British Journal of Medicine & Medical Research
18(3): 1-7, 2016, Article no.BJMMR.28901
ISSN: 2231-0614, NLM ID: 101570965

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Predictors of Positive Outcomes in Pulmonary Rehabilitation

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Authors' contributions

This work was carried out in collaboration between all authors. Author SA designed the study, performed the analysis and wrote the manuscript with assistance from authors MAD, CJB, RJ and MS. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2016/28901
Editor(s):
(1) N. Alyautdin Renad, Chair of the Department of Pharmacology (Pharmaceutical Faculty), I. M. Sechenov MSMU, Moscow, Russia.
Reviewers:
(1) L. I. Audu, University of Abuja, Nigeria.
(2) Ebru Calik Kutukcu, Hacettepe University, Turkey.
(3) William Grant, State University of New York , USA.
Complete Peer review History: http://www.sciencedomain.org/review-history/16487

Original Research Article

Received 11th August 2016
Accepted 28th September 2016
Published 8th October 2016

ABSTRACT

Aims: The study aims were to (1) determine the effect of participation in pulmonary rehabilitation on quality of life, severity of dyspnea, and exercise tolerance (2) evaluate predictors (number of pulmonary rehabilitation sessions attended, age, baseline quality of life, depression, and body mass index)of improvement in severity of dyspnea, exercise tolerance, and quality of life (3) to test if the amount of change in exercise tolerance and change in severity of dyspnea from the baseline to the end of pulmonary rehabilitation modifies the effect of the baselines variables on the change in quality of life from baseline to the end of rehabilitation.
Study Design: A descriptive retrospective design was used.
Methodology: We performed secondary analysis of records of 125 patients in the pulmonary rehabilitation registry in the University Hospitals of Cleveland / OH. The sample included all patients who completed six pulmonary rehabilitation sessions at least.
Results: Pulmonary rehabilitation improved quality of life, alleviate severity of dyspnea and enhance exercise tolerance. Greater baseline body mass index was the only significant predictor

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for the improvement in exercise tolerance (unstandarized β coefficient= 1.5, *P*= 0.02). None of the baseline variables predicted the change in severity of dyspnea. Better baseline quality of life was the only significant predictor for the improvement in quality of life (unstandarized β coefficient= -0.3, *P*=0.03). Changes in severity of dyspnea and change in exercise tolerance did not modify the effect of the baseline variables on the change in quality of life from baseline to the end of rehabilitation.

Conclusion: Positive rehabilitation outcomes are predicted by better baseline quality of life and higher body mass index. More research is needed to identify additional interventions to implement during rehabilitation to achieve positive outcomes in participants who have lower BMI and lower baseline quality of life.

Keywords: Pulmonary rehabilitation; quality of life; severity of dyspnea; exercise tolerance; body mass index; depression.

1. INTRODUCTION

Pulmonary rehabilitation is considered an evidence-based and effective treatment for chronic obstructive pulmonary diseases [1,2]. Measuring changes in quality of life, severity of dyspnea and exercise tolerance are essential outcomes related to effectiveness [3,4]. The benefits of pulmonary rehabilitation in improving quality of life in patients with chronic obstructive pulmonary diseases have been established [5,6]; however; quality of life is not fully explained by the improvement in respiratory function [7,8]. There is a significant proportion of patients who have little to no improvement in quality of life following enrollment in pulmonary rehabilitation [9]. It is unknown if there are specific variables that predict the changes in quality of life, severity of dyspnea and exercise tolerance beyond the dose of pulmonary rehabilitation (number of pulmonary rehabilitation sessions a patient attends). Identifying predictors of change in quality of life, severity of dyspnea, and exercise tolerance may help in maximizing the benefits for all who attend by individually tailoring the rehabilitation program. The purposes of this study were to (1) determine the effect of participation in pulmonary rehabilitation on quality of life, severity of dyspnea, and exercise tolerance (2) determine if the factors (number of pulmonary rehabilitation sessions attended, age, quality of life at the baseline, depression, and body mass index) predict the change (from the baseline to the end of pulmonary rehabilitation) in severity of dyspnea, exercise tolerance, and quality of life in patients with chronic obstructive pulmonary diseases who completed pulmonary rehabilitation. (3) Determine if the amount of change in exercise tolerance and change in severity of dyspnea from the baseline to the end of pulmonary rehabilitation modifies the effect of the baselines variables on the change in quality of life to the end of rehabilitation.

