



## **Utilization of Chronic Obstructive Pulmonary Disease Assessment Test (CAT) in Patients with COPD in Low Resource Countries**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors AAA and GEE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OD and BA managed the analyses of the study. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Background:** Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disorder commonly assessed by spirometry and health related quality of life (HRQoL) questionnaires. COPD assessment test (CAT) is a new questionnaire used for HRQoL evaluation especially in a clinic setting.

**Aims:** To assess HRQoL using the CAT, and to determine the relationship of CAT to other measures of COPD such as pulmonary function test (PFT), dyspnea and six minutes walking distance test (6MDWT) among patients with COPD in Nigeria.

**Settings and Design:** Cross-sectional study.

**Methods:** Sixty stable patients with a clinical and spirometric diagnosis of COPD according to the

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GOLD criteria were recruited into the study. Spirometry was performed according to ATS/ERS guidelines. Health status, dyspnea and functional capacity of the patients were assessed using the CAT questionnaire, modified medical research council (MMRC) dyspnea scale and six-minute walking distance (6MDWT) respectively.

**Results:** The mean age was 68.8 years  $\pm$  10.3. Sixty percent of the study participants were male. The mean BMI was 21.6  $\pm$  4.8 kg/m<sup>2</sup>, 37(61.7%) of the patients were ex-smokers, 3.3% were current smokers and 35% were never smokers. In terms of frequency of exacerbations 18.3% had  $\leq$  1 per year and 5.0% had  $\geq$  2 per year. The CAT was strongly associated with 6MDWT ( $r = 0.85$ ,  $P < 0.001$ ), FEV1% predicted ( $r = 0.67$ ,  $P < 0.001$ ) and with MMRC ( $r = 0.64$ ,  $p < 0.01$ ).

**Conclusions:** CAT scores correlated well with percent FEV1, dyspnea and exercise tolerance which measures various aspect of COPD. It may serve as an easy to administer sensitive tool in assessing stable COPD in outpatient clinics especially in low resource countries.

*Keywords: Utility; COPD assessment test; low resource countries.*

## 1. INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major public health challenge in both high and low-income countries [1]. Current evidence suggests that the global burden of COPD is substantial and it is on the increase at alarming rates across different countries [2,3]. This trend is mostly due to the changing demographics and increase in exposure to the risk factors of COPD. It is projected to become the 3<sup>rd</sup> leading cause of death of 2030 worldwide, and most of these deaths occur in middle and low-income countries [4]. In Nigeria, the overall prevalence of COPD is estimated to be 7.7% [5]. The disease is frequently under-recognized by the individual and under diagnosed by physicians without spirometry [6,7]. As a result, patients with COPD are usually undertreated and they suffer greatly from the disease. COPD is traditionally assessed with pulmonary function test (PFT), health related quality of life, exercise testing etc. unfortunately PFT which is frequently used to assess COPD patients does not provide a holistic assessment of the disease [8]. Studies have shown that PFT measurement do not correlate well with the disease progression and severity [9]. Furthermore, pulmonary function test is not a good predictor of exacerbations which have been shown from previous studies to be a major determinant in the progression of the disease [10]. Finally, COPD is frequently associated with other co-morbid medical conditions which have been shown to affect the individual's health and complete well-being, but this condition cannot be adequately assessed with PFT [11,12].

Health related quality of life (HRQoL) questionnaire are psychometric tools that are designed to assess various aspect of COPD in a systematic and cumulative manner, which on

their own cannot be easily measured by PFT [13-15]. One of the relatively new HRQoL tools is the COPD Assessment Test (CAT) [16-18]. It takes a short time to administer, its result is readily available for clinical use as compared to other tools that are cumbersome and time consuming, considering the busy clinic schedules. The relationships of CAT to other outcome measures like lung function test, dyspnea and six-minute walking distance test has not been well investigated among patients with COPD especially in sub-Saharan Africa.

Objectives of this study were; to assess HRQoL, and determine relationship of HRQoL to other measures such as the pulmonary function test (PFT), dyspnea and six minutes walking distance (6MDWT) in COPD patients. Also, to determine if the CAT can be use as a surrogate tool in assessing patients with COPD especially those living in countries with low health resources (where diagnosis and assessment of the disease severity is often inadequate).

## 2. MATERIALS AND METHODS

### 2.1 Study Design

This was a cross-sectional study.

