Medicine®

OPEN

Clinical assessment tests in evaluating patients with chronic obstructive pulmonary disease
A cross-sectional study

Ming-Lung Chuang, MD[a,b,*], I-Feng Lin, DrPH[c], Chai-Yuan Lee, RN, MS[d,*]

Abstract

Exertional dyspnea scales (EDS) and health-related quality-of-life questionnaires (HRQoLQs) are used to assess chronic obstructive pulmonary disease (COPD). The GOLD guidelines categorize patients according to either 1 of these 2 domains, the lung function and the frequency of acute exacerbations in the preceding year, however with inconsistent results. Combining EDS and HRQoLQs may yield better results; however, the best combination is unclear. Whether the EDS quantifies the exercise capacity or the dyspnea perception is also unclear. The study was designed to correlate the EDS with exercise capacity and dyspnea perception and to evaluate the best combination of the EDS and HRQoLQ.

Three EDS were compared by exercise capacity and Borg scores at rest and during exercise in 57 patients with COPD. Three HRQoLQs were compared by 4 domains of clinical assessments, and 2 types of exercise. The strength of correlation $|r|$ was categorized by quartiles from <0.3 to ≥ 0.6.

The EDS was better correlated with exercise capacities ($|r| = 0.29$–0.65, $P < 0.05$–<0.0001) than with the resting and exertional Borg scores ($|r| = 0.08$–0.55, $P = $ NS- <0.0001). The EDS were moderately to strongly interrelated, but this correlation was weaker when including Oxygen-cost Diagram (OCD) (with the modified Medical Research Council, mMRC $r = -0.56$, with the baseline dyspnea index, BDI $r = 0.49$ vs. mMRC with BDI $r = -0.73$); however, the OCD had the strongest correlation with walking distance ($r = 0.65$, vs mMRC $r = -0.59$, BDI $r = 0.5$) and peak oxygen uptake ($r = 0.39$ vs mMRC $r = -0.29$, BDI $r = 0.36$). Among the HRQoLQs, the COPD assessment test (CAT) was most strongly correlated with the St. George Respiratory Questionnaire (SGRQ) ($r = 0.77$) and similar to the SGRQ regarding significant correlations with the other instruments ($|r| = 0.29$–0.67 vs. 0.36–0.77) but poorly with walking distance ($r = -0.02$). The OCD was mildly correlated with the CAT ($r = -0.4$).

The EDS was more related to the exercise capacity than to the dyspnea perception and the CAT was most closely related to the other instruments but poorly with walking distance. The OCD can be used to compensate for this weak correlation. The study suggests using the CAT and the OCD simultaneously when undertaking clinical evaluation of patients with COPD.

Abbreviations: 6MWD = six-minute walking distance, 6MWT = six-minute walk test, ADL = activity of daily life, BDI = the Baseline Dyspnea Index scales, CAT = COPD assessment test, CETs = clinial evaluation tools, COPD = chronic obstructive pulmonary disease, CRQ = chronic respiratory disease questionnaire, EDs = exertional dyspnea scales, FEV_1 = forced expired volume in 1 second, GOLD = the global initiative of chronic obstructive lung disease, HAD = Hospital Anxiety Depression Scale, HRQoL = health-related quality of life, mMRC = modified Medical Research Council, OCD = oxygen-cost diagram, Q = questionnaire, SGRQ = St. Gorge Respiratory Questionnaire, SGRQ-C = the SGRQ specific for COPD.

Keywords: BDI, Borg scale, cardiopulmonary exercise test, CAT, CRQ, exertional dyspnea, HAD, mMRC, OCD, questionnaire, SGRQ, 6-minute walk test

[a] Division of Pulmonary Medicine and Departments of Internal Medicine and Critical Care Medicine, [b] School of Medicine, Chung Shan Medical University, Taichung, [c] Institute and Department of Public Health, National Yang Ming University, Taipei, [d] Department of Nursing, Chung Shan Medical University Hospital, Taichung, Taiwan, ROC.

[*] Correspondence: Ming-Lung Chuang, Department of Critical Care Medicine and Division of Pulmonary Medicine, Chung Shan Medical University Hospital, Taichung, Taiwan 40201, ROC (e-mail: yuan1007@ms36.hinet.net).

1. Introduction

Clinical assessment tools are widely used to evaluate patients with chronic obstructive pulmonary disease (COPD).[1] These tools generally include 4 domains: dyspnea perception and exertional dyspnea, and questionnaires of health-related quality of life (HRQoLQs) and mood.[2]

The modified Medical Research Council (mMRC) scale,[1] Baseline Dyspnea Index (BDI),[1] and Oxygen-Cost Diagram (OCD)[1] are common unidimensional exertional dyspnea scales (EDS).[1,3] The COPD assessment test (CAT),[4] St. George Respiratory Questionnaire (SGRQ),[5] and Chronic Respiratory Disease Questionnaire (CRQ)[6] are multidimensional HRQoLQs that include symptoms, exertional dyspnea, and other QoL factors. The GOLD[7] guidelines categorize patients with COPD using either 1 of these 2 domains and the lung function and the frequency of acute exacerbations in the preceding year; however, inconsistent results have been reported.[8,9] Combining the 2 domains may yield better results; however, the large number of scales and questionnaires make using them all impractical in clinical practice. The EDS is usually used for dyspnea scoring but not for exercise capacity classification, however with which the EDS better correlates is unclear. Therefore, the aim of this study was to evaluate the best combination of EDS and HRQoLQs for patients with COPD and to discriminate the role of exercise capacity and dyspnea perception played in the EDS.

