PEAK EXPIRATORY FLOW AS A SURROGATE FOR HEALTH RELATED QUALITY OF LIFE IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE: A PRELIMINARY CROSS SECTIONAL STUDY

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SUMMARY

Background: Health Related Quality of Life (HRQL) measures can capture the non-respiratory effects of Chronic Obstructive Pulmonary Disease (COPD). However the relationship with Peak Expiratory Flow (PEF) is not well understood

Aim: To determine the relationship of PEF and quality of life measurements in patients with COPD

Settings and Design: A cross section of consecutive patients in a university clinic

Methods: Stable patients with COPD defined by the Global Initiative on chronic Obstructive Lung Disease (GOLD) criteria, were recruited into the study. Spirometry was done using American Thoracic Society's standards and reference equations from African American norms of the US population. Quality of life was measured with the St George's Respiratory Questionnaire (SGRQ)

Results: Out of 50 patients recruited for the study, 48 provided complete data with acceptable spirometry and PEF data. The mean (SD) age and body mass index was 68.4 (8.9) years and 21.4 (4.6) kg/m^2 respectively and 96% of the patients were in moderate-severe stages of COPD using the GOLD criteria. Percent predicted PEF correlated with percent predicted FEV1; r= 0.559 p<0.001 and also showed a significant, though moderate correlation between PEF readings and SGRQ scores especially in the activity (r= -0.455 p< 0.01) and total scores (r=-0.415 p<0.01) for pre bronchodilator (BD) percent predicted PEF. In regression analysis, PEF was associated with SGRQ (-0.11 95% CI -0.19, -0.03) after adjusting for age, sex, height, smoking and disease severity

Conclusions: PEF correlates with SGRQ scores and may be a useful surrogate for HRQL in patients with COPD

Key words: Peak expiratory flow, quality of life, spirometry, primary care

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a respiratory disorder of significant public health importance. It is presently ranked as the third most important cause of death worldwide.[1] A diagnosis of COPD is established by a post bronchodilator (BD) forced expiratory volume in the first second (FEV1)/forced vital capacity (FVC) ratio of less than 0.7 [2] or the lower limit of normal (LLN).[3] It is largely under diagnosed in developing countries for various reasons including lack of affordable spirometers in primary care settings.[4]

Though the peak flow meter have been dismissed as unreliable for diagnosing COPD,[5,6] recent reports suggests that peak flow measurements may be an inexpensive way of screening[7] and initial identification of severe cases of COPD for subsequent confirmatory spirometry.[8,9] However COPD is a multi-systemic disease with extra-pulmonary manifestations that often elude spirometric assessment.[10,11]

Quality of life is an important criterion in the assessment of the impact and treatment outcome in patients with COPD. Quality of life scores assess an individual's ability to perform and derive satisfaction from activities of daily living such as social role functioning, home management, social and family relationships, self-care, mobility, recreation and hobbies.[12]

Quality of life questionnaires are commonly used to capture the non-respiratory manifestations of COPD but they are often difficult to complete in busy clinics especially in low literacy settings as in many developing countries. Peak flow meters could potentially serve as tools both for screening and for providing a measure of health related quality of life in COPD. It is thus imperative to understand how measures of peak expiratory flow (PEF) relate with quality of life scores.

We undertook a cross sectional assessment of patients with COPD to determine the relationship between PEF and quality of life measurements using the St George's Respiratory Questionnaire (SGRQ).

METHODS

Study Design

It was a cross sectional study. Stable patients with COPD were recruited consecutively from the outpatient respiratory clinic of Obafemi Awolowo University (OAU) teaching hospital, Ile-Ife, Nigeria. Inclusion criteria included a previous diagnosis of COPD based on a post bronchodilator FEV1/FVC ratio below 0.7. Patients were also further categorized into stages of disease severity using the criteria defined by the Global initiative for chronic Obstructive Lung Disease (GOLD). [2]

Patients were judged as stable if there was no history of recent worsening of symptoms, hospitalization or change in their medications over the preceding six weeks before presentation in the clinic.

Measurements

Health Status

Health related quality of life (HRQL) was assessed using the St George's Respiratory Questionnaire (SGRQ).[13] The SGRQ is a weighted questionnaire that has been shown to be valid, reliable and reproducible in patients with COPD. It contains 50 items with 76 weighted responses that cover three domains: symptoms – distress due to respiratory symptoms, activity – disturbances of physical activity and impact – overall impact on daily life and well-being.

In addition to the domain scores, there is also a total score.[14] The SGRQ is scaled from zero to 100 (with zero representing the best health-related quality of life). This questionnaire, which was forward and back translated in Yoruba language, was administered to each participant face to face by a trained interviewer.

