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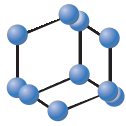
Differences between COPD Patients of a Pulmonary Rehabilitation Program According to the mMRC Dyspnea Scale

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Abstract: *Background*: The modified Medical Research Council scale (mMRC) is a standardized measure of the effect of dyspnea on the activities of the daily life of patients suffering from Chronic Obstructive Pulmonary Disease (COPD). The aim of this study was to determine the differences in the quality of life, tolerance to effort and symptoms among patients with COPD with lower (mMRC 0-1) and greater symptoms (mMRC ≥2).

Methods: Cross-sectional study that included patients admitted to a pulmonary rehabilitation program and who were classified into 2 groups: a group containing the less symptomatic patients and another group with the more symptomatic ones. We collected these patients' sociodemographic, clinical, anthropometric, anxiety, depression and quality of life (SGRQ) data. Likewise, the subjects performed the 6-minute walk test (6MWT). Finally, we measured the multidimensional BODE index score.

Results: 130 subjects were included, 35 presenting an mMRC of 0 to1 and 95 having an mMRC ≥ 2, with an age of 70.87 ± 9.45 years old. The 6MWT distance, the VO2e, the total score of SGRQ, and its domains of activities and impact showed significant differences between the groups (p <0.05). Significant correlations were found in the group presenting an mMRC of 0-1 between the mMRC and the FEV1 (p = 0.028), and in the group with an mMRC ≥2 for the FVC (p = 0.031), the 6MWT distance (p = 0.000), the VO2e (p = 0.010) and the BODE index (p = 0.000).

Conclusion: Patients with an mMRC of 0 to1 had better results in the 6MWT, the VO2e and the SGRQ in comparison with the most symptomatic ones.

Keywords: Chronic obstructive pulmonary disease, dyspnea, exercise tolerance, quality of life, patients, pulmonary rehabilitation program.

1. INTRODUCTION

Patients with the chronic obstructive pulmonary disease (COPD) predominantly present three symptoms: cough, expectoration and dyspnea. The latter causes the greatest daily limitation because it worsens with effort [1]. Like dyspnea, intolerance to exercise and reduction of functional capacity are found even in patients with mild COPD [2] and, as the disease progresses and reaches higher levels of severity, these symptoms are accentuated [3].

The modified Medical Research Council scale (mMRC) is a simple, standardized measure that determines the effect that dyspnea has on daily life activities [4-6]. In some studies, changes in the score of the mMRC scale have been evaluated with the application of pharmacological and non-pharmacological treatments in patients with COPD, and in turn, the relationship that this scale has with the capacity of exercise, the quality of life related to health, anxiety and depression and lung function [7]. However, all the variables that explore the correlations or group them according to the symptoms have not been included in a single investigation.

The COPD management guide (GOLD) states that highly symptomatic patients with mMRC dyspnea greater than or equal to 2 have a greater degree of functional impairment. However, in clinical practice, it is necessary to understand

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the aspects that are most affected according to the patients' degree of dyspnea when several validated tests are applied in that population [1]. The objective of this study was to determine the differences between patients with COPD with lower and higher symptoms according to the mMRC scale, in terms of functional capacity, physiological variables, anxiety and depression, BODE index and quality of life-related to health. The study was carried out with patients who entered to a pulmonary rehabilitation program. Furthermore, the correlation between dyspnea measured with the mMRC scale and the aforementioned variables was explored.

2. MATERIALS AND METHODS

We carried out a descriptive cross-sectional study through a non-probabilistic sampling, from July 2015 to June 2017, and we included patients who were diagnosed with COPD in the Pulmonologist's service due to lung changes in the chest X-ray, alteration in the ventilatory patterns of the Spirometry (GOLD), and who entered into a Pulmonary Rehabilitation program in Cali (Colombia). The participants were classified into 2 groups: those who were less symptomatic (mMRC 0-1) and those who were more symptomatic (mMRC ≥2), based on the symptom classification of the Global Obstructive Lung Disease (GOLD) [1]. The exclusion criteria that we used were: cognitive or compression impairment that limits the application of measurements, uncontrolled cardiac and/or metabolic diseases, and patients diagnosed with COPD without spirometry in the last month.

