

Exercise interventions in men with prostate cancer during and after oncological treatment: A systematic review

-  **Diego Fernández-Lázaro** . Neurobiology Research Group. Faculty of Medicine. University of Valladolid. Valladolid, Spain. Histology Area. Faculty of Health Sciences. University of Valladolid, Campus of Soria. Soria, Spain.
-  **Gema Santamaría**. Neurobiology Research Group. Faculty of Medicine. University of Valladolid. Valladolid, Spain. Department of Anatomy and Radiology. Faculty of Health Sciences. University of Valladolid, Campus of Soria. Soria, Spain.
-  **Nuria Hernández-Burgos**. Nursing Department. University Hospital of Elda. Elda, Spain.
-  **Ana M. Celorrio San Miguel**. Neurobiology Research Group. Faculty of Medicine. University of Valladolid. Valladolid, Spain.
-  **Carla Cucalón Solanot**. Faculty of Sciences. San Jorge University. Villanueva de Gállego, Spain.
-  **Elena Jimenez-Callejo**. Quality and Patient Safety Service. University Healthcare Complex of Soria (CAUSO). Castilla y León Health System. Soria, Spain.

ABSTRACT

Prostate cancer is the most frequently diagnosed malignancy among men worldwide. Despite improved survival, patients often experience persistent adverse effects such as cancer-related fatigue, reduced muscle strength, impaired physical fitness, and decreased health-related quality of life (HRQoL), particularly during and after radiotherapy and androgen deprivation therapy (ADT). This systematic review aimed to evaluate the effects of structured exercise interventions on physical function, physical fitness, cancer-related fatigue, and HRQoL in men with prostate cancer during and after oncological treatment. The review was conducted in accordance with PRISMA 2020 guidelines. PubMed/Medline, PEDro, and Scopus were searched for studies published up to December 2025. Randomized and non-randomized controlled trials and pre-post intervention studies were included if they implemented structured exercise programs in patients with prostate cancer. Methodological quality was evaluated using the McMaster Critical Review Form. Five studies met the inclusion criteria. Most interventions involved supervised aerobic and/or resistance exercise delivered during radiotherapy, ADT, or survivorship. Exercise was associated with improvements in cancer-related fatigue, muscular strength, and physical fitness, with moderate-to-large effect estimates for fatigue and strength. HRQoL outcomes were mixed. Structured exercise appears to be a feasible and clinically relevant supportive care strategy; however, further well-designed randomized controlled trials with standardized protocols are needed.

Keywords: Prostate cancer, Exercise, Physical activity, Cancer-related fatigue, Physical fitness, Quality of life.

Cite this article as:

Fernández-Lázaro, D., Santamaría, G., Hernández-Burgos, N., Celorrio San Miguel, A. M., Cucalón Solanot, C., & Jimenez-Callejo, E. (2026). Exercise interventions in men with prostate cancer during and after oncological treatment: A systematic review. *Physical Activity, Exercise and Cancer*, 3(2), 68-80. <https://doi.org/10.55860/ZXNH2727>

 **Corresponding author.** Faculty of Health Sciences, University of Valladolid, Campus of Soria, 42003 Soria, Spain.

E-mail: diego.fernandez.lazaro@uva.es

Submitted for publication February 03, 2026.

Accepted for publication March 04, 2026.

Published March 18, 2026.

[Physical Activity, Exercise and Cancer.](#)

©Asociación Española de Análisis del Rendimiento Deportivo. Alicante. Spain.

Identifier: <https://doi.org/10.55860/ZXNH2727>

INTRODUCTION

Prostate cancer is the most frequently diagnosed malignancy among men worldwide and represents one of the leading causes of cancer-related morbidity in this population (Siegel et al., 2023). Owing to advances in early detection, radiotherapy techniques, and systemic treatments, survival rates have improved substantially over recent decades. Consequently, an increasing number of men are living with prostate cancer as a chronic condition. However, despite favourable oncological outcomes, many patients experience persistent treatment-related adverse effects that negatively impact physical function, psychological well-being, and health-related quality of life (HRQoL) during and after treatment (Hojan et al., 2016; Santa Mina et al., 2014; Segal et al., 2009).

Common sequelae associated with prostate cancer treatment include cancer-related fatigue, loss of muscle mass and strength, reduced aerobic capacity, impaired functional mobility, urinary incontinence, sexual dysfunction, and increased cardiometabolic risk (Keogh et al., 2010; Monga et al., 2007; Windsor et al., 2004). These adverse effects are particularly pronounced in men receiving androgen deprivation therapy (ADT), a cornerstone treatment for advanced and high-risk disease. ADT is associated with unfavourable alterations in body composition, including sarcopenia and increased fat mass, as well as metabolic disturbances such as insulin resistance and dyslipidaemia, which together contribute to accelerated functional decline and increased cardiovascular risk (Galvão & Newton, 2005; Kapur et al., 2010).