Lung function

The FEV1 and FVC were measured using a standardized bellows spirometer (Vitalograph Ltd, Buckingham, England. 1997, Model 2150).

The PEF was measured using the mini-Wright peak flow meter.[15, 16] The parameters were assessed before and 20 minutes after the inhalation of 400µg of Salbutamol using a metered dose inhaler (MDI) and a spacer device. For spirometry, a minimum of three and a maximum of eight spirometry maneuvers were done according to ERS/ATS criteria.[17] The best three acceptable and reproducible maneuvers (within 200ml) were recorded for each patient.

For measurement of peak expiratory flow, patients were instructed to inhale to total lung capacity and exhale with a forceful blast. Three measurements were made and the best was recorded. The reference equation for the spirometry and PEF was derived from the African American norms of the third National Health and Nutrition Examination Survey (NHANES III).[18]

Other measurements

Height was measured without shoes to the nearest centimeter using a wall-mounted stadiometer while weight was measured without outer garment to the nearest 0.1 kilogram using a portable weight scale after zero calibration check.

Data analysis

The data was analyzed using Stata 11.2 statistical package (Stata Corp., College Station, TX, USA).[19] Continuous data were presented as means and standard deviations while categorical and discrete data were presented using proportions and frequencies. The SGRQ data was analyzed using the excel-based weighted scoring calculator developed in St George's Hospital.

Correlation coefficients between peak expiratory flow and the domains scores of the SGRQ was determined using spearman's correlation. Multiple linear regressions was used to determine the independent effect of PEF on SGRQ quality of life total scores after adjusting for the following co-variates- age, sex, height, smoking status and GOLD classification of disease severity. The best model was determined by changes in R squared value.

Ethical Clearance

The study protocol was approved by the ethics committee of Obafemi Awolowo University teaching hospital. Informed written consent was obtained from each study participant.

RESULTS

Out of 50 patients recruited for the study, 48 provided complete data with acceptable spirometry and PEF data and were included in the analysis.

The general characteristics of the patients included in the final analysis are shown in Table 1.

Forty percent of the respondents were female. The mean (SD) age and body mass index of the study population was 68.4 (8.9) years and 21.4 (4.6) kg/m^2 respectively. Fifty two percent of the patients had never smoked cigarette and almost all (96 %) of the patients were at least in moderate-severe stages of COPD using the GOLD criteria.

Table 1 Characteristics of the study participants

Variable	Mean ± SD or n (%)
Age (years)	68.4 ± 8.9
Height (cm)	161.9 ± 8.9
BMI (Kg/m2)	21.4 ± 4.6
Smoking Status	
Never	25 (52)
Previous	23 (48)
Current	-
GOLD Classification	
Mild	2 (4)
Moderate	12 (25)
Severe	20 (42)
Very Severe	14 (29)

SD - Standard Deviation; BMI – Body Mass Index; GOLD- Global initiative for chronic Obstructive Lung Disease
Post bronchodilator FEV1/FVC <0.7 & FEV1 ≥ 80% predicted (Mild); 50% <= FEV1 < 80% predicted (Moderate); 30% <=FEV1 < 50% predicted (Severe); FEV1 < 30% predicted (Very Severe). Proportions reported are based on the entire sample of patients.

Sixty five percent of the patients had peak flow readings below the acceptable lower limit of normal (LLN) for their age and height (Table 2). The mean (SD) of predicted post bronchodilator (post BD) PEF, FEV1, FVC and FEV1/FVC were 67.5 % (30.7), 40.7 % (17.4), 59.9 % (26.1) and 67.7 % (14.1) respectively.

In addition, there was a significant, though moderate correlation between PEF readings and SGRQ scores (Table 3). However the correlation between FEV1 and SGRQ scores were weak and generally not significant (Data not shown). The correlation between PEF and SGRQ was best in the activity and total scores.

The coefficients in the SGRQ activity score were r= -0.453 p<0.01 (pre BD PEF (l/min)), r= -0.455 p< 0.01 (pre BD % PEF), r= -0.469 p<0.001 (post BD PEF (l/min)) and r= -0.450 p<0.01 (post BD % PEF). The coefficients for the total scores were r=-0.370 p<0.01, r=-0.415 p<0.01, r=-0.435 p<0.01 and r=-0.431 p<0.01 for pre BD PEF l/min, pre BD % PEF, post BD PEF l/min and post BD % PEF respectively.
Peak expiratory flow was associated with SGRQ (-0.11 95% CI -0.19, -0.03) after adjusting for age, sex, height, smoking status and GOLD classification of severity (Table 4). This model explained 17% of the variability in SGRQ total score.

