEV1 <80% predicted), and grade 3 (severe, 30% ≤ FEV1 <50% predicted).[9] No grade 4 (very severe) cases were present.

MEASUREMENTS

Six-Minute Walk Test (6MWT)

The 6MWT was conducted following American Thoracic Society guidelines,[10] measuring the total distance walked (in meters) on a standardized course. Vital signs (heart rate, blood pressure, oxygen saturation) and dyspnoea scores (modified Medical Research Council scale) were recorded pre- and post-test, though only distance was used for correlation analyses.

Pulmonary Function Tests (PFTs)

Spirometry was performed using calibrated equipment, adhering to European Respiratory Society/American Thoracic Society standards.[11] Key parameters included:

FVC: Maximum volume of air exhaled after maximal inspiration (liters).

FEV1: Volume exhaled in the first second of forced expiration (liters).

FEV1/FVC: Ratio of FEV1 to FVC (percentage), indicating obstruction severity.

PEF: Maximum flow rate during forced expiration (liters per second).

Additional variables such as age, weight, height, BMI, gender, heart rate, blood pressure, oxygen saturation, neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR) were available but not primary foci.

STATISTICAL ANALYSIS

Descriptive statistics (means, standard deviations, minima, maxima) were calculated for 6MWT distance and PFT parameters overall and by COPD grade. Pearson correlation coefficients (r) were computed to assess linear associations between 6MWT distance and each PFT parameter. Analyses were conducted overall and stratified by COPD grade to explore severity-specific patterns. Correlation strength was interpreted as: |r| <0.3 (weak), 0.3-0.5 (moderate), >0.5 (strong).12 P-values <0.05 denoted statistical significance.

RESULTS

Participant Characteristics

The cohort comprised 21 patients (mean age 54.2 ± 5.3 years; 62% male) with a mean BMI of 24.1 ± 2.8 kg/m². COPD grade distribution across the 105 observations was: grade 1 (n=53, 50.5%), grade 2 (n=40, 38.1%), and grade 3 (n=12, 11.4%). Baseline

characteristics showed variability in physiological parameters, with mean heart rate 94.6 ± 9.8 bpm, systolic blood pressure 125.3 ± 7.2 mmHg, diastolic blood pressure 80.4 ± 6.1 mmHg, and oxygen saturation 91.2 ± 1.7%. Inflammatory markers included mean NLR 10.2 ± 4.1 and PLR 32.5 ± 15.6.

Descriptive statistics for primary variables are detailed in Table 1. Overall, mean 6MWT distance was 394.8 ± 25.8 m, increasing modestly over time (baseline: 365.1 ± 20.4 m; 10 weeks: 392.4 ± 28.6 m). PFT parameters showed stable means: FVC 2.85 ± 0.92 L, FEV1 2.21 ± 0.67 L, FEV1/FVC 85.7 ± 36.4%, and PEF 5.83 ± 1.22 L/s. Stratified by grade, grade 3 patients exhibited lower means for FEV1 (1.45 ± 0.32 L) and FEV1/FVC (35.2 ± 5.1%) compared to grade 1 (FEV1: 2.48 ± 0.71 L; FEV1/FVC: 110.3 ± 38.2%), reflecting greater obstruction.

Table 1: Descriptive statistics for 6MWT and PFT parameters overall and by COPD grade.

Variable	Overall (n=105) Mean ± SD (Min-Max)	Grade 1 (n=53) Mean ± SD	Grade 2 (n=40) Mean ± SD	Grade 3 (n=12) Mean ± SD
6MWT (m)	394.8 ± 25.8 (318-440)	381.2 ± 22.4	402.5 ± 24.6	378.9 ± 18.7
FVC (L)	2.85 ± 0.92 (1.24-5.21)	2.12 ± 0.65	3.15 ± 0.88	3.82 ± 0.74
FEV1 (L)	2.21 ± 0.67 (1.07-4.46)	2.48 ± 0.71	1.98 ± 0.54	1.45 ± 0.32
FEV1/FVC (%)	85.7 ± 36.4 (27.5-190.1)	110.3 ± 38.2	68.4 ± 22.1	35.2 ± 5.1
PEF (L/s)	5.83 ± 1.22 (3.52-8.33)	5.42 ± 1.15	6.12 ± 1.18	6.48 ± 1.03

Time-point specific trends indicated gradual improvements in 6MWT (e.g., +27.1 m from baseline to 10 weeks in grade 2) and minor fluctuations in PFTs, potentially reflecting therapeutic effects.

Overall Correlations

Pearson correlations between 6MWT distance and PFT parameters were weak and non-significant overall (Table 2). The strongest association was with FEV1 (r=0.178, p=0.069), suggesting a trend toward positive linkage with expiratory volume. FVC and PEF showed similar weak positive trends, while FEV1/FVC exhibited negligible correlation.

