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## ORIGINAL ARTICLE

**Distance from home to rehabilitation center did not influence adherence to pulmonary rehabilitation program: a retrospective study**

***A distância entre o domicílio e o centro de reabilitação não influencia a adesão ao programa de reabilitação pulmonar: um estudo retrospectivo***

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## Abstract

**Background:** Adherence to treatment is critical when dealing with chronic diseases. One of the difficulties in maintain long-term adherence is the distance from home to rehabilitation center. **Objective:** To determine the influence of the distance from subjects' residence to rehabilitation center on adherence of a 12-week pulmonary rehabilitation program in chronic respiratory disease. **Methods:** This retrospective study analyzed

patients' medical records with chronic respiratory diseases from a pulmonary rehabilitation center. Driving distance between patients' home and rehabilitation center was calculated with Google maps. The home-rehabilitation center distances were classified in three levels: up to 10, 10-30 and more than 30 km. *Results:* 280 medical records from patients with chronic pulmonary diseases with medical indication to follow the pulmonary rehabilitation program were found and 148 medical records were included in our study. Out of them, the majority ( $n = 93$ ) had chronic obstructive pulmonary disease (COPD). Seventy percent of patients lived up to 10 km, 24% lived between 10 and 30 km and 6% lived more than 30 km. No difference in adherence was found comparing the three groups based on the distance from home to rehabilitation center. *Conclusion:* In this study, distance between home and rehabilitation center did not influence adherence to pulmonary rehabilitation program.

**Keywords:** treatment adherence; rehabilitation; pulmonary disease; chronic obstructive.

## Resumo

*Introdução:* A adesão ao tratamento é um aspecto crítico quando se lida com doenças crônicas. Uma das dificuldades para manter a adesão a longo prazo é a distância entre o domicílio do paciente e o centro de reabilitação. *Objetivo:* Determinar a influência da distância na adesão a um programa de reabilitação pulmonar de 12 semanas para pacientes com doenças respiratórias crônicas. *Métodos:* Este estudo retrospectivo analisou os registros médicos dos pacientes com doenças respiratórias crônicas de um centro de reabilitação pulmonar. A distância foi calculada com o Google mapas e foram classificadas em três níveis: até 10 km, entre 10 e 30 e mais de 30 km. *Resultados:* Foram encontrados 280 registros médicos de pacientes com indicação para acompanhar o programa de reabilitação pulmonar e 148 foram incluídos em nosso estudo. Destes, a maioria ( $n = 93$ ) tinha doença pulmonar obstrutiva crônica (DPOC); 70% dos pacientes viviam até 10 km, 24% viviam entre 10 e 30 km e 6% viviam mais de 30 km. Não foi encontrada diferença na adesão comparando os três grupos com base na distância. *Conclusão:* A distância entre o domicílio do paciente e o centro de reabilitação não influenciou a adesão ao programa de reabilitação pulmonar.

**Palavras-chave:** adesão ao tratamento; reabilitação; doença pulmonar obstrutiva crônica.

## Introduction

The chronic obstructive pulmonary disease (COPD) is the most prevalent chronic respiratory disease [1] with global prevalence around 12.16% [2]. The COPD was

responsible by 3.23 million of death worldwide in 2019 [2]. An essential component of the integrate care of patients with chronic respiratory diseases is the pulmonary rehabilitation program (PRP) which has as benefits the reduction of patients' symptoms and hospitalizations, the improvement of exercise capacity, limb muscle strength and endurance, emotional function, quality of life and the enhancement of knowledge and self-efficacy [3-12].

Despite these important benefits, many patients do not follow the program [7,9, 13-17]. Adherence is defined as "the extent to which a patient's behavior coincides with medical advice" [18,19] and is influenced by a set of personal and environmental determinants that enables the free choice of people to adopt certain recommendations, thus becoming co-responsible on their treatment [20,21]. Adherence to treatment is critical for managing a chronic disease. Adherence to general long-term care in developed countries is around 30 to 50% and in developing countries, rates are even smaller [22-25]. The success of rehabilitation programs depends on the assessment of barriers that interfere with adherence [13,22,26,27].

