

RESEARCH PAPER (ORIGINAL)
ARTIGO DE INVESTIGAÇÃO (ORIGINAL)**Impact of a home-based exercise program on the functional capacity of the person with coronary artery disease**

Impacto de um programa de exercício físico domiciliário na capacidade funcional da pessoa com doença cardíaca isquémica

Impacto de un programa de ejercicio físico domiciliario en la capacidad funcional de la persona con enfermedad cardíaca isquémica

Ivo Lopes*^{ID}; Bruno Miguel Delgado**^{ID}; Maria Eugénia Rodrigues Mendes***^{ID}; Leonel São Romão Preto****^{ID}; André Filipe Morais Pinto Novo*****^{ID}**Abstract****Background:** Coronary artery disease is one of the most important causes of decreased functional capacity. Workout is essential for the recovery of the cardiac patient.**Objective:** To evaluate the effects of a home-based exercise program on the functional capacity of the person diagnosed with coronary artery disease; to evaluate the participants' adherence to the home-based exercise program.**Methodology:** Quasi-experimental study with 13 participants who were hospitalized between October and December 2016 and who did not participate in Phase II of the cardiac rehabilitation program. These patients underwent a home-based aerobic exercise program for 3 months.**Results:** Men (84.6%), average age 61.23 ± 11.34 years. On average, each participant performed 81 ± 9.58 exercise training sessions, which indicates an adherence to the program of approximately 92%. At the end of the program, there was an increase in the average number of meters walked in the 6-minute Walk Test (339.77 ± 61.34 vs. 533.77 ± 117.39 ; $p < 0.05$).**Conclusion:** At the end of the home-based aerobic exercise program, there was an improvement in functional capacity of the participants of the study.**Keywords:** rehabilitation nursing; cardiac rehabilitation; exercise; myocardial ischemia**Resumo****Enquadramento:** A doença cardíaca isquémica é uma das mais importantes causas de diminuição da capacidade funcional. O exercício físico é essencial para a recuperação do doente cardíaco.**Objetivo:** Avaliar o impacto de um programa de exercício físico domiciliário na capacidade funcional da pessoa com doença cardíaca isquémica; avaliar a adesão dos participantes ao programa de exercício físico domiciliário.**Metodologia:** Estudo quasi-experimental com 13 participantes que estiveram internados entre outubro e dezembro de 2016 e que não integraram a Fase II do programa de reabilitação cardíaca. Estes doentes foram submetidos a um programa de exercício físico aeróbio domiciliário durante 3 meses.**Resultados:** Homens (84,6%), média de idades de $61,23 \pm 11,34$ anos. Em média, cada participante realizou $81 \pm 9,58$ sessões de exercício físico, o que indica uma adesão ao programa de aproximadamente 92%. No final do programa, verificou-se um aumento no número médio de metros percorridos no Teste de Marcha de 6 minutos ($339,77 \pm 61,34$ vs. $533,77 \pm 117,39$; $p < 0,05$).**Conclusão:** No final do programa de exercício físico aeróbio domiciliário verificou-se uma melhoria na capacidade funcional dos participantes.**Palavras-chave:** enfermagem em reabilitação; reabilitação cardíaca; exercício; isquemia miocárdica**Resumen****Marco contextual:** La enfermedad cardíaca isquémica es una de las causas de disminución de la capacidad funcional más importantes. El ejercicio físico es esencial para la recuperación del enfermo cardíaco.**Objetivo:** Evaluar el impacto de un programa de ejercicio físico domiciliario en la capacidad funcional de la persona con enfermedad cardíaca isquémica; evaluar la adhesión de los participantes al programa de ejercicio físico domiciliario.**Metodología:** Estudio casi experimental con 13 participantes que estuvieron internados entre octubre y diciembre de 2016 y que no formaron parte de la Fase II del programa de rehabilitación cardíaca. Estos enfermos se sometieron a un programa de ejercicio físico aerobio domiciliario durante 3 meses.**Resultados:** Hombres (84,6%), media de edad de $61,23 \pm 11,34$ años. De media cada participante realizó $81 \pm 9,58$ sesiones de ejercicio físico, lo que indica una adhesión al programa de aproximadamente el 92%. Al final del programa se verificó un aumento en el número medio de metros recorridos en el Test de Marcha de 6 minutos ($339,77 \pm 61,34$ vs. $533,77 \pm 117,39$; $p < 0,05$).**Conclusión:** Al final del programa de ejercicio físico aerobio domiciliario se verificó una mejora en la capacidad funcional de los participantes.**Palabras clave:** enfermería en rehabilitación; rehabilitación cardíaca; ejercicio; isquemia miocárdica* MSc., Nurse, Centro Hospitalar do Porto, Hospital de Santo António, 4099-001, Porto, Portugal [cnlivolopes@gmail.com]. ^{ID} <https://orcid.org/0000-0002-3125-5714>. Contribution to the article: coordination of the study, data collection and article writing. 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Contribution to the article: statistical analysis and article revision.***** Ph.D., Adjunct Professor, Higher School of Health of the Instituto Politécnico de Bragança, 5300-121, Bragança, Portugal: CINTESIS – Health Technologies and Services Research Center [andre@ipb.pt]. ^{ID} <https://orcid.org/0000-0001-8583-0406>. Contribution to the article: statistical analysis and scientific and methodological guidance.

