Comparison of the effects of aerobic and force exercise in patients with heart failure after a cardiovascular rehabilitation program: randomized controlled trial

Comparación de los efectos del ejercicio aeróbico y de fuerza en pacientes con falla cardiaca luego de un programa de rehabilitación cardiovascular: ensayo controlado aleatorizado

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Palabras clave: Ejercicio, falla cardiaca, rehabilitación cardíaca, entrenamiento de fuerza.

ABSTRACT

Introduction and objectives: Cardiovascular diseases are the leading cause of mortality worldwide. Currently, rehabilitation programs are shown as adequate treatments to mitigate the effects of heart failure. The main objective is to compare the effects of aerobic exercise and strength in patients with heart failure after a cardiovascular rehabilitation program. Material and methods: Randomized controlled trial over a period of three years with a sample of 920 patients with heart failure distributed in two groups (aerobic exercise plus upper limb -MMSS- training and aerobic exercise plus training of lower limbs -MMII-). Blood samples were taken to determine blood glucose levels and lipid profile. In addition, tests for aerobic capacity, maximum heart rate, anthropometry, depression, anxiety, clinical and hemodynamic parameters. The tests were performed before and after 24 training sessions, 60 min, three times a week for two months. Results: Comparing the results between the groups, it was possible to show better results in the majority of the variables of group 2 (aerobic exercise + strength training MMII) (p ≤ 0.05%). However, no significant post training differences were found in the HDL, LDL and triglyceride variables (p ≥ 0.05%).

Conclusions: An aerobic training program combined with strength for patients with heart failure improves aerobic capacity, exercise tolerance, ejection fraction, glycemic indexes, MHR, muscle percentage and decreases body fat percentage and levels of depression and anxiety. These

RESUMEN

Introducción y objetivos: A nivel mundial, las enfermedades cardiovasculares son la primera causa de mortalidad. Actualmente, los programas de rehabilitación se muestran como un tratamiento efectivo para mitigar los efectos de la insuficiencia cardiaca. Se genera como objetivo principal comparar los efectos del ejercicio aeróbico y de fuerza en pacientes con falla cardiaca luego de un programa de rehabilitación cardiovascular. Material y métodos: Ensayo controlado aleatorizado en un periodo de tres años con una muestra de 920 pacientes con falla cardiaca distribuidos en dos grupos (Ejercicio aeróbico más entrenamiento de miembros superiores -MMSS- y ejercicio aeróbico más entrenamiento de miembros inferiores -MMII-). Se realizaron muestras hematológicas para determinar los niveles de glucemia y perfil lipídico. Además, pruebas y test para capacidad aeróbica, frecuencia cardiaca máxima (FCM), antropometría, depresión, ansiedad, parámetros clínicos y hemodinámicos. Las pruebas se realizaron antes y después de 24 sesiones de entrenamiento de 60 minutos, tres veces por semana durante dos meses. Resultados: Al comparar los resultados entre los grupos, se logró evidenciar mejores resultados en la mayoría de las variables del grupo experimental 2 (ejercicio aeróbico + entrenamiento de fuerza MMII) (p ≤ 0.05%). Sin embargo, no se encontró ninguna diferencia significativa post entrenamiento en las variables de HDL, LDL y triglicéridos (p ≥ 0.05%). Conclusiones:
INTRODUCTION

Cardiovascular diseases (CVD) are the set of alterations of the heart and blood vessels throughout the body. Among the diseases that cause most deaths in the world are noncommunicable diseases (NCDs) or chronic diseases, with a mortality indicator per year of 9 million between 2005 and 2010.1 The first cause of mortality in the world are CVD that represent 48.8% of deaths per year, that is, 17.5 million deaths per year.2 Of these diseases, 16.5% of these are of cerebrovascular origin; due to stroke, 9.1% due to arterial hypertension, 8.5%; for heart failure, 3.2% arteriopathies and other diseases;3-5 however, these diseases are preventable.6

Hence, the need and importance of the left ventricule ejection fraction (LVEF) and its quantification. It is an essential point for prognostic assessment, to create intervention strategies and to conclude important decisions in patients with heart failure (HF), highlighting that heart failure has multiple manifestations which are encompassed by the classification of the Colombian Society of Cardiology where it is mentioned that heart failure is divided into: heart failure with preserved ejection and with reduced ejection fraction.7 This is why echocardiography is the most useful and required non-invasive diagnostic test in patients with heart failure, since it confirms the diagnosis, complications and can determine the etiology of heart diseases.