The study was approved by the ethics committee of the Institución Universitaria Escuela Nacional del Deporte, and adopted the guidelines of Resolution 8430 of Colombia's Ministry of Health and Social Protection and the Declaration of Helsinki. Furthermore, all participants signed informed consent.

2.1. Instruments

The variables included in the study were: age, sex, marital status, socioeconomic status, home oxygen use, post-bronchodilator spirometry (FEV1, FVC, FEV1/FVC as a percentage of the predicted), dyspnea in daily life activities using the mMRC scale, weight, height and body mass index (BMI) [5].

On the mMRC scale, the patient reports a score of 0 when there is dyspnea only with strenuous effort; 1 when they present dyspnea when walking quickly or on a slope; 2 when they present more dyspnea walking on flat terrain than individuals of their same age or when they have to stop breathing when walking at a normal pace; 3 when the patient has to stop after walking 90-100 meters; and 4 when the patient cannot leave the house due to dyspnea or if dyspnea appears when dressing.

Functional capacity was measured with the 6-minute walk test (6MWT), in which data on heart rate, respiratory rate, and peripheral oxygen saturation (SpO2) were recorded at the beginning and at the end of the test. Moreover, the distance traveled (d6MWT), and the estimated oxygen consumption (VO2e) were recorded with the formula VO2e = 3.5 ml/kg/min + (vel m/min × 01) [8, 9], and the desaturation was obtained at the end of the test. The BODE index score was also performed [10].

The health-related quality of life (HRQoL) was measured with the Saint George Respiratory Questionnaire (SGRQ). This instrument includes 3 domains: symptoms, activity and impact. The total score and the score of each domain goes from 0 to 100, where the values that approach to 100 represent a worse HRQoL [11].

Anxiety and depression were evaluated with the Hospital Anxiety and Depression Scale (HADS), which comprises 14 items organized in the subscales of anxiety and depression, with 7 questions for each one. In this scale, the score goes from 0 to 3, where 0 suggests the absence of the symptom and 3 indicates a high frequency of the symptom. Thus, the scores of each question correspond to the subscale of anxiety or depression, and if the value of the sum is less than 7, it is considered negative, if the result goes from 8 to 10, it is considered doubtful and if the result is greater than 10, it is positive for the symptom [12].

2.2. Procedure

When entering the study, the participants signed an informed consent and then a physiotherapist conducted an interview to obtain their sociodemographic and clinical data, including the mMRC scale. The HADS and SGRQ questionnaire was applied in a self-administered manner.

Finally, the 6MWT was performed following the recommendations of the American Thoracic Society. In a 30-meter corridor, each patient was encouraged to walk as quickly as possible and was informed about the time elapsed during the minute-by-minute test. Partial oxygen saturation (SpO2) and heart rate were monitored with a pulse oximeter (NONIN GO2 Finger Pulse Oximeter® PN# 9570). At the end of the test, the d6MWT was recorded in meters and the oxygen consumption was calculated. Once all data were entered, the calculation of the BODE index was carried out [10].

2.3. Data Analysis

The data were consigned in a Microsoft Excel version 2013 database and subsequently processed in the statistical package SPSS version 24. Statistical tests were performed presenting the qualitative variables as frequency and percentage. On the other hand, the quantitative variables were measured assuming normality with the Kolmogorov test and were presented as the mean ± standard deviation (SD). To determine the difference between the two groups, the t-test was performed for independent samples. The Spearman method to establish the correlation between mMRC scale dyspnea and the 6MWT was used. For all tests, a p-value <0.05 was considered as statistically significant.

3. RESULTS

Between July 2015 and June 2017, 130 patients with COPD were included in the study, 35 in the least

Table 1.   Sociodemographic characteristics of patients.

