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Usefulness of the culturally adapted oxygen-cost diagram in the assessment of dyspnea in Puerto Rico

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Abstract

Objective—Breathlessness is a common and disabling symptom of pulmonary disease.

Measuring its severity is recommended as such measurements can be helpful in both clinical and research settings. The oxygen-cost diagram (OCD) and the Medical Research Council (MRC) dyspnea scale were developed in English to measure severity of dyspnea. These scales were previously translated to Spanish and adapted for use in a Hispanic population. The objective of this study is to assess the psychometric properties of these scales. We propose the scales correlate well with measures of physiological impairment.

Methods—Subjects having pulmonary disease rated their perceptions of dyspnea using the scales, performed a spirometry test, and did a 6-min walk. Spearman correlation coefficients (r) were used to correlate dyspnea scores with spirometric parameters and distance walked (6MWD).

Results—Sixty-six patients having stable asthma ($n = 36$), chronic obstructive pulmonary disease ($n = 19$), or interstitial lung disease ($n = 11$) participated in the study. OCD scores showed

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Disclosures:

All authors declare that there are no conflicts of interest with respect to this research.

Ethical Standards:

The research study was approved by the Institutional Review Board of the University of Puerto Rico Medical Science Campus, and the subjects who participated signed an informed consent. Ethical standards were observed.

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a significant correlation with FEV_1 ($r = 0.41$; $p < 0.01$), $FEV_1\%$ ($r = 0.36$; $p < 0.01$), FVC ($r = 0.44$; $p < 0.01$), and $FVC\%$ ($r = 0.37$; $p < 0.01$) in the study population. The OCD scores were highly correlated with $6MWD$ ($r = 0.59$, $p < 0.01$). The MRC dyspnea scale showed significant inverse correlation with FEV_1 ($r = -0.34$; $p < 0.01$) and $6MWD$ ($r = -0.33$; $p < 0.05$), but the correlations were weaker compared to the correlations with the OCD scale.

Conclusions—The severity of breathlessness as measured by the adapted Spanish OCD showed a moderate to high correlation with spirometric parameters and $6MWD$; therefore, the adapted OCD should prove to be useful in Puerto Rico.

Indexing terms

Dyspnea scales; Hispanics; Cultural adaptation; Spanish OCD; Spanish MRC; Sleep deprivation

Introduction

Dyspnea is a common and disabling symptom for patients with chronic lung disease. It is also an important outcome variable for both the clinical and the research evaluation of lung disease (1,2). Several instruments have been developed to measure its severity during daily living activities, but none has been validated for its use in the Latino/Hispanic population (3,4,5,6,7,8). To rectify this lack, the oxygen-cost diagram (OCD) and the Medical Research Council (MRC) dyspnea scales were translated from English to Spanish and culturally adapted for its use in Puerto Rico in a previous qualitative research study (9).

The OCD dyspnea scale is a vertically oriented visual analog scale that is 100 mm in length and that lists activities of daily living according to their levels of oxygen consumption; a measurement of 100 millimeters corresponds to brisk walking uphill (high oxygen consumption activity), whereas zero millimeter corresponds to sleeping (10). Subject being tested reads the activities on the scale from low to high oxygen consumption and makes a mark (x) near the activity at which he or she feels that breathlessness will restrict his or her pace. The measure for the subject is the distance in millimeters from zero to the patient's mark (x) in the scale.

The MRC is a self-administered scale describing 5 levels of dyspnea, ranging from no dyspnea except in strenuous exercise (grade 0) to dyspnea while dressing or undressing (grade 4) (11). The subject selects the statement that best fit his/her level of shortness of breath.

The objective of this study is to assess the psychometric properties of the Spanish translations of the MRC and OCD dyspnea scales as adapted for its use in Puerto Rico, a Hispanic population.

Methods

Study population

Adult Spanish speakers referred for pulmonary function tests in a laboratory affiliated with the University of Puerto Rico, School of Medicine; and having a physician diagnosis of asthma, chronic obstructive pulmonary disease (COPD), or interstitial lung disease (ILD).

Design

A cross-sectional study correlating the severity of breathlessness, as rated using the Spanish adapted MRC and OCD dyspnea scales, with spirometric parameters and with distance walked in a 6-min walk test (6MWD).

