

Characteristics and effects of physical exercise programs for older cancer survivors: A scoping review

Características y efectos de los programas de ejercicio físico para personas mayores sobrevivientes de cáncer: Una revisión de alcance

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Abstract. There is a discrepancy about the characteristics and effects of exercise-based programs in older cancer survivors (OCS). Therefore, this scoping review aimed to identify the characteristics and effects of physical activity programs in OCS health. This scoping review followed the PRISMA guidelines and included randomized clinical trials and clinical trials from MEDLINE by PubMed, Scopus, Scielo, and PEDro, published between 2010 and 2020. Results suggest that physical programs were carried out in health centers (54.2%) and were based on physical exercise (74.4%). The length of the exercise interventions was between 3–6 months (87.5%) was performed 2–3 times per week (73.1%) with a duration between 20–60 minutes (78.2%) and was run by health professionals (94.4%). The health outcomes with the most positive effects were physical activity, depression, and quality of life. In conclusion, physical programs for OCS based on aerobic exercises are safe and could be a therapeutic strategy to improve different health markers in OCS.

Key words: Aging; Cancer Survivors; Exercise Therapy; Scoping review.

Resumen. En la literatura existe discrepancia sobre las características y los efectos de los programas basados en el ejercicio físico en sobrevivientes de cáncer (SC) de edad avanzada. Por lo tanto, esta revisión de alcance tuvo como objetivo identificar las características y los efectos de los programas de actividad física en la salud de personas SC de edad avanzada. Esta revisión de ensayos clínicos aleatorizados y ensayos clínicos, se realizó considerando las siguientes bases de datos: MEDLINE (de Pubmed), Scopus, Scielo y PEDro, entre los años 2010 y 2020. Los resultados indican que los programas de ejercicio se realizaron en centros de salud (54.2%), y se basaron en ejercicio físico principalmente (74.4%). La extensión de las intervenciones físicas fue entre 3–6 meses (87.5%), se realizaron 2–3 veces por semana (73.1%) con una duración entre 20–60 minutos, y fueron dirigidas por profesionales de salud (94.4%). El impacto sobre la salud con mayores efectos positivos fueron la actividad física, la depresión y la calidad de vida. En conclusión, los programas de ejercitación física para personas SC en edad avanzada, basados en ejercicios aeróbicos son seguros y podrían ser una estrategia terapéutica para mejorar diferentes variables de salud en este grupo de personas.

Palabras claves: Envejecimiento; Sobrevivientes de cáncer; Terapia física; Revisión de alcance.

Introduction

Cancer diagnosis has experienced considerable growth; however, advances in early detection and treatment have contributed to increased cancer survivors (Miller et al., 2019). Classical treatment includes surgery, radiotherapy, and systemic treatment (e.g., chemotherapy); however, these treatments lead to physical, cognitive, and functional deterioration (NCI, 2020). In this regard, non-pharmacological therapies have gained interest as an alternative approach to cancer

survivors. Thus, physical exercise has emerged as an effective strategy to improve quality of life and fitness in cancer survivors (e.g., breast cancer) (Weaver et al., 2012). Evidence suggests beneficial effects of physical exercise in cancer survivors (Falzon, Radel, Cantor, & d'Arripe-Longueville, 2014; García, 2021; Santagnello et al., 2020; Soriano-Maldonado et al., 2019; Schwartz, de Heer, & Bea, 2017); however, few studies focus in older cancer survivors (OCS) (people older than 60 years) (Pergolotti et al., 2019; Rangel, Tomás, & Fernandes, 2018). Therefore, it is necessary to analyze and synthesize the existing information on physical exercise benefits in OCS.

In this line, a cancer survivor is defined as anyone with a history of cancer, from the time of diagnosis through the rest of their life (Denlinger et al., 2014). It

is estimated that the population of cancer survivors is expected to increase by more than 22,1 million globally by 2030 (ACS, 2021). Unhealthy lifestyles have been associated with increasing the risk of the disease, such as a bad diet (30%); smoking, corresponds to 87% of lung cancer mortality and physical inactivity (Mourouti, Panagiotakos, Kotteas, & Syrigos, 2017). Bad diet and physical inactivity used to lead to obesity. In 2013 the World Cancer Research Fund (WCRF) estimated that excess body fat causes about 3.6% of all cancers in the world (Byers & Sedjo, 2015). Therefore, eating healthier, performing physical activity, stop smoking, and maintaining a healthy weight can reduce your risk of cancer (Mourouti et al., 2017).

Cancer diagnosis is a long process where a wide variety of physical and psychosocial problems may occur (CancerQuest, 2020). Moreover, medical treatments lead to problems that subsequently interfere with completing treatments as prescribed, functioning independently, and performing activities of daily living (Mustian, Sprod, Janelsins, Peppone, & Mohile, 2012). Physical pain, fatigue, being more dependent, anxiety, depression, and tension in personal relationships greatly impact the quality of life, which is associated with a worse prognosis (Lang-Rollin & Berberich, 2018). In this context, *Global Cancer Observatory* (GCO) in 2018 (UICC, 2018) released a new version of the GLOBOCAN database. In decreasing order, the five cancers with the highest global incidence are lung cancer and breast cancer (11.6% each), colorectal cancer (10.2%), prostate cancer (7.1%) and stomach cancer (5.7%) (UICC, 2018). On the other hand, the estimated incident in 2018 is 31,772 new cases of cancer in older adults, where the five most common cancers are: prostate cancer, colorectal cancer, stomach cancer, lung cancer, and breast cancer (IARC, 2020a).