Introduction

In 2030, coronary artery disease (CAD) will continue to be the main cause of death and an important cause of decreased functional capacity (FC; World Health Organization [WHO], 2014). The FC corresponds to the ability of a person to effectively and autonomously perform the activities of daily life (ADL), and it is an important risk indicator for death among healthy individuals and patients with CAD (Casillas et al., 2013).

The treatment of CAD is the result of the pharmacological combination and the procedures for percutaneous revascularization with the control of the cardiovascular risk factors (CVRF) and the adoption of a healthy life style (Piepoli et al., 2016; Sociedade Portuguesa Cardiologia [SPC], 2016).

The transition to this life style is facilitated through a cardiac rehabilitation (CR) program, which is an essential tool for the cardiac patient, with the objective of facilitating recovery and preventing new relapses, promoting the lowering of cardiovascular risk, encouraging the adopting and maintaining of healthy behaviors. Its central component is a structured program of physical exercise (PE), accompanied by work in awareness-raising and teaching about cardiac disease and the management of the treatment regime.

The program begins during the hospitalization (Phase I), progressing to an out-patient phase following release (Phase II) and culminating in a maintenance phase (Phase III), in which the goal is to have the patient manage his disease autonomously (Buckingham et al., 2016; SPC, 2016).

Despite the evident benefits that a CR program brings to a cardiac patient, the number of patients in Portugal who are referred to these programs is around 10% of the total number of eligible users. In Europe, the average is 30% (SPC, 2016).

Based on this data, and taking into account the differentiation of the Nurse Specialist in Rehabilitation Nursing (NSRN), which allows him autonomy in the design, monitoring and assessment of cardiorespiratory and motor function reeducation programs, and of ADL workout programs, to promote health, the prevention of injuries, and rehabilitation, a home-based PE program was created for patients who are not

referred to the hospital CR program (Ordem dos Enfermeiros [OE], 2011).

The general objectives of the study are: to evaluate the effects of a home-based exercise program on the functional capacity of the person diagnosed with CAD to evaluate the participants' adherence to the home-based exercise program.

Background

The most common reasons for non-referral to a hospital CR program are the distance between the user and the hospital, the associated costs, the incompatibility of scheduling between the program and the patient's professional life, and the lack of human and material resources to support the CR programs (Buckingham et al., 2016; SPC, 2016).

To respond to the vacuum created, home-based CR programs were created. In this type of accompaniment, the user follows a CR distance program at his home, with remote monitoring by health professionals. The focus of this type of program continues to be PE and various studies have shown that this is a viable option that is safe and when compared with the hospital CR program produces similar results (Buckingham et al., 2016; Gielen, Laughlin, O'Conner, & Duncker, 2015).

The user must be instructed and trained to carry out PE while hospitalized, so that he can do the program at home. He must understand what the safe intensity is for the PE, recognizing the symptoms and signs indicating intolerance to the PE, and he must be given a safe and progressive plan of home-based PE (American College of Sports Medicine [ACSM], 2014; Peixoto et al., 2015).

