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Correlation Of Six-Minute Walk Test, Dyspnea Severity, And Spirometric Indices In Patients With Copd Exacerbations In A Tertiary Care Centre

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is a progressive disorder characterized by airflow limitation, inflammation, and reduced functional capacity. While spirometry remains the diagnostic gold standard, its limited availability in resource-restricted settings highlights the need for alternative functional assessments such as the six-minute walk test (6MWT) and the COPD Assessment Test (CAT). Evidence regarding their relationship during exacerbations remains limited.

Aim: To evaluate the correlation between 6MWT, dyspnea severity, and spirometric indices among patients with COPD experiencing exacerbations.

Methods: This prospective observational study was performed in the Department of Respiratory Medicine, Shri Sathya Sai Medical College and Research Institute, from December 2023 to December 2024. A total of 102 COPD patients aged ≥40 years fulfilling GOLD diagnostic criteria were included. Patients with major comorbidities, neurological or rheumatological disorders, active or past tuberculosis, pregnancy, or refusal to consent were excluded. CAT scoring and 6MWT were conducted according to standard guidelines, and spirometric parameters were recorded. Data were analyzed using SPSS v25 with chi-square test, paired t-test, and Pearson correlation.

Results: Younger age, lower mMRC dyspnea grade, non-smoking status, and lower CAT scores were significantly associated with greater 6MWT distance ($p<0.05$). Gender did not significantly influence 6MWT outcomes. Strong negative correlations were observed between CAT scores, dyspnea severity, smoking history, and 6MWT performance.

Conclusion: The 6MWT correlates significantly with dyspnea severity, symptom burden, and smoking exposure in COPD exacerbations, supporting its utility as a practical functional assessment tool, especially in settings with limited access to spirometry.

KEYWORDS: Chronic Obstructive Pulmonary Disease (COPD); Six-Minute Walk Test (6MWT); Spirometry; Dyspnea; mMRC Scale; COPD Assessment Test (CAT); Exercise Capacity; Exacerbations; Functional Assessment; Smoking; Biomass Exposure; GOLD Classification.

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a significant global health challenge, marked by enduring airflow restriction, chronic inflammation, and a continuous deterioration in pulmonary function. Early diagnosis is particularly difficult in low- and middle-income areas because to constrained resources and little knowledge. Spirometry is the definitive method for diagnosing and classifying COPD; nevertheless, its accessibility is limited in numerous rural and under-resourced areas. This underscores the significance of alternative functional assessments like the six-minute walk test (6MWT), which indicates the integrated respiratory, cardiovascular, and musculoskeletal constraints impacting exercise capacity. [1, 2, 3] The COPD Assessment Test (CAT), a validated instrument, offers critical insights into symptom load and quality of life. The 6MWT and CAT provide accessible, non-invasive assessments that enhance spirometric data. Exacerbations—defining occurrences in COPD—deteriorate functional capacity and elevate morbidity, rendering prompt evaluation essential. Research has demonstrated significant relationships between 6MWT performance, CAT scores, and spirometric metrics, indicating that 6MWT may act as a proxy in the absence of spirometry. Nevertheless, evidence during exacerbations is still scarce. This study examines the correlation between the 6-Minute Walk Test (6MWT) and spirometry in COPD exacerbations, advocating for the incorporation of these instruments into standard therapy, especially in settings with limited diagnostic resources. [4, 5, 6] We studied the relationship between six minute walk test, and dyspnea in chronic obstructive pulmonary disease patients with exacerbations in a tertiary care centre in Kancheepuram.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Respiratory Medicine at Shri Sathya Sai Medical College and Research Institute over a one-year period from December 2023 to December 2024, involving patients with COPD attending the department. The study included individuals aged 40 years and above of both genders who were diagnosed with COPD according to GOLD criteria and who provided informed written consent. Patients were excluded if they had comorbidities such as diabetes mellitus, systemic hypertension, pulmonary hypertension, cor pulmonale, coronary or ischemic heart disease, active or previously treated pulmonary/extrapulmonary tuberculosis, neurological or rheumatological diseases, acute exacerbation of COPD, dependence on non-invasive ventilation, pregnancy or lactation, or unwillingness to participate. The sample size was calculated based on a 2022 study by Konjrti et al., which reported that 35% of COPD patients walked more than 400 metres in the 6-minute walk test; using a 95% confidence interval, 10% absolute precision, and 10% additional sampling to compensate for non-response, the required sample size was determined to be 102 participants. Convenient sampling was employed for participant recruitment.

Patients were selected after applying inclusion and exclusion criteria. Informed written consent was obtained from the patients. Entire procedure was explained to them clearly. A CAT respiratory questionnaire was mark from all patients based on their symptoms. The total CAT score of each patient was calculated and recorded. 6 minute walk test (6MWT) was performed according to ATS guidelines. Before the test, heart rate, blood pressure, and SpO2 measurements were done. Emergency resuscitation measures were kept ready to treat the patients, incase any complication occur during the procedure. Patients were made to walk along a 30 meters long path marked at intervals of one meter each. They were allowed to walk at their own pace. If the patient developed any symptom of chest pain, severe dyspnea, or leg pain, they were allowed to rest during the test. Then they were allowed to continue. The patients were encouraged to complete the test. The patients were asked to stop after 6 minutes. After the test was over, again heart rate, blood pressure and SpO2 measurements were done. Distance walked by the patient at the end of 6 minutes was recorded in meters. A Pretested, semi-structured interviewer administered proforma was then completed.

DATA PROCESSING AND ANALYSIS:

Data were entered in Microsoft excel and SPSS version 25 was used for analysis. Descriptive data were analyzed in the form of frequency, percentage, mean and standard deviation. Categorical variables were mentioned as frequency distribution and percentage. Chi square test was used to find association between categorical variables. Paired t test was used to test association between means before and after. Pearson correlation coefficient was used to test correlation between variables. P value of less than 0.05 was considered as statistically significant. Data were represented by tables and chart wherever relevant.

