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# The impact of physical activity on chronic obstructive pulmonary disease hospitalization: A prospective study in Iran

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**Abstract:**

**BACKGROUND:** Decreasing hospitalization as a result of chronic obstructive pulmonary disease (COPD) exacerbations is a major objective in an effective process of the disease management. This study aimed to investigate the association between physical activity level in COPD patients, and specific-cause hospitalization in a prospective study of patients referred to a pulmonologist office in Qazvin, Iran.

**MATERIALS AND METHODS:** A prospective study was conducted among 150 patients with COPD from the population of Qazvin, a North West, industrialized city of Iran, from December 2017 to December 2018. Participants were enrolled among patients who referred to an outpatient respiratory care center to undertake respiratory function tests. Patients were followed up for 1 year and their related measures were gathered and recorded at two phases including baseline and 12 months. To assess the effect of several covariates on the response variable, a multivariate regression analysis was applied. Results were reported in the form of odds ratios, incident rate ratio (IRR), and their 95% confidence intervals (CIs).

**RESULTS:** The study findings revealed that individuals with severe pulmonary obstruction (<30%) were 4.21 times more likely to be hospitalized than those with a mild level of disease. Furthermore, the likelihood of hospitalization was  $\geq 3$  times higher among current smokers compared with nonsmokers. The history of hospitalization due to COPD 1 year before the enrolment was another significant factor which increased 21% the odds of being hospitalized during follow-up. In a multivariate model with the number of hospitalizations as an outcome variable, patients who reported moderate level of physical activity encountered a lower risk of COPD hospitalization compared to those who had a very low level of physical activity (IRR = 0.66; 95% CI = 0.44–0.92;  $P = 0.001$ ).

**CONCLUSIONS:** To decrease the risk of hospitalization among COPD patients, it is recommended to include regular physical activity in their integrated care program.

**Keywords:**

Chronic obstructive pulmonary disease, exacerbation, hospitalization, physical activity

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## Introduction

Chronic obstructive pulmonary disease (COPD) is a progressive disease that mainly influences the respiratory system of patients and subsequently leads to skeletal muscle dysfunction.<sup>[1]</sup> These abnormalities limit the pulmonary ventilation which is associated with dyspnea and exhaustion while performing physical activities. These unpleasant symptoms frustrate patients and avoid them from doing regular exercises. All these limitations cause depression in patients which consequently lead to an inactive lifestyle.<sup>[2]</sup>

Decreasing hospitalization as a result of COPD exacerbations is a major objective in an effective process of the disease management due to its considerable burden of financial and social costs.<sup>[3]</sup> Several studies have been conducted to identify contributing factors in reducing or preventing COPD exacerbations; among which some were related to lifestyle factors such as physical activity or diet.<sup>[4-6]</sup> Exacerbations are known as a deterioration of the patient's respiratory symptoms, leading to sputum production, increased cough, dyspnea, and chest congestion.<sup>[7]</sup> Literature affirmed the predictive role of physical activity in disease exacerbations and hospitalization among COPD patients.<sup>[8]</sup> A study conducted among patients with moderate-to-severe COPD in Spain reported the beneficial effects of physical activity in lowering the risk of hospitalization due to COPD exacerbation.<sup>[8]</sup>

The relationship between COPD exacerbations and physical activity is not always clear. Many researchers proved the predictive role of low activity levels on upcoming severe exacerbations.<sup>[4,8-11]</sup> Importance of the issue increases noticeably, as patient's physical activity is reduced during exacerbations.<sup>[12-14]</sup> Garcia-Rio *et al.* in a prospective study conducted to evaluate the prognostic value of daily physical activity in patients with moderate-to-very severe COPD reported that patients with a low level of physical activity faced with exacerbations more rapidly compared to those with higher activity levels.<sup>[4]</sup>

Among different COPD guidelines, the Global Initiative for Chronic Obstructive Lung Disease (GOLD) strategy recommended that COPD patients should actively take part in doing regular physical activities. Despite such recommendations, the optimal level of physical activity has not been defined clearly.<sup>[15]</sup> Thus, examining the association between different levels of physical activity on improvement in the health status of COPD patients is worth doing further studies.

Despite the importance of the issue and several researches conducted worldwide to determine the role

of physical activity in COPD exacerbation and related hospitalization, there is a gap of evidence in Iran to provide robust results in this regard. Therefore, in the current study, we aimed to investigate the association between physical activity in COPD patients, and specific-cause hospitalization in a prospective study of patients referred to a pulmonologist office in Qazvin, Iran. We hypothesized that a balanced level of physical activity could prevent COPD hospitalizations.

