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Systematic review

Cardiovascular rehabilitation increases quality of life and exercise capacity after cardiac ablation in patients with atrial fibrillation

Reabilitação cardiovascular aumenta qualidade de vida e capacidade de exercício após ablação cardíaca de pacientes com fibrilação atrial

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ABSTRACT

Introduction: Atrial fibrillation (AF) is one of the most common supraventricular arrhythmias. Cardiac ablation represents one of the therapeutic forms, as it prevents recurrences of AF and the side effects of medications. As an adjunct to ablation, cardiovascular rehabilitation can enhance exercise capacity and quality of life. **Objective:** To investigate the effects of cardiovascular rehabilitation on exercise capacity and quality of life in individuals with atrial fibrillation undergoing cardiac ablation surgery. **Methods:** Systematic review according to PRISMA, carried out by independent authors in the Pubmed, VHL, PEDro and SciELO databases, from August to September 2022. Clinical trials were included, without restriction as to publication time or language. The methodological quality of the studies was assessed using the PEDro scale. **Results:** 665 articles were screened, however only 3 were eligible. The sample size ranged from 24 to 210, totaling 302 individuals. Cardiovascular rehabilitation was maintained at moderate intensity, with resistance and aerobic exercises, for a period of 2 to 6 months. Eligible articles had moderate methodological quality. **Conclusion:** The studies showed significant improvement in exercise capacity and quality of life reflected in increased VO_{2max}, better performance on the 6-minute walk test, and improved physical and mental health components.

Keywords: atrial fibrillation; physical exercise; cardiac rehabilitation.

RESUMO

Introdução: A fibrilação atrial (FA) é uma das arritmias supraventriculares mais comuns. A ablação cardíaca representa uma das formas terapêuticas, pois evita as recorrências da FA e os efeitos colaterais das medicações. Como adjuvante a ablação, a reabilitação cardiovascular pode potencializar a capacidade de exercício e a qualidade de vida. **Objetivo:** Investigar os efeitos da reabilitação cardiovascular na capacidade de exercício e qualidade de vida de indivíduos com fibrilação atrial submetidos a cirurgia de ablação cardíaca. **Métodos:** Revisão sistemática conforme a PRISMA, realizada por autores independentes nas bases de dados Pubmed, BVS, PEDro e SciELO, no período de fevereiro a abril de 2020. Foram incluídos ensaios clínicos, sem restrição quanto ao tempo de publicação ou ao idioma. A qualidade metodológica dos estudos foi avaliada através da escala PEDro. **Resultados:** 526 artigos foram rastreados, contudo apenas 3 foram elegíveis. O tamanho amostral variou de 24 a 210, totalizando 302 indivíduos. A reabilitação cardiovascular manteve-se em intensidade moderada, com exercícios de resistência e aeróbicos, no período de 2 a 6 meses. Os artigos elegíveis apresentaram qualidade metodológica moderada. **Conclusão:** Os estudos mostraram melhora significativa da capacidade de exercício e da qualidade de vida refletida no aumento do $VO_{2máx}$, no melhor desempenho no teste de caminhada de 6 minutos e na melhora dos componentes de saúde física e saúde mental.

Palavras-chave: fibrilação atrial; exercício físico; reabilitação cardíaca.

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Introduction

Atrial fibrillation (AF) is one of the most common supraventricular arrhythmias worldwide, characterized by electrophysiological abnormalities in the atrial tissue, which prevent the regular propagation of the action potential in the heart muscle. Individuals with AF account for approximately 33% of all hospitalizations for arrhythmias, with a 3 to 5 times greater chance of having a cerebrovascular accident (CVA) [1]. Added to this, in Brazil, AF can impact about 1 billion dollars in health expenditures, contributing significantly to the overload of public agencies [2,3].

In this scenario, some alternatives have been proposed, and among them we can highlight cardiac ablation (AC). This intervention is performed using a variety of techniques and has been constantly evolving, proving to be safe and with satisfactory results compared to pharmacological treatment alone [4].