Treatments used to increase survival and quality of life are nutrition and physical activity (IARC, 2018). A systematic review and meta-analysis of RCTs studies suggest that physical activity and physical exercise improve quality of life in cancer treatment (Bourke et al., 2016). Physical activity has been recognized as a therapeutic tool to reduce treatment's side effects, and promote weight control and improve immune system function (Mourouti et al., 2017; Schwartz et al., 2017). In addition, it is positively associated with cardiorespiratory fitness, muscle strength, and endurance, a fact that could be beneficial for OCS as it could help them recover their physical condition and health before treatment. WCRF, American *Institute for*

Cancer Research (AICR) and *American Cancer Society* (ACS), recommend that cancer survivors be moderately physically active, for at least 30 minutes each day, for five or more days a week; thus, that along with appropriate dietary choices they maintain a healthy weight (Schwedhelm, Boeing, Hoffmann, Aleksandrova, & Schwingshackl, 2016). In 2009, the *American College of Sports Medicine* (ACSM) developed guidelines for survivors, which recommend to perform at least 150 minutes of moderate aerobic activity or 75 minutes of vigorous aerobic activity per week and two days a week of moderate to high-intensity endurance exercise, flexibility exercises and balance exercises for major muscle groups (Pekmezi & Demark-Wahnefried, 2011). Thus, the evidence indicates that endurance training causes an improvement in cancer-related fatigue, cognitive function, quality of life, and muscle strength (Schwartz et al., 2017). In this line, the physical activity programs must be according to the possibilities that the patient must carry out specific training to the patient's individual needs and physical activity levels (Lang-Rollin & Berberich, 2018).

The benefits of exercise in cancer survival are clear. However, although previous systematic reviews have determined that exercise generates positive effects in people with a diagnosis of cancer (Stout, Baima, Swisher, Winters Stone, & Welsh, 2017) and cancer survivors (Kessels, Husson, & van der Feltz-Cornelis, 2018), up to day no reviews have investigated the effects and characteristics of physical exercise programs in OCS. Therefore, this study aimed to characterize physical exercise programs for OCS. This review will also allow us to know OCS and the types of cancers that benefit the most from physical exercise effects.

Methodology

Research characteristics

A scoping review was conducted in accordance with standards established by the PRISMA statement (Liberati et al., 2009). The manuscript was not registered in PROSPERO. PROSPERO does not currently accept registrations for scoping reviews, literature reviews or mapping reviews. The PRISMA checklist can be found in the supplementary material (Appendix 1).

Search strategy for the identification of studies

The search was carried out using the following electronic databases MEDLINE by PubMed, Scopus, PEDro, and Scielo. The search covered the period from

January 2010 to October 2020 (end of the search in databases). The search strategy followed the guidelines of the Peer Review of Electronic Search Strategies (PRESS) (McGowan et al., 2016). The general search syntax was: («exercise therapy» OR «rehabilitation exercise») AND («cancer survivor» OR «neoplasm survivor»), which was adapted to each database. The complete search strategy and filters used for all databases are available in the supplementary material (Appendix 2).

Study eligibility

The articles selected by title and abstract should meet the following criteria: I) Physical exercise is a subcategory of physical activity that improves or maintains one or more physical components (WHO, 2010) in this sense, Physical exercise, physical activity, and recreational activities studies were eligible for inclusion. They can be used as a single or combined program. They must have at least one session per week, and the minimum duration of the program should have been a month. II) population: People older than 50 years from community-dwelling were considered; moreover institutionalized, self-supporting, or hospitalized cancer survivors were considered. III) Health outcomes: studies must study at least one of these outcomes a) physical: level of physical activity, functional capacity and physical condition, b) psychological: anxiety and depression and quality of life and c) cognitive functions: cognitive impairment IV) Type of article: Randomized clinical trials and clinical trials. V) Search limited to English publications in humans, between January 2010 and October 2020.

Exclusion criteria for gender or clinical condition were not applied. Furthermore, other types of articles such as reviews, editorial documents, protocols and/or studies conducted in animals were excluded.

Strategy for the narrative synthesis

A narrative synthesis of the findings was provided from the included studies/summarized in tables and figures. The results were ordered to present the general characteristics of articles, and programs as well as the effects of physical exercise programs on physical health, quality of life, psychological health, and cognitive functions outcomes. Furthermore, the characteristics of the population, variables analyses are presented.

Data extraction

In a first step, duplicated articles were identified

and removed from the databases using Mendeley software version 1.19.4. Two reviewers then applied the inclusion/exclusion criteria to all titles and abstracts (C.O and E.D). Articles that fit the inclusion criteria were selected and, when decisions could not be made based on the title and abstract alone, the full-text documents were also retrieved. The articles included in the review were independently verified by the two reviewers (C.O and E.D); however, when there were discrepancies, a third reviewer (I.C) reached a consensus (Figure 1). The authors used and applied a standardized questionnaire to extract the included articles' data and synthesize the evidence.

Risk of bias assessment tool and Consensus on Exercise Reporting Template (CERT) form

The Cochrane tool «Cochrane Handbook of Systematic Reviews of Interventions» by Higgins & Green (2011) was used to evaluate the risk of bias in the 24 full-text articles included in this systematic literature review. Based on the items proposed by the manual, selection bias, performance bias, detection bias, attrition bias and reporting bias were considered, leaving only the item «other biases» left out of the evaluation. Each article was independently graded by two reviewers (C.O and E.D), and the scores were compared. When there was a disagreement, a consensus was reached with a third evaluator (I.C). The risk of bias of the studies is shown in Appendix 3. In addition, the Consensus on Exercise Reporting Template (CERT) evaluation form was added to determine the proportion of articles that met the CERT20 items (Appendix 4).

Results

Literature search

A flow diagram summary in the article included based on the PRISMA (Liberati et al., 2009) guidelines is shown in Figure 1. A total of 1,344 potential records on physical exercise in OCS were identified. After removing duplicated articles (1,213) and screening titles and abstract (1,105), 108 records were full screened. After applying the eligibility criteria, 24 articles were finally included for the narrative synthesis (**Figure 1**).

Assessment of risk of bias and level of CERT compliance

Using the Cochrane tool «Cochrane Manual of Systematic Reviews of Interventions of Experimental Studies» (Higgins & Green, 2011), the articles were

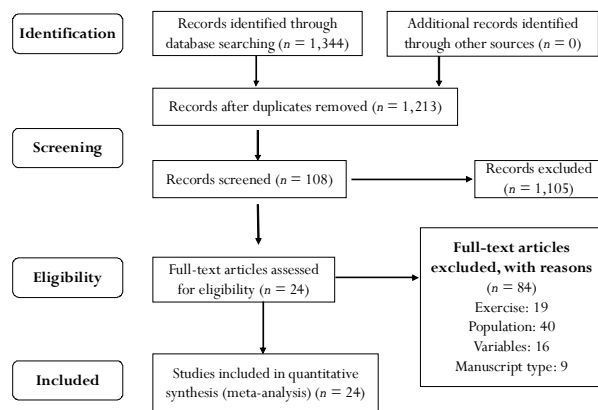


Figure 1. Flow Diagram PRISMA search and selection articles.

classified as low risk of bias in the sequence generation domains (88%), incomplete outcome data (67%), unclear risk in the domains of allocation concealment (46%), blinding of participants and staff (29%), and blinding of outcome assessors (63%). On the other hand, in the selective notification of results domain, 46% of the articles reported a high risk of bias (Appendix 3).