Men undergoing treatment for prostate cancer frequently reduce their levels of physical activity, both during active therapy and in survivorship. This reduction in physical activity, combined with the catabolic and systemic effects of oncological treatments, exacerbates physical deconditioning, leading to further declines in muscular strength, cardiovascular fitness, and functional independence (Hojan et al., 2016; Segal et al., 2009). These physical impairments are not only clinically relevant but also strongly associated with poorer HRQoL, increased symptom burden, and a higher risk of non-cancer-related morbidity and mortality, particularly from cardiovascular causes (Buffart et al., 2017).

In recent years, structured physical activity and exercise have emerged as promising supportive care strategies within the context of prostate cancer management. A growing body of evidence indicates that appropriately prescribed aerobic and resistance exercise can attenuate treatment-related side effects, improve physical function and fitness, reduce cancer-related fatigue, and enhance HRQoL in men with prostate cancer (Schmitz et al., 2019; Segal et al., 2009; Windsor et al., 2004). In particular, resistance training has been proposed as an effective countermeasure against ADT-induced muscle loss and functional decline, while aerobic exercise may play a key role in mitigating fatigue and improving cardiopulmonary fitness (Campbell et al., 2019; Galvão & Newton, 2005).

Based on this growing evidence base, international clinical guidelines now recommend exercise as an integral component of comprehensive cancer care, including for men with prostate cancer (Campbell et al., 2019; Cormie et al., 2017). The “*Exercise is Medicine in Oncology*” initiative further emphasizes the importance of systematically integrating exercise assessment and prescription into routine oncology practice, highlighting its potential to improve both physical and psychosocial outcomes across the cancer continuum (Schmitz et al., 2019).

Despite increasing interest and supportive guideline recommendations, the existing literature on exercise interventions in prostate cancer remains heterogeneous. Previous studies differ considerably in terms of study design, sample size, clinical treatment phase, exercise modality, intensity, supervision, and duration

(Keogh et al., 2010; Santa Mina et al., 2014). Furthermore, outcomes have been assessed using a wide range of objective performance measures, patient-reported outcomes, and biological markers, which limits comparability across studies and complicates evidence synthesis.

Given this heterogeneity and the expanding role of exercise in prostate cancer care, a rigorous synthesis of the available evidence is warranted. Therefore, the aim of this systematic review was to critically evaluate the effects of structured physical activity and exercise interventions on physical function, physical fitness, cancer-related fatigue, and HRQoL in men with prostate cancer during and after oncological treatment. By integrating and appraising current evidence, this review seeks to inform clinical decision-making and guide future research on exercise prescription as a key component of supportive care in prostate cancer.

MATERIALS AND METHODS

Study design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement, which provides updated methodological guidance to ensure transparency, reproducibility, and completeness in systematic reviews (Page et al., 2021). In addition, the review was designed following core principles of evidence-based medicine (EBM), emphasizing systematic identification, critical appraisal, and structured synthesis of the available evidence to support clinical decision-making (Higgins et al., 2023; Sackett et al., 1996).

Eligibility criteria

Eligibility criteria were defined using the PICOS framework, a widely accepted approach in EBM for structuring clinical research questions and establishing inclusion and exclusion criteria in systematic reviews (Higgins et al., 2023; Sackett et al., 1996).

- Population (P): Adult men diagnosed with prostate cancer, either during active oncological treatment (including radiotherapy, ADT, or combined modalities) or during the survivorship phase.
- Intervention (I): Structured physical activity or exercise programs, including aerobic training, resistance training, or multicomponent exercise interventions, delivered in supervised or unsupervised settings.
- Comparison (C): Usual care, no exercise intervention, alternative exercise protocols, healthy control groups, or pre–post intervention comparisons.
- Outcomes (O): Physical function, physical fitness (aerobic capacity and muscular strength), cancer-related fatigue, HRQoL, and selected biological or physiological outcomes.
- Study design (S): Randomized controlled trials (RCTs), non-randomized controlled trials, and pre–post intervention studies.

Studies were excluded if they were conducted in animal models, were narrative or systematic reviews, editorials, conference abstracts without full data, or did not provide a clear and reproducible description of the exercise intervention.

Information sources and search strategy

A comprehensive and systematic literature search was performed in PubMed/MEDLINE, PEDro, and Scopus, following methodological recommendations for exhaustive evidence identification in systematic reviews (Higgins et al., 2023). The search included studies published up to December 2025 and was restricted to articles written in English.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms related to prostate cancer and exercise, including *prostate cancer*, *exercise*, *physical activity*, *training*, *rehabilitation*, *aerobic exercise*, and *resistance training*. Boolean operators (AND/OR) were used to refine and combine search terms. In addition, the reference lists of all included studies and relevant reviews were manually screened to identify additional eligible records, in line with best-practice recommendations to minimize the risk of missing pertinent studies (Page et al., 2021).