RESULTS

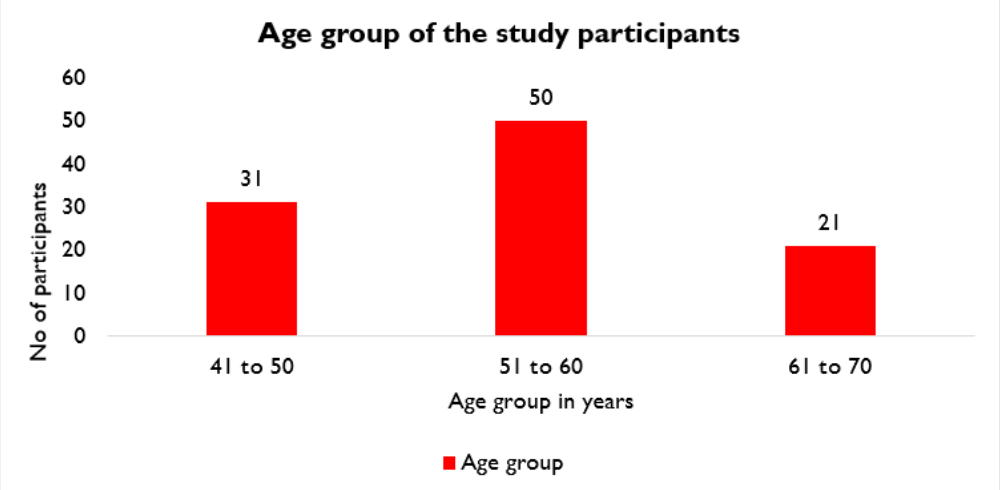
Age group of the study participants:

Table 1. Age group of the study participants

Age Category	Frequency	Percentage (%)
41 to 50	31	30.4
51 to 60	50	49.0
61 to 70	21	20.6
Total	102	100.0

The mean age of the participants was 54.75 ± 5.78 years. 31 participants (30.4%) were aged 41 to 50 years, 50 participants (49.0%) were aged 51 to 60 years, and 21 participants (20.6%) were aged 61 to 70 years.

Chart 1. Age group of the study participants



Gender of the study participants:

Table 2. Gender of the study participants

Gender	Frequency	Percentage (%)
Female	67	65.7
Male	35	34.3
Total	102	100.0

67 participants (65.7%) were female, and 35 participants (34.3%) were male.

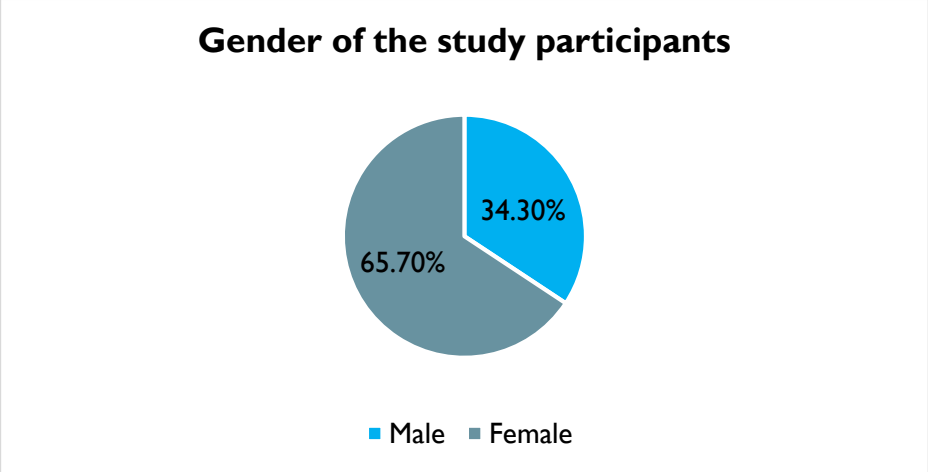


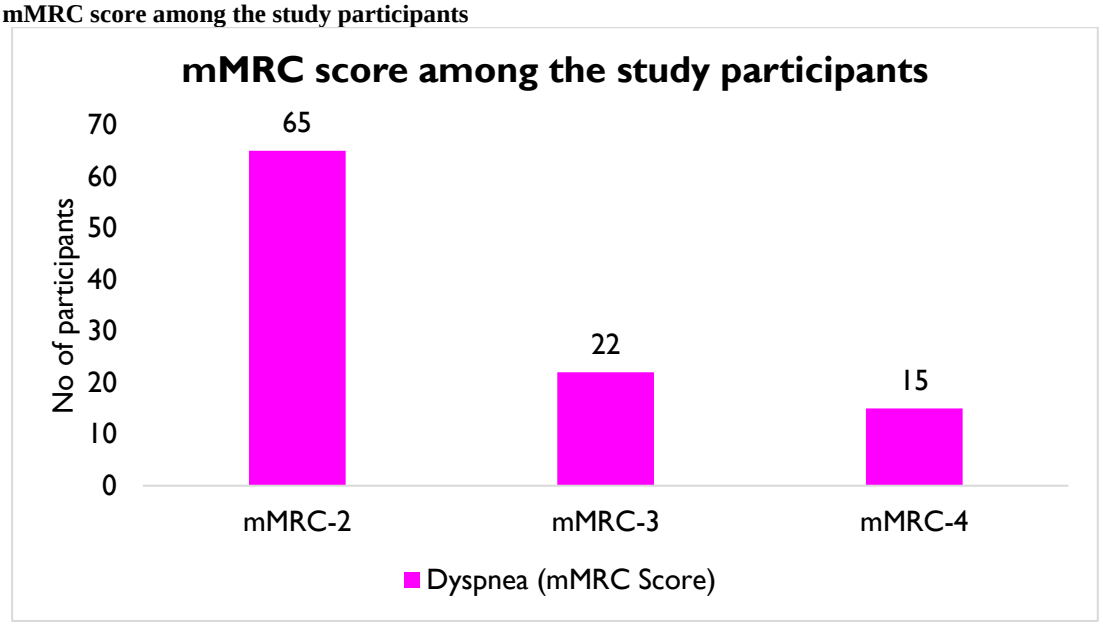
Chart 2. Gender of the study participants mMRC score among the study participants:

Table 3. mMRC score among the study participants

Dyspnea (mMRC Score)	Frequency	Percentage (%)
mMRC-2	65	63.7
mMRC-3	22	21.6
mMRC-4	15	14.7
Total	102	100.0

65 participants (63.7%) had an mMRC-2 score, 22 participants (21.6%) had an mMRC-3 score, and 15 participants (14.7%) had an mMRC-4 score.

Chart 3. mMRC score among the study participants



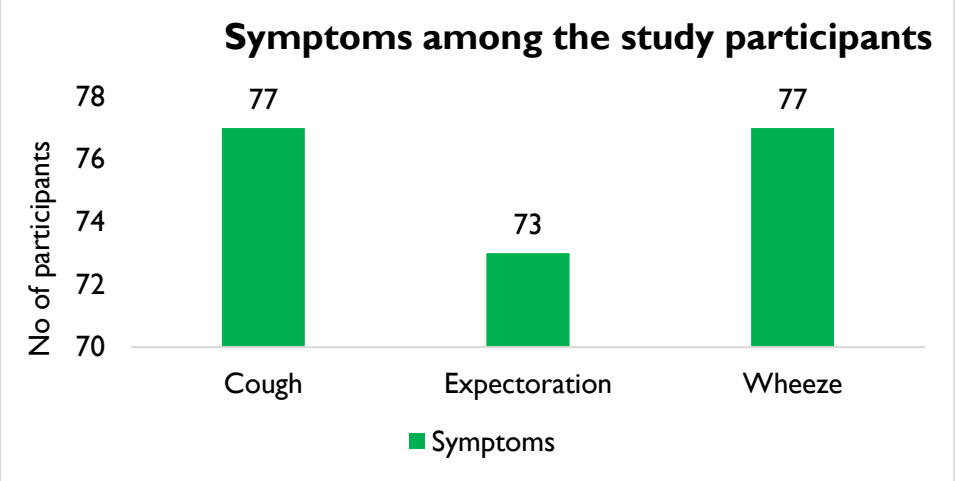
Symptoms among the study participants:

Table 4. Symptoms among the study participants

Symptoms	Frequency	Percentage (%)
Cough	77	75.5
Expectoration	73	71.6
Wheeze	77	75.5

77 participants (75.5%) reported cough, 73 participants (71.6%) had expectoration, and 77 participants (75.5%) experienced wheeze.

Chart 4. Symptoms among the study participants



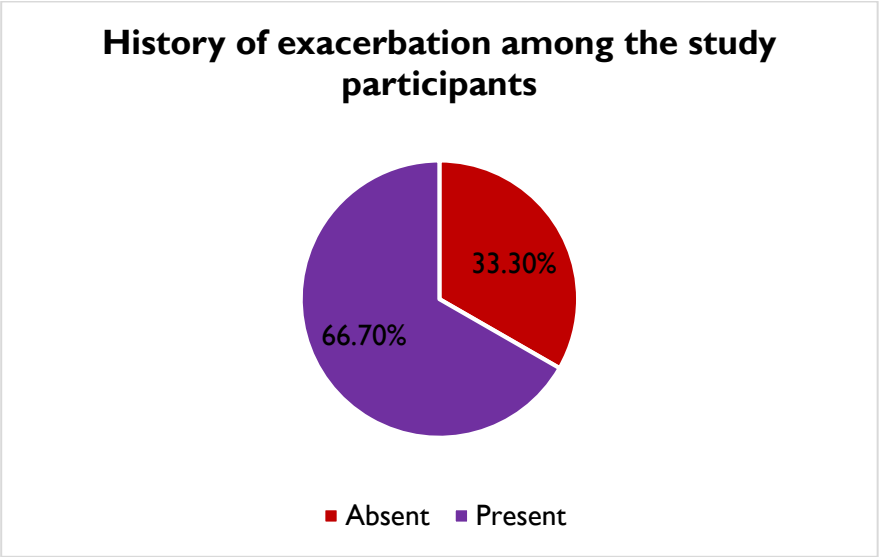
History of exacerbation among the study participants:

Table 5. History of exacerbation among the study participants

History of Exacerbation	Frequency	Percentage (%)
Absent	34	33.3
Present	68	66.7
Total	102	100.0

34 participants (33.3%) had no history of exacerbation, while 68 participants (66.7%) had a history of exacerbation.

