Artículo Original de Investigación

The Benefits of Physical Activity on Patients with Heart Failure: Meta-analysis.

Los beneficios de la actividad física en pacientes con insuficiencia cardíaca: meta-análisis.

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ABSTRACT

Objective: this study aimed to compare the impact of physical activity (PA) on improving exercise capacity (EC), functional capacity (FC), and physical function (PF), as well as its influence on left ventricle ejection fraction (LVEF) and age (middle-aged, or elderly) in patients with heart failure (HF).

Methods: this study used five databases namely Embase, MEDLINE, CINAHL, PEDro, Cochrane, and additional resources, following PRISMA guidelines. Furthermore, the analysis was carried out using RevMan 5.4 software.

Results: a total of 27 articles with randomized control trial (RCT) design were included in this review. PA had a significant effect on increasing EC (SDM: 0.32, 95% CI: -0.01 to 0.65, I2: 82%), FC (SDM: 0.65, 95% CI: 0.29 to 1.01, I2: 81%), and PF (SDM: 0.36, 95% CI: 0.06 to 0.65, I2: 60%). Additionally, there was a significant effect on LVEF <45% (SDM: 0.46, 95% CI: 0.23 to 0.69, I2: 80%), LVEF >45% (SDM: 0.54, 95% CI: 0.32 to 0.76, I2: 45%), elderly patients (SDM: 0.52, 95% CI: 0.29 to 0.74, I2: 79%), and middle-aged patients (SDM: 0.36, 95% CI: 0.05 to 0.67, I2: 66%) with HF using the Six Minutes Walking Test measurement (6MWT).

Conclusion: PA is highly beneficial for HF patients, serving as cardiac rehabilitation in improving EC, FC, and PF, including patients with LVEF <45% or LVEF >45%, as well as for middle-aged and elderly patients..

Los beneficios de la actividad física en pacientes con insuficiencia cardíaca: meta-análisis.

RESUMEN

Objetivo: este estudio tuvo como objetivo comparar el impacto de la actividad física (AF) en la mejora de la capacidad de ejercicio (CE), la capacidad funcional (CF) y la función física (FF), así como su influencia en la fracción de eyección del ventrículo izquierdo (FEVI) y edad (mediana edad o anciano) en pacientes con insuficiencia cardíaca (IC).

Métodos: este estudio utilizó cinco bases de datos, a saber, Embase, MEDLINE, CINAHL, PEDro, Cochrane y recursos adicionales, siguiendo las pautas PRISMA. Además, el análisis se realizó mediante el software RevMan 5.4.

Resultados: en esta revisión se incluyeron un total de 27 artículos con diseño de ensayo controlado aleatorio (ECA). La AF tuvo un efecto significativo en el aumento de la CE (SDM: 0,32, IC del 95 %: -0,01 a 0,65, I^2: 82 %), CF (SDM: 0,65, IC del 95 %: 0,29 a 1,01, I^2: 81 %) y FF (SDM: 0,36, IC del 95%: 0,06 a 0,65, I^2: 60%). Además, hubo un efecto significativo sobre la FEVI <45% (SDM: 0,46, IC del 95%: 0,23 a 0,69, I^2: 80%), FEVI >45% (SDM: 0,54, IC del 95%: 0,32 a 0,76, I^2: 45%), pacientes de edad avanzada (SDM: 0,52, IC del 95%: 0,29 a 0,74, I^2: 79%) y pacientes de mediana edad (SDM: 0,36, IC del 95%: 0,05 a 0,67, I^2: 66%) con IC utilizando la medición de la prueba de caminata de seis minutos (6MWT).

Conclusión: la AF es altamente beneficiosa para los pacientes con IC, sirviendo como rehabilitación cardíaca para mejorar la CE, la CF y la FF, incluidos los pacientes con FEVI <45% o FEVI >45%, así como para pacientes de mediana edad y ancianos.

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INTRODUCTION

Heart failure (HF) is a public health issue, which continuously increases annually, primarily associated with the aging population[1]. The clinical manifestations of HF such as dyspnea, fatigue, and shortness of breath (SOB), can affect daily life activity due to inadequate oxygen supply to support the body metabolism stemming from declining heart function[2]. These symptoms contribute to the reduction in exercise capacity (EC), functional capacity (FC), and physical functional (PF) among people with HF[3,4,5].

Several studies have shown that the need to develop effective and safe rehabilitation strategies to preserve EC, FC, and PF in HF patients. Wherein, EC refers to the ability of the body to improve oxygen uptake above their oxygen uptake at rest, and FC is the ability to perform tasks and activities that people find essential in their lives, whereas PF is the ability to perform basic activities of daily living; these factors are indicators of re-hospitalization, mortality, and morbidity rates[6,7,8]. Age and LVEF are believed to affect EC, FC, and PF, as the function of certain organs declines with age, and a decrease in LVEF can lead to a reduction in the volume of blood pumped by heart to the body[3,9,10,11]. Therefore, safe and appropriate rehabilitation is needed to maintain good EC, FC, and PF, considering age and LVEF in HF patients.

Physical activity (PA) is one of the recommended rehabilitative methods for HF patients, as it helps reduce severity progression[12,13]. Previous studies define PA as any voluntary bodily movement produced by skeletal muscles that need energy expenditure[12,13]. Several evidence-based studies have supported that routine PA can help maintain health status[14]. Consequently, there is a need to investigate the effects of PA on EC, FC, and PF, as well as its influence on age (middle-aged or elderly) and LVEF, using the Six Minutes Walking Test (6MWT) as a measurement tool in HF patients. A previous study has recommended 6MWT as a safe and easily conducted measurement to assess the health status[3,5,8,9,10]. Evidence-based studies are required to support the benefits of PA on these parameters, considering their importance in re-hospitalization, mortality, and morbidity rates, as well as the benefits of PA based on age (middle-age and elderly) and LVEF (> 45% and < 45%) in HF patients. An effective activity prescription should also include the type of PA intervention and exercise duration.