Seventeen out of nineteen items complied (scored «yes» on the CERT items) in at least 75% of the articles (C1 = 88%, C2 = 75%, C3 = 100%, C4 = 92%, C5 = 100%, C6 = 79%, C7a = 79%, C8 = 88%, C9 = 100%, C10 = 100%, C12 = 92%, C13 = 100%, C14a = 83%, C14b = 92%, C15 = 83%, C16a = 92% and C16b = 75%). The categories of items with the highest level of compliance were the categories: materials (1/1), supplier (1/1), location (1/1), dose (1/1), What? How? (3/3), planning (2/2). In contrast, the category of items with the lowest level of compliance was the one related to distribution (ten items, C7b = 71%, C11 = 38%) (Appendix 4).

Table 1. General characteristics of the analyzed articles on the effects of physical exercise in OCS.

Authors, Year, Country	Age		Age range (years)					Sample		Sex		Adherence total	Reason for withdrawal					Recruitment			Place of Intervention			Professional in charge			
	mean± SD	SD	50-59	60-70	71-80	80+	I/F	Female %	Man %	LT	PR		NWC	Att	HR	NS	HC	EC	Com	HC	EC	HorOA	CC	NS	HP	HT	NS
	(years)	(years)																									
Park S. (2012) Korea	65	-	*	-	-	-	66/49	-	100	-	74,2	-	-	-	-	-	*	-	*	-	*	-	-	-	*	-	
Winters-Stone K. (2012) USA	60	-	*	-	-	-	106/106	100	-	100,0	-	-	-	-	-	*	-	*	-	*	-	-	-	*	-		
Spahn G. (2013) Germany	56,7	*	*	-	-	-	64/55	100	-	85,9	*	*	-	-	-	-	*	*	*	*	*	*	*	*	*	*	
Brocki B. (2014) Denmark	-	-	*	-	-	-	78/59	-	-	75,6	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	
Campo R. (2014) USA	72	-	-	*	-	-	40/29	100	-	72,5	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	
Rogers L. (2015) USA	-	-	-	-	-	-	222/213	100	-	95,9	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Sprod L. (2015) USA	-	-	*	-	-	-	410/97	94	6	23,7	*	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	
Martin E. (2016) USA	-	-	*	-	-	-	159/72	-	-	45,3	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Devin J. (2016) Australia	-	-	*	-	-	-	47/39	-	-	83,0	-	*	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Hagstrom A. (2016) Australia	51,9 ± 8,8	*	*	-	-	-	39/39	100	-	100,0	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	
Zhou Y. (2017) USA	57,3 ± 8,6	*	*	-	-	-	144/113	100	-	78,5	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Winkels R. (2017) USA	59,4	*	*	-	-	-	351/293	100	-	83,5	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Rogers L. (2017) USA	54,4 ± 8,5	*	-	-	-	-	222/213	-	-	95,9	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Dieli-Conwright C. (2018) USA	53,5 ± 10,4	*	-	-	-	-	100/95	-	-	95,0	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Brown J. (2018) USA	-	-	*	-	-	-	39/39	62	38	100,0	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	
Lee C. (2018) China	65	-	*	-	-	-	223/192	-	-	86,1	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Lahart I. (2018) United Kingdom	52 ± 10	*	-	-	-	-	80/32	100	-	40,0	-	*	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Brown J. (2018) USA	56,5 ± 10,0	*	*	-	-	-	39/39	62	38	100,0	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	
Levin G. (2018) Australia	58,9 ± 9,4	*	*	-	-	-	32/16	-	-	50,0	*	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Iyer (2018) USA	-	-	*	-	-	-	95/43	100	-	45,3	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Zhang Q. (2018) China	-	-	*	-	-	-	72/67	100	-	93,1	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Gray M. (2019) USA	73	-	-	*	-	-	487/153	-	-	31,4	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Kneis S. (2019) Germany	62	-	*	-	-	-	50/37	-	-	74,0	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	
Bjerre E. (2019) Denmark	69	-	*	-	-	-	214/50	-	-	23,4	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	

USA: United State of America, SD: Standard deviation, Sample: I: Initial, F: final; Reason for withdrawal: LT = Lack of time = PR = Personal reasons; NWC = You do not want to continue; Att = Attendance; HR = Health; Recruitment: HC = Health Center; EC = Educational Center; Com = Community; Place of intervention: HC = Health Center; EC = Educational Center; HorOA = Home or Open Air; CC = Community Center; Professional in charge: HP = Health Profession; HT = Health Technician; Symbology: * = Specified; NS = Not Specified; - : Does not meet criteria.

General characteristics of the articles

Table 1 shows the general characteristics of the articles included. The oldest article was published in 2012, while the newest in 2019. The articles were carried out mainly in the United States (n=13). The total OCS at the beginning was 3,379 and at the end was 2,140, presenting an average adherence of 63.3%. The average age of the OCS was 61 years, and 75% of the articles were carried out in OCS between 60 and 70 years. Of the total articles, 34.6% did not record the number of subjects divided by sex. Of those who registered sex, 66.7% were carried out only in women (with breast cancer, ovarian cancer and endometrial cancer) and 13.3% only in men (prostate cancer only). The main cause of withdrawal from the program was health complications attributed to cancer (resumption of adjuvant therapy and/or presence of treatment side effects). Health centers were the principal place where the OCS were recruited for the programs (62.5%) and where the programs were carried out (54.2%). Unfortunately, 25% of the articles did not specify the professional who performs the program based on PA and PE. In those which did, 94.4% were performed by a health professional (Table 1).