Cardiovascular rehabilitation (CVR) takes a predominant role in this type of patients. In particular, it provides a multidisciplinary intervention that contributes to improving physical, social and emotional impact.8-10 These programs allow to promote the changes in the behavior of the disease, reducing dependence on drugs and improving the quality of life.

Likewise, rehabilitation programs contribute to modify alterations of the bone, joint and muscle system on cardiac function, vascular, neurohumoral and inflammatory reflexes.11 On the other hand, physical exercise in patients with heart disease allows acting on the anthropometric characteristics, reducing fat body mass, increasing muscle mass and acting on metabolic risk factors, decreasing insulin resistance.12 And from there, serving as the main engine, to decrease the cardiovascular risk factors and in its effect the metabolic syndrome.

Therefore, muscular alterations are given in relation to the reduction of lean muscle mass, leading to a decrease in muscle diameter and this is directly associated with the stage of the disease. This leads to establish the recurrent intolerance to exercise that has been shown in some researches on the relationship of muscle volume and functional capacity in heart failure.13-15

In addition, different investigations also explain changes in type I (oxygen-dependent) muscle fibers in cardiac alterations, thus reducing resistance to fatigue, and therefore, muscle strength itself is a predictor of survival with emphasis on muscle strength in lower limbs (MMII).16 Like the results presented by Leong et al.17 from the PURE study that included 140,000 patients between 35 and 70 years, which concludes with the direct relationship of strength as a biomarker of cardiovascular, non-cardiovascular mortality and stroke.

As also, a direct relationship between muscle strength and maximum oxygen consumption (maximum VO2), suggesting the implications and benefits of CVR and physical exercise in heart disease.18 It should also be mentioned that benefits stand out to a greater extent in an aerobic workout combined with MMII strength.
that greater levels of hand strength decrease the risk of mortality from any cause by 31% and higher levels of force measured with knee extension decrease the risk by 14%. However, taking into account the benefits of CVR, it is important to highlight the relationship between strength and muscle mass with functional capacity in patients with HF who increase the prognosis of life without increasing the risk of fatal events.

On the other hand, we mentioned that the effect of aerobic exercise in rehabilitation generates an increase in cardiac output and tissue perfusion at the muscular level, there is an increase in ventricular filling and beat volume, which increases the coronary vascular bed, improves the vasodilator response, the blood supply and decreases the viscosity to generate less resistance on the blood flow. Likewise, the improvements on the ejection fraction over the volume of the left ventricle have been discussed. Also, an increased response is shown in the endothelial and mitochondrial function that improves the prognosis that is reduced with age.

The above concepts highlight the importance and need to include strength training and aerobic exercise in cardiovascular patients. However, the guidelines and consensus for cardiac rehabilitation do not cover this topic as a main pillar of cardiovascular rehabilitation. That is why it is proposed as a research question: what are the effects of aerobic exercise with strength in patients with heart failure after a cardiovascular rehabilitation program? Based on these results, the role of strength work and aerobic exercise in patients attending cardiac rehabilitation can be clarified and thus determine the importance and necessity of this training mode. Having said all this, it is postulated as a hypothesis that cardiac rehabilitation patients under combined resistance exercise in lower limbs (MMII) and aerobic show greater benefits compared to aerobic exercise combined with strength in upper limbs (MMSS).

Due, that the muscular reduction in the inferior limbs stands out for its great importance since it generates a serious decrease in the functional capacity of the people, leading to a functional incapacity consequent with a rapid loss of strength (Fibers type II). One of the causes is a lower resistance of these fibers, denervation, deficit in the gene expression of myosin type II and a lower resistance of these fibers to oxidative stress. In addition, there are conclusions that show mechanisms that could be related to the deficit of testosterone in the elderly.

On the other hand, the mechanisms of regeneration and repair of muscle fibers are compromised in the elderly, generated by less activity of satellite cells oxidative stress and inadequate regulation to generate repair of damaged muscle fibers. In addition, several studies have shown that the poor tolerance to exercise of patients with heart failure is of multifactorial origin and includes some aspects such as: 1) respiratory limitation; 2) dysfunction of the peripheral musculature and 3) cardiovascular damage. Therefore, the following objective is generated: to determine and compare the effects of aerobic exercise plus strength training in upper limbs versus aerobic exercise plus strength training for lower limbs.