Although a CR program accepts users with a variety of heart pathologies, the most prevalent disease in individuals that participate in the program is CAD. This reality and the underuse of the CR program also occur in the Cardiology Department of the Hospital de Santo António (HSA) – Centro Hospitalar do Porto (CHP). In order to respond to this shortcoming, a home-based PE program was implemented for the CAD patient in September 2016.

The importance of the PE is such that it is a habit that interferes with the CAD, reducing

its incidence and the adverse effect caused by all the CVRF. One of the main benefits is related to the delay in the progress of atherosclerosis, which is the main cause of the obstruction of the coronary blood flow, which leads to CAD. Systematized PE reduces the mortality and morbidity rates caused by CAD, improves the quality of life and increases physical capacity (Gielen et al., 2015; Piepoli et al., 2016).

Aerobic PE results in the patient's improved tolerance to stress, increasing his ischemic threshold. These benefits are the consequence of the optimization of the distribution and peripheral use of oxygen, resulting in an increase in the submaximal stress level at which myocardial ischemia occurs (Magalhães et al., 2013).

These adaptations of the aerobic PE are essential for the cardiac patient who presents typical symptoms caused by CAD, such as the intolerance to activity, dyspnea or chest pain, making it possible to reduce them (ACSM, 2014; Corrà et al., 2010).

Thus, this workout program is essentially based on the aerobic PE, because it is demonstrably the best means of slowing the natural progression of heart disease and increasing the FC, which will allow individuals to perform their ADL more effectively, for a longer period of time and autonomously or with a lesser degree of dependency.

In the ischemic cardiac patient, in individuals with a high coronary risk or even in persons who are apparently healthy, the increase in PE, principally through the regular practice of moderate aerobic exercise will be the most recommended and consensual. This type of workout is more easily interiorized by the user, does not involve costs, may be done outside the patient's home, by walking, running or riding a bicycle, and it can be started up by those persons who are the most out of shape (ACSM, 2014; Corrà et al., 2010).

The clinical recommendations of the *European Society of Cardiology* on the management of patients who have suffered an acute myocardial infarction with ST- segment elevation (STEMI) or non-ST segment elevation myocardial infarction (NSTEMI), which will be the most serious diagnoses in CAD, point to aerobic exercise of moderate intensity at least five times a week and for 30 to 60 minutes (Roffi et al., 2016).

Research question

What impact does a home-based program of physical exercise have on the functional capacity of the person with coronary artery disease?

Methodology

A quasi-experimental study was designed for a single group, with repeated measures, encompassing all the patients who were hospitalized in the cardiology service between October and December 2016. Individuals were included according to the following criteria: principal medical diagnosis of STEMI, NSTEMI, unstable angina (UA) or stable angina (SA; diagnoses that make up the realm of CAD); over 18 years of age and having the cognitive ability to understand and execute a home-based PE plan. For the exclusion criteria, the following were defined: inclusion in Phase II of the HSA – CHP CR program; refusal to participate in the home-based PE program; a physical limitation that prevented doing the PE program at home; failure to complete the entire home-based PE program.

After applying the criteria for inclusion and exclusion, the sample was made up of 13 individuals.

Methodological procedures

The participants were given instructions on the PE program to be done at home. Besides this instruction, they were given printed documentation with all the signs indicating progress and the care to be taken during the execution of the PE, the type of exercise, the frequency and the maximum intensity that the exercise should bring to bear on them. They were also provided with a document to register the workouts completed during the program, which was handed in at the conclusion of the program.

The program consisted of 3 months of progressive aerobic workouts that began after release from hospital. During the first month, the patient was to perform the PE by walking at a pace identical to that he did at the cardiology department, beginning with about 10 minutes of exercise. He was to progressively increase the walk time by 1 to 2 minutes each day until he reached 20 minutes. In this first month, he was

to do 4 to 5 days of exercise a week.

