Original Article

Impact of Pulmonary Rehabilitation and Educational Component in Patients with Severe Asthma

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Abstract

Background: Asthma is a chronic inflammatory airways disease, which produces an increase in the reactivity and recurrent episodes of wheezing, respiratory distress and cough. Pulmonary rehabilitation (PR) and education is a strategy that improves the quality of life and health status of patients. **Objective:** To determine the impact of PR with an educational component on functional aerobic capacity, symptoms, anxiety, depression and quality of life related to health in patients with severe asthma. **Methods:** Prospective and non-controlled intervention study in 11 patients, who underwent the 6-minute walking test, spirometry, the Medical Research Council dyspnoea scale (MRC), the Hospital Anxiety and Depression Scale questionnaire (HADS) and the St George's Respiratory Questionnaire (SGRQ). The PR program comprised 8 weeks of muscle strength training, aerobic capacity and educational component with individual and group sessions. **Results:** 11 patients completed the PR program. The average age was 55.82 ± 19.96. The FVC had an average of 49.21 of the predicted SD ± 14.94. The distance covered in the 6-minute walking test had a difference in means and DE of 53.36 ± 50.7, being clinically significant. In anxiety and depression there was a mean difference of 1.18 ± 2.31 and 1.54 ± 2.62 respectively, anxiety with a p-value of 0.079 and depression with a p-value of 0.12. They did not have a statistically significant improvement, and in the quality of life related to health, the domain that presented the greatest improvement were activities, with a p-value of 0.000. **Conclusions:** In a PR program, education showed good results regarding variables such as functional aerobic capacity, symptoms and quality of life in patients with severe asthma.

Keywords: Asthma; Exercising; Pulmonary rehabilitation; Dyspnoea; Quality of life

Introduction

Asthma is a frequent and potentially serious chronic disease that places a considerable burden on patients, their families and society. It causes respiratory symptoms, limitation of activity and exacerbations (seizures or attacks) that sometimes require urgent medical assistance and can be fatal. [1]

According to the World Health Organization (WHO) there are approximately 383000 cases of deaths from this disease, mostly corresponding to older adults. [2] Patients with severe asthma comprise between 5 and 10% of the total population with asthma, and they present high rates of morbidity and high costs to the health system. [3]

The asthma treatment has several strategies, among which the pharmacological has been widely studied and used, however it is necessary to find new strategies to improve the particular state of these patients. [4] One of these strategies is pulmonary rehabilitation (PR), which has produced improvement in aerobic capacity, physical activity, activities of daily living, muscle strength, quality of life, and it has also reduced inflammation markers. [5]

Structured training is a fundamental part of PR, its benefits in chronic obstructive pulmonary disease (COPD) are well known and the evidence is superior to other chronic pulmonary diseases; [6-8] however, patients with severe asthma present intolerance to exercising due to episodes of bronchospasm, [9] muscle dysfunction and behavioural alterations, thus, the effects of RP could improve all these clinical aspects.

For the care of patients with chronic lung disease, several strategies have been developed, among which are smoking cessation, exercise promotion, knowledge of the disease and adherence to the pharmacological treatment. [10,11] All these in the framework of patient education. Furthermore, within PR, respiratory physiotherapy is included, which improves dyspnoea and fatigue, the correct use of inhalers and the acquisition of healthy lifestyles.

Due to the previously remarked, it is necessary to know how PR treatment, in which an educational program is included, can impact on different physiological, clinical and quality of life variables; being the objective of this research: To determine the

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impact of PR with an educational component on the functional aerobic capacity, symptoms, anxiety, depression and quality of life related to health in patients with severe asthma.

Methodology

Prospective uncontrolled intervention study in a population of 11 patients with asthma who entered to a PR program in a fourth level hospital in Cali, Colombia, during the period between January 2015 to December 2016. At the time of PR, all patients were receiving long-term treatment from a pulmonologist, according to the behavior of informed patterns of disease variability, triggering factors and receptivity to medications.