2. Methods

2.1. Study design

In this cross-sectional observational study, the relationships among 3 EDS and 3 HRQoLs, 1 mood scale, Borg dyspnea scale, and 2 types of exercise test were assessed. The outcomes were to determine which the EDS might correlate better with dyspnea perception or exercise performance and to choose the HRQoLQ with the best inter-relationship but low correlation with the EDS.

2.2. Subjects

Subjects with moderate-to-severe COPD were enrolled from the pulmonary division of our university-affiliated hospital in Taiwan between January 1, 2012, and December 31, 2012. Moderate-to-severe COPD was defined as a forced expired volume in 1 second (FEV_1) <80% of the predicted value and a FEV_1/forced vital capacity ratio <70%.[7] The local institutional review board approved this study (CSHRP 11144) and all of the participants provided informed consent. The study was conducted in compliance with the Declaration of Helsinki.

The participants were aged 40 to 85 years, and during the period of study, they abstained from cigarette smoking or maintained a low consumption, had no acute exacerbations of COPD, a stable clinical condition for 1 month or longer (Supplement 1), adhered to their COPD medications suggested by the GOLD guidelines,[7] and did not participate in any exercise training programs. The participants who took prednisolone >10 mg/day, had uncontrolled diabetes mellitus, uremia, chronic heart failure, cerebrovascular disease, uncontrolled anemia, late-stage malignant diseases or other acute illnesses, and those taking any systemic anti-inflammatory agents were excluded.

2.3. Protocols and measurements

Data on demographics, the 3 EDS, 3 HRQoLQs, Hospital Anxiety Depression Scale (HAD),[10] Borg scale, and exercise tests were recorded. The scales and questionnaires were evaluated once at rest. Lung function and exercise tests were undertaken within 7 days after the scales and questionnaires were conducted. The Borg category scale was used to rate dyspnea perception at rest and at the start and end of exercise tests.[11]

Lung function and maximum cardiopulmonary exercise test (CPET)[12] were conducted by an experienced technician, and the 6-minute walk test (6MWT)[13,14] by a nurse. Lung function was measured with pressure-sensitive body plethysmography (MasterScreen Body; Carefusion, Leibnizstrasse, Wuerzburg, Germany).[13]

The walking tests were conducted in a temperature-controlled 20-meter corridor, with verbal encouragement as per the American Thoracic Society recommendations.[14] Each patient performed the 6MWT twice, with >30 minutes rest in between. The longest distance walked was recorded in meters as 6-minute walk distance (6MWD).

The CPET was conducted according to the ATS/ACCP statement.[12] Workload, heart rate, oxyhemoglobin saturation, oxygen uptake (mL/min), CO_2 output (mL/min), minute ventilation, and blood pressure were also measured (MasterScreen CPX; CareFusion, Leibnizstrasse, Wuerzburg, Germany).[15]

2.4. Exertional dyspnea scales

The 3 EDS were used to evaluate dyspnea (Supplement 2). The patients completed these scales before the exercise tests, after they had been thoroughly explained by a nurse.

Oxygen-cost diagram[1]: The patients used the OCD to assess daily activities. They were asked to indicate a point on an OCD, a 100-mm long vertical line with everyday activities listed alongside the line, above which breathlessness limited them.[16] The distance from zero was measured and scored.

Baseline dyspnea index[1]: Briefly, the BDI includes 3 domains: functional impairment, magnitude of task, and magnitude of effort. Each domain is graded from 0 to 4 indicating very severe impairment to no impairment, dyspnea developing when carrying an object from no task to an extraordinarily heavy task, and dyspnea developing when performing a task from no effort to an extraordinary effort, respectively.

Modified Medical Research Council dyspnea scale[1]: Briefly, the mMRC scale includes 5 grades from 0 indicating "I only get breathless with strenuous exercise" to 4 "I am too breathless to leave the house."

Modified Borg Category Scale[11]: The patients were asked to rate the intensity of breathing effort.[17] The scale consists of a vertical scale labeled 0 to 10 with corresponding verbal expressions of progressively increasing sensation intensity. The patients were instructed to point to the number on the Borg scale that best indicated the intensity of their breathing effort at rest or at the start and end of exercise tests.

2.5. Health-related quality of life

The patients completed 3 HRQoLQs (Supplement 3) before the exercise tests, after they had been thoroughly explained by a nurse.