Despite being effective, treatment with AC can still be enhanced by cardiovascular rehabilitation (CR), a set of activities that presents physical exercise as one of its main tools [5]. The result of this combination promotes positive consequences in cases of AF, such as increased left ventricular ejection fraction (LVEF) and the reduction of systemic inflammation [6]; considerably decreasing the number of deaths and hospitalizations in other populations of cardiac patients [7].

As if clinical improvement were not enough, CR has also been identified as an important factor in improving self-perception of health, and in the functional capacity of people with AF [8]. Thus, its implementation has the potential to improve the quality of life (QOL) and exercise capacity of this population, giving them greater independence and a sense of well-being [9].

Despite the already reported benefits of CR in patients with AF, there are still few studies that evaluated this problem in people undergoing CA [10,11] . Thus, the objective of the present study is to systematically review evidence that investigated the effects of CR based on physical exercise on the physical exercise capacity and QOL of individuals with AF undergoing CA.

Methods

Outline

A systematic review study, based on the criteria established by the guideline Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [12], to answer the PICO question: What are the effects of cardiovascular rehabilitation on exercise capacity and quality of life in individuals with atrial fibrillation undergoing cardiac ablation surgery? Study registered on the PROSPERO platform under opinion CRD42020172711.

Search strategy

Data collection was carried out by independent reviewers [KNOS and LOS] from August to September 2022. Electronic databases were consulted for the study: Pubmed, VHL Regional Portal (Medline and Lilacs), SciELO and PEDro. The studies were sorted by crossing the following descriptors and keywords: "*atrial fibrillation*", "*exercise*" and "*ablation*" using the Boolean operator AND, with the exception of the PEDro platform, which did not use the Boolean operator. The descriptors were chosen by the "Descriptors in Health Sciences" (DeCS) platform. In case of discrepancies between the two reviewers, a third reviewer [VAG] was consulted. In the process of removing duplicates and managing references, the "EndNote" software was used.

Eligibility criteria

The inclusion criteria adopted in this review were: randomized clinical trials; studies published in national or international journals; studies performed in individuals with atrial fibrillation who underwent cardiac ablation procedure; studies with individuals who underwent cardiovascular rehabilitation. In this review, we consider cardiovascular rehabilitation to be a multidisciplinary program that consists of cyclic or resistance physical exercises and that aims to improve exercise capacity, working on muscle strength, flexibility, balance, preventing or rehabilitating any functional limitation presented by individuals. However, the following were excluded: abstracts; theses and dissertations; studies that did not assess exercise capacity or quality of life. There were no restrictions on the language or time of publication of the studies.

Exercise capacity

Physical exercise capacity can be defined as the trainable qualities of each individual. This is directly related to the ability to perform specific physical activities, together with motor skills, being linked to the components of physical performance. To measure this variable, the analysis of VO_{2max} (maximum oxygen consumption capacity) and performance in the 6-minute walk test (6MWT) are widely validated parameters [13].

Quality of life

QOL, according to the World Health Organization, is a global analysis performed by the individual that involves their perception of cultural insertion and social value systems. In this way, QOL encompasses not only physical, mental, psychological and emotional well-being, but is also linked to the sociocultural context. To analyze this variable, the SF-36 questionnaire is a widely recognized tool [14].

Study selection and data extraction

The article screening process was initially carried out by reading the titles and abstracts, so that articles that did not meet the eligibility criteria were excluded. Subsequently, the articles that met the criteria were retrieved for reading in full, an

analysis of the reference list of these articles was performed by manual search, and a new assessment was carried out regarding the eligibility for the extraction of the outcomes of interest, referring to: author and year, country of study, study type, study objective, population (sample size), population characteristics, cardiovascular rehabilitation, comparison, analyzed variables and main results obtained by the studies.