Characteristics	mMRC (0-1) n=35	mMRC (≥2) n=95	All	Valor-p
Age (years old)*	71.17 ± 9.07	70.76 ± 9.63	70.87 ± 9.45	0.826
Sex n (%)				
Male	21 (60.0)	58 (61.1)	79 (60.8)	0.926
Female	14 (40.0)	37 (38.9)	51 (39.2)	
Marital Status				
Stable union	19 (54.3)	59 (62.1)	78 (60.0)	0.545
No stable union	16 (45.7)	36 (37.9)	52 (39.2)	
Socioeconomic stratum				
Low	15 (42.9)	49 (51.6)	64 (49.2)	0.494
Medium	16 (45.7)	41 (43.2)	57 (43.8)	
High	4 (11.4)	5 (5.3)	9 (6.9)	
Visits to the emergency room				
Yes	19 (54.3)	70 (73.7)	89 (68.5)	0.058
No	16 (45.7)	25 (26.3)	41 (31.5)	
Hospitalizations				
Yes	17 (48.6)	54 (56.8)	71 (54.6)	0.521
No	18 (51.4)	41 (43.2)	59 (45.4)	
Home oxygen				
Yes	14 (40.0)	54 (56.8)	68 (52.3)	0.132
No	21 (60.0)	41 (43.2)	62 (47.7)	

* Variables presented as mean ± standard deviation.

Table **1** shows the general characteristics of the population; mostly men, middle socioeconomic stratum predominates and most of the participants reported using home oxygen.

symptomatic group (mMRC 0-1) and 95 in the most symptomatic group (mMRC≥ 2).

The mean age was 70.87 ± 9.45 years old, and the majority of participants were men. Moreover, most of the participants were in a stable union as their marital status. The sociodemographic and service demand characteristics did not show statistically significant differences between the groups (Table **1**).

Table **2** shows the anthropometric and clinical characteristics of the patients. The anthropometric variables lung function, anxiety and depression, and HRQOL presented similar values in the two groups (p > 0.05). However, the d6MWT, the estimated oxygen consumption, the SGRQ total score, the activity and impact subdomains, and the multidimensional BODE index showed statistically significant differences (p < 0.05).

The correlations between the mMRC and the other variables for each group (with mMRC 0-1 and mMRC≥2) are presented in Table **3**. Statistically significant differences were found in the group of mMRC 0-1 and FEV1 (r = -0.372, p = 0.028), and in the group of mMRC≥2 in FVC (r = -0.222; p = 0.031), the distance traveled in the 6MWT (r = -0.383, p = 0.000), the BODE index (r = 0.540, p = 0.000) and the VO2e (r = -0.262; p=0.010). When the total sample was analyzed, the mMRC presented significant differences comparing the different variables of our study (p <0.05), as is shown in Table **3**.

4. DISCUSSION

Since 2011, the GOLD has included the mMRC scale to classify patients as less symptomatic and more symptomatic. Although this classification has had some changes, it is still valid in 2019 and its use is essential in patients with COPD [1]. This is why the present study sought to determine the differences and correlations in terms of functional capacity, physiological variables and HRQoL, among patients with COPD who entered a PR program and who had lower and higher symptoms according to the mMRC.

The population that finished the training consisted of 130 patients, of which 35 were classified in the least symptomatic group and 95 in the most symptomatic group. This shows that although the least symptomatic (A and C) are the most prevalent, [13, 14] these are the ones that are less involved in PR, although it has been demonstrated that those patients present ventilatory and gas exchange alterations, and cardiac and musculoskeletal dysfunction, which can finally lead to exercise intolerance This can be explained, in part, by the fact that some systematic reviews

Table 2.   Anthropometric differences, functional capacity and quality of life between groups.

Variables	mMRC (0-1) n=35	mMRC (≥2) n=95	p value
HEIGHT	1.62 ± 0.10	1.60 ± 0.09	0.541
WEIGHT	66.07 ± 13.8	64.15 ± 13.81	0.482
BMI	25.30 ± 4.78	24.96 ± 5.24	0.738
FEV1	43.12 ± 11.86	42.62 ± 15.74	0.866
FVC	66.21 ± 18.20	67.90 ± 20.95	0.675
FEV1/FVC	62.69 ± 7.96	59.85 ± 11.09	0.168
6MWT Distance	342.23 ± 108.53	270.75 ± 107.01	**0.001***
VO2e	8.86 ± 2.01	7.65 ± 2.12	**0.004***
BODE index	3.17 ± 1.67	5.58 ± 2.17	**0.000***
Anxiety HAD	5.80 ± 4.6	6.74 ± 4.64	0.309
Depression HAD	4.40 ± 3.79	5.84 ± 3.92	0.063
TOTAL SGRQ	42.65 ± 15.36	53.43 ± 16.16	**0.002***
SGRQ symptoms	47.42 ± 1.65	49.62 ± 20.93	0.613
SGRQ activities	52.90 ± 23.10	64.64 ± 22.40	**0.011***
SGRQ impact	33.32 ± 15.90	44.24 ± 17.99	**0.005***