Table 2 Lung function and SGRQ scores of the participants

Variable	Mean ± SD or % (SE)
Pre BD PEF L/min	217.0 ± 91.2
Post BD PEF L/min	235.4 ± 100.6
Pre BD PEF (% Predicted)	62.2 ± 27.7
Post BD PEF (% Predicted)	67.5 ± 30.7
Pre BD FEV1 (L)	0.8 ± 0.4
Post BD FEV1 (L)	0.8 ± 0.4
Pre BD FEV1 (% Predicted)	39.7 ± 18.4
Post BD FEV1 (% Predicted)	40.7 ± 17.4
Pre BD FVC (L)	1.5 ± 0.6
Post BD FVC (L)	1.6 ± 0.6
Pre BD FVC (% Predicted)	57.5 ± 23.0
Post BD FVC (% Predicted)	59.9 ± 26.1
Pre BD FEV1/FVC (%)	52.2 ± 10.9
Post BD FEV1/FVC (%)	52.3 ± 11.3
Pre BD FEV1/FVC (% Predicted)	67.5 ± 13.6
Post BD FEV1/FVC (% Predicted)	67.7 ± 14.1
Post BD PEF<LLN *	64.6 (6.9)
Post BD FEV1 <LLN*	93.8 (3.5)
Post BD FVC <LLN*	81.3 (5.6)
Post BD FEV1/FVC <LLN*	91.6 (4.0)
SGRQ – Symptom	45.4 ± 26.9
SGRQ – Activity	49.3 ± 29.1
SGRQ – Impact	29.1 ± 19.9
SGRQ – Total	38.0 ± 22.1

Standard Deviation, SE – Standard Error, SGRQ - St George's Respiratory Questionnaire, BD – Bronchodilator, FEV1 – Forced expiratory volume in one second, FVC- Forced Vital Capacity, PEF – Peak Expiratory Flow, LLN – Lower Limit of Normal

*Represents proportions below the LLN and standard error based on prediction values derived from equations for African Americans in the third National Health and Nutrition Examination Survey (NHANES)

DISCUSSION

Our study showed that PEFR correlates with SGRQ quality of life scores in patients with COPD but explains a small proportion of the variance in quality of life after adjusting for age, sex, height, smoking status and disease severity. We also found that 64% of the patients had peak flow readings below the lower limit of normal for their age and height.

Our study provides preliminary data on the relationship between PEF and quality of life in patients with COPD, suggesting its possible utility as a surrogate for assessing quality of life in patients with COPD.

Table 3. Correlation coefficients between PEF, FEV1, FVC and SGRQ scores§

PEF	SGRQ				FEV1				FVC	
	Symptom	Activity	Impact	Total	Pre FEV1 (L)	Pre FEV1 (% Pred)	Post FEV1 (L)	Post FEV1 (% Pred)	Pre FVC (% Pred)	Post FVC (% Pred)
Pre BD PEF (L/min)	-0.394**	-0.453**	-0.281	-0.370**	0.649***	0.489***	0.591***	0.407***	0.394**	0.242
Pre BD PEF (% Predicted)	-0.394**	-0.455**	-0.353*	-0.415**	0.368*	0.559***	0.308*	0.505***	0.432**	0.321*
Post BD PEF (L/min)	-0.385**	-0.469***	-0.372**	-0.435**	0.686***	0.556***	0.633***	0.479***	0.417**	0.293*
Post BD PEF (% Predicted)	-0.344*	-0.450**	-0.431**	-0.458**	0.417**	0.661***	0.372**	0.612***	0.518***	0.432**

SGRQ - St George's Respiratory Questionnaire, PEF - Peak Expiratory Flow, BD – Bronchodilator, FEV1 – Forced expiratory volume in one second, FVC- Forced Vital Capacity. Pred- Predicted
SGRQ is divided into three subscores; 'symptom', 'activity', 'impact' and a 'total' score
'Pre' represents pre-bronchodilator test results while 'post' represents post-bronchodilator test results using salbutamol as a bronchodilating agent.
§ - Spearman's correlation coefficients
* $p<0.05$ ** $p<0.01$ *** $p<0.001$

Table 4 Multiple regression analysis of SGRQ total scores and peak expiratory flow rates

SGRQ Total	Coefficient	SE	95% CI		P value	Coefficient	SE	95% CI		P value
	Unadjusted					Adjusted				
Age	0.16	0.35	-0.55	0.87	0.66	0.15	0.34	-0.54	0.84	0.66
Sex	-6.99	6.34	-19.74	5.77	0.28	-12.57	9.86	-32.50	7.35	0.21
Height (cm)	0.03	0.36	-0.69	0.75	0.93	0.81	0.44	-0.07	1.69	0.07
Smoking Status	-2.27	6.30	-14.95	10.40	0.72	3.95	8.00	-12.20	20.11	0.62
GOLD Classification	6.94	3.57	-0.24	14.12	0.06	0.27	4.03	-7.87	8.40	0.95
Pre BD PEF	**-0.11**	**0.03**	**-0.17**	**-0.05**	**0.00**	**-0.11**	**0.04**	**-0.19**	**-0.03**	**0.01**
Intercept						-65.74	68.22	-203.51	72.03	0.34

SGRQ - St George's Respiratory Questionnaire, PEF – Peak Expiratory Flow, SE – Standard Error, CI – Confidence Interval

Adjusted coefficient of determination (R2)= 17%

We found strong correlation between PEF and FEV1 readings, moderate correlation between PEF and SGRQ but weak correlation between SGRQ and FEV1.