Study quality and risk of bias

The methodological analysis of the studies that met the inclusion criteria was performed using the PEDro scale, a tool that qualifies rehabilitation programs associated with physical therapy. Composed of 11 items, the PEDro scale aims to assess the methodological quality of randomized clinical trials. The final maximum score can range from 0 to 10 points (criterion 1 is not considered as a final score). We considered that scores from 0 to 4 would be of low methodological quality, from 5 to 7 as moderate quality, and from 8 to 10 we evaluated as high methodological quality. Each clinical trial was evaluated by two independent evaluators [KNOS and LOS] and, if there was disagreement on any item in question, a third evaluator [VAG] would make a final arbitration [15].

Results

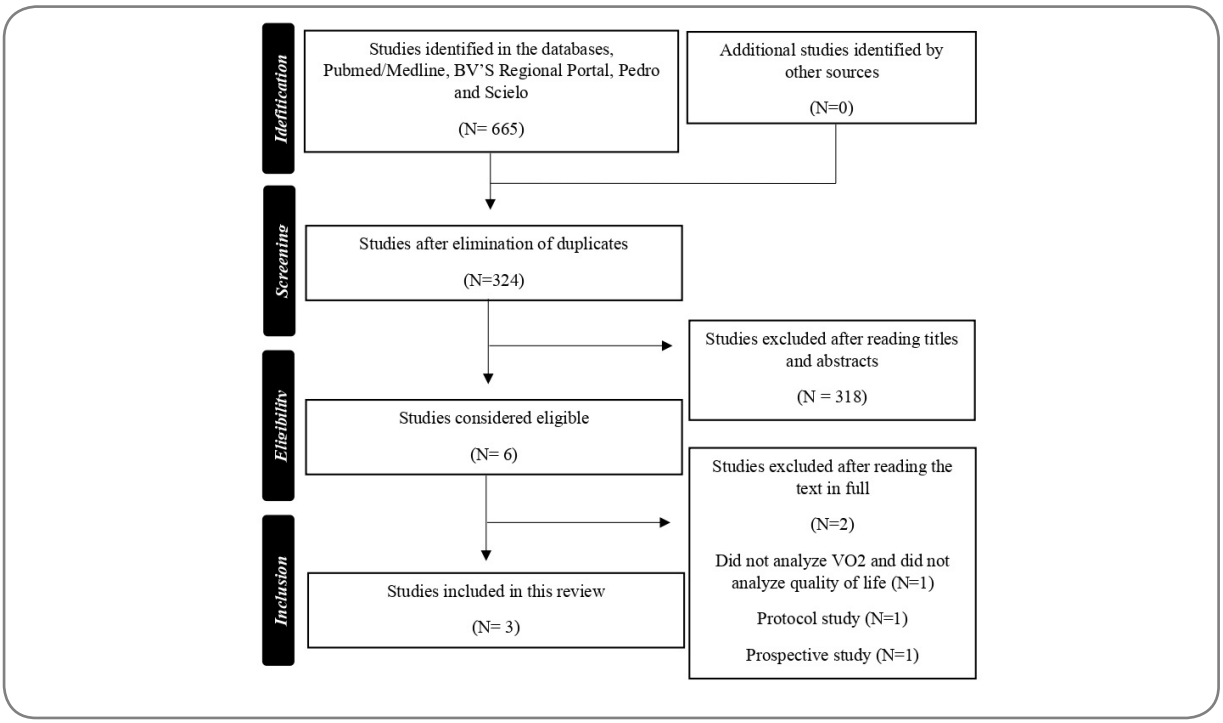
Research and selection of studies

A total of 665 articles were screened through data collection, however 341 were eliminated due to duplicity, 318 were excluded after reading the titles and abstract, leaving 6 articles eligible for full reading. The main reasons for exclusion were: study that did not analyze VO_{2max}, QOL, study with incomplete data (protocol study), and prospective study. Finally, 3 clinical trials met the eligibility criteria, as described in the flowchart in Figure 1.