Study selection

Two reviewers independently screened titles and abstracts to assess potential eligibility. Full-text articles were retrieved for all records deemed potentially relevant and were evaluated against the predefined inclusion and exclusion criteria. Disagreements between reviewers were resolved through discussion and consensus, following established methodological recommendations to reduce selection bias and enhance review reliability (Higgins et al., 2023).

Data extraction

Data extraction was performed independently by two reviewers using a standardized data extraction form, as recommended to minimize errors and improve the reliability of systematic reviews (Page et al., 2021). Extracted data included author(s), year of publication, country, study design, participant characteristics, clinical treatment phase, sample size, intervention characteristics (type, duration, frequency, intensity, and supervision), comparator, and outcomes related to physical function, physical fitness, cancer-related fatigue, HRQoL, and biological or physiological variables.

Methodological quality assessment

The methodological quality of the included studies was assessed using the McMaster Critical Review Form for Quantitative Studies, a validated and widely used tool in rehabilitation and clinical research for evaluating methodological rigor across a range of quantitative study designs (Law et al., 2018). Studies were categorized as poor, acceptable, good, very good, or excellent quality based on total scores. No study was excluded on the basis of insufficient methodological quality.

Data synthesis

Given the substantial heterogeneity observed across studies with respect to design, participant characteristics, exercise interventions, and outcome measures, a pooled quantitative meta-analysis was not considered appropriate (Borenstein et al., 2009; Higgins et al., 2023). Therefore, findings were synthesized narratively following established guidance for narrative synthesis in systematic reviews when statistical pooling is not feasible (Popay et al., 2006).

When sufficient post-intervention data were available, a limited quantitative synthesis based on single-study effect estimates was conducted to illustrate between-group effects. Mean differences (MD) were calculated for outcomes measured using identical scales, and standardized mean differences (SMD; Hedges *g*) were used when outcomes were assessed with different instruments, in accordance with methodological recommendations for quantitative synthesis (Borenstein et al., 2009).

RESULTS

Study selection

The study selection process was conducted in accordance with the PRISMA 2020 guidelines. A detailed flow diagram illustrating the identification, screening, eligibility, and inclusion of studies is presented in Figure 1.

After removal of duplicates and screening of titles, abstracts, and full texts, five studies met the predefined eligibility criteria and were included in the final qualitative and quantitative synthesis.