This study aimed to compare the effects of PA on EC, FC, and PF in HF patients as well as its impacts on LVEF (EF >45% and EF <45%) and age (middle-aged, and elderly). Furthermore, the investigation was carried out to analyze the components of PA (element and duration of PA) in the intervention group of HF patients.

METHOD

Data Sources and Systematic Literature Review

This study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic review[15]. The PICO format was used as follows: Population (P): HF patients, Intervention (I): PA, Comparison (C): Usual care, Outcome (O): primary (EC, FC, and PF), secondary (elderly and middle-aged). A total of five databases, including Embase, MEDLINE, CINAHL, Central Cochrane Library, PEDro, and additional sources, were used to search for articles. Keywords and Emtree/MESH terms used in the search included HF, cardiac failure, cardiac incompetence, chronic HF, heart backward failure, myocardial failure (related to Population); physical activity, "activity and physical" (related to Intervention); exercise capacity, exercise performance (for EC); capacity functional, functional capacity, functional status (for FC); physical performance, physical functional performance, physical functional (for PF) (related to Outcome). This review included several criteria, such as Randomized Control Trial (RCT) study design, articles in English, studies from 2004 to 2023, and the use of a control group. However, review articles, animal studies, and reports that did not use 6MWT measurement were excluded from this systematic review and meta-analysis.

The data searches were conducted according to the predefined PICO, followed by removing duplicate articles from the selected databases. Article screening was based on the title and abstract to evaluate whether the study used PA to improve EC, FC, and PF (primary outcome), age, and LVEF (secondary outcome) in HF patients. After the screening process, articles that did not fulfill the inclusion and exclusion criteria were excluded. The article search process ended when two reviewers investigated the reference lists of full-text articles and did not identify additional studies that fulfilled the inclusion criteria *(Figure 1)*.

Data Extraction and Quality Assessment.

A total of two reviewers independently conducted data extraction, including study design, respondent characte-

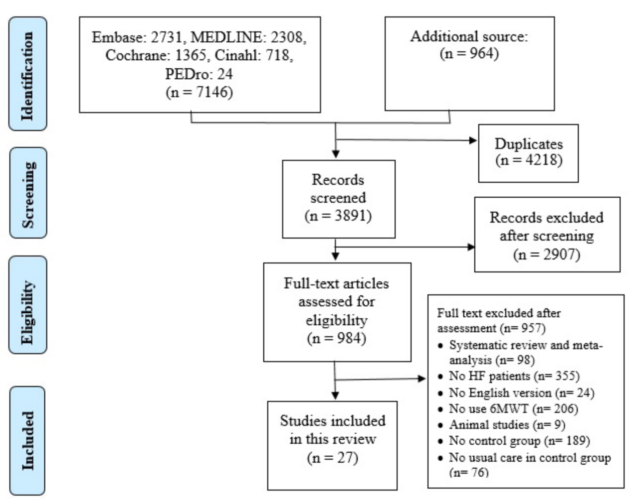

FIGURA 1
Flow diagram of the studies selection process

TABLA 1.
Mortalidad período Intrahospitalario.