### 2.2 Study Population

The study population is comprised of sixty patients with COPD, recruited consecutively from the medicine outpatients' clinic of the Obafemi Awolowo University Teaching Hospital, Ile-Ife, Nigeria. Patients selection was based on those who met the criteria for COPD diagnosis as defined by the Global initiative for chronic Obstructive Lung Disease (GOLD) guideline. The post-bronchodilator ventilatory ratio of forced

expiratory volume in one second (FEV1) to forced vital capacity of less than 70% and reversibility of <12% change in post-bronchodilator FEV1 and/or change of less than 200 ml with the administration of short-acting  $\beta_2$  agonist (400  $\mu$ g salbutamol). Patients were recruited consecutively as they presented to the clinic.

### 2.3 Measurements

Patients enrolled into the study were assessed using the following: questionnaire, health status, spirometry, and functional status.

### 2.4 Questionnaire

A modified version of the chronic respiratory disease questionnaire was used to obtain information on socio-demographic characteristics, respiratory symptoms and risk factors for COPD. Other clinical features and anthropometric measurement of the patients such as height were obtained using a wall-mounted stadiometer on a flat surface, patients barefooted, and to the nearest centimetre. Weight was measured to the nearest 0.1 kilograms using a digital weighing scale. The body mass index was extrapolated as a ratio of the measured weight in kilograms to the square of the measured height in meters squared ( $\text{kg}/\text{m}^2$ ).

### 2.5 Health-related Quality of Life

HRQoL was assessed using the chronic obstructive pulmonary disease Assessment Test (CAT) questionnaire. All patients self-completed the CAT questionnaire before the six-minute walk test.

### 2.6 Pulmonary Function Test

Patients' pulmonary function was assessed by spirometry. The spirometry was performed using the spiro-lab II spirometer manufactured by Medical International Research (MIR) based on ATS/ERS guidelines [19]. The best of the eight (8) spirograms which met the acceptability and reproducibility criteria was recorded. All lung function tests were performed at the same time of the day between 8 am to 12 noon to prevent intraday variability. A regular calibration check was performed on the spirometer weekly before the start of the PFT. Parameters measured included Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), and the

Ventilatory ratio of FEV1/FVC. The absolute and percentage predicted values were recorded. The reference values were based on the African descent values on the Spiro lab II software.

### 2.7 Functional Status

The functional status which measures the ability to meet the basic requirement of daily living was assessed by 6-minutes' walk test according to the set guidelines of the American Thoracic Society [20]. The total distance covered was recorded in nearest meters.

### 2.8 Data Analysis

Data was double entered into Epi Info software, clean, verified, validated and analysed with SPSS statistical software. Descriptive analysis was used to express proportions of interest. Categorical variables were tested by Chi Square and p-value. Continuous variable at different levels of CAT score was tested using analysis of variance (ANOVA) and p-value. The Pearson's test was used to assess for possible correlation between levels of dyspnea, six-minute walking distance and lung function and CAT.

## 3. RESULTS AND DISCUSSION

The demographic and general characteristic of the COPD patients in this study is presented in Table 1. The mean age of patients (n=60) was  $68.8 \pm 10.4$  years, with 36 (60%) of the patients being males. Thirty-nine (65%) of patients were either currently smoking or ex-smokers with mean pack years of  $11.8 \pm 2.0$ . In terms of categorization of severity of the disease by the GOLD criteria; 19 (31.7%), 20 (33.3%) 13 (21.7%) had moderate, severe and very severe airflow limitations respectively. Only a small proportion of the patients 8 (13.3%) had mild airflow limitation. More than half of the patients (65%) had dyspnea rating of MMRC grade 1 and below.

The results of the pulmonary function test including the mean post bronchodilator FEV1, FVC and ventilation ratio, the mean CAT scores and the six-minute walking distance covered by the patients across the categories of severity of the disease are represented in Table 2. There was a progressive decline of the air flow by FEV<sub>1</sub> from low impact level with measurements of  $1.9 \pm 0.6$  L to the very high impact level with  $0.5 \pm 0.1$  L. A similar pattern was observed for the

post-bronchodilation FVC, FEV1/FVC and the percentage predicted values for low, medium, high and very high impairment of patients' quality of life.