COPD Assessment Test[4]: The CAT questionnaire consists of 8 items with each graded from 0 to 5; the higher the more severe. The CAT covers cough, phlegm, chest tightness, breathlessness going up a hill/stairs, activity limitation at home, confidence in leaving home, sleep, and energy.

St. George Respiratory Questionnaire[5]: The SGRQ includes 50 items covering 3 domains: symptoms (eight items), activity (16
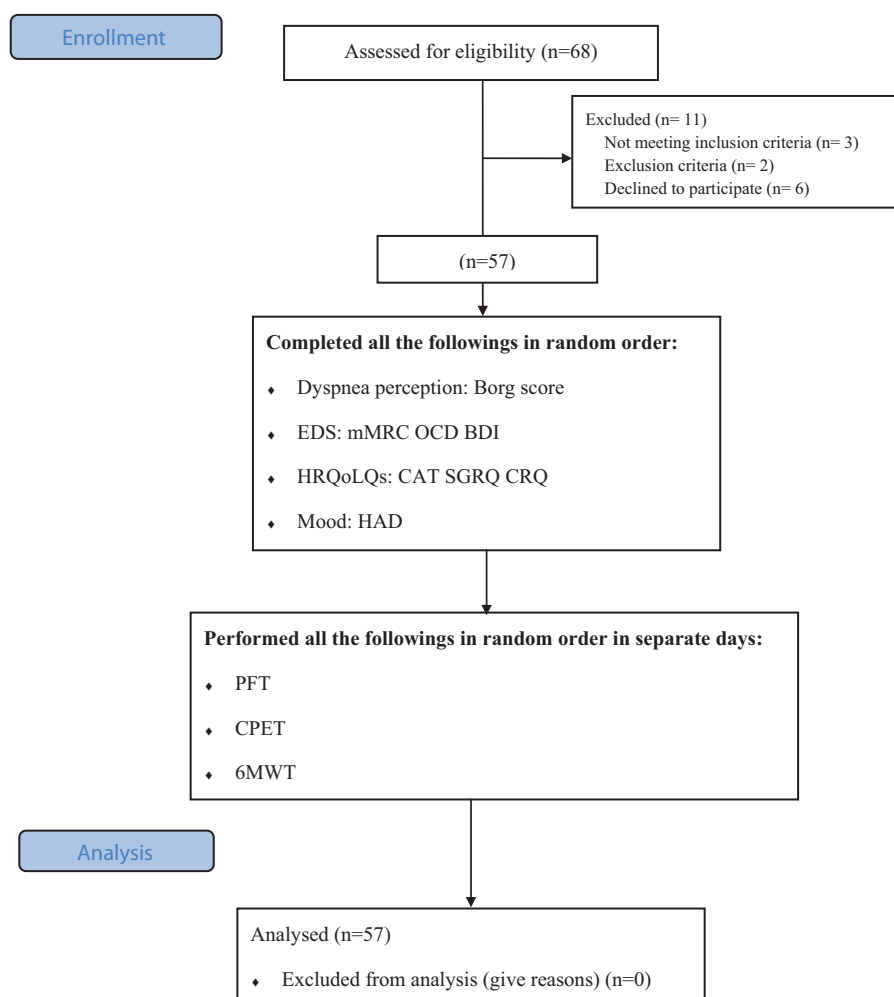
Figure 1. Flow diagram. A total of 68 patients with chronic obstructive pulmonary disease were screened. Eleven patients were excluded, and 57 subjects were enrolled. Measurements were completed as described in the boxes. BDI = baseline dyspnea index, CAT = COPD assessment test, COPD = chronic obstructive pulmonary disease, CRQ = chronic respiratory disease questionnaire, EDS = exertional dyspnea scales, HAD = hospital anxiety depression questionnaire, HRQoLQs = health-related quality-of-life questionnaires, mMRC = modified medical research council scale, OCD = oxygen-cost diagram, SGRQ = St. George respiratory questionnaire.

items), and impact (26 items). Each domain is scored using the SGRQ calculator, with the total score being the sum of the 3 domain scores. The questions covered the degree of chest trouble over the past 3 months (Supplement 4).

Chronic Respiratory Disease Questionnaire[6]: Briefly, the CRQ encompasses 20 items in 2 sections: exertional dyspnea (5 items), and mood/confidence in dealing with illness and energy (15 items) during the last 2 weeks. The first 5 items included 26 daily activities in which the patients experienced dyspnea, selected by the patients as being the most important such as being angry, bending, playing sports, or walking uphill, with each activity scored from 1 (extreme shortness of breath) to 7 (not at all short of breath). The remaining 15 items such as feeling impatient or frustrated, feeling embarrassed, having energy or confidence were omitted as recommended in the previous study.[1]

2.6. Mood

A mood is an emotional state classified as being positive or negative. The HAD questionnaire is widely used in patients with COPD (Supplement 5).[10,18–20]

Hospital Anxiety Depression Scale[10]: Briefly, this questionnaire contains 14 items: 7 on anxiety and 7 on depression. Each anxiety item is followed by 1 depression item. The psychiatric rating ranges from 0 (not at all) to 3 (very much) for each negative thinking item and 0 (as much as ever) to 3 (hardly at all) for each positive thinking item. A score ≤ 7 is defined as not having depression or anxiety, 8 to 10 possible or mild, 11 to 14 moderate, and ≥ 15 severe.[10,19] The lower the scores, the better the mood.