Procedures

The research study was approved by the Institutional Review Board of the University of Puerto Rico Medical Science Campus, and subjects who agreed to participate signed an informed consent.

Pre-study

Following Brislin's model of forward and back-translation, a modified version of Jones's expert panel group discussion, and field testing, the English versions of both the MRC and OCD were culturally adapted for its use in Puerto Rico (9,12,13,14). Briefly, the scales were translated to Spanish and then back-translated to English. An expert committee reviewed the source and target instruments, reviewed input obtained during field testing; and advised the investigators on ways to improve content relevance, semantic and technical equivalence.

The committee was composed of 2 pulmonary physicians, 1 epidemiologist, 1 statistician, 3 nurses, and 2 community members, all native Spanish speakers (7 of them bilingual); field testing was performed on groups of 10 subjects, either having or not pulmonary diseases.

The subjects were interviewed to assess their overall comprehension of the wording used for the two scales, the cultural relevance of each item, and the accuracy of the scales to assess the severity of breathlessness in the target population. Changes were made where necessary and as advised by the expert committee.

Study phase

Adult patients, ages 21 or older, using Spanish as their first language and having been referred to the Pulmonary Function Laboratory with a diagnosis of asthma, COPD, or ILD were asked to participate. Patients having physical limitations in terms of walking (used a wheelchair, have suffered a leg amputation) were excluded. Subjects rated their perceptions of dyspnea on the adapted Spanish OCD and MRC dyspnea scales and performed a spirometry using a pulmonary function test system (Pulmonizer PFT 3000 Med-Science) following the American Thoracic Society (ATS) recommendations (15). Then the subjects performed a 6-minute walk (6MW) test in a standard manner (16). The test took place in a previously measured hallway (23 meters) with the subjects being coached during the test by a trained nurse. The participants were instructed to walk as far as they could in 6 minutes. Though allowed to decrease the pace as needed, the subjects were told to avoid making any

complete stops. Ten minutes of rest was provided and the 6MW was repeated. Data from the longer of the 2 walks were analyzed.

Statistical analysis

Data were entered without identifiers into the statistical program Epi Info™ 3.5 and analyzed using the statistical package STATA 9 (Stata Corp LP, College Station, TX, USA). Continuous variables were described by means and standard deviation, median, and range; categorical variables were described using frequencies and percentages. Demographic characteristics and physiologic measures by group were evaluated using one-way analysis of variance (ANOVA) or the Kruskal-Wallis test (when a Gaussian distribution could not be assumed). Post hoc analyses were performed to test for pairwise significance using Bonferroni's method or Dunn's test (as appropriate). Categorical variables were evaluated using chi-square statistics (or Fisher's exact test, when applicable). Correlation analyses between spirometric parameters and MRC and OCD dyspnea scales as well as between distance walked in the 6MW test and both dyspnea scales were performed using the Spearman correlation coefficient (r). The significance of each analysis was defined as a p-value (<0.05).

Results

The scales were tested in 66 subjects who had asthma (n = 36), COPD (n = 19), or ILD (n = 11). All the patients answered the MRC, but 1 COPD patient could not answer the OCD. All the participants performed the spirometry test and 46 completed the 6MW test. The demographic characteristics of the participants are illustrated in Table 1. Overall, 64% were women; the mean age was 51 years (range, 21 to 81); smokers and ex-smokers comprised 46% of the study group. All levels of scholastic education were represented in the study group.

In the post hoc analyses, COPD patients were found to be significantly older than asthma patients, were more likely to be men, and to be current smokers or ex-smokers compared to asthma and ILD patients ($p<0.05$). Table 2 shows results of the physiologic tests for each subpopulation and overall. In general, COPD subgroup demonstrated a more severe obstructive pattern than asthma (mean FEV₁ % 58.9% vs 78.7%) while ILD patients showed a restrictive pattern (mean FVC% 62.4 with FEV₁/FVC% of 106.1).

