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# Physiotherapeutic intervention of lung capacity through controlled aerobic exercise: case study in ambulatory older adults

# Intervención fisioterapéutica de la capacidad pulmonar a través de ejercicios aeróbicos controlados: caso de estudio en adultos mayores ambulatorios

Adriana de los Ángeles Paredes Ramos[1], Julio Alfonso Mocha Bonilla[1], Kevin Israel Mocha Altamirano[1], Jorge Washington Jordán Sánchez[1]

[1]Universidad Técnica de Ambato, Ambato – Ecuador

Correo de correspondencia: aparedes7860@uta.edu.ec, ja.mocha@uta.edu.ec, kmocha6499@uta.edu.ec, jw.jordan@uta.edu.ec

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## Abstract

Introduction. Pulmonary capacity is linked to different volumes of air, which are characteristic of respiration. When talking about aging, the lungs are the most vulnerable in older adults due to covid-19. Objective. Determine the effect of controlled aerobic exercises in older adults during the pandemic stage. Materials and Methods. The population consisted of 60 participants whose average age was 83 years. Prior to the intervention, a spirometric assessment was performed in addition to the taking of vital signs both at the beginning and at the end of each physiotherapeutic intervention. The controlled aerobic exercise program was applied to the patients 4 times a week, during 3 months with a total of 35 sessions, each of the sessions had a duration of approximately 30 to 45 minutes. Results. When performing the final evaluations in each patient, positive results were obtained, observing the reduction of pulmonary age in older adults, as well as the progress of pulmonary capacity, aerobic capacity in relation to the initial evaluations. Conclusion. the pulmonary age in relation to the chronological age was closer in patients who attended the 35 sessions.

***Keywords:*** *Lung Capacity, Aerobic Exercises, Older Adults, Pandemic.*

## Resumen

Introducción. La capacidad pulmonar se encuentra ligada a diversos volúmenes de aire, los mismos que son característicos de la respiración, al hablar del envejecimiento los pulmones estos son los más vulnerables en adultos mayores por el covid-19. Objetivo. Determinar el efecto de los ejercicios aeróbicos controlados en adultos mayores durante la etapa de pandemia. Materiales y Métodos La población fue de 60 participantes cuya edad promedio fue de 83 años. Previo a la intervención, se realizó una valoración espirométrica además de la toma de signos vitales tanto inicial como final en cada intervención fisioterapéutica. El programa de ejercicios aeróbicos controlados se aplicó a los pacientes 4 veces por semana, durante 3 meses con un total de 35 sesiones, cada una de las sesiones tenía una duración entre 30 a 45 minutos aproximadamente. Resultados. Al realizar las evaluaciones finales en cada paciente, se logró obtener resultados positivos, observando la reducción de la edad pulmonar en los adultos mayores, así como el progreso de la capacidad pulmonar, capacidad aeróbica con relación a las evaluaciones iniciales. Conclusión. La edad pulmonar en relación con la edad cronológica fue más cercana en los pacientes que asistieron a las 35 sesiones.

***Palabras clave:*** *Capacidad Pulmonar, Ejercicios Aeróbicos, Adultos Mayores, Pandemia*.

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## INTRODUCTION

Aging is an objective of study worldwide, its purpose is to reverse the negative effects that occur in adulthood and promote a healthy life (Quintana, 2021), in the same way happens with the pulmonary structure of the individual, which is conditioned to alterations of functionality, which involve future inflammatory lung diseases and commorbid diseases (Abraham, 2002) thus deterioration of the patient's quality of life.

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The total pulmonary capacity remains stable throughout life, in the event that it decreases it will be considered that there is a decrease in inspiratory muscle strength and loss of height (Drobnic, 2012). That is to say that what really alters in old age are the subdivisions of the pulmonary volumes, being the fourth cause of death worldwide, therefore a disease of primary attention (Abia-Trujillo, 2021), as well as the FCR increases due to the loss of the elasticity of the thoracic wall limiting its expansion (Cuba Naranjo, 2021). Currently, due to the pandemic stage, respiratory rehabilitation in medical care has proven to be one of the best allies in treatments for the control and stabilization of respiratory diseases, with the aim of improving the quality of life of those who suffer from it (Aquilar, 2018).

The practice of respiratory rehabilitation exposes a multidisciplinary scheme, which is particularly adapted to the elderly, generating effective results at the moment of increasing aerobic resistance (Arbillaga, 2020), eliminating secretions, increasing pulmonary capacity (Cardona, 2016), improving gas exchange and decreasing pulmonary age, thanks to the application of controlled aerobic exercise protocols (Solano-García, 2018). The physiotherapeutic program based on controlled aerobic exercises is focused as an emotional and educational support, providing physio-psychopathological stability.