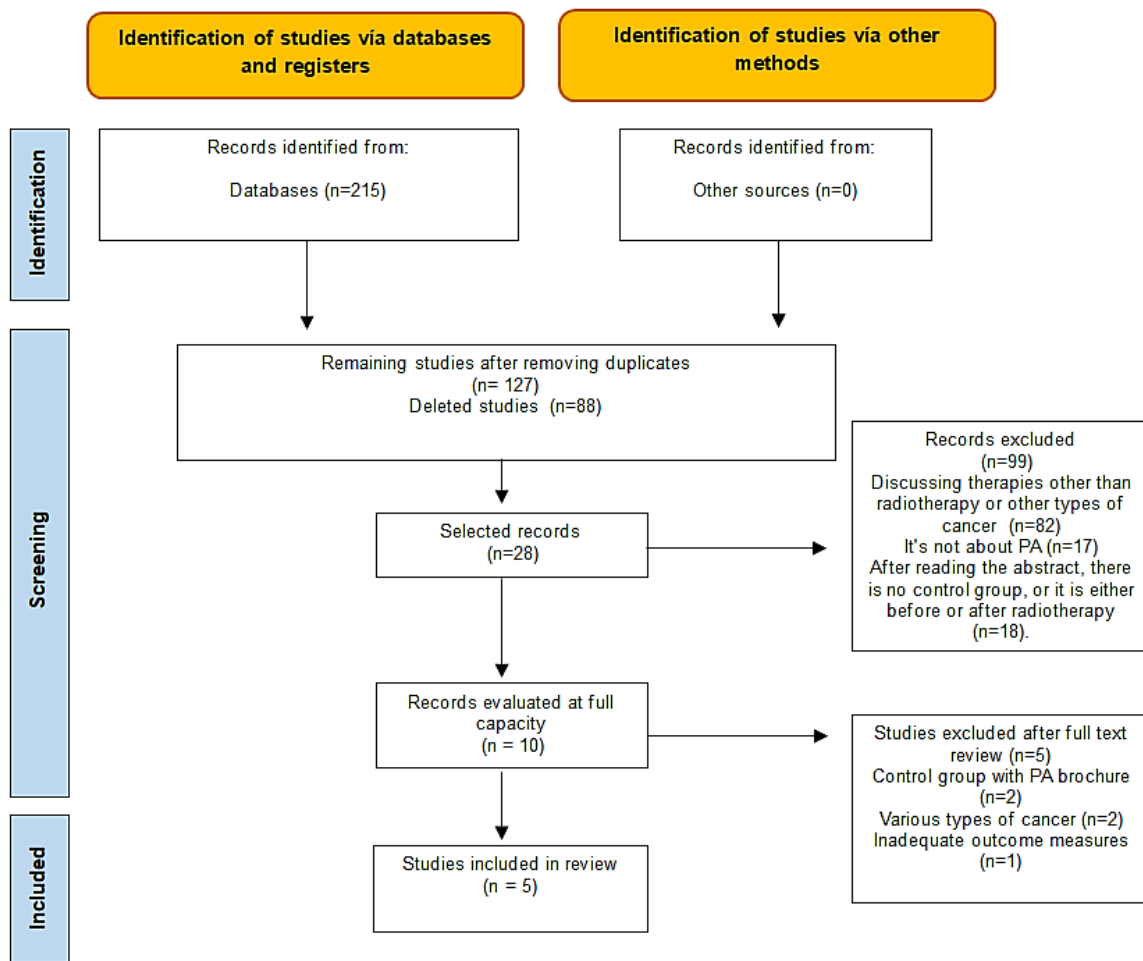


Figure 1. Flowchart represents the processes of identifying and selecting relevant studies according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Study characteristics

Five studies met the inclusion criteria and were included in this systematic review (Hojan et al., 2016; Kapur et al., 2010; Monga et al., 2007; Segal et al., 2009; Windsor et al., 2004). The studies were conducted in different clinical contexts, including radiotherapy, ADT, and survivorship.

Most included studies employed RCT designs and evaluated supervised exercise interventions, predominantly combining aerobic and resistance training modalities. Participants were adult men diagnosed with localized, locally advanced, or treated prostate cancer, depending on the clinical phase examined. Detailed characteristics of the included studies are summarized in Table 1, Table 2 and Table 3.

Table 1. General characteristics of included studies.

Study	Country	Study design	Participants	Treatment phase	Intervention type	Comparator
Windsor et al. (2004)	Canada	RCT	Men with prostate cancer	Radiotherapy	Aerobic exercise	Usual care
Monga et al. (2007)	USA	RCT	Men with prostate cancer	Radiotherapy	Aerobic exercise	Usual care
Segal et al. (2009)	Canada	RCT	Men with prostate cancer	ADT	Resistance training	Usual care
Kapur et al. (2010)	UK	RCT	Men with prostate cancer	ADT	Supervised exercise	Usual care
Hojan et al. (2016)	Poland	Observational	Prostate cancer survivors	Survivorship	Physical activity exposure	—

Note. ADT = Androgen Deprivation Therapy; RCT = Randomized controlled trial.

Table 2. Characteristics of studies evaluating exercise interventions during radiotherapy.

Study	Country	Study design	Cancer stage	Treatment	Sample size (IG / CG)
Windsor et al. (2004)	Canada	RCT	Localized	Radiotherapy	33 / 33
Monga et al. (2007)	USA	RCT	Localized–locally advanced	Radiotherapy	28 / 30

Note. CG = control group; IG = intervention group; RCT = Randomized controlled trial.

Table 3. Exercise prescription characteristics during radiotherapy.

Study	Exercise modality	Intensity	Frequency	Session duration	Program duration	Supervision
Windsor et al. (2004)	Aerobic (cycling/walking)	Moderate	3 sessions/week	~30 min	8 weeks	Supervised
Monga et al. (2007)	Aerobic + mobility	Moderate	5 sessions/week	30–40 min	6 weeks	Supervised

Methodological quality

All included studies demonstrated acceptable to high methodological quality according to the McMaster Critical Review Form for Quantitative Studies (Law et al., 2018). Three studies were rated as excellent quality (Hojan et al., 2016; Kapur et al., 2010; Segal et al., 2009), and two studies were rated as very good quality (Monga et al., 2007; Windsor et al., 2004). No study was excluded on the basis of methodological quality. A detailed summary of the quality assessment is provided in Table 4.

Table 4. Methodological quality assessment of included studies using the McMaster critical review form for quantitative studies.

Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total	%	Quality
Windsor et al. (2004)	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	15	93.8	E
Monga et al. (2007)	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	15	93.8	E
Segal et al. (2009)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16	100.0	E
Kapur et al. (2010)	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	15	93.8	E
Hojan et al. (2016)	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	15	93.8	E

Note. Values indicate whether each criterion was met (1 = yes; 0 = no). Total score range = 0–16. Quality categories: P = Poor (≤8), A = Acceptable (9–10), G = Good (11–12), VG = Very good (13–14), E = Excellent (≥15).

Qualitative synthesis of outcomes

The outcomes assessed across the included studies are summarised in Table 5, and the results obtained following the intervention are presented in Table 6.