1.1 Measurement

Quality of life was measured using the St George's Respiratory Questionnaire. St George's Respiratory Questionnaire is a 76 items questionnaire that measures the impact of respiratory disease on overall health, daily life and general wellbeing [10]. It is composed of three sections symptoms, activities and impact. The symptom items measure frequency, duration and severity of symptoms. The activity items measure activities that cause breathlessness or are limited by breathlessness. The impact items explore the overall effect of illness on individual's social life and disturbances that are caused by the disease. Scores in this questionnaire range from 0-100 with a higher score indicating worse symptoms and poor quality of life [11]. Depression was measured using the Beck Depression Inventory, Severity of dyspnea was measured using the Modified Medical Research Council (MMRC) Dyspnea Scale, and exercise tolerance was measured using the 6 Minute Walk Test.

2. METHODS

This study was a secondary analysis of the University Hospitals Pulmonary Rehabilitation (UHPR) Registry that had data on 243 patients who enrolled in the pulmonary rehabilitation programs from three medical centers (University Hospitals of Cleveland Case Medical Center, Chagrin Medical Center, and Mentor Medical Center) between January 2008 to August 2012. The UHPR Registry includes the following data (1) survey data from each participant at the first session and at the last session of pulmonary rehabilitation, (2) daily exercise session reports, and (3) baseline spirometry and exercise stress test results. Data in the UHPR included the SF36, St. George's Respiratory Questionnaire, 6 Minute Walk test, Beck Depression Inventory,

baseline demographic characteristics, and a brief knowledge test designed by the rehabilitation department's staff. There was no statistically significant difference in baseline characteristics among participants from the three centers Institutional Review Board approval was obtained from the Hospital's Institutional Review Board and the project was determined to be exempt as the data had no patient identifiers. None of the authors participated in management of the patients.

2.1 Sample

G power software [12] was used to calculate sample size for this study. Based on an estimated medium effect size $f^2 = 0.15$, power of 0.90, an alpha of 0.05 and multivariate regression test with 5 predictors, a sample of 125 subjects was determined to be adequate sample size. Fig. 1 explains how the sample was obtained from the pulmonary rehabilitation registry.

The study included 125 patients who completed at least six exercise sessions and had no missing data. Patients who attended less than six sessions were excluded as they have been identified as not receiving enough dose of pulmonary rehabilitation [13]. The maximum number of sessions was 35 sessions. Descriptive statistics of the sample are shown in Table 1.

2.2 Statistical Analysis

Data were analyzed using SPSS version 22 software. Paired sample t tests were used to compare the quality of life, severity of dyspnea and exercise tolerance in the baseline and end of rehabilitation. .Multivariate regression was used for each outcome to investigate predictors of change in quality of life, change in exercise tolerance and change in severity of dyspnea. Multiple hierarchical regressions were conducted to investigate if the change in exercise tolerance or the change in severity of dyspnea from the baseline to the end of rehabilitation moderated the effect of baseline variables on the change in quality of life from the beginning to the end of rehabilitation.