**Table 1. Socio-demographic characteristics of the study population**

Variables	Low/ medium (n= 44)	High/ very high (n=16)	Total (%)	P value
<b>Sex</b>				
Male	25	11	36(60)	0.50
Female	19	5	24(40)	
<b>Educational status</b>				
None	12	4	16 (26.7)	0.25
Primary	22	4	26 (43.3)	
Secondary	8	5	13(21.7)	
Post-secondary	2	3	5(8.3)	
<b>Smoking status</b>				
Current / Ex-smoker	31	8	39(65)	0.42
Non smoker	13	8	21(35)	
<b>Freq. of Exacerbation</b>				
None	36	10	46(76.7)	0.13
<1	6	5	11(18.3)	
>2	2	1	3(5)	
<b>Breathlessness</b>				
MMRC0	8	1	9 (15)	0.001
MMRC1	28	2	30(50)	
MMRC2	7	9	16(26.7)	
MMRC3	1	4	5(8.3)	
<b>GOLD staging</b>				
Mild	8	-	8(13.3)	0.001
Moderate	17	2	19 (31.7)	
Severe	15	5	20(33.3)	
Very severe	4	9	13 (21.7)	

*GOLD = Global burden of obstructive lung diseases, MMRC= Modified medical research dyspnea scale, CAT = COPD assessment test*

**Table 2. Categorization of patient's PFT, 6MDWT, into different levels of CAT scores**

CAT category	Low (<10) Mean (±SD)	Medium (10-20) Mean (±SD)	High (20-30) Mean (±SD)	Very high (>30) Mean (±SD)
Age	65.0 ±12.1	70.0 ± 14.9	68.0± 8.2	72.0 ±15.0
BMI	23.5 ±2.7	20.8 ±5.4	19.2 ±3.8	18.8 ±1.8
CAT scores	7.9 ±2.4	15.2 ±2.7	22.1±1.8	32.0 ±2.0
Pre-BD PEF (L)	4.8 ±2.2	2.6 ±1.6	2.0 ±0.7	1.0 ±0.3
Pre-BD FEV1 (L)	1.9 ±0.7	1.1 ±0.5	0.8±0.3	0.4 ±0.1
Pre-BD FVC (L)	1.9 ±0.5	1.9 ±0.7	1.5 ±0.4	0.9 ±0.4
Post-BD PEF (L)	4.2 ±1.9	2.3 ±1.2	2.3± 0.9	1.2 ±0.5
Post-BD FEV1 (L)	1.9 ±0.6	1.1 ±0.5	0.9± 0.3	0.5 ±0.1
Post-BD FVC (L)	3.1 ±0.7	2.0 ±0.7	1.7± 0.5	1.2 ±0.5
Pre BD FEV1 predicted %	83.4 ±19.0	50.1 ±14.9	38.2 ±13.8	18.0 ±2.0
Pre BD FVC predicted %	101.7 ±20.6	69.1 ±15.0	57.1 ±15.0	32.3 ±11.9
Post-BDFEV1predicted %	85.0 ±13.0	53.0 ±16.0	39.0 ±14.0	23.0 ±6.0
Post-BDFVC predicted %	110.0 ±8.0	73.0 ±15.0	63.0 ±13.0	52.0 ±18.0
Pre BD- FEV1/FVC	65.6 ±3.1	55.8 ±9.7	52.3 ±9.3	48.5 ±18.5
Post-BD FEV1/FVC	63.0 ±10.0	57.0 ±10.0	54.0 ±7.0	46.0 ±16.0
6MDWT (m)	410.0 ±35.4	291.0 ±4.1	215.0 ±3.0	123.3 ±5.9

*\*CAT = COPD assessment test, PFT= Pulmonary function test, BMI= Body mass index, BD = Bronchodilation, PEF= Peak expiratory flow, FEV1= Forced expiratory volume, FVC= Forced vital capacity, 6MWD= Six-minute walk test distance, L= Litres, m = Meters*

**Table 3. Correlation test between CAT scores, lung function test and 6MDWT**

Variable	Correlation coefficient ( $\rho$ )	P value
MMRC	0.64	0.01
Post-BD FEV <sub>1</sub>	0.75	0.001
Post-BD FVC	0.68	0.001
GOLD staging COPD	-0.67	0.001
6MDWT	-0.85	<0.0001

\* CAT = COPD assessment test, MMRC= Modified medical research council dyspnea, BD= Bronchodilation, FEV<sub>1</sub>= Forced expiratory volume, FVC= Forced vital capacity, 6MDWT = Six-minute walk test distance