Asthma patients (n = 36)

Twenty-eight (78%) of the asthma patients were women. The mean age was 45.5 years (range, 21 to 65). Eleven of 35 (31%) were smokers or ex-smokers (median pack years 10.0). The mean FEV₁ was 2.32 liters (range, 1.4 to 4.0 L), and the mean FEV₁% was 78.7% (range, 53 to 116). Eighteen had a normal FEV₁ (80% of predicted), 15 had mild to moderate obstruction (FEV₁% <80 and >60), and 3 had severe obstruction (FEV₁% <60%). The distribution of breathlessness severity as rated by the MRC scale consisted of 9 asthma patients at grade 0 (no breathlessness except during intense exertion), 14 at grade 1 (breathlessness during rapid walking or while walking uphill), 4 at grade 2 (stop while walking for 15 minutes on a level surface), 4 at grade 3 (stop while walking for a few

minutes on a level surface), 5 at grade 4 (breathlessness while dressing or undressing). In the OCD scale, 8 asthma patients stated that breathlessness would not allow them to continue sleeping (0 to 6 mm), while for 17 rapid walking or walking uphill (slowly or rapidly) led to breathlessness that would not allow them to continue exercising(measure >60 mm).

COPD patients (n = 19)

Eleven (58%) of these patients were men, mean age of all 19 was 61.8 years (range, 44 to 81), and 16 (84%) were smokers or former smokers (median pack years 25.5). The mean FEV₁ was 1.5 liters (range, 0.8 to 2.7 L), and the mean FEV₁% was 59% (range, 40.0 to 80.5%); these results were significantly lower than were those of the asthma subgroup. One patient having alpha-1 anti-trypsin deficiency and emphysema (confirmed by computerized tomography) had a normal FEV₁ (80% or more), while 11 COPD subjects had FEV₁ ranging from 50% to 79%, and 7 had FEV₁ ranging from 30% to 49%; no one was below 30% of predicted FEV₁.

The distribution of dyspnea severity as rated by the MRC scale was 4 COPD patients at grade 0, 3 at g1, 5 at g2, 5 at g3, and 2 at g4. The OCD showed that breathlessness interfered with rapid walking or walking uphill (slowly or rapidly) in 10 of 18 COPD patients, while in 8 patients, even normal walking was impaired.

Interstitial lung disease patients (n = 11)

Six (54%) of these patients were women; the mean age of all 11 patients was 52 years (range, 25 to 70), and 3 of the 11 were smokers or ex-smokers. The mean FVC was 2.46 (range, 1.0 to 4.6 L) and the mean FVC% was 62% (range, 34.3 to 92.7). The mean total lung capacity and diffusion capacity were 72% and 68% of that predicted respectively (data not shown).

The distribution of dyspnea severity rated by the MRC scale was 2 patients at grade 0, 7 at g1 in seven, 1 at g3, and 1 at g4. On the OCD 3 patients selected slow walking or making the bed as being troublesome because of dyspnea, while 8 selected higher oxygen-consumption activities, such as rapid walking as presenting difficulty.

Dyspnea scale correlation with physiologic measures

Table 3 shows the correlation of the OCD with spirometric parameters and 6MWD, by diagnostic category. Overall, the OCD demonstrated a significant moderate positive correlation with FEV₁, FEV₁%, FVC, and FVC% ($p<0.01$) in the study group. In the asthma subgroup, the OCD breathlessness scale was also positively correlated with FEV₁ ($r = 0.49$; $p<0.01$) and FEV₁% ($r = 0.33$; $p<0.05$). The correlation of the OCD scale with distance walked in a 6-min walk test (6MWD) was higher, reaching a coefficient of 0.63 for asthma ($p<0.01$). It was observed that 8 asthma patients (22% of the study population) selected sleeping as the activity that breathlessness would not allow them to continue. Their selection was regardless of their measured FEV₁. When these 8 subjects were excluded, the correlation with FEV₁ increased from 0.49 ($p<0.01$) to 0.58 ($p<0.01$), but correlation with 6MWD decreased from 0.63 ($p<0.01$) to 0.53 ($p<0.01$). This phenomenon was not observed in the COPD or ILD patients.

In the COPD subgroup, the OCD significantly correlated with FEV₁ % (p<0.02). Correlation with 6MWD was high but did not reach significance ($r = 0.57$; p=0.16). In the ILD subgroup, the OCD showed a consistent positive correlation with FEV₁, FEV₁%, FVC, FVC % and 6MWD, but the sample was too small to reach significance.

