Effects of isometric strength training in people with cancer: a systematic review

Efectos del entrenamiento de fuerza isométrica en personas con cáncer: una revisión sistemática

Authors

Aarón Gómez-Parra [1]
Adrián Moreno-Villanueva [2]
Boryi A. Becerra-Patiño [1,3]
Carlos Navarro-Martínez [1]
José Pino-Ortega [1]

[1] University of Murcia (Spain)
[2] Isabel I University, Burgos, Spain
[3] National Pedagogical University (Colombia)

Corresponding author:
Carlos Navarro Martínez
c.navarromartinez@um.es

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Abstract

Introduction: Isometric strength training was proposed as a safe alternative for individuals with restricted mobility or limited access to equipment. However, its specific effects in people with cancer had not been synthesized.
Objective: The objective was to summarize the effects of isometric strength training in people with cancer and to derive practical recommendations for its implementation in clinical and community settings.
Methodology: A systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Electronic databases, including PubMed, Scopus and Web of Science, were searched for studies published up to 23 September 2024. Methodological quality was assessed with the Physiotherapy Evidence Database scale in pre-test–post-test trials with randomly allocated experimental and control groups.
Results: Of 262 records identified, 13 studies met the inclusion criteria, involving 1,021 participants, 371 of whom received isometric strength interventions. Most programs targeted women with breast cancer and emphasized upper-limb isometric exercises. At least half of the studies assessed handgrip strength, and interventions typically lasted eight or more weeks with one-hour sessions.
Discussion: The reviewed programs generally improved muscle strength and selected functional outcomes, in line with previous resistance training research in oncology, but considerable variation in exercise type, volume and supervision limited direct comparisons between studies.
Conclusions: Isometric strength training appears to be feasible and adaptable for people with cancer and shows promising benefits, but future trials should standardize program design and outcome measures to optimize its implementation.

Keywords

Cancer; exercise; isometric training; physical functioning; quality of life.

Resumen

Introducción: El entrenamiento de fuerza isométrica se propuso como una alternativa segura para personas con movilidad restringida o con acceso limitado al equipamiento. Sin embargo, sus efectos específicos en personas con cáncer no habían sido sintetizados.
Objetivo: El objetivo fue resumir los efectos del entrenamiento de fuerza isométrica en personas con cáncer y derivar recomendaciones prácticas para su implementación en contextos clínicos y comunitarios.
Metodología: Se llevó a cabo una revisión sistemática siguiendo las directrices de los Ítems de Referencia Preferidos para Publicaciones de Revisiones Sistemáticas y Metaanálisis. Se realizaron búsquedas en bases de datos electrónicas, incluyendo PubMed, Scopus y Web of Science, de estudios publicados hasta el 23 de septiembre de 2024. La calidad metodológica se evaluó con la escala de la Base de Datos de Evidencia en Fisioterapia en ensayos con medidas pre y post intervención y asignación aleatoria a grupos experimental y de control.
Resultados: De 262 registros identificados, 13 estudios cumplieron los criterios de inclusión, con un total de 1.021 participantes, de los cuales 371 recibieron intervenciones de entrenamiento de fuerza isométrica. La mayoría de los programas se dirigieron a mujeres con cáncer de mama y enfatizaron ejercicios isométricos de las extremidades superiores. Al menos la mitad de los estudios evaluaron la fuerza de prensión manual, y las intervenciones tuvieron, por lo general, una duración igual o superior a ocho semanas con sesiones de una hora.
Discusión: Los programas revisados mejoraron, en general, la fuerza muscular y ciertos resultados funcionales, en consonancia con investigaciones previas sobre entrenamiento de fuerza en oncología, pero la considerable variación en el tipo de ejercicio, el volumen y la supervisión limitó las comparaciones directas entre estudios.
Conclusiones: El entrenamiento de isométrico pareció ser viable y adaptable para personas con cáncer y mostró beneficios prometedores, pero los ensayos futuros deberían estandarizar el diseño de los programas y las medidas de resultado para optimizar su implementación.

Palabras clave

Cáncer; ejercicio; entrenamiento isométrico; funcionamiento físico; calidad de vida.

Introduction

Cancer is a major contributor to global disease and mortality, with more than 20 million new cases identified and 9.7 million deaths per year worldwide (Bray et al., 2024). Despite advances in cancer therapies, which have dramatically improved survival rates, the burden of the disease remains significant, not only because of the high number of deaths, but also because of the lasting sequelae faced by survivors (Siegel et al., 2020). Cancer treatments, which include chemotherapy and radiation therapy, often cause side effects that negatively impact physical fitness. These effects can manifest as fatigue (Bower, 2014), muscle weakness and decreased functional capacity, which in turn affect the quality of life of cancer survivors (Santos-Olmo et al., 2019), and can even cause sarcopenia and osteoporosis, increasing the risk of falls and fractures in survivors (Brown et al., 2014; Rock et al., 2012).

Cancer rehabilitation is essential at all stages of cancer diagnosis and treatment as it addresses physical impairments and progressive disability, which are often exacerbated by the rapidly aging population (Cheville et al., 2020). Rehabilitation as physical exercise, therefore, has become a beneficial intervention to improve muscle strength, physical function, and overall well-being in cancer patients and survivors (Chongaway, 2021; Soriano-Maldonado et al., 2019; Pino-Ortega et al., 2025). As also, it has proven to be an effective strategy to mitigate these adverse effects and improve the overall health of oncology patients.

Several studies have shown that regular exercise can reduce fatigue, improve physical capacity and quality of life, and decrease the incidence of cancer recurrence and cancer-specific mortality (Schmitz et al., 2010; Speck et al., 2010). Physical activity is increasingly recognized as a vital component of cancer care, with numerous studies demonstrating its benefits in reducing treatment-related side effects, improving physical function, and enhancing psychosocial well-being (Tsuji et al., 2021; Twomey et al., 2018). Among the various exercise modalities, strength training has been particularly effective in counteracting muscle atrophy and strength loss associated with cancer and its treatments (Courneya et al., 2007; De Backer, 2009; Safran et al., 2022; Sweegers et al., 2019). Similarly, there is a systematic review that analyses the effects of strength training in prostate cancer patients undergoing treatment, concluding that significant changes have been found in several variables such as strength, physical performance, muscle mass, and cardiovascular and respiratory health (Anishchenko-Halkina et al., 2024; Sande-Rivadulla et al., 2024).

Despite the benefits of strength training, traditional dynamic exercises may not be suitable for all cancer patients, especially those with severe physical limitations or undergoing intensive treatments (Bettariga et al., 2023) or who have colon cancer (Jones et al., 2010; Van Rooijen et al., 2018). Isometric exercises, which involve muscle contractions without joint movement, offer an alternative that can be performed safely even in restricted environments or by people with restricted mobility (Lund et al., 2019; Schulz et al., 2018; Navarro-Martínez et al., 2025). In this context, isometric strength training has emerged as a promising intervention due to its multiple benefits, which include improved muscle strength, joint stability, and cardiovascular functioning (Kubo et al., 2006; Oranchuk et al., 2019). The stability and controlled nature of isometric exercises can offer unique advantages, particularly for individuals with limited mobility or those recovering from surgery (Vang & Niznik, 2020). This type of training, which involves muscle contraction without joint movement, may be particularly suitable for people with cancer (de Lima et al., 2016), who often face physical limitations that make it difficult to participate in dynamic exercise (Adamsen et al., 2009).