Both aerobic exercise and pulmonary rehabilitation are useful tools to break the vicious circle in older adults (Ramos, 2020). This research is specifically aimed at older adults located in a high geographical area; this geographical factor limits physical activity and decreases pulmonary capacity, since the higher the altitude, the lower the concentration of oxygen in the blood (Calderón, 2020).

The objective of the study was to decrease the progress of respiratory diseases, to identify the effectiveness of physiotherapeutic intervention through controlled aerobic exercises in older adults during the health pandemic, with the aim of increasing pulmonary capacity, the aerobic capacity of the older adult, and decreasing pulmonary age.

## MATERIALS AND METHODS

Subjects. The research was carried out with a total of 60 elderly patients, who were able to complete the protocol, of which 37 were women and 23 were men, whose average age was 83 years, belonging to the province of Tungurahua. Those who already provided the corresponding information signed the informed consent to start the intervention.

The inclusion criterion was older adults from 65 to 101 years of age and the exclusion criterion was adult patients with medical contraindications for not being able to perform medium intensity physical activity.

Protocols. A clinical history of each patient was taken prior to the application of the physiotherapeutic exercise program and spirometry, a quick and painless test that allows measuring the speed and amount of air that can be retained by the lungs during inhalation and exhalation during the patient's breathing (Almeida-Junior, 2020). The test was performed three times, taking the best result as valid.

Once the spirometric test was performed, the pulmonary age was determined, as well as the pulmonary volumes and capacities, depending on the results it was possible to determine the type of pulmonary pattern: normal, obstructive, restrictive or mixed. Vital signs were taken such as: pulse at rest, respiratory frequency, saturation, and heart rate, and the Karvonen formula was applied to determine the intensity of exercise (Martins, 2018).

Vital signs were taken daily before and after physical activity, in order to corroborate that work was performed at a light intensity, which was established between 50% and 60%. The intensity was determined thanks to Karvonen's formula (Martins, 2018).

During the first two weeks of the physiotherapeutic intervention, we worked with a low intensity, approximately 30% to 40% due to the coupling of the routines of the older adults. Continuing with the third week, the intensity was increased to a medium intensity of 50% to 60% with a daily control to maintain the indicated ranges.

Finally, a program of controlled aerobic exercises was applied to ambulatory older adults, which consisted of three phases: warm-up phase I, which consisted of joint mobilization activities of several repetitions and series with a duration of 10 minutes. Phase II of Fit training (Giné-Garriga, 2010), which consists of aerobic exercises of medium intensity performed between 50% to 60% in combination with respiratory exercises with a duration of approximately 20 to 35 minutes. Phase III of relaxation which consists of stretching exercises with a duration of 10 minutes.

## RESULTS

| | Initial Evaluation | | | |
|---|---|---|---|---|
| | Obstructive | Restrictive | Mixed | Normal |
| **Men** | 1.67 % (1) | 6.66% (4) | 28.34% (17) | 1.67% (1) |

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| | | | | |
|---|---|---|---|---|
| **Women** | 6.66% (4) | 20% (12) | 26.66% (16) | 8.34% (5) |
| **Total** | | 100% (60) | | |

**Table 1.** *Pulmonary patterns at the beginning of the study*.

| | **Final Evaluation** | | | |
|---|---|---|---|---|
| | Obstructive | Restrictive | Mixed | Normal |
| **Men** | 5% (3) | 5% (3) | 26.7 % (16) | 1.67% (1) |
| **Women** | 11.66% (7) | 11.66% (7) | 25% (15) | 13,34 % (8) |
| **Total** | | 100% (60) | | |

**Table 2.** *Pulmonary patterns at the end of the study.*

From the initial pulmonary evaluation in men a mixed pattern prevailed with 17 patients (28.34%) and in the final evaluation it decreased to 16 patients (26.7%). In women, initially 5 patients (8.34%) presented a normal pattern, increasing to 8 patients (13.34%) in the final evaluation.

| **Lung age** | | **65-75** | **76-85** |
|---|---|---|---|
| Initial Evaluation | Men | 1.67% (1) | 16.66% (10) |
| | Women | 8.34% (5) | 40% (24) |
| Final Evaluation | Men | 11.67% (7) | 20% (12) |
| | Women | 21.66% (13) | 35% (21) |