2.7. Statistical analysis

Data were summarized as mean ± standard deviation. Correlations were based on Pearson correlation coefficients using the correlation matrix function of NCSS software (v07.1.15; NCSS, Kaysville, UT). Statistical significance was set at $P < 0.05$, at which the strength of correlation $|r|$ was categorized by quartiles as weak (<0.3); mild ($0.3 \leq |r| < 0.45$); moderate ($0.45 \leq |r| < 0.6$); and strong (≥ 0.6).

3. Results

Sixty-eight patients were screened and 11 were excluded due to 3 not meeting inclusion criteria, 2 meeting exclusion criteria, and 6

Table 1

Demographic data, score of each scoring instrument, lung function, and exercise capacities.

Age, y	70 ± 8.8
Gender: M/F	56/1
Cigarette, pack·years	43.3 ± 21.8
BMI, kg/m^2	24.6 ± 4.1
Systolic BP, mm Hg	137 ± 16
Diastolic BP, mm Hg	77 ± 10
Medications used at entry, n (%)	
SAMA + SABA	17
LAMA	25
LABA	10
LABA + ICS	35
LABA + LAMA + ICS	17
Xanthines	35
Antihistamine	13
GOLD stage 1, (no.)	12
GOLD stage 2, (no.)	35
GOLD stage 3, (no.)	10
GOLD stage 4, (no.)	0
GOLD category A (no.)	25
GOLD category B (no.)	14
GOLD category C (no.)	5
GOLD category D (no.)	13
FVC, L (% predicted)	3.1 ± 0.7 (102 ± 20)
FEV$_1$, L (% predicted)	1.6 ± 0.5 (66 ± 16)
FEV$_1$/FVC, %	55 ± 12
Borg score at rest, AU (0–10)	0.6 ± 1
Oxygen-cost diagram, mm (100–0)	68 ± 11
Modified Medical Research Council, AU (0–4)	1 ± 0.8
Baseline dyspnea index score, AU (12–0)	7.4 ± 1.9
COPD assessment test, AU (0–40)	10.6 ± 7.4
CRQ (35–5)	27.8 ± 4.4
SGRQ (0–100): Total score	34 ± 16.9
Symptoms score	35.3 ± 17.8
Activity score	47.4 ± 23.5
Impact score	25.8 ± 16.8
Hospital anxiety depression score (0–42)	
Anxiety score (0–21)	2.5 ± 2.6
Anxiety score ≥7, no. (%)	3 (5.3)
Depression score (0–21)	3.6 ± 3.2
Depression score ≥7, no. (%)	6 (10.5)
Six-minute walking distance, m	437.6 ± 116.6
Oxygen uptake $_{peak}$ % pred, %	71 ± 13

Mean ± SD. (The 1st number - the 2nd number): in the parenthesis, from the 1st number to the 2nd number indicates a better status to a worse status; Anxiety or depression score ≤7: no anxiety, 8–10: possible, ≥11: definitely.

BMI = body mass index, CRQ = chronic respiratory disease questionnaire, ICS = inhaled corticosteroids, SABA/LABA = short-acting/long-acting β$_2$-agonist, SAMA/LAMA = short-acting/long-acting muscarinic antagonist, SGRQ = St George's respiratory questionnaire.

declining to participate (Fig. 1). Most of the 57 patients were older men and had a history of heavy smoking, with normal body mass index and GOLD stages 1 and 2, or categories A and B (Table 1).

3.1. Exertional dyspnea scales

The 3 EDS were moderately to strongly interrelated with each other, but this correlation was weaker when the OCD was included (with mMRC $r=-0.56$, with BDI $r=0.49$ vs mMRC with BDI $r=-0.73$, $P=0.0002$ to <0.0001, Table 2). The EDS was more strongly correlated with walking and peak exercise capacities than the resting and exertional Borg scores ($|r|=0.29–0.65$, $P<0.05–<0.0001$ vs $|r|=0.08–0.55$, $P=$NS to <0.0001). However, as compared with the mMRC and the BDI, the OCD had the strongest correlation with walking distance ($r=0.65$, vs -0.59, 0.5), peak oxygen uptake ($r=0.39$ vs -0.29, 0.36) and peak exercise Borg score ($r=0.33$ vs $r=-0.15$, 0.24), and weakest correlation with resting Borg score ($r=-0.08$ vs $r=-0.32$, -0.46). The correlations between the 3 dyspnea scales and walking Borg score were similar ($r=-0.41$, 0.48, and -0.55). The correlations between the 3 exertional dyspnea scales and HAD-anxiety ($r=-0.05$, 0.06, and -0.19) or between the 3 exertional dyspnea scales and HAD-depression ($r=0.04$, -0.07, and 0.01) were insignificant, respectively.

