



CORRELATION OF COPD ASSESSMENT TEST WITH PULMONARY FUNCTION, EXERCISE CAPACITY, AND QUALITY OF LIFE IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN CENTRAL INDIA: A CASE-CONTROL STUDY

Mo Shaqib^{1*}, Dr. Ashutosh Jain², Mohd Areeb³

^{1*}Research Scholar, Department of Physiology, Index Medical College Hospital & Research Centre, Indore, Madhya Pradesh, (Malwanchal University), India.

²Associate Professor, Department of Physiology, Index Medical College Hospital & Research Centre, Indore, Madhya Pradesh, (Malwanchal University) India

³Research Scholar, Department of Microbiology, Index Medical College Hospital & Research Centre, Indore, Madhya Pradesh, (Malwanchal University), India

Corresponding Author: Mo Shaqib

*Research Scholar, Department of Physiology, Index Medical College Hospital & Research Centre, Indore, Madhya Pradesh, (Malwanchal University), India

Email- moshag09@gmail. Com

ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a major contributor to global morbidity and mortality. Although spirometry remains the cornerstone for diagnosis, it does not adequately capture symptom burden, exercise intolerance, and quality of life. The COPD Assessment Test (CAT) is a simple patient-reported tool, but its correlation with multidimensional disease indices in Indian populations remains insufficiently explored.

Objectives: To evaluate the relationship between CAT score and pulmonary function tests (PFT), exercise capacity, dyspnea severity, BODE index, and health-related quality of life (SGRQ) in patients with COPD.

Methods: A case-control study including 180 participants (90 COPD patients and 90 healthy controls) was conducted. COPD was diagnosed as per GOLD guidelines. CAT, spirometry (FVC, FEV1, FEV1/FVC), six-minute walk distance (6MWD), modified Medical Research Council (mMRC) dyspnea scale, Body Mass Index (BMI), BODE index, and St. George's Respiratory Questionnaire (SGRQ) were assessed. Pearson's correlation analysis was performed.

Results: CAT showed significant negative correlations with FVC ($r = -0.516$, $p < 0.001$), FEV1 ($r = -0.772$, $p < 0.001$), FEV1/FVC ($r = -0.376$, $p < 0.001$), and 6MWD ($r = -0.279$, $p = 0.005$). Strong positive correlations were observed with mMRC dyspnea ($r = 0.862$, $p < 0.001$), BODE index ($r = 0.430$, $p < 0.001$), and SGRQ score ($r = 0.306$, $p = 0.002$). Higher CAT scores were associated with advanced GOLD stages, reduced exercise capacity, greater dyspnea, and poorer quality of life.

Conclusion: CAT is a reliable and practical surrogate marker of COPD severity, functional limitation, and quality-of-life impairment. Its strong association with physiological and multidimensional indices supports its routine clinical use, particularly in resource-limited settings.

Keywords: COPD, CAT score, Spirometry, BODE index, SGRQ, Quality of life, Exercise capacity

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive, preventable, and treatable disease characterized by persistent airflow limitation and chronic inflammatory response of the airways and lungs to noxious particles and gases [1]. COPD represents a leading cause of morbidity and mortality worldwide, with increasing prevalence driven by continued exposure to tobacco smoke, biomass fuel, occupational hazards, and environmental pollution [2,3]. According to the Global Burden of Disease Study, COPD ranks among the top three causes of death globally and contributes substantially to disability-adjusted life years (DALYs) [4].

In India, the burden of COPD is particularly high due to widespread tobacco consumption, indoor biomass fuel exposure, and ambient air pollution. Regional studies estimate prevalence ranging from 4% to 10% in adults, with higher rates among males and rural populations [5,6]. COPD not only causes respiratory disability but is also associated with systemic manifestations including weight loss, skeletal muscle dysfunction, cardiovascular disease, osteoporosis, and depression, contributing to impaired functional capacity and reduced quality of life [7,8].