## Materials and Methods

### Study design, participants and ethics

This was a prospective study which was conducted among 150 patients with COPD from the population of Qazvin, a North west, industrialized city of Iran, from December 2017 to December 2018. Participants were enrolled among patients who referred to an outpatient respiratory care center to undertake respiratory function tests. Patients were followed up for 1 year and their related measures were gathered and recorded at two phases including baseline and 12 months. Inclusion criteria include patients aged over 40 years with a COPD diagnosis according to the GOLD guidelines who were in a stable phase of the disease for the past 6 months. Those patients who refused to contribute in the study had other concurrent pulmonary diseases, or taking drugs other than those for COPD were excluded from the study. During the follow-up process, 22 patients were lost to be followed; however, after analyzing the demographic characteristics of those followed and those who lost to be followed, no differences were found between patients.

The ethics committee of the Qazvin University of Medical Sciences approved the study, and written informed consent was obtained from each of the participants.

### Study variables

The number of hospitalizations due to COPD exacerbation was the study response variable in the 1-year period after patients' enrollment, whereas physical activity level was one of the main independent predicting factors. According to the GOLD guideline, COPD patients were classified into four groups including mild (GOLD 1), moderate (GOLD 2), severe (GOLD 3), and very severe (GOLD 4). To obtain data regarding patients' level of physical activity, an International Physical Activity Questionnaire (short form) with confirmed validity and reliability was used.<sup>[16-18]</sup> This collection data instrument has consisted of two parts. The first section was related to demographic data, including gender, age, educational level, occupation, and marital status. Data regarding these factors in addition to patients' smoking habit, their comorbidities, lung function, and exercise capacity were collected at baseline. The second part incorporated seven questions, including items on work-related activities,

**Table 1: Patients' characteristics at enrolment in terms of their physical activity level**

Variables	Physical activity level			P
	Low	Medium	High	
Age (years)	75.2 (4.1)	72.8 (6.3)	64.9 (7.8)	0.000
FEV1 GOLD				
<30%	22 (17.1)	14 (10.9)	-	0.0005
30%-49%	12 (9.3)	16 (12.5)	4 (3.1)	
50%-80%	8 (6.5)	36 (28.1)	16 (12.5)	
Smoking habit				
Smoker	23 (17.9)	7 (0.4)	-	0.0001
Former smoker	21 (16.4)	17 (13.2)	-	
Nonsmoker	4 (3.4)	42 (32.8)	14 (10.9)	
History of previous hospitalization				
0	16 (12.5)	46 (35.9)	20 (15.6)	0.000
≥1	37 (28.9)	9 (7.1)	-	

Data are presented as *n*, *n* (%), or mean±SD. SD: Standard deviation, GOLD: Global Initiative for Chronic Obstructive Lung Disease, FEV1: Forced expiratory volume in 1 s

**Table 2: Patients' characteristics according to their hospitalizations during follow-up**

Characteristics	Hospitalization		P
	No	Yes	
Gender, <i>n</i> (%)			
Male	91 (91)	9 (9)	0.1
Age (years), mean±SD	62.4±12.6	65.5±11.3	0.001
Marital status			
Married	112 (92.6)	9 (7.4)	0.2
Educational level, <i>n</i> (%)			
With university degree	6 (85.8)	1 (14.2)	0.2
Current smoker, <i>n</i> (%)	21 (70)	9 (30)	0.001
BMI (kg/m <sup>2</sup> ), mean±SD	25.5±4.9	23.3±3.8	0.05
COPD grade, <i>n</i> (%)			
Mild	11 (8.5)	0 (0)	0.000
Moderate	62 (48.4)	4 (3.12)	
Severe	32 (25)	4 (3.12)	
Very severe	3 (2.34)	12 (9.52)	
Comorbidity, <i>n</i> (%)			
Yes	36 (85.8)	6 (14.2)	0.001
Level of physical activity			
Low	32 (25)	6 (4.6)	0.001
Moderate	60 (46.8)	4 (3.12)	
High	16 (20.48)	-	

Data are presented as *n*, *n* (%), or mean±SD. SD: Standard deviation, BMI: Body mass index, COPD: Chronic obstructive pulmonary disease

physical activity performed during leisure time, and household chores. Based on this questionnaire, physical activity levels were classified into three categories: intense physical activity, moderate physical activity, and inactivity. Intense activity belongs to activities which require high physical strength and make individuals breathe faster than normal situations. The moderate activity requires an average level of strength and makes individuals take breaths a little faster than normal.

Furthermore, the information about COPD hospitalizations during 1-year follow-up was obtained from patients by the research team through conducting

interviews. All reported data were confirmed by the hospital database medical records.