3.2. HRQoLQs

The 3 HRQoLQs were moderately to strongly interrelated. The correlation was strongest between the CAT and SGRQ, and weaker when the CRQ was included ($r=0.77$, $P<0.0001$, vs with CRQ $r=-0.5$, $P=0.02$, CRQ with SGRQ $r=-0.63$, $P=0.003$, Table 3). The CAT was similar to the SGRQ regarding the correlations with all the 4 domains of clinical assessment instrument scores ($|r|=0.02–0.67$, $P=$NS to <0.0001 vs $|r|=0.01–0.77$, $P=$NS to <0.0001), and the CRQ had a weaker correlation than the other 2 ($|r|=0.1–0.4$). The CAT had the strongest correlation with peak exercise capacity ($r=-0.53$ vs SGRQ $r=-0.01$, CRQ $r=0.3$), but the weakest correlation with 6MWD ($r=-0.02$ vs SGRQ $r=-0.39$, CRQ $r=0.13$). The OCD was only mildly correlated with the CAT ($r=-0.4$). The 3 HRQoLs were mildly correlated with the HAD-anxiety ($|r|=0.29–0.37$, $P=0.04–0.05$) but insignificantly correlated with the HAD-depression ($|r|=0.11–0.27$, all $P=$NS). The HAD-anxiety was well correlated with the HAD-depression ($r=0.68$, $P<0.0001$).

4. Discussion

The main findings of this study are that the EDS more correlated with exercise capacity than with dyspnea perception and that the OCD had the strongest correlation with exercise capacity and peak exercise Borg scores, but the weakest correlation with resting Borg score. In addition, the CAT was similar to the SGRQ regarding correlations with the 4 domains of clinical assessment scores while being easier to administer. Although the CAT was poorly correlated with 6MWD, the OCD can compensate for this when used in combination.

4.1. Exertional dyspnea scales

The mMRC, BDI, and OCD were well interrelated ($r=0.49–0.73$)[1] and represented the same category in factor analysis.[2,21,22] These instruments were originally designed to grade breathlessness on activities of daily life (ADLs).[2,21,22] However, these tools included a wide range of activities[3] but did not include different categories of dyspnea perception intensity. This might explain why the EDS correlated better with exercise capacity than with dyspnea perception in this study. Moreover, the EDS were much better correlated with 6MWD than with peak exercise capacity ($|r|=0.5–0.65$ vs 0.29–0.39, Table 2), which is consistent with a previous report.[23] Hence, these 3 instruments are used to delineate a patient's sub-maximum functional capability, as 6MWT is usually a submaximum exercise type.[3]

The OCD scale lists ADLs alongside a 100-mm line according to the required oxygen consumption.[1] The patient marks a point above which he/she becomes breathless, and this is used to

Table 2

Exertional dyspnea scales as related to exercise and dyspnea intensity at rest and moods.

Category	Tool	r=	OCD (10–0)	mMRC (0–4)	BDI (12–0)
Exertional dyspnea scales or Dyspneic functional class	OCD (10–0)		—	—	—
	mMRC (0–4)		−0.56*	—	—
	BDI (12–0)		0.49*	−0.73*	—
Submaximum exercise and dyspnea intensity during exercise	6MWD (>300–0 meters)		0.65*	−0.59*	0.5*
	6MW_Borg (0–10)		−0.41*	0.48*	−0.55*
Peak exercise & dyspnea intensity during exercise	Peak oxygen uptake (>2000–0 ml/min)		0.39*	−0.29*	0.36*
	Peak exercise_Borg (0–10)		0.33*	−0.15	0.24
Dyspnea intensity at rest	Borg at rest (0–10)		−0.08	0.32*	−0.46*
Moods	HAD_anxiety (0–21), A.U.		−0.05	0.06	−0.19
	HAD_depression (0–21), A.U.		0.04	−0.07	0.01

(The 1st number - the 2nd number): in the parenthesis, from the 1st number to the 2nd number indicate a better status to a worse status. BDI = baseline dyspnea index scale, HAD = hospital anxiety depression scale, mMRC = Modified Medical Research Council, OCD = oxygen-cost diagram. * $r \geq 0.29$, $P < 0.05$; for OCD, *$|r|$ = 0.33–0.65; for mMRC, *$|r|$ = 0.29–0.59; for BDI, *$|r|$ = 0.32–0.55.

indicate the peak exercise intensity for patients with moderate-to-severe COPD. This may explain why the OCD had the strongest correlation with peak exercise and peak Borg scores compared to the mMRC and BDI but were not correlated with Borg score at rest ($r = −0.08$) and was less interrelated with the other two scales. Of the instruments, the OCD had the weakest correlation with the 3 HRQoLQs (see below). In addition, the OCD has been correlated with 6MWD[13] and it has been used to predict oxyhemoglobin desaturation[24] and selection of the ramp slope for dyspneic patients.[15] In this context, the OCD might serve separately from the other 2 EDS.