Table 2: Overall Pearson correlations between 6MWT distance and PFT parameters (n=105).

PFT Parameter	Pearson r	95% CI	p-value
FVC	0.078	-0.115 to 0.266	0.429
FEV1	0.178	-0.014 to 0.359	0.069
FEV1/FVC	0.035	-0.157 to 0.225	0.720
PEF	0.149	-0.044 to 0.333	0.129

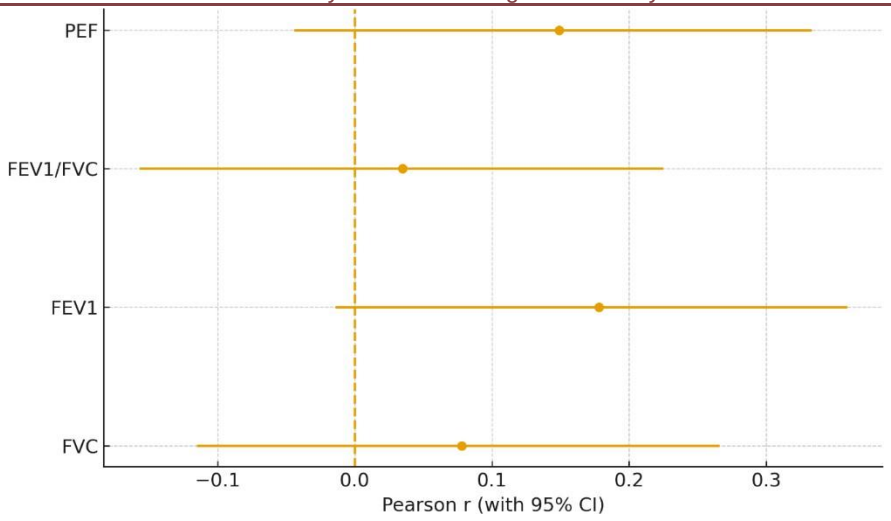

Figure 1: Correlation of 6MWT and PFT parameters

Correlations Stratified by COPD Grade

Stratification unveiled heterogeneity (Table 3). In grade 1 (mild COPD), a weak but significant positive correlation emerged with PEF (r=0.276, p=0.046), implying better peak flow aligns with enhanced walking capacity in early disease. Grade 2 (moderate) showed a moderate positive correlation with FEV1/FVC (r=0.319, p=0.045), highlighting obstruction's role. In grade 3 (severe), stronger correlations were observed with FVC (r=0.619, p=0.032) and PEF (r=0.795, p=0.002), indicating pronounced interdependence in advanced stages.

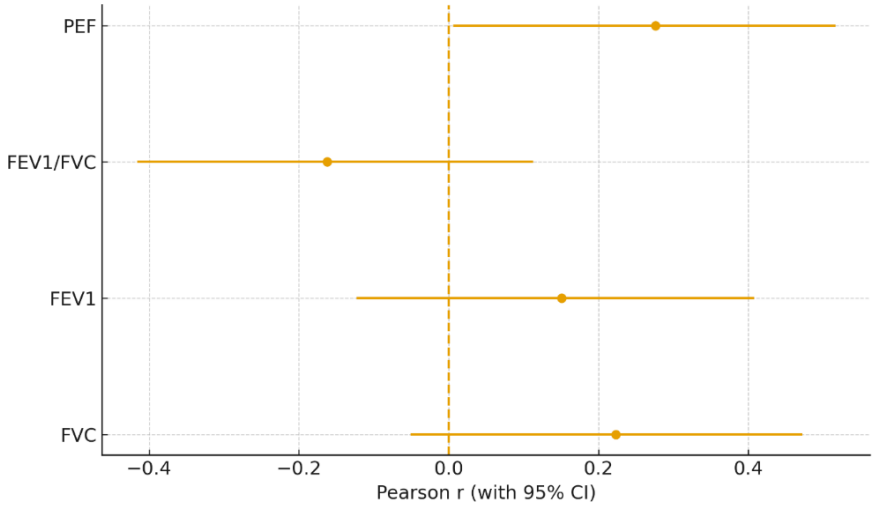

Figure 2: Correlation of PFT parameters in COPD grade 1

Table 3: Pearson correlations between 6MWT distance and PFT parameters by COPD grade.