**Table 3.** *Lung age at initial and final evaluation 65-85.*

| **Lung age** | | **86-95** | **96-101** | **Total** |
|---|---|---|---|---|
| Initial Evaluation | Men | 20% (12) | 0% (0) | 100% (60) |
| | Women | 11.66% (7) | 1.67% (1) | |
| Final Evaluation | Men | 6.67% (4) | 0% (0) | 100% (60) |
| | Women | 5% (3) | 0% (0) | |

**Table 4.** *Lung age at initial and final evaluation 86-101.*

From the initial evaluation of the pulmonary age of the older adults, in men the predominant age was 86-95 years with 12 patients (20%), decreasing considerably in the final evaluation with 4 patients (6.67%) and increasing patients in the range between 76-85 years with 12 patients (20%) and 4 adults in the range 65-75 years. In women the average lung age at the initial evaluation predominated between 76-85 years with 24 patients (40%); decreasing in the final evaluation with 21 patients (35%) and increasing in the age of 65-75 years with 13 patients (21.66%).

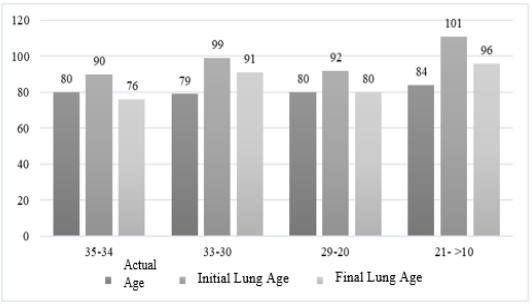


**Figure 1.** *Difference in real age and lung age by session.*

The patients who attended between 33-30 sessions had an average real age of 81 years, as for their initial lung age was 96 years having a difference of 15 years between their real age and their initial age, after being applied the physiotherapeutic protocol their final lung age was reduced to 86 years, that is, 10 years of difference between the final lung age with their initial age.

## CONCLUSIONS AND DISCUSSION

A program of controlled aerobic exercises for older adults was elaborated and applied, the pulmonary evaluations in comparison of the initial with the final one shows a change in the type of respiratory pattern, many went from a mixed to a restrictive pattern, thus improving their pulmonary and aerobic capacity. As for the pulmonary ages, they decreased considerably in both women and men after the physiotherapeutic intervention, which had a significant impact because they attended the intervention protocycle completely, that is to say, the pulmonary age in relation to the chronological age was closer in patients who attended the 35 sessions.

In the study subjects, when applying the physiotherapy protocol based on controlled aerobic exercises for older adults, an increase in the pulmonary capacity of the patients, improvement in aerobic capacity and a decrease in pulmonary age were observed. However, studies show that, in addition to aerobic exercises (Villada, 2013), it would be beneficial to accompany strength-based training,

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since it would increase the performance of spontaneous activities, as well as representing a positive factor, since it favors aerobic activities (Altamirano,2012).

Women age faster and earlier in relation to men, which is demonstrated in higher pulmonary ages in relation to chronological age (Castrejón-Vázquez, 2014), everything depends on the severity of respiratory diseases, which increase with pulmonary age, especially can be produced by the contagion of covid-19 (De León, 2020). Expiratory flow limitation may be more common in women compared to men; greater work of breathing in the female sex is probably attributed to smaller lung volumes and smaller airway diameters (McClaran, 1999).

According to Hernandéz, cardiorespiratory tolerance after aerobic exercise may be the result of a good VO2 max, as well as mechanical efficiency at the moment of covering a distance in less time, that is, improving aerobic capacity (Castrejón-Vázquez, 2014). When performing aerobic exercises there are significant changes in relation to forced expiratory volumes (FEV1) and forced vital capacity (FVC) (Sánchez-Delgado, 2019).

According to studies, it is recommended that to perform an aerobic exercise program (Sandoval, 2007), a minimum of 30 minutes of exercise per session should be accumulated. In addition, each session should be at least 3 times per week, with short rest intervals between 1 to 3 minutes (Vargas, 2003). General physical activity usually has a positive influence on spirometric values, improving pulmonary and aerobic capacity and decreasing lung age (Tello, 2020; González, 2010).

## CONTRIBUTION OF THE AUTHORS.

The contribution made by all the authors in the study was fundamental: Adriana de los Ángeles Paredes Ramos; Julio Alfonso Mocha Bonilla; Kevin Israel Mocha Altamirano; Jorge Washington Jordán Sánchez.

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