These barriers are classified into five domains: intra- or interpersonal, logistical, barriers related to the rehabilitation program and to the health system [28]. Intrapersonal barriers include self-reported health [23,28,29], health beliefs, lack of time [28], motivation [28,30], recurrent hospital admissions [31] and religious reasons [28,32]. Interpersonal barriers include lack of family or social support [28,30] and work conflicts [28]. Logistical barriers are related to transport [3,13,28,33], distance [28,31,34], availability of personal or community resources [28]. Barriers related to the rehabilitation program include services offered, group format, exercise component and perceptions about the rehabilitation program [28,33,35,36]. Health system barriers include lack of referral, cost [25,28], negative experiences with health system and language [28].

The distance from home to rehabilitation center has been many time suggested as one of the difficulties in maintain long-term (i.e.: > 12 weeks [37]) adherence [31,33,34]. We hypothesized that this distance may influence the adherence to a 12-week pulmonary rehabilitation program in chronic respiratory diseases.

The aim of this study was to verify the influence of the distance from patients' home to rehabilitation center on adherence of a 12-week pulmonary rehabilitation program in chronic respiratory diseases.

## Methods

This retrospective study analyzed all medical records from patients with chronic respiratory diseases from the pulmonary rehabilitation center in Cliniques universitaires

Saint-Luc (Brussels, Belgium) for a pre-established period of 45 months. The study was approved by local ethical committee (2020/12OCT/502).

The pulmonary rehabilitation center is easily accessible by public transport and has parking facilities. The indications to be part of the program are all chronic respiratory diseases with reduced exercise tolerance and restriction in daily live activities, and future or recent lung surgery. The program is tailored to the patients' capacities and objectives are identified during the initial assessment. The patients are accompanied by a team including physician, pulmonologist, physiotherapist, occupational therapist, social worker, psychological and nutritional therapists. The rehabilitation program lasts six months with three weekly sessions of one hour. Educational sessions are included once a month.

All patients who started and completed 12 weeks of PRP were included in this retrospective study and were divided in three groups considering the home-rehabilitation distance (up to 10 km, between 10 and 30 km and more than 30 km). Patients who presented exacerbation and were hospitalized during the PRP period were excluded from the study. The adherence rate was determined based on the frequency with which the patients attended the 12 weeks of rehabilitation program, i.e.:

$$\left[ \left( \frac{\text{number of attended sessions}}{\text{number of planned sessions of treatment}} \right) * 100 \right]$$

[24,38]

Then the rate was compared between each group. Data on lung function and functional exercise capacity were correlated with adherence.

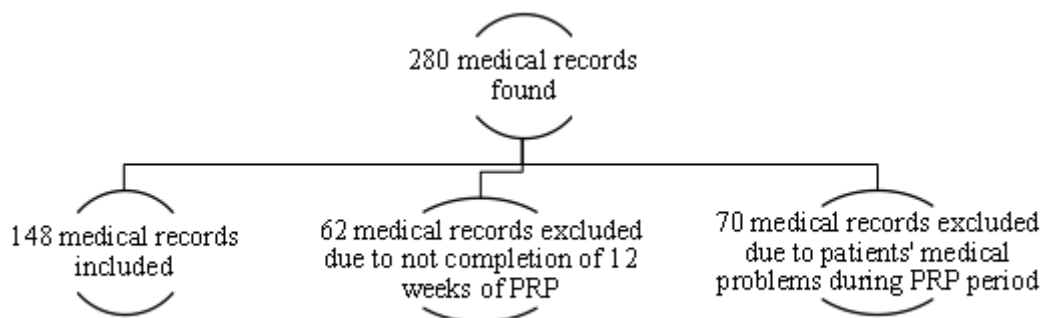
Descriptive analysis was performed for patients' background (age, weight, height, lung function volumes and six-minute walk test (6MWT)) using mean and standard deviation. The means were compared by an analysis of variance. Tukey-Kramer method was used for post-hoc comparisons. Correlations were analyzed by the Pearson correlation coefficient. The cutoff points used to interpret Pearson's correlation were: negligible correlation (0.00 – 0.10); weak correlation (0.10 – 0.39); moderate (0.40 – 0.69); strong (0.70 – 0.89) and very strong correlation (0.90 – 1.00) [39].