Chart 5. History of exacerbation among the study participants



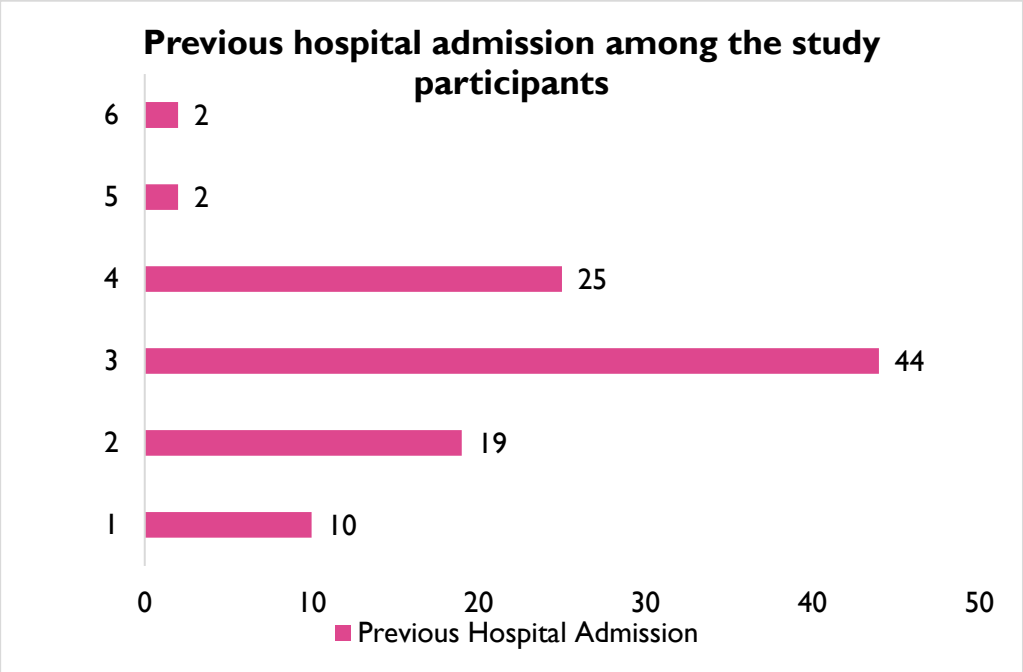
Previous hospital admission among the study participants:

Table 6. Previous hospital admission among the study participants

Previous Hospital Admission	Frequency	Percentage (%)
1	10	9.8
2	19	18.6
3	44	43.1
4	25	24.5
5	2	2.0
6	2	2.0
Total	102	100.0

The mean number of previous hospital admissions was 2.96 ± 1.04. 10 participants (9.8%) had one previous hospital admission, 19 participants (18.6%) had two, 44 participants (43.1%) had three, 25 participants (24.5%) had four, and 2 participants each (2.0%) had five and six previous hospital admissions.

Chart 6. Previous hospital admission among the study participants



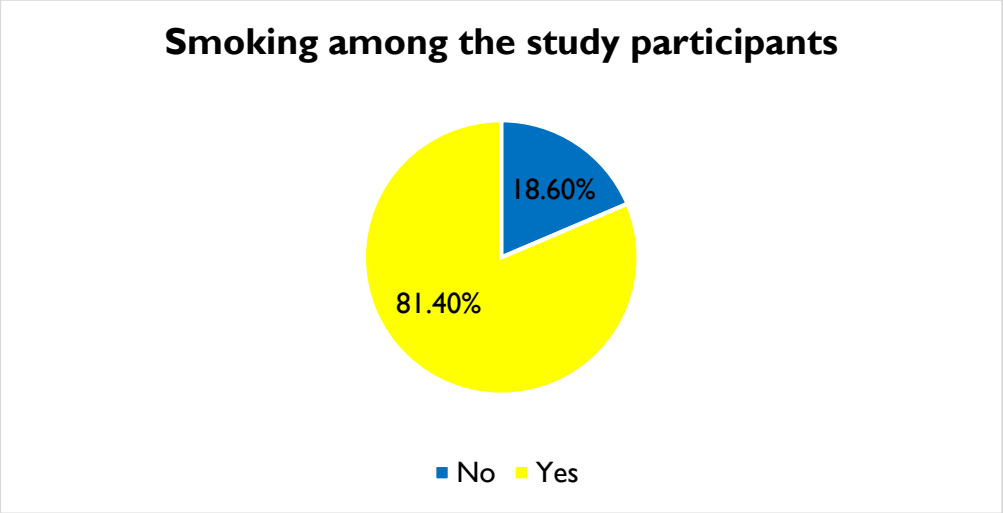
Smoking among the study participants:

Table 7. Smoking among the study participants

Smoking	Frequency	Percentage (%)
No	19	18.6
Yes	83	81.4
Total	102	100.0

19 participants (18.6%) were non-smokers, while 83 participants (81.4%) were smokers.

Chart 7. Smoking among the study participants



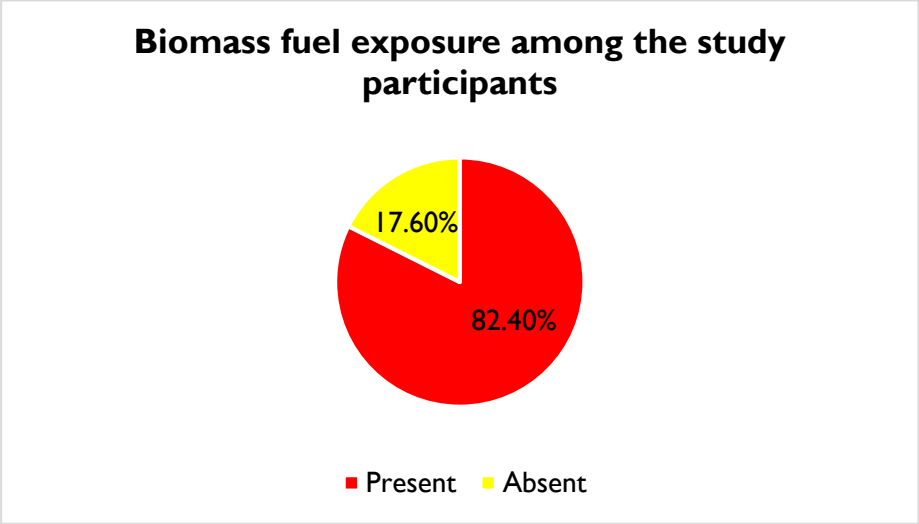
Biomass fuel exposure among the study participants:

Table 8. Biomass fuel exposure among the study participants

Biomass Fuel Exposure	Frequency	Percentage (%)
Absent	18	17.6
Present	84	82.4
Total	102	100.0

18 participants (17.6%) had no biomass fuel exposure, while 84 participants (82.4%) had biomass fuel exposure.