Population characteristics

The characteristics of OCS are presented in Figure 2. Ten types of cancer were detected; the most frequent was breast cancer (13 articles) whilst the least was kidney cancer (1 article). The most common stages were: Stage I, stage II and stage III (15 articles each). In contrast, the least frequent stage was stage 0 (1 article). The most frequent treatment received was

chemotherapy (22 articles), followed by radiotherapy (14 articles), surgery (12 articles), and hormonal therapy (6 articles). Within comorbidities, type 2 diabetes mellitus was the most frequent. However, in 22 articles, OCS had no comorbidities (Figure 2).

Main characteristics of the programs

Table 2 presents the characteristics of the programs based on the effects of physical exercise in OCS. 74.4%

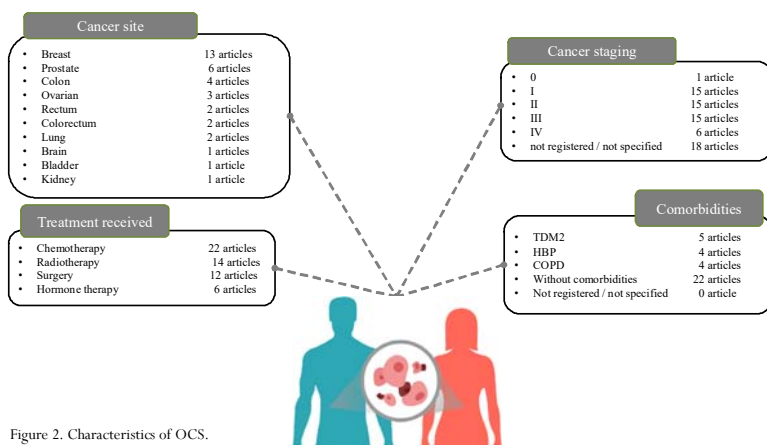


Figure 2. Characteristics of OCS.

of the articles performed physical exercise, 17.9% physical activity and 7.7% recreational activity. On average, the programs had an extension of six months, and 87.5% of the articles had an extension between 3–6 months. 2.9 sessions per week with a frequency of 2–3 sessions per week was the average reported in the articles (73.1%). The sessions had an average duration of 49.4 minutes, with a maximum of 20–60 minutes (78.2%). Regarding physical condition addressed during the programs, 44% included aerobic exercise, which varied between 15–30 minutes in 77.7% of the studies. Muscle strength exercises were included in 33.3% of studies, with a duration that varied between 15–30 minutes in 71.4% of the studies. Flexibility exercises were present in 20.5% of studies, with 10 minutes in 100% of the studies. 2.5% included balance and gait exercises lasting 30 minutes in 100% of the studies. 20.5%, 17.9%, and 15.4% did not specify aerobic exercise duration, muscular strength, and flexibility, respectively.

Table 2. Characteristics of physical exercise program in OCS.

Authors, Year	Modality			Length (months)	Frequency (Days/weeks)	Duration (min)			Type and time (min)				Intensity	
	PE	PA	RA			ST	(min)	B&G	Flex	(min)	Aer	(min)		
Park S. (2012)	EG1	-	-	3	2	30	-	-	-	*	NE	*	NE	Light
Winters-Stone K. (2012)	CG1	-	-	3	8	-	*	NE	-	-	-	-	-	Intense
	CG1	-	-	12	-	-	-	-	-	*	NE	-	-	-
Spahn G. (2013)	EG1	-	-	2.2	1	30	-	-	-	-	-	*	NE	-
	-	CG1	-	2.2	3	30	-	-	-	-	-	*	NE	-
Brocki B. (2014)	EG1	-	-	2.2	1	60	*	20	-	-	-	*	15	-
	CG1	-	-	2.2	2	-	*	NE	-	-	-	*	NE	Light
Campo R. (2014)	-	-	EG1	3	2	60	-	-	-	*	NE	-	-	-
	CG1	-	-	3	2	60	-	-	-	*	NE	-	-	-
Rogers L. (2015)	EG1	-	-	3	3	15-25	-	-	-	-	-	*	NE	Moderate
Sprod L. (2015)	-	-	EG1	1	2	75	-	-	-	*	NE	-	-	Light
Martin E. (2016)	EG1	-	-	2	3	60	-	-	-	*	10	*	25	Light
	EG2	-	-	2	3	38	-	-	-	*	10	*	25	Moderate
Devin J. (2016)	EG1	-	-	1	3	50	-	-	-	-	-	*	50	Intense
	CG1	-	-	1	-	-	-	-	-	-	-	-	-	Light
Hagstrom A. (2016)	EG1	-	-	4	3	60	*	NE	-	-	-	-	-	-
	CG1	-	-	4	3	60	*	NE	-	-	-	-	-	-
Zhou Y. (2017)	EG1	-	-	6	-	-	-	-	-	-	-	-	-	Moderate
Winkels R. (2017)	EG1	-	-	12	2	90	*	70-90	-	-	-	*	30	Moderate
	EG2	-	-	12	2	90	*	70-90	-	-	-	-	-	Moderate
Rogers L. (2017)	-	EG1	-	3	-	-	-	-	-	-	-	-	-	Moderate
Dieli-Conwright C. (2018)	EG1	-	-	4	3	-	-	-	-	-	-	-	-	Moderate
Brown J. (2018)	EG1	-	-	6	-	-	-	-	-	-	-	-	-	-
	EG2	-	-	6	-	-	-	-	-	-	-	-	-	-
Lee C. (2018)	-	EG1	-	24	5	-	-	-	-	-	-	*	=30	Moderate
	-	EG2	-	24	5	-	-	-	-	-	-	*	=60	Moderate
Lahart I. (2018)	-	EG1	-	6	3 to 7	30	-	-	-	-	-	*	NE	Moderate
Brown J. (2018)	EG1	-	-	6	-	-	-	-	-	-	-	-	-	Light
	EG2	-	-	6	-	-	-	-	-	-	-	-	-	Light
Levin G. (2018)	EG1	-	-	3	2	60	*	30	-	-	-	*	20	Intense
	-	EG2	-	3	-	10	-	-	-	-	-	*	15	-
Iyer (2018)	-	EG1	-	6	-	-	-	-	-	-	-	-	-	Moderate
Zhang Q. (2018)	EG1	-	-	3	3 to 5	25-60	*	NE	-	*	NE	*	NE	Moderate
Gray M. (2019)	EG1	-	-	12	-	30	*	15	-	-	-	-	-	-
	EG2	-	-	12	-	30	*	15	-	-	-	-	-	-
Kneis S. (2019)	EG1	-	-	3	2	-	*	30	*	30	-	-	-	Moderate
	CG1	-	-	3	2	-	*	NE	-	-	-	-	-	Moderate
Bjerre E. (2019)	-	-	EG1	12	-	60	-	-	-	-	-	*	NE	-