No	Authors	Study design	Sample I/C	Characteristics Respondent			Element of PA	Duration of PA	Control	Measurement	Outcome	JBI score
				Age (years)	LVEF (%)	NYHA						
1	Antonicelli et al., 2016[29]	RCT	170/76	76	47.9	II, III	Cardiac rehabilitation exercise	-	Usual care	6MWT	Functional capacity	8/13
2	Brubaker et al., 2020[1]	RCT	48/51	70	60	II, III	5': warm-up, 10': cooldown, 40': cycling ergometry	3 times/week for 16 weeks	Usual care	6MWT	Physical functional	10/13
3	Borland et al., 2014[9]	RCT	22/20	70	26	II, III	15': warm-up, cooldown, and ergometer cycling 45': main exercise (focus on peripheral muscle training)	3 times/week for 12 weeks	Usual care	6MWT	Physical functional	10/13
4	Chien et al., 2011[10]	RCT	22/22	58	40	I-III	30': Walking, and Strength exercise	3 times/week for 8 weeks	Usual care	6MWT	Functional capacity	13/13
5	Corvera-Tindel et al., 2004[11]	RCT	42/37	63	29	II-IV	10' to 60': walking exercise	5 times/week for 6 weeks	Usual care	6MWT	Functional capacity	11/13
6	Doletsky et al., 2017[2]	RCT	17/18	62	29	II, III	3': warm-up 2': cooldown 35': cycling ergometry	5 times/week for 3 weeks	Usual care	6MWT	Exercise capacity	7/13
7	Dracup et al., 2007[12]	RCT	86/87	54	26	II-IV	10' to 45': aerobic, walking, and resistance training	4 times/week for 24 weeks	Usual care	6MWT	Exercise capacity	9/13
8	Du et al., 2017[3]	RCT	67/65	60	32.6	II, III	30': Walking	24 weeks	Usual care	6MWT	Functional capacity	13/13
9	Gary et al., 2004[16]	RCT	16/16	67	54	II, III	5': warm-up 5': cooldown 30': walking	3 times/week for 12 weeks	Usual care	6MWT	Functional capacity	9/13
10	Gary et al., 2010a[10]	RCT	16/14	65	54	II, III	30' to 40': Walking	3 times/week for 12 weeks	Usual care	6MWT	Physical functional	13/13
11	Gary et al., 2010b[10]	RCT	15/14	65	54	II, III	30' to 40': Walking + cognitive behavioral therapy	3 times/week for 12 weeks	Usual care	6MWT	Physical functional	13/13
12	Gary et al., 2018a[13]	RCT	33/35	55		I-IV	5': warm-up 45' to 60': resistance training	3 times/week for 12 weeks	Usual care	6MWT	Functional capacity	12/13
13	Gary et al., 2018b[13]	RCT	37/35	55		I-IV	5': warm-up 45' to 60': resistance training + education	3 times/week for 12 weeks	Usual care	6MWT	Functional Capacity	12/13
14	Gary et al., 2022a[15]	RCT	14/14	60	34	II, III	45': walking	3 times/week for 12 weeks	Usual care	6MWT	Functional capacity	13/13
15	Gary et al., 2022b[15]	RCT	11/14	63	34	II, III	45': walking + cognitive training	3 times/week for 12 weeks	Usual care	6MWT	Functional capacity	13/13
16	Jonsdottir et al., 2006[17]	RCT	21/22	68	41.5		10': warm-up 15': bicycle 20': resistance training 5': cooldown	3 times/week for 20 weeks	Usual care	6MWT	Exercise capacity	11/13
17	Kato et al., 2021[30]	RCT	13/11	72.9	39.8	II, III	5' to 30': Cardiac rehabilitation exercise	6 to 10 days	Usual care	6MWT	Physical functional	13/13
18	Kawauchi et al., 2017a[18]	RCT	13/9	54	30		30': Low-intensity inspiratory, and Resistance training	7 times/week for 6 weeks	Usual care	6MWT	Exercise capacity	13/13
19	Kawauchi et al., 2017b[18]	RCT	13/9	56	28		30': Moderate-intensity inspiratory, and Resistance training	7 times/week for 6 weeks	Usual care	6MWT	Exercise capacity	13/13
20	Kitzman et al., 2021[4]	RCT	175/174	73	≥ 45%	II-IV	60': walking, strength exercise	3 times/week for 12 weeks	Usual care	6MWT	Physical functional	11/13
21	Ma et al., 2022[19]	RCT	68/68	64		I-III	20': warm-up & cooldown 70': Baduanjin, Elastic band	3 times/week: Baduanjin, 2 times/week: elastic band for 24 weeks	Usual care	6MWT	Exercise capacity	13/13
22	Nilsson et al., 2008[20]	RCT	40/40	69	30	II, III	50': warm-up, cooldown, and main exercise (aerobic)	2 times/week for 24 weeks	Usual care	6MWT	Functional capacity	11/13
23	Palevo et al., 2009[21]	RCT	10/6	70	<40%	II, III	5' to 8': warm-up, and stretching. 60% of I RM baseline (weight-training machines)	3 times/week for 8 weeks	Usual care	6MWT	Physical functional	7/13
24	Prescott et al., 2009[22]	RCT	20/23	68	33.8	III, IV	20': warm-up 70': Walking, cycling, resistance training	48 weeks	Usual Care	6MWT	Exercise capacity	8/13
25	Redwine et al., 2019a[23]	RCT	25/23	66	49		60': Tai Chi	3 times/week for 16 weeks	Usual Care	6MWT	Physical functional	13/13
26	Redwine et al., 2019b[23]	RCT	22/23	66	49		60': Resistance Training	3 times/week for 16 weeks	Usual care	6MWT	Physical functional	13/13
27	Sadek et al., 2022a[24]	RCT	10/10	52.5	<45%	II, III	20': Inspiratory muscle training	3 times/week for 12 weeks	Usual care	6MWT	Functional capacity	11/13
28	Sadek et al., 2022b[24]	RCT	10/10	51.6	<45%	II, III	30': walking (treadmill)	3 times/week for 12 weeks	Usual care	6MWT	Functional capacity	11/13
29	Sadek et al., 2022c[24]	RCT	10/10	51.8	< 45%	II, III	20': Inspiratory muscle training 30': walking (treadmill)	3 times/week for 12 weeks	Usual care	6MWT	Functional capacity	11/13
30	Witham et al., 2010[25]	RCT	53/52	80		II-III	Walking + Vitamin D	16 weeks	Usual care	6MWT	Exercise capacity	13/13
31	Witham et al., 2012[9]	RCT	53/54	80.4		II, III	60': warm-up, cooldown, and main PA (walking, and resistance training)	16 weeks	Usual care	6MWT	Exercise capacity	13/13
32	Yeh et al., 2004[28]	RCT	15/15	66	24	I-IV	60': Tai Chi	3 times/week for 12 weeks	Usual care	6MWT	Exercise capacity	10/13
33	Yeh et al., 2011[27]	RCT	50/50	68.1	28.3	I-III	60': Tai Chi	3 times/week for 12 weeks	Usual care	6MWT	Exercise capacity	13/13
34	Yeh et al., 2016[26]	RCT	50/50	69	28	I-III	60': Tai Chi	3 times/week for 12 weeks	Usual care	6MWT	Exercise capacity	10/13