Although the BDI contains the 3 domains of functional capability, and magnitudes of task and effort, all are related to activity or exercise intensity.[1] The mMRC contains a single dyspnea domain in response to different levels of ADLs.[3] However, the BDI and mMRC showed inconsistent results in categorizing patients at an individual level,[9] despite both being strongly related ($r = −0.73$).

A multidimensional dyspnea profile has already been developed,[25] and other 2-dimensional scales have recently been reported. The Barthel Index dyspnea scale is a modification of the Barthel Index using 5 categories of dyspnea perception intensity.[26] It has been reported to be a reliable and sensitive tool to measure the level of dyspnea when performing ADLs and the responsiveness after treatment. The Shortness of Breath with

Daily Activities questionnaire contains 13 items regarding low exercise intensity of ADLs, and also 5 categories of dyspnea perception intensity for each item.[27]

The EDS used in this study was not significantly correlated with HAD-anxiety or HAD-depression (Table 2). This might be due to HAD questionnaire being designed for the evaluation of patients' emotion but not physical illness.[10]

4.2. HRQoLQs

The SGRQ consists of 3 domains and 50 items, of which 24 are related to activity, exertion, and/or dyspnea[5] (16 are related to activity, and 8 in the impact domain are also related to activities, Supplement 4), so that the SGRQ is correlated with EDS, dyspnea intensity at rest, and 6MWD. At most, only 2 of the 50 items (items 43 and 44) represent heavy exercise. Thus, the SGRQ total score was poorly correlated with peak exercise. The remaining 26 items are related to other symptoms and impact on mood, confidence, work, and daily life. The SGRQ total score involves a wide spectrum of domains, thereby having the strongest interrelationship with other clinical evaluation tools except for peak exercise capacity and symptoms.

The CAT score consists of only 8 items, with 2 regarding exertion[4] and 6 being related to symptom and impact domains. This explains why the CAT was poorly correlated with 6MWD

Table 3

Health-related quality-of-life (HRQoL) questionnaires as related to exercise, exertional dyspnea, dyspnea intensity at rest, and moods.

Category	Tool	r=	SGRQ (0–100)	CAT (0–40)	CRQ (35–5)
HRQoL questionnaires	SGRQ (0–100)		—	—	—
	CAT (0–40)		0.77*	—	—
	CRQ (35–5)		−0.63*	−0.5*	—
Exercise capacity and dyspnea intensity during exercise	6MWD (>300–0 meters)		−0.39*	−0.02	0.13
	6MW_Borg (0–10)		0.55*	0.33*	−0.4*
	Peak oxygen uptake % predicted (100–0%)		−0.01	−0.53*	−0.3*
	Peak exercise_Borg (0–10)		−0.2	−0.28	0.1
Exertional dyspnea scales or dyspneic functional class	OCD (10–0), cm		−0.51*	−0.4*	0.1
	mMRC (0–4)		0.64*	0.46*	−0.33*
	BDI (12–0)		−0.77*	−0.67*	0.4*
Dyspnea intensity at rest	Borg (0–10)		0.49*	0.53*	−0.33*
Moods	HAD_anxiety (0–21)		0.36*	0.29*	−0.37*
	HAD_depression (0–21)		0.27	0.11	−0.23

(The 1st number - the 2nd number): in the parenthesis, from the 1st number to the 2nd number indicate a better status to a worse status.
6MWD = 6-minute walk distance, BDI = baseline dyspnea index scale, CAT = COPD assessment test, CRQ = chronic respiratory disease questionnaire, HAD = hospital anxiety depression, mMRC = Modified Medical Research Council, OCD = oxygen-cost diagram, SGRQ = St. George respiratory questionnaire.
*$r \geq 0.29$, $P < 0.05$; for SGRQ, *$|r|$ = 0.36–0.77; for CAT, *$|r|$ = 0.29–0.67; for CRQ, *$|r|$ = 0.3–0.4.