The inclusion criteria considered were: patients with a medical diagnosis of severe asthma confirmed by reversibility in spirometry, patients between 40 and 80 years of age, performing PR for the first time and patients capable of conclude the 8-week intervention. The exclusion criteria were: patients with decompensated cardiovascular and metabolic diseases, exacerbations requiring hospitalization or emergency visits in the last month, treatment with intravenous corticosteroid drugs in the last month after PR admission, current smokers or ex-smokers who gave up smoking during the previous 2 years, and smoking history greater than 15 packs per year. [12]

Taking into account the Helsinki declaration, the study was approved by the Institutional Ethics Committee of the hospital where the research was conducted; all the procedures were performed following international bioethics standards. Confidentiality and all the necessary security measures for the application of assessment and intervention instruments were guaranteed for patients.

Variables

The variables that were evaluated were sex, age, place of residence, values obtained in spirometry as Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV1) and the relationship between (FEV1/FVC) in percentage of the predicted, and body mass index (BMI). Moreover, dyspnoea was evaluated in activities of daily living with the Medical Research Council (MRC) scale pre and post PRP, in which grade I means dyspnoea only with very strong exercise; grade II ability to keep up the pace of a person of the same age in the plain without dyspnoea, but not in the flat or when climbing stairs; in grade III, the patient is able to walk on the plain in his pace without dyspnoea, but unable to keep up the pace of people of his age; in grade IV, the patient presents dyspnoea when slowly walking 100 meters; and in grade V, there is dyspnoea at rest or with small efforts like dressing. [13]

The distance travelled in the six-minute walk test (6MWT) before and after PR was analysed. Furthermore, anxiety and depression were evaluated with the Hospital Anxiety and Depression Scale (HADS), pre- and post-PR. This scale consists of a questionnaire of 14 questions, divided into two subscales of anxiety (7 questions) and depression (7 questions), with a maximum score of 21 and structured Likert-type responses (eight). This questionnaire is based on the prevalence of depression and anxiety in patients who attend a general medicine hospital and who may coexist with a physical illness leading to greater stress. The score for each of the subscales is obtained by adding up the values of the selected sentences with values of 0 to 3, with a score range of between 0 to 21. It is considered to be normal when the subscale of anxiety or depression has a score of 0-7, doubtful when it is of 8-10, and a major clinical problem when the score is greater than 11.

Quality of life related to pre- and post- RP health was determined with the St. George Respiratory Questionnaire (SGRQ), an instrument designed to measure the impact on general health, daily living, and the perception of well-being in patients with obstructive airway disease. [14] The SGRQ consists of 3 dimensions: symptoms, activity and impact. In the first dimension, aspects such as the presence of dyspnoea, cough and expectoration, and the frequency with which they occur are measured. In the second dimension, the limitation of activity due to dyspnoea is assessed (e.g. walking slower than others, having to stop to rest on a flight of stairs or not being able to ride a bicycle). Finally, in the third dimension, the most psychosocial aspects are considered, such as the problems that the medication intake can cause. [14]

Procedures

All patients initially signed the informed consent before initiating the PR and subsequently they responded, in a self-administered way, the HADS questionnaire and the SGRQ questionnaire, with intervals of ten minutes between both questionnaires. The estimated time in which patients answered the questionnaires was 60 minutes. The application of the MRC dyspnea scale was performed by a physiotherapist specialist in the area. Finally, the functional capacity was evaluated with the 6MWT, taking into account the recommendations of the American Thoracic Society (ATS). [15] For this test, there was a 30 m long flat track, with two cones at the ends to delimit the distance. At the beginning of the test, the patient was encouraged to walk as quickly as possible and was told of the time elapsed during the test minute by minute.

Pulmonary rehabilitation program

The PR program was carried out in an outpatient clinic, and consisted of 24 sessions of exercise and educational activities, distributed in 3 sessions per week (one hour per session) for 8 weeks. Patients were instructed to use a short-acting bronchodilator, 15 minutes before each session.