Spirometry is the gold standard for the diagnosis and staging of COPD and provides objective assessment of airflow limitation through parameters such as Forced Expiratory Volume in one second (FEV1), Forced Vital Capacity (FVC), and FEV1/FVC ratio [1,9]. However, spirometric indices alone do not adequately reflect symptom burden, activity limitation, or psychosocial impact. Patients with similar FEV1 values often report markedly different levels of dyspnea, fatigue, and health-related quality of life [10,11]. This recognition has led to a paradigm shift toward multidimensional assessment of COPD severity.

Health status and quality of life in COPD are commonly evaluated using disease-specific questionnaires such as the St. George's Respiratory Questionnaire (SGRQ) and the Chronic Respiratory Disease Questionnaire (CRQ). The SGRQ is a validated instrument that assesses symptoms, activity limitation, and psychosocial impacts of respiratory disease and is sensitive to clinical change [12,13]. However, its length and complexity limit its routine use in busy outpatient settings, particularly in low-resource environments.

To facilitate rapid clinical assessment, the COPD Assessment Test (CAT) was developed as a concise, eight-item questionnaire measuring cough, sputum, chest tightness, breathlessness, activity limitation, sleep, and energy levels [14]. CAT has demonstrated good reliability, internal consistency, and responsiveness to treatment [15,16]. Studies from Europe, East Asia, and the Americas have reported significant correlations between CAT and FEV1, dyspnea scales, and quality-of-life instruments such as SGRQ [17–19]. However, variability exists across populations, emphasizing the need for regional validation.

Beyond symptom scales, the multidimensional BODE index (Body mass index, airflow Obstruction, Dyspnea, and Exercise capacity) has emerged as a powerful predictor of mortality and hospitalization in COPD [20]. Unlike spirometry alone, BODE integrates nutritional status, physiological impairment, functional capacity, and symptom burden, providing a holistic view of disease severity. Several investigators have explored the relationship between CAT and BODE index, reporting moderate to strong correlations and suggesting CAT as a practical surrogate for multidimensional disease burden [21–23].

Exercise capacity, commonly assessed using the six-minute walk test (6MWT), reflects functional limitation and has prognostic significance in COPD [24]. Similarly, dyspnea severity measured by the modified Medical Research Council (mMRC) scale is a strong determinant of health status and mortality [25]. Understanding how CAT relates to these functional and prognostic markers is essential to establish its clinical utility.

Despite growing international evidence, data from Central India on the correlation of CAT with pulmonary function, exercise tolerance, multidimensional indices, and quality of life remain limited. Given the high burden of COPD in this region and the practical advantages of CAT, validating its role in comprehensive assessment is of considerable clinical relevance. Therefore, this study aimed to evaluate the relationship between CAT score and pulmonary function tests, dyspnea grading,

exercise capacity, BODE index, and health-related quality of life measured by SGRQ in patients with COPD in Central India.

Materials and Methods

This hospital-based case–control study was conducted in the Departments of Physiology and Respiratory Medicine at a tertiary care teaching hospital in Central India.

Study Population and Sample Size

A total of 180 participants were enrolled:

Cases: 90 patients diagnosed with COPD

Controls: 90 healthy adult volunteers

Sample size was calculated using standard statistical formulae with $\alpha = 5\%$, $\beta = 20\%$ (power 80%), and allowance for 10% data loss.

Inclusion Criteria

1. Adults aged ≥ 35 years
2. Diagnosed COPD as per GOLD guidelines (Stages I–IV)
3. Clinically stable with no acute exacerbation in the preceding 6 weeks
4. Willingness to participate and ability to perform spirometry and 6-minute walk test

Exclusion Criteria

1. Oxygen saturation $< 90\%$ during 6-minute walk test
2. Patients on long-term oxygen therapy
3. Inability to perform spirometry or 6-minute walk test
4. Presence of severe comorbid conditions limiting exercise (e.g., advanced cardiac disease, neuromuscular disorders)

Study Tools and Measurements

Pulmonary Function Tests (PFT):

Performed using standardized spirometry to record FVC, FEV1, and FEV1/FVC ratio.

COPD Assessment Test (CAT):

An eight-item questionnaire assessing symptom burden and disease impact.