($r = 0.02$, $P = NS$), consistent with a previous report.[28] Paradoxically, the CAT was moderately correlated with peak exercise capacity ($r = -0.53$, $P < 0.0001$), indicating that the weight of item 4 near the subjects' peak exercise capacity was significant. The CAT has been reported to be weakly to mildly correlated with incremental shuttle walking test ($r = -0.49$, $P = 0.002$), endurance shuttle walking test ($r = 0.39$, $P = 0.01$),[29] and 6MWD ($r = -0.33$, $P = 0.002$),[30] although 6MWD has been reported to independently predict CAT score ($\beta = -0.32$, $P = 0.019$).[30] The CAT is regarded to be a HRQoLQ and a brief form of the SGRQ,[4] which may explain the excellent correlation with the SGRQ ($r = 0.77$). Therefore, the CAT may serve as a surrogate for the SGRQ[28] and may predict acute exacerbations.[8] The GOLD committee recommend integrating FEV_1 and CAT[4] or mMRC scores and frequency of acute exacerbations in the preceding year to evaluate patients with COPD.[7] As the CAT and mMRC belong to different domains, it is not surprising that discrepancies have been reported in categorizing patients using these tools.[31]

The CRQ encompasses 4 dimensions (exertional dyspnea, fatigue, emotion, and mastery). The exertional dyspnea component includes light and heavy exercise intensity of 26 ADLs,[6] of which patients are allowed to select 5 they frequently performed in the last 2 weeks and that are important in their day-to-day life. Hence, the CRQ dyspnea score had a weaker correlation with the other 2 HRQoLQs, EDS, and 6MWD and score of each individual could not be compared directly but only longitudinally.

The 3 HRQoL questionnaires used in this study were mildly correlated with HAD-anxiety but insignificantly correlated with HAD-depression (Table 3) despite anxiety and depression being well correlated in patients with COPD in this study ($r = 0.68$) and in the literature ($r = 0.81$).[32] The findings in this study confirm that HAD questionnaire should be deemed as a separate instrument for evaluating patients with COPD[2,10] and might be attributed to low diagnostic accuracy for depression in COPD patients.[33] The incidences (5.3/10.5%) and mean scores (2.5/3.6) of anxiety/depression in the present study are lower than those reported previously (12.5/25% and 4.6–10/3.9–8.5).[18]

4.3. Study limitations

This is a cross-sectional study, so the temporal effect on the stability of the response of each tool is unknown despite good reported test-retest reliability.[1,28,34] Although the sample size was small, the validity with the selected clinical evaluation tools was higher than in previous reports.[1,28] The time needed to complete the measurements was also not recorded. On the basis of previous reports, 15 to 25 minutes are needed to complete the CRQ[6] and 2 minutes for the CAT.[28] The SGRQ is lengthy and complex to score, and the need for recall is also problematic. The SGRQ specifically used for patients with COPD (SGRQ-C) removed 10 items from the original form including questions requiring recall; however, it is still lengthy.[35] The performance of the CAT was not inferior to the SGRQ, as demonstrated in this and in previous studies.[28,34] The time to complete the CAT is generally much shorter than that of the SGRQ[28] or SGRQ-C. The CRQ Self-administered Standardized[36] dyspnea questionnaire is a concise form of the original CRQ and encompasses 5 items: 1 involving the emotional domain and 4 involving ADLs. The exercise intensity of the 4 ADL items is so low that they may have been less discriminatory for the patients with less severe COPD in this study.

5. Conclusions

The EDS were both related to exertional dyspnea perception and exercise capacity with better relation to exercise capacity but poorer to the resting dyspnea perception. The CAT is concise and closely related to the SGRQ, but poorly correlated with 6MWD, which can be overcome by also using the OCD. The study suggests using the CAT and the OCD simultaneously when undertaking clinical evaluation of patients with COPD.

Acknowledgment

References

[1] Mahler DA. Clinical Measurement of Dyspnea. 1990;New York:Futura Publishing, 75-126.

[2] Hajiro T, Nishimura K, Tsukino M, et al. Analysis of clinical methods used to evaluate dyspnea in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1998;158:1185–9.

[3] Parshall MB, Schwartzstein RM, Adams L, et al. An official American Thoracic Society statement: update on the mechanisms, assessment, and management of dyspnea. Am J Respir Crit Care Med 2012;185:435–52.

[4] Jones PW, Harding G, Berry P, et al. Development and first validation of the COPD assessment test. Eur Respir J 2009;34:648–54.

[5] Jones PW. Health status measurement in chronic obstructive pulmonary disease. Thorax 2001;56:880–7.

[6] Guyatt GH, Berman LB, Townsend M, et al. A measure of quality of life for clinical trials in chronic lung disease. Thorax 1987;42:773–8.

[7] GOLD Committees. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease (revised 2015). Disclosure forms for GOLD Committees are posted on the GOLD Website. Available at: www.goldcopd.org. Accessed July 31, 2015.

[8] Lee SD, Huang MS, Kang J, et al. The COPD assessment test (CAT) assists prediction of COPD exacerbations in high-risk patients. Respir Med 2014;108:600–8.

[9] Perez T, Burgel PR, Paillasseur JL, et al. Modified Medical Research Council scale vs Baseline Dyspnea Index to evaluate dyspnea in chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis 2015;10:1663–72.

[10] Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67:361–70.

[11] Borg G. Psychophysical bases of perceived exertion. Med Sci Sports Exercise 1982;14:377–81.