Study characteristics

Clinical trials aimed to assess exercise capacity, QoL, inflammatory status, cardiac function and safety in individuals with AF undergoing CA. The sample size ranged from 24 to 210, totaling 302 individuals. The variables used in this study were physical capacity and QoL, measured through the cardiopulmonary test and SF-36 respectively, since the other variables were not in the objectives of this review.

The intervention started one month after cardiac ablation surgery, and cardiovascular exercises and resistance exercises were used as a CR program, which were prescribed respecting the individuality of the participants, through the data obtained in the ergospirometric test. The intensities were progressively increased throughout the sessions, and later became moderate, having as parameters up to 75% of the HR reserve [16], the anaerobic threshold [17] and the Borg scale with a score of 15 and FC [18]. However, they differed by the duration of the studies, which ranged from 2 to 6 months. The characteristics of the studies are shown in table 1.



Source: Authors' elaboration
Figure 1 - Flowchart of sorting and selection of articles

Physical capacity and quality of life

Physical capacity was evaluated through VO_{2max} in all studies, and two studies in addition to VO_{2max} used the 6MWT [17,18], considering that both parameters serve to measure the exercise capacity of individuals. The 6MWT is a low-cost, easy-to-administer test that assesses individuals ' submaximal efforts [19]. The VO_{2max} is the main indicator of respiratory fitness, and can be obtained through the ergospirometric test [20]. The study by Rissom et al. [18] identified a statistically significant (main effect $p = 0.003$) increase in VO_{2max} in the rehabilitation group compared to the control group after the intervention. Added to this, Kato et al. [17] show that VO_{2max} increased significantly ($p < 0.01$) in the rehabilitation group compared to baseline. Seo et al. [16] signaled that there was no significant difference in VO_{2max} between the two groups ($P = 0.90$) and that exercise induced an improvement in VO_{2max}). In assessing performance on the 6MWT after CR, studies have shown that individuals have increased performance on the test, with significant improvements in the values of the rehabilitation group compared to baseline ($p < 0.01$ in both) [17,18].

QOL was evaluated in two studies [16,18], which used the SF-36 questionnaire as a parameter, consisting of 11 questions and 36 items covering eight domains. The individual receives a score in each domain, which varies from 0 to 100, with 0 being the worst score and 100 the best [21]. Rissom et al. [18] applied the SF-36 in the 1st, 4th and 6th month after the intervention, noting lasting effects on the mental health component, whereas Seo et al. [16] identified improvements in the physical and mental health components. The results of physical capacity and QOL were described in table II.

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Table I – Characteristics of the studies