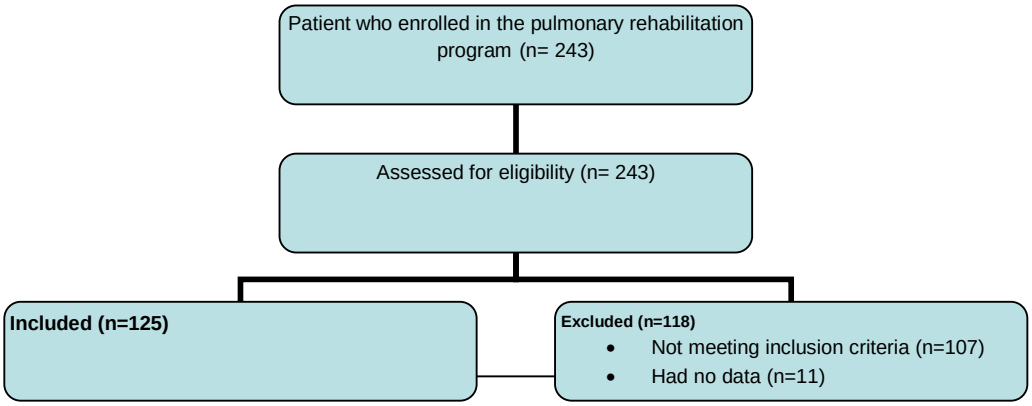

Fig. 1. Consort diagram explains how sample was obtained from the registry

Table 1. Study sample and population characteristics of participants attending pulmonary rehabilitation

Characteristics	Sample (N=125) X(SD)	Registry (N=232) X(SD)
Age (years)	72.5(8.6)	69.5(11.2)
Baseline body mass index (kg/m^2)	28.6(6.9)	29.5(8.5)
Number of exercise sessions attended	29.2(7.5)	22(11.4)
Exercise tolerance at the baseline (Meters)	319(97.0)	306(110.0)
Baseline quality of life score	45(15)	47(16)
Quality of life at program completion score	36(15)	*
Baseline depression score	8.4(5.9)	10.4(7.4)
Severity of dyspnea at baseline (Grade)	2.4(1.1)	2.4(1.1)

**Quality of life was measure only for patients who completed the program and had data*

3. RESULTS

Participants in the study showed statistically significant improvement in all outcome variables (a) quality of life from the baseline (M=45, SD=15) to the end (M=36, SD=15); t (124) =9.0, *P*= 0.02; (b) exercise tolerance from the baseline (M=319, SD=97) to the end (M=366, SD=99);t (124)=10.1, *P*=0.03;(c) severity of dyspnea from the baseline (M=2.4, SD=1.1) to the end (M=1.7, SD=0.9); t (124) =7.0, *P*=0.02. Results are shown in Table 2.

Predictors of exercise tolerance (the number of pulmonary rehabilitation sessions attended, age, baseline quality of life, depression, and body mass index) explained 11.6% of the variance in the change in exercise tolerance from the baseline to the end R^2 =0.12, F (5) =2.61, *P*=0.04 (adjusted R^2=0.07), 95% CI BMI(0.30-2.8). The only significant predictor was body mass index, 95% CI [0.30, 2.8]. (Table 3). The higher the BMI, the greater the change in exercise tolerance. Predictors of the change in severity of dyspnea (the number of pulmonary rehabilitation sessions attended, age, baseline quality of life, depression, and body mass index) did not explain the variance in change in severity of dyspnea from the beginning to the end of rehabilitation, R^2 =0.07, F (5) =1.68, p=0.18 (Table 4). Predictors of the change in quality of life explained 16% of the variance in the change in quality of life from the baseline to the end of rehabilitation, R^2 =0.16, F (6) =3.16, *P*=0.02 (adjusted R^2=0.1). Quality of life at the baseline was the only significant predictor in the model (β=0.32, *P*=0.03), 95% CI [0.15, 0.46]. (Table 5). The better the quality of life at baseline the greater the improvements in quality of life at the completion of the program. Neither the change in exercise tolerance from the baseline to the end of rehabilitation nor the change in severity of dyspnea moderated the effect of number of pulmonary rehabilitation sessions attended, age, baseline quality of life, depression, and body mass index on the change in quality of life from the baseline.