BMI: Body Mass Index; FEV1: Forced Expiratory Volume in the first second; FVC: Forced Vital Capacity; 6MWT: 6-Minute Walk Test; VO2e: Estimated peak oxygen consumption; HADS: Hospital Anxiety and Depression Scale questionnaire; SGRQ: St. George Respiratory Questionnaire. * Statistically significant p< 0.05.
Table **2** shows the anthropometric and clinical characteristics of the patients. The anthropometric, lung function, anxiety and depression and HRQoL variables presented similar values in both groups (p> 0.05).

Table 3.   Correlation between mMRC and anthropometric characteristics, functional capacity, HRQL and anxiety and depression.

	mMRC (0-1) n=35		mMRC (≥2) n=95		Total Population (n=130)	
Variables	r	p value	R	p value	r	p value
HEIGHT	0.195	0.260	-0.087	0.403	-0.045	0.615
WEIGHT	0.177	0.308	0.022	0.835	-0.012	0.892
BMI	0.083	0.635	0.072	0.487	0.020	0.821
FEV1	-0.372	**0.028***	-0.199	0.053	-0.150	0.088
FVC	-0.248	0.151	-0.222	**0.031***	-0.104	0.241
FEV1/FVC	-0.285	0.097	-0.092	0.374	-0.176	**0.046***
6MWT Distance	-0.038	0.829	-0.383	**0.000***	-0.392	**0.000***
BODE index	0.162	0.352	0.540	**0.000***	0.610	**0.000***
VO2e	-0.146	0.403	-0.262	**0.010***	-0.334	**0.000***
Anxiety HAD	-0.053	0.762	0.109	0.291	0.110	**0.211**
Depression HAD	0.018	0.919	0.128	0.217	0.189	**0.031***
Total SGRQ	0.342	0.060	-0.111	0.366	0.266	**0.008***
SGRQ symptoms	0.155	0.405	-0.116	0.348	0.021	0.838
SGRQ activities	0.335	0.066	0.070	0.573	0.295	**0.003***
SGRQ impact	0.337	0.064	-0.165	0.179	0.224	0.026*

BMI: Body Mass Index; FEV1: Forced Expiratory Volume in the first second; FVC: Forced Vital Capacity; 6MWT: 6-Minute Walk Test; VO2e: Estimated peak oxygen consumption; HADS: Hospital Anxiety and Depression Scale questionnaire; SGRQ: St. George Respiratory Questionnaire. * statistically significant p< 0.05.
Table **3** shows the correlations between the mMRC and the other variables for each group (with mMRC 0-1 and mMRC≥2) and for the total study population. The distance traveled in the walk test, the BODE index and the total SGRQ score correlated with the dyspnea scale.

have found significant but discrete improvements in terms of HRQOL, and non-significant clinical changes in the distance covered in the 6MWT after PR in patients with COPD, which may result in lower referral of patients to rehabilitation programs [15].

The mean age of the participants in our study was greater than 70 years old. This fact resembles that of the research by Cameron-Tucker *et al.* [16], who reported that the mean age of the participants of their study was 65 years old, and the study by Hjalmarsen in which the mean age was 69.2 years old [17]. Likewise, in both of the groups of the study, the majority of the population was men: in the less symptomatic group, it was of 60% and 61.1% in the more symptomatic group. These results are similar to those found by Benavides *et al.* [18] where 58.3% of the participants were men and to the results of the studies that were included in the systematic review by Osterling in which more than half of the participants were men [19].

Regarding the anthropometric variables, there were no significant differences in the BMI between the two groups (25.3 ± 4.7 in the mMRC 0-1 group *vs.* 24.96 ± 5.2 in the mMRC ≥ 2 group, p = 0.738). The latter shows that, on average, the participants were overweight. These data are in accordance with multiple publications that show that patients being overweight and suffering from COPD have better values in terms of lung function, aerobic capacity and reduction in mortality risk [9]. In addition, an association has been found between the reduction of dyspnea valued with the mMRC scale and weight reduction of people with morbid obesity after bariatric surgery [20].