In the second month following release, the walk time was to continue increasing, using the same rule of progression as that of the first month, adding 1 to 2 minutes each day of exercise. After reaching 30 to 40 minutes, he was to increase the pace of the walk, this increased speed increasing the intensity of the exercise. In this second month, it was recommended to do the PE at least 5 to 7 times a week.

In the third and last month of the plan, the pace of the walk was to be increased again and the total time of the exercise should be 60 minutes. In this phase, the patient was to perform 7 sessions of the PE per week.

The FC is determined using a six-minute walk test (6MWT). The 6MWT is one of the most widely used instruments for assessing an individual's stress tolerance. It reflects the FC, the amount of time a user can walk and the effectiveness of the PE workout in a CR program (ACSM, 2014; Casillas et al., 2013). The 6MWT was taken by all the patients at the time of their release and 3 months later, in the corridor of the cardiology ward. This corridor is 40 meters long and about 3 meters wide.

The adherence to the home-based program is assessed by the total number of PE sessions the participant completed. Thus, a 100% adherence would mean the individual did 64 PE sessions. This value is attained if the person follows what is described in the home-based PE plan, performing four PE sessions per week in the first month, five sessions per week in the second month and seven sessions per week in the third month. If the patient wishes to do the PE more frequently than what is stipulated, this is possible, provided that the intensity of the workout is respected and there is no adverse symptomatology.

The intensity of the workout is measured using the Borg Rating of Perceived Exertion (RPE) scale. This scale helps to gauge the RPE during the performance of the PE, through self-assessment by the participant, who rates his level of fatigue on a range of 6 to 20. There is a qualitative correspondence for the numerical values, facilitating the use of the instrument by the participant (ACSM, 2014).

The patient who initiates the performance of the PE following a diagnosis of CAD should start the PE at a light intensity, as a way of

adapting to the workout. After this phase, the individual can begin exercising at a moderate intensity, progressing in the frequency and length of time of the workout. When the patient is adapted to this workout, without adverse reaction to the PE, he can move on to PE with a hard level of perceived exertion (Piepoli et al., 2016; SPC, 2016).

During the phase of hospitalization, the participant is instructed on how to use this scale so that he can later use it at home. The PE performed in the first month of the program should be at an intensity between 10 and 11, which corresponds to low intensity of exertion. In the second month of workouts, the intensity of the exercises may fall between 12 and 13, corresponding to a moderate intensity. In the third month, the PE can be done at an intensity of 14 to 16, a high intensity of exercise. If the perceived exertion by the user is higher than what was stipulated for the month of workout he is currently doing, he should reduce the time and/or speed for doing the exercise in the following workout, until his perceived degree of fatigue is within the established limits (ACSM, 2014).

The hospital CR programs present a similar progression of workouts, in which Phase I establishes that the PE performed by the user should not surpass a value of 13, according to the Borg RPE. In Phase II of the program, the intensity should not be greater than 16 (ACSM, 2014).

If there are symptoms adverse to the PE (dizziness, dyspnea, flutter, chest pain, headaches or excessive fatigue), the patient is instructed to stop the workout and return to the health services to be reevaluated (ACSM, 2014).

The accompaniment during the program is carried out through weekly telephone calls. Through this tool, it is possible to know how many PE sessions were performed and if there was any adverse symptomatology. It is also a means of support and motivation through which the NSRN can help the patient adjust his workout, so that it is safe and effective.

This program was constructed by the researcher based on the recommendations on PE in CAD issued by various international entities. The workout plan is intended to be simple and easily executed by the user (ACSM, 2014; Gielen et al., 2015; Piepoli et al., 2016).

Statistical analysis

The IBM SPSS Statistics program, version 23.0, was used for the statistical analysis, the descriptive statistic being presented through the average \pm standard deviation, minimum and maximum values. For the inferential analysis, the Wilcoxon nonparametric test was used for the comparison study between the two assessment times. The nonparametric tests were chosen due to the small size of the group and because the group did not follow a normal distribution; the statistical significance is considered for a value of $p \leq 0.05$.

Ethical-legal considerations

The research project was analyzed and accepted by the Health Ethics Committee, the Research Coordinating Office, the Directorate of the Department of Education, Training and Research, the Directorate of Nursing and by the Chairman of the Board of Directors of the CHP.