4. DISCUSSION

In agreement with the literature, the study findings revealed that significant proportion of the participants in the study obtained clinically significant improvement in quality of life[14], exercise tolerance [15], and severity of dyspnea [16].

Findings of this study revealed that the higher the baseline body mass index the more the improvement in exercise tolerance by the end of pulmonary rehabilitation. This finding was consistent with the work of Antonelli and colleagues [17] who investigated predictors of efficacy of pulmonary rehabilitation in COPD patients(N=117) and Meijer and colleagues [18] who conducted a retrospective analysis

Table 2. Change in exercise tolerance, severity of dyspnea and quality of life in participants of pulmonary rehabilitation

Variable	X(SD) baseline	X(SD) end	T	df
Exercise tolerance (Meter)	319(97)	366(99)	10.1*	124
Severity of dyspnea (Grade)	2.4(1.1)	1.7(0.9)	7.0*	124
Quality of life (Score)	45.0(15)	36.0 (15)	9.0*	124
Depression (Score)	8.4(5.9)	6.4(5.1)	5.7*	112
BMI (kg/m^2)	28.6(6.9)	28.4(6.2)	3.0	124

**significant p<0.05*

Table 3. Predictors of change in exercise tolerance

Variables	N=125		
	β coefficient unstandarized	Standard error	β coefficient standarized
Number of pulmonary rehabilitation sessions attended	0.4	0.6	-0.01
Age (years)	-1	0.6	-0.1
Depression at the baseline score	-0.8	0.9	-0.1
Body mass index (kg/m^2)	1.5	0.6	0.2*
Quality of life at the baseline score	-0.1	0.3	-0.05

Dependent variable: Change in exercise tolerance from baseline to the end of rehabilitation
**significant, p<0.05, R^2= 0.12 p<0.05*

Table 4. Predictors of change in severity of dyspnea

Variables	N=125		
	β coefficient unstandarized	Standard error	β coefficient standarized
Number of pulmonary rehabilitation sessions attended	0.01	0.01	0.05
Age (years)	-0.01	0.01	-0.1
Depression at the baseline score	-0.02	0.02	-0.1
Body mass index (kg/m^2)	0.01	0.01	0.1
Quality of life at the baseline score	0.01	0.01	0.24

Dependent variable: Change in severity of dyspnea from baseline to the end of rehabilitation. R2= 0.07, p=0.2

Table 5. Predictors of change in quality of life

Variables	N=125		
	β coefficient unstandarized	Standard error	β coefficient standarized
Number of pulmonary rehabilitation sessions attended	0.1	0.2	0.1
Age (years)	0.03	0.1	0.2
Depression at the baseline score	-0.3	0.2	-0.1
Body mass index (kg/m^2)	0.01	0.1	0.00
Quality of life at the baseline score	-0.3	0.1	-0.5*
Severity of dyspnea at baseline (grade)	-2.0	1	-0.2

Dependent variable: Change in quality of life from baseline to the end of rehabilitation
R2= 0.16, p<0.05, significant, p<0.05

to study the effect of pulmonary rehabilitation on another sample of COPD patients (N=437). One explanation for this finding is that chronic obstructive pulmonary disease participants with a high BMI are at a lower risk for systemic abnormalities in comparison with participants with low BMI and therefore have the potential for greater improvements in exercise tolerance. Such abnormalities include loss of muscle mass, abnormal metabolism [19], and oxidative stress during exercise, fatigue [20].

In contrast to prior studies, none of the other variables in the study (number of sessions attended, age, baseline quality of life, depression, and BMI) predicted the change in severity of dyspnea from the baseline to the end of rehabilitation. Prior studies found that factors such as number of pulmonary rehabilitation sessions attended [21], age [22], quality of life at the baseline, depression [23], and BMI were related to improvements in dysnpea. Possible explanation for this findings is that the prticipants in the current study were older (mean =72.5) compared with the other studies and had worse dyspnea as 36% of the participants had grade3 dyspnea and 15.2% had grade 4.