The intervention protocol was guided by a Physiotherapist specialized in Cardiac and PR, where patients performed continuous predominance exercise in endless band for 30 minutes, starting at 60% of the estimated VO_2 reached in the 6MWT. [16]

The progression in exercise intensity was performed using the modified Borg scale to maintain a score between 3 (moderate) and 5 (severe). [17,18] Muscle strengthening was performed by

4 sets of 12-15 repetitions starting at 50% of the maximum resistance (MR), and 4 weeks after it was increased to 60% of the MR for upper and lower limbs. [19]

At the end of the PR program, each patient was given a written program of domiciliary exercises based on the activities and intensities performed during the last two weeks of training. Additionally, 30 minutes per week of individual educational component and 60 minutes per week of group educational component were incorporated.

Educational component

Patients received education on topics such as: knowledge of the disease, importance of not smoking, use of inhalers, recognition of warning signs, management of breathing in activities of daily living, use of home oxygen, adequate nutrition, energy conservation techniques and domiciliary respiratory exercises. [20,21]

The individual educational component was performed once the patient entered the PR program. In the first session, with the help of audiovisual elements, patients were informed about issues related to the knowledge of the disease. Initially, we inquired about the initial knowledge the patient had and the necessary feedback was done, and later, the same process was carried out once a week with the other subjects.

The group activities were carried out in sessions held once a week, with the collaboration of a professional in psychology, nutrition, physiotherapy and medicine, who each week addressed issues related to the burden of the disease, how to live and accept a chronic pulmonary disease, the support of family members, leisure strategies, adequate nutrition, exercising at home, the knowledge of medications and home oxygen use. In these meetings, patients could attend in the company of a family member and, in a participative way; the health professionals presented the ideas and complemented them with examples. At any time, patients/relatives made contributions sharing their experiences and questions with the group, and in the end the health professional generated a general conclusion for each group offering recommendations of interest for each of the members of the group.

Statistical analysis

The information was processed in Microsoft Office Excel® 2010, and then, it was analyzed in the statistical package SPSS version 24. The sociodemographic variables were presented in frequencies and percentages, and normality tests were performed for each of the quantitative variables with the Shapiro-Wilk test, presenting them as mean and ± standard deviation. To establish the differences between before and after the PR, t-test was done for independent samples. Considering a confidence level of 95%, a p-value less than 0.05 was assumed as statistically significant.

Results

6 out of the 22 patients evaluated were excluded due to double comorbidity, 3 out left the treatment without known justification and 2 dropped out due to economic reasons; in the end 11 patients completed the PR program.

The socio-demographic characteristics are described in Table 1. Most of the participants were female (73%) and predominantly married. The ages ranged between 27 and 88 years with a mean of 55.82 ± 19.96. With respect to the socioeconomic stratum, 46% belonged to stratum 2, a medium-low classification in Colombia, the country where the study was conducted.

Table 1: Socio-demographic and clinical features.

Variables	Classification	(%)	n: 11
Gender	Male	27%	3
	Female	73%	8
Civil status	Married	40%	4
	Single	10%	1
	Free union	40%	4
	Widower	10%	2
Residence place	Cali	82%	9
	Yumbo	9%	1
	Candelaria	9%	1
Sociodemographic stratum	2	45%	5
	3	45%	5
	4	10%	1
Home oxygen use	Si	27%	3
	No	73%	8
Visits to the emergency room	Si	64%	7
	No	36%	4
Age	Mean/(SD) 55.82 ± 19.96		

Table 2 shows the pulmonary function of the participants, which was measured with flow-volume curve spirometry pre and post bronchodilator, obtaining severe obstruction in patients. The anthropometric measurements are shown in Table 3. The BMI had an initial mean of 23.62 ± 4.09, without significant changes at the end of the PR (p=0.81).

Table 2: Spirometry data.