Studies on isometric strength training in cancer patients are still limited, but preliminary research indicates that it may be beneficial in improving muscle strength and quality of life (Juvet et al., 2017). In addition, this type of training may be safer and more accessible for patients who have mobility restrictions or are in early stages of recovery (Tian et al., 2016). However, there is a lack of specific programs incorporating isometric strength training for this population, and current studies generally do not address the particular needs of cancer patients and survivors (Cormie et al., 2017; S et al., 2017).

The integration of isometric strength training into rehabilitation programs holds great promise for improving the physical health and quality of life of cancer patients and survivors. To our knowledge, no systematic review has been reported that considers the effectiveness of isometric strength training programs in cancer survivors. This review took into consideration studies focused on the collection of scientific evidence in search of a better understanding of this topic. Therefore, this systematic review aims to evaluate the development and effectiveness of isometric strength training intervention programs designed specifically for cancer patients and survivors. The main objectives, therefore, are to synthesize the existing evidence on the outcomes of isometric training in this population and to provide recommendations for implementing such programs in clinical and community settings.

Method

Experimental Approach to the Problem

This systematic review was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and guidelines for performing systematic reviews in sport sciences (Rico-González et al., 2022).

Information Sources

A systematic search was conducted in four major databases (PubMed, Scopus, and Web of Science) to identify articles published from January 2000 through September 23, 2024,

Search Strategy

The PICO (Participants, Problem, or Population – Intervention or Exposure – Comparison, Control, or Comparator – Outcome[s]) design was used to provide an explicit statement of the question. The authors were not blinded to journal names or manuscript authors. The following search terms were used: ("cancer" OR "oncology" OR "oncologic" OR "oncological") AND ("isometric strength" OR "isometric training" OR "isometric force" OR "isometric exercise" OR "isometric activity" OR "isometric resistance").

Eligibility criteria

Two authors (AGP) and (AMV) conducted the search independently and compared their results to ensure that they had identified the same articles. Next, the identifying information for the articles was downloaded using filters (title, authors, date, and database) and transferred to an Excel spreadsheet (Microsoft Corporation, Redmond, WA, USA), with duplicates removed. The remaining articles were independently screened for meeting inclusion and exclusion criteria (Table 1). Moreover, relevant articles not previously identified were also screened in an identical manner and further studies that complied with the inclusion-exclusion criteria were included and labelled as “included from external sources”. Furthermore, any disagreements (5% of the total number of documents) regarding the final inclusion/exclusion status of all documents were resolved through academic discussion during both the selection and inclusion phases. Throughout this process, the two independent authors simultaneously analysed the articles according to the criteria established in the order shown in Table 2. This process was systematized in Excel following the protocol of other reviews (Becerra-Patiño et al., 2026).

Table 1. Inclusion/exclusion criteria.

Topic	Inclusion	Exclusion	Search coherence
Population	Adults who suffer from some type of cancer.	People without cancer	cancer OR oncology OR oncologic OR oncological
Intervention or exhibition	Studies with isometric strength intervention program Studies with pre-post isometric strength exercises	Studies that did not apply isometric force in any of the cases.	"Isometric strength" OR "isometric training" OR "isometric force" OR "isometric exercise" OR "isometric activity" OR "isometric resistance"
Results	Outcomes related to Cancer and isometric strength	Results extracted from opinions, interviews, observations, perceptions, or experiences during a certain program. Program proposals without considering people with any cancer. Study protocols.	-
Study design	Randomized controlled trials or parallel trials	Non-randomized controlled trials or parallel trials	.
Other critics	Peer-reviewed, original, full-text studies	Articles written without peers, reviewing the complete original text studies.	-

Data extraction

Data extraction was prepared using an Excel spreadsheet in accordance with the Cochrane Consumers and Communication Review Group's data extraction template (Group, 2016). The spreadsheet was used to assess inclusion and exclusion requirements for all selected studies. The process was independently conducted by the two authors (A.G.-P) and (A.M.-V). Any disagreement regarding study eligibility was resolved in a discussion by a third author (J.P.-O). Full text articles that were excluded from the analysis were recorded with reasons for exclusion. All records were stored in the spreadsheet.

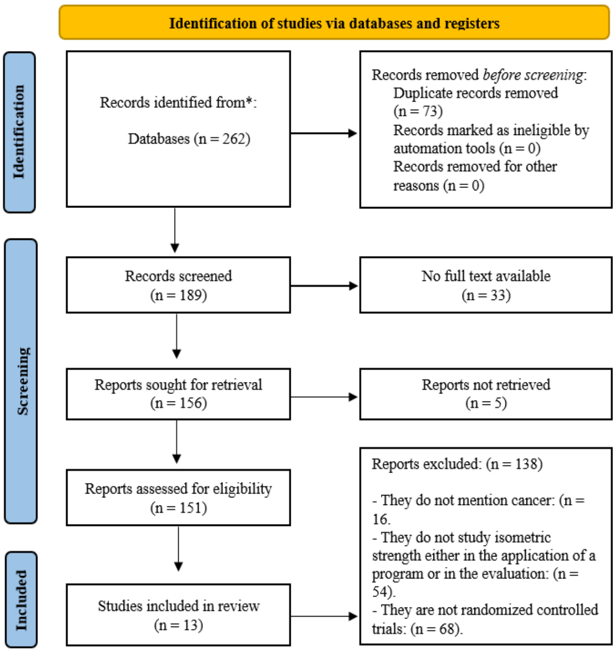
Extracted information and variables of interest

A list of the articles included in the data sheet and qualitative synthesis is reported in Table 2. The Table 2 cluster information about the aim of the studies, pre-post variable isometric strength results (cancer type, body part and tests), isometric strength results in intervention program (participant characteristics, cancer type, time in Weeks, isometric strength exercises), instrumentation results (cancer type, tool and instrumentation), and conclusions.

Identification and selection of studies

A total of 262 original articles, of which 73 were duplicates. Thus, a total of 189 unique articles were identified. After checking titles and abstracts, 33 articles were excluded because they did not meet inclusion criteria number five. The full text of the remaining 156 articles was then analysed; 16 articles was excluded because they did not meet inclusion criteria number one, 20 articles were excluded because they did not meet inclusion criteria number two, 34 articles were excluded because they did not meet exclusion criteria number three, and 68 were excluded because they did not meet exclusion criteria number four. Thus, a total of 13 articles met all the inclusion criteria and were included in the final qualitative synthesis (Figure 1).

Figure 1. Identification of studies via databases and registers



Assessment of study methodology

On the other hand, the Physiotherapy Evidence Database (PEDro) scale was used to assess the methodological quality of pre-test post-test studies with experimental (EXP) group and control (CON) groups randomly selected. The scale scores the internal study validity in a range of 0 (low methodological quality) to 10 (high methodological quality). The score that each section receives can be from 0 ("no") to 1 ("yes"), depending on the quality obtained by each point. Ten items are measured in the scale.

Table 2. PEDro scale with the different items added in the revision.