COPD Grade	n	Parameter	Pearson r	95% CI	p-value
1	53	FVC	0.223	-0.051 to 0.472	0.108
		FEV1	0.151	-0.123 to 0.408	0.282
		FEV1/FVC	-0.162	-0.416 to 0.113	0.247
		PEF	0.276	0.006 to 0.516	0.046
2	40	FVC	-0.151	-0.447 to 0.166	0.351
		FEV1	0.212	-0.107 to 0.496	0.189

		FEV1/FVC	0.319	0.007 to 0.579	0.045
		PEF	-0.022	-0.330 to 0.290	0.891
3	12	FVC	0.619	0.076 to 0.889	0.032
		FEV1	0.348	-0.272 to 0.774	0.268
		FEV1/FVC	0.005	-0.569 to 0.576	0.988
		PEF	0.795	0.411 to 0.941	0.002

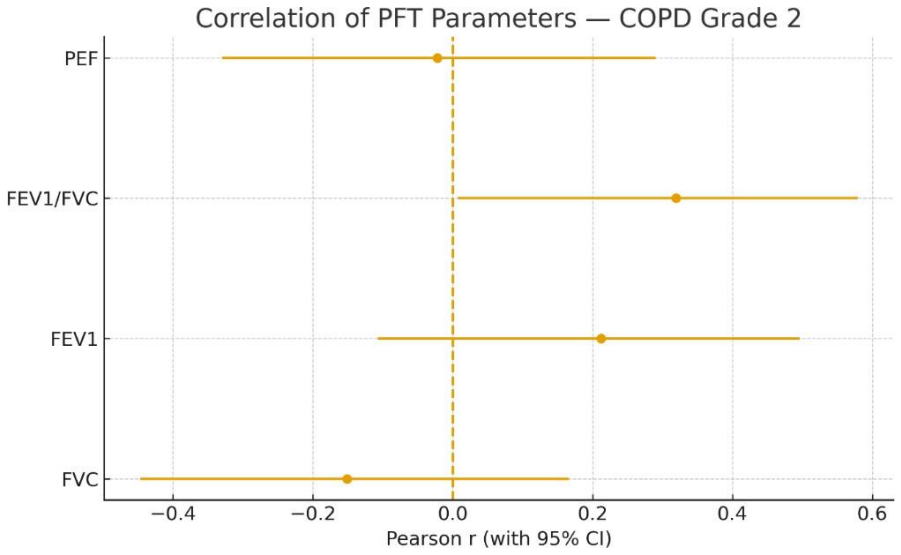

Figure3: Correlation of PFT parameters in COPD grade 2

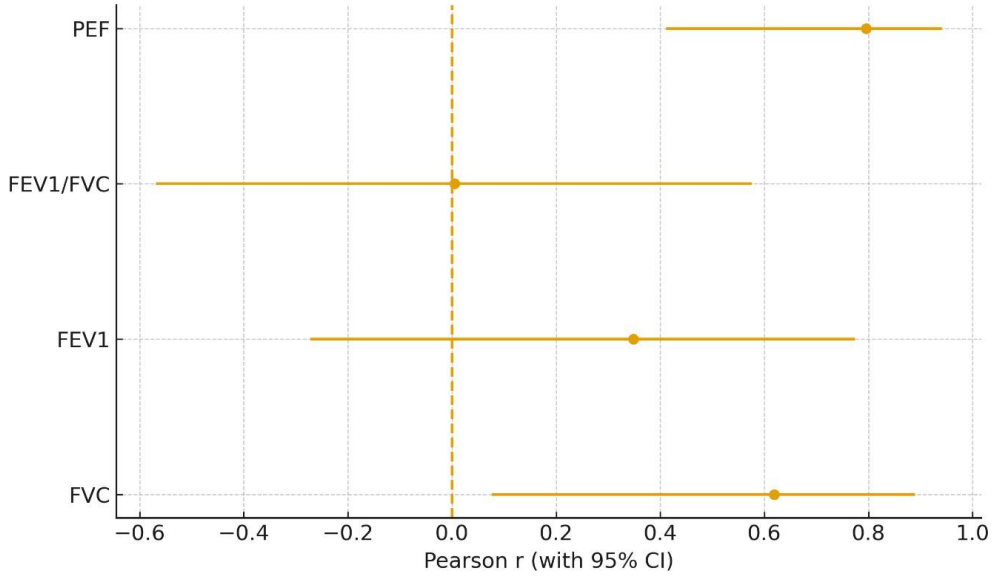

Figure 4: Correlation of PFT parameters in COPD grade 3

DISCUSSION

This longitudinal analysis reveals predominantly weak correlations between 6MWT distance and PFT parameters in COPD patients, aligning with prior evidence that 6MWT captures multifaceted functional status beyond isolated lung function.[6] The near-significant association with FEV1 (p=0.069) echoes findings from Agrawal and Awad, who reported positive correlations

(r=0.26-0.42) between 6MWD and FEV1/FVC in chronic pulmonary diseases, including COPD.[8] However, our overall weak links may reflect the pooled nature of data across severities and time, diluting severity-specific signals.