Chart 8. Biomass fuel exposure among the study participants



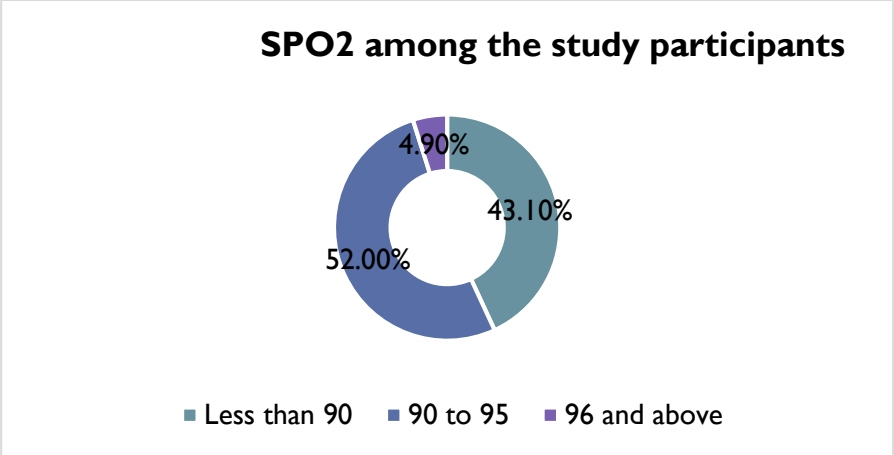
SPO2 among the study participants:

Table 9. SPO2 among the study participants

SPO2 Level	Frequency	Percentage (%)
Less than 90	44	43.1
90 to 95	53	52
96 and above	5	4.9
Total	102	100.0

The mean SPO2 was 90.40 ± 2.51%. The mean CAT score was 20.11 ± 4.44. 44 participants (43.1%) had an SPO2 level of less than 90, 53 participants (52.0%) had an SPO2 level between 90 and 95, and 5 participants (4.9%) had an SPO2 level of 96 and above.

Chart 9. SPO2 among the study participants



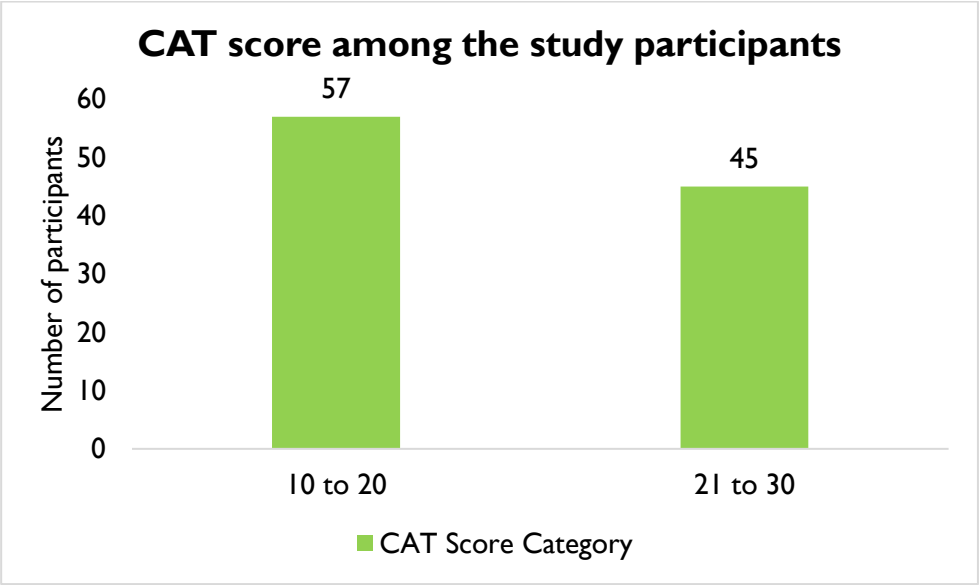
CAT score among the study participants:

Table 10. CAT score among the study participants

CAT Score Category	Frequency	Percentage (%)
10 to 20	57	55.9
21 to 30	45	44.1
Total	102	100.0

57 participants (55.9%) had a CAT score between 10 and 20, and 45 participants (44.1%) had a CAT score between 21 and 30.

Chart 10. CAT score among the study participants



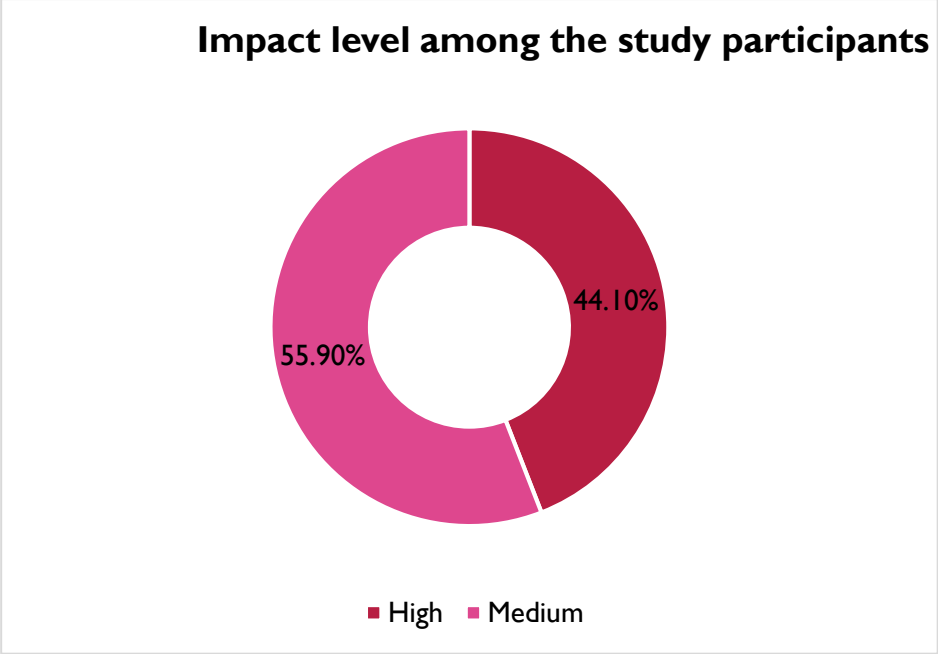
Impact level among the study participants:

Table 11. Impact level among the study participants

Impact Level	Frequency	Percentage (%)
High	45	44.1
Medium	57	55.9
Total	102	100.0

45 participants (44.1%) were classified as having a high impact level, while 57 participants (55.9%) were classified as having a medium impact level.

Chart 11. Impact level among the study participants



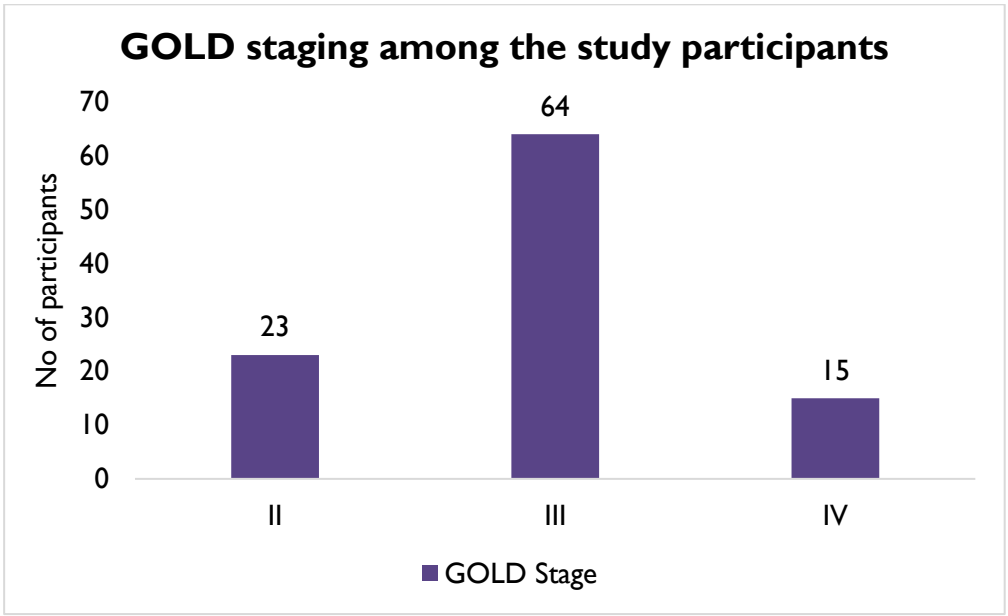
GOLD staging among the study participants:

Table 12. GOLD staging among the study participants

GOLD Stage	Frequency	Percentage (%)
II	23	22.5
III	64	62.7
IV	15	14.7
Total	102	100.0

23 participants (22.5%) were in GOLD stage II, 64 participants (62.7%) were in GOLD stage III, and 15 participants (14.7%) were in GOLD stage IV.

Chart 12. GOLD staging among the study participants



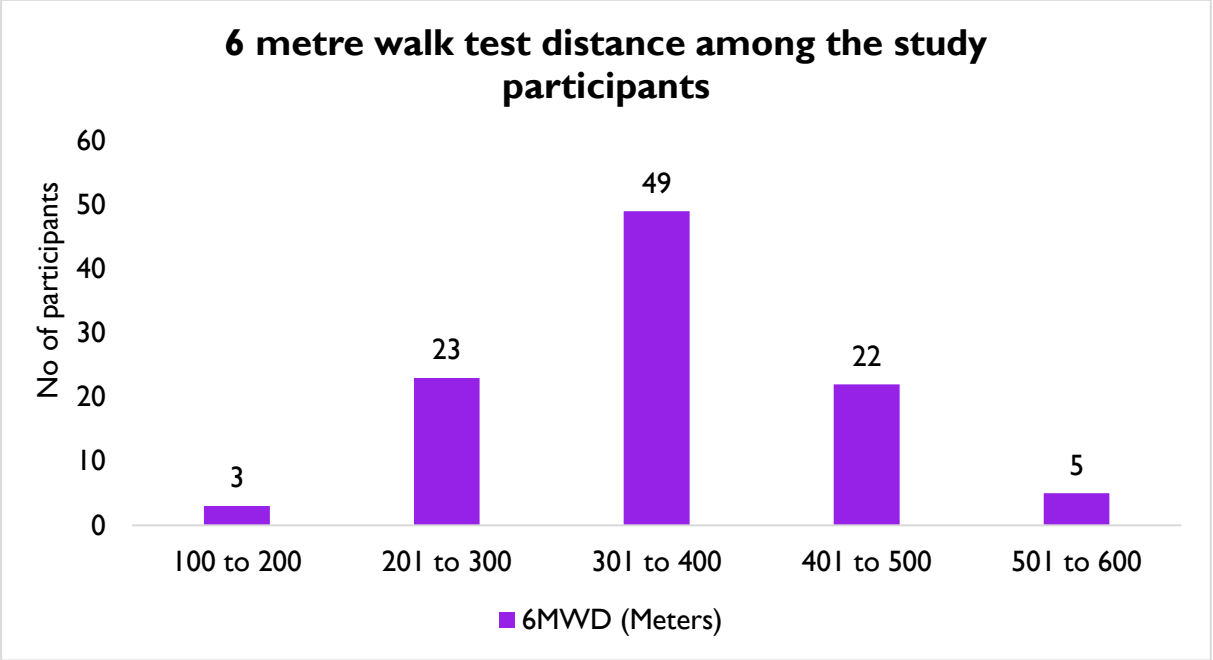
6 metre walk test distance among the study participants:

Table 13. 6 metre walk test distance among the study participants

6MWD (Meters)	Frequency	Percentage (%)
100 to 200	3	2.9
201 to 300	23	22.5
301 to 400	49	48.0
401 to 500	22	21.6
501 to 600	5	4.9
Total	102	100.0

The mean 6-minute walk distance (6MWD) was 359.59 ± 87.23 meters. 3 participants (2.9%) walked between 100 to 200 meters, 23 participants (22.5%) walked between 201 to 300 meters, 49 participants (48.0%) walked between 301 to 400 meters, 22 participants (21.6%) walked between 401 to 500 meters, and 5 participants (4.9%) walked between 501 to 600 meters.

Chart 13. 6 metre walk test distance among the study participants



FEV1 ratio among the study participants:

The mean post FEV1/FVC ratio was 0.56 ± 0.10. The mean post FVC% was 57.25 ± 14.07, and the mean post FEV1 was 41.50 ± 12.31.

Association between Age and 6 metre walk distance test among the study participants:

Table 14. Association between Age and 6 metre walk distance test among the study participants

Age Category	100 to 200	201 To 300	301 to 400	401 to 500	501 to 600	Total	Chi-square value	P value
41 to 50	0	2 (6.5%)	7 (22.6%)	18 (58.1%)	4 (12.9%)	31 (100.0%)	32.24	**0.001***
51 to 60	0	6 (12%)	39 (78%)	4 (8%)	1 (2%)	50 (100.0%)		
61 to 70	3 (14.3%)	15 (71.4%)	3 (14.3%)	0	0	21 (100.0%)		
Total	3 (2.9%)	23 (22.5%)	49 (48.0%)	22 (21.6%)	5 (4.9%)	102 (100.0%)		

*-statistically significant by Chi square test

Among participants aged 41 to 50 years, 2 participants (6.5%) walked between 201 to 300 meters, 7 participants (22.6%) walked between 301 to 400 meters, 18 participants (58.1%) walked between 401 to 500 meters, and 4 participants (12.9%) walked between 501 to 600 meters. In the 51 to 60 years age group, 6 participants (12.0%) walked between 201 to 300 meters, 39 participants (78.0%) walked between 301 to 400 meters, 4 participants (8.0%) walked between 401 to 500 meters, and 1 participant (2.0%) walked between 501 to 600 meters. Among participants aged 61 to 70 years, 3 participants (14.3%) walked between 100 to 200 meters, 15 participants (71.4%) walked between 201 to 300 meters, and 3 participants (14.3%) walked

between 301 to 400 meters. The chi-square value for the association between age category and 6-meter walk distance was 32.24, with a p-value of 0.001, indicating a statistically significant association.

Association between Gender and 6 metre walk distance test among the study participants:

Table 15. Association between Gender and 6 metre walk distance test among the study participants

Gender	100 to 200	201 to 300	301 to 400	401 to 500	501 to 600	Total	Chi-square value	P value
Female	3 (4.5%)	15 (22.4%)	30 (44.8%)	16 (23.9%)	3 (4.5%)	67 (100.0%)	2.55	0.63
Male	0 (0.0%)	8 (22.9%)	19 (54.3%)	6 (17.1%)	2 (5.7%)	35 (100.0%)		
Total	3 (2.9%)	23 (22.5%)	49 (48.0%)	22 (21.6%)	5 (4.9%)	102 (100.0%)		

Among female participants, 3 participants (4.5%) walked between 100 to 200 meters, 15 participants (22.4%) walked between 201 to 300 meters, 30 participants (44.8%) walked between 301 to 400 meters, 16 participants (23.9%) walked between 401 to 500 meters, and 3 participants (4.5%) walked between 501 to 600 meters, with a total of 67 female participants (100.0%). Among male participants, no participants (0.0%) walked between 100 to 200 meters, 8 participants (22.9%) walked between 201 to 300 meters, 19 participants (54.3%) walked between 301 to 400 meters, 6 participants (17.1%) walked between 401 to 500 meters, and 2 participants (5.7%) walked between 501 to 600 meters, with a total of 35 male participants (100.0%). The chi-square value for the association between gender and 6MWD is 2.55, with a p-value of 0.63, indicating no significant association.

Association between mMRC (dyspnoea) and 6 metre walk distance test among the study participants:

Table 16. Association between mMRC (dyspnoea) and 6 metre walk distance test among the study participants

Dyspnea (mMRC)	100 to 200	201 to 300	301 to 400	401 to 500	501 to 600	Total	Chi-square value	P value
mMRC-2	0	2 (3.1%)	39 (60%)	19 (29.2%)	5 (7.7%)	65 (100.0%)	41.24	**0.001***
mMRC-3	0	9 (40.9%)	10 (45.5%)	3 (13.6%)	0	22 (100.0%)		
mMRC-4	3 (20%)	12 (80%)	0	0	0	15 (100.0%)		
Total	3 (2.9%)	23 (22.5%)	49 (48.0%)	22 (21.6%)	5 (4.9%)	102 (100.0%)		

*- statistically significant by Chi square test

Among participants with an mMRC-2 score, 2 participants (3.1%) walked between 201 to 300 meters, 39 participants (60.0%) walked between 301 to 400 meters, 19 participants (29.2%) walked between 401 to 500 meters, and 5 participants (7.7%) walked between 501 to 600 meters, with a total of 65 participants (100.0%). Among participants with an mMRC-3 score, 9 participants (40.9%) walked between 201 to 300 meters, 10 participants (45.5%) walked between 301 to 400 meters, and 3 participants (13.6%) walked between 401 to 500 meters, with no participants (0.0%) walking between 100 to 200 meters or 501 to 600 meters,

with a total of 22 participants (100.0%). For participants with an mMRC-4 score, 3 participants (20.0%) walked between 100 to 200 meters, and 12 participants (80.0%) walked between 201 to 300 meters, with no participants (0.0%) walking between 301 to 400 meters, 401 to 500 meters, or 501 to 600 meters, with a total of 15 participants (100.0%). The chi-square value for the association between dyspnea (mMRC) and 6MWD was 41.24, with a p-value of 0.001, indicating a statistically significant association.