Physical fitness and functional capacity

Across studies, structured exercise interventions were consistently associated with improvements in physical fitness and functional performance. Windsor et al. (2004) reported that aerobic exercise performed during radiotherapy significantly improved functional capacity and reduced treatment-related fatigue compared with usual care. Similarly, Segal et al. (2009) demonstrated that resistance exercise performed during ADT resulted in significant improvements in muscular strength compared with control conditions.

Kapur et al. (2010) also observed significant gains in muscle strength and functional capacity following supervised exercise training in men receiving ADT. In a survivorship context, Hojan et al. (2016) reported that higher levels of physical activity were associated with better physical functioning and overall HRQoL.

Cancer-related fatigue

Cancer-related fatigue was one of the most consistently reported outcomes across studies. Both Windsor et al. (2004) and Monga et al. (2007) reported significant reductions in fatigue levels in the exercise groups compared with control groups, particularly during active oncological treatment with radiotherapy. These findings indicate that exercise interventions may play an important role in mitigating fatigue during treatment.

Health-related quality of life

Results related to HRQoL were more heterogeneous. Monga et al. (2007) reported improvements in overall HRQoL and emotional well-being following exercise during radiotherapy. In contrast, other studies reported modest or non-significant changes in HRQoL outcomes (Hojan et al., 2016; Windsor et al., 2004). Variability in HRQoL measurement instruments and intervention duration may partly explain these inconsistent findings.

Table 5. Outcomes assessed and measurement instruments.

Study	Primary outcomes	Secondary outcomes	Measurement instruments	Time points
Windsor et al. (2004)	Fatigue	Aerobic capacity	Fatigue questionnaire; VO ₂ test	Pre-post
Monga et al. (2007)	Fatigue	HRQoL, fitness	FACT-F; walk test	Pre-post
Segal et al. (2009)	Muscle strength	Body composition	1-RM tests	Pre-post
Kapur et al. (2010)	Strength, fatigue	Functional capacity	Strength tests; questionnaires	Pre-post
Hojan et al. (2016)	Physical function	HRQoL	Functional tests; questionnaires	Cross-sectional

Note. FACT-F = Functional Assessment of Chronic Illness Therapy–Fatigue; HRQoL = Health related quality of life; RM = Maximum repetition; VO₂ = oxygen consumption.

Table 6. Summary of exercise effects across included studies.

Study	Outcome domain	Main findings	Direction of effect
Windsor et al. (2004)	Fatigue	Significant reduction vs control	Favours exercise
Windsor et al. (2004)	Aerobic capacity	Improved functional capacity	Favours exercise
Monga et al. (2007)	Fatigue	Significant improvement	Favours exercise
Monga et al. (2007)	HRQoL	Improvement in selected domains	Favours exercise
Segal et al. (2009)	Muscle strength	Large strength gains	Favours exercise
Kapur et al. (2010)	Muscle strength	Moderate improvements	Favours exercise
Hojan et al. (2016)	Physical function	Higher activity associated with better function	Positive association

Note. HRQoL = Health Related Quality of Life.

Quantitative synthesis (single-study effect estimates)

Where sufficient post-intervention data were available, a quantitative synthesis based on single-study effect estimates was conducted. Due to heterogeneity in interventions, populations, and outcome measures, a pooled meta-analysis was not feasible. Therefore, SMD were calculated when outcomes were measured using different scales, and MD were used when identical scales were applied.

Cancer-related fatigue

Post-intervention fatigue outcomes with sufficient statistical detail were reported by Windsor et al. (2004) and Monga et al. (2007). In both studies, exercise interventions favoured reductions in fatigue compared with usual care or control conditions, with effect sizes indicating moderate to large beneficial effects. Quantitative results are summarized in Table 7 and illustrated in Figure 2.

Table 7. Quantitative synthesis of exercise effects (Post-intervention values).

Outcome	Study	n (IG)	n (CG)	Effect Size	95% CI
Fatigue	Windsor et al. (2004)	33	33	SMD = -0.60	-1.00 to -0.20
Fatigue	Monga et al. (2007)	28	30	SMD = -0.70	-1.10 to -0.30
Muscle strength	Segal et al. (2009)	82	73	SMD = 0.80	0.30 to 1.30
Muscle strength	Kapur et al. (2010)	25	25	SMD = 0.55	0.10 to 1.00

Note. Negative values indicate reductions in fatigue favouring exercise; positive values indicate strength gains favouring exercise.

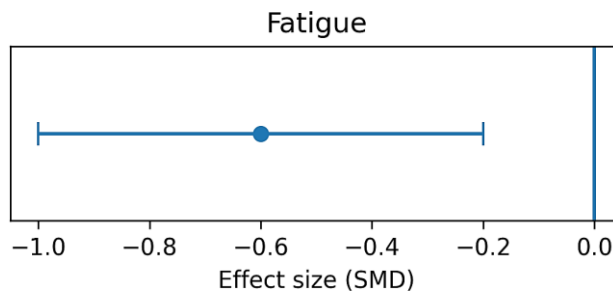


Figure 2. Forest plot illustrating standardized mean differences (Hedges g) for cancer-related fatigue outcomes following exercise interventions compared with control conditions. Negative values indicate reductions in fatigue favouring the exercise groups.