Reference	1	2	3	4	5	6	7	8	9	10	Score
Artene et al. (2017)	1	1	1	1	0	0	1	1	1	1	8
Bell et al. (2021)	1	0	1	1	1	0	1	1	0	1	7
Burtin et al. (2017)	1	1	0	1	0	0	1	1	1	1	7
De Oliveira et al. (2020)	1	1	1	1	0	0	1	1	0	0	6
Dotevall et al. (2023)	1	0	1	1	0	1	1	1	1	1	8
Esteban-Simón et al. (2021)	1	1	1	1	0	0	1	1	1	0	7
Hashem et al. (2020)	1	1	1	1	0	0	1	1	1	1	8
Krukowska et al. (2010)	1	1	1	1	0	1	0	1	1	1	8
Leaf et al. (2003)	1	0	1	1	1	0	1	1	1	0	7
Lonbro et al, (2011)	1	0	0	1	1	1	1	1	1	1	8
Lopez-Garzon et al. (2022)	1	1	1	1	0	0	1	1	0	1	7
Rief et al. (2014)	1	1	1	1	1	0	1	1	1	1	9
Sweeney et al. (2019)	1	1	1	1	0	0	1	1	1	0	7

Note: Item 1 = subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received); Item 2 = allocation was concealed; Item 3 = the groups were similar at baseline regarding the most important prognostic indicators; Item 4 = there was blinding of all subjects; Item 5 = there was blinding of all therapists who administered the therapy; Item 6 = there was blinding of all assessors who measured at least one key outcome; Item 7 = measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; Item 8 = all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"; Item 9 = the results of between-group statistical comparisons are reported for at least one key outcome; Item 10 = the study provides both point measures and measures of variability for at least one key outcome.

Results

Isometric strength as a pre-post variable

After analysing the related articles, there is no clear trend of one type of cancer predominating over the rest, although we can highlight the articles that use several types of cancer such as lung (Burtin et al., 2017), colon cancer (Lopez-Garzon et al., 2022) and renal (Leaf et al., 2003). Also, cancer specific breast cancer which two stand out (Esteban-Simon et al., 2021; Sweeney et al., 2019). However, with isometric strength as a pre-post variable in people with cancer, there is a clear predominant trend in upper body isometric strength exercises (De Oliveira et al., 2020; Esteban-Simón et al., 2021; Lopez-Garzon et al., 2022; Leaf et al., 2003; Sweeney et al., 2019) with respect to lower body (Burtin et al., 2017; Lonbro et al., 2013). With respect to upper body exercises, manual grip (Esteban-Simón et al., 2021; Leaf et al., 2003) and isometric shoulder strength exercises (De Oliveira et al.,2020; Sweeney et al., 2019) stand out in equal parts without a clear tendency for one to stand out over the other. Another variable to highlight would be isometric abdominal strength, with an article addressing that issue (Lopez-Garzon et al., (2022). Finally, mention that the main lower body exercise would be isometric quadriceps extension strength (Burtin et al., 2017; Lonbro et al., 2013) (Table 3).

Table 3. Isometric strength pre-post variable.

Study	Cancer type	Body location	Tests
Bustin et al. (2017)	Lunge	Lower limb	Peak isometric strength in quadriceps (3 seconds)
De Oliveira et al. (2020)	Various	Upper limb	Maximal voluntary isometric contraction (MVIC) of shoulder.
Esteban-Simón et al. (2021)	Breast	Upper limb	Handgrip strength and peak isometric strength
Lonbro et al. (2013)	Various	Lower limb	Maximal voluntary knee extensor (KE) and flexor (KF) strength
Lopez-Garzon et al. (2022)	Colon	Upper limb	Isometric abdominal strength
Leaf et al. (2003)	Kidney	Upper limb	Hand grip strength
Sweeney et al. (2019)	Breast	Upper limb	Shoulder (Flexion, external and internal rotation and horizontal abduction)

Isometric strength in an intervention program

After analysis a total of 371 participants were identified within intervention programs that included isometric strength. Within the programs it is concluded that there is a predominance towards breast cancer (Artene et al. 2017; Bell et al. 2021; Krukowska et al. 2010) followed by the combination of various types of cancer (Rief et al. 2014; Hashem et al. 2020), as we see in Table 2. The time spent in the programs have been different, ranging from a minimum of 8 weeks (Dotevall et al., 2023) to a maximum of 24 weeks (Rief et al. 2014). There is no correlation between sessions per week; number of exercises;

sets and repetitions, except for the duration of sessions which agree on 1 hour a session in several articles (Bell et al. 2021; Krukowska et al. 2010). Isometric strength exercises have been totally different, but whose conclusions give value due to the fact that the exercises improve their quality of life such as fitness improvements (Bell et al., 2021; Hashem et al., 2020) and pain relief (Rief et al., 2014) (Table 4).

Table 4. Isometric strength in an intervention program.

Study	Characteristics of the participants	Cancer type	Duration (weeks)	Exercises	Conclusions
Artene et al. (2017)	N= 165. All women with breast cancer (ER+/PR}/HER2, after surgery and chemotherapy, on antiestrogenic medication). They were all experiencing the effects of chemotherapy or anti-estrogen therapy, which could lead to weight gain and other health problems.	Breast	12	x7 isometric balance exercises for 4 minutes	The exercise protocol for oncological nutritional intervention is essential during chemotherapy and antiestrogenic treatment.
Bell et al. (2021)	N= 52 (53±10 years old; BMI (27.5±5.4 kg·m− 2). Overweight based on BMI (27.5±5.4 kg·m− 2), and abdominally obese (waist circumference: 94.3±13.7 cm)	Breast	20	Unilateral isometric strength of the biceps (forearm flexion) and quadriceps (knee extension)	An exercise frequency of 1.2 sessions/week stimulated significant fitness improvements and may represent a more realistic goal for patients during active treatment.
Dotevall et al. (2023)	N= 47 males. Participants were adult patients diagnosed with tumors of the tonsils, base of tongue, hypopharynx, or larynx who had undergone external beam radiotherapy (EBRT) ± brachytherapy or chemotherapy. All participants had difficulty swallowing (dysphagia)	Head/Neck	8	Shaker head-lift exercise	The results of the study indicate that HLE alone cannot be considered an effective rehabilitation effort in patients with mild to severe dysphagia following oncologic treatment of HNC.
Krukowska et al. (2010)	N= 33 females (mean 52.0±8.1 years) after mastectomy with lymphoedema of the arm. 23 women (70%) were classified as having type I lymphoedema. 10 women (30%) had type II lymphoedema.	Breast	10	Isometric and active exercises of themuscles of the neck	Complex decongestive physiotherapy is an effective method to reduce lymphoedema in women after mastectomy.
Hashem et al. (2020)	N= 13 (10 males, 3 females (39-77 years). Participants had multiple cancer diagnoses and a history of elective surgeries.	Various	12	x10 multi-joint exercises	An isometric exercise intervention tailored to people with abdominal cancer has the potential to be acceptable to perioperative patients to help increase their physical activity as well as assist with emotional and psychological recovery.
Rief et al. (2014)	N= 60 (61.3±10.9 years; 33 males, 24 females). All patients had histologically confirmed cancer with solitary or multiple bone metastases located in the thoracic or lumbar segments of the spine or sacrum.	Various	24	Paravertebral muscles	Isometric strength training of native muscles may improve pain relief over a 6-month period in patients with stable spinal metastases.

Note: HLE: head-lift exercise; HNC: head and neck cancer; BMI: Body Mass Index; ER: Estrogen Receptor; PR: Progesterone Receptor; HER2: Human Epidermal growth factor Receptor; EBRT: External Beam Radiation Therapy; kg·m: kilogram meters.