Author/ Year	Objective	Kind of study	Population	Characteristics of the population	Rehabilitation cardiovascular	Comparation	Analyzed variables	Results
Seo et al. 2019 [16]	To evaluate the effects of 8 weeks of exercise-based cardiac rehabilitation on cardiopulmonary fitness and quality of life after RTA surgery.	Clinical Trial.	24 patients (GI =12) (GC = 12)	GI - Age: 58.4 ± 6.5 Weight: 73.8 ± 9.6 Paroxysmal FA: 4 Persistent FA 8 Hypertension: 3 Diabetes mellitus: 1 Dyslipidemia: 4 CG - Age: 59.5 ± 6.1 Weight: 72.5 ± 9.5 Paroxysmal FA: 4 Persistent FA 8 Hypertension: 6 Dyslipidemia: 2	2 sessions per week for 8 weeks with aerobic training at an intensity of 40% to 50% of RHR for 10 minutes, with progression throughout the sessions to 75% of RHR in up to 30 minutes. Resistance training was started after 2 weeks of aerobic training, performed in 2 to 3 sets with 10 to 15 repetitions. The load or intensity of resistance training was not reported.	The CG had only drug treatment.	VO_{2max} and mental and physical component score of the SF-36 questionnaire).	Improvement of the physical and mental component of the SF-36 showed significant improvement.
Kato et al. 2019 [17]	To evaluate the effects of cardiac rehabilitation on exercise capacity, cardiac function, inflammatory status, and safety in patients with persistent AF undergoing catheter ablation.	Controlled and randomized clinical trial.	68 Patients (GI= 34) (GC = 34)	GI - Age: 67 ± 10 BMI: 23.8 ± 2.6 Persistent FA: 28 Long-term persistent AF (≥8 months) : 5 Hypertension: 20 diabetes: 5 Dyslipidemia: 11 CG - Age: 65 ±8 BMI: 23.9 ± 3.2 Persistent FA: 31 Long-term persistent AF (≥8 months) : 6 Hypertension: 18 diabetes: 7 Dyslipidemia: 11.	The IG performed supervised exercise 1-2 times weekly and unsupervised moderate-intensity walking exercise for 30 min, 2-3 times weekly for 6 months. Each session lasted 60min, 30min of endurance exercises at moderate intensity, 30min of resistance exercises with an intensity of 40% to 50% of 1RM.	The CG had a visit with a cardiologist at the hospital for follow-up at one, three and six months.	Physical Function; Exercise Capacity; Weight; FC; Echocardiographic parameters; inflammatory status and other blood markers;	Increase in components of physical function and exercise capacity except RER; Improved cardiac function and inflammatory status. There was no increased risk in cardiac rehabilitation.
Rissom et al. 2016 [18]	To assess the effects of comprehensive cardiac rehabilitation compared with usual care on the physical capacity and mental health of patients treated with catheter ablation for AF.	RFA randomized clinical trial.	210 patients (GI= 105) (GC = 105)	GI - Age: 60 ± 9 BMI: 27 ± 46 Paroxysmal FA: 76 Persistent FA 29 Hypertension: 30 Diabetes mellitus: 4 Palpitation: 68 GC - Age: 59 ± 12.25 BMI: 28 ± 5.62 Paroxysmal FA: 76 Persistent FA 29 Hypertension: 31 diabetes: 5 Palpitation: 53.	Three sessions per week for 12 weeks. Rehabilitation was through graded cardiovascular training, intensity measured using the 15-point Borg scale, and strength exercises gradually changed during training sessions. The training intensity was progressively increased during the 12 weeks.	Usual care, including a 3- to 6-month follow-up visit with a physician	Ergospirometry (VO_{2max}), 6MWT, Sit to stand test, SF -36, Adverse Events.	There was a significant improvement in VO_{2max}. And there were no significant QOL results.

ATT = totally thoracoscopic ablation, GC = control group, GI = intervention group; AF = atrial fibrillation, HRR = heart rate reserve, 1RM = one repetition maximum, PCF = physical component scores, BMI = body mass index, 6MWT = 6-minute walk test, CM = maximal load, RER = Respiratory Exchange, LA = anaerobic threshold, HR = heart rate, ECHO = echocardiogram, QOL = quality of life; SF-36 = Abridged version of Questionnaire 36; VO_{2max} = Maximum oxygen consumption; *The studies adopted the value of P< 0.05 as statistically relevant. Source = Authors' elaboration

Quality of studies and risk of bias

In the assessment of methodological quality, the score between the studies ranged from 5 to 6 points on the PEDro scale, with the average score between them being 5.6. The studies were classified as having moderate methodological quality. The main non-scored items are related to the blinding of participants and evaluators, as shown in table III.