Dyspnea Assessment:

Modified Medical Research Council (mMRC) dyspnea scale.

Exercise Capacity:

Six-minute walk test (6MWT) conducted as per American Thoracic Society guidelines, recording distance walked in meters.

Nutritional Status:

Body Mass Index (BMI) calculated as weight/height^2 (kg/m^2).

Multidimensional Severity:

BODE index calculated using BMI, FEV1, mMRC grade, and 6MWD.

Quality of Life:

St. George's Respiratory Questionnaire (SGRQ), providing symptom, activity, impact, and total scores.

Statistical Analysis

Data were analyzed using statistical software. Continuous variables were expressed as mean $\pm$ standard deviation, categorical variables as frequencies and percentages. Pearson's correlation coefficient (r) was used to assess associations between CAT and clinical parameters. A p -value < 0.05 was considered statistically significant.

RESULTS

A total of 180 participants were studied, including 90 COPD patients and 90 healthy controls. Among COPD patients, increasing CAT score categories were associated with progressively worse disease severity, functional limitation, and quality-of-life impairment.

Patients with low CAT scores (0–10) were predominantly classified as having mild COPD according to GOLD staging, with 90% falling into the mild category. This group demonstrated preserved exercise capacity, with 70% walking ≥ 250 meters in the 6-minute walk test, minimal dyspnea (mMRC grade 0–1 in 90%), low BODE index (1–2 in 100%), and relatively good quality of life as reflected by lower SGRQ scores (mean 34.60 ± 11.18).

As CAT scores increased into the 11–20 and 21–30 ranges, there was a marked shift toward moderate and severe GOLD stages, accompanied by declining exercise capacity and increasing dyspnea. Patients with CAT scores of 21–30 showed that 60% walked only 150–249 meters, 47.5% reported mMRC grade 3 dyspnea, and SGRQ scores rose to 46.40 ± 12.36 , indicating substantial deterioration in quality of life.

In the highest CAT category (31–40), disease burden was most pronounced. A majority (83.3%) of these patients were classified as very severe COPD. Exercise tolerance was significantly impaired, with 75% walking < 250 meters on 6MWT. All patients in this group reported severe dyspnea (mMRC grades 3–4), BODE index was ≥ 5 in 50%, and quality of life was poorest, with mean SGRQ score of 54.42 ± 13.03 . All associations between CAT categories and GOLD stage, 6MWD, mMRC grade, and SGRQ were statistically significant ($p < 0.05$).

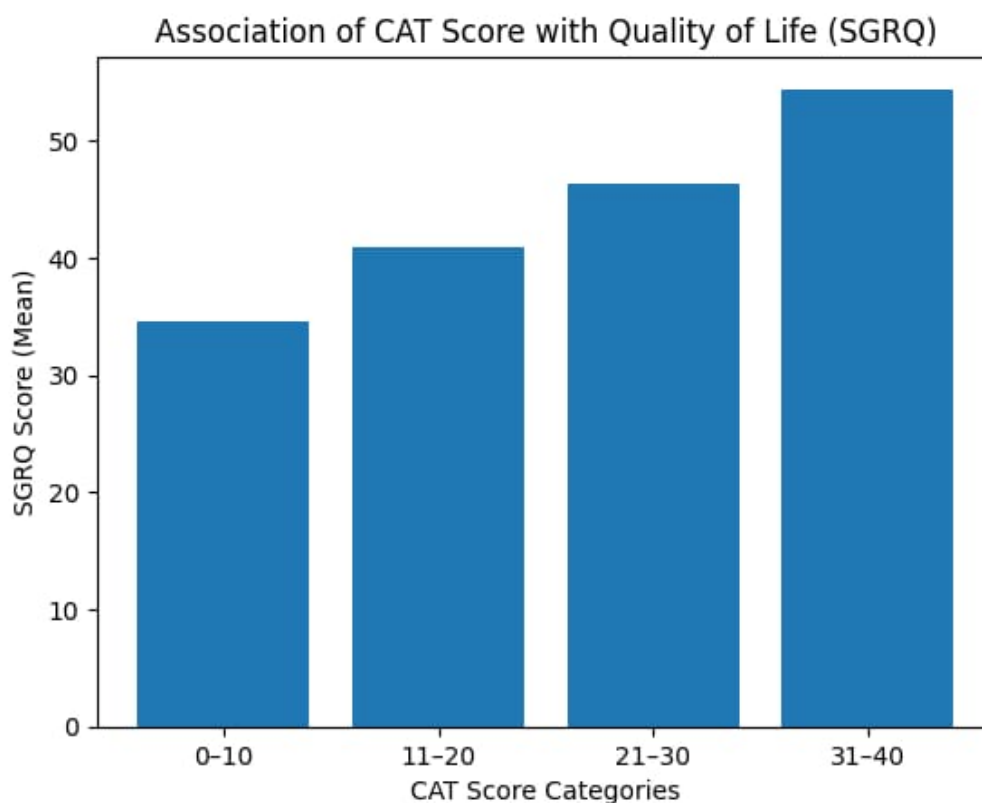
(CAT Score and Its Correlation with Lung Function, Exercise Capacity & Quality of Life in COPD)