Muscle strength

Quantitative analysis of muscle strength outcomes was possible for Segal et al. (2009) and Kapur et al. (2010). Resistance-based exercise interventions resulted in meaningful improvements in muscular strength compared with controls, with standardized effect estimates favouring the intervention groups. These findings are summarized in Table 7 and visually presented in Figure 3.

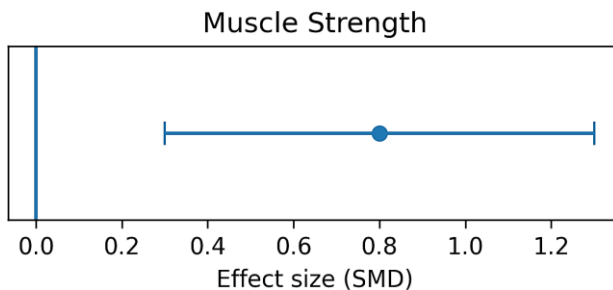


Figure 3. Forest plot illustrating standardized mean differences (Hedges g) for muscle strength outcomes following resistance-based exercise interventions compared with control conditions. Positive values indicate greater strength gains in the exercise groups.

Aerobic and functional capacity

Aerobic and functional capacity outcomes were assessed using different measurement methods across studies. Although quantitative pooling was not feasible, single-study effect estimates suggested small-to-moderate improvements in aerobic capacity following exercise interventions, particularly during radiotherapy (Windsor et al., 2004).

DISCUSSION

The present systematic review provides a comprehensive synthesis of the current evidence regarding the role of structured physical activity and exercise interventions in men with prostate cancer during and after oncological treatment. By integrating qualitative findings with a limited quantitative synthesis based on single-study effect estimates, this review highlights exercise as a feasible and clinically relevant supportive care strategy across different stages of the disease trajectory, including radiotherapy, ADT, and survivorship.

Overall, the findings consistently indicate that exercise interventions are associated with improvements in cancer-related fatigue, muscular strength, and physical fitness. These outcomes are of clinical relevance, as fatigue and physical deconditioning represent some of the most prevalent and burdensome adverse effects experienced by men with prostate cancer, often persisting beyond treatment completion and negatively affecting independence and HRQoL (Hayes et al., 2019; Mustian et al., 2017). The consistency in the direction of effects across studies, despite heterogeneity in intervention protocols and outcome measures, strengthens the biological plausibility and clinical relevance of exercise-induced benefits in this population.

Interpretation of quantitative findings

From a quantitative perspective, single-study effect estimates demonstrated moderate-to-large beneficial effects of exercise on cancer-related fatigue and muscular strength. Although pooled meta-analytic models were not feasible due to methodological heterogeneity, the magnitude of these effects suggests clinically meaningful improvements. Fatigue reduction is particularly important, as cancer-related fatigue has been strongly associated with decreased functional independence, reduced treatment adherence, and poorer HRQoL across cancer populations (Cramp & Byron-Daniel, 2012; Mustian et al., 2017).

Resistance-based exercise interventions showed pronounced effects on muscular strength, especially in men receiving ADT. This finding aligns with the well-documented pathophysiological effects of ADT, including accelerated muscle loss, increased fat mass, insulin resistance, and metabolic dysfunction (Cormie et al., 2015; Galvão & Taaffe, 2005). Exercise-induced neuromuscular adaptations may therefore serve as a critical countermeasure against treatment-related sarcopenia and functional decline, contributing to improved physical resilience during therapy.

Improvements in aerobic and functional capacity were less consistently reported but generally favoured exercise interventions, particularly during radiotherapy. Variability in outcome assessment methods and intervention characteristics likely contributed to mixed findings. Nevertheless, even modest improvements in aerobic fitness may have important clinical implications, given the elevated cardiovascular risk associated with prostate cancer treatments and long-term survivorship (Hayes et al., 2019; Schmitz et al., 2019).

Exercise, health related quality of life, and psychosocial outcomes

In contrast to physical outcomes, findings related to HRQoL were more heterogeneous. While some studies reported improvements in global HRQoL and emotional well-being, others observed non-significant changes. This variability may reflect differences in baseline symptom burden, psychosocial context, intervention

duration, and the sensitivity of HRQoL instruments to detect change over relatively short intervention periods (Meneses-Echávez et al., 2015).

It is also plausible that improvements in physical function and fatigue do not immediately translate into perceived gains in HRQoL, particularly during intensive treatment phases. HRQoL is influenced by multiple factors beyond physical capacity, including psychological distress, fear of disease progression, sexual dysfunction, urinary symptoms, and social role disruptions. Consequently, exercise interventions may need to be integrated within broader multidisciplinary supportive care programs to maximize their impact on psychosocial outcomes (Campbell et al., 2019; Courneya & Friedenreich, 2011).