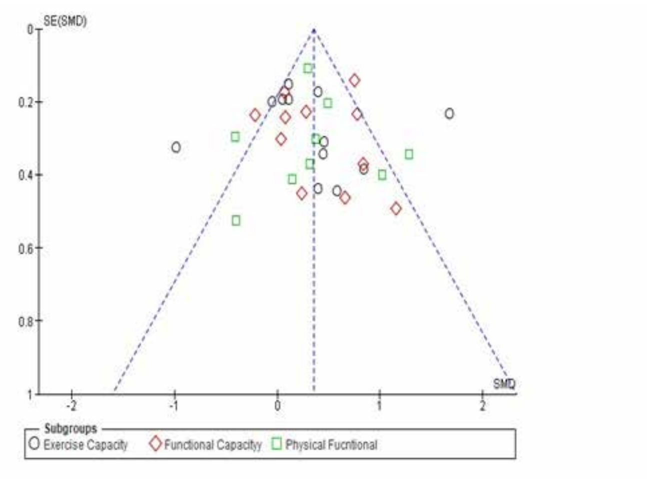

FIGURA 2
Effect of PA on EC, FC, and PF patients with HF

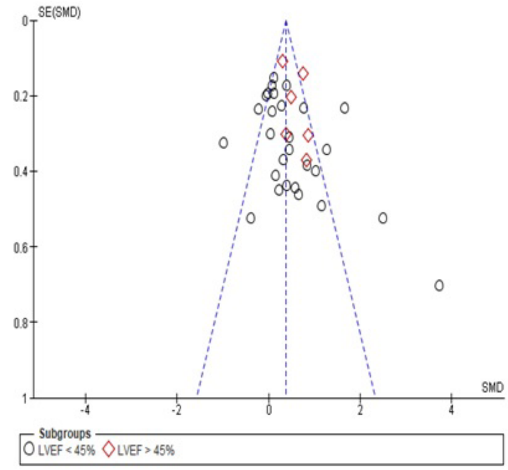

FIGURA 3
Effect of PA on LVEF patients with HF

ristics (age, LVEF, New York Heart Association (NYHA) Classification), PA elements, PA duration, measurement, and outcomes, as illustrated in *Table 1*. Additionally, the reviewers independently assessed the methodological quality of the studies using the Joanna Briggs Institution (JBI) checklist *(Table 1)*.

Data Synthesis and Statistical Analysis

In this meta-analysis, RevMan 5.4 software was used to perform data synthesis and the outcome measures were described as changes from baseline to follow-up. Data synthesis was presented using standardized mean difference (SMD). A significant value was set at $p < 0.05$ with a confidence interval (CI) of 95% and heterogeneity among studies was quantified using the I2 test. Subsequently, changes in EC, FC, PF, age, and LVEF were presented with effect size (ES), and a random-effect model was used in this review.

RESULTS

Description of Selected Studies

A total of 8,110 articles were obtained from five databases, namely Embase (2,731), Medline (2,308), Cochrane (1,365), Cinahl (718), and PEDro (24), and additional sources (n: 964). Before screening, 4,218 articles were removed based on duplicate titles, and 2,097 articles were excluded due to title and abstract screening. This was followed by full-text screening, where a total of 984 eligible articles were identified. Furthermore, 957 articles were excluded after full-text screening for seven reasons, which included systematic review and meta-analysis (n= 98), no HF patients (n= 355), absence of English version (n= 24), no use of 6MWT measurement (n= 206), animal studies (n= 9), lack of control group (n= 189), and no usual care in the control group (n= 76). Finally, 27 articles fulfilling the criteria were included in this review, as shown in *Figure 1* [3,4,5,9,10,12,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36].

Characteristic of the Studies

This meta-analysis included a total of 27 articles with RCT designs from 2004 to 2021, consisting of both male and female HF patients. The intervention and control groups consisting of 1,287 and 1,177 respondents, respectively, were included in this meta-analysis. The mean age ranged from 51.6 to 80.4 years old, and the respondents had NYHA Classification I to IV, with mean LVEF between 26% and 60%, as presented in *Table 1*.

Effect of PA on EC, FC, and PF in HF patients

As shown in *Figure 2*, the sub-group analysis of EC consisted of 12 articles, with 459 and 457 respondents in the intervention and control groups, respectively. This indicated that PA had a significant effect on increasing EC in the intervention group using 6MWT measurement (SDM: 0.32, 95% CI: -0.01 to 0.65, I^2: 82%) compared to the control group[9,20,24,26,33,34,35,36]. Furthermore, in the sub-group analysis of FC, 13 articles were included in the analysis, consisting of 482 and 384 respondents in the intervention and control groups. This suggested that PA increased FC in the intervention group using 6MWT measurement (SDM: 0.65, 95% CI: 0.29 to 1.01, I^2: 81%) compared to the control group[5,16,18,19,21,23,24,28,29,30,31,32]. The sub-group analysis of PF showed that out of 8 articles consisting of 168 and 164 in both respective groups, PA had a significant effect on increasing PF in the intervention group using 6MWT measurement (SDM: 0.36, 95% CI: 0.06 to 0.65, I^2: 78%) compared to the control group[3,10,12,17,22,23,29,31]

Effect of PA based on LVEF in HF patients

Figure 3 showed that 33 articles included in the analysis were divided into 28 and 5 articles in the sub-group LVEF < 45% (n= 1645) and LVEF > 45% (n= 470), respectively. The results indicated that PA had a significant effect on HF patients with LVEF <45% in the intervention group (SDM: 0.46, 95% CI: 0.23 to 0.69, I^2: 80%) [4,5,9,12,19,20,21,22,23,24,25,26,27,28,30,32,33,34,36]. Similarly, PA affected HF patients with LVEF >45%

in the intervention group (SDM: 0.54, 95% CI: 0.32 to 0.76, I^2: 45%) compared to the control group[3,10,16,24,31].