All statistical analyses were performed using SPSS 25.0 (IBM Software, Minneapolis, Arizona). A significance level of 5% probability was established.

## Results

Two hundred eighty chronic subjects presented a clinical indication to follow the PRP. One hundred forty-eight medical records were included in the study. Sixty-two

medical records did not fulfill the inclusion criteria (to start and to follow a minimum of twelve weeks of PRP). Seventy medical records were excluded due to medical problems (exacerbations, hospitalizations) during the PRP period. The recruitment process is shown in figure 1.



**Figure 1** - Flowchart describing the included and excluded medical records

Sample characteristics are shown in table I. Out of the 148 subjects, 93 subjects had chronic obstructive pulmonary disease (COPD); 21 interstitial lung diseases; 2 diaphragmatic paralysis; 1 bronchiectasis; 9 obstructive sleep apnea syndrome; 4 pulmonary arterial hypertension; 4 lung cancer without surgery; 3 lobectomy due to lung cancer; 2 hypoventilation related to obesity; 2 neuromuscular disease; 4 asthma; 1 lung transplant; 1 respiratory failure; 1 acquired immune deficiency syndrome.

**Table I** - Characterization of the sample

Variables	Total	Female	Male
n	148	67	81
Age (years)	67.3 ± 12.4	64.3 ± 12.7	69.7 ± 11.7
Height (cm)	166.7 ± 9.3	160.4 ± 7.6	172.0 ± 7.2
Weight (kg)	73.7 ± 21.1	65.5 ± 17.4	80.6 ± 21.6
Adherence (%)	72.8 ± 17.4	69.6 ± 16.9	75.4 ± 17.5
FEV <sub>1</sub> (%)	56.5 ± 27.0	54.7 ± 26.7	58.2 ± 27.4
FVC (%)	75.9 ± 26.9	76.9 ± 29.9	74.9 ± 24.0
FEV <sub>1</sub> /FVC (%)	60.6 ± 19.2	61.8 ± 18.2	59.6 ± 20.0
TLC (L)	5.7 ± 1.91	4.77 ± 1.6	6.55 ± 1.8
6MWT (%)	86.4 ± 32.4	84.3 ± 34.9	88.3 ± 30.3
LTOT (n/%)	22 (14.8)	14 (63.6)	8 (36.4)

Values expressed as mean ± standard deviation; L = liters; FEV<sub>1</sub> = forced expiratory volume in one second; FVC = forced vital capacity; TLC = total lung capacity; 6MWT = six-minute walk test; LTOT = long-term oxygen therapy

The functional exercise capacity in admission was good with the walked distance covered in the 6MWT over 80% of the predicted value [40] in our general sample (shown in table I). It was not different depending on the group based on the distance from the subjects' residence to the rehabilitation center (shown in table II).