Symbology = *: used; -: Not reported; NE: Does not specify; **Modality**: PE = Physical Exercise; PA = Physical Activity; RA = Recreational Activity; Length: months; Frequency: (days / weeks); Duration: minutes; **Type and time (min)**: ST = Strength exercises; B&G = Balance and Gait Exercises; Flex = Flexibility Exercises; Aer = Aerobic fitness Exercises; Training zone. EG1: Experimental Group 1; EG2: Experimental Group 2; CG1: Control Group 1, minutes = min.

The moderate-intensity was the most frequent (58%), followed by light intensity (29.2%) (Table 2).

Health outcomes analyzed

The health outcomes analyzed are presented in Figure 3. They were grouped and described in four categories: physical health, quality of life, psychological health and cognitive functions. The physical health category was considered only in 70.8% of the articles and was divided into eight outcome variables. The most evaluated was the level of physical activity (7 articles), and the least evaluated was flexibility (1 article). The quality of life category was considered only in 54% of the articles (13 articles). The psychological health category was considered only in 37.5% of the articles and was grouped into two outcome variables. The most evaluated was depression, including nine articles. The category of cognitive functions was considered only in 4.2% of the articles and was grouped into mild cognitive impairment, evaluated in one article (Figure 3).

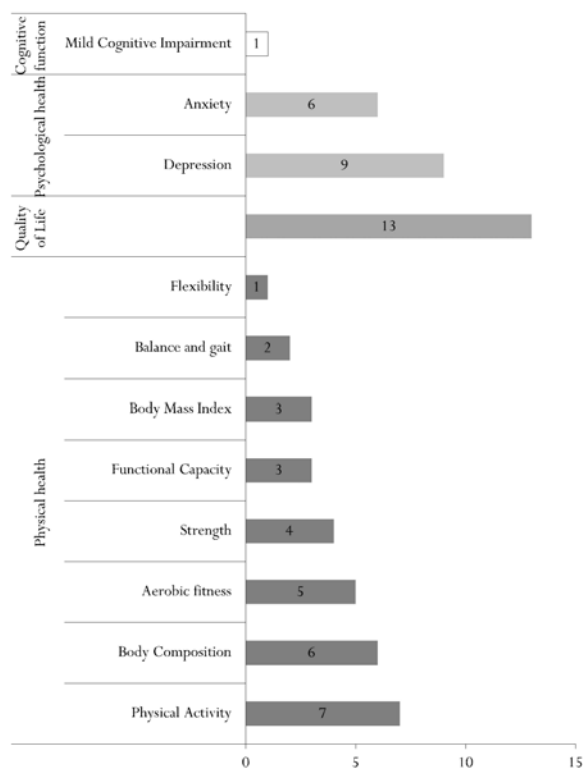


Figure 3. Analysis variables grouped in physical health, quality of life, psychological health and cognitive functions.

Effects on physical health, quality of life, psychological health, and cognitive function outcomes

Table 3 presents a narrative that analyzes the effects of physical exercise programs on the health outcomes of OCS. 17 out of 24 articles (71%) reported

monomodal programs based on physical exercise used. Seven used a multimodal physical program with nutritional program, cognitive therapy, or psychological therapy. The physical health with more statistically significant improvements was the level of physical activity (7 of 12 articles). Depression was the adverse outcome with the best positive benefits after the programs (7 of 14 articles). In addition, there were statistically significant improvements in the quality of life in 24 of 27 articles. Complementary, when the effects on health outcomes were broken down by type of exercise, it was evidenced that:

- Physical exercise: In physical health, the most positive outcomes were muscle strength (6 out of 10 articles) and balance and gait (5 out of 8 articles). In the quality of life, there were positive effects in 14 of 16 articles. In psychological health, depression showed the most positive effects (3 out of 7 articles).

- Physical activity: In physical health, the outcome with the most positive effects was the level of physical activity (2 of 2 articles). In the quality of life, there were positive effects in 3 of 3 articles. In psychological health, anxiety showed the most positive effects (2 of 2 articles).

- Recreational activity: In physical health, the outcome with the most positive effects was physical activity level (1 of 1 article). In the quality of life, there were positive effects in 3 of 3 articles. In psychological health, anxiety showed the most positive effects (1 of 2 articles).

- PA or PE combined with another program: In physical health, the outcome with the most positive effects was physical activity level (4 out of 5 articles). In the quality of life, there were positive effects in 4 of 5 articles. Anxiety showed the most positive effects (2 of 2 articles) (Table 3).

Discussion

This scoping review aimed to investigate the characteristics and effects of physical exercise in OCS. Results suggest that physical exercise programs must consider the extent, frequency, duration, and intensity in OCS. Likewise, those characteristics can safely improve physical health, quality of life, and psychological health.

We found twenty-four RCTs and Clinical Trials. In this context, the initial sample was 3,379, and the final 2,140, presenting an average adherence of 63.3% to PE programs. 75% of the studies were carried out in OCS

Table 3. Effects on physical health, quality of life, psychological health, and cognitive functions of physical exercise program in OCS.