Table 1: Association of CAT Score with Disease Severity, Functional Capacity and Quality of Life

Parameter	CAT 0–10 (n=10)	CAT 11–20 (n=38)	CAT 21–30 (n=40)	CAT 31–40 (n=12)	P value
GOLD Stage					<0.001
Mild	9 (90.0%)	2 (5.3%)	1 (2.5%)	0 (0.0%)	
Moderate	1 (10.0%)	19 (50.0%)	3 (7.5%)	0 (0.0%)	
Severe	0 (0.0%)	17 (44.7%)	20 (50.0%)	2 (16.7%)	
Very Severe	0 (0.0%)	0 (0.0%)	16 (40.0%)	10 (83.3%)	
6-Min Walk Distance (m)					0.044
250–349	7 (70.0%)	13 (34.2%)	9 (22.5%)	3 (25.0%)	
150–249	1 (10.0%)	16 (42.1%)	24 (60.0%)	6 (50.0%)	
<150	0 (0.0%)	4 (10.5%)	5 (12.5%)	3 (25.0%)	
mMRC Dyspnea Scale					<0.001
0–1	9 (90.0%)	25 (65.8%)	1 (2.5%)	0 (0.0%)	
2	1 (10.0%)	12 (31.6%)	17 (42.5%)	0 (0.0%)	
3	0 (0.0%)	1 (2.6%)	19 (47.5%)	4 (33.3%)	
4	0 (0.0%)	0 (0.0%)	3 (7.5%)	8 (66.7%)	
SGRQ Score (Mean $\pm$ SD)	34.60 ± 11.18	41.00 ± 14.42	46.40 ± 12.36	54.42 ± 13.03	0.002

Statistical analysis demonstrated a highly significant association between COPD Assessment Test (CAT) score categories and disease severity, functional capacity, dyspnea, and quality of life.

- GOLD stage distribution showed a statistically significant difference across CAT categories ($p < 0.001$), with patients in higher CAT score groups predominantly classified into severe and very severe GOLD stages. This indicates progressive worsening of airflow limitation with increasing symptom burden.
 - Six-minute walk distance (6MWD) differed significantly among CAT score categories ($p = 0.044$). Patients with lower CAT scores walked longer distances, whereas those with CAT scores ≥ 21 demonstrated markedly reduced exercise capacity.
 - mMRC dyspnea grades showed a strong and statistically significant association with CAT score ($p < 0.001$). Lower CAT scores were associated with minimal dyspnea (mMRC 0–1), while higher CAT scores were associated with severe dyspnea (mMRC 3–4).
 - Quality of life assessed by SGRQ worsened significantly with increasing CAT scores ($p = 0.002$). Mean SGRQ scores increased progressively across CAT categories, reflecting deteriorating health-related quality of life.
- Overall, these findings confirm that higher CAT scores are significantly associated with advanced disease stage, reduced functional capacity, increased dyspnea, and poorer quality of life.