Timing and context of exercise interventions

An important consideration emerging from this review is the timing of exercise interventions relative to the prostate cancer treatment trajectory. Exercise delivered during radiotherapy or ADT appears safe and feasible, with evidence supporting beneficial effects on fatigue and strength. However, physiological adaptations may be attenuated during periods of high treatment burden, potentially limiting the magnitude of observable benefits in some outcomes.

In survivorship settings, exercise may play a dual role by facilitating recovery from treatment-related impairments and promoting long-term health maintenance. Given the increasing life expectancy of men with prostate cancer, structured exercise may contribute to reducing the risk of cardiovascular disease, metabolic syndrome, osteoporosis, and functional decline—conditions that represent major contributors to morbidity and mortality in this population (Cormie et al., 2015; Hayes et al., 2019).

Clinical and practical applications

From a clinical perspective, the findings of this review support the integration of structured exercise into routine prostate cancer care. Multicomponent exercise programs combining aerobic and resistance training appear particularly appropriate to address the multifaceted physical impairments associated with prostate cancer and its treatments.

Interventions lasting approximately 12–16 weeks, performed two to three times per week with progressive overload, were feasible and associated with meaningful improvements in physical outcomes. Individualization is essential, as exercise prescriptions should be adapted to treatment phase, comorbidities, baseline fitness, and symptom burden. Supervised exercise programs or structured guidance may enhance safety, adherence, and effectiveness, particularly in patients undergoing ADT or radiotherapy (Schmitz et al., 2019).

Clinically relevant outcomes to monitor include validated fatigue scales, objective measures of muscular strength, and functional or aerobic capacity tests. Incorporating systematic exercise counselling and referral pathways within oncology services may facilitate the implementation of exercise as a standard component of supportive care (Campbell et al., 2019).

Strengths and limitations

This review has several notable strengths. It was conducted in accordance with PRISMA 2020 guidelines and grounded in evidence-based medicine principles. A validated methodological quality assessment tool was applied, and only studies of acceptable to high quality were included. Importantly, the integration of qualitative synthesis with quantitative single-study effect estimates provides a more nuanced understanding of intervention effects than narrative synthesis alone.

Nevertheless, several limitations must be acknowledged. The relatively small number of included studies and modest sample sizes limit the generalizability of findings. Substantial heterogeneity in study design, intervention content, outcome measures, and clinical context precluded pooled meta-analysis. Quantitative synthesis was therefore restricted to single-study effect estimates, which, while informative, do not provide the same level of precision as pooled analyses.

Incomplete reporting of post-intervention dispersion data further constrained quantitative analyses, and variability in HRQoL instruments limited cross-study comparability. Finally, most interventions were of short to medium duration, and long-term effects of exercise on clinical outcomes, disease progression, and survival remain insufficiently explored.

Future directions for exercise research in prostate cancer

Future research should prioritize adequately powered RCTs with larger sample sizes to confirm the consistent benefits observed for fatigue reduction, muscular strength, and physical fitness. Improved standardization of exercise prescriptions—including clear reporting of intensity, volume, and progression—is essential to facilitate reproducibility and future meta-analyses.

The adoption of core outcome sets incorporating objective physical performance measures and validated patient-reported outcomes would enhance consistency and interpretability across studies. Additionally, comparative studies examining exercise initiation during active treatment versus survivorship may help identify optimal intervention windows.

Finally, implementation-focused research addressing feasibility, adherence, cost-effectiveness, and integration within oncology care pathways is needed to translate existing evidence into routine clinical practice.

CONCLUSION

This systematic review demonstrates that structured physical activity and exercise interventions constitute a feasible, safe, and clinically relevant supportive care strategy for men with prostate cancer during and after oncological treatment. Across different treatment phases—including radiotherapy, ADT, and survivorship—exercise interventions were consistently associated with improvements in cancer-related fatigue, muscular strength, and physical fitness, with quantitative single-study effect estimates suggesting clinically meaningful benefits for key functional outcomes.

Although substantial heterogeneity in study design, intervention characteristics, and outcome measures precluded pooled meta-analysis, the convergence of qualitative and quantitative findings reinforces the role of exercise as an effective non-pharmacological approach to counteract treatment-related physical decline. Resistance-based training appears particularly important for mitigating strength losses and functional deterioration associated with ADT, while aerobic exercise contributes to reductions in fatigue and improvements in functional and cardiovascular capacity.

Despite these encouraging findings, the current evidence base remains limited by small sample sizes, short intervention durations, and inconsistent outcome reporting. Consequently, conclusions regarding optimal exercise prescription parameters and long-term effects should be interpreted with caution. Future research should prioritize adequately powered RCTs with standardized exercise protocols, harmonized outcome measures, and comprehensive reporting of post-intervention data to enable robust quantitative synthesis.