MATERIAL AND METHODS

The study was conducted with a sample of 920 high-risk patients in cardiac rehabilitation, which after the exclusion criteria, was of 511 individuals who were organized into 2 groups (Figure 1). This investigation was a randomized controlled trial with a basic probabilistic sampling by means of a table of random numbers, which its order was randomized through the program Microsoft Excel 16.0 being that, experimental group 1 ended with 256 participants (aerobic exercise + strength training in upper limbs) and experimental group 2 with 255 (aerobic exercise + strength training for lower limbs). The present investigation was carried out in a period of 3 years (April 2014-2017) which contains the following attributes:

Characteristics of the participants

The participants had similar characteristics taking into account ejection fraction,
Inclusion criteria

The patients had to be in the post-operative stage of cardiovascular surgery that go to a phase II cardiac rehabilitation program, which at the time had to sign an informed consent endorsed by the ethics and research committee of the institution. Likewise, it was necessary for participants to have heart failure with ejection fraction greater than 35%; do not have any inconvenience when doing the questionnaires, tests and measures that the investigation demands, and a commitment to go 3 times a week to cardiac rehabilitation.

Exclusion criteria

Patients who had severe pain in the lower limbs, unstable angina, heart rate > 120 bpm at rest, systolic blood pressure > 190 mmHg, diastolic blood pressure > 120 mmHg were excluded. Similarly, patients who had a positive contraindication for cardiac rehabilitation were not admitted in the study (Table 1). In addition, we pointed out that the participant had the option of being able to withdraw from the research when he wished or to show hemodynamic instability without improving during any test or during the intervention process.

Anthropometric measurement

In all the participants the following data were obtained: Family and personal history using a self-created questionnaire. Likewise, anthropometric measures (weight, height, body mass index, abdominal circumference, fat and muscle percentage) using standardized techniques in the Colombian population.

The weight, fat percentage and muscle, were obtained by using the Tezzio TB-30037 digital scale previously calibrated and located on a flat and stable surface, using the indications in the user’s manual. On the other hand, the size was obtained with the Kramer 2104 Adult Acrylic Wall Height Measurement, placing the patient standing, with the head in Frankfort plane and with the shoulders relaxed to avoid lordosis and MMII completely against the wall.
Having said the above, with these variables the BMI was determined in kg/m⁻².

Then, with a tape measure and a precision of 1 mm, the abdominal circumference measurement was collected taking the anatomical referents described by Frisancho. The "Waist circumference cut points for the diagnosis of abdominal obesity in the Colombian population using bioimpedancetry as reference standard" were chosen as cutting points: in men 91 cm and women 89 cm according to Buendía R et al.²⁸

Clinical and hemodynamic parameters

Following all the above procedures, fasting blood glucose levels were determined on the first and last day of the training session using an Accu-Chek® Performa glucometer following the technical specifications suggested by the manufacturer. The blood sample was taken between 07:00 and 08:00 a.m., after 8-10 hours of fasting. It should be added that blood samples were collected in the laboratory of the hospital to define the levels of cholesterol, triglycerides, low density lipoproteins (LDL) and high density lipoproteins (HDL). Each patient underwent 2-D (two-dimensional) echocardiography before and after surgery. In this same assessment, the functional class of each patient was identified according to the NYHA classification which, designates 4 classes (I, II, III and IV) based on the limitations of physical activity of the patient, caused by cardiac symptoms (Table 2). Similarly, perceived dyspnea and effort were assessed using the modified Borg scale. The heart rate was detected by the Polar Multisport RS800CX system and the respiratory one, just as the systolic and diastolic blood pressure was obtained manually, while the oxygen saturation was obtained with a portable pulse oximeter (Nellcor Puritan Bennett).
Tests and questionnaires

From the beginning, the patient underwent a medical assessment by the area of physiatry to understand the current state of the patient, sociodemographic, anthropometric and physiological characteristics. On the same day, tolerance to exercise was estimated by the 6-minute walk test, which was performed before and after 24 sessions of cardiac rehabilitation. The protocol of the 6-minute walk test was performed according to the ATS Statement: Guidelines for the six-minute walk test of the American Thoracic Society.30,31 On the other hand, to denote the initial weight of strength training for upper limbs (MMSS) and lower limbs (MMII), weights were used in repetition series with increase or decrease of the load of 2.5 to 8 lb, until achieving the maximum weight to lift. A maximum repetition (1RM) was considered appropriate with a full extension of the muscle group used, without muscle substitutions. After this evaluation day, the patient had to return for an effort test according to the Naughton protocol, which is recommended in high-risk patients, with stages of 2 minutes. We emphasize that for these tests, the patient was told that he should avoid smoking, drinking or any type of drug or medication that could alter his vital signs or performance during the test.