Authors, Year	Modality						Physical health	Effects		
	PE	PA	RA	NUT	CT	PT		Quality of life	Psychological health	Cognitive functions
Park S. (2012)	EG1	-	-	-	-	-	↑Flex; ↑B&G; ↑ST	↑	↓Dep	
Winters-Stone K. (2012)	CG1	-	-	-	-	-	↑B&G; ↑ST			
	EG1	-	-	-	-	-	↑B&G			
Spahn G. (2013)	EG1	-	-	*	*	*		↑	↓Anx	
	-	CG1	-	-	-	-		↑	↓Anx	
Brocki B. (2014)	EG1	-	-	-	-	-	↑B&G; ↑Aer	↑		
	CG1	-	-	-	-	-	↑B&G; ↑Aer	↑		
Campo R. (2014)	-	-	EG1	-	-	-		↑		↓Anx
	CG1	-	-	-	-	-		↑		
Rogers L. (2015)	EG1	-	-	-	*	-	↑Aer	↑		
Sprod L. (2015)	-	-	EG1	-	-	-		↑		↓Dep
Martin E. (2016)	EG1	-	-	-	-	*		↑		
	EG2	-	-	-	-	-		↑		
Devin J. (2016)	EG1	-	-	-	-	-	↑BC			
	CG1	-	-	-	-	-				
Hagstrom A. (2016)	EG1	-	-	-	-	-	↑ST	↑		
	CG1	-	-	-	-	-		↑		
ZhouY. (2017)	EG1	-	-	-	-	-		↑		
Winkels R. (2017)	EG1	-	-	-	-	-	↑BC	↑		
	EG2	-	-	-	-	-	↑BC	↑		
Rogers L. (2017)	-	EG1	-	-	*	-	↑PA			↓Anx; ↓Dep
Diehl-Conwright C. (2018)	EG1	-	-	-	-	-	↑ST	↑		↓Anx; ↓Dep
	EG1	-	-	-	-	-				
Brown J. (2018)	EG1	-	-	-	-	-				
	EG2	-	-	-	-	-	↑FC	↑		
Lee C. (2018)	-	EG1	-	*	-	-	↑PA			
	-	EG2	-	-	-	-	↑PA			
Lahart I. (2018)	-	EG1	-	-	-	-	↑PA; ↑BC; ↑Aer			
Brown J. (2018)	EG1	-	-	-	-	-	↑Aer			
	EG2	-	-	-	-	-	↑Aer			
Levin G. (2018)	EG1	-	-	-	-	-	↑ST	↑		↓Anx; ↓Dep
	-	EG2	-	-	-	-	↑ST	↑		↓Anx; ↓Dep
Iyer (2018)	-	EG1	-	-	-	-		↑		
Zhang Q. (2018)	EG1	-	-	-	*	-				↓Dep
Gray M. (2019)	EG1	-	-	*	-	-	↑PA			
	EG2	-	-	*	-	-	↑PA	↑		
Kneis S. (2019)	EG1	-	-	-	-	-		↑		
	CG1	-	-	-	-	-		↑		
Bjerre E. (2019)	-	-	EG1	-	-	-	↑BC ↑PA	↑		
	-	-	-	-	-	-		↑		

Symbology = *: used; - : Not reported; **Modality**: PE= Physical Exercise; PA= Physical Activity; RA = Recreational Activity; EG1: Experimental Group 1; EG2: Experimental Group 2; CG1: Control Group 1; **Combination**: NUT = Nutrition; CT= Cognitive Therapy; PT= Psychological Therapy; **Effects**: ↑ PA = Physical Activity increased; ↑ FC = Functional Capacity increased; ↑ ST = Muscle strength increased; ↑ B&G = Balance and Gait increased; ↑ Flex = Flexibility increased; ↑ Aer = Aerobic fitness increased; ↑ BC = Body Composition improved; ↑ QoL: Quality of Life improved; ↓ Anx = Anxiety decreased; ↓ Dep = Depression decreased.

between 60 and 70 years old, with an average age of 61. 86.8% were women. The main cause of withdrawal from the program was health complications attributed to cancer, as previous studies have shown (Cigarroa et al., 2021). Studies were mainly conducted in OCS with breast cancer (14/24 articles) in stages I, II, and III (15 articles each). The physical programs were predominantly carried out in health centers (54.2%) and were based on PE (74.4%). Besides, 25.7% of all articles received a combined program. The physical programs by health professionals (94.4%) were carried out 2–3 times a week (73.1%) with moderate intensity (58%), with a session duration between 20–60 minutes (78.2%) lasted mainly between 3–6 months (87.5%); moreover, aerobic exercise was the most performed type of exercise. Physical activity level and depression were the two physical and psychological outcomes with the most positive results. In addition, there were positive effects on quality of life in 24 of 27 articles. The recreational activity showed the highest number of articles with positive effects on physical health outcomes. The modality of PA and PE combined with another program were those that presented a greater number of articles with positive effects on psychological health outcomes. The PA modality was the one that presented the highest number of articles with positive effects on

quality of life, and neither modality presented positive effects on cognitive function outcomes.

Most of the studies were developed in the United States, which could be associated with a high number of older adults (BIRF–AIF, 2019), and is the second country in the world in scientific production (FECYT, 2019). Regarding the characteristics of the OCS, the sex that predominated was female (86.8%), and adherence was 63.3%. This contrasts with the latest health surveys that place women as more physically inactive than men (Sallis et al., 2016) and with the fact that the practice of physical activity decreases over the years (WHO, 2015). It is noteworthy that only 8.3% included older adults 71–80 years, which could be associated with a higher prevalence of comorbidities in that range of age (Peranovich, 2016); likewise, more than 70% in these groups did not comply with public health recommendations ACSM (Kilari et al., 2016). On the other hand, recruitment and programs were carried out mainly in health centers, which may suggest that older adults are willing to participate in studies related to PE, which could incentivize researchers to develop programs that include more to older adults as study subjects.

Results on the risk of bias stress that a high percentage of articles included reported risk unclear in

domains allocation concealment (46%), blinding of participants and staff (29%) and blinding of outcome evaluators (63%). Cochrane Manual refers to the lack of blinding in these items could skew the results and affect the trial participants (Higgins & Green, 2011). However, blinding either the control or experimental groups is complicated due to the nature of exercise-based programs. In the selective reporting of results domain, 46% of the articles reported a high risk of bias, which is striking since all the articles in this scoping review present an experimental and randomized methodological design (RCT), which corresponds to the better level of evidence relative to original studies. Regarding compliance with the CERT, seventeen out of nineteen items complied (rated «yes» on the CERT items) in at least 75% of the articles. The category of items with a lower level of compliance was related to the distribution. Similar results were observed on the level of compliance in another systematic review (Hay-Smith et al., 2019). This could be because the CERT was developed in 2016 to make exercise-based clinical trials transparent and replicable and has not yet been sufficiently absorbed by researchers.