### Statistical analysis

Statistical analysis was conducted using Stata software, version 13.0 (TX: stataCorp LP). Descriptive statistical analysis of data was done using mean ± standard deviation and frequency (relative frequency). To compare continuous variables by the level of categorical variables, analysis of variance for normally distributed variables, and the Wilcoxon and Kruskal–Wallis tests for those with nonnormal distribution were used. Furthermore, the same analysis for categorical variables was done with Chi-square or Fisher's exact test.

To assess the effect of several covariates including age, gender, smoking habit, previous hospitalizations for COPD in the last year prior to enrolment, forced expiratory volume in 1 s (FEV1)%, and the level of physical activity among patients on the response variable, a multivariate regression analysis was applied. The final model included those covariates with a statistically significant influence on hospitalization for COPD. Results were reported in the form of odds ratios and their 95% confidence intervals (CIs).

## Results

Table 1 depicts the baseline characteristics of patients who were enrolled in the study. A total of 128 patients were included in the study. Those with a medium level of physical activity belonged to nonsmokers in lower age groups who had lower airflow obstruction with fewer number of hospitalizations during 1 year before the enrolment.

Table 2 shows patients' characteristics according to their hospitalization during follow-up. Results affirm that patients who experienced at least 1 hospitalization

during this period of time, belonged to higher age groups, lower body mass index, and very severe pulmonary obstruction.

Univariate analysis of assessing the effect of physical activity level on hospitalization rate revealed that individuals with severe pulmonary obstruction (<30%) were 4.21 times more likely to be hospitalized than those with a mild level of disease. Furthermore, the likelihood of hospitalization was ≥3 times higher among current smokers compared with nonsmokers. The history of hospitalization due to COPD 1 year before the enrolment was another significant factor which increased 21% the odds of being hospitalized during follow-up [Table 3].

Table 4 presents different levels of physical activity among patients according to their disease severity. As results reveal, the level of physical activity was very low among patients with severe COPD; while those

with low to moderate severity of the disease had a balanced (moderate) level of activity during their life.

During the follow-up period, 7.02% of participants had at least one hospitalization due to COPD. In a multivariate model with the number of hospitalizations as an outcome variable, patients who reported moderate level of physical activity encountered a lower risk of COPD hospitalization compared to those who had a very low level of physical activity (incident rate ratio [IRR] = 0.66; 95% CI = 0.44–0.92; *P* = 0.001). After adjusting for variables including age, FEV1%, and smoking habit in a multivariate model, results confirmed that changes in the level of physical activity were significantly related to hospitalization among COPD patients. In fact, patients who reported a moderate level of physical activity had a lower probability of being hospitalized [IRR = 0.73; 95% CI = 0.62–0.97; *P* = 0.00; Table 5].

## Discussion

Our study emphasizes the importance of physical activity as a main strategy for decreasing COPD exacerbation and its related hospitalization among patients. In this regard, research findings confirmed the contributing role of physical activity on hospitalization of patients during 1-year follow-up time period. Considering the evidence provided in various studies, our findings revealed that maintaining a balanced level of physical activity during the course of disease exposure would act as a defending factor against disease exacerbation and related hospitalization.<sup>[19]</sup> The result confirms that even a low level of physical activity might bring significant benefits to patients. This beneficial effect is mostly due to the fact that having regular exercise acts as a respiratory rehabilitation program for patients with COPD of all stages.<sup>[20]</sup> In a study conducted by Petty *et al.* findings revealed that doing 1-h daily exercise as a care program for COPD patients decreased the number of hospitalization significantly.<sup>[21]</sup> Based on the scientific evidence, physical activity improved the function of peripheral muscles, which consequently led patients to use lower amount of health services.<sup>[22,23]</sup>

Concerning the relationship between doing a balanced level of physical activity and improving the health status

**Table 3: Univariate regression with influencing factors on the rate of hospitalization 1 year after enrolment among chronic obstructive pulmonary disease patients**

Variables	OR	P	95% CI
FEV1 GOLD			
<30%	4.21	0.0002	0.627-4.36
30%-49%	2.84	0.01	2.22-3.74
Smoking habit			
Smoker	3.07	0.000	2.84-3.96
Former smoker	1.58	0.000	0.94-2.79
History of previous hospitalization			
≥ 1	1.21	0.001	0.07-1.88
Age	1.28	0.001	1.05-1.36

All patients with follow-up at 1 year after enrolment included the study sample (*n*=128). GOLD: Global Initiative for Chronic Obstructive Lung Disease, FEV1: Forced expiratory volume in 1 s, CI: Confidence interval, OR: Odds ratio