Table II – Characteristics of the studies

	$VO_{2máx}$ (ml/kg/min)	6MWT (m)	Quality of life
Seo *et al.* **2019[16]**	Baseline: GC: 28.31± 7.44 GI: 26.91 ± 7.18 Side dish: GC: 26.85± 6.23 GI: 28.89 ± 7.63 (P = 0.055)		Two physical health scores (physical function, P = 0.013 and general health, P = 0.05) and three mental health scores (vitality, P = 0.027, social function, P = 0.016 and mental health, P = 0.003) improved significantly.
Kato *et al.* **2019[17]**	Baseline: GI: 17.8 ± 3.4 Side dish: GI: 19.8 ± 4.6 (P < 0.01)	Baseline: GC: 551 ± 84 GI: 545 ± 123 Side dish: GC: 565 ± 95 GI: 596 ±95 (P < 0.01)	
Rissom *et al*, **2016[18]**	Baseline: GC: 20 GI: 22 Side dish: GC: 21 GI: 24 (P = 0.003)	Baseline: GC: 559 GI: 548 Side dish: GC: 576 GI: 592 (P = 0.88)	The self-reported SF-36 PCM – No significant difference between groups (53.8 points vs. 51.9 points , P = 0.20)

TC6M = teste de caminhada de 6 minutos; GC = grupo controle; GI = grupo intervenção; PCM = pontuações de componentes mentais. Fonte: Elaboração dos autores

Tabela III – Methodological quality of the studies

Study	1	2	3	4	5	6	7	8	9	10	11	TOTAL	AVERAGE
Seo *et al.*, **2019[16]**	Yes	No	No	Yes	No	No	No	Yes	Yes	Yes	Yes	5/10	
Kato *et al.*, **2019[17]**	Yes	Yes	No	Yes	No	No	Yes	Yes	No	Yes	Yes	6/10	5,6
Rissom *et al.* **2016[18]**	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	No	6/10	

1 = Specification of inclusion criteria; 2 = Random allocation; 3 = Secrecy in the allocation; 4 = Initial similarity between groups; 5 = Masking of participants; 6 = Therapist masking; 7 = Masking of evaluators; 8 = Measures of a primary outcome (85% of participants); 9 = Intent-to-treat analysis; 10 = Comparison between groups on a primary outcome; 11 = Central tendency and variability of at least one variable. *Item 1 did not contribute to the total score. Source = Authors' elaboration

Discussion

This systematic review investigated the effects of exercise-based CR on QOL and exercise capacity in individuals with AF undergoing cardiac ablation surgery. Data from three clinical trials with a total of 302 subjects were included. The main results found indicated an improvement in exercise capacity and QoL in individuals after CR when compared to the control group.

It is known that VO_{2max} is directly correlated with physical exercise capacity. Therefore, some clinical trials identified an improvement when analyzing this variable in individuals undergoing CR programs. This improvement is due to several factors that lead to an increase in cardiac output and arteriovenous oxygen difference. Among them, the increase in angiogenesis stands out; the size and number of mitochondria and mitochondrial enzymes; elevation of parasympathetic activity (vagal tone) and reduction of sympathetic activity [22].

Kato et al. [17] observed an increase in LVEF after a physical exercise program, potentiated by the optimization of myocardial glucose uptake, with subsequent improvement in cardiomyocyte metabolism. Such changes would be responsible for providing healthy left ventricular hypertrophy and consequent improvement in cardiac function, expressed by the increase in stroke volume in relation to end -diastolic volume [23]. The aforementioned changes promote an optimization of oxygen use, providing better energy efficiency in relation to anaerobic metabolism, which is translated into an increase in exercise capacity [24].

Still on the VO_{2max}, it is known that it is possible to estimate it through the 6MWT [25,26]. Therefore, two of the eligible studies [17,18] in this review used this tool and identified improvement in the CR group compared to the CG. If this were not enough, it was possible to perceive in the study by Kato et al. [17] , an improvement in handgrip and lower limb strength, showing that CR can enhance physical fitness parameters, which reinforces its positive impact on health in general [27] .

The study by Seo et al. [16] showed no increase in physical capacity, which can be explained by the shorter duration and intensity of the exercises applied, compared to other studies. The Physiotherapist Clinical Practice Guideline for the Treatment of Individuals with Heart Failure of 2020 [28], suggests that an exercise protocol should be able to spend a certain weekly caloric consumption for better results to be achieved. By way of comparison, it is recommended that in high-intensity interval training (HIIT), for example, better results are observed when energy expenditure exceeds 460 Kcal/week. In the study by Seo et al. [16], the weekly energy consumption was not measured, so it was not possible to make this comparison.