Regarding pulmonary function, the mean FEV1 did not present significant differences between the groups (p = 0.866), which suggests that the participants who entered the study were in a severe stage of the disease from the structural point of view. This situation is similar in subjects who entered PR programs in the studies by Heleen Demeyer *et al.* in 2014 [21], and Benavides & Betancourt-Peña in Colombia [18, 22], in which the mean FEV1 ranged between 42% and 48%. However, it is necessary to clarify that the results presented above contradict two studies that show discordant data between them and with our study: the study by Cameron-Trucher *et al.* [16], in which almost 50% of the participants were in a severe stage of the disease, and the study by Jácome *et al.* [23] in which most of the subjects were in a mild structural alteration with an FEV1 of 72.2%.

The main symptoms of COPD are dyspnea and fatigue of the extremities, which promptly lead to disability and inactivity, which in turn contributes to greater physical deterioration and more dyspnea, resulting in a vicious circle [24]. The d6MWT has been used in order to assess the physical condition of the patients and the response to the PR intervention. It is considered that a distance traveled of less than 350 meters is related to poor prognosis for patients with COPD; therefore, the present study is on average below these values and contrasts with the results of investigations carried out by authors such as López Varela *et al*, who reported an average of 412 meters, [25] Cameron-Trucker who reported an average of 353 m [16] and Spruit in 2010 who found an average of 370 meters [26].

Furthermore, the 6MWT has been widely used to measure stress tolerance as an indicator of aerobic capacity. In our study, we found significant differences between the groups (p < 0.001). These results agree with those found by Spruit in 2010, in which they state that dyspnea with an mMRC≥2 is a measure of poor prognosis for the performance of a 6MWT with good results, that is, one in which the patient travels more than 350 meters [26]. In addition, in 2015 Patel reported that there is a significant correlation between the 6MWT and the mMRC (p <0.001); a situation that generates reliability in the results obtained in our investigation since it corroborates that the more symptoms the person with COPD has, the less distance they travel in the 6MWT.

The BODE index, as well as dyspnea, are predictors of mortality, and the sensation of suffocation, accompanied by the BMI, the distance traveled in the 6MWT and the pulmonary function establish the multidimensional measurement most used in recent years. In our study, significant differences were also found in the BODE index between groups, of which the mMRC is one of the determinant variables of the index [12].

Similar to what happened with the previously evaluated variables, dyspnea intervenes in the quality of life related to health, and in this case with the SGRQ score, in which we obtained an average total score of 42.65 in the less symptomatic group ± 15.36 and an average score of 53.4 ± 16.6 (p <0.05) in the most symptomatic group. This situation allows us to suppose that the more dyspnea there is the worse the patient's quality of life will be. This result can be compared with the obtained by Kaymaz *et al.* [27] in which they found a strong correlation between the dyspnea questionnaire and the SGRQ in patients with COPD. This situation also occurred in the investigation by Mariko Morishita-Katsu *et al.* [28], where they found a positive correlation between HRQOL and dyspnea (r: 0.63). This can be explained by the appearance of dyspnea in most of the activities of daily life, decreasing functional independence, which is a main part of HRQoL, mainly in the "activities" domain [29], so that patients with an mMRC greater than 2 obtain more unfavorable scores in the SGRQ questionnaire.

Regarding the correlation between the variables of our study, a strong relationship was found between dyspnea mMRC and 6MWT (p <0.0001), estimated oxygen consumption and BODE index (p <0.000), and moreover, we found a good correlation between the lung functions that measure obstructive alterations: FEV1 and FEV1/FVC ratio (p < 0.05). Manescu *et al.* found in 2012 that the result of the mMRC scale and the distance covered in the 6MWT had a strong relationship and that one variable explained the other (p <0.001). This result is similar to the one presented in our investigation, where there was a significant positive correlation (r: 0.39). However, it is interesting to note that the relationship is stronger in the more symptomatic patients compared to those who presented fewer symptoms. This could be explained because musculoskeletal dysfunction, dyspnea and structural alterations of more symptomatic patients affect in a greater way the performance of a submaximal test such as the 6MWT, compared with those

patients that have fewer alterations. The same happens with the estimated VO2.