Effect of PA based on age in HF patients

A total of 34 articles included in the analysis were divided into 23 articles in the elderly sub-group (n= 1843) and 11 in the middle-aged sub-group (n= 621) of HF patients. The results indicated that PA had a significantly higher effect on the elderly in the intervention group (SDM: 0.52, 95% CI: 0.29 to 0.74, I^2: 79%) [3,4,9,10,12,16,17,19,21,22,24,25,27,28,29,30,31,33,36]. PA also affected middle-aged patients in the intervention group (SDM: 0.36, 95% CI: 0.05 to 0.67, I^2: 66%) compared to the control group, as shown in *Figure 4* [5,18,20,21,23,26,32].

Element of PA

Table 1 provides a comprehensive overview of the various elements of PA. Among the studies observed, 15 used walking sessions for 10 to 60 minutes as their PA intervention[5,9,10,18,19,20,22,23,24,30,32,33]. Five studies used cycling for 15 to 40 minutes[3,4,17,25,30]. Thirteen applied resistance training (RT) for 30 to 60 minutes[10,18,20,21,25,26,29,30,31]. Two used aerobic exercises for 10 to 50 minutes[20,28]. Furthermore, 2 studies conducted cardiac rehabilitation for 5 to 30 minutes[12,16]. Two used low/moderate intensity inspiratory exercises for PA (20 to 30 minutes) [26]. And another 5 studies used Baduanjin/Tai Chi for 60 to 70 minutes[27,31,34,35,36].

Some components of the element of PA, such as warm-up and cooldown, were explained in this study, as illustrated in *Table 1*. Specifically, 11 studies included a warm-up of 3 to 10 minutes before the main exercise, followed by a cooldown of 2 to 10 minutes after the exercise[3,4,17,21,24,25,27,28,29,30]. Regarding the duration, 1 study reported PA being conducted 2 times/week[28]. Twenty one studies implemented PA 3 times/week[3,10,17,18,21,22,23,24 25,27,29,31,32,34,35,36]. Furthermore, 3 studies conducted PA 4 and 5 times/week[4,19,20]. Three studies carried out PA 7 times/week[12,26]. A total of 4 studies did not specify the frequency of PA per week. For the total duration, 15 studies implemented PA intervention for 12 weeks[10,12,17,21,22,23,24,32]. Five studies for 16 weeks[3,9,31,33]. Three studies for 6 weeks19 26. Two studies each reported a duration of 8 and 24 weeks[18,20]. Additionally, three studies reported PA duration of 3, 20, and 48 weeks [4,25,30]. Only 1 study did not specify16.

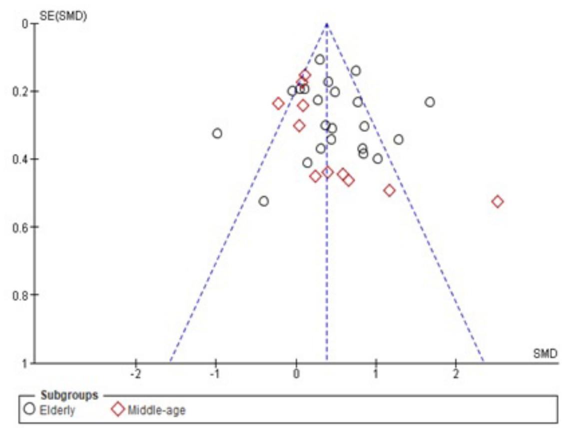

FIGURA 4
Effect of PA on age patients with HF

DISCUSSION

This study aimed to compare the effect of PA between the intervention and control groups, consisting of 2464 HF patients. The results showed that PA improved EC in HF patients with a random effect SMD of 32% *(Figure 2)*. Previous investigations stated that routine PA enhanced circulation and optimized oxygen regulation in the body, positively influencing EC in HF patients[3,4,11,14,16]. Additionally, the benefits of PA was observed in increasing FC with a random effect SMD of 65% *(Figure 2)*, as increased FC was associated with high oxygen consumption (VO2 max) and cardio-respiratory function[23,32]. Previous studies have found a consistent relationship between improved FC and better health status, particularly in engaging in routine PA[23]. Similarly, the study indicated these benefits in increasing PF, with a random effect SMD of 36% *(Figure 2)*, enhancing LVEF through improved cardiac output[12]. Some investigations added that routine PA provided benefits in improving physical fitness and cardiac function, significantly contributing to enhanced PF in HF patients[17,31].

The results showed the benefits of PA for HF patients, regarding the LVEF > 45% or LVEF < 45%. Specifically, the random effect of PA on LVEF > 45% was 54%, while for LVEF < 45%, it was 46%, which was 8% higher *(Figure 3)*. Previous studies have supported the idea that higher LVEF yielded better cardiac output but lower LVEF significantly affected the limitations in HF patients [11,37]. Considering the benefits of LVEF, PA has a significant impact on increasing the plasma levels of tumor necrosis factor-alpha and interleukin 6 (IL-6), as well as improving plasma IL-10 levels. These effects have a positive impact on improving the inflammatory profile, and cardiac function and reducing the progressive process of cardiac remodeling in HF patients[38]. Several investigations have acknowledged that PA is highly beneficial for improving the health status of HF patients in LVEF > 45% or < 45%[8,11,38]. It was discovered that PA has a positive impact on both middle-aged and elderly HF patients. Engaging routine practice also decreases plasma brain natriuretic peptide (BNP) levels, positively affecting the health status of patients, and thereby reducing morbidity and mortality rates[39]. The review also noted a 38% difference in SMD between the elderly and middle-aged patients *(Figure 4)*. Although age affected PA[40], other factors such as NYHA Class, LVEF, the use of HF medications, and comorbidities played a more significant role. Various reports have recognized that an increase in NYHA Class and a decrease in LVEF can affect PA limitation[41]. The presence of more comorbidities and side effects from HF medications also caused a significant reduction among HF patients[42].