[12] American Thoracic Society; American College of Chest Physicians. This Joint Statement of the ATS and the ACCP was adopted by the ATS Board of Directors, March 1, 2002 and by the ACCP Health Science Policy Committee, November 1, 2001. ATS/ACCP Statement on cardiopulmonary exercise testing. Am J Respir Crit Care Med 2003;167:211–77.

[13] Chuang ML, Lin IF, Wasserman K. The body weight-walking distance product as related to lung function, anaerobic threshold and peak VO2 in COPD patients. Respir Med 2001;95:618–26.

[14] statement ATS. guidelines for the six-minute walk test. Am J Respir Crit Care Med 2002;166:111–7.

[15] Chuang ML, Lee CH, Lin IF. Using the oxygen-cost diagram in ramp-slope selection for dyspneic patients. Intern Med 2010;49:1325–32.

[16] McGavin CR, Artvinli M, Naoe H, et al. Dyspnoea, disability, and distance walked: comparison of estimates of exercise performance in respiratory disease. Br Med J 1978;2:241–3.

[17] Mador MJ, Rodis A, Magalang UJ. Reproducibility of Borg scale measurements of dyspnea during exercise in patients with COPD. Chest 1995;107:1590–7.

[18] Coventry PA, Bower P, Keyworth C, et al. The effect of complex interventions on depression and anxiety in chronic obstructive pulmonary disease: systematic review and meta-analysis. PLoS One 2013;8: e60532.

[19] Eisner MD, Blanc PD, Yelin EH, et al. Influence of anxiety on health outcomes in COPD. Thorax 2010;65:229–34.

[20] Ng TP, Niti M, Tan WC, et al. Depressive symptoms and chronic obstructive pulmonary disease: effect on mortality, hospital readmission, symptom burden, functional status, and quality of life. Arch Intern Med 2007;167:60–7.

[21] Mahler DA, Harver A. A factor analysis of dyspnea ratings, respiratory muscle strength, and lung function in patients with chronic obstructive pulmonary disease. Am Rev Respir Dis 1992;145:467–70.

[22] Wegner RE, Jorres RA, Kirsten DK, et al. Factor analysis of exercise capacity, dyspnoea ratings and lung function in patients with severe COPD. Eur Respir J 1994;7:725–9.

[23] Rodriguez DA, Garcia-Aymerich J, Valera JL, et al. Determinants of exercise capacity in obese and non-obese COPD patients. Respir Med 2014;108:745–51.

[24] Chuang ML, Lin IF, Chen SP. Kinetics of changes in oxyhemoglobin saturation during walking and cycling tests in COPD. Respir Care 2014;59:353–62.

[25] Meek PM, Banzett R, Parshall MB, et al. Reliability and validity of the multidimensional dyspnea profile. Chest 2012;141:1546–53.

[26] Vitacca M, Paneroni M, Baiardi P, et al. Development of a Barthel Index based on dyspnea for patients with respiratory diseases. Int J Chron Obstruct Pulmon Dis 2016;11:1199–206.

[27] Watkins ML, Wilcox TK, Tabberer M, et al. Shortness of Breath with Daily Activities questionnaire: validation and responder thresholds in patients with chronic obstructive pulmonary disease. BMJ Open 2013;3: e003048.

[28] Tsiligianni IG, van der Molen T, Moraitaki D, et al. Assessing health status in COPD. A head-to-head comparison between the COPD assessment test (CAT) and the clinical COPD questionnaire (CCQ). BMC Pulm Med 2012;12:20.

[29] Candemir I, Kaymaz D, Ergun P, et al. Assessment of pulmonary rehabilitation efficacy in chronic obstructive pulmonary disease patients using the chronic obstructive pulmonary disease assessment test. Expert Rev Respir Med 2015;9:487–92.

[30] Durr S, Zogg S, Miedinger D, et al. Daily physical activity, functional capacity and quality of life in patients with COPD. COPD 2014;11: 689–96.

[31] Rhee CK, Kim JW, Hwang YI, et al. Discrepancies between modified Medical Research Council dyspnea score and COPD assessment test score in patients with COPD. Int J Chron Obstruct Pulmon Dis 2015;10:1623–31.

[32] Light RW, Merrill EJ, Despars JA, et al. Prevalence of depression and anxiety in patients with COPD. Relationship to functional capacity. Chest 1985;87:35–8.

[33] Nowak C, Sievi NA, Clarenbach CF, et al. Accuracy of the Hospital Anxiety and Depression Scale for identifying depression in chronic obstructive pulmonary disease patients. Pulm Med 2014;2014:973858.

[34] Gupta N, Pinto LM, Morogan A, et al. The COPD assessment test: a systematic review. Eur Respir J 2014;44:873–84.

[35] Meguro M, Barley EA, Spencer S, et al. Development and validation of an improved, COPD-specific version of the St. George Respiratory Questionnaire. Chest 2007;132:456–63.

[36] Schunemann HJ, Griffith L, Jaeschke R, et al. A comparison of the original chronic respiratory questionnaire with a standardized version. Chest 2003;124:1421–9.