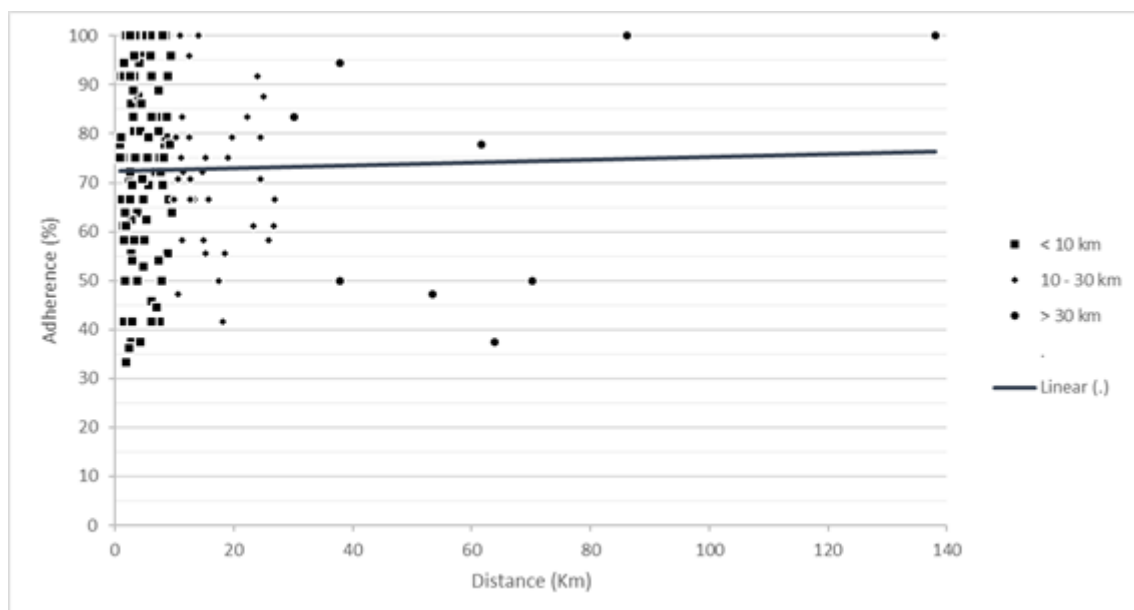
The mean age, adherence, forced expiratory volume in one second (FEV1), 6MWT and the number of long-term oxygen therapy for each group based on distance from subjects' residence to rehabilitation center are shown in table II.

**Table II** - Comparison between the distance from patients' residence to rehabilitation center and age, adherence, FEV1, 6MWT and LTOT

	<10 km	10-30 km	>30 km	p-value
n (%)	104 (70)	35 (24)	9 (6)	
Age	68.0 ± 11.8 <sup>(a)</sup>	65.6 ± 14.6	60.7 ± 21.5 <sup>(b)</sup>	0.016
Adherence	73.7 ± 17.4	73.6 ± 14.0	64.6 ± 32.8	0.765
FEV <sub>1</sub> (%)	52.5 ± 26.1	57.4 ± 26.1	65.2 ± 22.3	0.792
6MWT	86.6 ± 33.9	78.8 ± 29.1	112.3 ± 26.2	0.539
LTOT (n/%)	17 (77.3)	4 (18.2)	1 (4.5)	

Values expressed as mean ± standard deviation; km = kilometers; FEV1 = forced expiratory volume in one second; 6MWT = six-minute walk test; LTOT = long-term oxygen therapy; p-value between (a) and (b) = 0.011

Most of them (70%) lived up to 10km distance from the rehabilitation center. The number of patients decreased as the driving distance increased. The driving distance did not influence the adherence ( $p = 0.77$ ) in this group of patients. Neither the walked distance during the 6MWT ( $p = 0.54$ ) nor FEV1 ( $p = 0.79$ ) were different between groups based on the driving distance.



**Figure 2** - Correlation between adherence and distance

There was a significant difference when comparing the age between the groups ( $p = 0.016$ ). This difference was present among patients living more than 30 km away (60.7 y.o. ± 21.5) compared to patients living up to 10 km away (68.0 y.o. ± 11.8) ( $p = 0.016$ ), patients living further away were younger. There was no significant difference when comparing the age between the groups living up to 10 km away with those living

between 10-30 km ( $p = 0.76$ ) as well as those living between 10-30 km with those living more than 30 km ( $p = 0.15$ ) (table II).

The adherence rate was neither correlated to the distance from patients' home to rehabilitation center ( $r = 0.028$ ;  $p = 0.74$ ), 6MWT ( $r = -0.069$ ;  $p = 0.44$ ) nor FEV1 ( $r = 0.020$ ;  $p = 0.82$ ) (figure 2).