**Table 4: Patients' physical activity according to chronic obstructive pulmonary disease severity**

	Gold I Mild	Gold II Moderate	Gold III Severe	Gold IV Very severe	P
Physical activity level					
Very low	1 (5.7)	3 (16.6)	8 (4.4)	6 (33.3)	0.001
Low	8 (26.6)	11 (36.6)	7 (23.3)	4 (13.5)	
Moderate	14 (21.87)	36 (56.25)	12 (18.75)	2 (3.13)	
High	6 (37.5)	7 (43.75)	2 (12.5)	1 (6.25)	

Values are presented as *n* (%)

**Table 5: Association between level of physical activity and hospitalizations among chronic obstructive pulmonary disease patients**

	<i>n</i>	Crude IRR	95% CI	P	Adjusted IRR*	95% CI	P
Physical activity level							
Very low	18	1			1		
Low	30	0.81	(0.67-1.42)	0.1	0.78	0.59-1.27	0.2
Moderate	64	0.66	(0.44-0.92)	0.001	0.73	0.62-0.97	0.00
High	16	0.78	(0.48-0.82)	0.001	0.77	0.56-0.79	0.00

\*Multivariate model adjusted for age, smoking habit, and ischemic heart disease. IRR: Incident rate ratio, CI: Confidence interval

of elderly people, a research conducted by Buman *et al.* among older adults has shown that those participating in low-intensity activities were more likely to be socialized, having less stress, and greater quality of life.<sup>[24]</sup> In the same way, World Health Organization guidelines advised that all adults should perform at least 150 min of a balanced-intensity physical activity per week to keep themselves healthy.<sup>[25]</sup>

This finding is also in line with similar studies which focus on the association between performing regular physical activity and the risk of exacerbation in COPD patients.<sup>[4-6,26]</sup> In a study conducted among patients who were suffering from severe COPD, those with low levels of physical activity were admitted to a hospital in a shorter time compared to patients who had higher activity levels.<sup>[4]</sup>

Literature explained that severely ill patients were more inactive due to more frequent COPD exacerbations, and this mobility limitation has been proven to increase the risk of hospitalization in the following year of patients' life.<sup>[12]</sup> In contrast, those with higher levels of physical activity had better pulmonary function in terms of carbon dioxide removal capacity, maximum oxygen absorption, and pulmonary muscle strength which consequently led to an increased exercise capacity.<sup>[8]</sup> These literatures have provided strong evidence for approving the recommendations given by the NICE guideline published in December 2018 to give medical and care advice to COPD patients. Encouraging patients to have regular physical activity is among one of the most important strategies which have been emphasized in the mentioned guideline.<sup>[27]</sup>

Despite all these similarities, a study conducted in Spain with the purpose of evaluating the effect of high quantity and intensity of physical activity on COPD hospitalization has shown that performing physical activity with such intensity might be unhelpful in COPD patients who were suffering from severe-to-very severe airflow obstruction.<sup>[28]</sup> This dissimilarity might be due to the difference in the type of physical activity measurement tool which was used in the mentioned study. Donaire-Gonzalez used an objective tool to measure the number of steps per day, and the number of days that patients were physically active in a week, also minutes per day which was spent in performing physical activity.<sup>[28]</sup> A few researches have affirmed this finding and reported that low-intensity activities were more useful for COPD patients. They explained that due to their airflow limitation, these patients use a higher percentage of their respiratory capacity compared with their healthy peers. Thus, doing heavy physical activity might put pressure on them and threaten their health status.<sup>[29]</sup> Therefore, judging about the intensity

of physical activity mainly depends on the study population and their type of disease.<sup>[30]</sup>

## Conclusion

Despite some slight differences, almost all studies supported the positive impact of physical activity on decreasing the risk of exacerbation and its related hospitalization among COPD patients. The GOLD strategy proposed that all COPD patients should take part in physical activity on a daily basis. Despite this advice and an important role of daily exercise as an essential part of the clinical management for patients, the recommended level of physical activity has not been defined clearly.<sup>[28]</sup> Thus, to provide adequate evidence regarding this issue and since to our knowledge, this is the first study conducted in Iran among COPD patients to explore the potential impact of physical activity, we managed to do the research and find an appropriate level of physical activity needed to be performed among these types of patients.

There are some limitations regarding this study. First, we used a self-reported questionnaire to measure the intensity of physical activity performed by the study population which was mainly dependent on patients' memory which might disagree with the results obtained from an objective assessment and negatively affect the results' reliability. Second, the study multivariate model included smoking, marital status, education, and income as covariates but ignored the diet data of patients, which is firmly recommended to investigate it in future studies.

To decrease the risk of hospitalization among COPD patients and reduce the frequency of exacerbation among them, it is recommended to include regular physical activity in their integrated care program. Regular physical activity helps patients actively participate in their daily activities which is good for both physical and mental health.

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## Conflicts of interest

There are no conflicts of interest.

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