Depression and anxiety

The HADS questionnaire (Hospital Anxiety and Depression Scale: Zigmond and Snaith, 1983, republished by De las Cuevas, C. et al., 1995)32 was used for anxiety and depression. Regarding anxiety, the questions are aimed at identifying if the user has been tense, worried or with some kind of fear. However, the questions of depression are aimed at identifying if the user shows disinterest in the activities of daily life, negativity about things and their attitude to be happy. At this point it is emphasized that the questionnaire was applied by two independent and blinded authors (P. P-R and D. P-F); which delivered the questionnaires to two other authors (R. P-R and C. Q-G) for verification and analysis.

Assignment of the sample

This research reported a population of 511 participants (289 men versus 222 women) who were divided into 2 groups using a simple probabilistic model by a table of random numbers, whose randomization was carried out in the Microsoft Excel program 16.0.

Blind methodology

A simple blind clinical study was carried out, in which the patients were assessed by a non-research professional (physiatrist of the cardiac rehabilitation service), as well as blood tests. Afterwards, patients accessed a database in Microsoft Excel 16.0 exclusively with an identification number that allowed blinding of the authors. Blindly, a first author (J. P-R) captured the result of the assignment of the participants in the 2 cardiac rehabilitation groups and provided the list of experimental groups 1 and 2 to the blinded authors P. P-R and D. P-F; R. P-R and C. Q-G; respectively.

The researchers prepared the questionnaires and tests without them knowing the assignment of each patient. After the tests, participants were suggested to approach cardiac rehabilitation to let them know their schedule and start date to the training program. Ignoring the cardiopulmonary rehabilitators, after 24 training sessions according to the assigned group, they gave an accurate report on the physiological changes and behavior in each training session.

However, we emphasize that from the initial tests until the end of the training program the authors did not establish conversation outside the topic with the participants or therapists. Exclusively the author J. P-R. held periodic meetings with the cardiopulmonary rehabilitators to notice and harmonize the training of each group but not intimate with the participants.

After the training program, tests were carried out to the patients of each group to calculate the post-training changes. Taking into account the information collected pre- and post, the statistical analyzes for experimental group 1 were carried out by K. S-P and J. H-S; experimental group 2 for P. P-R and D. P-F. Finally, once the different variables were
studied in a blinded manner, all the authors were informed about the groups with their corresponding patients and results in order to elaborate the conclusions.

Intervention by group

The cardiac rehabilitation program consisted of 24 sessions of 60 minutes a day (10 minutes of warm-up, 40 minutes of training and 10 minutes of cool down phase), three times a week, for two months. With regard to warming, it was based on mobilization exercises by muscle groups. Cool down phase was done with proprioception exercises, stretching, coordination and breathing exercises.

Related to the 40 minutes of training, it was modified according to the assigned group. Patients of experimental group 1 performed aerobic exercise on a treadmill and an elliptical bike plus strength exercises for upper limbs with dumbbells, multi-strength equipment and Theraband. On the other hand, patients of the experimental group 2 executed the same order of experimental group 1, but the strength training was focused only for the lower limbs with theraband, multi-strength equipment and exercises for activation of the sole-twin pump.

The work force for aerobic exercise was 50 to 70% of their maximum heart rate (MHR) achieved in the stress test according to the Naughton protocol. For strength, between 30% to 50% of 1 RM was determined, prolonging a percentage of heart rate that did not surpass 70% of the MHR nor the subjective uptake of physical effort to more than 6 on the modified Borg scale. For groups 1 and 2, strength training was based on a progressive increase in load Kraemer and Ratamess (2005).

Ethical considerations

It should be noted that the design and development of the research was carried out under the ethical considerations of the Declaration of Helsinki and Resolution No. 008430 of the Ministry of Health of Colombia and with the approval of the directors and the Ethics and Research Committee of the institution where the research was conducted.