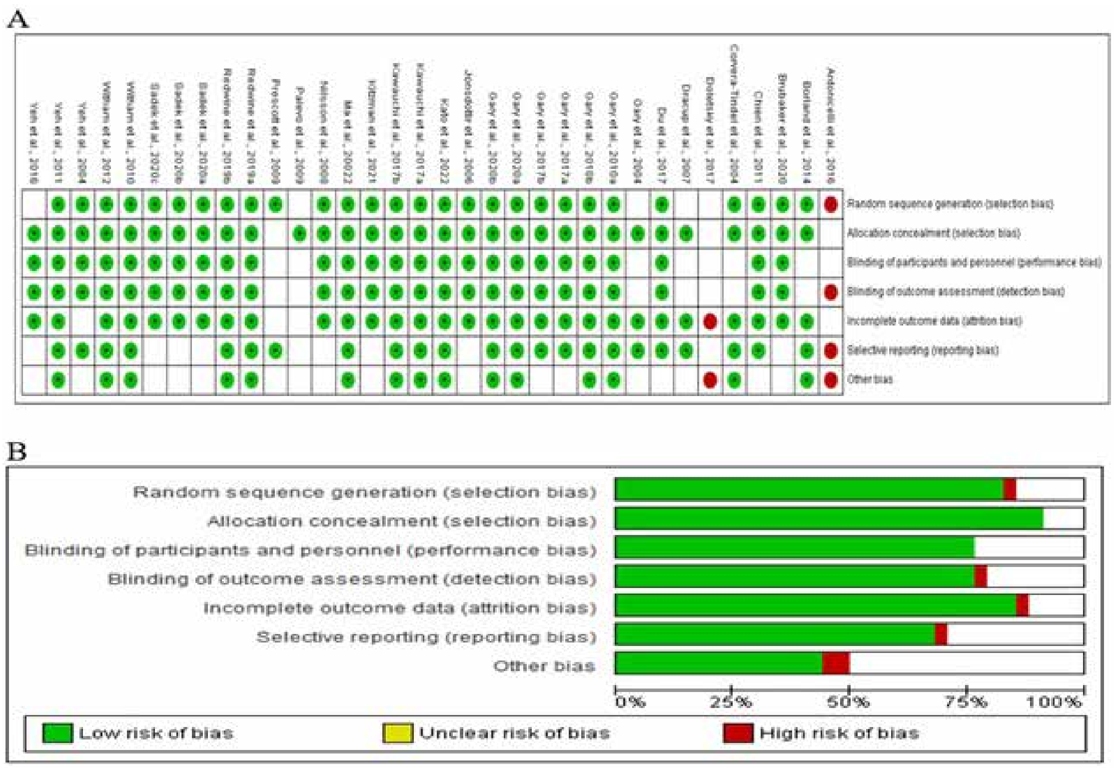

FIGURA 4
Effect of PA on age patients with HF

Various PA elements need to be considered, including walking, cycling, and aerobic exercises that are easily performed by HF patients and beneficial for their health[3,5,20]. Tai Chi and Baduanjin are traditional PA practices that have been trusted to be beneficial for overall health, providing relaxation for the mind and enhancing physical fitness[27,34]. Resistance and inspiratory muscle training have been proven effective in increasing oxygen consumption (VO2) for muscle strength and addressing sarcopenia issues[43,44]. Moreover, according to Klompstra et al. (2022) found that routine PA including occupational, transportation, housework, and leisure time can improve the health-related quality of life (HRQOL) of patients with HF[45]. Engaging in routine PA for more than 30 minutes activates interleukin 6 (IL-6), which serves as a pleiotropic cytokine in immunoregulation, hematopoiesis, and anti-inflammation, and is highly beneficial for health[46]. Furthermore, incorporating warm-up and cooling-down routines into PA can relax the muscles used during exercise and prevent injuries[47].

RELEVANCE IN CLINICAL PRACTICE

Regular PA, alone or as part of a planned cardiac rehabilitation programme in a mixture with guideline-directed medical therapy, benefits avoiding disease progression, reduced rehospitalizations or mortality rate, and increases HRQOL for patients with HF[2,45]. Furthermore, PA is highly beneficial for HF patients due to its capacity to improve EC, FC, and PF, which are crucial indicators for enhancing health status. Furthermore, with improvements in these three components, the morbidity and mortality rates can decrease. PA is also recommended for HF patients with LVEF > 45% or < 45%, as well as for middle-aged and elderly patients.

LIMITATION

The limitations of this study included the use of only English-language studies. The review also showed minimal publication bias, with *figure 5* illustrating that some articles were incomplete in selective reporting, while others lacked comprehensive bias-related components. To minimize the risk of bias, three independent reviewers, comprehensive searches across 5 databases, and special methods were used in the analysis. The review indicated high heterogeneity, as presented in the forest plot, and funnel plot *(Figures 2 to 5)*. Moreover, it was assumed that unexamined factors in this review, such as NYHA Class, different elements of PA (levels of PA, type of PA, and duration of PA), and varying sample sizes in different articles, contributed to the increased heterogeneity.

CONCLUSION

In conclusion, this study showed that PA was highly beneficial for HF patients. RCT articles examined indicated differences in the elements of routine PA practices, without hindering the improvement of EC, FC, and PF. These practices were also found to be beneficial for HF patients with both increased and decreased LVEF, including middle-aged and the elderly. This indicated that PA offered a promising potential as a form of cardiac rehabilitation to enhance the health status. Based on the results, this review can guide future studies by providing data and information on the benefits of PA for HF patients.