Graph 1: : Association of CAT Score with Disease Severity, Functional Capacity and Quality of Life

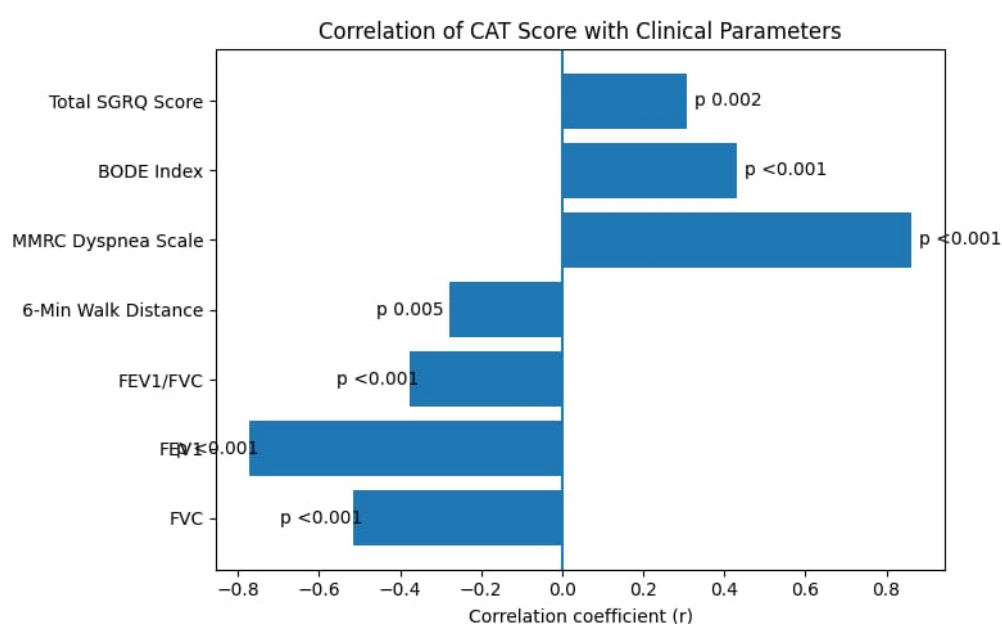
Table 2: Correlation of CAT Score with Pulmonary Function Tests, Exercise Capacity, Dyspnea, BODE Index and SGRQ

Parameter	r-value	p-value
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FVC	–0.516	<0.001
FEV1	–0.772	<0.001
FEV1/FVC	–0.376	<0.001
6-Min Walk Distance (6MWD)	–0.279	0.005
MMRC Dyspnea Scale	0.862	<0.001
BODE Index	0.430	<0.001
Total SGRQ Score	0.306	0.002

Pearson's correlation; $p < 0.05$ considered statistically significant.

Pearson's correlation analysis revealed statistically significant relationships between CAT score and all studied clinical parameters.



Graph 2: Correlation of CAT Score with Pulmonary Function Tests, Exercise Capacity, Dyspnea, BODE Index and SGRQ

- CAT score showed a **significant negative correlation** with:
 - **Forced Vital Capacity (FVC)** ($r = -0.516, p < 0.001$)
 - **Forced Expiratory Volume in 1 second (FEV₁)** ($r = -0.772, p < 0.001$)
 - **FEV₁/FVC ratio** ($r = -0.376, p < 0.001$)

These findings indicate that increasing CAT scores are associated with worsening pulmonary function.

- A significant inverse correlation was observed between CAT score and 6-minute walk distance ($r = -0.279, p = 0.005$), suggesting reduced exercise capacity with increasing symptom burden.
- CAT score showed a very strong positive correlation with mMRC dyspnea scale ($r = 0.862, p < 0.001$), confirming dyspnea as the dominant contributor to CAT score.
- A moderate positive correlation was noted between CAT score and BODE index ($r = 0.430, p < 0.001$), indicating that higher CAT scores reflect greater multidimensional disease severity.
- CAT score also correlated positively with total SGRQ score ($r = 0.306, p = 0.002$), confirming that increasing CAT scores are associated with poorer health-related quality of life.

All correlations were statistically significant, reinforcing the validity of CAT as a comprehensive marker of COPD severity and impact.