The main characteristics of the intervention programs are shown in Table 5, detailing that there is heterogeneity in the number of sessions per week and total weeks that the training lasted, as well as the duration of the training ranging from a minimum of 30 minutes to a maximum of 120 minutes.

Table 5. Intervention program considerations.

Study	Session/week or total sessions	Training duration	Exercises	Sets/reps
Artene et al. (2017)	7 sessions/week ()	1 min 4 times a day	x7 different exercises	-
Bell et al. (2021)	2 sessions/week (12 weeks)	1h	Strength and endurance	15-30 min strength and strength 1-2 sets of 10 to 20 reps
Dotevall et al. (2023)	21 sessions/week (8weeks)	-	Isometric and isokinetic head and neck exercises	Isometrics (60 seconds x3) Isokinetic (30 reps)
Hashem et al. (2020)	-	90-120min	Involvement of all muscle groups	-

Krukowska et al. (2010)	10 total sessions. (10 days). Active and passive exercises: These exercises were performed for 10-15 minutes, three times a day.	1h	Isometric upper body, abdomen and breathing exercises	-
Rief et al. (2014)	3 sessions/week. Two weeks of training ()	30m	x3 isometric strength exercises	Depending on the physiotherapist's assessment

Instruments used in both variables

The instrumentation used in both the pre and post-test variable, as well as in the isometric strength intervention program there is a predominance of the dynamometer (Bustin et al 2017; Bell et al 2021; De Oliveira et al. 2020; Esteban-Simón et al 2021; Leaf et al 2003; Lonbro et al 2013; Sweeney et al 2019). As shown in Table 6, with more than 50% of the analysed articles have used this grip force grasping tool.

Table 6. Instruments used in both searches.

Author´s	Cancer type	Device	Device characteristics
Artene et al. (2017)	Breast	Physical test	Friedman Test, then with Wilcoxon signed-rank
Bell et al. (2021)	Breast	Dynamometer and linear variable differential transformer (LVDT)	nd
Bustin et al. (2017)	Lung	Dynamometer	Biodex Medical Corporation, Shirley, NY
De Oliveira et al. (2020)	Various	Dynamometer	EMG 830c
Dotevall et al. (2023)	Head/Neck	Physical test	The Shaker head-lift exercise (HLE)
Esteban-Simón et al. (2021)	Breast	Dynamometer	TKK 5401 Grip-D, Takei Scientific Instruments Co., Ltd., Niigata, Japan
Hashem et al. (2020)	Various	Qualitative test	nd
Krukowska et al. (2010)	Breast	Goniometer	nd
Leaf et al. (2003)	Kidney	Dynamometer	Jamar, Clinton, NJ
Lonbro et al. (2013)	Various	Dynamometer	nd
Lopez-Garzon et al. (2022)	Colon	Ultrasound	MyLab 25; Esaote Medical System, Genova, Italy
Rief et al. (2014)	Various	Scale	Visual analog scale (VAS)
Sweeney et al. (2019)	Breast	Dynamometer	MicroFET®3, Hoggan Scientific, LLC, USA

Note. nd = not described.

Discussion

The integration of isometric strength training into rehabilitation programs holds great promise for improving the physical health and quality of life of cancer patients and survivors, where it has been defined that there is no correlation between sessions per week, number of exercises, sets and repetitions. This is the first systematic review that addresses an isometric strength intervention program with pre-post endpoints in cancer patients. Isometric strength stands out for its easy assessment and adaptation, hence its importance in people who depend on a reduced angle of movement, such as people with cancer.

The main findings of this review, starting with the pre-post variables, highlight those of the upper body, more specifically the manual grip through dynamometer (Bell et., al 2021; Bustin et al., 2017; De Oliveira et al. 2020; Esteban-Simón et al., 2021; Leaf et al., 2003; Lonbro et al., 2013; Sweeney et al 2019). Regarding the intervention program, the relevant cancer type has been breast cancer (Artene et al., 2017; Bell et al., 2021; Krukowska et al., 2010). The training programs had a duration of minimum 8 weeks (Dotevall et al., 2023) and maximum 24 (Rief et al., 2014). There is no correlation between sessions per week; number of exercises; sets and repetitions, except for the duration of the sessions which agree on 1 hour a session in several articles (Bell et al., 2021; Krukowska et al., 2010). Isometric strength exercises have been totally different, but whose conclusions give value due to the fact that the exercises improve their quality of life such as fitness improvements (Bell et al., 2021; Hashem et al., 2020) and pain relief (Rief et al., 2014). Similarly, it has been shown that an exercise frequency of 1.2 sessions per week stimulates improvements in the physical fitness of patients (Bell et al., 2021), where it appears that isometric strength training could improve pain relief over 6 months in patients with metastases

(Reif et al., 2014). Another contribution of isometric exercise is described by Hashem et al. (2020) in their study when concluding that an intervention with this type of training helps to improve the practice of physical activity and, in turn, favour emotional and psychological processes.

Upper body strength assessment in cancer patients, especially breast cancer survivors, can be effectively accomplished through a combination of established strength testing and innovative assessment technologies (Santos et al., 2024). In addition, exercise interventions have been shown to significantly improve upper body function and strength, as demonstrated by randomized controlled trials that reported improved perceived and clinically measured upper body function post-intervention (Hayes et al., 2013).

Muscle strength is an important indicator of current and future health, the focus of much research. In the general population, high levels of muscle strength have been shown to be associated with a reduced likelihood of developing cardiovascular disease and premature mortality (Carbone et al., 2020). In order to evaluate such strength, in the sample analysed in this systematic review regarding isometric strength used as a pre-post assessment variable in physical activity intervention programs, it has been observed that there is a clear predominant trend in isometric strength exercises of the upper body (De Oliveira et al., 2020; Esteban-Simón et al., 2021; Lopez-Garzon et al., 2022; Leaf et al., 2003; Sweeney et al., 2019) with respect to the lower body (Burtin et al., 2017; Lonbro et al., 2013). This may be due to several factors. First, many studies have focused on upper body muscle strength because of its critical role in daily activities and the impact of cancer treatments, especially in breast and prostate cancer patients, who often have upper body impairments (Saxton & Ashton, 2022; Stene et al., 2013). Second, while lower body muscle strength and function are also important, they have received less attention, especially in advanced stages of cancer, where evidence is sparse (Stene et al., 2013). Finally, it may be because the lower body requires greater energy expenditure and the target population is more fragile than the population due to its limitations (Ryan et al., 2023). Such limitations, as contemplated in Schootman et al. (2009), show a prevalence of functional limitations in the lower body, with 57% involvement compared to 26.6% of patients in the control group.

Strength training offers significant advantages for cancer patients, particularly in improving muscle strength and functional performance (Bell et al., 2021). In addition, strength training has been associated with counteracting muscle atrophy, which is crucial for maintaining tolerance to treatment and improving overall prognosis (Koeppel et al., 2021). Strength training itself, in addition to the benefits and improvement in its own right, some research indicates that strength training can improve maximal lower body muscle strength by 20%, as well as improve walking economy and endurance during treatment (Ceševko et al., 2020; Metcalfe et al., 2024). Concurrent training (strength and endurance commination) shows that it can improve body composition, muscle mass, muscle strength, physical performance and aerobic capacity in patients with cancer (Houben et al., 2023; Van Rooijen et al., 2017) and multiple sclerosis (Grazioli et al., 2019). However, challenges exist, such as variability in training protocols and the need for individualized approaches, as the optimal type, timing and intensity of exercise remain unclear (Gerland et al., 2021).