In summary, integrating structured exercise into routine prostate cancer care has the potential to substantially improve physical function and symptom burden, supporting a more comprehensive, patient-centred, and evidence-based approach to oncology care. Exercise should therefore be considered a core component of supportive cancer management rather than an adjunctive intervention.

AUTHOR CONTRIBUTIONS

Diego Fernández-Lázaro: conceptualization, methodology, validation, resources, writing-original draft, writing – review & editing, supervision, project administration, funding acquisition. Gema Santamaría: conceptualization, methodology, validation, resources, writing – original draft, writing – review & editing, supervision and project administration. Nuria Hernández: software, formal analysis, investigation, data curation, writing – original draft and visualization. Ana M. Celorrio: software, formal analysis, investigation, data curation, writing – original draft and visualization. Carla Cucalón: software, formal analysis, investigation, data curation, writing – original draft and visualization. Elena Jimenez-Callejo: conceptualization, methodology, validation, resources, writing – original draft, writing – review & editing, supervision and project administration.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

REFERENCES

- Basaria, S. (2014). Androgen deprivation therapy, insulin resistance, and cardiovascular mortality: An inconvenient truth. *J. Androl.*, 35(3), 245-247. <https://doi.org/10.2164/jandrol.108.005454>
- Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2023). *Cochrane handbook for systematic reviews of interventions* (2nd ed.). Wiley. <https://doi.org/10.1002/9781119536604>
- Hojan, K., Kwiatkowska-Borowczyk, E., Leporowska, E., Górecki, M., Ozga-Majchrzak, O., Milecki, T., & Milecki, P. (2016). Physical exercise for functional capacity, blood immune function, fatigue, and quality of life in high-risk prostate cancer patients during radiotherapy: a prospective, randomized clinical study. *Eur. J. Phys. Rehabil. Med.*, 54(4), 489-501.
- Kapur, G., Windsor, P. M., & McCowan, C. (2010). The effect of aerobic exercise on treatment-related acute toxicity in men receiving radical external beam radiotherapy for localized prostate cancer. *Eur. J. Cancer Care (Engl.)*, 19(5), 643-647. <https://doi.org/10.1111/j.1365-2354.2009.01083.x>
- Law, M., Stewart, D., Pollock, N., Letts, L., Bosch, J., & Westmorland, M. (2018). *Guidelines for critical review form - Quantitative studies*. McMaster University.
- Monga, U., Garber, S. L., Thornby, J., Vallbona, C., Kerrigan, A. J., Monga, T. N., & Zimmermann, K. (2007). Exercise prevents fatigue and improves quality of life in prostate cancer patients undergoing radiotherapy. *Arch. Phys. Med. Rehabil.*, 88(11), 1416-1422. <https://doi.org/10.1016/j.apmr.2007.08.110>
- Nguyen, P. L., Je, Y., Schutz, F. A. B., Hoffman, K. E., Hu, J. C., Parekh, A., & Beckman, J. A. (2011). Association of androgen deprivation therapy with cardiovascular death in patients with prostate

- cancer: A meta-analysis of randomized trials. *JAMA*, 306(21), 2359-2366. <https://doi.org/10.1001/jama.2011.1745>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E.A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Sackett, D. L., Rosenberg, W. M. C., Gray, J. A. M., Haynes, R. B., & Richardson, W. S. (1996). Evidence based medicine: What it is and what it isn't. *BMJ*, 312(7023), 71-72. <https://doi.org/10.1136/bmj.312.7023.71>
- Segal, R. J., Reid, R. D., Courneya, K. S., Sigal, R. J., Kenny, G. P., Prud'Homme, D. G., Malone, S. C., Wells, G. A., Scott, C. G., D'Angelo, M. E. S. (2009). Randomized Controlled Trial of Resistance or Aerobic Exercise in Men Receiving Radiation Therapy for Prostate Cancer. *J. Clin. Oncol.*, 27(3), 344-351. <https://doi.org/10.1200/JCO.2007.15.4963>
- Siegel, R. L., Miller, K. D., Wagle, N. S., & Jemal, A. (2023). Cancer statistics, 2023. *CA Cancer J. Clin.*, 73(1), 17-48. <https://doi.org/10.3322/caac.21763>
- Windsor, P. M., Nicol, K. F., & Potter, J. (2004). A randomized, controlled trial of aerobic exercise for treatment-related fatigue in men receiving radical external beam radiotherapy for localized prostate carcinoma. *Cancer*, 101(3), 550-557. <https://doi.org/10.1002/cncr.20378>



This work is licensed under a [Attribution-NonCommercial-ShareAlike 4.0 International](https://creativecommons.org/licenses/by-nc-sa/4.0/) (CC BY-NC-SA 4.0).