DISCUSSION

This study demonstrates a robust and consistent association between CAT score and multiple dimensions of COPD severity, including pulmonary function, dyspnea, exercise capacity, multidimensional disease burden, and health-related quality of life. The findings support the role of CAT as a comprehensive yet practical tool for routine clinical assessment.

The strong negative correlation observed between CAT and FEV1 ($r = -0.772$) indicates that symptom burden measured by CAT closely reflects the degree of airflow limitation. This finding is consistent with previous reports by Jones et al. [14], who demonstrated that CAT scores increase progressively with declining lung function. Similarly, Huang et al. [17] reported significant negative correlations between CAT and FEV1% predicted, emphasizing that patients with worse spirometric impairment experience greater health status deterioration.

Dyspnea is a central symptom in COPD and a major determinant of activity limitation and prognosis. In the present study, CAT showed a very strong positive correlation with mMRC dyspnea grade ($r = 0.862$). Kim et al. [18] observed similar findings, reporting that CAT scores correlated strongly with mMRC across all severity grades, with dyspnea items showing the highest item-level correlations. This underscores that CAT effectively captures subjective breathlessness, which is often more relevant to patients than spirometric values.

Exercise intolerance, assessed using 6MWD, is a powerful predictor of hospitalization and mortality in COPD [24]. Our finding of a significant inverse correlation between CAT and 6MWD ($r = -0.279$) aligns with reports by Dodd et al. [19], who demonstrated that higher CAT scores were associated with reduced exercise performance. These findings suggest that CAT reflects not only symptom burden but also functional capacity.

The BODE index is a validated multidimensional predictor of survival in COPD [20]. In this study, CAT correlated significantly with BODE index ($r = 0.430$), indicating that CAT mirrors composite disease severity. Ladeira et al. [21] reported a similar association ($r = 0.475$, $p < 0.001$), while Gu et al. [22] found an even stronger correlation ($r = 0.888$, $p < 0.001$). These comparisons reinforce the discriminative validity of CAT as a complement to established multidimensional indices.

Quality of life impairment is a central outcome in chronic respiratory disease. The positive correlation between CAT and SGRQ ($r = 0.306$) observed in this study confirms that higher CAT scores reflect poorer health status. Hwang et al. [23] reported even stronger associations between CAT and SGRQ total and domain scores, highlighting CAT's sensitivity to changes in health-related quality of life. While SGRQ remains a gold standard, its length and scoring complexity limit routine application. CAT, in contrast, offers rapid assessment without substantial loss of information.

Importantly, our categorical analysis showed that higher CAT scores were associated with advanced GOLD stages, reduced exercise capacity, severe dyspnea, higher BODE indices, and markedly worse SGRQ scores. This graded relationship supports CAT as a meaningful stratification tool for disease severity. Similar patterns have been reported in multicenter studies from Europe and Asia [16–19], but regional data from Central India have been limited. Our findings therefore provide valuable local evidence supporting CAT's clinical relevance.

From a practical standpoint, these results have significant implications for resource-limited healthcare settings. In many parts of India, access to comprehensive pulmonary function testing, exercise testing, and lengthy questionnaires may be restricted. CAT offers a simple, patient-centered, and time-efficient alternative that correlates strongly with objective and multidimensional indices of disease severity. Incorporation of CAT into routine outpatient assessment could enhance early identification of high-risk patients, facilitate monitoring of disease progression, and guide individualized management strategies.

CONCLUSION

The COPD Assessment Test (CAT) demonstrates strong and significant correlations with pulmonary function, dyspnea severity, exercise capacity, multidimensional disease burden, and

health-related quality of life. CAT is therefore a reliable, valid, and practical surrogate marker of overall disease impact in COPD. Its routine use alongside spirometry can enhance comprehensive patient assessment and is particularly valuable in resource-constrained clinical settings.

Limitations

1. Single-center design limits generalizability.
2. Cross-sectional nature precludes causal inference.
3. Possible overlap between early asthma and COPD.
4. Absence of advanced imaging or biomarker analysis.

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