DISCUSSION

Chronic obstructive pulmonary disease (COPD) is a progressive respiratory condition characterized by airflow limitation, inflammation, and significant functional impairment. Assessing disease severity and its impact on patients' quality of life requires a combination of clinical, spirometric, and functional evaluations. The six-minute walk test (6MWT) has emerged as a valuable tool for evaluating exercise capacity, particularly in settings with limited access to spirometry. [7, 8] This study aimed to explore the relationship between 6MWT, spirometry indices, and COPD Assessment Test (CAT) scores among patients with COPD exacerbations, providing a comprehensive assessment of disease severity and functional status.

The current study revealed a significant association between age and six-minute walk test (6MWT) distance (p=0.001), with younger participants walking longer distances compared to older ones. This finding aligns with Krishna et al12 who observed a negative correlation between age and 6MWT distance (p=0.0075), highlighting reduced exercise capacity in older participants. Similarly, Bainara et al11 demonstrated a linear decline in 6MWT distance with increasing age, reinforcing the impact of aging on functional exercise capacity. Dinakar et al68 also found a significant negative correlation between age and 6MWT distance (r=-0.384, p=0.00), further substantiating these findings. Zeng et al48 identified age as a significant predictor of 6MWT performance but emphasized that other factors, such as DLCO and CAT scores, might have stronger predictive value. [9,10]

In this study, no significant association was found between gender and 6MWT distance (p=0.63). This contrasts with findings from Chaudhary et al4 who reported statistically significant differences in 6MWT performance between males and females, with males generally walking longer distances. Similarly, Krishna et al12 observed gender-based differences, where males had better 6MWT outcomes than females. However, Zeng et al48 and Bainara et al11 found that while gender might play a role in 6MWT performance, other variables such as age, spirometry parameters, and comorbidities were more critical determinants of functional capacity. [11, 12]

The severity of dyspnea, assessed using the modified Medical Research Council (mMRC) scale, showed a significant association with 6MWT distance in this study (p=0.001). Participants with higher mMRC scores walked shorter distances, consistent with the findings of Dinakar et al68 who reported a significant negative correlation between 6MWT and mMRC grading (r=-0.559, p=0.00). Similarly, Chaudhary et al observed reduced 6MWT distances in patients with more severe dyspnea, supporting the relationship between breathlessness and diminished functional exercise capacity. Kurmi et al5 highlighted that patient with higher mMRC scores had significantly reduced 6MWT grades, reflecting greater disease severity. Zeng et al also confirmed mMRC as significant predictor of 6MWT outcomes, further validating the current study's findings. [13, 14]

This study found a significant negative correlation between CAT scores and the distance covered during the 6-Minute Walk Test (r = -0.432, p = 0.001), suggesting that higher CAT scores, which indicate poorer health status, were linked to reduced walking distances. These findings are consistent with those of Vengada Kiishnaraj et al2 who reported a significant negative correlation between CAT scores and 6MWT performance. Similarly, Win et al3 observed a moderate inverse relationship between CAT scores and 6MWT distances (r=-0.396, p=0.025), emphasizing the role of health status in determining exercise capacity. Zeng et al48 identified CAT scores as a significant predictor of 6MWT outcomes, linking higher CAT scores to reduced physical performance. Konjeti et al1 further confirmed that CAT scores are inversely correlated with 6MWT, highlighting the impact of disease burden on functional exercise capacity. [15, 16]

Smoking history was significantly associated with 6MWT performance in this study (p=0.04), with non-smokers walking longer distances than smokers. This is in agreement with findings from Krishna et al12 who reported a significant negative correlation between smoking index and 6MWT distance (p=0.0295), suggesting that smoking adversely affects exercise capacity. Chaudhary et al4 similarly observed reduced 6MWT distances in smokers, linking tobacco use to diminished pulmonary function. Bainara et al11 emphasized the negative impact of smoking on exercise performance in COPD patients, highlighting its contribution to disease progression. Rawul et al49 corroborated these findings, reporting that smoking history significantly affects 6MWT outcomes and overall functional capacity. [13, 14, 15, 16]

This study was conducted in a single centre. Conducting the study in multiple centres and a larger sample size is recommended in the future. Additionally, subjective measures such as patient effort during the 6MWT could introduce variability in results.

CONCLUSION

Our study demonstrates that the six-minute walk test is a valuable functional assessment tool in patients with COPD experiencing exacerbations, showing significant associations with age, dyspnea severity (mMRC), CAT scores, and smoking history. Patients with higher symptom burden and greater airflow limitation exhibited reduced walking distances, emphasizing the test's ability to reflect disease severity. Gender showed no significant influence on 6MWT performance. Given its simplicity, non-invasiveness, and strong correlation with clinical and symptomatic indices, the 6MWT can serve as an effective surrogate marker in settings

where spirometry is limited. Integrating 6MWT, CAT scoring, and spirometric evaluation provides a comprehensive assessment of COPD, enhancing clinical decision-making and patient management.

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