Stratification by COPD grade uncovered escalating correlations with disease progression, particularly strong in grade 3 for FVC and PEF (r>0.6). This pattern corroborates Chen et al.'s observation of moderate correlations (|r|=0.34-0.67) exclusively in severe/very severe COPD, attributing it to heightened ventilatory constraints limiting exercise.[5] Similarly, Dajczman et al. noted significant associations between higher 6MWD and better FEV1/FVC in severe COPD, underscoring 6MWT's prognostic utility.[4] In milder grades, the modest PEF correlation in grade 1 and FEV1/FVC in grade 2 suggest early-stage factors like muscle strength or motivation influence 6MWT more than airflow limitation, as posited by Wise and Brown in emphysema patients.[6]

These findings imply that while PFTs excel in diagnosing obstruction, 6MWT complements by reflecting real-world functional decline, especially in advanced COPD where correlations strengthen due to compounded impairments.[13] Clinically, this supports integrating 6MWT into routine monitoring for severe cases, potentially predicting exacerbations or rehabilitation needs.[14] However, discrepancies with studies showing stronger overall correlations (e.g., r=0.4-0.5 for FEV1)[7] may arise from our longitudinal design capturing variability over time, or the small grade 3 subsample (n=12), limiting power.

Limitations include the retrospective design, potential unaccounted interventions affecting measurements, and pooling without mixed-models for repeated measures, risking overestimation of significance due to clustering.[15] The dataset's origin (possibly a treatment study) introduces bias, and absence of confounders like comorbidities or smoking status hinders adjustment. Future prospective studies with larger cohorts, advanced modeling (e.g., generalized estimating equations), and inclusion of grade 4 patients could validate these patterns.

CONCLUSION

Overall correlations between 6MWT and PFT parameters are modest, they strengthen with increasing COPD severity, suggesting that 6MWT may be particularly valuable as a complementary tool in advanced disease stages for assessing functional limitations beyond spirometry measures

REFERENCES

[1] Agustí A, Celli BR, Criner GJ, Halpin D, Anzueto A, Barnes P, et al. Global Initiative for Chronic Obstructive Lung Disease 2023 report: GOLD executive summary. Am J Respir Crit Care Med. 2023;207(7):819-37.

[2] Graham BL, Steenbruggen I, Miller MR, et al. Standardization of spirometry 2019 update. An official American Thoracic Society and European Respiratory Society technical statement. Am J Respir Crit Care Med. 2019;200(8):e70-e88.

[3] ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166(1):111-117.

[4] Dajczman E, Wardini R, Kasymjanova G, Préfontaine D, Baltzan MA, Wolkove N. Six minute walk distance is a predictor of survival in patients with chronic obstructive pulmonary disease undergoing pulmonary rehabilitation. Can Respir J. 2015;22(4):225-229.

[5] Chen H, Liang BM, Tang YJ, et al. Relationship between 6-minute walk test and pulmonary function test in stable chronic obstructive pulmonary disease with different severities. Chin Med J (Engl). 2012;125(17):3053-3058.

[6] Wise RA, Brown CD; National Emphysema Treatment Trial Research Group. Reproducibility of the 6-minute walk test in patients with severe emphysema. Am J Respir Crit Care Med. 2003;167(11):1562-1566.

[7] Sciurba F, Criner GJ, Lee SM, et al. Six-minute walk distance in chronic obstructive pulmonary disease: reproducibility and effect of walking course layout and length. Am J Respir Crit Care Med. 2003;167(11):1522-1527.

[8] Agrawal MB, Awad NT. Correlation between Six Minute Walk Test and Spirometry in Chronic Pulmonary Disease. J Clin Diagn Res. 2015;9(8):OC01-OC04.

[9] Singh D, Agusti A, Anzueto A, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive lung disease: the GOLD science committee report 2019. Eur Respir J. 2019;53(5):1900164.

[10] Holland AE, Spruit MA, Troosters T, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. Eur Respir J. 2014;44(6):1428- 1446.

[11] Graham BL, Steenbruggen I, Barjaktarevic IZ, et al. Standardization of spirometry 2019 update: an official American Thoracic Society and European Respiratory Society technical statement. Am J Respir Crit Care Med. 2019;200(8):e70-e88.

[12] Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Lawrence Erlbaum Associates; 1988.

[13] Andrianopoulos V, Holland AE, Singh SJ, et al. Six-minute walk distance in patients with chronic obstructive

pulmonary disease: which reference equations should we use? Chron Respir Dis. 2015;12(2):111-119.

[14] Spruit MA, Singh SJ, Garvey C, et al. An official American Thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. Am J Respir Crit Care Med. 2013;188(8):e13-e64.

[15] Fitzmaurice GM, Laird NM, Ware JH. Applied longitudinal analysis. 2nd ed. Wiley; 2011

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