Similar to our findings on severity of dyspnea, we were unable to find prior studies that addressed changes in quality of life after pulmonary rehabilitation [21]. We found that baseline quality of life was the only significant predictor for change in quality of life. Another study by Meijer and colleagues (2011) reported that baseline BMI, exercise tolerance, and severity of dyspnea were significant predictors for change in quality of life. The inconsistent findings from our study can possibly be explained by the significant differences between the baseline characteristics of the participants in our study compared with other studies in the literature. Participants in the current study were older and had worse dyspnea symptoms which could impact the findings.

5. SIGNIFICANCE OF FINDINGS

The finding that baseline BMI predicts the change in exercise tolerance is important and is supported in the literature [17,18]. Participants with higher BMI appear to have the capacity to make greater improvement in exercise tolerance in pulmonary rehabilitation program. Another important finding in this study is that for each 1 unit decrease in the quality of life at the baseline the value of the change in quality of life from the baseline to the end decreases by 0.3 unit (the better the quality of life at the baseline the better at the end). Participants who have better quality of life at the baseline and higher BMI have the potential to make greater gains as a result of pulmonary rehabilitation.

6. STUDY LIMITATIONS

The limitation to our study was the use of registry data which were originally obtained for quality improvement purposes. In addition, we were unable to control for the actual process (intensity of exercise) of the pulmonary rehabilitation sessions. For example, intervention sessions at one program may have provided higher intensity targets than sessions at other programs. The staff also was not blinded to the baseline quality of life or exercise tolerance and they may have provided more or less attention to different types of individuals.

7. RECOMMENDATIONS

Participants with a higher BMI attain more benefits from pulmonary rehabilitation especially improvement in exercise tolerance than those with lower BMI. Participants identified at baseline with a BMI of less than 25 kg/m^2 require some additional interventions such as diaphragmatic breathing technique and strength training. Participants with poor baseline quality of life may benefit from additional alternative interventions such as educational classes to teach diaphragmatic breathing and enhancing self-management skills that can be enhanced by direct application of skills performed during the pulmonary rehabilitation program. Future research is needed to test the efficacy of these interventions to advance the science of pulmonary rehabilitation Moreover participants who are older may need modified rehabilitation program or alternative interventions.

8. CONCLUSION

This study used a registry to determine predictors of changes in exercise tolerance, severity of dyspnea, and quality of life in participants of pulmonary rehabilitation. Higher BMI was the only significant predictor for the significant improvement in exercise tolerance and higher baseline quality of life was the only significant predictor for the improvement in the change in quality of life from the beginning to the end of pulmonary rehabilitation. Future research is needed to target interventions for participants with low BMI and poor quality of life at baseline to optimize outcomes.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Peña J, Gutiérrez H. Effects of pulmonary rehabilitation in patients with diffuse interstitial lung disease. International Journal of Physical Medicine & Rehabilitation; 2015.
2. Steiner MC, Roberts CM. Pulmonary rehabilitation: The next steps. The Lancet Respiratory Medicine. 2016;4(3):172.
3. Mukundu L, Matiti MR. Managing COPD using pulmonary rehabilitation: A literature review. Nursing Standard. 2015;30(14):38-43.
4. Rugbjerg M, Iepsen UW, Jorgensen KJ, et al. 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.
5. Olveira G, Olveira C, Doña E, et al. Oral supplement enriched in HMB combined with pulmonary rehabilitation improves body composition and health related quality of life in patients with bronchiectasis (Prospective, Randomised Study). Clinical Nutrition; 2015.
6. da Costa C, de Azeredo Lermen C, Colombo C, et al. Effect of a pulmonary rehabilitation program on the levels of anxiety and depression and on the quality of life of patients with chronic obstructive pulmonary disease. Revista Portuguesa de Pneumologia (English Edition). 2014;20(6): 299-304.
7. Omachi TA, Katz PP, Yelin EH, et al. Depression and health-related quality of life in chronic obstructive pulmonary disease. The American Journal of Medicine. 2009;122(8):778,e9-78,e15.
8. Giardino ND, Curtis JL, Andrei A-C, et al. Anxiety is associated with diminished exercise performance and quality of life in severe emphysema: A cross-sectional study. Respiratory Research. 2010;11(1):1.
9. Spielmanns M, Gloeckl R, Schmoor C, et al. Effects on pulmonary rehabilitation in