## Discussion

The literature has indicated that most dropouts in rehabilitation programs occur during the first three months with dropout rate ranging from 30 to 50% [22,31], with similar results in all age groups, regardless of gender [41]. It can be explained by the fact that we considered only subjects who attended at least 12 weeks of rehabilitation program. Then, patients who had clinical indication of pulmonary rehabilitation, but who did not start the program, were not considered in our study.

In this retrospective analysis, it was demonstrated that there is no relationship between adherence to the pulmonary rehabilitation program and distance from home to the rehabilitation center. Of the 148 patients included in this study, nine (6%) lived more than 30 km away. We think, then, probably subjects who live far from the rehabilitation center and accept to follow the program are, then, adherent. Probably, those who hesitate due to distance do not even start the program. To verify whether this hypothesis is confirmed, it was decided to analyze the distances from home to the rehabilitation center of the 62 patients who did not meet the inclusion criteria, i.e., did not complete the 12 weeks of the rehabilitation program to be included in this study. Our intention was to verify if these 62 patients lived far enough away to abandon the rehabilitation program and the distance would then be an influential factor of adherence by doing these subjects not even starting the program or abandoning it in the first sessions. When we analyzed these patients, it was seen that most of them (81%) lived up to 10 km from the rehabilitation center and only 6.4% lived more than 30 km away. This means that the distance does not explain the non-adherence of these patients to the rehabilitation program.

In this study, the driving distance did not influence the adherence to the program, as we did not find difference between groups according to the distances. This finding is in accordance with previous studies [22,26,31]. One study [22] compared adherence and distance by analyzing 796 medical records of patients in general rehabilitation programs. Their medical conditions included cardiorespiratory diseases, cancers, obesity and/or diabetes. The rehabilitation program was similar to our study regarding the frequency (three to six times a week) and patients had freedom of choice of days and times to

attend the sessions. In this study, distance also did not influence adherence ( $p = 0.41$ ). Other study [31] investigated which physiological or environmental factors could predict the participation in a pulmonary rehabilitation program. It was also a retrospective analysis with 243 patients (204 COPD; 28 COPD and asthma and 11 had asthma) who followed two kinds (short and long) of rehabilitation program. The short one included three sessions per week for 6 weeks and the long one, one session per week for 18 weeks. Long and short programs had identical content and format, each session lasting for approximately two hours and included educational activities, individualized exercise prescription, and educational sessions addressing the psychological aspects of chronic disability. In this study, distance also did not influence adherence ( $p = 0.55$ ).

One study [25] retrospectively identified variables related to adherence in a lung rehabilitation program in Argentina. The authors analyzed 388 medical records and found a significant relationship between adherence and distance ( $p = 0.002$ ). They considered the cut-off point of the distance of 10 km, then analyzed the adherence of patients who lived more or less than 10 km from the hospital. Patients who lived more than 10 km to reach the hospital were less adherent, the authors suggested that this non-adherence may also be related to socioeconomic factors. The socioeconomic profile of our patients was not analyzed because data to perform such analysis was not available. A possible explanation for the difference in the results between our study and the Boim's *et al.* study [25] is that our patients had higher lung function values ( $FEV1 - 56.5\% \pm 27.0$ ) when compared to that of their study ( $39.6\% \pm 17$ ) and also the duration of rehabilitation program was different. We analyzed the adherence for 12 weeks and then, for 16 weeks, these 4 extra weeks may have made the difference in this case.

A relationship between FEV1 and adherence was not found. The FEV1 ranged from 52% of the predicted value for patients living up to 10 km to 65% for patients living over 30 km ( $p = 0.79$ ). This means that our patients did not have a high degree of airway obstruction. Similar to ours, four previous studies [25,29,31,42] were carried out with most COPD patients. One of them [31] was a retrospective analysis with 243 patients (COPD and/or asthma) who followed a short (6 weeks) or a long (18 weeks) rehabilitation program. The program was similar to our program, except the duration of each session which was approximately two hours, twice as much as ours. The mean FEV1 of patients in this study was  $39.1\% \pm 17$  for adherents and  $36.4\% \pm 15$  for non-adherents, they also found no significant difference in correlating FEV1 with adherence ( $p = 0.39$ ). Another study [42] was similar to our study in terms of duration of each session, length of the program and exercise types. They included only patients with COPD ( $n = 217$ ). In our sample this pathology affected 58% of our sample. General parameters of disease



severity, such as FEV1 did not differ among patients who complete the entire program compared to those who stopped the program ( $p = 0.44$ ).