The relationship of dyspnea and lung function is similar to that found by Patel in 2015 [30] in which, despite not being a strong relationship, it does produce positive results that explain in some way the symptomatic and structural relationship evaluated with the two variables and contrasts with that of Ghada A. Attia in which the relationship between VEF and mMRC was not significant (p> 0.05) [31]. This could be explained due to the number of patients evaluated (n) since in the 2016 study 80 patients with COPD were admitted, while in our study, the sample was of 130 patients. Thus, having evaluated a larger number of patients could have interfered in the statistics.

CONCLUSION

In conclusion, this study determined that patients with an mMRC of 0-1 presented better results in the distance and in the VO2 estimated in the 6-minute walk test, the activity, impact and total scores of the health-related quality of life questionnaire (SGRQ) in comparison with the more symptomatic patients classified as mMRC $\geq$ 2.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the ethics committee of the Institución Universitaria Escuela Nacional del Deporte, and adopted the guidelines of Resolution 8430 of Colombia's Ministry of Health and Social Protection.

HUMAN AND ANIMAL RIGHTS

No Animals were used for studies that are base of this research. All human procedures were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Human subjects used in the study provided informed consent to participate.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of the article is available in www.figshare.com, doi: 10.6084/m9.figshare.9642083.

FUNDING

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

REFERENCES

[1]   Global Strategy for the Diagnosis, Management and Prevention of COPD - Global Initiative for Chronic Obstructive Lung Disease - GOLD. 2019.

[2]   O'Donnell DE, Gebke KB. Activity restriction in mild COPD: A challenging clinical problem. Int J Chron Obstruct Pulmon Dis 2014; 9: 577-88.

[3]   Liu Y, Pleasants RA, Croft JB, et al. Smoking duration, respiratory symptoms, and COPD in adults aged >/=45 years with a smoking history. Int J Chron Obstruct Pulmon Dis 2015; 10: 1409-16.

[4]   Gallego MC, Samaniego J, Alonso J, Sánchez A, Carrizo S, Marín JM. Disnea en la EPOC: Relación de la escala MRC con la disnea inducida en las pruebas de marcha y de ejercicio cardiopulmonar máximo. Arch Bronconeumol 2002; 38(3): 112-6.

[5]   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(4): 435-52.

[6]   Spruit MA, Singh SJ, Garvey C, et al. An official American Thoracic Society/European Respiratory Society statement: Key concepts and advances in pulmonary rehabilitation. Am J Respir Crit Care Med 2013; 188(8): e13-64.

[7]   Lacasse Y, Martin S, Lasserson TJ, Goldstein RS. Meta-analysis of respiratory rehabilitation in chronic obstructive pulmonary disease. A Cochrane systematic review. Eura Medicophys 2007; 43(4): 475-85.

[8]   American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription. Ninth Edition. Lippincott, Williams & Wilkins; 2014.

[9]   Holland AE, Spruit MA, Troosters T, et al. An official European Respiratory Society/American Thoracic Society technical standard: Field walking tests in chronic respiratory disease. Eur Respir J 2014; 44(6): 1428-46.

[10]   Celli BR, Cote CG, Marin JM, et al. The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. N Engl J Med 2004; 350(10): 1005-12.

[11]   Ferrer M, Villasante C, Alonso J, et al. Interpretation of quality of life scores from the St George's Respiratory Questionnaire. Eur Respir J 2002; 19(3): 405-13.

[12]   Terol-Cantero MC, Cabrera-Perona V, Martín-Aragón M. Hospital Anxiety and Depression Scale (HADS) review in Spanish Samples. An Psicol-Spain 2015; 31(2): 494-503.

[13]   Boland MR, Tsiachristas A, Kruis AL, Chavannes NH, Rutten-van Molken MP. Are GOLD ABCD groups better associated with health status and costs than GOLD 1234 grades? A cross-sectional study. Prim Care Respir J. 2014; 23[1]: 30-7.

[14]   Mapel DW, Dalal AA, Johnson PT, Becker LK, Hunter AG. Application of the new GOLD COPD staging system to a US primary care cohort, with comparison to physician and patient impressions of severity. Int J Chron Obstruct Pulmon Dis 2015; 10: 1477-86.