Table 4 shows the correlation of the MRC dyspnea scale with spirometric parameters and the 6MWD. The MRC dyspnea scale demonstrated a mild to moderate inverse correlation with FEV₁, FVC, FVC%, and 6MWD in the study group and in the asthma subgroup ($r = -0.29$ to 0.49; p<0.05), but there was no such correlation with COPD subgroup. The ILD subgroup was small and although MRC was inversely correlated with several measures, the p-value was not significant.

Correlation between scales

The correlation between the MRC and the OCD breathlessness scales was strong, both overall ($r = -0.63$; p<0.001) and for each subgroup (Table 5).

Discussion

The MRC and the OCD dyspnea scales were previously translated to Spanish and adapted for use in Puerto Rico (9). Significant cultural differences were observed during the qualitative phase of the study and are summarized as follows: First, using distance walked to measure the severity of breathlessness in the MRC was ineffective. When the concept distance walked was changed to time elapsed during walking the subjects were able to differentiate the different intensities of the activity described on the MRC scale. This modification appears to have improved and corrected the cultural interpretation of the statements (time versus distance) used in the original scale. Second, there was a tendency for the patients to scan the written documents rather than read them thoroughly. For both the MRC and the OCD dyspnea scales, it was necessary to reverse the order of the activities from low to high oxygen consumption in order to encourage a thorough reading and therefore a more fitting response. Third, using numerical symbols in the scales distracted some subjects, who appeared to be more interested in the value of the number than in a given item's description. Removing numerical symbols from the scales promoted the subjects' focusing on the descriptors when selecting a response. Fourth, in the MRC, grade 2 and grade 3 appear to convey the same level of impairment. Grade 2 in the 1982 ATS Official Statement describes moderate breathlessness as "walks slower than people of the same age on the level because of breathlessness or has to stop for breath when walking at own pace on the level", while grade 3 describes severe breathlessness as "stops for breath after walking about 100 yards or after a few minutes on the level" (11). When grade 2 was changed to "has to stop for breath after walking 15 minutes", as originally described by Fletcher, subjects appeared to better perceive a difference between the two grades (17).

To assess its psychometric properties, the Spanish translated and culturally adapted MRC and OCD dyspnea scales were then tested in 66 Spanish-speaking patients with asthma, COPD, or ILD. The severity of breathlessness rated in the scales was correlated with the degree of impairment observed in a spirometry test and a 6MW test.

The OCD demonstrated a significant positive correlation with the FEV₁, FEV₁%, and the 6MWD in the overall study group, and the COPD and the asthma subgroups. A consistent correlation was also observed in ILD subgroup, but significance was not reached, probably because of the small sample size. The greatest correlation of the OCD scale was to distance walked during a 6MW test ($r = 0.589$, $p < 0.001$) and was consistently high in the 3 subgroups.

In the other side, the MRC dyspnea scale showed a significant inverse correlation with FEV₁ and FVC, as well as with 6MWD in the overall study group and in asthma subgroup, but there was no correlation at all in the COPD subgroup. The small size of the sample was a limitation of the study. Nevertheless, it was observed that the OCD scale was able to discriminate levels of impairment in the same subgroup. Other reasons for inconsistent correlation between the MRC and the physiologic measures were further explored.

As previously described, during the qualitative phase of the study some subjects had difficulties to differentiate grade 2 and grade 3 of the MRC as described in the ATS Official Statement, because for these subjects both items described the same degree of impairment. This prompted a literature review and g2 was changed to its equivalent: “stop after 15 minutes walking on the level at your own pace” (17). It may be possible that for some patients, the difference between the 2 grades was still not evident. Furthermore, it was observed that 50% of the COPD subgroup selected Grade 2 or Grade 3 compared to 22% of the asthma subgroup and 9% of the ILD subjects. A lesser proportion of subjects in Grade 2 and 3 in the asthma and ILD subgroup could hide a potential imprecision of the MRC differentiating Grade 2 from Grade 3. Doubling the number of items in the OCD scale and the simplicity of the descriptors (relatively compared to those of the MRC scale) may encourage more fitting response from the participants. A limitation of the MRC in terms of grading breathlessness with the MRC was suggested by Chabra et al (18). They observed that post-bronchodilator FEV₁% was significantly different between patients with modified MRC grade 2 and grade 4, while grade 3 patients did not differ significantly with grade 2 and grade 4 patients.