Conversely, Sahin et Naz [13] and Heerema-Poelman [43] found a relationship between FEV1 and adherence. The first study [13] aimed to determine the reasons why patients with COPD completed or failed to complete the pulmonary rehabilitation program. They included 359 patients with COPD and out of them, 147 did not complete the program. The group of patients who did not complete the program had significantly lower FEV1 ( $p = 0.024$ ) and significantly lower walked distance ( $p = 0.001$ ). The second one [43] analyzed the adherence of 70 patients with COPD during a one-year rehabilitation program. They found a significant difference between FEV1 values from adherents' patients comparing to non-adherents ( $p = 0.37$ ). In both studies, the patients had worse lung function (FEV1 = 39% [13] and 35% [43] when compared to our patients (FEV1 = 56%).

In this study, the functional exercise capacity measured by the 6MWT was greater than 78% of the predicted value regardless of the group. Two studies [29,42] conducted with 1218 [29] and 217 [42] COPD patients also did not find a significant relationship between adherence and 6MWT ( $p = 0.90$  [29];  $p = 0.53$  [42]). One study [13] aimed to compare demographic and clinical characteristics of patients with COPD who complete and fail to complete pulmonary rehabilitation program. They found a statistically significant difference between adherence and the walk distance measured by the 6MWT ( $p = 0.001$ ). The number of subjects receiving long-term oxygen treatment in this study was higher ( $n = 80$ ) than in our study ( $n = 22$ ), this may probably explain the differences between our studies.

We decided to analyze FEV1 and 6MWT values of the 62 patients who did not complete the 12 weeks of rehabilitation to be included in the study. Our intention was to verify whether the functional exercise capacity and/or level of obstruction of these patients could explain the non-participation or abandonment before the first twelve weeks of the program. Regarding FEV1, subjects who lived more than 30 km away had higher FEV1 ( $81.4 \pm 17.0$ ) when compared to subjects living up to 10 km away ( $61.2 \pm 23.3$ ). Regarding physical capacity, subjects who lived more than 30 km also presented higher values in the 6MWT ( $103.1 \pm 2.4$ ) when compared to those who lived up to 10 km away ( $71.7 \pm 36.1$ ).

The limitation of this research was the use of data coming only from the medical records of the patients followed in our hospital, therefore, we do not have data if they have been absent from the program due to hospitalization in other hospitals than ours. To minimize the risk of bias in patients not included in the study, we analyzed the distance traveled, the FEV1, and the 6MWT. The patients of this study have several

pathologies where the degree of commitment may differ and influence or not the adherence. Although we had zip code data to calculate the distance, we did not have information about the socioeconomic profile of subjects, this factor may influence adherence. We considered the distance in relation to the length in kilometers, we did not consider the time required to cover this distance, which may influence adherence. However, the advantage of this retrospective methodology is linked to the fact that the subjects does not know that their presence or absence is being verified and therefore, the adherence is not influenced by the fact that he knows that he is part of a research on adherence.

## Conclusion

The results of this study indicate that for such a program (12 weeks with fixed exercising schedule), the distance between the subjects' residence and the rehabilitation center had no effect on adherence to pulmonary rehabilitation program when they accept to participate.

### Statement of ethics

The study was approval by Comité d'Ethique Hospitalo-Facultaire Saint-Luc – UCLouvain (2020/12OCT/502).

### Conflict of interest statement

The authors declare no conflict of interest.

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### Authors' contributions

*Development of the research design and concept:* Macedo JRFF, Reychler G; *Data collection:* Macedo JRF; *Data analysis:* Reychler G; *Revised for intellectual content:* Liistro G, Caty G, Pieters T. All authors approved the final version to be published.

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