[15]   Rugbjerg M, Iepsen UW, Jorgensen KJ, Lange P. Effectiveness of pulmonary rehabilitation in COPD with mild symptoms: A systematic review with meta-analyses. Int J Chron Obstruct Pulmon Dis 2015; 10: 791-801.

[16]   Cameron-Tucker HL, Wood-Baker R, Owen C, Joseph L, Walters EH. Chronic disease self-management and exercise in COPD as pulmonary rehabilitation: A randomized controlled trial. Int J Chron Obstruct Pulmon Dis 2014; 9: 513-23.

[17]   Hjalmarsen A, Brenn T, Jongsma Risberg M, Meisler Antonsen K, Kristiansen Benum E, Aaseboe U. Retrospective survival in elderly COPD patients receiving pulmonary rehabilitation; A study including maintenance rehabilitation. BMC Res Notes 2014; 7: 210.

[18]   Benavides V, Wilches-Luna E. Cambios en la puntuación del índice bode en pacientes con enfermedad pulmonar obstructiva crónica antes y después de rehabilitación pulmonar. Revista Ciencias de la Salud 2018; 16(1): 101-13.

[19]   Osterling K, MacFadyen K, Gilbert R, Dechman G. The effects of high intensity exercise during pulmonary rehabilitation on ventilatory parameters in people with moderate to severe stable COPD: A systematic review. Int J Chron Obstruct Pulmon Dis 2014; 9: 1069-78.

[20]   Boissiere L, Perotin-Collard JM, Bertin E, et al. Improvement of dyspnea after bariatric surgery is associated with increased

Expiratory Reserve Volume: A prospective follow-up study of 45 patients. PLoS One 2017; 12(9): e0185058.

[21] Demeyer H, Burtin C, Van Remoortel H, *et al*. Standardizing the analysis of physical activity in patients with COPD following a pulmonary rehabilitation program. Chest 2014; 146(2): 318-27.

[22] Betancourt-Peña J, Tonguino-Rosero S, Rosero-Carvajal HE, Hurtado H. Diferencias de la rehabilitación pulmonar en pacientes con EPOC, con y sin indicación de oxígeno domiciliario a largo plazo. Fisioterapia 2018; 40(4): 167-222.

[23] Jacome C, Marques A. Short- and Long-term effects of pulmonary rehabilitation in patients with mild COPD: A comparison with patients with moderate to seveRE COPD. J Cardiopulm Rehabil Prev 2016; 36(6): 445-53.

[24] Parada A, Klaassen J, Lisboa C, Saldias F, Mendoza L, Diaz O. [Reduction of physical activity in patients with chronic obstructive pulmonary disease]. Rev Med Chil 2011; 139(12): 1562-72.

[25] López Varela MV, Anido T, Larrosa M. Estado funcional y supervivencia de los pacientes con EPOC tras rehabilitación respiratoria. Arch Bronconeumol 2006; 42(9): 434-9.

[26] Spruit MA, Watkins ML, Edwards LD, *et al*. Determinants of poor 6-min walking distance in patients with COPD: The ECLIPSE cohort. Respir Med 2010; 104(6): 849-57.

[27] Kaymaz D, Candemir IC, Ergun P, Demir N, Tasdemir F, Demir P. Relation between upper-limb muscle strength with exercise capacity, quality of life and dyspnea in patients with severe chronic obstructive pulmonary disease. Clin Respir J 2018; 12(3): 1257-63.

[28] Morishita-Katsu M, Nishimura K, Taniguchi H, *et al*. The COPD assessment test and St George's Respiratory Questionnaire: Are they equivalent in subjects with COPD? Int J Chron Obstruct Pulmon Dis 2016; 11: 1543-51.

[29] Betancourt-Peña J, Muñoz BE, Mora-Guerra RV. Calidad de vida en pacientes con enfermedad Pulmonar obstructiva crónica al ingreso de Un programa de rehabilitación pulmonar. Rev Col Rehab 2015; 14(1): 46-53

[30] Patel A. Correlation of spirometry with six minute walk test and grading of dyspnea. Eur Respir J 2015; 46: PA604

[31] A. Attia G. Correlation of respiratory pump function with symptomatology in COPD. Egypt J Chest Dis Tuberc 2016; 65(1): 35-40.