Finally, we observed that some asthma participants stated that breathlessness impaired their sleep, regardless of their measured FEV₁. Keeping this subset of asthma patients in the analysis lowered the correlation of the OCD scale with FEV₁. When the subset was removed from the analysis, the correlation of the OCD with FEV₁ improved. Interestingly, keeping this subset of the asthma group in the analysis improved the correlation between the OCD scale and the distance walked in a 6MW test ($r = 0.63$ vs. $r = 0.53$; $p < 0.01$) suggesting that sleep deprivation decrease ambulation capacity in the asthma population. Therefore, we kept “sleeping” in the scale, acknowledging that the correlation with FEV₁ weakens, but that the correlation with diminished ambulation capacity is stronger.

In summary, the Spanish version of the OCD and MRC dyspnea scale, as adapted for use in a Hispanic population, were evaluated in 66 patients who had asthma, COPD or ILD. The severity of breathlessness as measured by the adapted OCD showed a moderate to high correlation with spirometric parameters and 6MWD. Meanwhile, the correlation for the MRC was mild to moderate, and some inconsistencies were observed. Based on the results of this study, we propose that the adapted OCD dyspnea scale can be used to assess the

severity of breathlessness in patients in Puerto Rico, but that the MRC needs further evaluation before it can be so used.

This study highlighted the importance of having culturally adapted instruments when assessing clinical outcomes. If patients are unable to understand the instrument or the concept being described by a given question, the answer will most probably be incorrect or invalid. That our participants interpreted the concepts of distance traveled and of time elapsed during an activity differently provides evidence that the cultural adaptation of an instrument is probably more important than its corresponding forward and back-translation in order to achieve concept equivalence.

Also, further studies are needed to elucidate the impact of sleep deprivation due to breathlessness on the ambulation capacity of asthma patients considering nocturnal asthma, concurrent sleep disorders or other confounding variables. To our knowledge these findings has not been previously reported.

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Abbreviation List

ATS	American Thoracic Society
COPD	Chronic obstructive pulmonary disease
ILD	Interstitial lung disease
MRC	Medical Research Council
OCD	Oxygen-cost diagram
FEV₁	Forced expiratory volume at 1 second
FVC	Forced vital capacity
6MW	6-min walk

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Demographic characteristics of the study group by diagnosis

Variable	Total N=66	Asthma n=36	COPD n=19	ILD n=11	p-value
Age					
Mean ± SD	51.4 ± 13.2	45.5 ± 11.2	61.8 ± 10.7	52.5 ± 12.3	<0.0001 ^a
Range	21–81	21–65	44–81	25–70	
Gender, n (%)					
Women	42 (63.6)	28 (77.8)	8 (42.1)	6 (54.6)	
Men	24 (36.4)	8 (22.2)	11 (57.9)	5 (45.4)	0.026 ^b
Smoking status, n (%)					
n=35*					
Active smoker	10 (15.4)	5 (14.3)	4 (21.1)	1 (9.1)	
Ex-smoker	20 (30.8)	6 (17.1)	12 (63.2)	2 (18.2)	
Never smoked	35 (53.8)	24 (68.6)	3 (15.7)	8 (72.7)	
Pack years					
Median	19	10	25.5	9.5	
Range	1–99	1–34	6–99	4–15	
Education, n (%)					
Primary or lower	14 (21.5)	5 (13.9)	7 (38.9)	2 (18.2)	0.114 ^c
Secondary	26 (40.0)	13 (36.1)	8 (44.4)	5 (45.5)	
University or higher	25 (38.5)	18 (50.0)	3 (16.7)	4 (36.4)	

COPD = chronic obstructive pulmonary disease; ILD = interstitial lung disease.

* Smoking history was not recorded in 1 subject who had asthma.

Statistical tests:

^a Kruskal-Wallis test;^b chi-square statistic;^c Fischer's exact test

Table 1

Results of spirometry and of the 6MWD tests of the study group, by diagnosis

Table 2

Variable	Total cohort N = 66	Asthma n = 36	<i>Mean (SD)</i>			p-value ^a
			COPD n = 19	ILD n = 11		
FEV₁, L						
Mean ± SD	2.04 ± 0.73	2.32 ± 0.63	1.50 ± 0.52	2.05 ± 0.87		
Range	0.8–4.0	1.4–4.0	0.8–2.7	1.0–3.5		
FEV₁, % pred						
Mean ± SD	70.82 ± 16.86	78.74 ± 13.46	58.92 ± 13.58	65.47 ± 18.87		<0.0001
Range	40.0–116.1	53.2–116.1	40.0–80.5	43.0–93.8		
FVC, L						
Mean ± SD	2.72 ± 0.94	2.99 ± 0.90	2.35 ± 0.80	2.46 ± 1.09		0.0312
Range	1.0–5.8	1.7–5.8	1.3–3.9	1.0–4.6		
FVC, % pred						
Mean ± SD	75.73 ± 18.10	82.13 ± 14.59	71.35 ± 19.08	62.38 ± 18.68		
Range	34.3–13.9	56.3–113.9	45.1–109.8	34.3–92.7		
FEV₁/FVC %						
Mean ± SD	94.31 ± 13.59	95.95 ± 9.56	84.41 ± 15.64	106.06 ± 9.62		
Range	51.9–126.6	73.4–111.5	51.9–110.0	93.7–126.6		
6MWD (m)^b						
Mean ± SD	444.18 ± 79.98	456.03 ± 70.93	417.44 ± 91.28	449.84 ± 0.29		0.3652
Range	272.3–630.9	293.6–564.5	272.3–630.9	278.9–564.5		

6MWD = 6-min walk distance; COPD = chronic obstructive pulmonary disease; ILD = interstitial lung disease; FEV₁ = forced expiratory volume in 1 second; FVC = forced vital capacity

a Kruskal-Wallis test

b Forty-six subjects performed a 6MWD test

Table 3

Correlation between the oxygen-cost diagram and physiologic measures, by diagnosis

Physiologic measures	<i>Spearman correlation coefficient (p-value)</i>			
	Total N=45)	Asthma n=36	COPD n=18	ILD n=11
FEV₁, L	0.412 (<0.01)	0.489 (<0.01)	0.398 (0.10)	0.455 (0.16)
FEV₁, % pred	0.364 (<0.01)	0.334 (<0.05)	0.522 (<0.02)	0.536 (0.08)
FVC, L	0.439 (<0.01)	0.463 (<0.01)	0.505 (0.03)	0.482 (0.13)
FVC, % pred	0.370 (<0.01)	0.336 (0.045)	0.552 (<0.02)	0.409 (0.21)
6MWD (m)*	N=45 0.589 (<0.001)	n=26 0.630 (<0.01)	n=12 0.568 (0.16)	n=7 0.595 (0.16)

COPD = chronic obstructive pulmonary disease; ILD = interstitial lung disease; FEV₁ = forced expiratory volume in 1 second; FVC = forced vital capacity; 6MWD = 6-min walk distance

* Forty-five subjects performed a 6MWD test and answered the OCD

Table 4

Correlation between the Medical Research Council Dyspnea scale and physiologic measures, by diagnosis

Physiologic measures	Spearman correlation coefficient (p-value)			
	Total N=66	Asthma n=36	COPD n=19	ILD n=11
FEV₁, L	-0.336 (<0.01)	-0.490 (0.02)	0.025 (0.92)	-0.312 (0.31)
FEV₁, % pred	-0.227 (0.07)	-0.297 (0.08)	-0.004 (0.99)	-0.400 (0.22)
FVC, L	-0.380 (<0.01)	-0.554 (<0.01)	-0.189 (0.44)	-0.312 (0.35)
FVC, % pred	-0.289 (0.02)	-0.414 (0.01)	-0.256 (0.29)	-0.211 (0.53)
6MWD (m)*	N=46	n=26	n=13	n=7
	-0.332 (0.02)	-0.444 (0.02)	-0.116 (0.71)	-0.558 (0.19)

COPD = chronic obstructive pulmonary disease; ILD = interstitial lung disease; FEV₁ = forced expiratory volume in 1 second; FVC = forced vital capacity; 6MWD = 6-min walk distance

* Forty-six subjects performed a 6MWD test and they answered the MRC

Table 5

Correlation between OCD and MRC dyspnea scales, by diagnosis

Disease	OCD and MRC scales		
	n	Spearman coefficient	p-value
Asthma	36	-0.648	<0.001
COPD	18	-0.532	0.023
ILD	11	-0.819	0.002
Overall	65	-0.630	<0.001

COPD = chronic obstructive pulmonary disease; ILD = interstitial lung disease