Statistic analysis

First, a database was created in Microsoft Excel 16.0 with all the patients, test results and pre- and post-training measures. Then, the descriptive statistics was carried out to estimate and show the data by averages with their corresponding standard deviation. The normality of the data was assessed by means of the Kolmogorov-Smirnov test and the indication of specificity was evident for all the analyzes. Likewise, for the pre- and post-training relationship, the analysis of variance ANOVA (Analysis of one-way variance) and subsequently post hoc tests was used, through the Tukey test, to assess the characteristics of the different age groups, gender and anthropometry. In all cases, a significance level of 5% was established (p < 0.05) and carried out in the Stata program.

RESULTS

The cardiac rehabilitation program included 920 patients in the period studied, allowing an initial sample of 645 patients who met the inclusion criteria. After the application of the exclusion criteria 134 of them came out, allowing the final sample of 511 (M: 289 versus F: 222) patients with cardiovascular postoperative diagnosis and heart failure.

Regarding the academic level, 29% studied up to secondary education, 51% university students and 19% had only attended primary school. Cardiovascular surgical procedures performed were: (Table 3).

On the other hand, when comparing blood lipid profile values, fasting glycemic levels, muscle, fat percentage and BMI and maximum oxygen consumption (VO₂) as an indicator of tolerance to exercise and the distance in meters completed before and after the intervention of each training program based on aerobic exercise plus a component of muscular strength, showed a significant improvement in
In addition, when comparing the results between the groups, it was possible to show better results with significant difference in experimental group 2 (aerobic exercise + strength training for lower limbs) (p ≤ 0.05%). Similarly, an increase in muscle strength after training of 21 and 24% was observed in experimental group 1 and experimental group 2 respectively. However, no significant pre-post difference was found in the HDL, LDL and triglyceride variables (p ≥ 0.05%) (Table 5).

On the other hand, during the sessions of the training program, participants reported a perceived dyspnea according to the Borg scale between 6 to 8 (moderate intensity) as well as the feeling of fatigue during exercise. There were no hemodynamic, electrocardiographic or metabolic complications during the training sessions of each of the participants.

Regarding the perception of the exercise using the Borg scale for dyspnea and fatigue, meters traveled, METs (metabolic equivalent) and VO2 as indicators of tolerance to exercise at the beginning and end of the intervention in each group, an improvement was observed significant in all the variables. Highlighting that, after the intervention, higher values were observed in VO2 for experimental group 2 (7.8 ± 4.3 mL/kg-1/min-1 versus 17.45 ± 3.3 mL/kg-1/min-1), in comparison with experimental group 1 (7.3 ± 5.7 mL/kg-1/min-1 versus 12.4 ± 3.3 mL/kg-1/min-1). As in the values of METs (2.22 ± 1.2 versus 4.98 ± 0.9) (Figure 2), meters traveled (219 ± 53 m versus 399 ± 18 m), dyspnea (8 ± 3.8 versus 4.3 ± 2.3) and fatigue (9 ± 1.1 versus 3 ± 2.6) (Table 5).
DISCUSSION

Endurance exercises aim to increase strength, power and muscular endurance. In addition, physical training causes positive effects on cardiovascular function; since it generates hemodynamic, hormonal, metabolic, neurological and respiratory function changes. Likewise, it helps to mitigate the presence and advances of cardiovascular risk factors, without any effect on cardiovascular mortality, when compared with sedentary patients as mentioned by Powell R et al., whose results agree in a great way with those presented in this investigation.

Likewise, exercise has benefits in patients with heart disease. However, any recommendation for the exercise of these patients should be based on the particular pathology of the person, individual response to the exercise and the measurements obtained during the stress test, which should also contemplate the adaptation to a force test.

According to the Australian Institute for Sports, the volume and intensity of exercise recommended will depend on the severity of the syndrome, although it is agreed that in most patients with HF it should consist of a combination of low to moderate intensity aerobic exercise in most days of the week and strength training prescribed individually from low to moderate intensity at least twice a week. That is why, the present investigation carried out tests to determine 1RM, estimated VO₂ and MHR of the participants and thus be able to generate a prescription of the individualized exercise according to the needs of the individual.