BIBLIOGRAPHY

1. Shahim B, Kapelios CJ, Savarese G, et al. Global Public Health Burden of Heart Failure: An Updated Review. Card Fail Rev **2023**; 9: e11.
2. Ponikowski P, Voors AA, Anker SD, et al. 2016 ESC Guidelines for the Diagnosis and Treatment of Acute and Chronic Heart Failure. Rev Esp Cardiol (Engl Ed) **2016**; 69: 1167.
3. Brubaker PH, Avis T, Rejeski WJ, et al. Exercise Training Effects on the Relationship of Physical Function and Health-Related Quality of Life among Older Heart Failure Patients With Preserved Ejection Fraction. J Cardiopulm Rehabil Prev **2020**; 40: 427 - 433.
4. Doletsky A, Andreev D, Giverts I, et al. Interval training early after heart failure decompensation is safe and improves exercise tolerance and quality of life in selected patients. Eur J Prev Cardiol **2018**; 25: 9 - 18.
5. Du H, Newton PJ, Budhathoki C, et al. The Home-Heart-Walk study, a self-administered walk test on perceived physical functioning, and self-care behavior in people with stable chronic heart failure: A randomized controlled trial. Eur J Cardiovas Nurs **2018**; 17: 235 - 245.
6. Fuentes-Abolafio IJ, Stubbs B, Perez-Belmonte LM, et al Physical functional performance and prognosis in patients with heart failure: a systematic review and meta-analysis. BMC Cardiovascular Disorders **2020**; 20: 512.
7. Georgiopoulou VV, Kalogeropoulos AP, Chowdhury R, et al. Exercise Capacity, Heart Failure Risk, and Mortality in Older Adults: The Health ABC Study. Am J Prev Med **2017**; 52: 144 - 153.
8. German CA, Brubaker PH, Nelson MB, et al. Relationships between objectively measured physical activity, exercise capacity, and quality of life in older patients with obese heart failure and preserved ejection fraction. J Cardiac Fail **2021**; 27: 635 - 641.
9. Witham MD, Fulton RL, Greig CA, et al. Efficacy and cost of an exercise program for functionally impaired older patients with heart failure: a randomized controlled trial. Circulation: Heart Failure **2012**; 5: 209 - 216.
10. Kitzman DW, Whellan DJ, Duncan P, et al. M. Physical Rehabilitation for Older Patients Hospitalized for Heart Failure. N Engl J Med **2021**; 385: 203 - 216.
11. Sljivic A, Pavlovic Kleut M, Bukumiric Z, et al. Association between right ventricle two- and three-dimensional echocardiography and exercise capacity in patients with reduced left ventricular ejection fraction. PloS One **2018**; 13: e0199439.
12. Kato M, Ono S, Seko H, et al. Trajectories of frailty, physical function, and physical activity levels in elderly patients with heart failure: impacts of interruption and resumption of outpatient cardiac rehabilitation due to COVID-19. Int J Rehabi Res **2021**; 44: 200 - 204.
13. Chien HC, Chen HM, Garet M, et al. Predictors of physical activity in patients with heart failure: a questionnaire study. J Cardiovas Nurs **2014**; 29: 324 - 331.
14. Maurits RD, Fanhi AB, Chen HM. Physical Activity Improve Health-Related Quality of Life, 6MWT, and VO2 peak before and during COVID-19 in Patients with Heart Failure: A Meta-analysis. SEMERGEN **2023**; 49: 102039.
15. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Rev Esp Cardiol (Engl Ed) **2021**; 74: 790 - 799.
16. Antonicelli R, Spazzafumo L, Scalvini S, et al. Exercise: a "new drug" for elderly patients with chronic heart failure. Aging **2016**; 8: 860 - 872.
17. Borland M, Rosenkvist A, Cider A. A group-based exercise program did not improve physical activity in patients with chronic heart failure and comorbidity: a randomized controlled trial. J Rehabil Med **2014**; 46: 461 - 467.
18. Chien CL, Lee CM, Wu YW, et al. Home-based exercise improves the quality of life and physical function but not the psychological status of people with chronic heart failure: a randomised trial. J Physiot **2011**; 57: 157 - 163.
19. Corvera-Tindel, T, Doering LV, Woo MA, et al. Effects of a home walking exercise program on functional status and symptoms in heart failure. Am Heart J **2004**; 147: 339 - 346.
20. Dracup K, Evangelista LS, Hamilton MA, et al. Effects of a home-based exercise program on clinical outcomes in heart failure. Am Heart J **2007**; 154: 877 - 883.
21. Gary R, Dunbar SB, Higgins M, et al. An Intervention to Improve Physical Function and Caregiver Perceptions in Family Caregivers of Persons with Heart Failure. J Appl Gerontol **2018**; 39: 181 - 191.
22. Gary RA, Dunbar SB, Higgins MK, et al. Combined exercise and cognitive behavioral therapy improves outcomes in patients with heart failure. J Psychosom Res **2010**; 69: 119 - 131.
23. Gary RA, Paul S, Corwin E, et al. Exercise and Cognitive Training Intervention Improves Self-Care, Quality of Life and Functional Capacity in Persons With Heart Failure. J Appl Gerontol **2022**; 41: 486 – 495.
24. Gary RA, Sueta CA, Dougherty M, et al. Home-based exercise improves functional performance and quality of life in women with diastolic heart failure. Heart and Lung **2004**; 33: 210 - 218.
25. Jonsdottir S, Andersen KK, Sigurosson AF, et al. The effect of physical training in chronic heart failure. Eur J Heart Fail **2006**; 8: 97 - 101.
26. Kawauchi TS, Umeda IIK, Braga LM, et al. Is there any benefit using low-intensity inspiratory and peripheral muscle training in heart failure? A randomized clinical trial. Clin Res Cardiol **2017**; 106: 676 - 685.
27. Ma C, Zhou W, Jia Y, et al. Effects of home-based Baduanjin combined with elastic band exercise in patients with chronic heart failure. Eur J Cardiovasc Nurs **2022**; 21: 587 - 596.
28. Nilsson BB, Westheim A, Risberg MA. Effects of group-based high-intensity aerobic interval training in patients with chronic heart failure. Am J Cardio **2008**; 102: 1361 - 1365.
29. Palevo G, Keteyian SJ, Kang M, Caputo JL. Resistance exercise training improves heart function and physical fitness in stable patients with heart failure. J Cardiopulm Rehabil Prevention **2009**; 29: 294 - 298.
30. Prescott E, Hjardem-Hansen R, et al. Effects of a 14-month low-cost maintenance training program in patients with chronic systolic heart failure: a randomized study. Eur J Cardiovasc Prev Rehabil **2009**; 16: 430 - 437.
31. Redwine LS, Wilson K, Pung MA, et al. A Randomized Study Examining the Effects of Mild-to-Moderate Group Exercises on Cardiovascular, Physical, and Psychological Well-being in Patients with Heart Failure. J Cardiopul Rehabil Prev 2**019**; 39: 403 - 408.
32. Sadek Z, Salami A, Youness M, et al. A randomized controlled trial of high-intensity interval training and inspiratory muscle training for chronic heart failure patients with inspiratory muscle weakness. Chronic Illn 2022; 18: 140 - 154.
33. Witham MD, Crighton LJ, Gillespie ND, et al. The effects of vitamin D supplementation on physical function and quality of life in older patients with heart failure: a randomized controlled trial. Circulation: Heart Failure **2010**; 3: 195 - 201.
34. Yeh GY, Chan CW, Wayne PM, et al. The Impact of Tai Chi Exercise on Self-Efficacy, Social Support, and Empowerment in Heart Failure: Insights from a Qualitative Sub-Study from a Randomized Controlled Trial. PloS One **2016**; 11: e0154678.
35. Yeh GY, McCarthy EP, Wayne PM, et al. Tai chi exercise in patients with chronic heart failure: a randomized clinical trial. Arch Intern Med **2011**; 171: 750 - 757.
36. Yeh GY, Wood MJ, Lorell BH, et al. Effects of tai chi mind-body movement therapy on functional status and exercise capacity in patients with chronic heart failure: a randomized controlled trial. Am J Med **2004**; 117: 541 - 548.
37. Horodinschi RN, Diaconu CC. Heart Failure and Atrial Fibrillation: Diastolic Function Differences Depending on Left Ventricle Ejection Fraction. Diagnostics (Basel) **2022**; 12: 839.
38. Santoso A, Purwowiyoto SL, Purwowiyoto BS et al. Exercise Training Improved Longitudinal Intrinsic Left Ventricle Function in Heart Failure with Preserved Ejection Fraction. Int J Angiol **2019**; 28: 44 - 49.