Still justifying the results of the study by Seo et al. [16], a sample with greater exercise capacity was observed (VO_{2max} of 28.31 in the control group vs. 26.91 in the intervention group [16]) in relation to other studies (20.1 and 22.1 respectively in the control and intervention group [18] and 17.8 intervention group [17]) according to sex and age. Thus, it is natural to expect a better response to physical exercise in individuals with lower VO_{2max}, as this variable has a greater margin of improvement. Optimization of exercise capacity is significant for these individuals, because for every 3.5 ml/O2/kg min of VO_{2max} increased, a reduction in mortality rate of 17% to 24% is expected [29].

It is worth noting that patients with AF tend to have an altered inflammatory state [30], interfering with O2 metabolism. This condition provides an increase in the contribution of anaerobic pathways, resulting in a lower performance of individuals

in functional tests [31]. In the study by Kato et al. [17] a significant improvement in the inflammatory profile of the intervention group was identified. This finding is reinforced by other studies that analyzed the anti-inflammatory effect of physical training [32], especially through the decrease of the pro-inflammatory cytokines TNF alpha and Interleukin 6 [33].

With regard to QOL, assessed through the SF-36 questionnaire, in the study by Seo et al. [16], significant increases were found in the physical and mental health components. Regarding the study by Rissom et al. [18], despite obtaining improvement in all components, such improvements were not statistically relevant, especially when comparing the questionnaire indices between the groups. In the study by Kato et al. [17] QOL was not evaluated, if investigated, it would probably present an improvement, since domains of the questionnaire such as vitality and physical aspects are directly related to optimized parameters in this study [34] .

The differences in the findings between the studies may be related to the fact that the authors applied the questionnaire in different ways. While one carried out the evaluation in the 1st, 4th, 6th month [18] after the intervention, the other [16] applied the SF-36 questionnaire adapted for his study only once [34], which may have interfered in the QoL analysis.

Therefore, as in other studies, positive effects of CR were observed on QOL, exercise capacity and cardiopulmonary fitness in individuals with AF, highlighting the findings of this review [35].

Limitations

The main limitation of this review is the moderate methodological quality of the eligible studies, since they presented weaknesses in aspects related to the blinding of participants and evaluators, which can significantly increase the risk of bias. In addition, the heterogeneity in the duration of the exercise protocol between the studies makes it difficult to compare the results. However, providing evidence that CR promotes positive effects, the data presented here can substantially contribute to the implementation of CR programs in the investigated population. In addition, CR contributes to a decrease in mortality rates, recurrences of arrhythmic events and hospitalizations. As a result, the CR program can help to reduce the burden on health services, which leads us to reflect on the need to implement this program in clinical guidelines.

Conclusion

In view of the observed aspects, we concluded that CR associated with cardiac ablation promotes significant improvements in exercise capacity, which is reflected in the increase in VO_{2max} and in a better performance when performing the 6MWT. In addition, it is worth mentioning that QoL was translated into better SF-36 scores, in individuals who underwent cardiovascular rehabilitation, compared to the control

group. However, in terms of the methodological quality of the clinical trials analyzed, it is necessary to carry out new studies with greater methodological rigor.

Conflict of interest
The authors of this review declare that they have no conflicts of interest, thus: there was no institutional support for the submitted work.

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Authors' contribution
Research conception and design: Santos KNO, Santos LO, Moura RF**; Data collection:** Santos KNO, Santos LO, Gomes VA; **Data analysis and interpretation:** Santos KNO, Santos LO, Gomes VA, Barbosa RM; **Manuscript writing:** Santos KNO, Santos LO, Moura RF, Gomes VA; **Critical review of the manuscript for important intellectual content:** Barbosa RM, Gomes VA, Fontes RF

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