Since strength is shown to be a predictor of cardiovascular, non-cardiovascular mortality, myocardial infarction and stroke in people between 30 and 75 years of age.
Therefore, the methodology used and our results indicate that the unique and universal prescription of the elements that make up the physical exercise of patients with HF (type of exercise, intensity, duration, frequency, progression and recovery) is not possible due to the multiple cardiovascular risk factors and the characteristics of each individual, as well as the diversity of complex alterations that these patients present. However, different studies mention that physical exercise can satisfactorily increase the perception of exercise and improve the symptomatology of individuals with heart failure with reduced and preserved ejection fraction, which, in turn, increases the quality of life.39,40

Therefore, we recommend an initial assessment, test and individualized measures and interventions.41 Currently, guidelines worldwide, developed by experts and current evidence such as the American Heart Association (AHA)42 and the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR)43 show the general training regulations for heart disease.

There are also consensus and guidelines according to the different areas of the world that contribute to the knowledge of the care of heart patients such as: the Australian Cardiovascular Health and Rehabilitation Association (ACRA)44-46 in Australia, European Association of Cardiovascular Prevention and Rehabilitation (EACPR)47 for Europe and in South America the American South Society of Cardiology and the Inter-American Committee on Cardiovascular Prevention.40 In addition, there are specific countries such as: France,49 United Kingdom,50 Ireland,51 Japan,52 Canada,53 England,54 Germany,55 Scotland,56 New Zealand,57 Netherlands58 and the United States.41,59,60 However, all these guidelines conclude that the intervention in cardiac rehabilitation must be accompanied by: aerobic exercise, strength, endurance and flexibility; although to date there is no international consensus on the intensities and frequencies of each intervention, since it varies according to the country, continent or association.61

According to the citation of McCartney (2011), in the study by Wenger et al.,62 they analyzed 12 investigations where 100% of the sample had coronary heart disease. Resistance training was applied for MMSS and MMII with load of 30%-60% of 1RM, there were found benefits in strength and muscular resistance on the study population. This research supports our results as well as those found by Brown J (2001),63 Bjarnoson B, Mayer W, Meister E et al. (2004);64 Stiwart K, Franklin BA. (2001)65 who mention that strength training compared to aerobic exercise, has a greater increase given by mechanisms such as the increase in cardiac output at the expense of heart rate more than the ejection volume.

Similarly, an increase in muscle strength of 21% and 24% was observed in experimental group 2 and control group respectively; without presence of adverse clinical events or intolerance to activity, as in those published by Thibaut G, Labrunée M, Bensnier F, et al. (2016),66 Anderson L et al. (2016),67 Gayda M, Ribeiro P, Juneau M et al. (2016),68 Nogueira F, Sousa A, Souza F et al. (2016).69

Considering the above mentioned, our results show that strength training with aerobic exercise is necessary in cardiovascular patients, due to its effects on multiple cardiopulmonary variables. These beneficial effects manage to trigger an increase in oxygen consumption and temporarily in the heart rate values associated with sympathetic stimulation, which triggers a progressive increase in catecholamine levels.

Now, the strength-endurance exercise has an important effect on the synthesis of...
contractile proteins responsible for muscle hypertrophy and strength, in addition to those involved in oxidative metabolism. Although the strength-endurance exercise essentially employs the glycolytic-anaerobic pathway during training, the temporal sequence of use of energy substrates during anaerobic muscle work is sufficient to induce increases in temperature, pH and impact the glycogen deposits of muscles involved in muscle contraction and affect protein synthesis and mitochondrial biogenesis.70,71 These affirmations were corroborated by Zapata-Lamana R, Cigarroa I, Diaz E et al. (2015).72

The evidence suggests that the strength-resistance exercise produces a series of physiological adaptations such as the increase of mitochondrial enzymes, mitochondrial proliferation, conversion of muscle fiber types and vascular remodeling, including capillarization.73 Therefore, the effects of strength training will depend on the type of muscular work, intensity, time and duration of the program.

Limitations of the study

One of the main limitations of the study, common in this type of research are the multiple variables that exist around the cardiovascular patient. Among them, the pharmacological treatment and the quality of life; which were not included as variables to be evaluated; although inescapably, they fulfill a predominant factor in the cardiovascular response to exercise. In addition, it is important to note that the present investigation used the 6-minute walk test to determine the VO₂ values but, if possible, an ergospirometry or a gas analysis, would be ideal for the investigation.

CONCLUSIONS

It was possible to demonstrate greater benefits in the patients who were given aerobic training plus strength training in lower limbs compared to the aerobic training group plus strength training in upper limbs. Aerobic training combined with strength exercises is effective as long as an adequate assessment, prescription and monitoring of the exercise is carried out, safely carrying more activities of daily life, leisure and work; as well as giving greater and better social and family integration to patients with cardiovascular disorders.

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