patients with COPD or ILD: A retrospective analysis of clinical and functional predictors with particular emphasis on gender. Respiratory Medicine. 2016;113:8-14.
10. Jones PW, Quirk F, Baveystock C. The St George's respiratory questionnaire. Respiratory Medicine. 1991;85:25-31.
11. Miedinger D, Lavoie KL, L'Archeveque J, et al. Identification of clinically significant psychological distress and psychiatric morbidity by examining quality of life in subjects with occupational asthma. Health and Quality of Life Outcomes. 2011;9(1):1.
12. Erdfelder E, Faul F, Buchner A. Gpower: A general power analysis program. Behavior Research Methods, Instruments, & Computers. 1996;28(1):1-11.
13. Beauchamp MK, Janaudis-Ferreira T, Goldstein RS, et al. Optimal duration of pulmonary rehabilitation for individuals with chronic obstructive pulmonary disease-a systematic review. Chronic Respiratory Disease. 2011;8(2):129-40.
14. Mehta AC, Bhatia S. Improving functional capacity and quality of life with comprehensive pulmonary rehabilitation in patient with copd. Int J Physiother Res. 2015;3(2):919-27.
15. Fuschillo S, De Felice A, Martucci M, et al. Pulmonary rehabilitation improves exercise capacity in subjects with kyphoscoliosis and severe respiratory impairment. Respiratory Care. 2015;60(1):96-101.
16. Rivas-Perez H, Nana-Sinkam P. Integrating pulmonary rehabilitation into the multidisciplinary management of lung cancer: A review. Respiratory Medicine. 2015;109(4):437-42.
17. Vagaggini B, Costa F, Antonelli S, et al. Clinical predictors of the efficacy of a pulmonary rehabilitation programme in patients with COPD. Respiratory Medicine. 2009;103(8):1224-30.
18. Van Ranst D, Otten H, Meijer JW, et al. Outcome of pulmonary rehabilitation in COPD patients with severely impaired health status. Int J Chron Obstruct Pulmon Dis. 2011;6(1):647-57.
19. Nici L, ZuWallack R. Chronic obstructive pulmonary disease: Co-morbidities and systemic consequences: Springer Science & Business Media; 2011.
20. Itoh M, Nemoto K, Tsuji T, et al. Effect of pulmonary rehabilitation on oxidative stress in patients with pulmonary diseases. Advances in Bioscience and Biotechnology. 2012;3(7A):1028.
21. Jacobsen R, Frølich A, Godtfredsen NS. Impact of exercise capacity on dyspnea and health-related quality of life in patients with chronic obstructive pulmonary disease. Journal of Cardiopulmonary Rehabilitation and Prevention. 2012;32(2): 92-100.
22. Garrod R, Marshall J, Barley E, et al. Predictors of success and failure in pulmonary rehabilitation. European Respiratory Journal. 2006;27(4):788-94.
23. Ryerson CJ, Donesky D, Pantilat SZ, et al. Dyspnea in idiopathic pulmonary fibrosis: A systematic review. Journal of Pain and Symptom Management 2012; 43(4):771-82.

Peer-review history:
The peer review history for this paper can be accessed here:
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