Data	Mean	Mean difference
FEV1	49.21	14.94
FVC	72.09	20.87
FEV1/FVC	67.94	14.69

The evaluation of symptoms was conducted with the MRC dyspnoea scale. In this, statistically significant changes were observed ($p<0.05$), obtaining a difference of more than one point in the measurement, going from a mean of 2.82 ± 1.32, to a final average of 1.64 and ± 1.50 [Table 3].

In terms of functional aerobic capacity, the distance travelled after the PR program had an average improvement of 53.36 meters, being statistically significant. The mean for METS at baseline was 2.63 with a standard deviation of 0.74, and at the end of the program there was a mean of 3.06 with a standard deviation of 0.55 with a p of 0.28 being no statistically significant [Table 3].

Furthermore, Table 3 shows the results of HRQoL and anxiety and depression measurements. In the first, there were statistically significant changes in the domains of activities, impact, and

Table 3: Changes after the pulmonary rehabilitation program.

Variables	Before PR	After PR	Mean difference ± SD	p-value
Body mass index (BMI)	23.62 ± (4.09)	23.58 (3.82)	0.03 ± 0.54	0.81
Weight	59.35 ± (13.60)	59.48 ± (13.21)	0.12 ± 0.30	0.68
MRC scale	2.82 ± (1.32)	1.64 ± (1.50)	1.18 ± 0.75	0.001
Distance covered	379.27 ± (136.21)	432.64 ± (116.79)	53.36 ± 50.7	0.006
Estimated VO_2	9.23 ± (2.64)	10.71 ± (1.95)	1.48 ± 0.61	0.034
Mets	2.63 ± (0.74)	3.06 ± (0.55)	0.43 ± 0.55	0.028
HADS depression	5.18 ± (3.45)	4.00 ± (2.82)	1.18 ± 2.31	0.12
HADS anxiety	7.09 ± (3.59)	5.55 ± (3.80)	1.54 ± 2.62	0.079
SGRQ				
Symptoms	52.00 ± (23.20)	42.00 ± (25.31)	10 ± 24.9	0.21
Activities	65.18 ± (19.33)	43.09 ± (24.63)	22.09 ± 13.4	0.000
Impact	40.91 ± (21.72)	28.55 ± (18.53)	12.36 ± 14.8	0.02
Total	50.82 ± (19.62)	36.18 ± (19.50)	14.63 ± 13.8	0.006

global in the SGRQ questionnaire, with the activity domain having the greatest difference in change: (22.09 ± 13.4), followed by global (14.63 ± 13.8), impact (12.36 ± 14.8) and symptoms (10 ± 24.9). Regarding anxiety and depression, patients with severe bronchial asthma who were in the RP program, both at the beginning and at the end had a mean difference of 1.18 for depression and 1.54 for anxiety, without obtaining statistically significant impacts.

Discussion

The importance of this research lies in determining the repercussion of the addition of an educational component to PR in patients with severe asthma, and how there may be changes in physiological and clinical variables when carrying out interventions of health promotion and prevention of diseases. From the point of view of public health, there could be significant reductions of costs to the health system that could be generated if all available primary care strategies were applied, considering the limited resources destined to that area in many countries.

Despite the fact that the population with severe asthma has the lowest proportion in this type of disease, it consumes more than half of the total resources allocated for treatment, [22] which is why it is important to identify the causes that lead these patients to develop diseases of advanced stage, with high rates of exacerbations, hospitalizations and greater use of health systems, a situation that justifies this investigation. In the present study, it was found that most patients were female, married and with an average age of 56 years old. These results coincide with those found in a research developed by Trevor et al.[21] were they found similar ages and greater frequency in females. This situation is possibly explained by the fact that the prevalence of asthma is observed in patients over 40 years old and in females, indicating the need for an increasing number of patients with asthma and indicating the need to perform PR.