The current literature lacks robust trials specifically to isometric strength training in cancer populations, so further research is needed to elucidate its potential benefits (Follans et al., 2016). Isometric strength is most effective when combined with other exercise modalities, suggesting that it should not be the sole focus of a strength training regimen (Baffour-Awuah et al., 2023; Wright et al., 2023), thus the programs analysed in the review have all been within the main part of the session in concurrent training with other types of training such as strength training (Artene et al., 2017; Bell et al., 2021; Dotevall et al., 2023; Hashem et al., 2020; Krukowska et al., 2010; Rief et al., 2014). However, some conclusions can be drawn from programs that are aided by isometric strength for the improvement of people with cancer. In addition, isometric strength training combined with supervised aerobic exercise significantly improved muscle activity, muscle performance and reduced fatigue in women with breast cancer during adjuvant chemotherapy treatment (Hiraoui et al., 2023). Importantly, for better training efficacy, cancer survivors prefer personalized and supervised interventions, suggesting that professional care is key to adherence to exercise programs (Hashem et al., 2020).

In addition, isometric strength gives more safety to the performance protocol due to the fact that mobility influences the safety of a performance protocol by affecting joint mobility (Gehringer, 2018). Therefore, isometric strength can produce significant adaptations in muscle strength and, in some cases, can improve joint mobility (Folland et al., 2005). It has even been shown that isometric strength training can improve core stability and muscle strength, which could contribute to injury prevention (Huxel Bliven & Anderson, 2013).

The manual grip strength (MPF) has been the most widely used in the review in a resounding way, whose proposal as a health indicator is very relevant in different populations: older adults (Bohannon, 2008) and in populations with other limiting conditions, in this case, people with cancer, directly linked to the idea of isometric strength allowing to obtain useful information through a simple, fast, low cost and without risk of injury assessment. More specifically, manual grip strength (MPF) has been found to be positively associated with upper and lower limb isometric strength in female breast cancer survivors, suggesting that MPF may be a good indicator of overall muscle strength (Esteban-Simón et al., 2021).

With respect to upper body exercises, manual grip (Esteban-Simón et al., 2021; Leaf et al., 2003) and isometric shoulder strength exercises (De Oliveira et al., 2020; Sweeney et al., 2019) and to a lesser extent isometric abdominal strength assessment for colon cancer using ultrasound (Lopez-Garzon et al., 2022) stand out.

Isometric strength stands out for its easy evaluation and adaptation, hence its importance in people who depend on a reduced angle of movement, such as people with cancer. The duration of the programs has a minimum duration of 8 weeks and there is no correlation between sessions per week, number of exercises, series and repetitions. It is defined that 1 hour is the duration of the session for these population groups. Further research in this area is recommended to better understand the physical, psychological and emotional factors derived from isometric training in people with cancer, and, in turn, to be able to define the different doses of training to understand more clearly the effects it produces in the various population groups.

Limitations

The main limitations of the study are related to the diversity of types of cancer, which may make it difficult to homogenize the results found. Similarly, another difficulty lies in the variety of muscle groups evaluated. Similarly, methodological variability was observed due to the different types of cancer, as well as small sample sizes and heterogeneity in the interventions, which highlights the need for standardized protocols and trials that need to be replicated in future studies.

Conclusions

This systematic review indicates that isometric strength training is a promising intervention to enhance physical function and quality of life in cancer patients, particularly among breast cancer survivors. The studies reviewed demonstrate improvements in upper body strength such as enhanced grip and shoulder isometric performance which are critical given the limitations imposed by cancer treatments. Moreover, the adaptability and safety of isometric exercises make them a viable option for patients with restricted mobility. However, the heterogeneity of intervention protocols highlights the need for standardized training regimens to optimize outcomes. Overall, the evidence supports incorporating isometric strength training into rehabilitation programs, although further research is necessary to establish optimal dosing and protocols.

Conflicts of interest

The authors declare that there are no conflicts of interest related to this study.

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References

Adamsen, L., Andersen, C., Midtgaard, J., Møller, T., Quist, M., & Rørth, M. (2009). Struggling with cancer and treatment: young athletes recapture body control and identity through exercise: qualitative findings from a supervised group exercise program in cancer patients of mixed gender undergoing chemotherapy. *Scandinavian Journal of Medicine & Science in Sports, 19*(1), 55-66. https://doi.org/10.1111/j.1600-0838.2007.00767.x

Anishchenko-Halkina, S., Chaowdhary Beauty, N. J., Gil-Gallego, M. T., Lorenzo-Quijada, M., Doménech-Asensi, G., & Sánchez-Moya, T. (2024). Benefits of strength and resistance exercise in cancer patients: a systematic review of clinical trials. *Retos, 61*, 518–527. https://doi.org/10.47197/retos.v61.107988

Artene, D., Bordea, C.I., Blidaru, A. (2017). A moderately high protein diet and 4' isometric exercises efficacy in breast cancer patients treated with antiestrogenic medication. *Romanian Journal of Medical Practice, 12*(2), 83-90. doi: 10.37897/RJMP.2017.2.5

Baffour-Awuah, B., Pearson, M. J., Dieberg, G., Wiles, J. D., & Smart, N. A. (2023). An evidence-based guide to the efficacy and safety of isometric resistance training in hypertension and clinical implications. *Clinical Hypertension, 29*(1), 9. https://doi.org/10.1186/s40885-022-00232-3

Becerra-Patiño, B. A., Monterrosa-Quintero, A., Olivares-Arancibia, J., López-Gil, J. F., & Pino-Ortega, J. (2025). Differences in Anthropometric and Body Composition Factors of Blind 5-a-Side Soccer Players in Response to Playing Position: A Systematic Review. *Journal of Functional Morphology and Kinesiology, 10*(3), 238. https://doi.org/10.3390/jfmk10030238

Bell, K. E., Pfeiffer, A. G., Schmidt, S., Bos, L., Russell, C., Barnes, T., Di Sebastiano, K. M., Avrutin, E., Gibson, M., Dubin, J. A., & Mourtzakis, M. (2021). Low-frequency exercise training improves cardiovascular fitness and strength during treatment for breast cancer: A single-arm intervention study. *Scientific Reports, 11*(1), 22758. https://doi.org/10.1038/s41598-021-01962-4

Bettariga, F., Bishop, C., Taaffe, D.R., Galvão, D.A., Maestroni, L., & Newton, R.U. (2023). Time to consider the potential role of alternative resistance training methods in cancer management? *Journal of Sport and Health Science, 12*(6), 715-725. https://doi.org/10.1016/j.jshs.2023.06.007

Bohannon, R. W. (2008). Hand-grip dynamometry predicts future outcomes in aging adults*. Journal of Geriatric Physical Therapy, 31*(1), 3-10. https://doi.org/10.1519/00139143-200831010-00002

Bower, J. E. (2014). Cancer-related fatigue—mechanisms, risk factors, and treatments. *Nature Reviews Clinical Oncology, 11*(10), 597-609. https://doi.org/10.1038/nrclinonc.2014.127

Bray, F., Laversanne, M., Sung, H., Ferlay, J., Siegel, R. L., Soerjomataram, I., & Jemal, A. (2024). Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: a Cancer Journal for Clinicians, 74*(3), 229-263. https://doi.org/10.3322/caac.21834