60% of all malignant tumors and 70% of cancer deaths occur in older adults 65 years of age (Nuñez, 2017). As the risk of cancer increases with age, older adults are vulnerable (IARC, 2020b). Breast cancer was the most common cancer reported in the selected articles. On the other hand, this scoping review shows limited evidence about the effects of PE in other cancer types, an aspect that should be considered in future research. The latter is not surprising considering the high incidence of this cancer worldwide (11.6%) (Bray et al., 2018). Combination therapy with drugs in cancer participants (62.5%) is most effective; thus, cancer cells becoming resistant is reduced (Manual MSD, 2020). In agreement with the *Encuesta Nacional de Dependencia en Adultos Mayores* (ENADEAM, acronym in Spanish) 54.2% of the older adults has comorbidities, 75% of older adults express having at least one chronic disease, such as arterial hypertension (62.1%), one of the most common pathologies in older adults; therefore it becomes a risk factor for the development of other types of pathologies, such as diabetes (21.8%) (Soler, Mellinas, Sánchez, & Jiménez, 2010).

Following the WHO guidelines, PE programs must consider an extension of 3–6 months, with a frequency of 2–3 times per week and per session lasting between 20–60 minutes, and be run by health professionals (WHO, 2020), in line with our results. It is an important

aspect because it shows that different studies are implementing these guidelines. According to the types of PE, 74.4% of the articles performed PE, while 17.9% performed PA and 7.7% recreational activity. This suggests that PE and PA predominate over recreational activity, but the last decade has also led to the development of recreational programs that have proven to be just as effective compared to PE and PA programs (Bjerre et al., 2019; Brown et al., 2018a; Brown et al., 2018b; Campo et al., 2014; Devin et al., 2016; Dieli-Conwright et al., 2018; Gray et al., 2019; Hagstrom et al., 2016; Iyer et al., 2018; Kneis et al., 2019; Lahart, Carmichael, Nevill, Kitas, & Metsios, 2018; Lee et al., 2018; Levin, Greenwood, Singh, & Newton, 2018; Martin, Battaglini, Hands, & Naumann, 2016; Rogers et al., 2017; Sprod et al., 2015; Winkels et al., 2017; Zhang Q, Li, Zhang H, Yu, & Cong, 2018; Zhou et al., 2017). For example, Qigong (which is a viable form of PA for OCS because it is performed at a slow pace, without excessive physical exertion), yoga, and soccer mitigate some negative side effects such as cancer-related fatigue, depression, joint pain, and PA has also been shown to be associated with longer survival (Bjerre et al., 2019; Brown et al., 2018a; Brown et al., 2018b; Campo et al., 2014; Devin et al., 2016; Dieli-Conwright et al., 2018; Gray et al., 2019; Hagstrom et al., 2016; Iyer et al., 2018; Kneis et al., 2019; Lahart et al., 2018; Lee et al., 2018; Levin et al., 2018; Martin et al., 2016; Rogers et al., 2017; Winkels et al., 2017; Zhang et al., 2018; Zhou et al., 2017). Regarding the components of programs, 44% mainly considered aerobic exercise and 58.3% of the articles were developed in the moderate workout, this being the first recommendation by the ACSM (Wolin, Schwartz, Matthews, Courneya, & Schmitz, 2012). In addition, only few articles considered the balance and gait components' training. This is surprising since their alteration increases the risk of falls (Izquierdo et al., 2004). Finally, the flexibility component was considered in only 20.5% of the articles, a variable that is not specifically found within the WHO recommendations (WHO, 2020). This contrasts with the fact that flexibility exercises have been shown to improve aspects of older adults' physical health and psychological health (Sivaramakrishnan et al., 2019). Currently, multi-component exercise is promoted (WHO, 2020); in this sense, future research should consider this in its proposal.

The scientific community has recognized the potential of exercise to cope with various adverse effects caused by cancer treatment, both for mental health, cognitive

function and physical well-being, and for the deterioration of operation associated with aging (Grimmett et al., 2019) and cancer survivors (Palesh et al., 2018). Programs were based on PE, PA, recreational activity, PA or PE combined with another program. Considering physical health variables in 70.8% of the articles, 54% of the articles considered the effects of these programs on the quality of life variable, 37.5% on psychological health variables and 4.2% on cognitive functions. This scoping review shows scarce evidence on variables such as physiological health and cognitive functions. Therefore, these should be included in PE researches, considering the mental health of OCS. Studies suggest that PE significantly affects mental health, especially in neuroprotection mechanisms during aging (e.g., on cognitive reserve) (Cheng, 2016; Wikee & Martella, 2018).

Muscular strength showed the greatest PE effect both in PA, recreational activity, and combined programs. On the other hand, in cognitive functions, the variable mild cognitive impairment did not present effects. It can be concluded that PE brings both physical and psychological benefits in older adults regardless of the age of the subjects (Hill, Hunter, Batchelor, Cavalheri, & Burton, 2015; Galloza, Castillo, & Micheo, 2017). However, no effects in mild cognitive impairment contrasts with the fact that physical programs are necessary to stop cognitive impairment in older adults and provide a better quality of life (Barnes, Whitmer, & Yaffe, 2007).

PA program shows better effects on physical health, which is related to the activities recommended by the WHO (moderate-intensity aerobic PA or vigorous-intensity aerobic PA) and better effects on quality of life in patients. Comparison with the other programs, which is in agreement with the literature, since the practice of physical activity improves the health and well-being of older adults (Soler et al., 2010). On the other hand, PA or PE program combined with another program (nutrition, cognitive and psychological therapy) shows more significant effects, both in anxiety and depression; in fact, the literature suggests combined program reveals high levels of self-esteem and lower levels of depression and anxiety (Kandola et al., 2018).