Dyspnoea is a prevalent symptom in patients with asthma, constituting a qualitative variable that was evaluated by the MRC scale, finding a significant improvement after PR. Similar results were found in a case study with severe asthma in the city of Bogotá, [23] where the decrease in the score of the scale is greater than 1, which implies a clinically significant improvement. However, in other studies the MRC scale has not been used as a result variable since these changes have generally been evidenced using the domains of quality of life. [12]

The improvement in the symptoms (dyspnoea) of patients with bronchial asthma after RP can also be attributed to intrinsic conditions of the disease, as mentioned by Cruz C. et al. They stated that in the medium term, well-planned exercise provides optimal adaptations, increasing the production of antioxidants such as reactive nitrogen species (NRN), eosinophils and neutrophils that counteract the effect of the disease on the respiratory system, producing benefits over the patient's quality of life. [24] Dyspnoea is also a good predictor of cardiovascular function and therefore the benefits are not only symptomatic. [25] It is necessary to establish whether the educational component in PR, through relaxation techniques, allows this parameter to be improved.

In 2012, in a systematic review of clinical trials conducted in children with asthma, Crosbie concluded that PR does not influence the results of lung function, which can be explained from the morphological point of view since changes in the PR are expressed mostly in skeletal muscle of extremities and not in pulmonary smooth muscle. [26] This result agrees with the present investigation where, with a p-value of 0.81, there were no differences before and after the educational intervention or exercise.

According to Trevor et al.the distance covered in the 6MWT is a measure of the functional status and response to the intervention. In our study, the average improvement distance was 53 meters, being statistically significant at the end of the PR program. [21] These data coincide with that of the patients evaluated by Lingner et al. in 2015, [27] who had an increase of 60 meters before and after PR. Furthermre, in a study conducted in patients with severe asthma but with home intervention, Renolleau et al. obtained an average improvement of 33 meters ($p<0.05$), demonstrating the effectiveness of training in this type of patients. [28] It is important to clarify that in the study of Lingner et al.they included patients with moderate asthma and thus, the superiority of their results might come from there, whereas in the Renolleau study, there were baseline characteristics of pulmonary function and tolerance to effort similar to those of our

investigation. The present investigation obtained greater results in terms of distance, which may generate the hypothesis that the educational component within the program also influences the improvement of this physical quality.

The HADS questionnaire did not show a statistically significant improvement, but nevertheless, it had a decrease in the anxiety domain without significant changes. Since this is a psychosocial problem often present in the disease, it is essential to have an educational component in a PR program to show significant improvements in anxiety and depression. [29] These results differ from those obtained by Agbetile et al. [30] They found significant changes in this variable. It is important to keep in mind that although the program has psychological support for education, there is no possibility of conducting individual sessions that could have an impact in this regard. Additionally, there is a research by Uchmanowicz et al. which shows that anxiety is strictly linked to cigarette smoking; the increase in this leads to an increase in the number of cigarettes consumed; [31] An important strategy that realizes a psychological strategy that all PR programs can also produce changes in therapy, as well as changes associated with the promotion of healthy lifestyles; This psychological intervention, we believe, should be both group and individualized, since there are special situations that vary from patient to patient (e.g. smoking) and that a particular approach could offer better results than those seen in our report.

In our research, the quality of life related to the health of patients was assessed using the SGRQ questionnaire. According to Nelsen et al.[32] this questionnaire is an integral tool with high valid content, since it evaluates the health status of patients with severe asthma. In our research, we found a statistically significant improvement in the symptoms, total score and impact domains. Changes in quality of life have been described in several studies, among which are that of Agbetile, [30] Crosbie [26] y Lingner, [27] where it was found that HRQoL improves after PR, even when applying different scales such as the quality of life scale of the WHO, the Chronic Respiratory Questionnaire and the SGRQ used by us.

It is important to clarify that it is necessary to deepen the results obtained, using scales that evaluate the knowledge of patients with severe asthma, and using also the realization of post-PR follow-ups to identify the true application of the knowledge and habits acquired during the RP.

Conclusion

The addition of education to a PR program showed good results regarding variables such as functional aerobic capacity, symptoms and quality of life in patients with severe asthma.

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Conflict of Interest

All authors disclose that there was no conflict of interest.

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