Respect for the ethical principles raised by the study was guaranteed, with concern for the privacy, dignity and well-being of the participants. All the patients who agreed to take part in the home-based PE program had the right to interrupt their participation at any time.

Results

The sample was made up of a total of 13 patients, 11 men and 2 women. The overall average of ages was 61.23 ± 11.34 , the youngest patient being 43 years old and the oldest 78. In regard to the CVRF present in the sample, there was a higher incidence of arterial hypertension (AHT; 76.9%) and hypercholesterolemia (69.2%; Table 1). Overall, there was an average of 2 CVRF in the sample, the minimum CVRF value found in a patient being 1 and the maximum 5.

Table 1
Description of the sample according to the type of CVRF (n = 13)

Arterial hypertension	Yes	10	76.9%
	No	3	23.1%
Diabetes <i>mellitus</i>	Yes	1	7.7%
	No	12	92.3%
Hypercholesterolemia	Yes	9	69.2%
	No	4	30.8%
Smoking	Yes	2	15.4%
	No	11	84.6%
Sedentarism	Yes	1	7.7%
	No	12	92.3%
Stress	Yes	2	15.4%
	No	11	84.6%
Medical history	Yes	3	23.1%
	No	10	76.9%
Obesity	Yes	3	23.1%
	No	10	76.9%

The patients did an average of 81 ± 9.58 PE sessions and only one patient did not record an adherence of 100%, performing only 59

PE sessions (Table 2). The adherence of the sample was therefore approximately 92% (Table 3).

Table 2

Description of the sample as a function of the average number of PE sessions completed

	PE Sessions
<i>n</i>	13
Average	81
Standard deviation	9.58
Minimum	59
Maximum	93

Table 3

Description of the sample as a function of the number of PE sessions completed by patient

Patients in the Sample	Number of PE Sessions
1	59
2	82
3	83
4	67
5	90
6	93
7	73
8	83
9	88
10	82
11	89
12	84
13	80

There were 144 telephone calls made, with an average of 11.08 ± 1.61 calls per patient, the minimum number of calls made to a patient being 8 and the maximum, 14. Comparing the two times of the assessment,

the average distance covered in the 6MWT increased from 339.77m to 533.77m (Table 4). This increase presents a change with statistical significance ($z = -3.181$; $p = 0.001$).

Table 4

Description of the sample in accordance with the distance covered in the 6MWT

	Distance covered (m) in the 6MWT upon discharge	Distance covered (m) in the 6MWT 3 months after discharge	
<i>n</i>	13	13	
Average	339.77	533.77	$z = -3.181$
Standard deviation	61.34	117.39	$p = 0.001$
Minimum	232	345	
Maximum	408	735	

One adverse event was recorded, in which one of the patients in the sample presented chest pain associated with the PE. The patient interrupted the exercise due to the symptomatology, as instructed, and the pain ceased.

Discussion

The average age of the sample and the dominant gender are in line with the literature (Claes, Buys, Budts, Smart, & Cornelissen, 2017; Ferreira, 2016; WHO, 2014).

In the study sample, all the CVRF are present, AHT and hypercholesterolemia being the most common ones among the patients. The values obtained are similar to those obtained in studies on the effects of home-based CR programs for CAD patients (Piotrowicz et al., 2014; Szalewska et al., 2015).

The adherence of a user to a PE workout plan and to an active life style will be two of the most relevant objectives of a CR program (Piepoli et al., 2016). In this study, the adherence to the workout program was approximately 92%. In a bibliographic review of Cochrane in 2015, in which the effects produced by the hospital CR programs are compared with those that are home-based, the adherence was higher in the latter (Taylor et al., 2015). In a study with patients in a telemonitored home-based program, adherence was considered effective when 80% of the planned sessions were in fact completed and the percentage of adherence was 81.8% (Piotrowicz et al., 2014).