Limitations and clinical implications

This study had some limitations. Firstly, most of the included studies were developed in the USA, which does not allow a complete overview concerning PE

programs in OCS in the rest of the world. This could be considered a challenge for researchers in the rest of the countries to develop research with PE-based programs in OCS in their respective countries. Secondly, about the risk of bias, the domains of allocation concealment, blinding of participants and staff, and blinding of evaluators reported unclear risk in most articles, which could bias the results when affecting the outcomes of the participants in the programs. Finally, this scoping review did not consider a meta-analysis of the 24 articles selected; moreover, RCTs or Clinical Trials were not included in another language but from English.

The clinical implications of this review provide a broad and updated view of the characteristics and effects of PE programs that are being developed for OCS. The findings will be useful for prescribing future PE programs for OCS, encouraging the development of future studies in this area of knowledge.

Conclusions

In conclusion, PE programs positively affect OCS health outcomes, such as PA, depression, and quality of life, especially in Breast cancer (most frequently reported). Positive effects are shown in physical programs based on aerobic exercise when it is considered the range of months, frequency per week, and duration no more than 60 minutes. The mode of a program based on a recreational activity had higher positive effects on physical health outcomes. The modality of a program based on PA had higher positive effects on quality of life and psychological health outcomes. Physical programs are a safe and effective therapeutic strategy to improve physical health markers, quality of life, and psychological health in OCS.

This scoping review made it possible to describe the effects of PE in OCS and the types of cancers that benefit the most, since before our research project, there was no clarity or consensus about the effects and the mode of programs based on PE that can improve variables such as physical health, quality of life, psychological health, and cognitive functions in OCS.

Moreover, this scoping review characterized the PE programs in OCS, as well the most frequently used outcome measures, by summarizing available evidence derived from RCTs and Clinical Trials.

Acknowledgments

ANID-Subdirección de Capital Humano/Doctorado Nacional/2021-21212181 (David Toloza-Ramírez).

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APPENDIX 1. PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	2-3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, and if where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4-5, appendix 2
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4-5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4-5 figure 1
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4-5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5 Appendix 3 and 4
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	does not apply
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	does not apply
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	5
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	does not apply
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5, figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	6
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	5-6, Appendix 3 and 4
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	6-8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	does not apply
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	5-6, Appendix 3 and 4
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	does not apply
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	8-11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	12
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	does not apply

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

Appendix 2. Supplementary File: Search strings for all databases in the systematic review.

Table 1.

Search strings for Medline (by Pubmed)

- 1 "Exercise therapy" OR "rehabilitation exercise"
- 2 "Cancer"
- 3 #1 AND #2
- 4 All fields: Articles type: Randomized controlled trial and clinical trials
- 5 FILTER: Species: Humans
- 6 FILTER: Language: English
- 7 FILTER: Age: Middle Aged: 45-64 years, 65+ years, 80 and over: 80+ years
- 8 FILTER: 2010 to 2020

Table 2.

Search strings for Scopus

- 1 "Exercise therapy" OR "Rehabilitation exercise"
- 2 "Cancer" OR "Neoplasm"
- 3 #1 AND #2
- 4 FILTER: 2010 to 2020
- 5 FILTER: Keyword: Cancer survivors

Table 3.

Search strings for Scielo

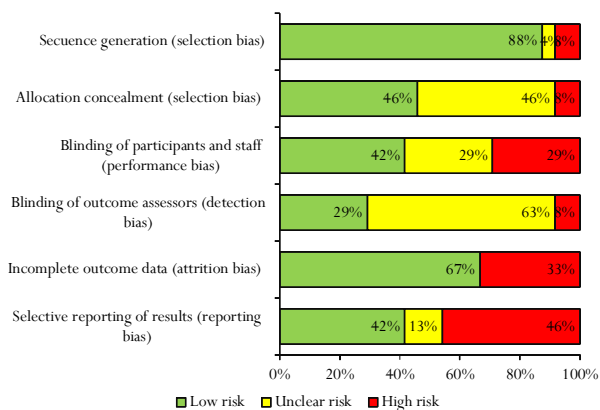
- 1 "Ejercicio"
- 2 "Cáncer"
- 3 #1 AND #2
- 4 FILTER: Literature type: Article

Table 4.

Search strings for PEDro

- 1 "Exercise therapy"
- 2 "Cancer"
- 3 #1 AND #2
- 4 All fields: Method: Clinical Trials
- 5 FILTER: Therapy: Fitness training
- 6 FILTER: Subdiscipline: Oncology
- 7 FILTER: Published Since: 2010

Appendix 3. Assessment of the methodological quality of the reviewed studies.



Appendix 4

Item category	CERT item description	N. items rated "Yes"/N. papers with responses (Percentage)
WHAT: materials	C1: Detailed description of exercise equipment (e.g. weights, treadmill, ergometer, etc.)	21/24 88%
	C2: Detailed description of instructor expertise, qualifications, and/or training	18/24 75%
	C3: Describe whether exercises are performed individually or in a group	24/24 100%
	C4: Describe whether exercises are supervised or unsupervised; how they are delivered	22/24 92%
	C5: Detailed description of how adherence to exercise is measured and reported	24/24 100%
	C6: Detailed description of motivation strategies	19/24 79%
	C7a: Detailed description of decision rule(s) for determining exercise progression	19/24 79%
	C7b: Detailed description of how exercise program was progressed	17/24 71%
	C8: Detailed description of each exercise to enable replication	21/24 88%
HOW: delivery	C9: Detailed description of any home program component	*12/12 100%
	C10: Describe any non-exercise components, e.g. education, cognitive behavioral therapy, etc.	*8/8 100%
	C11: Describe the type and number of adverse events that occur during exercise	9/24 38%
WHERE: location	C12: Describe the setting in which the exercises are performed	22/24 92%
WHEN, HOW MUCH: dosage	C13: Detailed description of exercise intervention, e.g. reps, sets, sessions	24/24 100%
	C14a: Describe whether the exercises are generic (one size fits all) or tailored	20/24 83%
TAILORING: what, how	C14b: Detailed description of how exercises are tailored to the individual	22/24 92%
	C15: Describe the decision rule for determining the starting level, e.g. beginner, intermediate, advanced, etc.	20/24 83%
	C16a: Describe how adherence or fidelity to the intervention is assessed/measured	22/24 92%
HOW WELL: planned, actual	C16b: Describe the extent to which the intervention was delivered as planned	18/24 75%

* Not all articles made this item. So, the total of answered articles is different from 24.