Brown, J. C., Huedo-Medina, T. B., Pescatello, L. S., et al. (2014). The efficacy of exercise in reducing depressive symptoms among cancer survivors: A meta-analysis. *PloS One, 7*(1):e30955. https://doi.org/10.1371/journal.pone.0030955

Burtin, C., Franssen, F. M. E., Vanfleteren, L. E. G. W., Groenen, M. T. J., Wouters, E. F. M., & Spruit, M. A. (2017). Lower-limb muscle function is a determinant of exercise tolerance after lung resection surgery in patients with lung cancer. *Respirology (Carlton, Vic.), 22*(6), 1185–1189. https://doi.org/10.1111/resp.13041

Carbone, S., Kirkman, D. L., Garten, R. S., Rodriguez-Miguelez, P., Artero, E. G., Lee, D. C., & Lavie, C. J. (2020). Muscular strength and cardiovascular disease: an updated state-of-the-art narrative review. *Journal of Cardiopulmonary Rehabilitation and Prevention, 40*(5), 302-309. https://doi.org/10.1097/hcr.0000000000000525

Cešeiko, R., Thomsen, S. N., Tomsone, S., Eglītis, J., Vētra, A., Srebnijs, A., Timofejevs, M., Purmalis, E., & Wang, E. (2020). Heavy resistance training in breast cancer patients undergoing adjuvant therapy. *Medicine and Science in Sports and Exercise, 52*(6), 1239-1247. https://doi.org/10.1249/mss.0000000000002260

Cheville, A., Smith, S., Barksdale, T., & Asher, A. (2020). *29 - Cancer Rehabilitation. In Braddom's Physical Medicine and Rehabilitation*. (568-593.e7). In Braddom's Physical Medicine and Rehabilitation. https://doi.org/10.1016/b978-0-323-62539-5.00029-1

Chongaway, A. (2021). Utilization of Isometric Strength Training and Interval Training With a Patient With Cancer in the Acute Care Setting. *Cureus, 13*(6):e15570. https://doi.org/10.7759/cureus.15570

Cormie, P., Zopf, E. M., Zhang, X., & Schmitz, K. H. (2017). The impact of exercise on cancer mortality, recurrence, and treatment-related adverse effects. *Epidemiologic Reviews, 39*(1), 71-92. https://doi.org/10.1093/epirev/mxx007

Courneya, K. S., Segal, R. J., Mackey, J. R., Gelmon, K., Reid, R. D., Friedenreich, C. M., Ladha, A. B., Proulx, C., Vallance, J. K., Lane, K., Yasui, Y., & McKenzie, D. C. (2007). Effects of aerobic and resistance exercise in breast cancer patients receiving adjuvant chemotherapy: A multicenter randomized controlled trial. *Journal of Clinical Oncology: Official journal of the American Society of Clinical Oncology, 25*(28), 4396-404. https://doi.org/10.1200/jco.2006.08.2024

De Backer, I. C., Schep, G., Backx, F. J., Vreugdenhil, G., & Kuipers, H. (2009). Resistance Training in Cancer Survivors: A Systematic Review. *International Journal of Sports Medicine, 30*(10), 703-12. https://doi.org/10.1055/s-0029-1225330

de Lima, J. A. N., de Oliveira, S. F. M., de Oliveira, L. I. G. L., & da Cunha Costa, M. (2016). Evaluation of isometric strength in people with spinal cord injury: a review. *Manual Therapy, Posturology & Rehabilitation Journal*, 1-10. https://doi.org/10.17784/mtprehabjournal.2016.14.361

de Oliveira, P. F., Alves, R. D. S., Iunes, D. H., de Carvalho, J. M., Borges, J. B. C., Menezes, F. D. S., & Carvalho, L. C. (2020). Effect of exergaming on muscle strength, pain, and functionality of shoulders in cancer patients. *Games Health, 9*(4), 297-303. https://doi.org/10.1089/g4h.2019.0113

Dotevall, H., Tuomi, L., Petersson, K., Löfhede, H., Bergquist, H., & Finizia, C. (2022). Treatment with head-lift exercise in head and neck cancer patients with dysphagia: results from a randomized, controlled trial with flexible endoscopic evaluation of swallowing (FEES). *Supportive Care in Cancer: official journal of the Multinational Association of Supportive Care in Cancer, 31*(1), 56. https://doi.org/10.1007/s00520-022-07462-z

Esteban-Simón, A., Díez-Fernández, D. M., Artés-Rodríguez, E., Casimiro-Artés, M. Á., Rodríguez-Pérez, M. A., Moreno-Martos, H., Casimiro-Andújar, A. J., & Soriano-Maldonado, A. (2021). Absolute and Relative Handgrip Strength as Indicators of Self-Reported Physical Function and Quality of Life in Breast Cancer Survivors: The EFICAN Study. *Cancers, 13*(21), 5292. https://doi.org/10.3390/cancers13215292

Folland, J. P., Hawker, K., Leach, B., Little, T., & Jones, D. A. (2005). Strength training: Isometric training at a range of joint angles versus dynamic training. *Journal of Sports Sciences, 23*(8), 817-824. https://doi.org/10.1080/02640410400021783

Gehringer, P. (2018). Sustaining positive outcomes with a progressive upright mobility program protocol in cancer patients. *Journal of Clinical Oncology, 36*(30). https://doi.org/10.1200/JCO.2018.36.30_suppl.126

Gerland, L., Baumann, F. T., & Niels, T. (2021). Resistance exercise for breast cancer patients? Evidence from the last decade. *Breast Care, 16*(6), 657-663. https://doi.org/10.1159/000513129

Grazioli, E., Tranchita, E., Borriello, G., Cerulli, C., Minganti, C., & Parisi, A. (2019). The effects of concurrent resistance and aerobic exercise training on functional status in patients with multiple sclerosis. *Current Sports Medicine Reports, 18*(12), 452-457. https://doi.org/10.1249/jsr.0000000000000661

Hanson, E. D., Wagoner, C. W., Anderson, T., & Battaglini, C. L. (2016). The independent effects of strength training in cancer survivors: a systematic review. *Current Oncology Reports, 18*(5):31. https://doi.org/10.1007/s11912-016-0511-3

Hashem, F., Corbett, K., Stephensen, D., Swaine, I., Ali, H., & Hutchins, I. (2020). The importance of cancer patients' functional recollections to explore the acceptability of an isometric-resistance exercise intervention: A qualitative study. *Health Science Reports, 3*(3): e186. https://doi.org/10.1002/hsr2.186

Hayes, S.C., Rye, S., Disipio, T., Yates, P., Bashford, J., Pyke, C., Saunders, C., Battistutta, D., & Eakin, E. (2013). Exercise for health: a randomized, controlled trial evaluating the impact of a pragmatic, translational exercise intervention on the quality of life, function and treatment-related side effects following breast cancer. *Breast Cancer Research and Treatment, 137*(1), 175-86. https://doi.org/10.1007/s10549-012-2331-y

Hiraoui, M., Al Busafi, M., Al-Hadabi, B., Al-Kitani, M., Ben Lagha, F., Al-Jadidi, K., Doutrellot, P. L., Mezlini, A., Gmada, N., & Ahmaidi, S. (2023). Effects of combined resistance and aerobic training program on myoelectric activity of Vastus Lateralis in patients with breast cancer during adjuvant chemotherapy period. *European Review for Medical and Pharmacological Sciences, 27*(22), 11169-11179. https://doi.org/10.1556/2060.2022.00148