Hence, the results obtained in the study are shown to coincide with the generality of the literature, which reveal an excellent adherence of the patients to the home-based CR programs. The high level of adherence would be related to a greater probability of maintaining an active lifestyle over the long term (Frost, Levati, McClurg, Brady, & Williams, 2016; Heron et al., 2016). One of the first motivations for carrying out this study was to search for a response to the under-utilization of the CR programs. The results obtained for adherence reinforce the importance of betting on home-based programs for patients who, for the most varied reasons, are not referred to the hospital CR program. Two of the main reasons for non-referral have to do with the condition of the patient, when

he lives far from the CR center or if he is still of a working age, he may justify his lack of available time to participate in the program by travelling to the location where the program is held. With a home-based program, these situations are less restrictive, giving the patient greater flexibility in terms of time and space.

The use of telephone contact as a means of monitoring the patient is a recurrent feature in various home-based programs. Besides enabling the monitoring of the workout, it is an important recourse for maintaining a good therapeutic relationship, facilitating the support and motivation for the completion of the therapeutic plans (Housholder-Hughes et al., 2015; Peixoto et al., 2015).

In regard to the 6MWT, when the average distance covered upon discharge is compared with that at 3 months afterwards, there is an increase with statistical significance, revealing an improvement in the FC of the sample. All the participants increased the distance covered between each of the assessments, and in only one case, the difference between the two assessments was not greater than 50 meters. Some authors refer to 50 meters as being the minimum difference between the two tests in order to affirm that the individual improved his FC (Casillas et al., 2013). In the various scientific articles consulted, all the patients improved their FC after completing a home-based PE program. The literature further sets forth that the increase of FC is similar, when hospital CR programs are compared to the home-based programs (Buckingham et al., 2016; Peixoto et al., 2015; Piotrowicz et al., 2014). One of the limitations of the study is the fact that it cannot be proven that the improvement in the FC is solely due to the PE program, given the size of the sample and the type of study (absence of group control). However, the statistical significance obtained from the analysis of the values from the 6MWT strongly suggests the effect of the PE on the functionality of the patients, encouraging the continuity of research in this field.

The main support for the safety of the patients were the telephone contacts and the teaching, instruction and training on the PE that were given during the hospitalization. In the future it will be important to resort to other means to control the intensity, frequency, volume and progression of the workout, monitoring ECG, PA and FC, for

example, to be able to effectively measure the PE completed at home by the patient, providing it with a lower probability of adverse events.

Despite the limitation described, even though the PE is not done by the patient exactly as prescribed, something that is confirmed in the home-based programs, the most important thing will be the adherence to exercise, opposing the sedentarism, doing PE of progressive intensity. The generality of literature reveals that these programs are safe and reliable, and the benefits of the PE will always be greater than its risks (ACSM, 2014; Buckingham et al., 2016).

Conclusion

At the end of the study, there was an improvement in the FC of the participants. This increase in the FC results in a greater ability of the person to perform the ADL, as well as in a higher aerobic capacity and muscle strength. The 6MWT is a submaximal test, which is highly pertinent, because most of the ADL do not require maximum exertion to be performed, so this instrument provides valid, reliable results on the person's degree of autonomy. Another interesting and positive result was the level of adherence of the patients, as the average number of PE sessions completed was higher than the stipulated minimum, which enhanced the benefits of the PE.

The application of this type of program can be an important tool to respond to the under-utilization of the hospital CR program, because all cardiac patients, regardless of their cardiovascular risk or other comorbidities and dependencies, benefit from some degree of physical activity and should be prepared and encouraged to adopt an active life, benefitting from the instruction and accompaniment in doing the PE.

In this way, the NSRN should be involved in the treatment and rehabilitation of the cardiac patient, seeing that one of the goals of the nurse's intervention is the person with special needs over the course of his life cycle. This will be reflected while the patient is hospitalized and in the community. The differentiation of the NSRN gives him autonomy in the design, monitoring and assessment of cardiorespiratory and motor function reeducation programs, and of ADL workout programs, to promote

health. The NSRN, therefore, should invest in the design of programs similar to the one explained in this paper, increasing their visibility in the multidisciplinary team and the health services, in a context of extreme importance for the person with CAD, the disease with the highest mortality rate in the world.

In the future, it would be interesting to design experimental studies, adopting more technological resources, making it possible to make a more efficient measurement of the PE done by the patient at home.

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