In a previous analysis,[20] we noted that the correlation between SGRQ scores and lung function parameters like FEV1 and FVC was weak, possibly suggesting that spirometry and quality of life are independent, albeit complementary modalities of evaluation of patients with COPD. PEF correlates with FEV1 but unlike FEV1, PEF also correlate with SGRQ quality of life scores (Table 3).
The relationship between PEF and quality of life in patients with COPD is possibly connected to daily changes in respiratory airflow capacity, ventilatory ability and sense of breathlessness, which impacts significantly on quality of life.

Though the diagnosis of COPD is spirometry-based,[2] it is worthwhile to note that there is no evidence to suggest that spirometry has an advantage over PEF in the day-to-day monitoring or management of patients with COPD,[21] neither is it time efficient or easier to perform.[22]
As a result, PEF measurements, even without bronchodilation, could provide useful and readily accessible information to the general practitioner or primary care physicians about the daily or short-term structural changes in the airway and its effect on quality of life.

We also observed that pre bronchodilator PEF predicts SGRQ quality of life score independent of age, sex, height, smoking status or severity of COPD. However, PEF explains a small percentage of the variability in

SGRQ scores and as such, there may be other parameters that also affect quality of life in COPD other than a simple measurement of the airflow status using a PEF meter.

There is very sparse information on the utility of PEF assessment as an outcome measure in COPD. Hansen and colleagues showed that PEF could be used to predict survival in patients with COPD.[23] They compared the utility of FEV1 and PEF for assessing outcome in a sample of 1095 patients with COPD who were initially enrolled in the Copenhagen City Study.[23] After a decade of follow up, they found the best PEF was at least equal to the best FEV1 as a predictor of overall mortality in subjects with COPD, after controlling for age, smoking, sex, and body mass index. They concluded that, ".... despite close correlation to FEV1, PEF provided independent prognostic information in patients with COPD".[23] The present study corroborates this finding and indicates that PEF may thus be invaluable in assessing the impact of COPD and for predicting its long-term outcome especially in primary care centres. However, there is clearly a need for large sensitivity studies on this subject.

Interestingly, we also observed that sixty five percent of the patients in our study population had low lung function parameters (FEV1 & FVC) compared with predicted values using reference equations for African Americans. Forced vital capacity has been shown to correlate with survival.[24] Populations with low forced vital capacity appear to suffer greater mortality however its determinants are poorly understood. Our population of patients was generally of the low socioeconomic class, a group known to have poor access to health care. It is unclear why our sample of patients had very low forced vital capacity and other lung parameters. This may probably be because the patients with COPD in our clinics appears quite late for treatment when they are already at advanced stages of the disease. Low lung function parameters may also suggest low maximally attained pre-morbid lung function and a subsequent rapid decline over time, a phenomenon described as 'horse racing'.[25, 26] Though this phenomenon cannot be evaluated in the present cross sectional study, it warrants further investigation.

It is important, however, to exercise caution in interpreting the results of the present study. Our sample comprised patients with moderate-severe cases of COPD and the results may not be applicable to all cases of COPD. Our PEF measurements were obtained separately from spirometry test using mini-Wright peak flow meters. This may not be entirely comparable with PEF readings obtained from spirometry manoevres as was done is previous studies.[8, 9] In addition, this study is limited by the small sample size. A larger study will provide more robust effect estimates.

Notwithstanding these limitations, this study adds to the body of evidence that shows that PEF meters may be veritable tools for evaluating patients especially in clinic settings. It also provides a simple measure of the expiratory flow and large airway caliber.

It is important for policy makers to encourage further research into the applicability of this simple and inexpensive device as a screening tool in COPD and as a marker of HRQL. This by no means suggests that spirometry should be replaced by PEF in the evaluation of ventilation but rather, in local clinics with no access to quality spirometry, a measure of PEF in patients with severe COPD can provide a reasonably good day-to-day indication of the lung function and quality of life status.

CONCLUSION

In conclusion we have shown that peak expiratory flow correlates with quality of life scores and may be an important simple measure for assessing both lung function and quality of life in patients with COPD in low-income primary care settings.

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