Houben, L. H. P., Overkamp, M., VAN Kraaij, P., Trommelen, J., VAN Roermund, J. G. H., DE Vries, P. et al. (2023). Resistance exercise training increases muscle mass and strength in prostate cancer patients on androgen deprivation therapy. *Medicine and Science in Sports and Exercise, 55*(4), 614-624. https://doi.org/10.1249/mss.0000000000003095

Huxel Bliven, K. C., & Anderson, B. E. (2013). Core stability training for injury prevention. *Sports Health, 5*(6), 514–522. https://doi.org/10.1177/1941738113481200

Jones, R.M., Devers, K.J., Kuzel, A.J., & Woolf, S.H. (2010). Patient-reported barriers to colorectal cancer screening: a mixed-methods analysis. *American Journal of Preventive Medicine, 38*(5), 508-16. https://doi.org/10.1016/j.amepre.2010.01.021

Juvet, L. K., Thune, I., Elvsaas, I. K. Ø., Fors, E. A., Lundgren, S., Bertheussen, G., Leivseth, G., & Oldervoll, L. M. (2017). The effect of exercise on fatigue and physical functioning in breast cancer patients during and after treatment and at 6 months follow-up: A meta-analysis. *Breast, 33*, 166-177. https://doi.org/10.1016/j.breast.2017.04.003

Koeppel, M., Mathis, K., Schmitz, K. H., & Wiskemann, J. (2021). Muscle hypertrophy in cancer patients and survivors via strength training. A meta-analysis and meta-regression. *Critical Reviews in Oncology/Hematology, 163*:103371. https://doi.org/10.1016/j.critrevonc.2021.103371

Krukowska, J., Terek, M., Macek, P., & Woldanska-Okonska, M. (2010). The methods of treatment of lymphoedema in women after mastectomy. *Physiotherapy 18*(4), 3-10. doi: 10.2478/v10109-010-0075-y

Kubo, K., Ikebukuro, T., & Yata, H. (2006). Effects of isometric training at different knee angles on the muscle-tendon complex in vivo. *Scandinavian Journal of Medicine & Science in Sports, 16*(3), 159-67. https://doi.org/10.1111/j.1600-0838.2005.00450.x .

Leaf, D. A., MacRae, H. S., Grant, E., & Kraut, J. (2003). Isometric exercise increases the size of forearm veins in patients with chronic renal failure. *The American Journal of the Medical Sciences, 325*(3), 115–119. https://doi.org/10.1097/00000441-200303000-00003

Lønbro, S., Dalgas, U., Primdahl, H., Johansen, J., Nielsen, J. L., Aagaard, P., Hermann, A. P., Overgaard, J., & Overgaard, K. (2013). Progressive resistance training rebuilds lean body mass in head and neck cancer patients after radiotherapy--results from the randomized DAHANCA 25B trial. *Radiotherapy and Oncology: Journal of the European Society for Therapeutic Radiology and Oncology, 108*(2), 314–319. https://doi.org/10.1016/j.radonc.2013.07.002

Lopez-Garzon, M., Postigo-Martin, P., González-Santos, Á., Arroyo-Morales, M., Achalandabaso-Ochoa, A., Férnández-Pérez, A. M., & Cantarero-Villanueva, I. (2022). Colorectal cancer pain upon diagnosis and after treatment: a cross-sectional comparison with healthy matched controls. *Supportive Care in Cancer: official journal of the Multinational Association of Supportive Care in Cancer, 30*(4), 3573–3584. https://doi.org/10.1007/s00520-022-06803-2

Lund, L. W., Ammitzbøll, G., Hansen, D. G., Andersen, E. A. W., & Dalton, S. O. (2019). Adherence to a long-term progressive resistance training program, combining supervised and home-based exercise for breast cancer patients during adjuvant treatment. *Acta Oncologica, 58*(5), 650–657. https://doi.org/10.1080/0284186X.2018.1560497

Metcalfe, J. W., Orange, S. T., Madden, L. A., Marshall, P., & Vince, R. V. (2024). Effects of resistance training on quality of life, fatigue, physical function, and muscular strength during chemotherapy treatment: a systematic review and meta-analysis. *Supportive Care in Cancer, 32*(9), 593. https://doi.org/10.1007/s00520-024-08766-y

Mustian, K. M., Alfano, C. M., Heckler, C., Kleckner, A. S., Kleckner, I. R., Leach, C. R., Mohr, D., Palesh, O. G., Peppone, L. J., Piper, B. F., Scarpato, J., Smith, T., Sprod, L. K., & Miller, S. M. (2017). Comparison of pharmaceutical, psychological, and exercise treatments for cancer-related fatigue: A meta-analysis. *JAMA Oncology, 3*(7), 961-968. https://doi.org/10.1001/jamaoncol.2016.6914

Navarro-Martínez, C., Villarejo-García, D. H., Carvajal-Espinosa, R., Cánovas-Ambit, G., Becerra-Patiño, B. A., & Pino-Ortega, J. (2025). IMU-Based Assessment of Arm Movement in Breast Cancer Survivors: An Exploratory Study. *Women, 5*(4), 41. https://doi.org/10.3390/women5040041

Oranchuk, D. J., Storey, A. G., Nelson, A. R., & Cronin, J. B. (2019). Isometric training and long-term adaptations: Effects of muscle length, intensity, and intent. *Scandinavian Journal of Medicine & Science in Sports, 29*(4), 484-503. https://doi.org/10.1111/sms.13375

Pino-Ortega, J., Carvajal-Espinoza, R., Becerra-Patiño, B., Gómez-Parra, A., & Moreno-Villanueva, A. (2025). Handgrip strength assessment in breast cancer patients: validity and reliability of the Activ5 dynamometer. *Supportive Care in Cancer: Official Journal of the Multinational Association of Supportive Care in Cancer, 33*(10), 866. https://doi.org/10.1007/s00520-025-09895-8

Rico-González, M., Pino-Ortega, J., Clemente, F. M., & Arcos, A. L. (2022). Guidelines for performing systematic reviews in sports science. *Biology of Sport, 39*(2), 463–471. https://doi.org/10.5114/biolsport.2022.106386

Rief, H., Petersen, L. C., Omlor, G., Akbar, M., Bruckner, T., Rieken, S., Haefner, M. F., Schlampp, I., Förster, R., Debus, J., Welzel, T., & German Bone Research Group (2014). The effect of resistance training during radiotherapy on spinal bone metastases in cancer patients - a randomized trial. *Radiotherapy and Oncology: Journal of the European Society for Therapeutic Radiology and Oncology, 112*(1), 133–139. https://doi.org/10.1016/j.radonc.2014.06.008

Rock, C. L., Doyle, C., Demark-Wahnefried, W., et al. (2012). Nutrition and physical activity guidelines for cancer survivors. *CA: a Cancer Journal for Clinicians, 62*(4), 243-74. https://doi.org/10.3322/caac.21142

Ryan, J., Hebert, E. P., Billiot, K. L., Ort, B. N., Thomschon, K., & Kraemer, R. R. (2023). The effects of separate and simultaneous upper and lower body cycling on cardiorespiratory responses in young men. *The Journal of Sports Medicine and Physical Fitness, 64*(2), 129-136. https://doi.org/10.23736/s0022-4707.23.15306-0