Table 3 shows results of the correlation test between the cat scores, lung function measurements and six-minute walk distance. The post-bronchodilation FEV<sub>1</sub> and FVC demonstrated moderate to strong correlation coefficient with the CAT scores; CAT vs. FEV<sub>1</sub> ( $r = 0.75$ ,  $p = 0.001$ ); CAT vs. FVC ( $r = 0.68$ ,  $p = 0.001$ ). The ventilation ratio FEV<sub>1</sub>/FVC showed weak correlation coefficients. CAT vs. Ratio FEV<sub>1</sub>/FVC' ( $r = 0.42$ ,  $p = 0.001$ ). The FEV<sub>1</sub> has the strongest correlation compared to the other lung function variable. Finally, there was a strong correlation between 6MDWT and the cat scores. The relationship was statistically significant ( $r = 0.85$ ,  $p < 0.001$ ).

### 3.1 Discussion

Chronic Obstructive Pulmonary Disease (COPD) is a multisystem disorder. The present study was designed to assess the health-related quality of life of COPD patients using a simple clinic-based questionnaire and to assess for its correlation with other traditional outcome measures of the disease.

The present study was able to identify that a substantial proportion of our patients already had significant impairment in their health-related quality of life. In addition, from the pulmonary function test conducted, 55% of the patients already have severe to very severe airflow limitation by GOLD staging of COPD. This finding is similar to previous observation made by Obaseki and his colleagues [21]. Although staging of the disease severity with the GOLD classification identified more patients with advanced disease, it is not a good predictor of disease severity and progression. In this study we observed a significant inverse correlation between the FEV<sub>1</sub> and the CAT scores and groups. This result suggests that as the FEV<sub>1</sub> declines, the CAT score will increase with its associated impairment in the patients' health related quality of life. Similar observations were made for FVC, ratio FEV<sub>1</sub>/FVC and their

percentage predicted values. Measuring the FEV<sub>1</sub> and HRQoL at the same time may be complementary to each other in the assessment of the disease.

**CAT and MMRC dyspnea scale:** This study also showed a significant association between patient's symptoms assessed by MMRC dyspnea scale and health-related quality of life scores. Patients with worse dyspnea level have higher CAT scores than those with mild dyspnea. The MMRC is a simple and valid surrogate tool for which assesses the level of disability of the patient's symptom of COPD and by extension the disease severity. This observation is in agreement with a previous study conducted by Jones and his colleagues who demonstrated that patients with less severe MMRC dyspnea scale (only breathlessness with strenuous activity) have significant impairment in their quality of life scores [22]. Even patients with less severe MMRC dyspnea scale (only breathlessness with strenuous activity) already have significant impairment in their quality of life scores. Also, in the same study they observe that patients with scores CAT  $\geq 10$  are more likely to have significant impairment in their activities of daily living, get fatigued easily and present with more symptoms of breathlessness. Higher CAT scores are associated with worse health status.

Finally, the CAT scores and the 6MDWT distance showed a statically significant association. The 6MDWT is a standardized, reliable, well-tolerated test for assessing the functional status of patients with COPD. In this study; The functional status diminishes across all severity stages of COPD patients. In addition, the CAT score had a strong negative correlation with total distance covered in six minutes. This finding is not surprising because of the prolonged period of physical inactivity and muscle mass depletion which is commonly associated with COPD patients affect their functional status negatively [23-26].

#### 4. STUDY LIMITATION

This study has some limitations; the first is that only few of the COPD patients had a severely impaired HRQoL. The present study only represents patients with mild to moderate impairment of HRQoL. Further investigations are required to assess patients with severe impairment. The second major limitation is that of the relatively small size of patients used in this study. We recommend a large community base study to validate our findings'.

#### 5. CONCLUSION

Assessing COPD is complex and would require measuring both physical (pulmonary and non-pulmonary) and psychosocial factors. This study has demonstrated variable correlation between CAT score and other patient reported outcome measures of COPD. This suggests that CAT questionnaire can measure different aspects of the effects of the disease. The CAT can serve as a surrogate tool for assessing patient with copd and we recommend its routine usage especially in resource constrained population where spirometry may be absent and busy clinic schedules will not permit routine assessment of other traditional outcome measures of COPD.

#### ETHICAL APPROVAL AND CONSENT

Ethical approval for the study was obtained from the Ethics and Research Committee of the OAUTHC, Ile-Ife. All participants were provided with a patient information sheet containing the details of the research and their participation. Written informed consent was obtained from all the participants.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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