39. Nishiguchi S, Nozaki Y, Yamaji M, et al. Plasma brain natriuretic peptide level in older outpatients with heart failure is associated with physical frailty, especially with the slowness domain. J Geriatr Cardiol **2016**; 13: 608 - 614.
40. Jordan C, Charman SJ, Batterham AM, et al. Habitual physical activity levels of adults with heart failure: systematic review and meta-analysis. Heart **2023**; 109: 1357 - 1362.
41. Santos-Lozano A, Sanz-Ayan P, Gonzalez-Saiz L, et al. Effects of an 8-month exercise intervention on physical capacity, NT-proBNP, physical activity levels and quality of life data in patients with pulmonary arterial hypertension by NYHA class. Data Brief **2017**; 12: 37 - 41.
42. McGuinty C, Leong D, Weiss A, et al. Heart Failure: A Palliative Medicine Review of Disease, Therapies, and Medications With a Focus on Symptoms, Function, and Quality of Life. J Pain Sympt Manag **2020**; 59: 1127 - 1146.
43. Gomes-Neto M, Duraes AR, Conceicao LSR, et al. Effect of combined aerobic and resistance training on peak oxygen consumption, muscle strength and health-related quality of life in patients with heart failure with reduced left ventricular ejection fraction: a systematic review and meta-analysis. Int J Cardiol **2019**; 293: 165 - 175.
44. Ruku DM, Tran Thi TH, Chen HM. Effect of center-based or home-based resistance training on muscle strength and VO2 peak in patients with HFrEF: A systematic review and meta-analysis. Enfermeria Clinica (English Edition) **2021**; S1130-8621: 00040.
45. Klompstra L, Deka P, Almenar L, et al. Physical activity enjoyment, exercise motivation, and physical activity in patients with heart failure: A mediation analysis. Clin Rehabil **2022**; 36: 1324 -1331.
46. Docherty S, Harley R, McAuley JJ, et al. The effect of exercise on cytokines: implications for musculoskeletal health: a narrative review. BMC Sports Sci Med Rehabil **2022**; 14: 5.
47. Hernandez-Martinez J, Ramirez-Campillo R, Vera-Assaoka T, et al. Warm-up stretching exercises and physical performance of youth soccer players. Front Physiol **2023**; 14: 1127669.