Safran, E. E., Mutluay, F., & Uzay, A. (2022). Effects of neuromuscular electrical stimulation combined with resistance exercises on muscle strength in adult hematological cancer patients: A randomized controlled trial. *Leukemia Research*, 121:106932. https://doi.org/10.1016/j.leukres.2022.106932

Sande-Rivadulla, M., Alonso-Calvete, A., & Soto-González, M. (2024). Effects of Muscle Strength Training in Prostate Cancer: A Systematic Review. *Archivos Espanoles de Urologia, 77*(1), 1-15. https://doi.org/10.56434/j.arch.esp.urol.20247701.1

Santos, W., Marques, V., de Lira, C. A. B., Martins, W., Vieira, A., Mani, D., Battaglini, C., & Vieira, C. (2024). Reliability of dynamic and isometric upper muscle strength testing in breast cancer survivors. *PeerJ, 12*, e17576. https://doi.org/10.7717/peerj.17576

Santos-Olmo, P. A. S., Díaz, J. F. J., & Collado, N. R. (2019). Effect of a short duration exercise program on physical fitness and quality of life in rural breast cancer survivors: A pilot study. RICYDE. *Revista Internacional de Ciencias del Deporte, 15*(56), 171-186. https://doi.org/10.5232/ricyde2019.05604

Saxton, J. M., & Ashton, R. (2022). Exercise testing in breast and prostate cancer. In Sport and Exercise Physiology Testing Guidelines: Volume II-Exercise and Clinical Testing, 258-266. *Routledge.* https://doi.org/10.4324/9781003045267-39

Schmitz, K. H., Courneya, K. S., Matthews, C., Demark-Wahnefried, W., Galvão, D. A., Pinto, B. M., Irwin, M. L., Wolin, K. Y., Segal, R. J., Lucia, A., Schneider, C. M., von Gruenigen, V. E., Schwartz, A. L., & American College of Sports Medicine (2010). American College of Sports Medicine roundtable on exercise guidelines for cancer survivors. American College of Sports Medicine roundtable on exercise guidelines for cancer survivors. *Medicine and Science in Sports and Exercise, 42*(7), 1409-26 https://doi.org/10.1249/MSS.0b013e3181e0c112

Schootman, M., Aft, R., & Jeffe, D. B. (2009). An evaluation of lower-body functional limitations among long-term survivors of 11 different types of cancers. *Cancer, 115*(22), 5329-5338. https://doi.org/10.1002/cncr.24606

Schulz, S. V. W., Laszlo, R., & Otto, S. (2018). Feasibility and effects of a combined adjuvant high-intensity interval/strength training in breast cancer patients: a single-center pilot study. *Disability and Rehabilitation, 40*(13), 1501-1508. https://doi.org/10.1080/09638288.2017.1300688

Siegel, R. L., Miller, K. D., & Jemal, A. (2020). Cancer statistics, 2020. *CA: a Cancer Journal for Clinicians, 70*(1), 7-30. https://doi.org/10.3322/caac.21590

Soriano-Maldonado, A., Carrera-Ruiz, Á., Díez-Fernández, D. M., Esteban-Simón, A., Maldonado-Quesada, M., Moreno-Poza, N. et al. (2019). Effects of a 12-week resistance and aerobic exercise program on muscular strength and quality of life in breast cancer survivors. *Medicine (Baltimore), 98*(44):e17625. https://doi.org/10.1097/MD.0000000000017625 Erratum in: Medicine (Baltimore). 2019 Dec;98(49):e18419. https://doi.org/10.1097/MD.0000000000018419

Speck, R. M., Courneya, K. S., Mâsse, L. C., Duval, S., & Schmitz, K. H. (2010). An update of controlled physical activity trials in cancer survivors: A systematic review and meta-analysis. *Journal of Cancer Survivorship: Research and Practice, 4*(2), 87-100. https://doi.org/10.1007/s11764-009-0110-5

Stene, G. B., Helbostad, J. L., Balstad, T. R., Riphagen, I. I., Kaasa, S., & Oldervoll, L. M. (2013). Effect of physical exercise on muscle mass and strength in cancer patients during treatment—a systematic review. *Critical Reviews in Oncology/Hematology, 88*(3), 573-93. https://doi.org/10.1016/j.critrevonc.2013.07.001

Sweegers, M. G., Altenburg, T. M., Brug, J., May, A. M., van Vulpen, J. K., Aaronson, N. K. et al. (2019). Effects and moderators of exercise on muscle strength, muscle function and aerobic fitness in patients with cancer: a meta-analysis of individual patient data. *British Journal of Sports Medicine, 5*3(13), 812. https://doi.org/10.1136/bjsports-2018-099191

Sweeney, F. C., Demark-Wahnefried, W., Courneya, K. S., Sami, N., Lee, K., Tripathy, D., Yamada, K., Buchanan, T. A., Spicer, D. V., Bernstein, L., Mortimer, J. E., & Dieli-Conwright, C. M. (2019). Aerobic and resistance exercise improves shoulder function in women who are overweight or obese and have breast cancer: a randomized controlled trial. *Physical Therapy, 99*(10), 1334-1345. https://doi.org/10.1093/ptj/pzz096

Tian, L., Lu, H. J., Lin, L., & Hu, Y. (2016). Effects of aerobic exercise on cancer-related fatigue: A meta-analysis of randomized controlled trials. *Supportive Care in Cancer: Official Journal of the Multinational Association of Supportive Care in Cancer, 24*(2), 969-983. https://doi.org/10.1007/s00520-015-2953-9

Tsuji, K., Matsuoka, Y. J., & Ochi, E. (2021). High-intensity interval training in breast cancer survivors: a systematic review. *BMC Cancer, 21*(1), 184. https://doi.org/10.1186/s12885-021-07804-w

Twomey, R., Martin, T., Temesi, J., Culos-Reed, S. N., & Millet, G. Y. (2018). Tailored exercise interventions to reduce fatigue in cancer survivors: study protocol of a randomized controlled trial. *BMC Cancer, 18*(1), 757. https://doi.org/10.1186/s12885-018-4668-z

Van Rooijen, S. J., Engelen, M. A., Scheede-Bergdahl, C., Carli, F., Roumen, R. M. H., Slooter, G. D., & Schep, G. (2018). Systematic review of exercise training in colorectal cancer patients during treatment. *Scandinavian Journal of Medicine & Science in Sports, 28*(2), 360-370. https://doi.org/10.1111/sms.12907

Vang, C., & Niznik, A. (2020). The Effectiveness of Isometric Contractions Compared with Isotonic Contractions in Reducing Pain For In-Season Athletes With Patellar Tendinopathy. *Journal of Sport Rehabilitation, 30*(3), 512–515. https://doi.org/10.1123/jsr.2019-0376

Wright, B. H., Antrobus, M. R., Jones, P. G. W., & Baross, A. W. (2023). Effects of novel isometric resistance training on resting and ambulatory blood pressure measures: a comparison between exercise modes. *The European Journal of Public Health, 33*(Suppl 1), 133-168. https://doi.org/10.1093/eurpub/ckad133.168

Authors' and translators' details:

Aarón Gómez-Parra	aaron.gomez@um.es	Author
Adrián Moreno-Villanueva	Adrian.moreno@ui1.es	Author
Boryi A. Becerra-Patiño	babecerrap@pedagogica.edu.co	Author
Carlos Navarro-Martínez	c.navarromartinez@um.es	Autor and Translator
José Pino-Ortega	josepinoortega@um.es	Autor